IBM High Availability Solution for IBM FileNet P8 Systems

- Provides HA strategies and options for IBM FileNet P8 systems
- Includes HA implementation for Content Engine, Process Engine, and Application Engine
- Describes HA implementation for Content Search Engine, Image Services, and databases

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Contents

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Preface

Many organizations require almost continuous availability of their mission-critical, IBM® FileNet® P8 systems. Loss of system resources and services can translate directly into lost revenue and lost customers. The goal, therefore, is to design and implement IBM FileNet P8 systems, which are highly available by compensating for both planned and unplanned system outages, and therefore to eliminate single points of failure.

IBM FileNet P8 Platform provides availability features that are built into the core components. With these features, the high availability (HA) of an IBM FileNet P8 system can be achieved through redundancy: redundant components, redundant systems, and redundant data. Hardware and software components might fail. With redundancy, the failure can be eliminated or minimized.

This IBM Redbooks® publication covers strategies and options for core IBM FileNet P8 system components. In addition, the book provides detailed, step-by-step procedures that we used to implement high availability for our case study IBM FileNet P8 system. This book serves as both a theoretical and practical reference when you design and implement highly available IBM FileNet P8 systems.

The core components and the high availability implementation that we discuss in the book include:

- Hardware load balancer (F5 BIG-IP®)
- Web tier (Farm)
- Application Engine (Farm)
- Content Engine (Farm)
- Process Engine (Farm, using a hardware load balancer)
- Content Search Engine (High-Availability Cluster Multi-Processing (HACMP™))
- Image Services (HACMP)
- DB2® (Data Server High Availability and Disaster Recovery (HADR) feature with IBM Tivoli System Automation for Multiplatforms (TSA))

This book is intended for IT architects, IT specialists, project managers, and decision makers, who need to identify the best high availability strategies and integrate them into the IBM FileNet P8 system design process.

The team who wrote this book

This book was produced by a team of specialists from around the world working at the International Technical Support Organization, San Jose Center.

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Part 1

Concepts and overview

1

Introducing high availability

High availability is important to mission-critical applications. Maintaining high levels of access to content within an IBM FileNet P8 environment can be challenging. This chapter provides an introduction to concepts that are critical to high availability and its implementation.

We discuss the following topics:

- High availability
- Measuring availability
- Levels of availability
- High availability cost compared to loss
- High availability and continuous availability
- IBM FileNet P8 platform infrastructure fundamentals

1.1 High availability

Availability is a measure of the time that a server or process functions normally for general usage, as well as a measure of the amount of time that the recovery process requires after a component failure.

High availability is system design and implementation that achieves system and data availability *almost* all of the time, 24 hours a day, 7 days a week, and 365 days a year. High availability does not equate to 100% availability. To achieve 100% availability is not a cost-effective reality for the large majority of implementations today; rather, it is a goal.

Many organizations require almost continuous availability of their mission-critical applications and server resources. Loss of system resources and services, also called a system *outage*, can translate directly into lost revenue or lost customers. The goal, therefore, is to design and implement systems that are highly available by compensating for both planned and unplanned outages that can be caused by a single point of failure.

Vertical scalability provides availability by using multiple processes. However, the physical machine might become a single point of failure. A highly available system topology, therefore, typically involves both vertical and horizontal scaling with redundancy across multiple processes, servers, and machines.

The IBM FileNet P8 Platform provides availability features that are built into the core components. With these features, high availability of an IBM FileNet P8 system can be achieved through *redundancy*: redundant components, redundant systems, redundant data, and even redundant people. Hardware and software components might fail. With redundancy, the failure can be eliminated or minimized. Redundancy is the key of a highly available system.

Note: Redundancy is the key to achieve high availability and avoid single points of failure.

1.2 Measuring availability

Availability is measured in percentage of time. If a system is available 99% of the time for normal business operation, the system's availability is 99%. This availability percentage translates to the average of the specific amount of downtime per day or per year.

To truly measure the availability of a system, we must first differentiate the planned outages and the unplanned outages.

1.2.1 Planned compared to unplanned outages

Outages can be broadly classified into two categories. One category encompasses the planned outages that take place when the operations staff takes a server offline to perform backups, upgrades, maintenance, and other scheduled events. The other type is unplanned outages that occur due to unforeseen events, such as power loss, a hardware or software failure, system operator errors, security breaches, or natural disasters. As a result, system downtime can be caused by both planned and unplanned events, as shown in Table 1-1. Planned events can account for as much as 90% of downtime. Unplanned events account for 10% of downtime. The most important issue is how to *minimize* the unplanned downtime, because nobody knows when the unplanned downtime occurs, and businesses require that their systems are up during normal operating hours.

Table 1-1 Planned outages compared to unplanned outages

Type	Planned[a]	Unplanned
Software	13%	30%
Hardware	8%	15%
Application	8%	27%
Network	10%	N/A
Operation	52%	25%
Other	9%	3%

a. source: *IBM TotalStorage Solutions for Disaster Recovery*, SG24-6547

Unplanned outages (failures) are spread across the various components that make up an IBM P8 Platform, such as hardware, software, and applications. It is important to understand that a redundant hardware-only solution clearly helps to prevent unplanned outages, but a true highly available system must take into account all the components of an end-to-end solution. You must also include the human factor. The human error factor can be a major contributor to downtime. Although education is important, it is also important, or perhaps even more important, to design easy-to-use system management facilities with well-documented and executed polices and procedures to help minimize any potential human factors contributing to downtime.

Note: The most important issue is minimizing the unplanned downtime, because nobody knows when the unplanned downtime occurs, and this downtime impacts business operations.

1.2.2 Availability matrix

In an ideal environment, we strive for no unplanned outage, or 100% uptime. In reality, a 100% uptime system is expensive to implement. For certain applications, 99.9% uptime is adequate, leaving a downtime of only 1.4 minutes per day on average or 8.8 hours per year. See the following formula:

```
With 99.9% uptime, the total downtime
= (100% - 99.9%) x 24 hours/day x 60 minutes/hour
= 1.4 minutes per day on average OR
= 1.4 minutes/day x 365 days = 8.8 hours per year
```

For certain applications, 99.99% or higher uptime is required. It is common to refer to 99%, 99.9%, 99.99%, and 99.999% as two nines, three nines, four nines, and five nines. The five nines uptime is generally thought of as the most achievable system with reasonable costs, leaving a downtime of less than a second per day on average or 5.26 minutes per year. See the following formula:

```
With 99.999% uptime, the total downtime
= (100% - 99.999%) x 24 hours/day x 60 minutes/hour x 60 seconds/minute
= 0.86 second (less than a second) per day on average OR
= 0.86 second / 60 seconds/minute x 365 days = 5.26 minutes per year
```

Table 1-2 shows the relationship of availability in percentages and the actual downtime or time loss per year.

Table 1-2 Availability matrix

Availability in percentage	Approximate time loss per year
99.9999% (six nines)	32 seconds
99.999% (five nines)	5 minutes
99.99% (four nines)	53 minutes
99.9%	8.8 hours
99%	87 hours (3.6 days)
90.0%	876 hours (36 days)

1.2.3 Total availability of a system

The total availability of a system is calculated by multiplying the availability of each component:

```
Total availability of a system
= Availability (component1) x ... Availability of component n
```

It is extremely important to balance the availability of all components in the implemented system, *as perceived by the users*. Therefore, the true availability is the product of the availability of *all* the components or the weakest link comprising the end-to-end solution, as shown in Figure 1-1. Do not under-spend and under-engineer on one component, and overspend and over-engineer on other components. For example, the system that is shown in Figure 1-1 has a system availability of 86.12% as experienced by the users, compared to the availability of the process servers at 99.8%:

```
Total availability of the example system
= 98.5% x 98.5% x 99.5% x 98.1% x 99.6% x 97.3%
x 97.4% x 98.3% x 99.9% x 99.8% x 99.6% x 99.7%
= 86.12%
```

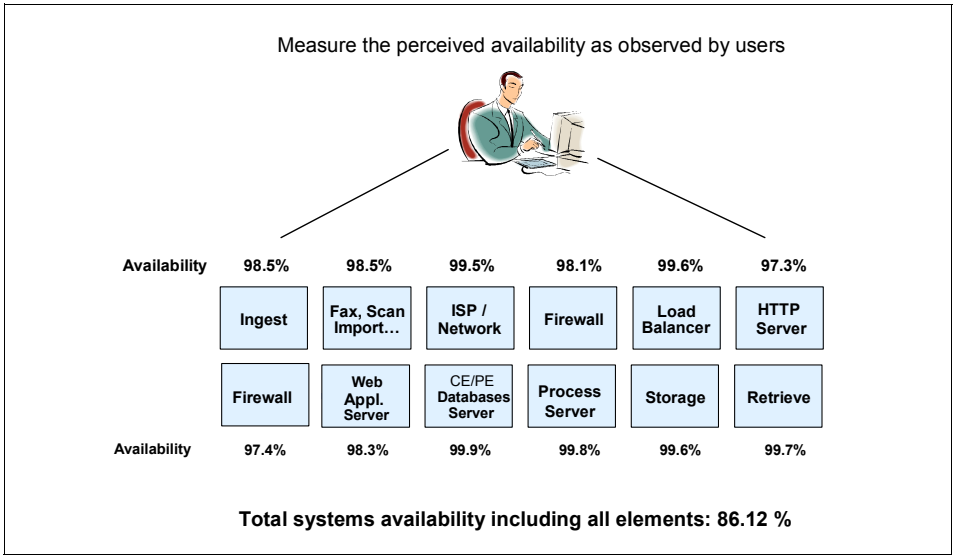


Figure 1-1 Total availability as the product of the availability of all its components

Availability is not free. It takes hard work and serious management attention to integrate the many diverse components, people, and processes into a stable, highly available system. High availability starts with reliable products. Today's IBM FileNet P8 products are reliable and are capable of delivering high levels of availability, but reliable products alone do not assure high quality service. A high

level of availability relies on an infrastructure and application design that includes availability techniques and careful system integration. A lack of, or failure to follow, careful management and effective systems management procedures is one of the most common causes of an outage. Change management, in particular, requires more emphasis. Effective change and operational management practices that employ defined and repeatable processes contribute significantly to higher levels of availability. In the long run, these practices actually decrease the cost of IT services because of the resulting more effective and efficient use of IT resources.

1.3 Levels of availability

The high availability solutions require up-front planning with continual monitoring. Many areas have to be taken into consideration when designing and implementing a highly available solution. They include:

- Internet Protocol (IP) sprayer/load balancer
- Firewall process
- HTTP server
- Web application server or mid-tier applications
- Lightweight Directory Access Protocol (LDAP) server
- Databases
- Core processes, services, or engines
- Disk subsystem
- Operating system processes
- Cluster or farm setups

Multiple technologies can be deployed to achieve high availability for systems. Figure 1-2 on page 9 shows availability levels and several of the commonly used technologies that are implemented to achieve each level.

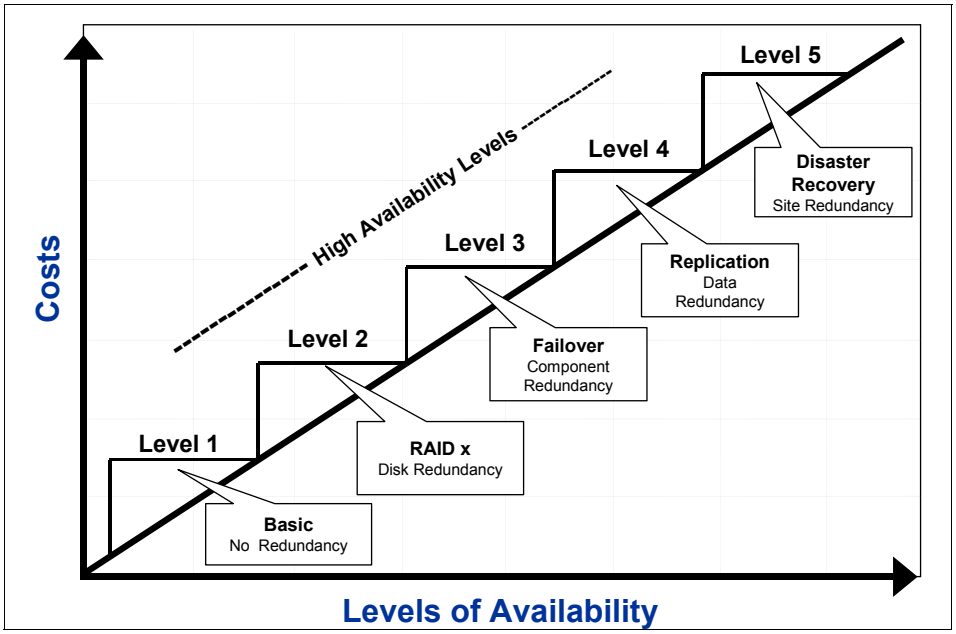


Figure 1-2 High availability levels

Availability can be divided into five levels:

- Level 1: Basic
- Level 2: RAID *x*
- Level 3: Failover
- Level 4: Replication
- Level 5: Disaster Recovery

At Level 1, Basic, there is no redundancy involved. Systems do not employ any special measures to protect against loss of data or services. Backups are most likely taken on a regular basis. When an outage occurs, support personnel restore the system from the backup (usually tape).

At Level 2, RAID x, disk redundancy, disk mirroring, or both disk redundancy and disk mirroring are used to protect the data against the loss of a physical disk or volume at this level. Disk redundancy can also be extended to include newer technologies, such as storage area network (SANs), network-attached storage (NAS) devices, or Virtual Storage Infrastructures. Several of these technologies are emerging in the marketplace as *best practices* implementations for highly available disk subsystems.

At Level 3, Failover, multiple instances or component redundancy are used to prevent a single-point-of-failure. In a system where multiple components are involved, an outage in any single component can result in service interruption to users. Multiple instances or redundancy for any single component need to be deployed for availability purposes. There are two primary techniques to deploy *failover* strategies:

- *Application clustering*, which is also known as *farming* (for example, WebSphere clustering)
- *Platform clustering,* for example, IBM PowerHA for AIX (HACMP - formerly IBM High Availability Cluster Multi-Processing)

Both of these methods are fundamental approaches to accomplishing high availability. Components that support application clustering can also take advantage of load balancing in addition to availability benefits. In order to achieve high availability in an IBM FileNet P8 Platform environment, you typically deploy both application clustering and platform clustering, assuming your solution is operating in a multi-tier and multi-server environment. If you run the full IBM FileNet P8 Platform stack on a single server (with all components in one machine), platform clustering or IP-based failover might be the appropriate strategy to deploy.

In a platform clustering environment, a standby or backup system is used to take over for the primary system if the primary system fails. In principle, almost any component can become highly available by employing platform clustering techniques. With IP-based cluster failover, we can configure the systems as active/active mutual takeover or active/standby (hot spare).

At Level 4, Replication or data redundancy, high availability implementation extends the protection by duplicating the database content (metadata and control tables) and file system content to another machine (server, NAS device, or SAN device) in the event of a hardware, software, disk, or data failure. This approach provides another level of protection and high availability in the event of a failure with data and content being replicated compared to a shared disk with failover strategy for Level 3. This type of a high availability implementation (replication) can also be used as a disaster recovery strategy; the difference is whether the servers are located within the same location or are geographically separated.

At Level 5, Disaster recovery, systems are maintained at separate sites. When the primary site becomes unavailable due to a disaster, the remote site (the backup site) becomes operational within a reasonable time to continue business operations. This level of high availability can be achieved through regular data backups in combination with geographical clustering, replication, or mirroring software. Disaster recovery is not addressed in this book.

It is possible and a best practice to combine multiple high availability levels within a single solution. For example, you can have a failover (Level 3) strategy for hardware and a replication strategy (Level 4) for the database content and file system content with all servers using a disk redundancy strategy (Level 2).

IBM high availability solutions for IBM FileNet P8 use multiple strategies and technologies. The strategies and technologies that are used must be weighed against the costs for a particular implementation to meet the business requirements.

1.4 High availability cost compared to loss

Designing high availability solutions always requires you to balance the *cost against the loss.* Although highly available systems are desirable, an optimum balance between the costs of availability and the costs of unavailability is usually required. Factoring in the intangible consequences of an outage adds to the requirement to invest in extremely high levels of availability.

It is critical to understand the *business impact* of a failure and what the loss to the business is if an unplanned outage occurs. Too many times, we under design a solution that is too simple for a business and is not adequate to meet the business requirements, or we over design a solution that is too complex to manage and is not necessary for the business. Various businesses have differing costs for downtime. While a certain business might be less impacted when their systems are down, other businesses, such as financial services, might lose millions of dollars for each hour of downtime during business hours. The cost of downtime includes direct dollar losses and potentially reputation losses and bad customer relationships. Understanding the impact of downtime for your business helps you to define the level of high availability that you want to achieve for your business solution.

Note: The objective of designing and implementing a high availability solution is to provide *an affordable level of availability* that supports the business requirements and goals with *acceptable system downtime*.

Figure 1-3 on page 12 shows how this balance applies to various operating environments and when the investment in availability can reach the point of diminishing returns. At a certain point, the cost of availability and the loss due to availability reaches an optimum availability investment point. The optimum point can be difficult to calculate with quantifying the losses being the more challenging of the two variables. The concept, though, is to try to reach an optimum balance by designing the most cost-effective, highly available solution

to support the business environment. As shown in Figure 1-3, high availability becomes increasingly expensive as you approach continuous availability (100%).

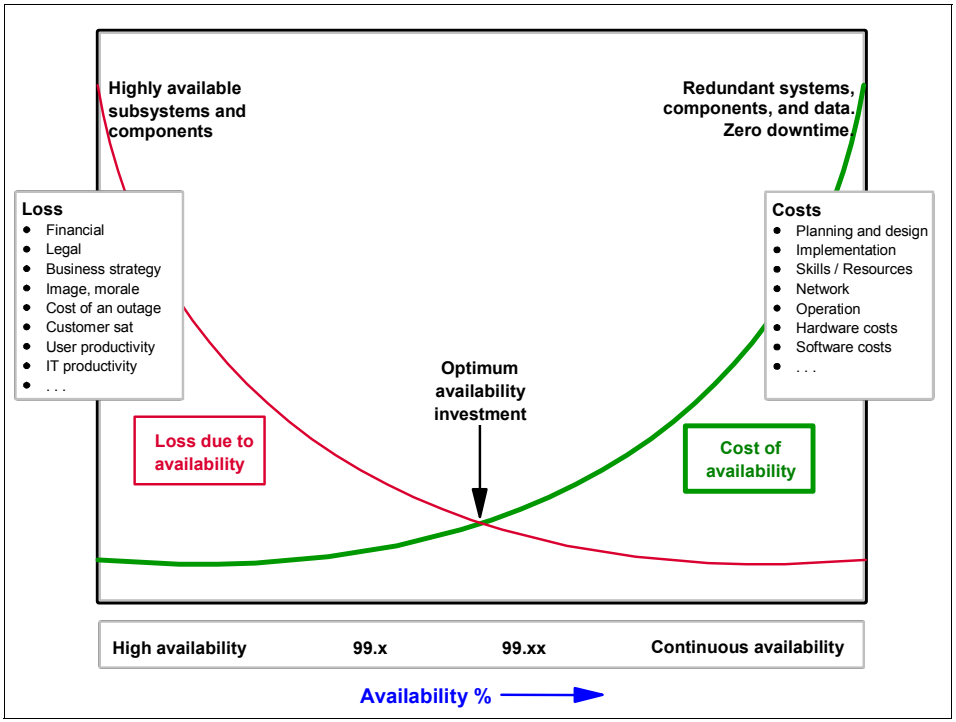


Figure 1-3 Cost of availability as opposed to loss due to availability

Note: To achieve a high availability of five nines means to achieve system availability 99.999% of the time.

1.5 High availability and continuous availability

Confusion often occurs between high availability and continuous availability. High availability focuses on reducing the downtime for unplanned outages. Continuous availability focuses on continuous operation of the systems and applications. The sum of high availability and continuous operations equals continuous availability.

Figure 1-4 on page 13 shows how bringing acceptable levels of high availability and continuous operations delivers a continuously available solution.

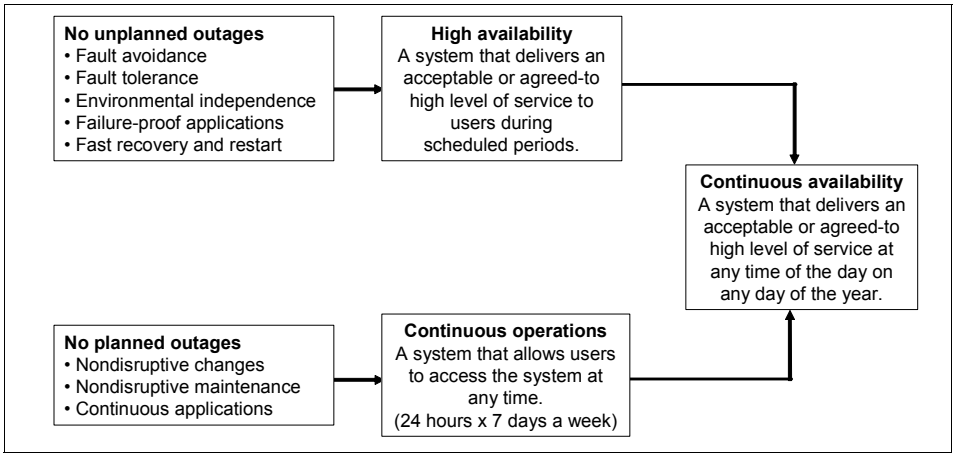


Figure 1-4 High availability and continuous availability

1.6 IBM FileNet P8 platform infrastructure fundamentals

The growth of the Internet and the World Wide Web has led to the widespread need for computing services that are scalable (can be expanded easily to handle an increasing rate of requests over time) as well as being highly available. The solution that has evolved that meets both of these needs is the *n-tier* architecture. In this approach, a monolithic service is broken down into separate components, such as a Web presentation tier, a business logic tier, a database tier, and a storage tier, but more or other tiers can also be employed. This architecture provides a number of advantages:

- The software is broken into separate components, each of which can be developed and maintained separately.
- Certain components, such as the database tier, can potentially be sourced from third parties.
- Similarly, price and performance trade-off can be made by, for instance, substituting a higher performing, but more costly, storage subsystem for a slower, lower cost subsystem.
- Because each tier operates independently, it is often the case that it can be implemented to function independently. This approach allows for a farmed configuration that achieves both scalability (by adding more servers at a given tier) and availability (because more than one instance of each service is available).

The IBM FileNet P8 Platform conforms to this standard architecture. You can view this architecture from a logical perspective, focusing on the services that are provided by each tier, or from a physical perspective, examining the actual implementation of the architecture. A logical architecture of the P8 platform is shown in Figure 1-5. In Figure 1-5, all of the necessary services are shown from a high-level, logical perspective. However, the diagram does not depict which services reside within which tiers of the architecture or on which servers. Instead, all the services are depicted as they are seen from a user's perspective: the user knows that each service is available, but not necessarily how it is actually implemented.

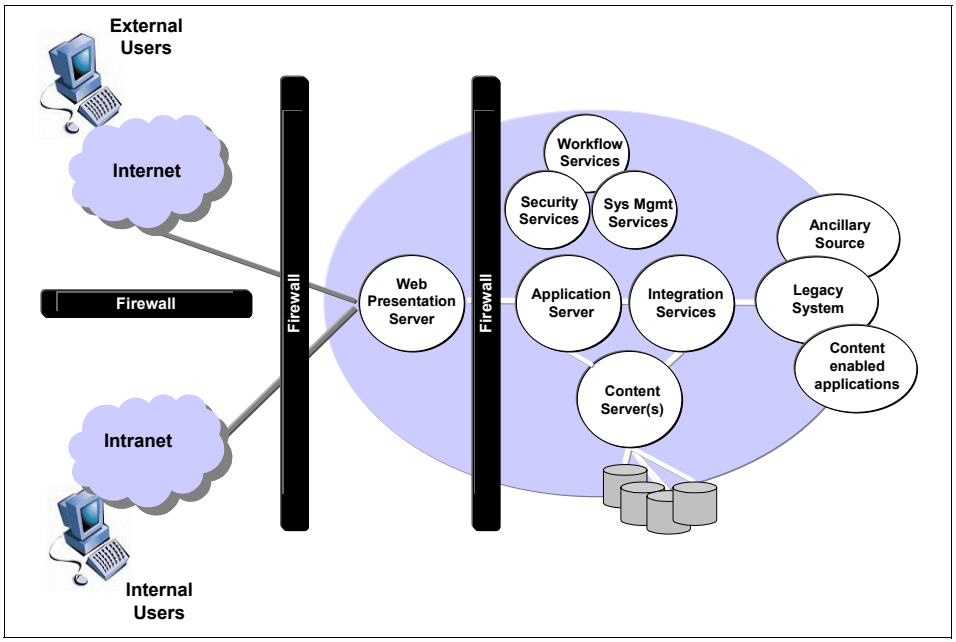


Figure 1-5 IBM FileNet P8 logical components and tiers

In contrast, a multi-tier *physical model*, as represented in Figure 1-6 on page 15, depicts how these services would be deployed across a collection of physical computer hardware. In this typical case, we have divided the services into the following functional tiers, which are explained in more depth:

- Client tier
- Presentation tier
- Business logic or application tier
- Data tier
- Storage tier

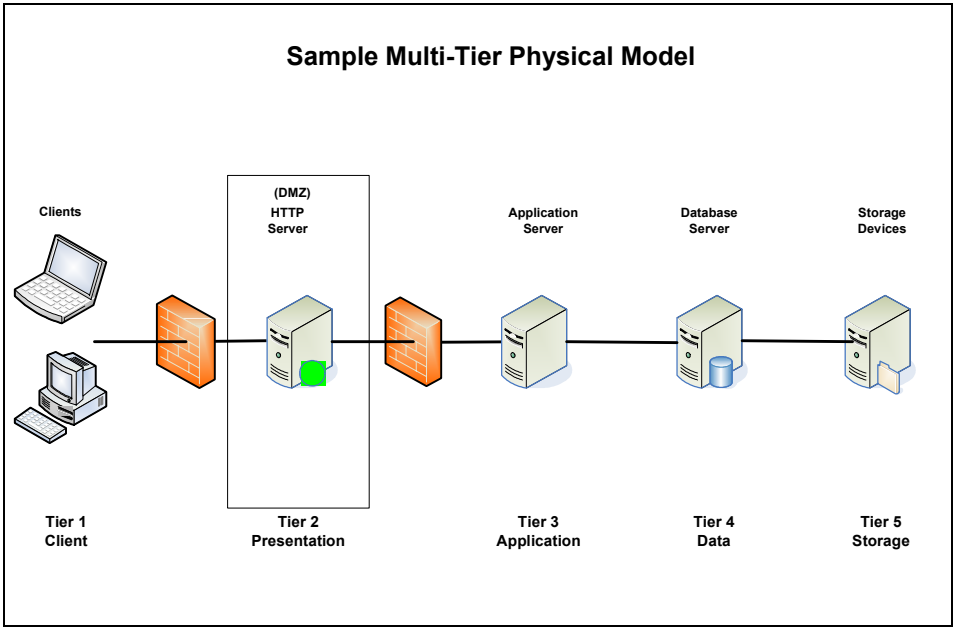


Figure 1-6 Sample Multi-Tier Physical Model

The *client tier* encompasses various client types, such as browsers, applets, or stand-alone application clients. These clients can reside both within and outside of the enterprise firewall. User actions are translated into server requests, and the server responses are translated into a user-readable format.

The *presentation tier* provides services to enable a unified user interface. It is responsible for all presentation-related activity. In its simplest form, an HTTP server accesses data and services from other tiers, handles user requests and work flow, and can also control user interaction. In order to separate the *presentation tier* from an *application tier*, an HTTP server is used in conjunction through plug-ins with a Web application server, such as WebSphere. The advantage of using a separate HTTP is that you can move the application server behind the domain firewall into the secure network, where it is more protected.

The *business logic* or *application tier* embraces Web components, JavaServer Pages (JSPs), beans, or servlets, which are deployed in Web containers. The Web application server provides the infrastructure for application and business logic. It is capable of running both presentation and business logic, but it generally does not serve HTTP requests.

The *data tier* is commonly referred to as the *back-end tier*; examples include database manager systems, *content management* systems, mainframe transaction processing, and other existing systems.

In a highly available IBM FileNet P8 solution, there are several components within the tiers that have to be taken into consideration when designing an end-to-end high availability system:

- Client workstations
- The Domain Name System (DNS) server
- IP sprayers/load balancers
- Firewall process
- HTTP servers
- Web application server and mid-tier applications (such as Workplace/WorkplaceXT)
- IBM FileNet P8 applications
- Databases
- Disk subsystems
- LDAP servers

Redundancy of these components can be accomplished through either application clustering, platform clustering, or a combination of both application clustering and platform clustering.

1.6.1 Application clustering (server farms)

A *server farm* is a group of identical servers, which are accessible through hardware or software load balancing technology. All the servers are actively providing the same set of services and are interchangeable. A *load balancer* distributes incoming client requests over the servers in the group. For example, there are hardware-based load balancers that automatically spread the incoming client workload across a farm of servers, each providing access to the same content or services. Also available are the software-based load balancing capabilities that are built into products, such as WebSphere Network Deployment Edition. As requests come in from external clients, the software-based load balancer spreads out the requests across the servers to balance the workload evenly. Both software and hardware load balancers offer various algorithms that can be set up to spread requests among multiple servers in a farm.

A load-balanced server farm provides both better availability and better scalability than a single server. When a server fails, the load balancer automatically detects the failure and redirects user requests to another server in the farm, thereby keeping the site available. Administrators can increase system performance and capacity by adding servers to the farm.

With a hardware-based load balancing solution, redundant load balancers are required to avoid a single point of failure. The software-based load balancers are typically designed to avoid a single point of failure by running the network load balancing software on each server in the farm. There are many competing load balancing products that can be considered to find the best combination of price and performance.

Server farms are best suited to server tiers that are processing-centric rather than data-centric, because all the servers in the farm are clones of each other. Processing logic does not change often, so it is feasible to keep all the servers identical in a processing-centric tier. Web servers and application servers that execute business logic are both good candidates for server farms.

Data-centric tiers, such as file servers and data servers, are not well suited for farming, because their data content constantly changes. Keeping this dynamic data identical across a group of cloned file or data servers, and managing the client accesses to the data to protect the integrity of the data in the face of multiple writers, can be difficult in a farm, with a copy of data and file on each server. The better solution for this type of server is the platform clustering.

1.6.2 Platform clustering (server clusters)

Platform clustering, which is sometimes referred to as *server clusters*, is based on the concept of shared software configuration data storage. The servers have a shared disk that holds the configuration data that is shared between both nodes. In contrast, server farms do not share software configuration data among the servers in the farm. Each server has its own copy of the configurations that it has to run, and in most cases, the configuration is an exact copy of the files that are on the other servers in the farm.

Many server hardware and software vendors offer vendor-specific server clustering products as their high availability offering for these kinds of data-centric servers. These products all have the following general characteristics:

- Two or more servers share a highly available disk array for data storage. The array incorporates redundant copies of the data, but it appears as a single disk resource to the servers, therefore, avoiding the need for data replication between servers. Each server has its own local disk for the static storage of the operating system, utilities, and other software.
- A common set of applications runs on each server.
- Server clients see the cluster as a single virtual server.
- If the active server fails, the other server picks up the workload of the failed server (sometimes referred to as a *failover*). When the failed server is

repaired and is brought back online, the workload is shifted back from the other server to the originally active server (sometimes referred to as a *failback*). In certain configurations, the repaired server simply becomes the new backup server, and no failback is required.

- The failover feature can mask both planned and unplanned outages from users. For instance, an intentional failover can be done to allow one of the servers to be backed up and then brought back online in a failback.
- In most server clusters, only one server is actively serving clients at a time, which is called an *active-passive configuration*. Certain cluster server products also support another mode, which is called an *active-active configuration*. In this mode, all the servers in the cluster can be actively sharing part of the workload at the same time. It typically requires an application that is designed to partition data sets among the servers to avoid data integrity problems resulting from concurrent updates to the same data from multiple servers.

IBM offers IBM PowerHA™ for AIX (HACMP - formerly IBM High Availability Cluster Multi-Processing), as the server cluster product for the AIX environment.

Server clusters typically communicate through a broadcast, or they share a central repository to keep track of cluster information and cluster node status. Each machine in the cluster is referred to as a *node*. Each node in the cluster monitors the local services that it is running and broadcasts this information on a private network connection. This private network connection allows all nodes in the cluster to know the status of all clustered resources. In the event that a service on one node fails, another node receives this status through the private network connection and in response, can start the service locally to maintain high availability for the service.

1.6.3 Choosing between a farm or a cluster

The technology direction for the IBM FileNet P8 Platform and its products is to support load-balanced server farms wherever possible, in preference to active-passive server clusters.

Load-balanced server farms have a scalability advantage, exhibit better server utilization, and recover more quickly from server failures when compared to active-passive server clusters. Farming support is continually being added to the IBM FileNet P8 Platform and products that previously only supported active-passive server clusters. See Chapter 3, “High availability strategies for IBM FileNet P8 systems” on page 43 for a further description of each component in the IBM FileNet P8 Platform and the type of clustering configuration that it supports.

2

IBM FileNet P8 system architectural overview

In this chapter, we provide an overview of the overall IBM FileNet P8 Platform system architecture and its three core components: Content Engine, Process Engine, and Application Engine. In addition, we describe two other important server components: Image Services (IS) and the Content Search Engine (CSE). We discuss the services that these engines provide and the communication protocols that are employed for communication between the various components.

We describe the following topics:

- Architectural overview
- Content Engine
- Process Engine
- Application Engine
- Image Services and CFS-IS
- Content Search Engine

2.1 Architectural overview

The IBM FileNet P8 suite of products provides a business-centric Enterprise Content Management (ECM) system. The core components of the IBM FileNet P8 suite of products are Content Engine (CE), Process Engine (PE), and Application Engine (AE). Content Engine stores documents, workflow objects, and custom objects. Process Engine manages business processes, also known as *workflows* or *workflow processes*. Application Engine is the ready to use, predefined user interface for the IBM FileNet P8 Platform, which through its layered application, Workplace or WorkplaceXT, provides a general folder-based view of an IBM FileNet P8 content repository. The user interface also provides various Process Engine components for representing objects, such as inboxes, public queues, and step processors.

Together, these core engines provide the IBM FileNet P8 Platform on which many applications are built, including:

- IBM FileNet Content Manager
- IBM FileNet Business Process Manager (BPM)
- Process Analyzer (a tool that is provided with BPM)
- Process Simulator (a tool that is provided with BPM)
- IBM FileNet Capture
- IBM FileNet Email Management (currently replaced by IBM Content Collection for Emails)
- IBM FileNet Records Crawler (currently replaced by IBM Content Collection for File Systems)
- IBM FileNet Records Manager
- IBM FileNet Business Activity Monitoring (BAM)
- IBM FileNet eForms
- IBM FileNet Business Process Framework (BPF)
- Rendition Engine
- Client-developed applications

Content Engine and Process Engine are servers. They can be accessed by client programs, including the Application Engine user interface, but also by stand-alone programs that can be developed by clients or third parties. The CE and PE both provide Application Programming Interfaces (APIs) for accessing all of their features and capabilities. Client programs of these servers are often Java™ programs, so they both offer Java APIs. The Java APIs allow stand-alone or Java 2 Platform, Enterprise Edition (J2EE™)-based applications written in

Java to access all the features of Content Engine and Process Engine. Most of the products that are listed access Content Engine or Process Engine using their Java APIs, which is usually the most efficient method to access the engines.

2.2 Content Engine

In an enterprise content management environment, the content of each document is stored and managed by content management software. In the case of the IBM FileNet P8 suite of products, this function is performed by the Content Engine (CE) server. It is implemented as a J2EE application, and so it runs within a J2EE application server. Content Engine supports WebSphere, WebLogic, and JBoss® application servers.

The properties associated with each document comprise the document's *metadata*. Typical metadata properties include: creator of the document, creation time of the document, and the type of the document. The metadata is stored in a database that is known as the *document catalog*. Content Engine supports DB2, Oracle, and SQL Server® databases. Searching for a particular document consists of querying the Content Engine database, and then retrieving the content corresponding to the matching documents. More than one piece of content, which is called a *content element*, can be associated with a single document. The content elements can be stored in any of the following locations:

- Database
- Conventional file system
- Fixed-content device

Although content can be stored in the Content Engine database, customers typically do not use this configuration, because the database can become too large and therefore difficult to manage if it holds all the content. Most customers therefore use one of the other two choices to store content: the file system or a fixed content device. If a file system is used, it is most often stored on a network-attached storage (NAS) or storage-attached network (SAN) device. Implementing a Redundant Array of Independent Disks (RAID) system provides both higher performance and high availability of the data.

Fixed content devices typically include specialized storage subsystems that meet certain compliance requirements, such as the ability to guarantee that content is never modified and that it cannot be deleted until a specified date in the future. These devices are often used to store legal and other documents in the financial, insurance, and related industries.

The architecture of Content Engine allows for a variety of different devices to be used as fixed content devices. Content Engine can also be connected to other

content storage systems, using these systems to store the content as conventional fixed content devices do. Content Federated Services (CFS) allows Content Engine to import document metadata and populate its object store while leaving the actual content in the remote content management system. This process, called *federation*, provides a number of unique benefits:

- New applications, taking advantage of the rich metadata object model provided by Content Engine, can be developed and used with both new content that is stored natively inside Content Engine and with older content that resides in an existing content management system.
- Because the content remains inside the existing system, applications that use interfaces that are provided by that system can continue to be used.
- The time and space required to federate the metadata of existing documents is much less than the time and space required for a full migration of content from the old system to the new one. No downtime is required of either system. Users can continue to use and add new documents to the existing system during the federation process.
- Clients can continue to use the existing systems and related hardware for as long as desired. Conversely, a migration over time can be effected, first by quickly federating the metadata, and then slowly moving content from the existing system into Content Engine as time and storage space permit. When the content of the last documents in the existing system have been moved, then the existing system can be retired.

A single Content Engine domain can manage one or more content repositories, which are called *object stores*. Each object store consists of a metadata database and one or more content storage locations. Information about object stores and domain configuration information are kept in a database called Global Configuration Data (GCD). By sharing access to the GCD, multiple Content Engines can participate in a single Content Engine domain, allowing these Content Engines to access the same object stores. This feature is the key for both Content Engine's scalability (more servers can be added as demand grows) and its high availability (if one node fails, the other nodes can still be used to continue processing requests until the failed node can be restored).

Content Engine supports user-extensible document classes, allowing users to define new types of documents that can be stored and what additional metadata these classes of documents will maintain. The CE also supports event processing, that is, the ability to perform a user-defined action whenever a chosen event happens, such as creating, deleting, checking in, and checking out documents. Security can be configured on document classes or on an individual document using an Access Control List (ACL), allowing the owner of a document to define precisely who can access or modify the document. Content can be versioned, that is, revisions to the content of the document can be checked into

the CE, and the CE maintains a list of all these versions over time. Documents within Content Engine can be arranged hierarchically by filing them into one or more folders.

Content Engine uses any of a number of supported Lightweight Directory Access Protocol (LDAP) servers to perform user authentication. Using an LDAP server simplifies the installation and administration of the CE system, because most corporations use an LDAP system for maintaining their user IDs and passwords. Content Engine caches the responses from the LDAP server (keeps a copy for a period of time), which reduces the number of LDAP queries and reduces future response times. In addition, Process Engine uses Content Engine for user authentication, again simplifying its installation and administration.

Figure 2-1 depicts the Content Engine system architecture.

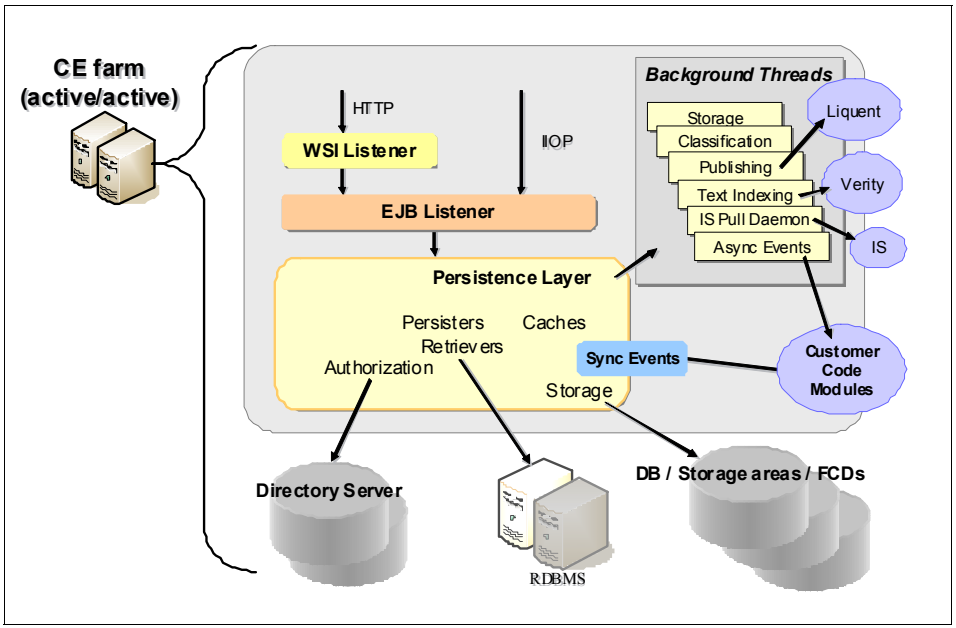


Figure 2-1 Content Engine system architecture

As seen in Figure 2-1, Content Engine's system architecture can be divided into three general areas: client connectivity, persistence, and background processing threads. Client connectivity is based on the Enterprise JavaBeans (EJB™) Listener, which receives client requests, executes them, and returns the results to the client. In order to accommodate standard Web Services clients, a Web Services Interface (WSI) Listener converts external Content Engine Web Services (CEWS) calls into the corresponding EJB calls and then passes them to the EJB layer for processing.

The Persistence Layer is responsible for many of the Content Engine's basic functions. It handles communications with the supported databases and storage and retrieval of content from storage areas, including the database, FileStore Areas, and Fixed Content Devices (FCDs). The Persistence Layer also performs authorization for the Content Engine by communicating with the supported LDAP server, and this layer also manages Content Cache Areas and their use. Finally, the Persistence Layer initiates event processing in response to changes to content and metadata, such as document creation, updates, and deletions.

For Synchronous Events, the corresponding event code is executed directly by the Persistence Layer. In other cases, the Persistence Layer will signal a background thread about an action of interest, and the Content Engine will perform further processing asynchronously. *Asynchronous processing* means that the activity occurs within a separate transaction and that the server does not wait until the operation has completed before returning control to the client. Such processing not only includes explicit Asynchronous Events, which can be used for workflow launches to request processing by the Process Engine, but it also includes activities, such as:

- Classification: Content Engine provides a framework for automatically assigning incoming documents to a designated document class. With automatic document classification, you can automatically change a document's class and set its property values. Content Engine provides ready to use, predefined support for the auto-classification of documents.
- Publishing: Content Engine's publishing framework provides a rich set of tools and capabilities for re-purposing the content that is contained in document objects into HTML and PDF formats. Publishing is useful when you want to make a document available to customers, but you do not want them to be able to modify the document. When you publish a document, you maintain control over the source document and can continue to update and make changes to the source that are not visible to users of the publication document. When you are ready to make the new version of the document available to your users, you republish the source document, thereby creating a new version of the publication document. Document Publishing is performed by the Rendition Engine.
- Indexing: Indexing a document consists of breaking the document into individual words and storing those words into a separate database, which is called a *Collection*, so that users can search for documents based on their content. This process is called *Content Based Retrieval (CBR)* or *full text indexing*.

Other background threads within the Content Engine include the IS Pull Daemon, which is responsible for communicating with an Image Services server to perform Content Federated Services for Image Services (CFS-IS), and storage

management, which handles copying content into FileStore Areas and finalizing the file's location, or deleting it if its originating transaction fails.

In addition to the Content Engine server, Content Engine also includes the IBM FileNet Enterprise Manager, a Microsoft® Management Console (MMC) snap-in application through which you can manage Content Engine services and object stores.

2.2.1 Database

Figure 2-2 shows the internal database structures for Content Engine. A Content Engine can have one to many object stores. This diagram shows the databases of two object stores, OS1 and OS2. These databases store information about the content and can store the content itself. The Global Configuration Database (GCD) stores information about the object stores and information about the system configuration.

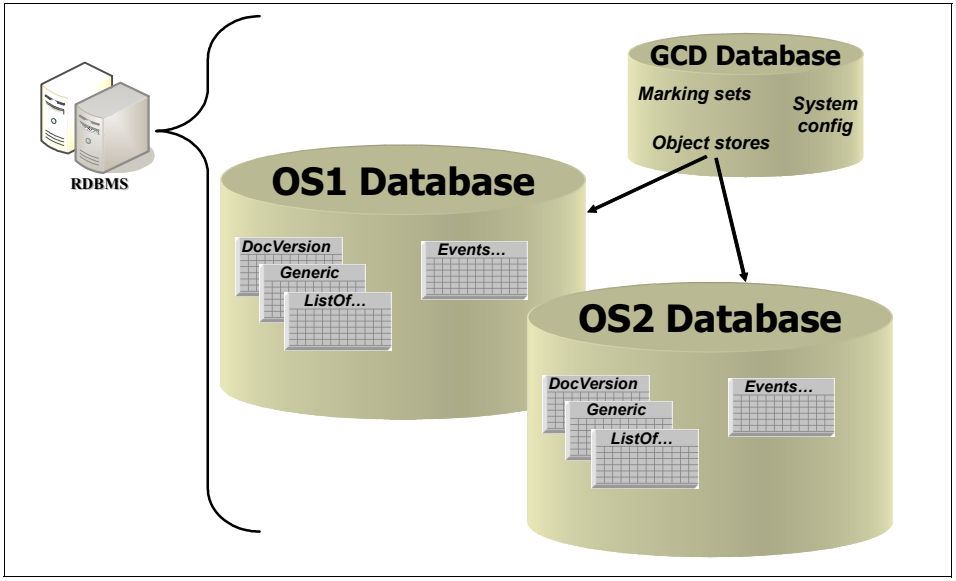


Figure 2-2 Content Engine internal database structure

2.2.2 Communication protocols

Content Engine supports a single API, with two transport protocols available for clients to use: Enterprise JavaBeans (EJB) and the Web Services Interface (WSI), also known as Content Engine Web Services (CEWS). Both transports support the same API, and each transport can access the full capabilities of

Content Engine. These transports are sometimes referred to as the EJB API and the Web Services API of Content Engine. In reality, both transports offer the same set of services and thus represent the same API in separate ways.

The EJB transport resolves to a protocol that is specific to each application server. Therefore, clients of the Java API running within a J2EE application server and using the EJB transport must be running on the same application server as Content Engine (for instance, IBM WebSphere Application Server) so that the client and server portions of the EJB transport are compatible. Stand-alone Java applications that are to be Content Engine clients must similarly be linked with client libraries supplied with the application server on which Content Engine is running.

The Content Java API allows either transport to be used by Java clients. The EJB transport generally provides faster performance than the WSI transport, because internally within Content Engine, the WSI layer is built on top of the EJB layer. For this reason, most IBM FileNet P8 products that are written in Java and work with Content Engine, such as the Application Engine, use the Java API with the EJB transport. However, the WSI transport offers several advantages:

- Client applications can be written in any language, not just Java, because the Web Services Interface and transport are standards.
- No application-server-specific libraries are required by the clients, and access through firewalls can be simpler, easing deployment.
- The availability of the Web Services Interface allows Content Engine to participate fully in standard service-oriented architectures (SOAs).

Content Engine also provides a .NET API. This API uses the WSI transport to communicate with the server. Similarly, there is a COM API provided for backward compatibility with earlier versions of Content Engine. This API also uses the WSI transport for server communications.

2.3 Process Engine

Process Engine is a 32-bit C++ application that follows a single-threaded multi-process model. Process Engine currently runs on IBM AIX operating system, Hewlett-Packard UNIX (HP-UX) operating system, Sun™ Microsystem Solaris operating environment, and Microsoft Windows® operating system. Process Engine provides enterprise-level software services for managing all aspects of business processes, including process modeling, routing, execution, process simulation, and analysis. Process Engine allows you to create, modify, and manage processes implemented by applications, enterprise users, or external users (such as partners and customers).

Figure 2-3 illustrates the Process Engine system architecture.

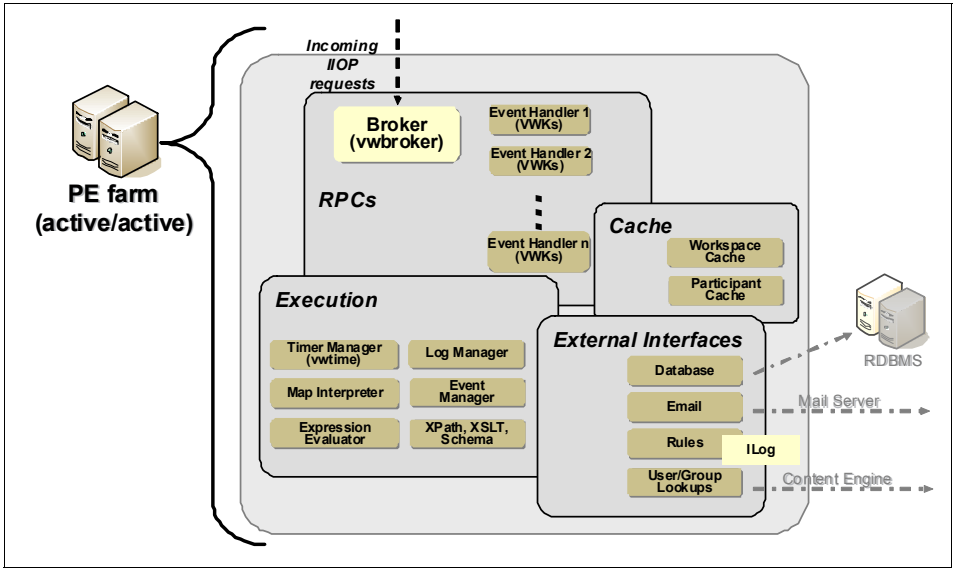


Figure 2-3 Process Engine system architecture

As shown in Figure 2-3, the Process Engine's system architecture is divided into four areas:

- VWBroker processes receive incoming Internet Inter-ORB Protocol (IIOP) requests from clients and route them to a VWK's process.
- Execution subsystem is the heart of the Process Engine, and it is mostly embedded in VWKs. It executes the steps of the defined workflow and in response moves workflow items from one queue to another queue. Interprocess Communication occurs between all the processes that implement the Execution subsystem. The Execution module includes these pieces:
  - Timer Manager: Controls workflow timers, deadlines, delays, and similar time-related activities. It is implemented by vwtime.
  - Map Interpreter: Interprets workflow maps. A *workflow map* is a graphical representation of the workflow that shows the sequences of steps needed to complete the business processes.
  - Expression® Evaluator: Evaluates expressions. *Expressions* are formulas that are used to obtain results for route properties, data field definitions, and other field-related expressions.

  - Log Manager: Manages logs. *Event logs* contain a record of specific system-related or workflow-related events for each isolated region. This type of logging is useful for tracking and analyzing workflow activity.
  - Event Manager: Workflows within Process Engine can involve waiting for an event to occur, after which the workflow can proceed. This processing is handled by the Event Manager.
  - XPath/Extensible Stylesheet Language Transformation (XSLT) processing: Processes XPath and XSLT. It includes functions for manipulating XML formatted strings.
- Cache: For performance reasons, Process Engine caches commonly used information. In particular, the users and groups that are returned by the directory service are cached in the Participant Cache. Another cache is Workspace Cache (a *workspace* is the configuration components of a type of workflow instance).
- External Interfaces of the PE include its database connections, the ability to originate Simple Mail Transfer Protocol (SMTP) e-mail, the authentication of users and groups through the Content Engine, and its interface for rules processing.

As with Content Engine, each Process Engine can operate independently of any others, storing all necessary data in the database. By load balancing requests across a group of PE servers, clients can achieve both scalability and high availability with Process Engine.

2.3.1 Component Integrator

Component Integrator provides a framework that enables Process Engine to connect to external applications or services. With Component Integrator, you can make custom Java code or existing Java Message Service (JMS) components available in a workflow. A component, in this context, can be a Java object or a JMS messaging system. Component Integrator handles the import of Java classes and manages the communication between Process Engine and the external interfaces. Component Integrator provides the Web Services invocation framework for process orchestration, which uses SOAP/HTTP as its transport protocol. Component Integrator includes adaptors that communicate events from Process Engine to external system, services, or entities. Adaptors interact with various types of components from a workflow process step. Each of these interfaces is managed in Application Engine by an instance of Component Manager.

Component Integrator provides a default set of Content Engine operations in Process Engine. It can also include any custom components that are created by you or other people. Instances of Component Manager manage connections to

external components. In a consistent way, Content Engine operations allow a workflow step to perform operations on Content Engine, such as filing a document in a folder or setting the properties of a document.

2.3.2 Communication protocols

Similar to Content Engine, Process Engine offers its services through two transports: Web Services and CORBA/IIOP. The Process Java API uses the IIOP transport, so clients, such as Application Engine, use this transport to connect to Process Engine. The Web Services interface can be used by clients in many languages, including IBM FileNet P8 applications, such as the SharePoint® Connector.

Process Engine acts as a client of Content Engine. In response to Content Engine requests, Process Engine executes workflow operations. It also uses Content Engine to authenticate IBM FileNet P8 domain users. The connections are made using Content Engine's Web Services transport.

Process Engine can be either a provider or a consumer of Web services by using the process orchestration framework. Process orchestration uses standard Web Services definitions for business process management systems, such as Business Process Execution Language (BPEL), that were created to allow an IBM FileNet Business Process Manager system to participate in an SOA. Process orchestration also uses the Web Services transport.

2.4 Application Engine

Application Engine forms the Web tier front end, or presentation layer, to Content Engine and Process Engine. Application Engine is the IBM FileNet P8 Platform component that hosts the Workplace or WorkplaceXT[1] Web application, Workplace Java applets, application development tools, and other IBM FileNet P8 Web applications.

Workplace or WorkplaceXT forms the presentation layer (a Web-based user interface) for both Content Engine and Process Engine. When a user logs in, the credentials that are supplied are maintained and protected by Application Engine. If Secure Sockets Layer (SSL) security is in use, Application Engine also provides this function. Workplace or WorkplaceXT runs in a Web container in a J2EE application server, such as IBM WebSphere Application Server, as used in the configuration for this book. Component Manager, another Java application residing in Application Engine, manages interaction with external entities (in this

[1] WorkplaceXT is the new application name, replacing the previous version that is called Workplace.

context, components). Workplace can provide custom actions by integrating external custom code. Workplace also has the ability to configure custom viewers based on document Multipurpose Internet Mail Extensions (MIME) types.

In addition to the Workplace application, Application Engine can host a number of other features and applications:

- Records Manager is an addition to the features of Workplace that provides records management-related functions. These functions include declaring records, setting retention periods, and performing record holds on documents that must not be deleted because of pending litigation or other reasons.
- eForms is an electronic forms management package.
- Integration with Microsoft Office enables users to manage Office documents and Outlook® e-mail messages within the IBM FileNet P8 content repository. Users can store, search, and retrieve documents, e-mail, and attachments directly from Microsoft Office menus. In addition to securing and versioning Office documents, users can browse object stores and insert properties into Word and Excel® documents. Users can also use entry templates to add documents to an object store and launch an approval workflow.
- WebDAV Servlet allows users to create and edit documents and manage content from WebDAV-compliant applications, such as Microsoft Word.
- Component Integrator provides a framework that allows you to create connectors to external applications, services, or entities. See 2.3.1, “Component Integrator” on page 28 for details.

In addition to the these features, Application Engine includes the Java APIs for Content Engine and Process Engine, the .NET API for Content Engine, and the Web Application Toolkit (WAT). The Web Application Toolkit is the basis of Application Engine and Records Manager. It provides an extensible framework and reusable modules for building Web applications. The Toolkit provides application developers with access to Content Engine, Process Engine, and third-party back-end servers. It supplies the behaviors and data structures for authentication, event routing, state information, preferences, localization, and other features of robust and scalable applications. The Toolkit’s reusable user interface component model facilitates the development of a robust HTML-based application user interface with little or no DHTML/JavaScript required. In addition to the toolkit, Application Engine also includes the Application Integration Toolkit and the Application Integration Express Add-in. For more information about these services and applications, refer to *IBM FileNet P8 System Overview*, GC31-5482.

Figure 2-4 on page 31 shows the Application Engine system architecture.

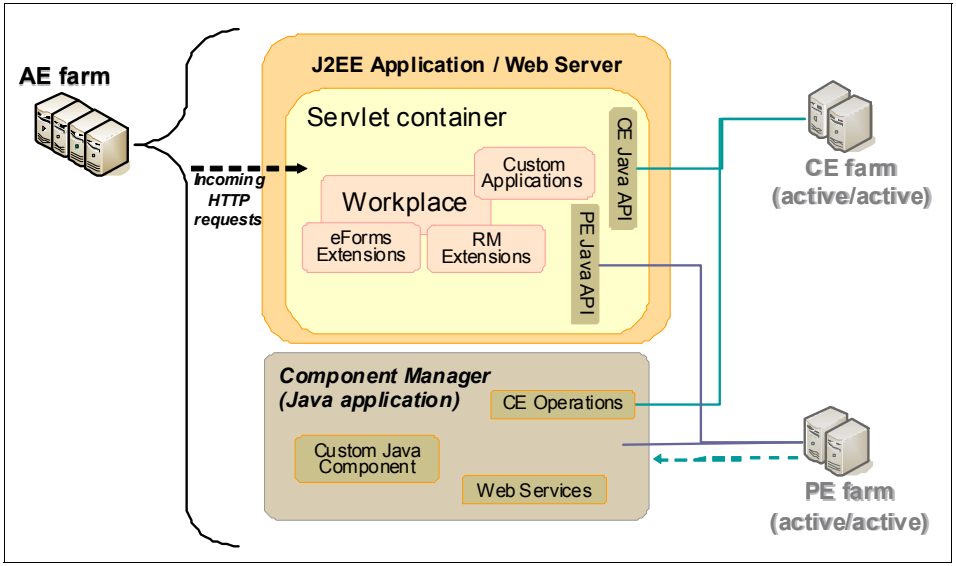


Figure 2-4 Application Engine system architecture

The Application Engine's system architecture includes two major parts.

The first part, the Servlet Container, which is within the supporting application server, supports the execution of Workplace/WorkplaceXT, Records Manager, eForms, and any custom applications. The CE Java API and the PE Java API are used by these applications to communicate with the corresponding CE and PE servers. Requests arrive at the AE through HTTP, typically from users on Web browsers, and responses are also delivered to the clients over the same HTTP connection.

The second part of the Application Engine shown in Figure 2-4 is implemented by the Component Integrator, which is described fully in 2.3.1, "Component Integrator" on page 28. One or more Component Managers (Java applications) can run. CE operations allow workflows to access the Content Engine, and Web Services provides an invocation framework that is used for process orchestration.

Because each Application Engine works independently of any others and does not store any user data on disk, clients can easily provision a set of AE servers. This configuration results in both scalability and high availability.

2.4.1 Communication protocols

Clients of Application Engine are Web browsers. They use the HTTP or HTTPS protocols in connecting to Application Engine. As a client of Content Engine and Process Engine, Application Engine uses their client protocols to connect to them. For Content Engine, the communication protocol used is the EJB transport. For Process Engine, the protocol is IIOP. Both protocols are carried over TCP/IP connections.

2.5 Image Services and CFS-IS

Image Services (IS) is a powerful image and document management system. It integrates with a number of storage devices, including optical disk systems, Magnetic Storage and Retrieval (MSAR), and specialty storage units for compliance, such as IBM System Storage™ DR550 and IBM System Storage N series storage.

Many companies with Image Services implementations want to take advantage of the functionality and features in the IBM FileNet P8 suite, including Content Engine's document class data model and Process Engine's process workflow capabilities. Without having to give up existing applications and procedures that work with Image Services, IBM FileNet P8 offers Content Federation Services for Image Services (CFS-IS) for these companies.

Content Federation Services (CFS) allows Content Engine to function as the master metadata catalog for documents that are stored in IBM FileNet P8, Image Services, and other disparate content sources. Documents can be searched and retrieved directly by any IBM FileNet P8 application, no matter where the actual content is stored.

For Image Services, CFS-IS federates the Image Services documents to the IBM FileNet P8 catalog, meaning that the Image Services document metadata is stored in the IBM FileNet P8 catalog, while the content remains where it was stored originally, until a user retrieves the document.

CFS-IS allows the Image Services users to deploy new IBM FileNet P8 applications, which can use the documents that are stored in Image Services, while the existing Image Services applications can continue to function for as long as they are required, until the decision is made to replace them with IBM FileNet P8 applications.

CFS-IS also enables Content Engine to use Image Services as a content storage device. Users of IBM FileNet P8 applications can have full access to content that is stored in existing Image Services repositories. Anything that is created in

Workplace or created programmatically using Content Engine APIs can be stored in the Image Services' permanent storage infrastructure if desired, allowing companies to continue using their Image Services systems.

With CFS-IS, existing Image Services content is preserved and usable by Image Services clients, and it is also reusable by IBM FileNet P8 applications, such as WorkplaceXT and Records Manager, without duplication and without change to existing applications. The location of document content is transparent to all Content Engine applications. Applications that store documents in Image Services systems can continue to be used.

For companies that are migrating from Image Services to IBM FileNet P8 Platform, CFS-IS provides an initial bridge that allows Content Engine to be implemented quickly, without first requiring a full migration of all data. In this case, Content Engine can be configured to store new documents in its native storage areas, and content stored on the Image Services system can be migrated slowly while production operations continue. New applications can be developed in the IBM FileNet P8 platform. When all content is migrated from the Image Services system, and the Image Services system is no longer required for any applications, the Image Services system can be decommissioned.

If Image Services applications must run in parallel with the IBM FileNet P8 application for at least a certain period of time, dual cataloging of documents is an option. Image Services documents can be cataloged in the Content Engine catalog, and they can also be cataloged in the Image Services catalog, resulting in all content being accessible by both Image Services clients and any application built on the IBM FileNet P8 platform, such as WorkplaceXT. Both the Image Services and Content Engine catalogs are masters and are automatically synchronized by CFS-IS. If properties change in Image Services, they are automatically propagated to the Content Engine catalog (metadata). Note that synchronization is not bidirectional. Updates in the Content Engine metadata do not propagate back to the Image Services catalog, so they are available only to IBM FileNet P8 clients. Therefore, as long as Image Services clients are still in use, any updates must be made through the Image Services clients so that they are reflected in both catalogs (metadata).

During the transition period from the Image Services catalog to the Content Engine catalog, both IBM FileNet P8 platform applications and Image Services clients can run concurrently, accessing the documents that are stored in Image Services. When a transition to the Content Engine catalog is complete, you can remove entries from the Image Services catalog, and you can replace the existing Image Services clients with native IBM FileNet P8 applications.

You can catalog existing documents, images, and other content that are already cataloged on the Image Services system on an IBM FileNet P8 system. The Image Services Catalog Export tool exports existing index data (document

properties) from an Image Services catalog to a Content Engine catalog. The tool includes an option to delete the index entries from the Image Services index database after the index data has been exported to the Content Engine catalog. In preparation for implementing CFS-IS, the administrator must define a mapping between the document classes and properties within the Image Services system's catalog and the document classes and properties in Content Engine. Properties that do not have a defined mapping are not exported. After CFS-IS is fully configured, CFS-IS automatically propagates the catalog entries of new documents added to Image Services document classes that are mapped to Content Engine document classes to the Content Engine catalog.

Architecturally, Image Services implements various components as separate processes. All of these processes can execute on the same host, in a combined server configuration, or you can spread the root/index and library services across multiple hosts in a dual server configuration. Although Image Services does not support an active/active configuration, separation of these processes can allow an Image Services system to be scaled within limitations to accommodate increased demand. For high availability, only a combined server configuration is supported, with all the services resident in the same host. Remote Cache servers can also be used to improve performance in a geographically distributed environment by caching local copies of document content at remote work sites.

2.5.1 Communication protocols

The CFS-IS threads reside in Content Engine. CFS-IS connects Image Services with Content Engine using a proprietary protocol over TCP/IP.

2.5.2 CFS-IS architecture

In IBM FileNet P8 4.0, the implementation of CFS-IS resides within Content Engine as a number of Java classes and threads. This implementation is an important feature, because it means that the CFS-IS functionality is spread across all Content Engines in a Content Engine farm. This design increases performance and scalability automatically as the number of active Content Engines in the farm increases. From a high availability standpoint, the CFS-IS functionality is inherently highly available when Content Engine is configured in this way. Figure 2-5 on page 35 depicts the integration of Content Engine and an Image Services system.

When you add new documents to an Image Services system that is federated using CFS-IS, you can configure CFS to operate in one of two ways:

- Index new documents to the Content Engine catalog only.
- Index new documents to the Content Engine catalog and the Image Services catalog.

In the latter option, updates to Image Services catalog entries are automatically propagated to the Content Engine catalog.

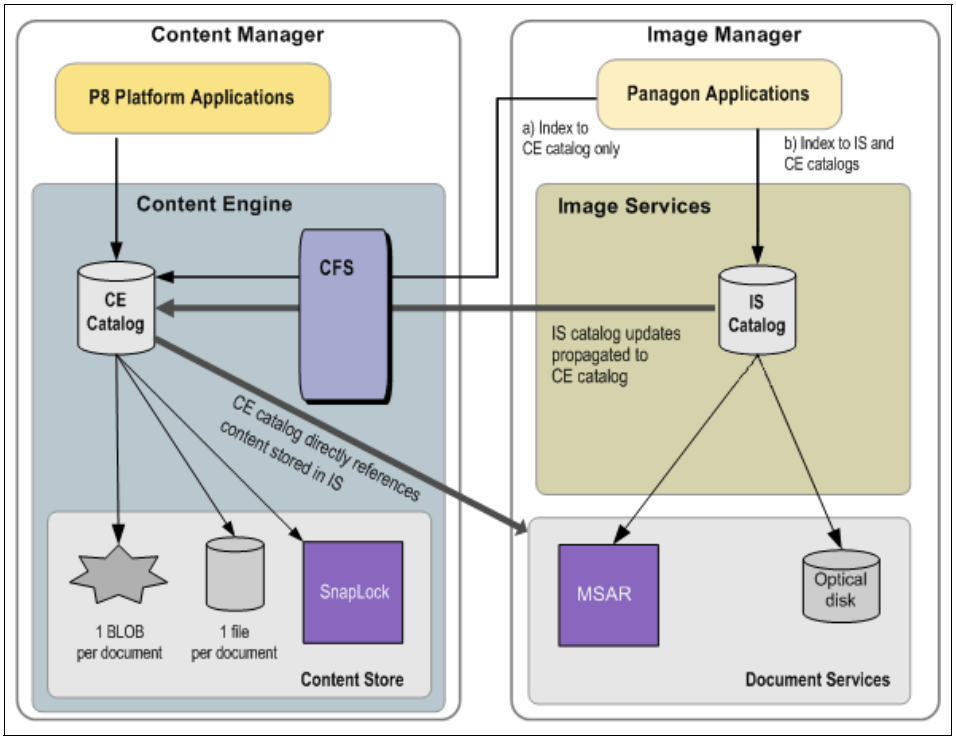


Figure 2-5 Integration of Content Engine and Image Services with CFS-IS

More than one Image Services system can be federated to the same Content Engine system, because each Image Services system appears to Content Engine as an individual fixed-content device.

2.6 Content Search Engine

Content Search Engine (CSE) provides the ability to search for documents within Content Engine based on the content of the documents. It performs two basic functions:

- Full-text indexing: New documents that are added to the Content Engine repository can be full-text indexed. That is, the documents are scanned to determine individual words that are found throughout the documents. The administrator can define a list of common words that are not to be indexed (also known as the Excluded Word List); the use of this list greatly reduces both the size of the indexes and the time that it takes to index each document.
- Search, also known as *Content Based Retrieval (CBR)*: This function identifies the documents whose content and properties match a given search query.

In defining a search template, a user can specify a search for one or more keywords, possibly also with conditional or alternative requirements, such as 'high NEAR availability OR HA". Search capabilities also include the ability to account for misspelled words, typographical errors, phonetic searching, word stem searching, synonym expansion, and wildcard searching, based on the search language that has been configured. Other important aspects of the search function include:

- A single search can span multiple object stores across databases. This type of search is known as a *Cross Repository Search (CRS)*. A Cross Repository Search is specified in Workplace simply by including more than one object store in the list of search targets.
- Workplace users can search for documents, folders, and custom objects. Searches can be designed to specify multiple folders, including a common folder name used in multiple object stores. Search templates can be constructed using a Query Builder, or more complex searches can be specified using the Verity Query Language (VQL).
- Content searches return matches not only on content but also on properties enabled for full-text indexing.
- Search results can be ranked automatically by relevancy.
- Searches can use language-specific processing and indexing.
- Bulk operations can be performed on search results in IBM FileNet Enterprise Manager, where the operations can be scripted, or selected from a set of predefined operations, such as delete, cancel checkout, file, unfile, and change security.

- Searches can be created and stored for easy execution of common queries. Search templates provide a simple user interface for entering search criteria. Shortcuts to searches can be saved so it is easy to find them later.
- Searches can be expanded to retrieve documents, folders, and custom objects in the same search specification.

2.6.1 Content Search Engine architecture

Content Search Engine consists of a number of components that can be deployed across one or more computers. Figure 2-6 shows an example CSE deployment, illustrating how the major components of CSE are interrelated.

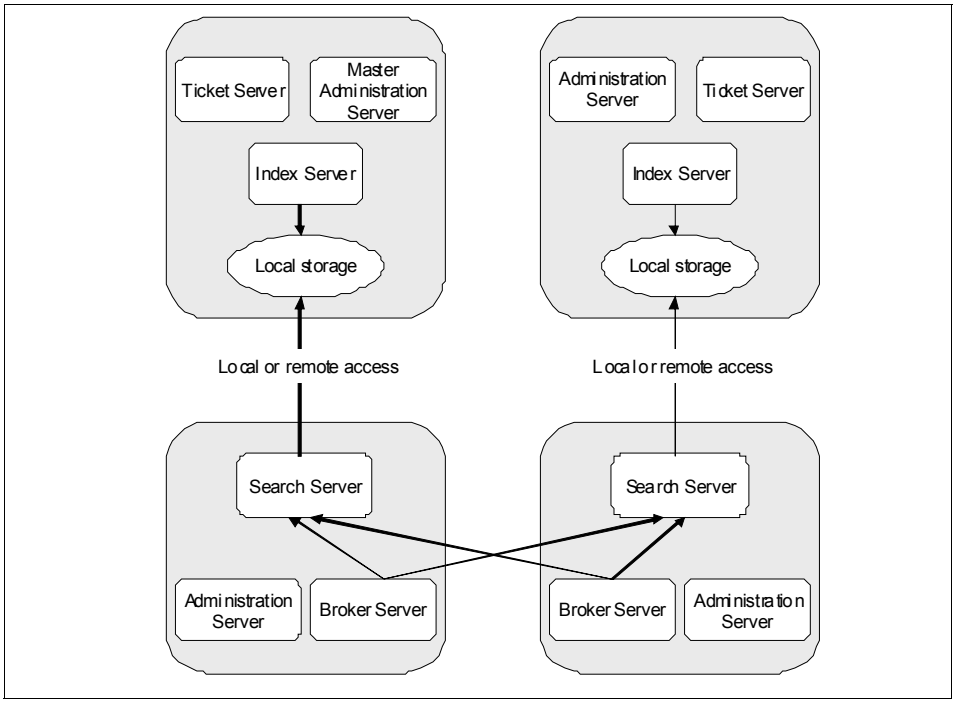


Figure 2-6 Example CSE configuration

When a document is indexed by Content Search Engine, relevant information is stored in a proprietary database format in a file called a *collection*. Collections are stored within an *Index Area*, which is a Content Engine object created within IBM FileNet Enterprise Manager. When a collection becomes full, a new collection is automatically created, up to the maximum number of collections that has been specified for the Index Area.

To initiate a request for Content Search Engine to index a document, Content Engine copies the document's content to a temporary area, and then it submits a request to a Content Search Engine Index Server to index that document. In IBM FileNet Content Manager Version 4.0 or prior, if there are multiple Content Engines in a farm environment, you need to manually set one Content Engine to initiate the index request. This unique Content Engine is designated by setting its EnableDispatcher configuration parameter to true. Starting from Version 4.5, the system automatically assign a Content Engine to perform the task. So, if this Content Engine fails, another Content Engine from the farm will take over automatically.

If the Content Search Engine Indexing Servers are down or unavailable, Content Engine queues up requests to index documents, up to a maximum of 100,000 documents. Under normal circumstances, therefore, the unavailability of the Content Search Engine server does not prevent ingestion of new documents into Content Engine. Monitoring to insure that the CSE Indexing Servers are up and running is therefore an important administrative task.

Not all new documents are required to be indexed. You can configure specific document classes and properties within the document classes to be full-text indexed, and documents of other classes will not be indexed. In addition to automatic indexing of new documents, the administrator can manually submit a reindexing job from IBM FileNet Enterprise Manager for a given document class, for all documents that have been marked for indexing, or for an individual document, folder, or subclass of any base document class. For example, the administrator can manually submit a reindexing job from IBM FileNet Enterprise Manager to restore a collection that was lost because of a hardware failure. During the time that documents are being reindexed, search queries can still be performed against the existing collections. When the newly created collections are ready, the old ones are deleted and the new ones become active. Reindexing jobs are typically time-consuming, so we recommend performing this task during non-peak business hours.

The following sections describe each of the components of the Content Search Engine software. Although the term "server" is used for these components, each one is really a service, and within limits, each one can be deployed separately, helping to achieve scalability and availability requirements. In a minimal configuration, all of these services can be deployed on a single host computer, as in the configuration employed for this book. However, for scalability purposes, many clients spread these services across multiple host computers (or logical equivalents, such as logical partitions (LPARs) as is done in the configuration used for this book). The services that require the most compute resources are the Index Servers and the Search Servers. Chapter 3, "High availability strategies for IBM FileNet P8 systems" on page 43 discusses the high availability considerations and the requirements for the components.

2.6.2 K2 Master Administration Server

For every Content Search Engine installation, there must be exactly one K2 Master Administration Server running. This server maintains information for all the other Content Search Engine server components. When Content Search Engine configuration changes (for instance, a new Search Server is added), the Master Administration Server updates itself and all of the other K2 Administration Servers so that they have the latest configuration settings. The Administration Servers also synchronize periodically with the Master Administration Server, upon startup and every 15 minutes thereafter.

An installation of a Master Administration Server and all the related services (which can be on the same or on remote hosts) is referred to as an *Autonomy K2 domain.*

2.6.3 K2 Administration Server

Only one host computer within a K2 domain runs the Master Administration Server at a given time. Every other host computer in the K2 domain instead runs the K2 Administration Server.

Administration Server monitors the health of the Content Search Engine components installed on its host machine. In addition, Administration Servers can transfer configuration files that are used by the Content Search Engine system from one Content Search Engine host to another Content Search Engine host in order to propagate configuration changes.

Administration Server software is automatically installed when any other Content Search Engine server software is installed on a host machine. Remote Administration Servers are maintained by the Master Administration Server, including information, such as the configuration and status of a Content Search Engine installation. The information maintained by the local Administration Server is used by the other services running on the same host.

2.6.4 K2 Ticket Server

K2 Ticket Server is used for the security of the Content Search Engine system and its collection data. One or more Ticket Servers can exist in a K2 domain. The Ticket Servers store authentication information for users and grant access to the index collections accordingly. When a user authenticates to an LDAP server, the user receives a ticket. The Ticket Server gives the user access only to the part of the Content Search Engine system for which the user has the correct ticket. In the case of Content Engine, the credentials and other information that is necessary for Content Engine to connect with the Content Search Engine

servers are stored in the K2 domain Configuration tab of the IBM FileNet P8 domain root properties page within IBM FileNet Enterprise Manager.

2.6.5 K2 Index Server

K2 Index Server is the software application that performs full-text indexing of documents. Specifically, Index Server reads a document, breaks it down into its component words, eliminates words that are in the Excluded Word List, and then creates entries in the collection, mapping those words to the particular document. Breaking apart the document to identify its relevant keywords for indexing is called *information abstraction*. Index Server is capable of performing this process on a wide range of document types.

Only Index Server writes to the collection files. To do so, Index Server requires local file access to the collection files. Physically, the files do not have to reside within the computer hosting Index Server. Most commonly, especially for highly available configurations, the collection files are stored on a SAN and accessed through a Fibre Channel network. Such access creates the appearance that the files are stored on a local Small Computer System Interface (SCSI) device, which Index Server can then access. Index Server cannot access collection files through network file share, such as Common Internet File System (CIFS) or Network File System (NFS).

The properties of each Index Area specify one or more Index Servers that Content Engine can use for that Index Area. By using this list, Content Engine can pick an Index Server for each document to be indexed. Figure 2-7 on page 41 shows how Content Engine distributes indexing requests among several Index Servers.

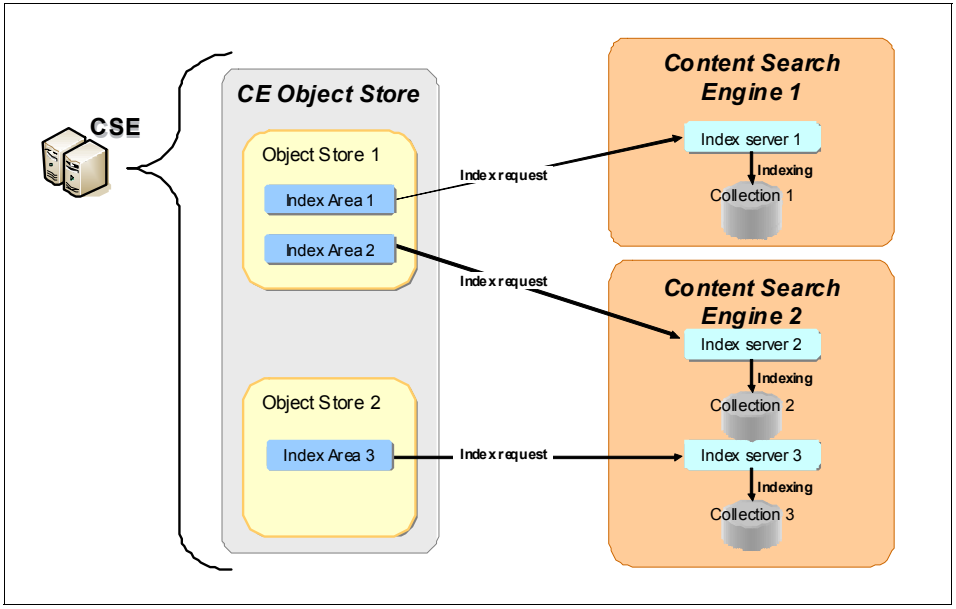


Figure 2-7 How Content Engine index requests are sent to Index Servers

2.6.6 K2 Broker and Search Servers

The content search process is the heart of a Content Search Engine system. Content Search Engine divides this process across two types of servers: K2 Broker Server and Search Server. When there is a search request, Content Engine sends the request to one of the Broker Servers. That Broker Server, in turn, divides the request into smaller pieces and spreads these pieces across a number of Search Servers. The configuration of each Broker Server determines to which Search Servers that broker distributes the request. When the Search Servers return their results to the Broker Server, it collates and merges the data into a single response and returns that response to the requesting Content Engine. Because the search process is one of the most critical functions of the Content Search Engine system, Search Servers are sometimes referred to simply as *K2 Servers*.

As with the farming capabilities of AE, CE, and PE, this architecture allows automatic load balancing and scalability: as more Search Servers are added, individual searches can be spread over more servers, allowing faster response times. This process is called *parallel querying*. It also provides for automatic high availability: if a particular Search Server fails, as long as at least one Search Server is available, the search process can still function.

Search Servers can access the collection files either as a local disk or through a network share, such as CIFS or NFS. Content Engines are automatically made aware of the Broker and Search Servers in the K2 domain by querying the Master Administration Server. When new Brokers or Search Servers are added, the Content Engines are automatically kept up-to-date.

2.6.7 Communication protocols

As a client of Content Search Engine, Content Engine connects to the Content Search Engine as a K2 Java client over TCP/IP. Installing the P8CSE client software on each of the Content Engine servers in the farm and then re-deploying the FileNetEngine.ear file installs the necessary K2 Java client files.

3

High availability strategies for IBM FileNet P8 systems

This chapter describes high availability options and strategies for IBM FileNet P8 core components.

We discuss the following topics:

- Component redundancy
- Virtualization compared to high availability
- Application Engine
- Content Engine
- Process Engine
- Content Search Engine
- Image Services and CFS-IS

3.1 Component redundancy

Depending on the availability requirement that is set by your business, achieving high availability requires that there is no single point of failure in an entire system, in either a hardware component or a software component. All components in the system must be redundant.

Note: One of the key factors in providing high availability for a system is ensuring hardware and software redundancy for all of the components that are involved in the system.

Multiple IBM FileNet P8 components work together to comprise a total solution. They depend upon other services to function in a production environment. These other services, therefore, must also be highly available to ensure the entire solution is highly available. These other services include the Network File System (NFS) service and the network service. Make sure that other services involved in the solution are also highly available.

In certain cases, a hardware component already provides internally built-in redundancy, and if so, you do not need to set up two separate hardware components to achieve high availability. For hardware components, such as storage subsystems, network load balancers, switches, and routers, it is common to use this type of internal redundancy, because these components are often used in high availability environments.

When considering making a network application highly available, determine the types of network communication that the service receives from its clients, and any connections from the software to other services. The protocols used, the caching of data on a per-session or per-user basis, and other factors dictate the best methods of achieving load balancing and high availability.

In this book, we focus on providing redundancy for IBM FileNet P8 components only.

In conjunction with this book, we recommend that you read the following publications in the area of high availability, and use them for your reference:

- *IBM FileNet P8 Platform High Availability Technical Notice*, GC31-5487

  Consult this technical paper, especially if you are configuring a IBM FileNet P8 high availability environment using software components other than IBM software.

- *Content Manager Backup/Recovery and High Availability: Strategies, Options, and Procedures,* SG24-7063

  This book focuses on achieving high availability for IBM Content Manager Enterprise Edition. Although it covers another product, several of the concepts and practical procedures provided in the book can be a good reference when you design and implement your high availability system.

3.2 Virtualization compared to high availability

Platform virtualization is a technique that is used to partition a single computing system into a number of separate systems, each a software emulation of a separate computer system and operating system instance. There are a number of techniques for achieving virtualization. You can achieve virtualization through software emulation of the underlying hardware, hardware partitioning, or virtualized operating system partitioning. In the case of IBM AIX on Power hardware, the hardware is partitioned into logical partitions (LPARs).

Partitioning a single large system into effectively smaller systems offers several advantages:

- The amount of computing resources devoted to each partition can be varied dynamically as demand changes over time. This ability allows administrators to be responsive and helps to meet system-level agreements.
- Each partition can potentially run a separate operating system.
- A security breach in one partition does not affect any other partitions.
- Similarly, an application or operating system software fault in one partition does not affect the other partitions.
- By consolidating multiple servers, administrators can reduce the hardware footprint, reduce administrative and energy costs, and increase efficiency.
- Because each system runs on an abstract hardware platform, it is isolated from the particulars of any given piece of hardware. Therefore, if the hardware fails, the same virtual machine can immediately be brought back up on another virtual server.
- In the same way, a new partition can be allocated and deployed much more easily than a new hardware platform.

High availability is achieved through the elimination of all single points of failure, whether hardware or software. You can eliminate all single points of failure through the wholesale duplication of an entire computer system's hardware and software. Often, this approach is exactly how high availability is achieved, although doing so doubles hardware and software costs. Certain hardware

platforms have built-in redundancy by duplicating all essential components of the hardware platform, such as network ports, memory, CPU, and buses. They provide automatic failover at the hardware and software level if a component fails.

The feature of virtualization that allows a virtual machine to quickly start up on the same or another hardware platform is useful in achieving high availability, disaster recovery, or both. However, platform virtualization, by itself, does not guarantee high availability. While it can provide quick recovery from software faults, it does not eliminate the possibility of hardware failures. This problem can be overcome either through the use of two (or more) virtualized platforms, in an active/passive or an active/active configuration, or through the use of a hardware platform that includes built-in redundancy of all components so that no single points of failure exist. The configuration that is used in this book uses the latter approach, a single hardware platform that is fully redundant at the hardware level, and the use of multiple LPARs to provide software redundancy with active/passive clusters and active/active farms.

3.3 Application Engine

The Application Engine (AE) is implemented in Java as a Java 2 Platform, Enterprise Edition (J2EE) application. It therefore executes in a J2EE application server, such as IBM WebSphere Application Server Network Deployment. Clients of the Application Engine are Web browsers. They use the HTTP protocol over TCP for communication.

AE is a platform and toolkit for client applications for Content Engine (CE) and Process Engine (PE). The supported applications include Workplace, WorkplaceXT, eForms, Records Manager, and other applications. From the perspective of providing high availability, any or all of these applications are the same, so in this chapter, we refer to this platform, and whatever applications are deployed on it, as Application Engine.

The best recommended high availability strategy for Application Engine is using a load-balanced server farm, which is also known as an active/active cluster. By having all nodes active simultaneously, the best possible performance and scalability are achieved, and no hardware is left idle. An active/active configuration also provides the best possible high availability solution, because if any given node fails, the other nodes are already up, operational, and continue to process any incoming requests. The failover time consists only of the time that is required to detect that the node has failed.

In a typical installation, the Application Engine tier is placed behind an HTTP server tier that implements the WebSphere HTTP Plug-in. The HTTP servers

accomplish several functions, including off-loading work from the Application Engine servers, such as the encryption and decryption of secure communications (HTTPS traffic). Performing these functions allows these servers to be placed within a DMZ area in the network, separated by firewalls from the users and other machines in the network. This approach greatly enhances the security of the network, because it minimizes the sources of connections that are allowed to reach the interior servers. The HTTP Plug-in provides a load balancing mechanism for HTTP traffic to WebSphere-based applications. It spreads the load across the available Application Engine servers, but more importantly, if one of the Application Engine servers goes down, or a new one is added to the pool of available servers, the Plug-ins automatically accommodate this change. This configuration is considered the best practice in a WebSphere environment for both high availability, scalability, and security. We implemented this configuration in our case study, with the exception that the firewalls necessary to create a DMZ area were omitted for simplicity.

To avoid introducing single points of failure, at least two HTTP servers must exist in the Web service tier. They can be front-ended by a hardware load balancer. This load balancer must either internally implement high availability through redundant hardware, or a secondary load balancer must be available, to avoid the introduction of a single point of failure.

An alternative configuration that does not provide the same level of security as the best practices configuration is to use a hardware or software load balancer directly in front of the Application Engine tier. Again, whatever load balancing mechanism is used, avoid introducing single points of failure, either hardware or software, into the system.

In order for all Application Engine nodes to be configured identically, they must share a configuration directory and bootstrap properties. In order to avoid single points of failure, this shared configuration directory must be made highly available and mounted from all Application Engine nodes. Alternatively, you can install Application Engine in a single, highly available shared location, with all Application Engine instances run from the same set of binaries and configuration files.

The Application Engine is a client of the Content Engine and the Process Engine, in both cases, using their Java APIs. The protocol used for the Application Engine to communicate with Content Engine is the Enterprise JavaBean (EJB) transport over TCP. For Process Engine communications, Common Object Request Broker Architecture (CORBA)/Internet Inter-ORB Protocol (IIOP) is used running again over TCP. We discuss the high availability considerations for these protocols in the following sections describing the high availability aspects of the Content Engine and Process Engine.

3.3.1 Session affinity for Application Engine

When a user connects to the Application Engine, that user has to log in to the system to access the services behind it (the Content Engine and the Process Engine). The load balancer in front of the Application Engine tier can use any algorithm for load balancing these initial connections. Because Web browsers can disconnect from a server after each interaction, the Application Engine maintains the user's state between each interaction, including the user's logon credentials and the document with which the user is currently working. It is therefore important that the user connections are directed to the same Application Engine server consistently after the user logs in. This load balancer behavior is known as *session affinity* or *sticky sessions*.

3.4 Content Engine

Like the Application Engine, the Content Engine is implemented in Java and runs under an application server. For our case study implementation, we use IBM WebSphere Application Server Network Deployment.

The Content Engine accepts connections from clients using two separate transports, which are both carried by TCP connections:

- EJB/IIOP (Remote Method Invocation (RMI)/IIOP for WebSphere)

  Only the Java applications using the Java API for Content Engine use this protocol. Application Engine, portions of IBM FileNet Records Manager, and custom Java applications that are written with the Java API use this protocol.

- Web Services Interface (WSI) over HTTP

  The .Net API of Content Engine and the backward-compatible Content Engine 3.*x* COM API use this protocol. IBM FileNet Enterprise Manager and Process Engine use this transport to connect to the Content Engine. Portions of IBM FileNet Records Manager use it also. Third-party service-oriented architecture (SOA) applications written in a variety of languages can use this protocol, as well.

Each of these transport protocols, EJB and WSI, requires special consideration when constructing a high availability environment for Content Engine. Consequently, you must employ two load balancing mechanisms to make Content Engine highly available.

3.4.1 Load balancing the EJB transport

For the EJB/IIOP transport, we recommend always using the native load balancing software that is provided with the application server if at all possible. In the case of WebSphere Application Server, this feature is the Network Deployment Workload Manager. We do not recommend using hardware or external software load balancers, which results in extremely poor performance.

Note: Because the EJB clients must use the client software that is provided with the application server, clients that run within an application server, such as the Application Engine, must be deployed on the same type of application server as the Content Engine.

3.4.2 Load balancing the WSI transport

Because the WSI transport uses the standard HTTP protocol for connections, it can be load-balanced by either a hardware or a software load balancer. In the case study configuration that is used in developing this book, we use a hardware load balancer, the F5 BIG-IP. One example of a software load balancer that you can use is the the WebSphere HTTP Plug-in, which we use for load balancing connections.

3.4.3 Session affinity for Content Engine

The Content Engine is, by design, stateless. Any request can be made to any Content Engine within a farm. Certain transactions might perform better with session affinity, but it is not proven in testing. When load balancing EJB clients, the WebSphere Network Deployment Workload Manager can provide session affinity only for statefull session beans. Because the Content Engine is designed to be stateless, it uses only stateless beans. WebSphere Application Server Network Deployment does not provide session affinity for these types of clients. Most load balancers that might be used with WSI, however, offer session affinity as an option.

While session affinity might produce higher performance for a small number of request types, it can lead to an imbalance in the load across a farm of Content Engine servers, depending upon client behavior, and this imbalance leads to lower overall performance and throughput. We therefore consider it the best practice not to attempt to perform session affinity for connections to the Content Engine for this reason.

Special configuration note regarding IBM FileNet Enterprise Manager: Refer to the P8 4.*x* High Availability Technical Notice, GC31-5487, which can be downloaded from the following URL:

http://www.ibm.com/support/docview.wss?rs=3278&uid=swg27010422

Scroll down to FileNet P8 Platform Technical Notices for this document.

Applications, such as IBM FileNet Enterprise Manager (which uses the WSI transport) that can create new document classes, *must not* load balance their interactions across a farm of servers. Content Engine caches the metadata state of each object store (in particular, information about the document classes defined for that object store). If a class is created on node 1, and the user immediately attempts to use that class on node 2, node 2 will not be aware of the class until its refresh interval has passed. In this scenario, it appears to the user that the class just created is unavailable. Therefore, we recommend that you configure IBM FileNet Enterprise Manager to communicate with a particular node in a server farm rather than to the virtual address of the server farm.

3.5 Process Engine

In releases prior to 4.0, Process Engine requires an active/passive cluster configuration to achieve high availability. Starting with Release 4.0, Process Engine has been redesigned to be stateless, so that an active/active server farm can be implemented. Just as with the Content Engine, this stateless configuration is the best practice configuration for achieving high availability. However, unlike Application Engine and Content Engine, Process Engine is not a J2EE application, so it does not run within an application server. Therefore, the external load balancers must be used in front of Process Engine to balance its client traffic. Up until the date that this book was written, only hardware load balancers have been tested and qualified for this purpose. For our case study, we set up an active/active cluster configuration of Process Engine using the F5 BIG-IP hardware load balancer.

The alternative high availability configuration, using an active/passive cluster, is also an option for Process Engine. It is not the best practice high availability configuration, but clients who use the IBM FileNet P8 Version 3.5 in that configuration might upgrade to Version 4.*x* while keeping the active/passive approach. As presented in the P8 4.*x* High Availability Technical Notice, GC31-5487, Microsoft Cluster Server and Veritas Cluster Server have been tested and qualified for use with Process Engine 4.*x* for an active/passive configuration.

Like Content Engine, Process Engine offers two separate: a Java API that uses the CORBA/IIOP protocol and a Web Services Interface (WSI) that uses the HTTP transport protocol. Among IBM clients of Process Engine, Application Engine (Workplace and WorkplaceXT) and custom Java applications use the Java API, while SharePoint Connector and any custom Web Service applications for Process Engine use WSI, and thus HTTP. Fortunately, load balancing for both APIs can be performed using a hardware load balancer, as long as it is capable of load balancing all ports and protocols, not just HTTP traffic over TCP. In addition to the F5 BIG-IP hardware load balancer that is used in the configuration for this book, the Cisco Local Director has also been tested with Process Engine.

3.5.1 Session affinity for Process Engine

Process Engine is stateless; therefore, any client request can be directed to any Process Engine within an active/active server farm. Unlike Application Engine, Process Engine maintains the user state within the database, so that no information is lost if a particular node in a server farm goes down. User credentials are passed with each interaction with the server so that no new logon is required if the user's connection is redirected from one server to another server upon failover. In practice, the Java API maintains session affinity automatically as long as the original server remains available. This behavior can lead to an imbalance in load across the servers in a farm, depending upon client behavior.

3.6 Content Search Engine

The Content Search Engine (CSE) consists of a number of components, each with unique high availability considerations:

- K2 Master Administration Server
- K2 Administration Servers
- K2 (search) Servers
- K2 Index Servers
- K2 Broker Servers
- K2 Ticket Servers

In a minimal configuration, all of these servers, or services, can be deployed on a single host, which is the configuration that we used for the case study for this book. However, for scalability purposes, many solutions spread these services across multiple hosts. The services that require the most computing resources are the Index Servers and the Search Servers.

There are several potential single points of failure in this set of servers:

- The Master Administration Server
- CE Dispatcher
- Index Servers

Master Administration Server

For any IBM FileNet P8 4.0 solution, there must be only one Master Administration Server; therefore, it must be paired in an active/passive cluster to achieve high availability.

Dispatcher

Within the Content Engine farm, in Version 4.0.0 and Version 4.0.1, you can only designate one Content Engine as the dispatcher. Therefore, only one Content Engine can send requests for documents to be indexed to the administration servers. This functionality is enabled within the Content Engine by setting the EnableDispatcher configuration setting. Because this function must be enabled on only one Content Engine at a time, if that Content Engine fails, dispatching stops. In these versions of the Content Engine, the administrator must manually enable this setting on a separate Content Engine if the designated Content Engine fails. A potential method of automating the failover of this functionality is to include the Content Engine with this setting enabled in an active/passive cluster of the Master Administration Server. Then, if a failover happens for any reason, the passive Content Engine can be brought up with the setting enabled, and dispatching continues. As of this writing, this approach has not been tested for our case study. Beginning in Release 4.5, more than one Content Engine can have this setting enabled. Therefore, all Content Engines at the site where the Content Search Engine servers reside can submit the request, thus eliminating the single point of failure.

Index Servers

Each Index Server manages one or more collections of documents, and each collection is a member of only one Index Area within the Content Engine. When a document is added to an object store, the Content Engine determines which Index Area is used to index that document, based on a number of factors that are designed to maximize performance, and thus choosing a set of collections. When a collection becomes full, a new collection is automatically created.

There are two aspects of the Index Servers that impact high availability configurations:

- K2 Index Servers manage all writes and updates to the collection files. To do so, they require local disk access to the file system housing the collections. While such a file system can be housed on a storage area network (SAN) and connected through a Fibre Channel network (so that it appears as a local disk

to the server), it *cannot* be accessed by the Index Server through a network share, such as Network File System (NFS) or Common Internet File System (CIFS). Testing has shown that if the Index Server accesses the collections through a network share, corruption of the collection files can result.

- The Index Server is not designed to work in an active/active configuration. Therefore, for any given set of collections (Index Area), there can be only one Index Server active at a time. Therefore, for a high availability configuration, each Index Server must be paired in an active/passive cluster configuration. In order for the passive node to be able to access the collections as local storage, it is also therefore necessary to store the collections on a SAN and access them through a Fibre Channel network, so that the passive system can take control of the storage area at the time of failover.

Compared with the Index Servers, it is easy to make the Search Servers highly available. Requests for searches are sent to the Broker Servers. The Brokers farm the requests across all available Search Servers and coalesce the results before returning them to the Content Engine. This approach implements a proprietary high availability solution. The Search Servers, unlike the Index Servers, can access the collections through shared file systems. Because this file system is the local storage on the Index Server host, this approach is typically implemented by having that host share the storage using NFS or CIFS. The number of Search Servers can thus be easily scaled at any time to meet high availability and performance requirements

Figure 3-1 on page 54 illustrates a typical IBM FileNet P8 4.0 system configured for high availability, including an *N*+1 active/passive cluster for Content Search Engine.

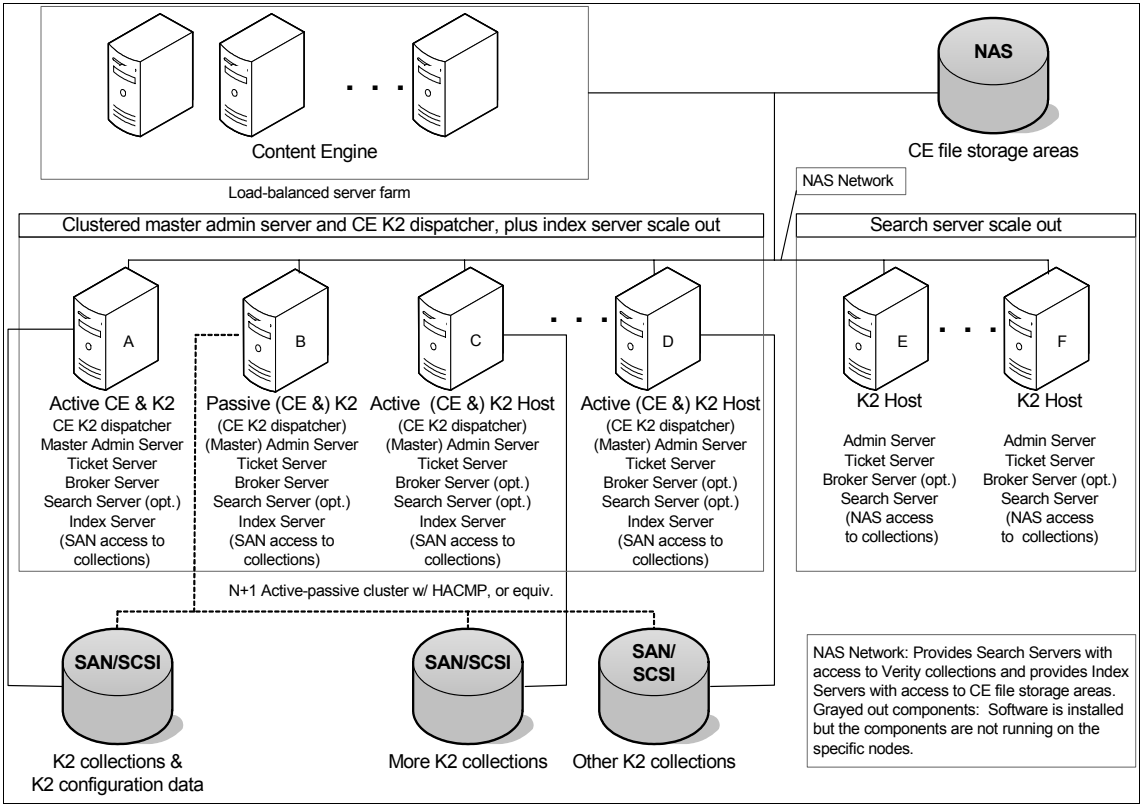


Figure 3-1 N+1 active/passive cluster for CSE in a P8 high availability configuration

In the active/passive cluster shown in Figure 3-1, four servers (A, B, C, and D) are configured with identical software and settings. Any one server can be used as the passive server. In this configuration, server A is the active server that runs everything. Server B is the passive server. Although all the software is installed on this passive server, it is not running these components, and thus, server B is shown with the installed software grayed out, in a steady state of the *N*+1 cluster. Servers C and D are the scaled-out active Index Servers. Each Index Server must be configured with its own dedicated K2 collection, but searches span all of the collections. The Broker Server and the Search Server are optional components on these servers. The servers can run these components or be dedicated to indexing other collections. In addition, they do not run the Master Administration Server or the CE K2 dispatcher, because only one active server in the cluster needs to perform these tasks. Starting with Release 4.5, CSE can detect when the active CE K2 dispatcher fails and start it automatically on another CE. So, the clustering software does not need to start, stop, or monitor the CE K2 dispatcher in Release 4.5. Server E and server F are scaled out servers dedicated for searching. Depending on system performance

requirements, you can scale out multiple servers dedicated only for indexing other collections or performing searches.

For more information about various configuration options, see the Autonomy documentation, which you can find at this Web site:

http://www.f5.com

Note: In Version 4.5 and later releases, because more than one CE can dispatch indexing requests, CE is not part of the active/passive cluster. Otherwise, the configuration is identical to Figure 3-1.

3.7 Image Services and CFS-IS

Image Services is a collection of native programs written in C. It does not operate under an application server. The only option for high availability for Image Services is an active/passive cluster. For scalability, the separate services that comprise Image Services can be spread across multiple servers, but the high availability operation only supports a combined server with all of the services co-resident.

Tests of high availability configurations of Image Services have included Microsoft Cluster Server and Veritas Cluster Server. Detailed information about configuring Image Services for high availability is in *IBM FileNet Image Services: VERITAS Cluster Server and VERITAS Volume Replicator Guidelines,* GC31-5545.

For the case study that we implemented for this book, the Image Services cluster is managed by IBM PowerHA for AIX (HACMP - formerly IBM High Availability Cluster Multi-Processing).

One restriction on the Image Services configuration for high availability is that only Magnetic Storage and Retrieval (MSAR) storage is supported, not optical drives on Small Computer System Interface (SCSI) connections.

If the database goes down and comes back up (in the case of a database failover in an active/passive cluster) while Image Services is operating, versions of IS prior to 4.1.2 do not automatically reconnect to the database and continue operating. The Image Services system must be stopped and restarted manually. For this reason, for these versions, the best practice is to collocate the database and the Image Services system, so that a failover of either component (database or Image Services) automatically results in a failover of the other component. An undocumented alternative is to automate the restart of Image Services whenever the database is restarted under control of the cluster management software.

Starting with Version 4.1.2, Image Services can reconnect to the database after the connection is lost. A new setting, db_reconnect_disabled, must be disabled (set to the value “0”) to configure this new behavior. If the configuration is done this way, users who are executing a transaction at the time of a database connection loss, might receive a <121,0,41> error message, after which the transaction is automatically retried.

Image Services normally operates as a stand-alone product. When integrated with Content Engine, each instance of Content Engine includes connector software known as Content Federated Services for Image Services (CFS-IS). There is a many-to-one relationship between the Content Engine instances and a single Image Services instance. The import agent portion of CFS-IS pulls new documents from an import queue within Image Services, so this function is automatically farmed across all Content Engine instances.

There are two important differences in the 4.*x* version of CFS-IS compared with the 3.5 version:

- In the 3.5 version, CFS-IS was not integrated with Content Engine. For a high availability solution, while Content Engine 3.5.*x* can be farmed, the File Store Service (FSS) in Content Engine 3.5.*x* could not be farmed, only active/passive-clustered. The best solution for Content Engine 3.5 was to set up FSS on a separate computer.
- The 3.5.*x* version of CFS-IS required the installation of the Image Services Toolkit (ISTK) on the Content Engine hosts.

With the 4.*x* version of CFS-IS, these steps are no longer required.

3.8 Summary

Table 3-1 on page 57 summarizes the high availability options and recommended strategies for the main P8 server components.

Table 3-1 High availability options and best practice strategies for P8 components

Server	Supported HA solutions	Best practice HA strategy
Content Engine	Farming or active/passive clustering	Farming
Process Engine	Farming[a] or active/passive clustering	Farming
Application Engine	Farming or active/passive clustering	Farming
Image Services	Active/passive clustering	Active/passive clustering
CFS-IS	Farming with CE	Farming with CE
Content Search Engine	*N*+1 active/passive cluster	*N*+1 active/passive cluster

a. Process Engine farming only supports hardware load balancers at the time of writing this book.

Part 2

High availability implementation for IBM FileNet P8 system components

4

Infrastructure setup: Introducing the case study

This chapter describes the high-level architecture of our lab environment that is used as the case study for this IBM Redbooks publication. In this case study, we set up the entire IBM FileNet P8 environment from the beginning. We use the best practices that are recommended to set up high availability (HA) for P8 whenever possible. The steps that are used for this setup are shared in the later chapters to provide a practical guide for you to follow when you plan and set up your high availability solutions. We discuss the following topics:

- Case study introduction
- Hardware
- Physical architecture
- Architecture summary
- Installation sequence reference

Note: The steps we take are not always the only way to accomplish the tasks. We recommend that you also consult the *IBM FileNet High Availability* White Paper for additional information. To access this paper, go to the FileNet Product Documentation Web site:

http://www-01.ibm.com/support/docview.wss?rs=3278&uid=swg27010422

And then, search for “High Availability” under the Technical Notices section.

4.1 Case study introduction

Based on the high availability strategies and best practices that were presented in Chapter 3, “High availability strategies for IBM FileNet P8 systems” on page 43, for our case study, we implement a highly available IBM FileNet P8 solution in conjunction with writing this book.

The steps involved in implementing this infrastructure are documented in detail in the remaining chapters of this book. Use these steps as sample, practical procedures that you can reference when planning, designing, and implementing high availability for your IBM FileNet P8 solution.

Many of the IBM FileNet P8 software components can be configured in multiple ways to achieve high availability. Where it was feasible and possible within our lab environment, we set up and test these configurations.

Assumptions and dependencies

For our case study, we assume that the network infrastructure, the external storage infrastructure, and other components and services provided by the network, such as Domain Name System (DNS), Lightweight Directory Access Protocol (LDAP), security, and firewalls are highly available. Setting up those components (that are not directly within the IBM FileNet P8 environment) is outside the scope of this book. However, it is worthy to note that if any of those dependency services are not highly available, they can represent a single point of failure outside of the IBM FileNet P8 infrastructure that can cause an outage.

Work with your architecture team to ensure that there is no single point of failure outside of your IBM FileNet P8 environment.

4.2 Hardware

For our case study, we use the IBM System p5® 595 server to deploy the IBM FileNet P8 components. The hardware load balancer that we use is an F5 BIG-IP series 6800. There are other options for servers and load balancers. Check with your architecture team to determine the best servers and load balancers to use for your environment.

4.2.1 IBM p5 595 features and overview

The IBM System p5 595 server (Figure 4-1) is one of the most powerful IBM System p servers, which delivers exceptional performance, reliability, scalability, and flexibility, enabling businesses to take control of their IT infrastructure by confidently consolidating application workloads onto a single system.

Equipped with advanced 64-bit IBM POWER5+™ processor cores in up to 64-core symmetric multiprocessing (SMP) configurations, this server provides the processing power for a full range of complex, mission-critical applications with demanding processing requirements, including business intelligence (BI), enterprise resource planning (ERP), transaction processing, and ultra high performance computing (HPC).

With twice the number of processors, twice the memory capacity, and nearly four times the commercial performance of the previous top-of-the-line IBM eServer™ pSeries® 690 server 1, the p5-595 can ultimately help companies make decisions faster and drive business innovation.

For more information about P595, refer to the following Web site:

`http://www.ibm.com/systems/p/hardware/highend/595/index.html`

Figure 4-1 IBM p5 595

Table 4-1 on page 64 lists the p5-595 features.

Table 4-1 System p5 595 features

Features	Benefits
POWER5+ technology	► Designed to provide excellent application performance and high reliability. ► Includes simultaneous multithreading to help increase commercial system performance and processor utilization.
High memory/I/O bandwidth	► Fast processors wait less time for data to move through the system. ► Delivers data faster for the needs of high performance computing (HPC) and other memory-intensive applications.
Flexibility in packaging	► High-density 24-inch system frame for maximum growth.
Shared processor pool[a]	► Provides the ability to transparently share processing power between partitions. ► Helps balance processing power and makes sure that the high priority partitions get the processor cycles that they need.
Micro-Partitioning[a]	► Allows each processor in the shared processor pool to be split into as many as 10 partitions. ► Fine-tunes processing power to match workloads.
Virtual I/O[a]	► Helps save cost and ease systems administration by sharing expensive resources.
Virtual LAN[a]	► Helps speed internal communication between partitions at memory speeds.
Dynamic logical partitioning[a]	► Allows reallocation of system resources without rebooting affected partitions. ► Offers greater flexibility in using available capacity and more rapidly matching resources to changing business requirements.
Mainframe-inspired reliability, availability, and serviceability (RAS)	► Delivers exceptional system availability using features that include redundant service processor, IBM Chipkill memory, First Failure Data Capture, dynamic deallocation of selected system resources, hot-plug/blind-swap PCI-X slots, hot-swappable disk bays, redundant hot-plug cooling and power subsystems, selective dynamic firmware updates, hot-add I/O drawers, dual system clocks, and more.

Features	Benefits
Broad range of capacity on demand (CoD) offerings[a]	► Provides temporary access to processors and memory to meet predictable business spikes. ► Provides prepaid access to processors to meet intermittent or seasonal demands. ► Offers a one-time 30 day trial to test increased processor or memory capacity before permanent activation. ► Allows processors and memory to be permanently added to meet long-term workload increases. ► Provides backup system with inactive processors to be activated in disaster recovery situations.
Grid Computing support[a]	► Allows sharing of disparate computing and data resources across heterogeneous, geographically dispersed environments, helping to increase user productivity.
Scale-out with communications storage manager (CSM) support[a]	► Allows for more granular growth so user demands can be readily satisfied. ► Provides centralized management of multiple interconnected systems. ► Provides ability to handle unexpected workload peaks by sharing resources.
High Performance Switch attachment[a]	► Offers maximum performance, scalability, and throughput for parallel message-passing applications. ► Allows attachment of up to 16 server nodes.
Multiple operating system support	► Allows clients the flexibility to select the right operating system and the right application to meet their needs. ► Provides the ability to expand application choices to include many open source applications.
AIX 5L™ operating system[a]	► Delivers increased throughput for mixed workloads without complex system configuration or tuning. ► Delivers integrated security features designed for system protection. ► Extends application choices with Linux® affinity.
Linux operating system[a]	► Enables access to 32-bit and 64-bit open source applications. ► Provides a common operating environment across IBM server platforms. ► Built on open standards.

a. Indicates this feature is optional, is available on selected models, or requires separate software.

Case study usage

For our case study, we use a fully loaded IBM p5 595 system. The system is equipped with 64 processor nodes operating at 2.1GHz and 512 GB of RAM. We partitioned the p5 595 system into multiple logical partitions (LPARs), each allocated with four processors and 4 GB of RAM. Storage is allocated on an IBM DS8300 connected to each LPAR via multiple 2 Gbps Fibre Channel virtual paths. We installed AIX 5.3 in all logical partitions.

The high availability techniques that are discussed in this book are applicable not only to this type of configuration. You can also use multiple, less powerful machines to achieve high availability.

4.2.2 BIG-IP 6800 system features and overview

For our case study, we use the BIG-IP 6800 hardware load balancer (Figure 4-2) to load balance HTTP traffic between our active/active clusters.

The BIG-IP 6800 system is a port-based, multi-layer switch that supports the virtual local area network (VLAN) technology, F5 Network. Refer to Chapter 5, “Hardware load balancer implementation (F5 BIG-IP)” on page 73 for features and an overview.

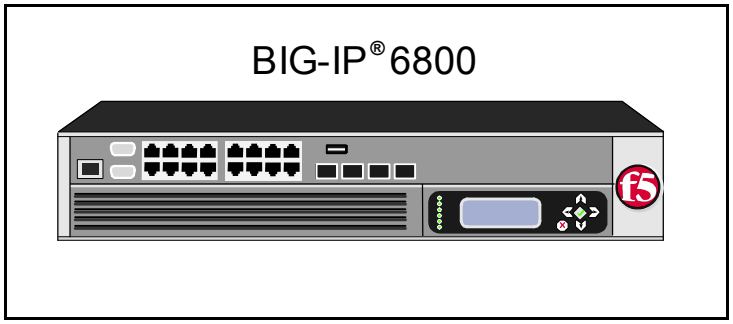


Figure 4-2 F5 BIG-IP 6800

4.3 Physical architecture

Our case study consists of two scenarios. Figure 4-3 on page 67 illustrates the physical architecture of scenario A of our case study system. The remaining sections of the chapter describes the logical architecture of our system.

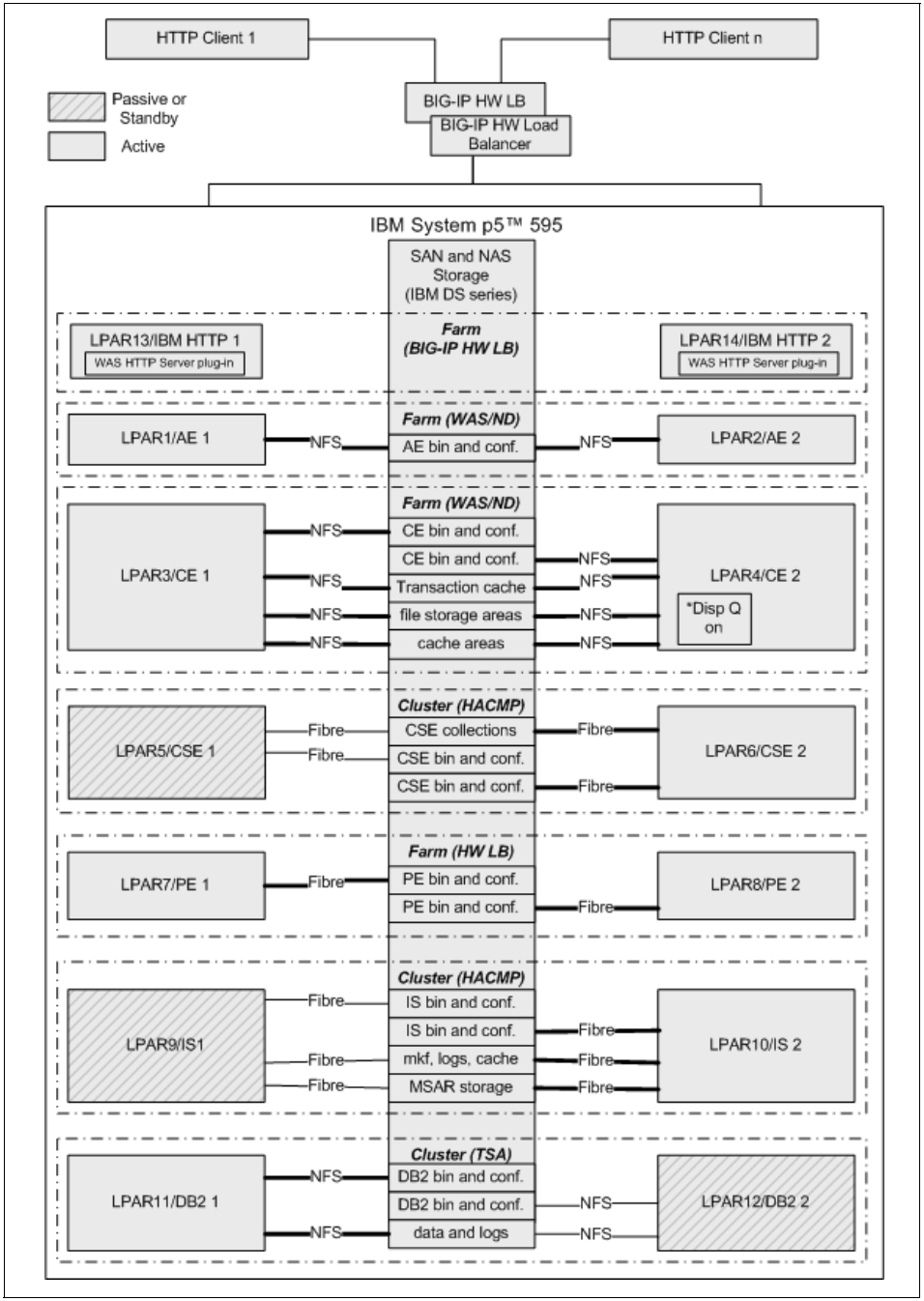


Figure 4-3 Scenario A: P8 physical architecture with PE in an active/active setup

Note the following information in Figure 4-3 on page 67:

- Each rectangle represents a machine or a system. A clear rectangle shows the active or primary system in this HA configuration, and a shaded rectangle shows the standby or secondary system.
- “NFS” indicates a particular directory or file system is shared via an NFS mount.
- “Fibre” indicates a particular directory or file system is shared via Fibre Channel connections; therefore, all systems that are connected with “Fibre” will access the exact same storage or disks.
- The storage units in the center of the diagram list all the critical P8-related configuration files, binaries, and data that require HA setup.
- In general, the lines that connect all the rectangular boxes indicate network connection, unless marked “Fibre.”

All of the hardware used in our case study existed as logical partitions (LPARs) of a single p5 595 server. However, the behavior from the standpoint of high availability is the same as if part or all of the logical servers are implemented on physically separate servers. Because the hardware of the p5-595 contains redundant components, it is considered to be highly available even though it is a single system.

Scenario B is an alternative to scenario A. In scenario B, instead of using a farm for Process Engine, we use IBM PowerHA for AIX (HACMP - formerly IBM High Availability Cluster Multi-Processing) to set up an active/passive cluster for Process Engine. Figure 4-4 shows the portion of the physical architecture diagram for scenario B that differs from scenario A.

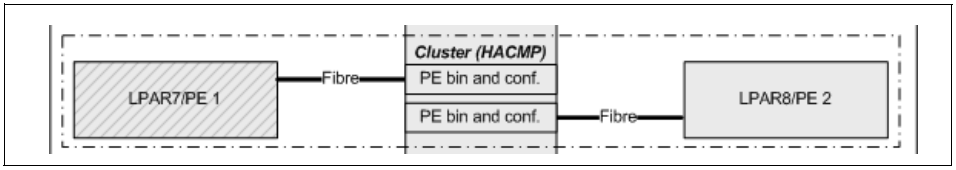


Figure 4-4 Scenario B: Physical architecture (partial) with PE in an active/passive setup

This book describes the details of the scenario A setup in later chapters.

4.4 Architecture summary

This section describes the architecture that is set up for our case study. We set up two environments: scenario A and scenario B.

4.4.1 Scenario A

Figure 4-5 shows scenario A. In this scenario, the IBM FileNet P8 Process Engine is set up in an active/active mode with a hardware load balancer distributing the requests for the Process Engine. For a new setup of an IBM P8 environment, scenario A is the best practice approach.

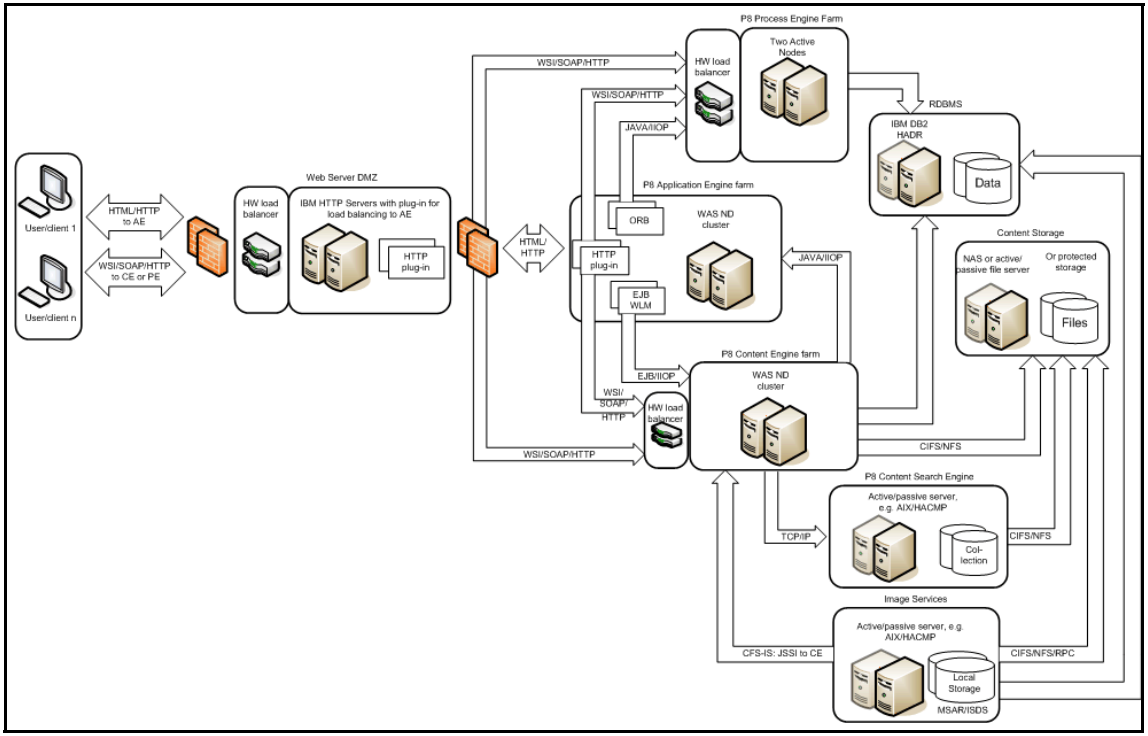


Figure 4-5 Scenario A: P8 logical architecture with Process Engine in an active/active setup

As shown in Figure 4-5, client communications enter the system through a DMZ, which is separated from the outside world, and from the inner, protected network, by a pair of firewalls. The use of a DMZ is not a requirement for a P8 installation, but we recommend using it to achieve security of the network and servers. Inside the DMZ is a stand-alone Web server that does not store local data and thus cannot easily be compromised. Because we are configuring this environment for

high availability, there must be two of these Web servers to avoid having a single point of failure in the network. Because there are two servers, we use a hardware load balancer and a backup load balancer for redundancy, to route traffic to the Web servers. Because the target system to which the Web servers will connect is a WebSphere application server, the two Web servers in the DMZ have the WebSphere HTTP Plug-in installed. The plug-in handles the WebSphere-specific load balancing task.

After the traffic passes through the inner firewall, it then reaches the WebSphere cluster running the Application Engine. The communication path from the clients through the AE is always over HTTP or the equivalent HTTPS transport protocol. Application Engine then communicates with the Content Engine WebSphere cluster and the Process Engine farm via their required protocols: IIOP through a hardware load balancer for PE and EJB/IIOP; for certain applications layered on AE, Web Services Interface (WSI) over HTTP for CE; or WSI for PE. Again, for redundancy, two load balancers are shown in front of the PE farm. Note also that there is direct communication between CE and PE. This bidirectional communication always uses the Web Services protocol over HTTP. The load balancers shown in front of the PE farm will be used to balance these connections when made from a PE to the CE cluster.

The figure also shows an existing Image Services system. The content stored on this system is made accessible to the P8 clients via CFS-IS. Each CE manages its own CFS-IS connection software, so this portion of the system is automatically made redundant by the fact that there is more than one CE instance in the CE cluster. The Image Services system is made highly available via an active/passive cluster (HACMP).

Figure 4-5 on page 69 shows Image Services, CE, and PE accessing the same database server. In practice, you can separate this function into two or more database servers, depending upon capacity and scalability considerations. You can have as many database servers as one for each CE object store, plus one for the PE farm, and one for the Image Services server.

Finally, the Content Engine uses the Content Search Engine. Figure 4-5 on page 69 shows that the CSE service is made highly available by an active/passive HACMP cluster.

CE, CSE, and IS also make use of content storage, which must also be made highly available. In order for this storage to be available to all the servers, it must be made available via a file sharing protocol, such as NFS or CIFS. Therefore, this storage is frequently stored on a Network Attached Storage (NAS) device. In other cases, it might be stored on a Storage Attached Network (SAN). In this case, the storage must be shared over the network either by a "*NAS Head*," a hardware device that exposes the SAN's storage via file sharing protocols over the network, or by attaching it to a particular computer system and having that

system share the storage via NFS or CIFS. In all of these cases, there must be no single points of failure for an HA configuration, so each device must have a duplicate standby device available, or its hardware must include redundant components (as is available for most NAS head devices).

4.4.2 Scenario B

Figure 4-6 shows scenario B. In this scenario, the IBM FileNet P8 Process Engine is set up in an active/passive mode utilizing IBM HACMP software. For the clients with IBM FileNet P8 Process Engine 3.*x* in a high availability setup who are upgrading to P8 4.*x*, the first step is to upgrade to the scenario B configuration. In P8 3.*x*, the only HA solution for Process Engine was an active/passive cluster. After upgrading to 4.*x*, certain clients might prefer to continue using the active/passive cluster approach for PE high availability. However, the best practice recommendation is then to convert the PE cluster to an active/active farm (scenario A), because this configuration uses the otherwise-passive node during normal operations, resulting in better performance, as well as requiring no downtime if a failure of one of the PE nodes occurs.

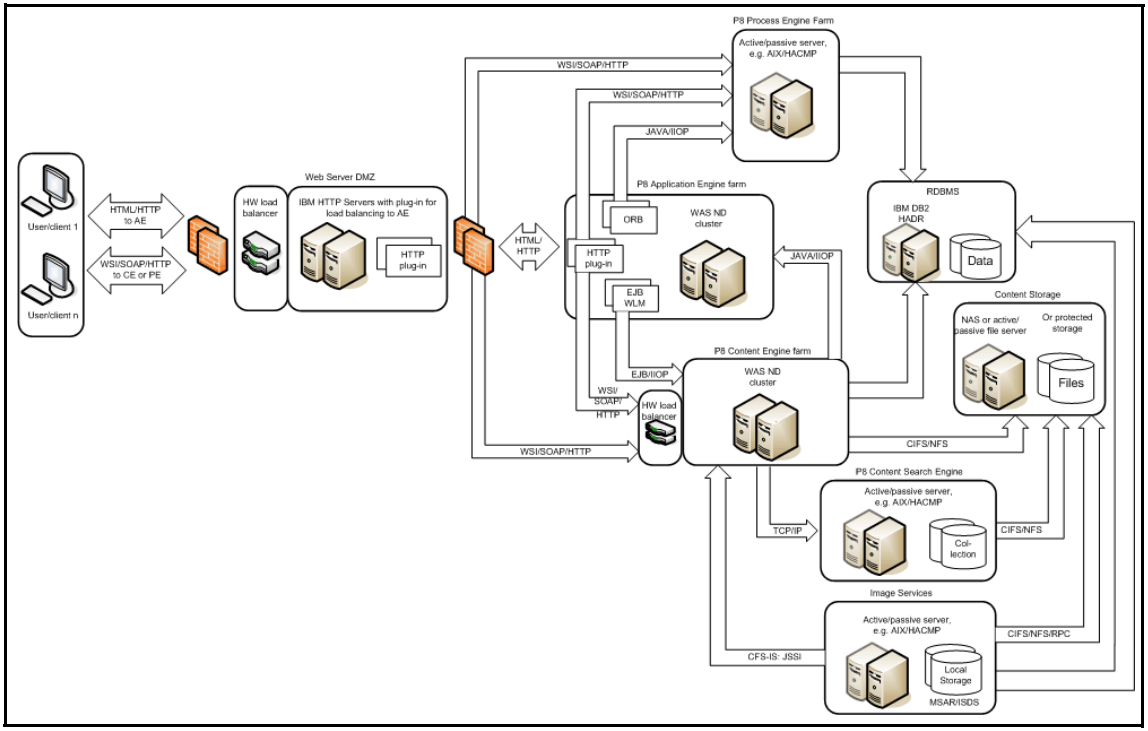


Figure 4-6 Scenario B: P8 logical architecture with Process Engine in an active/passive setup

The remainder of the configuration in scenario B is identical to the best practice approach that is illustrated in scenario A, so refer to 4.4.1, “Scenario A” on page 69.

Note: This book describes the detailed configuration for scenario A only.

4.5 Installation sequence reference

Although there is not a documented recommended order to install IBM FileNet P8 components, we recommend installing the components in the following order:

1. Hardware load balancer and its associated software
2. Web tier (WebSphere) and databases (DB2), which can be installed in parallel.
3. ecm_help
4. Content Engine
5. Application Engine
6. Process Engine
7. Content Search Engine
8. Image Services, which can be installed in parallel with Content Search Engine.

Hardware load balancer and its software can be installed at a later time if you do not have the hardware available at the beginning of the project.

This sequence is another possible installation order:

1. Hardware load balancer and its associated software
2. Web tier (WebSphere) and database (DB2)
3. ecm_help
4. Content Search Engine
5. Content Engine
6. Process Engine
7. Application Engine

5

Hardware load balancer implementation (F5 BIG-IP)

The best practice to set up Process Engine for high availability is to use a Process Engine farm. You can farm Process Engine by using hardware load balancers only. For our case study setup, therefore, we choose to use a lab-approved hardware load balancer, the BIG-IP System from F5 Network.

This chapter describes the use of the BIG-IP 6800 system, the hardware load balancer that is also known as the application delivery controller (ADC), in our IBM FileNet P8 high availability setup. For the convenience of the setup and to take advantage of the many benefits that the BIG-IP System has to offer, you can also use the load balancer for multiple IBM FileNet P8 components for high availability purposes.

We discuss the following topics:

- BIG-IP System overview
- BIG-IP configuration for IBM FileNet P8
- Setting up and configuring standby BIG-IP
- Set up administrative partitions for P8

5.1 BIG-IP System overview

The BIG-IP System is a port-based, multilayer switch that supports virtual local area network (VLAN) technology. Because hosts within a VLAN can communicate at the data-link layer[1], a BIG-IP System reduces the need for routers and IP routing on the network, which, in turn, reduces equipment costs and boosts overall network performance. At the same time, the BIG-IP System can perform IP routing at the network layer, as well as manage TCP, User Datagram Protocol (UDP), and other application protocols at the transport layer through the application layer (for example, the Web page level). These capabilities provide comprehensive and simplified traffic management and security for IBM FileNet P8 components, such as the Web servers, Content Engine, and Process Engine.

5.1.1 Core modules

BIG-IP System provides comprehensive traffic management and security for many traffic types through the following modules that are fully integrated in the device:

- BIG-IP Local Traffic Manager
- BIG-IP WebAccelerator
- BIG-IP Global Traffic Manager
- BIG-IP Link Controller
- BIG-IP Application Security Manager
- BIG-IP Secure Access Manager

BIG-IP Local Traffic Manager

The BIG-IP Local Traffic Manager features ensure that you get the most out of your network, server, and application resources. BIG-IP Local Traffic Manager removes single points of failure and virtualizes the network and applications using industry-leading layer 7 (L7) application intelligence. BIG-IP Local Traffic Manager includes rich static and dynamic load balancing methods, including Dynamic Ratio, Least Connections, and Observed Load Balancing, which track dynamic performance levels of servers in a group. These methods ensure that all sites are always on, more scalable, and easier to manage than ever before.

[1] Open Systems Interconnection Basic Reference Model (OSI Model) divides network architecture into seven abstract layers: (1) Physical, (2) Data Link, (3) Network, (4) Transport, (5) Session, (6) Presentation, and (7) Application.

For more information, see the *Configuration Guide for BIG-IP Local Traffic Management*. You can access BIG-IP documentation from the following Web sites:

- *BIG-IP System Management Guide*:

  https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys.html

- Instructions for BIG-IP 5 high availability configuration in the GUI:

  https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys/9_0_xSystemMgmtGuide-13-1.html#wp1020826

BIG-IP WebAccelerator

BIG-IP WebAccelerator is an advanced Web application delivery solution that provides a series of intelligent technologies that overcomes performance issues involving browsers, Web application platforms, and wide area network (WAN) latency. By decreasing page download times, WebAccelerator offloads servers, decreases bandwidth usage, and ensures the productivity of application users.

BIG-IP Global Traffic Manager

The BIG-IP Global Traffic Manager provides intelligent traffic management for high availability across multiple data centers, for managing backup and disaster recovery, and for your globally available network resources. Through the Global Traffic Manager, you can select from an array of load balancing modes, ensuring that your clients access the most responsive and robust resources at any given time. In addition, the Global Traffic Manager provides extensive monitoring capabilities so the health of any given resource is always available. For more information, see the *Configuration Guide for BIG-IP Global Traffic Management*.

BIG-IP Link Controller

BIG-IP Link Controller monitors the availability and performance of multiple WAN connections to intelligently manage bidirectional traffic flows to a site, providing fault-tolerant, optimized Internet access regardless of connection type or provider. The Link Controller ensures that traffic is always sent over the best available link to maximize user performance and minimize bandwidth cost to a data center. For more information, see the Configuration Guide for BIG-IP Link Controller.

BIG-IP Application Security Manager

BIG-IP Application Security Manager provides Web application protection from application layer attacks. BIG-IP Application Security Manager protects Web applications from both generalized and targeted application layer attacks, including buffer overflow, SQL injection, cross-site scripting, and parameter

tampering. For more information, see the Configuration Guide for BIG-IP Application Security Manager.

BIG-IP Secure Access Manager

BIG-IP Secure Access Manager is a high-performance, flexible security platform, providing a unified secure access solution on a single appliance. Using Secure Sockets Layer (SSL) technology for encrypted traffic, BIG-IP Secure Access Manager provides policy-based, secure access to enterprise applications for any client user, from employees, contractors, partners, suppliers, and customers to any corporate resource. BIG-IP Secure Access Manager provides end-to-end data protection for secured Web application client connectivity to enterprise applications.

5.1.2 Key benefits

BIG-IP provides many benefits to a high availability environment:

- High availability: Delivers the industry's most advanced system to ensure that applications are always available.
- Accelerated applications: Provides unmatched control to accelerate application performance by up to 3-15x, ensuring that priority applications are served first and off-loading expensive server cycles.
- Reduced server and bandwidth cost: Triples server capacity through a rich set of infrastructure optimization capabilities, and reduces bandwidth costs by up to 80 percent through intelligent HTTP compression, bandwidth management, and more.
- Greater network and application security: From denial-of-service (DoS) attack protection to cloaking to filtering out application attacks, BIG-IP Local Traffic Manager adds critical security features that simply cannot be addressed elsewhere in the network.
- Unmatched application intelligence and control: The industry's only solution that delivers complete application fluency, enabling network-speed full payload inspection, and programmable, event-based traffic management to understand and act upon application flows.
- Total integration for all IP applications: Provides a comprehensive solution that can integrate with all applications, not just Web-based protocols (HTTP and HTTPS). Provides organizations with a centralized solution for all IP applications, including existing and emerging applications, such as Voice over Internet Protocol (VoIP) — all in a single, unified system.
- Industry-leading performance: Delivers the industry's fastest traffic management solution to secure, deliver, and optimize application performance. As a proven leader, BIG-IP Local Traffic Manager sets the

performance bar with best-in-market SSL transactions per second (TPS), bulk encryption, and the highest concurrent SSL connections available today.

- Easy to manage, better visibility: An advanced GUI greatly simplifies product configuration, offering granular visibility into traffic and system resources, as well as support for making rapid changes across large configurations.
- Extends collaboration between network and application groups: Through partitioned views and application/protocol-specific monitors, BIG-IP Local Traffic Manager improves administrative functions and provides more application-aware traffic management.

5.2 BIG-IP configuration for IBM FileNet P8

For our high availability case study, we utilize and configure the F5 BIG-IP 6800 system for our scenario. BIG-IP is available in a variety of platforms. See your local F5 reseller professional or contact F5 directly for proper sizing. We design our deployment to load balance traffic that is running various protocols in IBM WebSphere servers, specifically Content Engine, HTTP servers for Application Engine, and Process Engine. Figure 5-1 on page 78 shows the configuration with a redundant pair of BIG-IP clusters of WebSphere Application Engine servers (AE1 and AE2), Content Engine servers (CE1 and CE2), and Process Engine servers (PE1 and PE2).

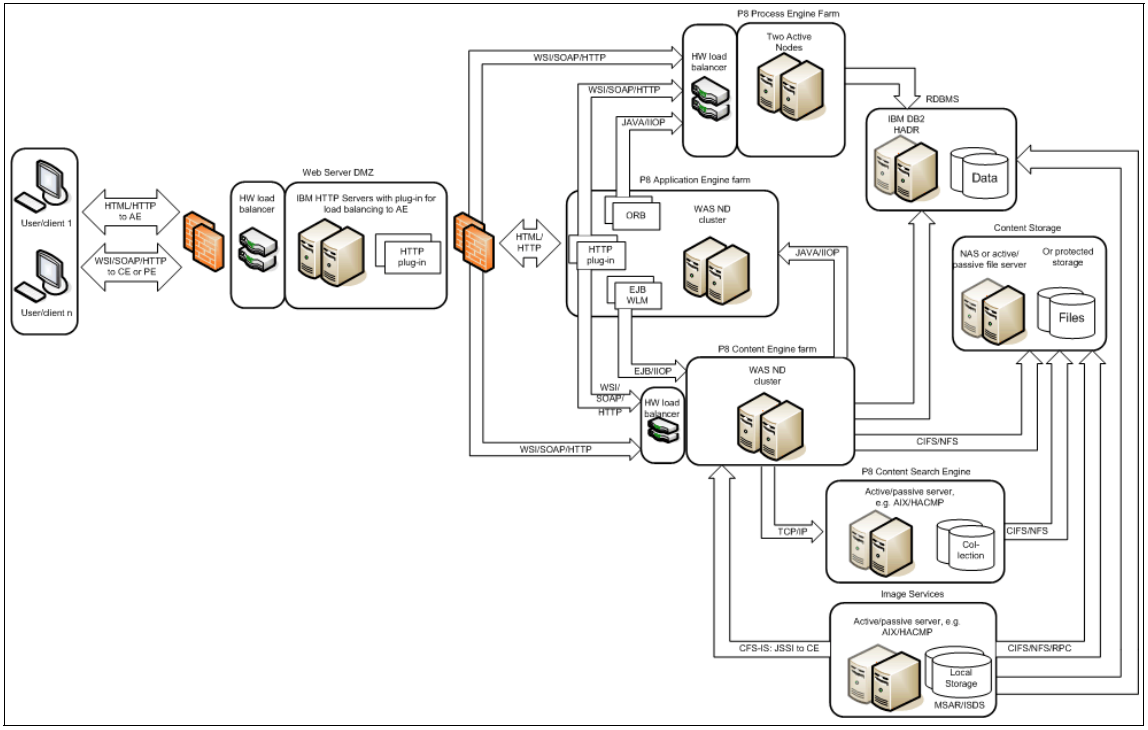


Figure 5-1 BIG-IP hardware load balancer configuration for IBM FileNet P8 high availability setup

Application Engine is implemented in Java and runs as a WebSphere application. It serves as the user's entry point into an IBM FileNet P8 enterprise content management environment, typically through the Workplace application. We use a front-tier Web server, running IBM HTTP Server, to load balance the Web traffic to all Application Engine servers by using the WebSphere HTTP plug-in. You can optionally use a separate pair of BIG-IP Local Traffic Managers in the Web Tier in the DMZ. We choose to focus this chapter on the Application Tier servers and traffic flows. We then load balance the HTTP servers with BIG-IP. We recommend this configuration for both performance and security reasons. This configuration enables us to locate the HTTP servers in a DMZ.

Content Engine is implemented in Java and provides two APIs to facilitate its communications with other P8 components. One API uses Enterprise JavaBeans (EJB). The other API is Web Services Interface (WSI), using the HTTP transport. The HTTP transport is load-balanced in the BIG-IP configuration, whereas the EJB transport is configured with the WebSphere Workload Manager. See the details in Chapter 6, "Web tier implementation" on page 119.

Process Engine provides workflow management capabilities. Process Engine is implemented in C and supports a load-balanced farm configuration. We use BIG-IP to load balance two Process Engine instances in the high availability configuration.

The following sections provide the detailed setup procedures for BIG-IP in the IBM FileNet P8 high availability solution. Follow the sections in order, because the sections include the dependencies.

These steps are required to configure the load balancer for our system:

1. Configuring the self IP and virtual local area networks.
2. Define the pools for Application Engine, Content Engine, and Process Engine.
3. Define the virtual servers for Application Engine, Content Engine, and Process Engine.
4. Enable session affinity for Content Engine in BIG-IP.
5. Configure health monitors for Application Engine, Content Engine, and Process Engine.

5.2.1 Configuring the self IP and virtual local area networks

When a new BIG-IP System is first installed, you must use the administrative console to perform any tasks. The administrative console is a Web application running in a browser. You can access the application in one of the two ways:

- Be on the same network (192.168.1.*xxx*) as the console interface.
- Configure a self IP on one of the lights-out management network ports.

The *lights-out management system* provides the ability to remotely manage certain aspects of the operation of the hardware unit and the BIG-IP traffic management operating system in the event that the traffic management software becomes incapacitated.

The lights-out management system consists of the following elements:

- Switch card control processor (SCCP)

  The hardware that provides the hardware control over the whole unit.

- Host console shell (hostconsh)

  The shell that provides access to the command menu.

- Command menu

  The menu that contains the options for lights-out management.

- Traffic management operating system

  The software that you configure to manage the traffic for your site.

- Out-of-band management commands

  The commands that provide the ability to control various aspects of the system with a series of keystrokes. The command menu operates independently of the traffic management operating system through the management port, the serial port console, and remotely through the traffic management ports.

You can use the command menu to reset the unit, even if the BIG-IP traffic management system has locked up. You can also remotely set a unit to netboot for a software re-installation from an ISO image. You can get console access to the BIG-IP traffic management system itself, so you can configure the traffic management system from the command line interface.

The lights-out management system and the BIG-IP traffic management system function independently within the hardware unit. Figure 5-2 shows the relationship between the lights-out management system and the traffic management system.

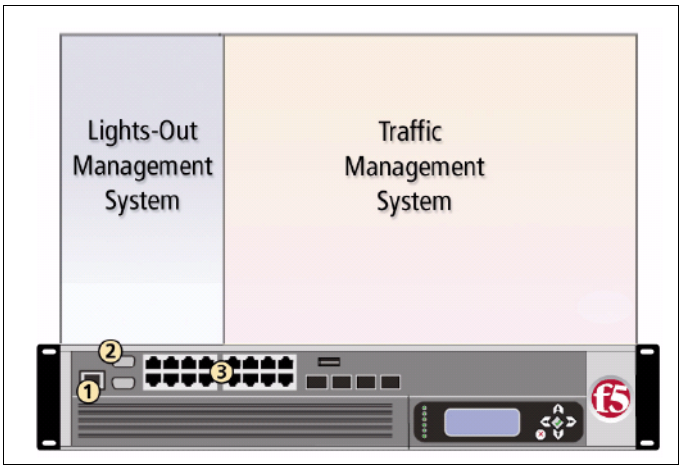


Figure 5-2 BIG-IP lights-out management system

The BIG-IP lights-out management system is accessible through the management interface (number 1 in Figure 5-2) and the console port (number 2 in Figure 5-2). This functionality is independent of the traffic management system (number 3 in Figure 5-2).

Create and manage virtual local area networks

A virtual local area network (VLAN) is a logical subset of hosts on a local area network (LAN) that operate in the same IP address space. Grouping hosts together in a VLAN has distinct advantages:

- Reduce the size of broadcast domains, thereby enhancing overall network performance.
- Reduce system and network maintenance tasks substantially. Functionally related hosts (for example, IBM FileNet P8 Content Engine, Process Engine, and Application Engine) no longer need to physically reside together to achieve optimal network performance.
- Enhance security on your network by segmenting hosts that must transmit sensitive data.

We configure all of the IBM FileNet P8 servers onto a VLAN, which is called vlan_9 in the BIP-IP setup (Figure 5-3). Though simplified, the overall network setup is not only valid in many production environments, but also fully illustrates the concept of using a hardware load balancer within a highly available configuration.

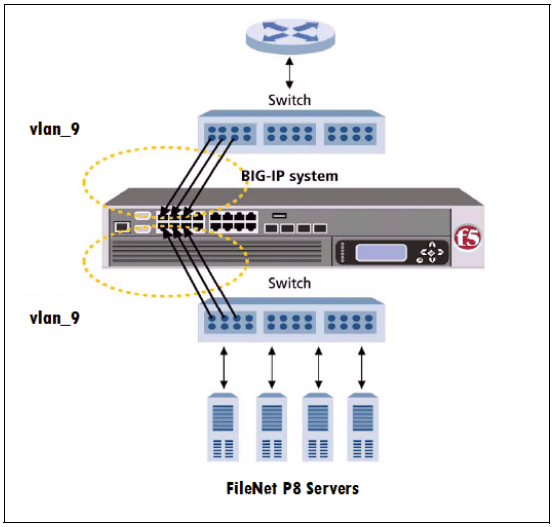


Figure 5-3 VLAN configuration on BIP-IP for IBM FileNet P8

To configure a VLAN in a FileNet P8 HA environment, log on to the BIG-IP administrative console, select **Network** → **VLANs**, and create a VLAN called vlan_9, as shown Figure 5-4 on page 82. Make sure to select the interfaces (that is, port numbers) and assign them as Untagged. 1.1 and 1.2 are the names of the interfaces or ports that are available to connect our network. The rest of the settings are default BIG-IP values.

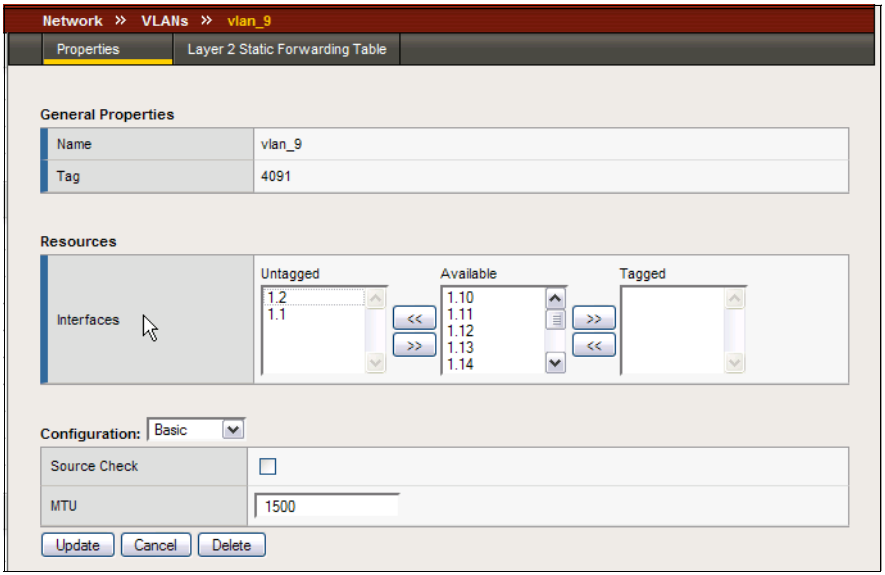


Figure 5-4 Create a VLAN in BIG-IP

Assign a self IP to a VLAN

We configure a self IP address to associate with our VLAN, allowing access to hosts in that VLAN. By virtue of its netmask, a self IP address represents an address space, that is, a range of IP addresses spanning the hosts in the VLAN, rather than a single host address.

Self IP addresses serve three purposes in our HA setup. First, when sending a message to a destination server, the BIG-IP System uses the self IP addresses of its VLANs to determine the specific VLAN in which a destination server resides. For example, the VLAN vlan_9 has a self IP address of 9.30.188.93, with a netmask of 255.255.255.0, and the destination Content Engine's IP address is 9.30.188.20 (with a netmask of 255.255.255.0). The BIG-IP System recognizes that the server's IP address falls within the range of the VLAN self IP address, and therefore sends the message to that VLAN. More specifically, the BIG-IP System sends the message to the interface that you assigned to that VLAN. If more than one interface is assigned to the VLAN, the BIG-IP System takes additional steps to determine the correct interface, such as checking the Layer 2 forwarding table. A Layer 2 forwarding table correlates MAC addresses of network devices to the BIG-IP System interfaces through which those devices are accessible. On a BIG-IP System, each VLAN has its own Layer 2 forwarding table.

Second, a self IP address serves as the default route for each destination server in the corresponding VLAN. In this case, the self IP address of a VLAN appears as the destination IP address in the packet header when the server sends a response to the BIG-IP System.

Third, a self IP can also be used to allow the administrator to connect remotely to the BIG-IP to manage the objects in the system, which means that the administrator does not have to be physically near the system. See the URL address in Figure 5-5.

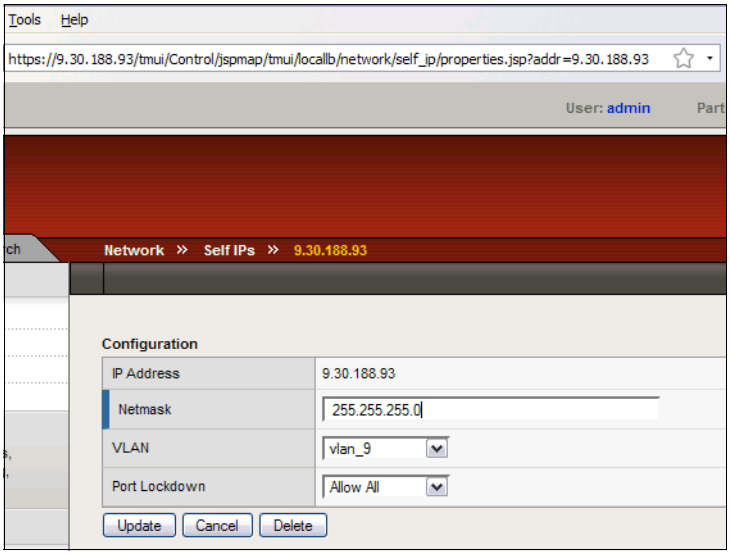


Figure 5-5 Configure a Self IP for a VLAN in BIG-IP

For more advanced configuration, refer to these resources at https://support.f5.com:

- *BIG-IP System Management Guide*:

  https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys.html

- *BIG-IP System Management Overview*:

  https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys/9_0_xSystemMgmtGuide-13-1.html#wp1024795

- Instructions for BIG-IP 5 high availability configuration in the GUI:

  https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys/9_0_xSystemMgmtGuide-13-1.html#wp1020826

5.2.2 Define the pools for Application Engine, Content Engine, and Process Engine

A *pool* is composed of a group of network devices (called *members*). The BIG-IP System load balances requests to the nodes within a pool based on the load balancing method and persistence method that you choose when you create the pool or edit its properties.

The core FileNet P8 servers that use a load balancing method are HTTP Servers for Application Engine (AE), Content Engine (CE), and Process Engine (PE). In the FIleNet P8 HA environment, we configure the following pools:

- p8ae_pool, for Application Engine nodes, AE1 and AE2
- p8ce_pool, for Content Engine nodes, CE1 and CE2
- p8pe_pool, for Process Engine nodes, PE1 and PE2

Other servers can also be configured as a pool, or you can use a pool as additional monitors to report a system's status, as we show in 5.4, "Set up administrative partitions for P8" on page 114.

To create a pool using the BIG-IP Configuration utility, perform the following steps (for brevity, we use CE as the example):

1. In the navigation pane, click **Pools**. The Pools window opens.
2. Click **Add**. The Add Pool window displays.
3. In the Name field, enter a name for your pool. In our example, we use `p8ce_pool`, for the CE servers.
4. In the Load Balancing Method field, select the preferred load balancing method. We recommend one of the following load balancing methods, although various load balancing methods can yield optimal results for a particular network:
   - Least Connections

     In Least Connections mode, the BIG-IP System passes a new connection to the node that has the least number of current connections. Least Connections mode works best in environments where the servers (or other equipment) that you are load balancing have similar capabilities.
   - Fastest

     In Fastest mode, the BIG-IP System passes a new connection based on the fastest response of all currently active nodes. Fastest mode can be particularly useful in environments where nodes are distributed across separate logical networks, or where the servers have varying levels of performance.

Figure 5-6 shows the list of all available load balancing methods in the BIG-IP device.

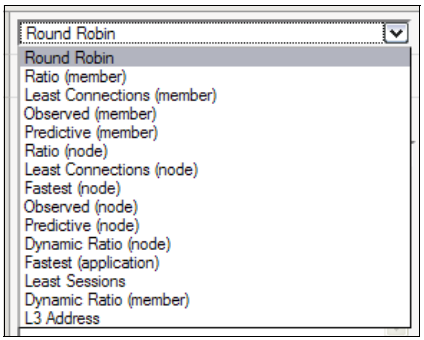


Figure 5-6 List of available load balancing methods

Select the appropriate load balancing method for your environment. For detailed information about the available load balancing method, refer to BIG-IP product manual.

5. In the Resources section, add the FileNet P8 servers to the pool:
   a. In the Member Address field, type the IP address of the server. In our example, the first IP address that we type is `9.30.188.20`, for the first CE server.
   b. In the Service field, type the service number that you want to use for this node (for example, `9080`), or specify a service by choosing a service name from the list (for example, `http`). In our example, we use the default service for WebSphere, `9080`.
   c. The Member Ratio and Member Priority boxes are optional.
   d. Click the Add icon  to add the member to the Current Members list.
   e. Repeat Steps a to d for each FileNet P8 server (for example, CE1 and CE2).
   f. The other fields in the Add Pool window are optional. Configure these fields as applicable for your network. For additional information about configuring a pool, click **Help**.
   g. Click **Done**.

Figure 5-7 on page 86 and Figure 5-8 on page 87 show the properly configured CE pool in the BIG-IP.

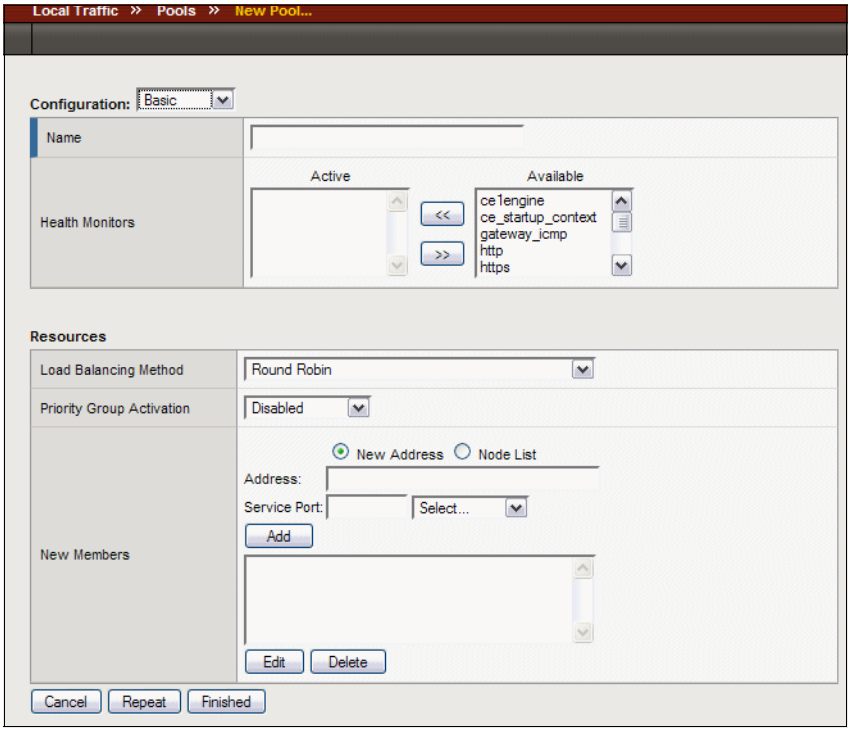


Figure 5-7 Create a new pool window

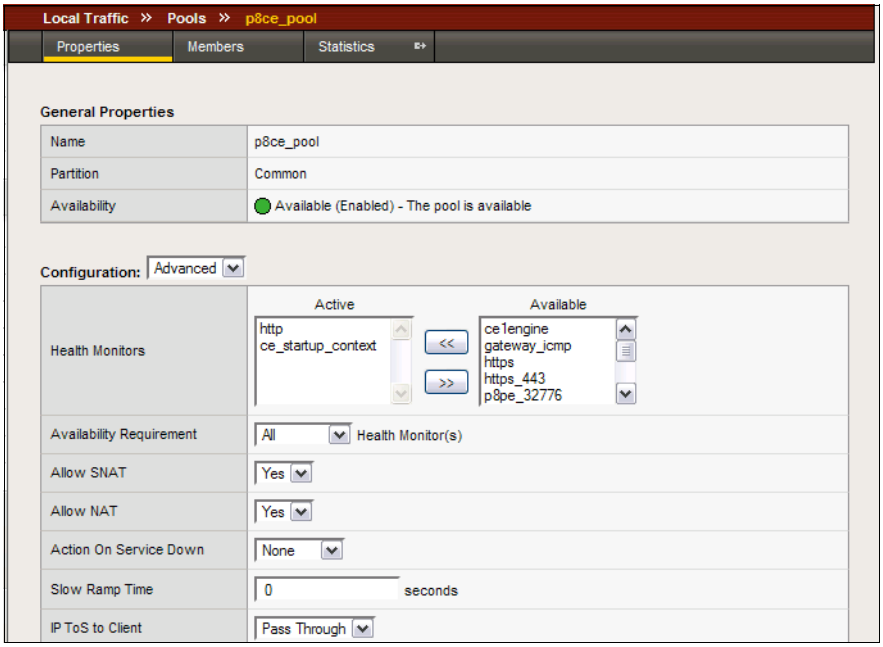


Figure 5-8 Configured load balance pool for CE

As shown in Figure 5-9 on page 88, CE is listening on port number 19080 when it is up and running. HTTP is the protocol that runs on that port. You can configure this protocol into a health monitor, and then, add it to the Health Monitors property of the server member. Refer to 5.2.5, “Configure health monitors for Application Engine, Content Engine, and Process Engine” on page 91 for details about how to set up health monitors for various software components.

When health monitors return an available status, the status shows green. If health monitors are unavailable, the status turns red.

You can always add health monitors to an existing server member. We show the details of health monitors in 5.2.5, “Configure health monitors for Application Engine, Content Engine, and Process Engine” on page 91. In this example, both nodes are available.

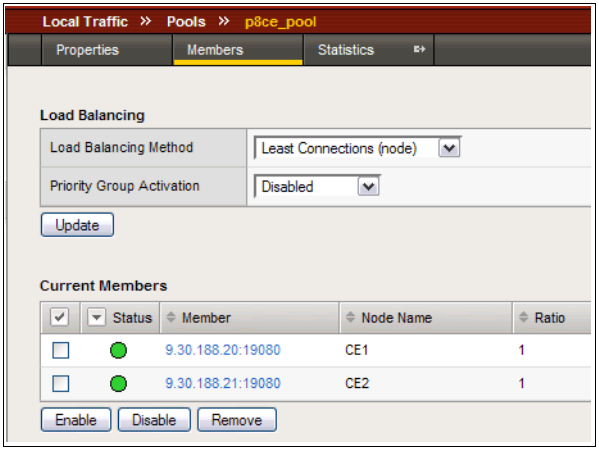


Figure 5-9 Show Members of a Pool in BIG-IP

5.2.3 Define the virtual servers for Application Engine, Content Engine, and Process Engine

Based on terminology defined by F5 Network, virtual servers are a specific combination of virtual address and virtual port, associated with a content site that is managed by an BIG-IP System or other type of host server.

In the FIleNet P8 HA environment, we configure the following virtual servers:

- Web application entry point for user, or virtual server for HTTP servers
- Content Engine virtual server for all HTTP traffic used by PE and others
- Process Engine virtual server for AE and CE traffic

The virtual servers are used during the configuration of AE, CE, PE, and other P8 components that require communications with those servers.

Next, we define a virtual server that references the pool. Again, we define the virtual server from the BIG-IP Configuration utility:

1. In the navigation pane, click **Virtual Servers**. The Virtual Servers window opens.
2. Click **Add**. The Add Virtual Server window opens.
3. Enter the IP address and service for the virtual server, and then, click **Next**. In our example, we use 9.30.188.91 with service of 0 (for all ports). We can specify a particular port number if that is the only port that needs load balancing. We use 0, which means all ports, to simplify the configuration and testing time. See Figure 5-10 on page 89.

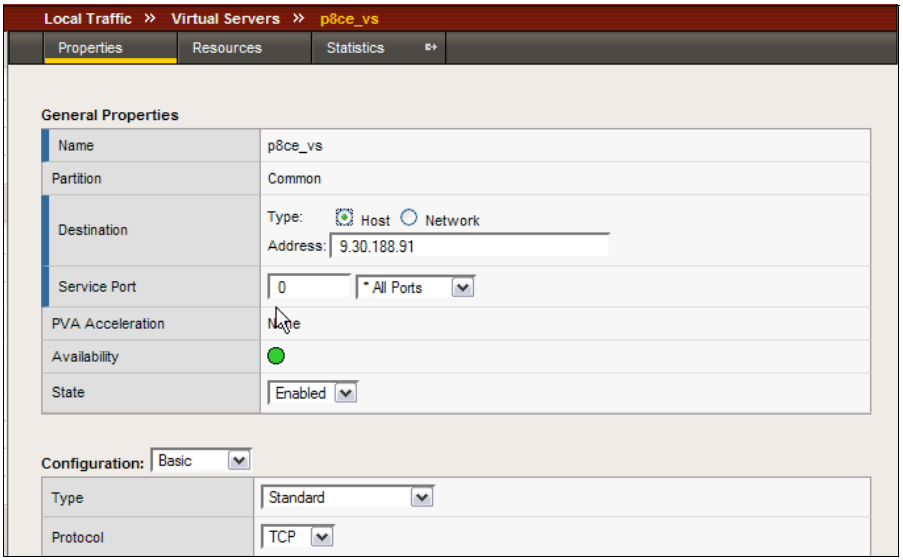


Figure 5-10 Configure a virtual server for a Content Engine farm

4. On the Configure Basic Properties window, leave Enable Address Translation and Enable Port Translation boxes checked. The other fields are optional; configure these fields as applicable to your network. Click **Next**.
5. The Select Physical Resources window displays. Click **Pool option**, and from the list, select the pool that you just created in 5.2.2, “Define the pools for Application Engine, Content Engine, and Process Engine” on page 84. See Figure 5-11.

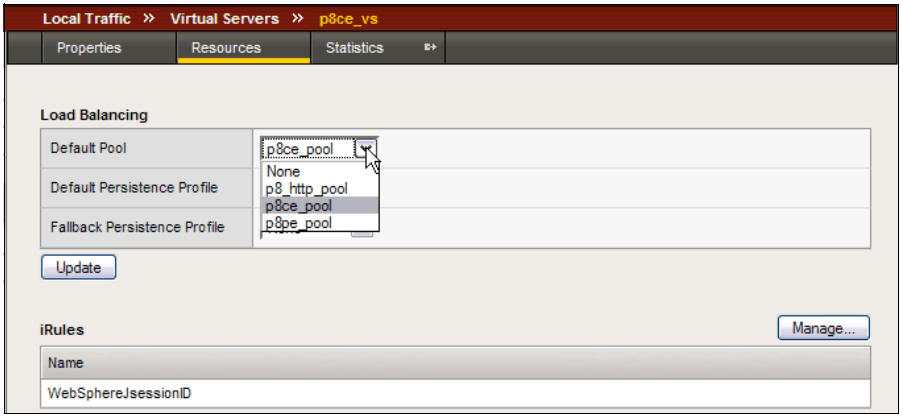


Figure 5-11 Select a predefined pool as the resource for a virtual server

Repeat the same step to create virtual servers for AE and PE.

5.2.4 Enable session affinity for Content Engine in BIG-IP

By design, session affinity is not required for CE. However, it provides better performance for WSI/HTTP applications (for example, PE). In this section, we show how to configure the BIG-IP System to load balance CE servers with persistence on the pool. For optimal load balancing, we recommend the Insert mode of F5's cookie persistence for BIG-IP Version 4.0 and later.

Cookie persistence is a mode of persistence where the local traffic management system stores persistent connection information in a cookie. This method allows previous connections made by the same client to stay alive so that no new connection needs to be established to the same or a separate server. Cookie persistence generally improves performance.

You can configure cookie persistence from the Configuration utility:

1. In the navigation pane, click **Virtual Servers**.
2. In the virtual server list, select the name of the CE virtual server. The properties of that virtual server appear.
3. Click the **Resources** tab at the top of the window.
4. In the Resources section, select **cookie** from the Default Persistence Profile drop-down menu.
5. Click **Update**. See Figure 5-12.

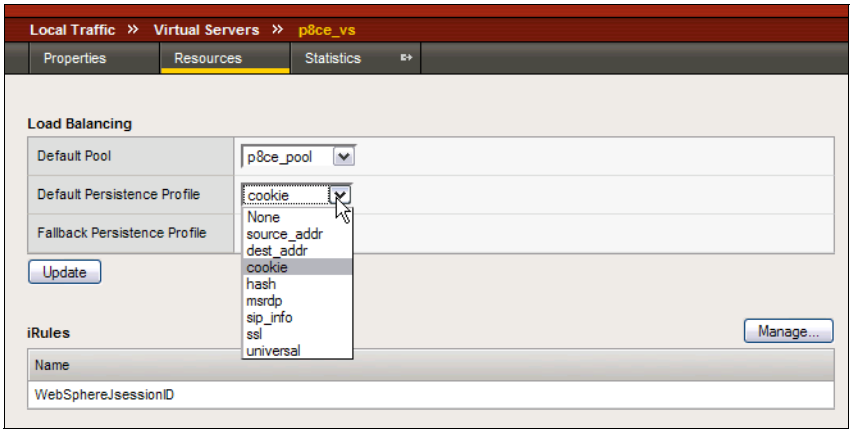


Figure 5-12 Configure CE Affinity using a cookie in BIG-IP

For more information about selecting the appropriate persistence profile, refer to the *BIG-IP Network and System Management Guide*.

5.2.5 Configure health monitors for Application Engine, Content Engine, and Process Engine

A health monitor checks a node to see if it is up and functioning for a given service. If the node fails the check, it is marked down. Multiple monitors exist in BIG-IP for checking various services. We create FileNet P8 specific health monitors to monitor P8 servers. Table 5-1 lists the FileNet P8 specific health monitors used.

Table 5-1 New monitors created for FileNet P8 servers in BIG-IP

FileNet P8 Server	Health monitors used	Notes
HTTP Servers for AE	http	BIG-IP built-in monitor
CE	http ce_startup_context	BIG-IP built-in monitor Custom monitor
PE	p8pe_32777 p8pe_32776 p8pe_32776_http	Custom monitor Custom monitor Custom monitor

HTTP Server health monitor

The default http health monitor in BIG-IP sends a http request to the root of the Web server running the virtual server. In our case, the IBM HTTP Server, when running, displays the welcome page as shown in Figure 5-13 on page 92.

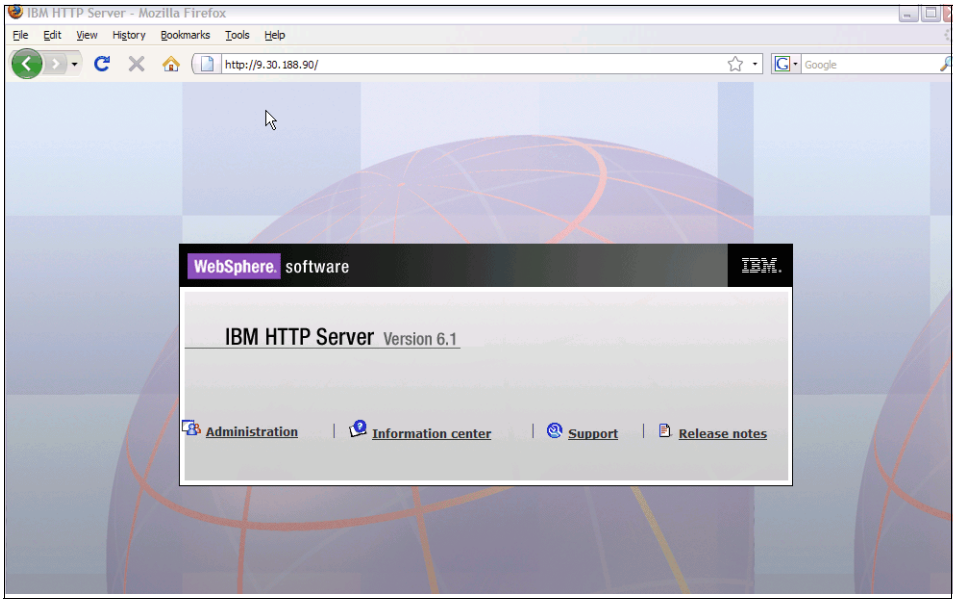


Figure 5-13 Default welcome page of IBM HTTP Server 6.1

The BIG-IP gets a successful return code (that is, 200) from this page and marks the node available for that HTTP Server. Figure 5-14 on page 93 shows the properties of the http monitor in BIG-IP.

It is beyond the scope of this book to discuss in detail the configuration setup and the reason behind each monitor. For detailed information, refer to *BIG-IP Network and System Management Guide*.

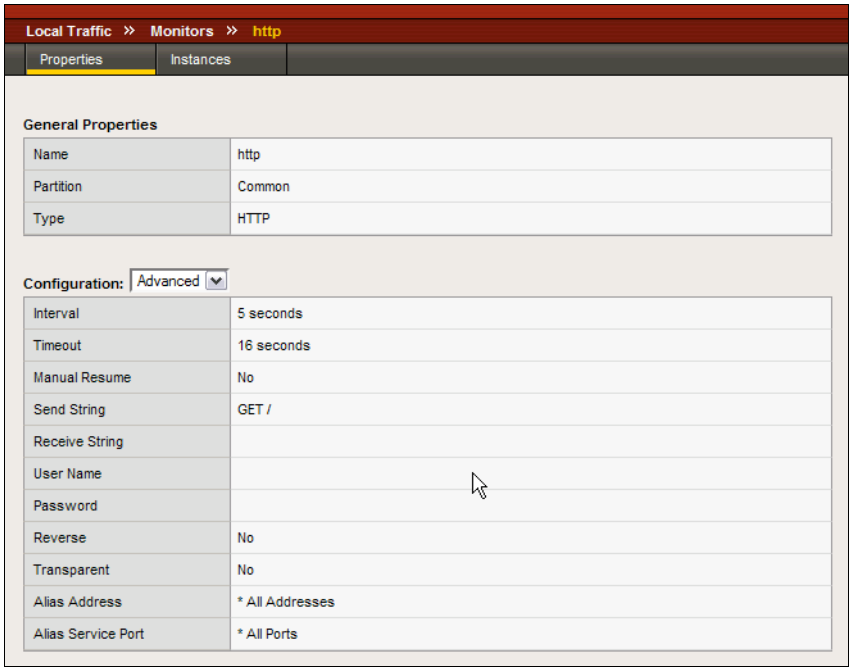


Figure 5-14 HTTP health monitors in BIG-IP

The best practice is a 5 second interval and a 16 second timeout, because health checks can overload the server.

Content Engine health monitors

When the CE WebSphere application server starts successfully, you can get to the Startup Context page, which displays key running applications and their corresponding version information, as shown in Figure 5-15 on page 94.

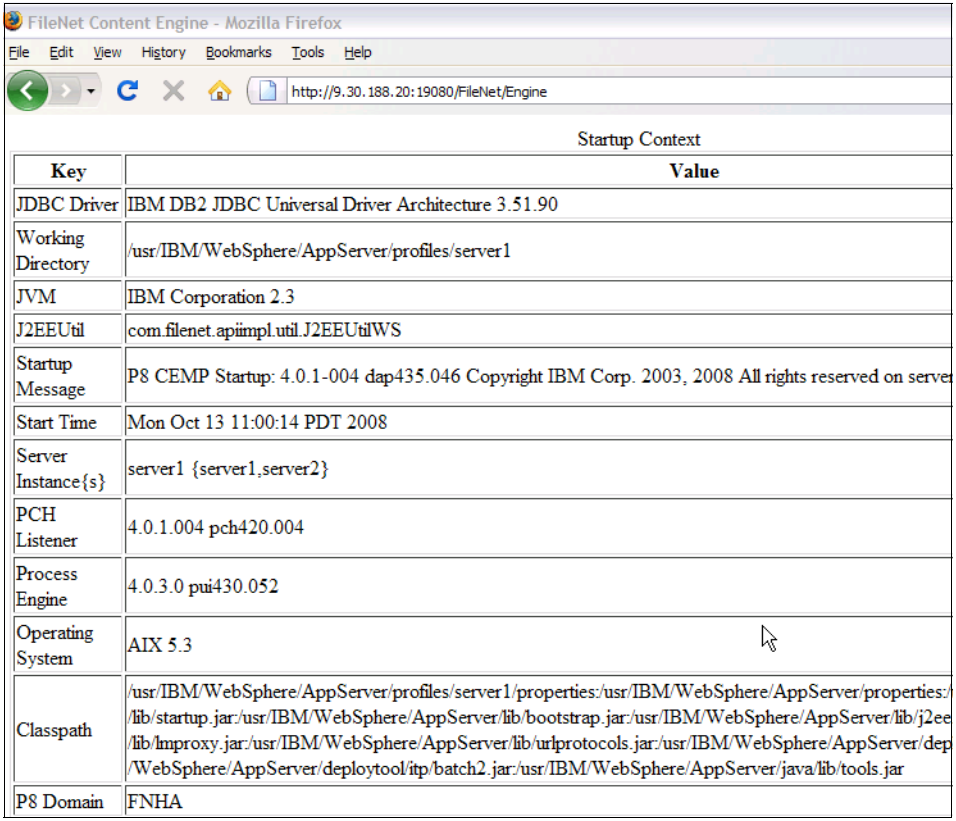


Figure 5-15 CE Startup Context Web page as a monitor

We configure this Startup Context page as one of the CE monitors using the BIG-IP Configuration utility:

1. In the navigation pane, click **Monitors**. The Network Monitors window opens.
2. Click **Add**. The Add Monitor window opens.
3. In the Add Monitor window, type the name of the CE monitor. In our example, we enter `ce_startup_context`. In the Inherits From box, select the http monitor template from the list. Click **Next**.
4. In the Configure Basic Properties section, type an Interval value and a Timeout value. We recommend a 1:3 +1 ratio between the interval and the timeout value (for example, the default setting has an interval of 5 and a timeout of 16).
5. In the Send String box, enter `/FileNet/Engine`. The value /FileNet/Engine is the starter Web page URL that IBM FileNet P8 uses to validate CE's operational status.

After completing the applicable information, click **Done**. See Figure 5-16.

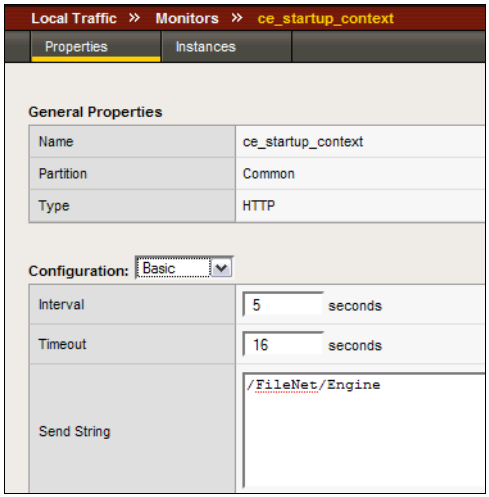


Figure 5-16 Create a CE monitor on the Startup Context page

Process Engine health monitors

The FileNet P8 Process Engine runs many processes as a whole. Each process runs as a separate combination of a host name and a port. Two important process broker services, vwbroker and vworbbroker, run on ports 32776 and 32777, respectively.

You can verify the status of the broker process from a browser by using the following URL:

`http://9.30.188.30:32776/IOR/ping`

Figure 5-17 shows the monitor output in a browser.

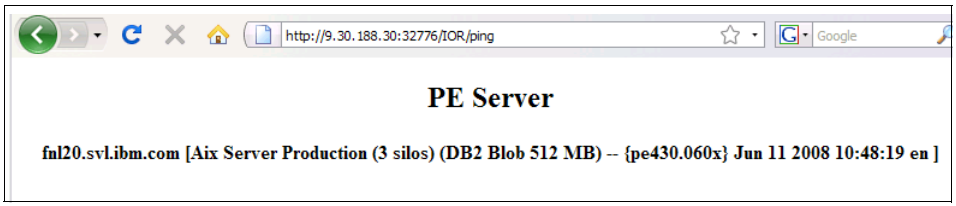


Figure 5-17 PE monitor as shown in a browser

For our HA case, we create two monitors for PE in BIG-IP. The first monitor is the TCP monitor on port 32776 and port 32777. See Figure 5-18. The best practice for the interval and timeout values is 30/91, because health checks can overload the server.

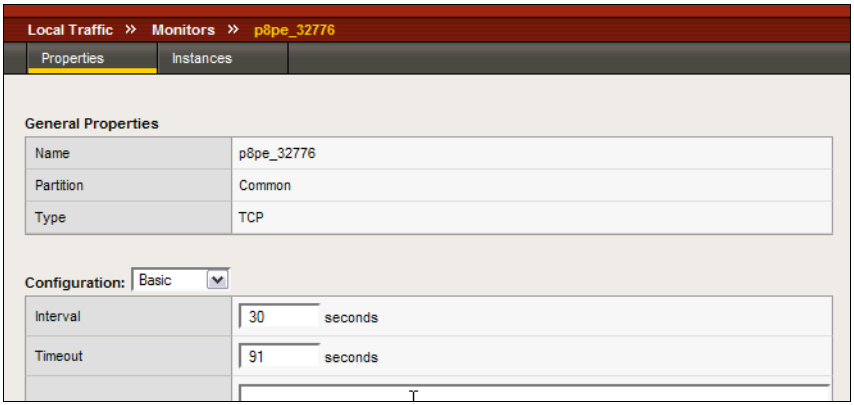


Figure 5-18 PE TCP monitor on port 32776

The second monitor is the http on /IOR/ping. See Figure 5-19.

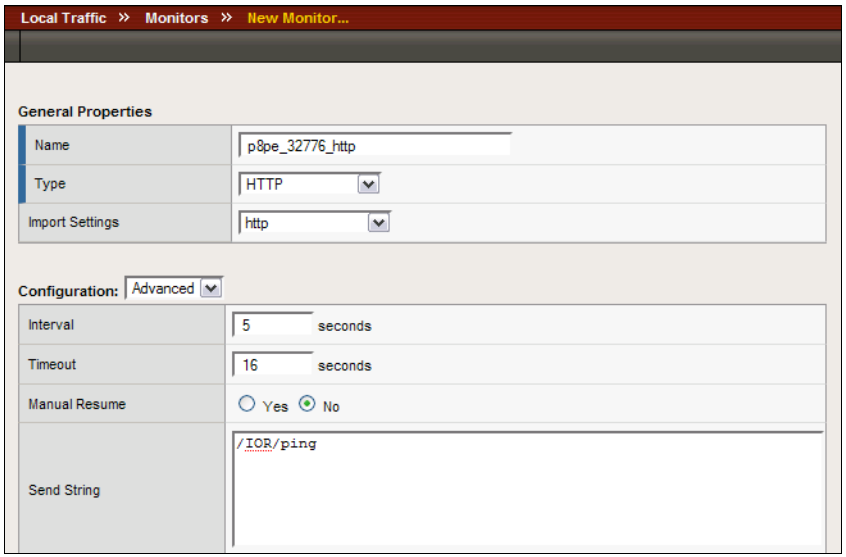


Figure 5-19 Create a PE http monitor in BIG-IP

We must then add these monitors to the PE pool that was previously defined as shown in Figure 5-20 on page 97. In this window, we add three health monitors: p8pe_32776, p8pe_32777, and p8pe_32776_http. We add this redundancy for

better reliability. In addition, because PE runs so many services (for example, operational system-level processes), having multiple health monitors can aid in the determination of a process that is down.

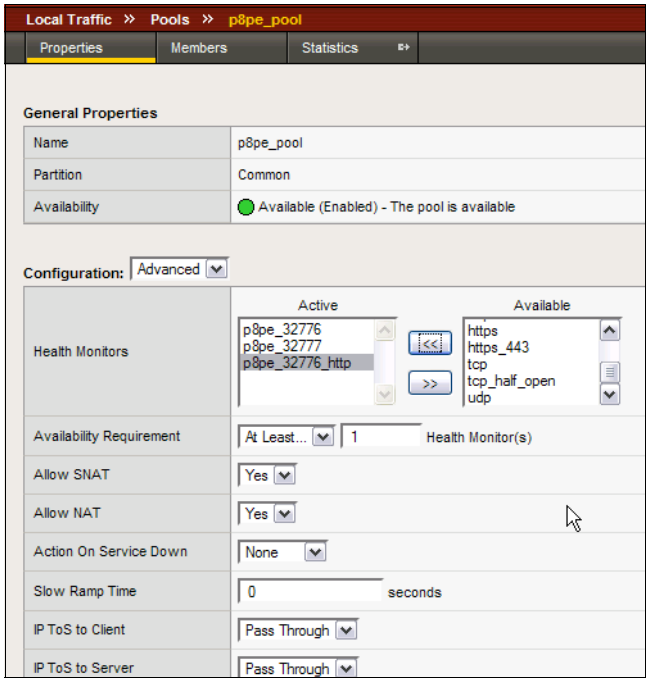


Figure 5-20 Add a new monitor to PE pool in BIG-IP

5.2.6 Validate load balancing

After we create all the high availability objects in BIG-IP, we need to validate the load balancing that is actually accessing all the nodes in the pools. Table 5-2 is the summary of our configured HA environment.

Table 5-2 Summary of HA nodes

Virtual server	Load-balanced node IPs	FileNet P8 Server
9.30.188.90	9.30.188.11 9.30.188.12	HTTP Servers to AE servers
9.30.188.91	9.30.188.20 9.30.188.21	CE Servers
9.30.188.92	9.30.188.30 9.30.188.31	PE Servers

Our test cases ensure that each of the nodes in each pool gets access during uptime, and when one of these nodes goes down, the second node will be accessed by all clients on subsequent requests. Table 5-3 summarizes the tests, and the actual results are shown in the following sections.

Table 5-3 Test cases to validate BIG-IP load balancing

Test case	Test	Expected result	Actual result
Test 1	Both HTTP nodes up. Requests load balanced.	Different client hits different Web server.	See 5.2.7, “Test 1: Load balancing on two HTTP nodes” on page 99.
Test 2	BIG-IP monitors showing one HTTP server down. Requests still being served.	Response from entry IP still serving content.	See 5.2.8, “Test 2: Load balancing on one HTTP node” on page 100.
Test 3	Both CE nodes up. Requests load balanced.	Different client hits different CE server in the farm, shown from the virtual server.	See 5.2.9, “Test 3: Load balancing on two CE nodes” on page 101.
Test 4	BIG-IP monitors showing one CE server down. Requests still being served.	Response from the virtual host for all clients.	See 5.2.10, “Test 4: Load balancing on one CE node” on page 103.
Test 5	Both PE nodes up. Requests load balanced.	Different client hits different PE server.	See 5.2.11, “Test 5: Load balancing on two PE nodes” on page 104.
Test 6	Both PE nodes up. Requests load balanced.	Response from the virtual host for all clients.	See 5.2.12, “Test 6: Load balancing on one PE node” on page 106.

5.2.7 Test 1: Load balancing on two HTTP nodes

A simple way to test whether a farm of HTTP servers are load balanced is to place a test image onto the docroot of each Web server. The image is specific to the Web server (for example, using the host name of the Web server in the image), but with the same file name. Example 5-1 shows a list of all images under the IBM HTTP server docroot, with a custom image named `fnha_test.gif`.

Example 5-1 Images under the IBM HTTP server docroot

```
[/usr/IBM/HTTPServer/htdocs/en_US/images]ls -l
total 536
-rwxr-xr-x    1 root     system          223 Sep 25 15:44 administration.gif
-rwxr-xr-x    1 root     system       183099 Sep 25 15:44 background.gif
-rwxrwxrwx    1 root     system        15107 Oct 15 10:49 fnha_test.gif
-rwxr-xr-x    1 root     system        52822 Sep 25 15:44 foreground.gif
-rwxr-xr-x    1 root     system          210 Sep 25 15:44 help.gif
-rwxr-xr-x    1 root     system          170 Sep 25 15:44 notes.gif
-rwxr-xr-x    1 root     system           49 Sep 25 15:44 odot.gif
-rwxr-xr-x    1 root     system          150 Sep 25 15:44 support.gif
```

We then make a browser request to the image:

`http://9.30.188.90/images/fnha_test.gif`

In this request, 9.30.188.90 is the BIG-IP virtual host for the HTTP servers, or the entry point for the entire FileNet P8 application.

We open two separate browsers (for example, FireFox and Microsoft Internet Explorer®) to create two separate sessions, which simulates two separate client requests to the load balancer. Figure 5-21 on page 100 shows that one request returns an image from HTTP server 2, and the other request returns an image from HTTP server 1, while both requests (that is, the URL) in the browser are identical.

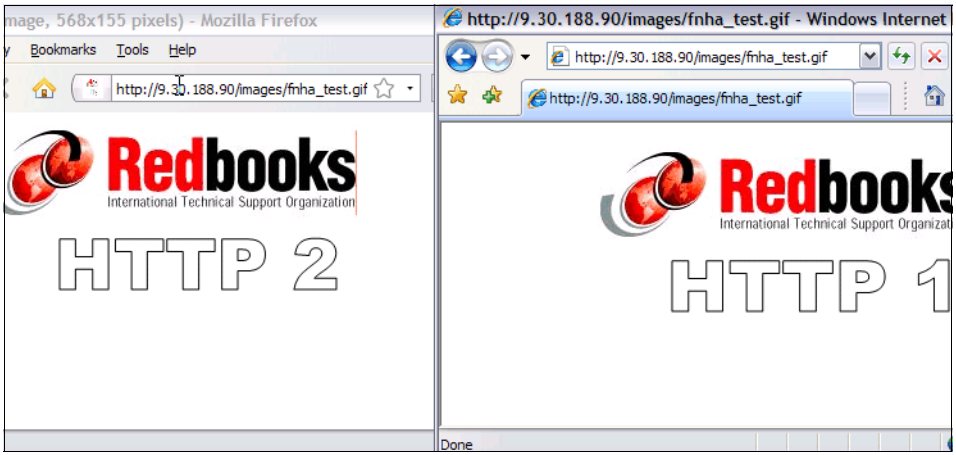


Figure 5-21 Load-balanced HTTP server test results

5.2.8 Test 2: Load balancing on one HTTP node

If one of the HTTP servers goes down, all HTTP requests from every client will now be served from the other HTTP server. For this text, we shut down the HTTP server through the WebSphere administrative console (**Servers** → **Web servers** → **Stop**). Figure 5-22 shows that HTTP server 1 is down.

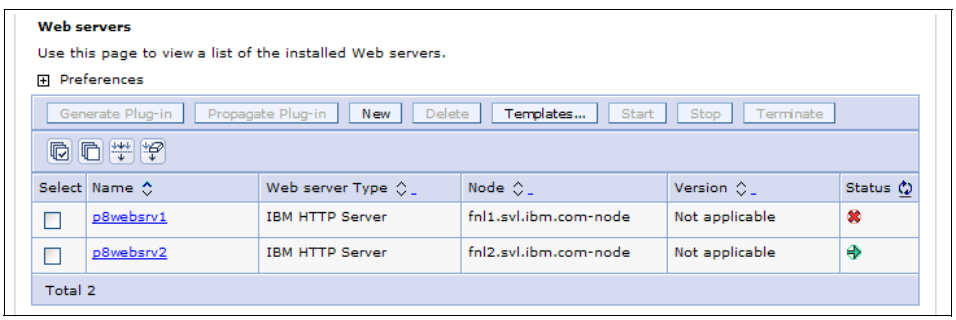


Figure 5-22 WebSphere administrative console shows that one HTTP is down

One of the nodes goes down, and BIG-IP also reports the corresponding status, as shown in Figure 5-23 on page 101.

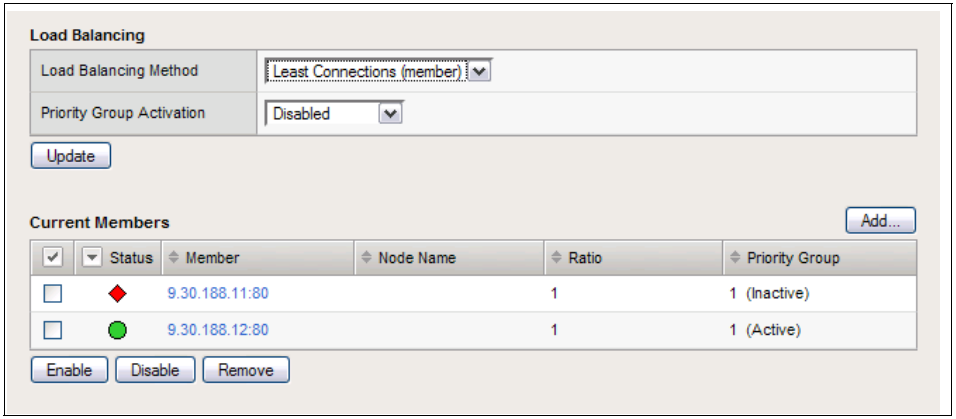


Figure 5-23 BIG-IP shows HTTP server is down

We now switch to our browsers and issue the same requests to the test image. As expected, both clients now see HTTP server 2, as shown in Figure 5-24.

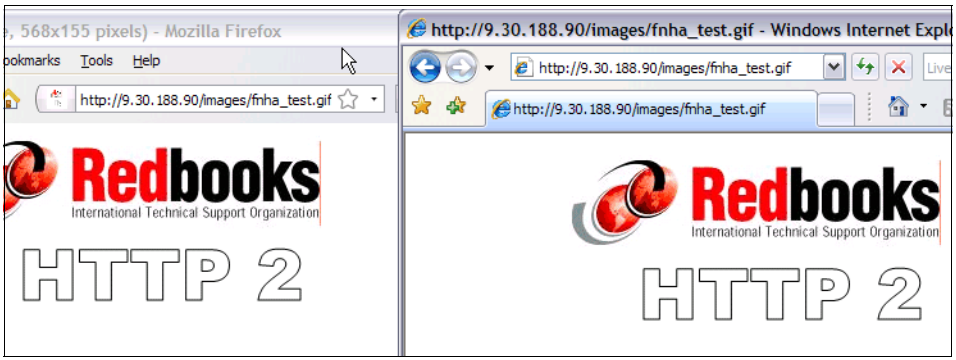


Figure 5-24 HTTP requests now go to server 2

5.2.9 Test 3: Load balancing on two CE nodes

The virtual server on BIG-IP for the CE nodes is 9.30.188.91:19080. We configure FileNet P8 components that communicate to CE on port 19080 by using that virtual server. To test that the two CE servers are load-balanced, we issue the following HTTP request:

```
http://9.30.188.91:19080/FileNet/Engine
```

This page is called the CE Startup Context page. In a WebSphere clustered configuration, this page displays the server instance on which a particular request is served, as shown in Figure 5-25 on page 102.

Startup Message	P8 CEMP Startup: 4.0.1-004 dap435.046 Copyright IBM Corp. 2003, 2008 All rights reserved on server2
Start Time	Thu Oct 09 17:43:19 PDT 2008
Server Instance{s}	server2 {server1,server2}

Figure 5-25 CE Startup Context page shows which instance is currently impacted

We open two browsers (for example, FireFox and Microsoft Internet Explorer) to create two separate client requests to the Startup Context page. We show that each client hits on a different CE instance. See Figure 5-26.

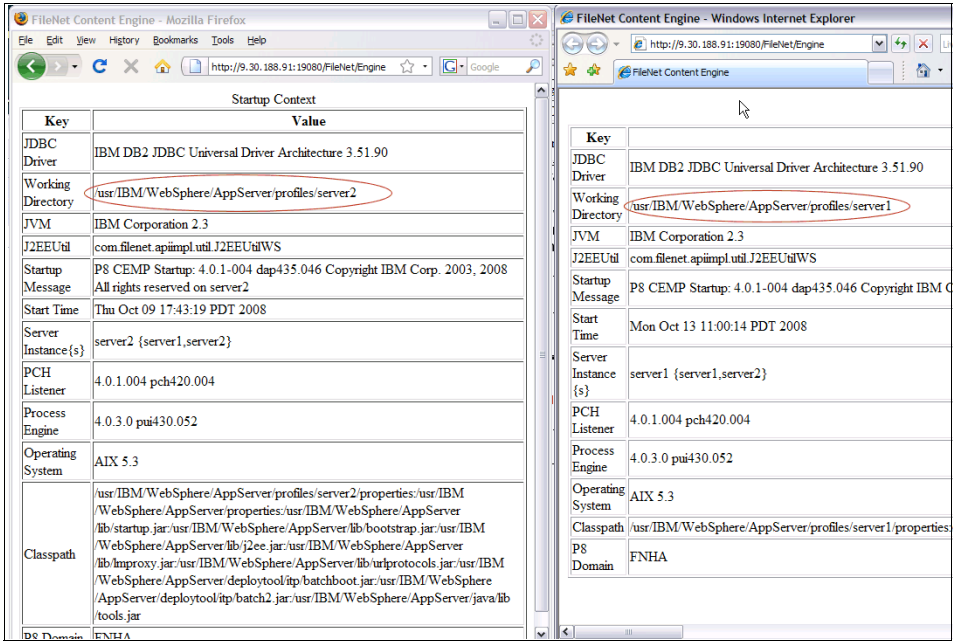


Figure 5-26 Two CE requests hit two separate instances

Additionally, if we refresh the page in both browsers, we get the same results: the request is served by the exact same instance. This test confirms that the session affinity that we configured in 5.2.4, “Enable session affinity for Content Engine in BIG-IP” on page 90 works, because requests from the same client session always go to the same CE instance.

5.2.10 Test 4: Load balancing on one CE node

All requests must go to the “live” CE instance if the other instance goes down. We show the results for this test in this section. We first shut down CE instance 1 in the CE cluster by using the WebSphere administrative console (**Servers** → **Application servers** → **(select the instance) Stop**).

Figure 5-27 shows that CE instance 1 is down.

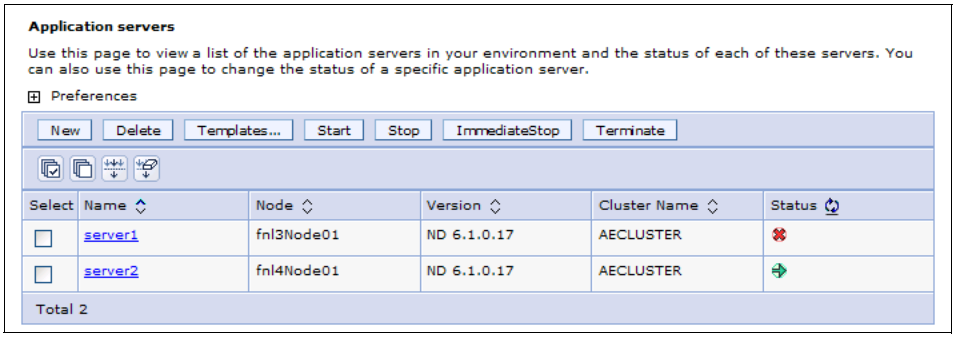


Figure 5-27 CE instance 1 is down

We close our previous browser sessions to clear any cached objects (images, cookies, HTML pages, and so forth). We open the same two browsers with requests to the Startup Context page, http://9.30.188.91:19080/FileNet/Engine. Results in Figure 5-28 show that CE instance 2 now serves both requests.

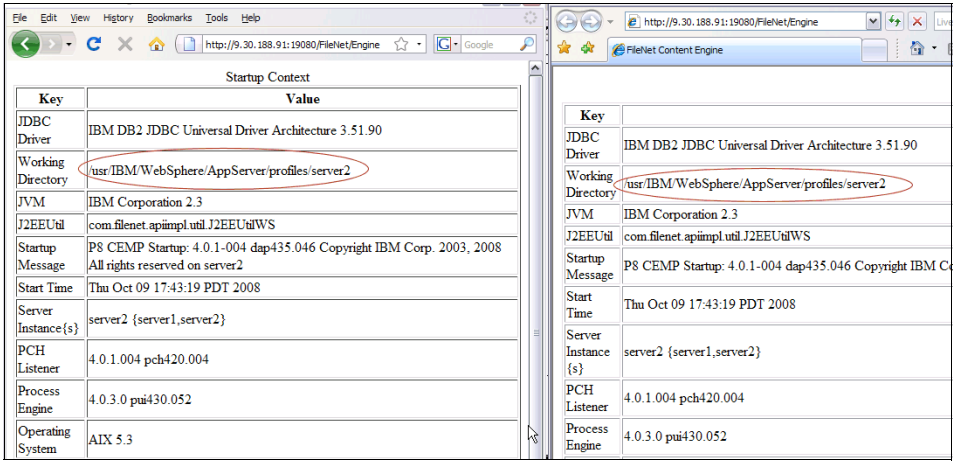


Figure 5-28 All CE requests go to instance 2

5.2.11 Test 5: Load balancing on two PE nodes

The virtual server on BIG-IP for the PE nodes is 9.30.188.92:32776. We configure FileNet P8 components that communicate to PE on port 32776 by using that virtual server. To test that the two PE servers are load-balanced, we issue the following HTTP request:

```
http://9.30.188.92:32776/IOR/ping
```

We receive the response as shown in Figure 5-29.

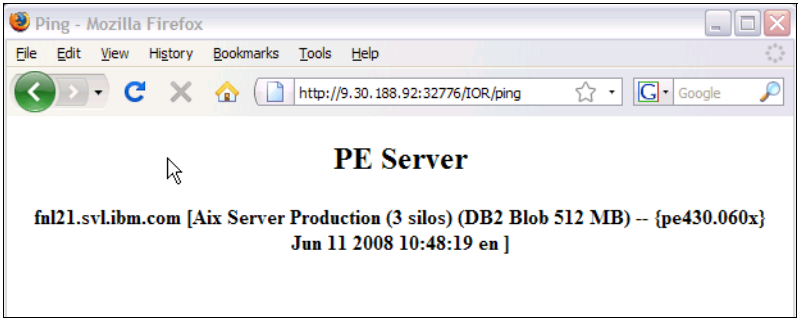


Figure 5-29 PE vwbroker ping page

We open two browsers (for example, FireFox and Microsoft Internet Explorer) to create two separate client requests to the Startup Context page. We show that each client hits on a separate PE instance. Figure 5-30 on page 105 shows that the same request from both browsers goes to two PE hosts (that is, fnl21 and fnl20).

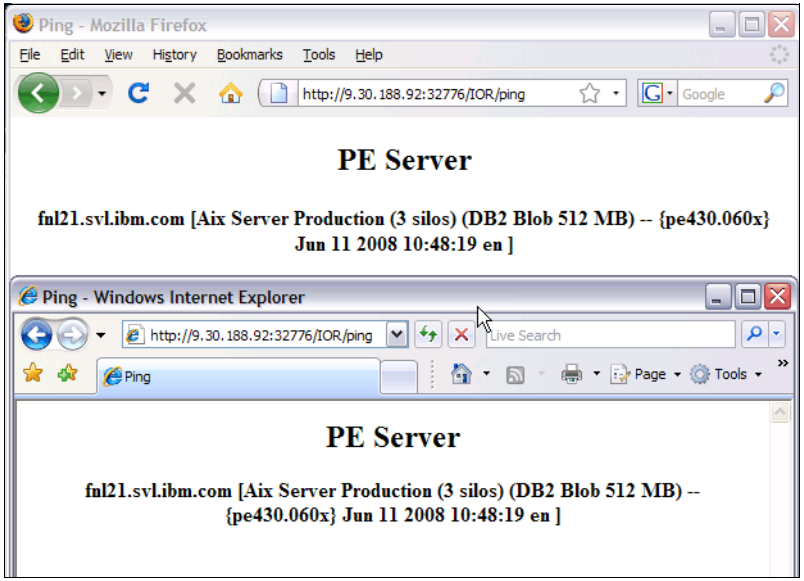


Figure 5-30 Load-balanced PE instances

Additionally, we show in Figure 5-31 that PE does not have affinity configured, because in the same browser, refreshing the request lands us on the second PE instance (that is, before we were on fnl20, and now, we are on fnl21).

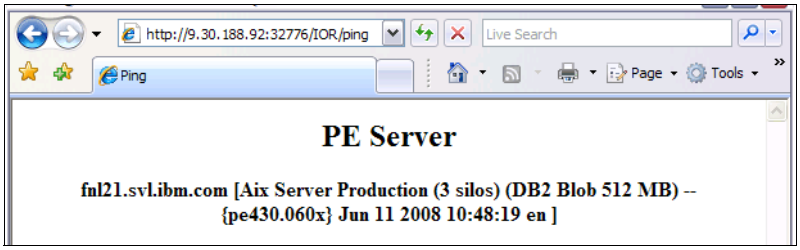


Figure 5-31 No affinity was set up for PE

5.2.12 Test 6: Load balancing on one PE node

We stop all services on PE instance 1 so it stops serving requests. BIG-IP shows that the corresponding node is down, as shown in Figure 5-32.

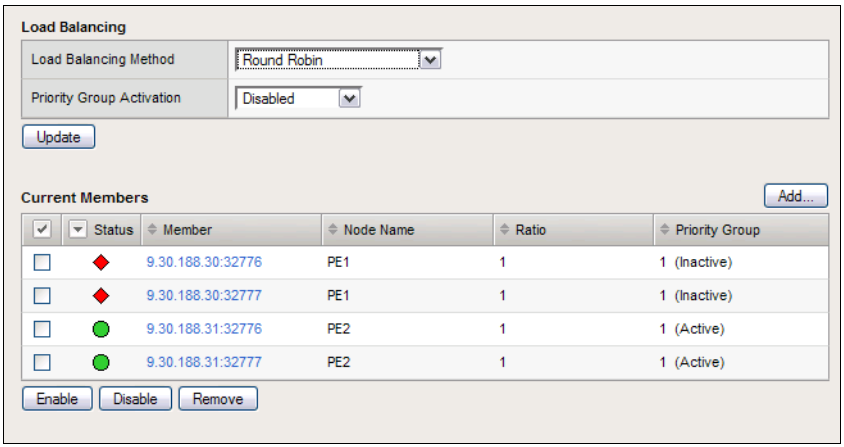


Figure 5-32 PE node 1 is down

We then refresh the PE ping page continuously to show that the same PE node serves the requests (instead of toggling). See Figure 5-33.

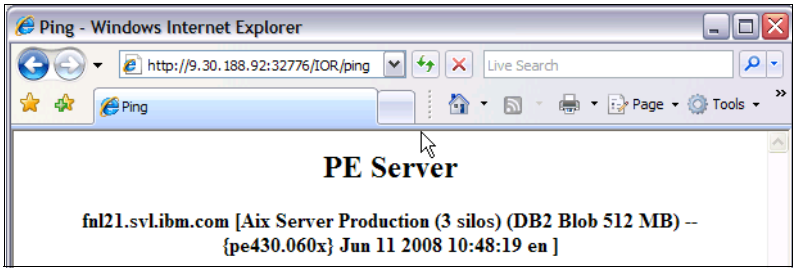


Figure 5-33 Refresh the PE ping page to test PE load balancing

5.3 Setting up and configuring standby BIG-IP

This section describes how to create a redundant pair by adding a second BIG-IP 9.*x* system to an existing system.

Important: To eliminate single points of failure and achieve high availability for your system, use more than one load balancer for your system to ensure redundancy in this component.

Note: For this IBM Redbooks publication, it is not part of the testing scope to set up and configure a standby BIG-IP. However, for your reference, we provide the procedures of setting up and configuring a standby BIG-IP per F5 Networks' recommendation and documentation.

Both BIG-IP Systems in the failover pair must both run the exact same version of the BIG-IP software. If the existing BIG-IP runs on a later software version, you must upgrade the peer system so that both versions match. F5 Networks does not support BIG-IP redundant pair configurations that run different software versions. If you have a pair with different software versions installed, the configuration can have a detrimental effect on the failover process. For information about upgrading, refer to the BIG-IP Local Traffic Manager Release Notes.

You will need to reboot the existing BIG-IP System. Therefore, you must perform this configuration change during a low-traffic period or maintenance window. As a result of this procedure, both BIG-IP Systems might be in active-active mode for a period of 2 to 5 minutes. During this period, performance is severely impacted.

To help you prepare for your BIG-IP redundant pair configuration change, we use the following example setup and configuration.

Original single controller configuration

For the original single controller configuration, the existing external and internal IP addresses (external_IP_1 and internal_IP_1) will become the new shared addresses on the redundant system:

- The external_IP_1 address is the IP address to which the external router directs traffic.
- The internal_IP_1 address is the default route for the servers whose loads are being balanced.

Two additional external and two additional internal IP addresses are required for the full configuration.

Redundant configuration

For the new redundant controller configuration, external_IP_2 and external_IP_3 are the new primary external interface addresses for each controller, and internal_IP_2 and internal_IP_3 are the new primary internal interfaces. The external_IP_1 and internal_IP_1 addresses are changed to the floating addresses that are shared between the units, which eliminates the need to modify the upstream router or downstream nodes.

These addresses are the specific configuration for the BIG-IP redundant pair:

- BIG-IP 2 configuration (the new BIG-IP that is being added):
  - external_IP_2 is the new primary external interface.
  - internal_IP_2 is the new primary internal interface.
  - external_IP_1 and internal_IP_1 are the new shared addresses.
- BIG-IP 1 configuration (the original stand-alone BIG-IP):
  - external_IP_3 is the new primary external interface.
  - internal_IP_3 is the new primary internal interface.
  - external_IP_1 and internal_IP_1 are the new shared addresses.

Setup and configuration summary

For our example, follow this procedure to set up and configure a redundant pair:

1. Configuring the new BIG-IP in a redundant pair
2. Configuring the original BIG-IP as a standby system
3. Synchronizing configurations

5.3.1 Configuring the new BIG-IP in a redundant pair

To configure the new BIG-IP System in a redundant pair, perform the following procedure:

1. Connect the new BIG-IP System with a failover cable to the existing BIG-IP System, and turn on the power.

   Important: Do not connect the network cabling to the new BIG-IP System, because connecting the cabling can cause a network disturbance after the system reboots.

2. Connect a console to the new BIG-IP System. When the system is powered up, type the following command:

   ```
   config
   ```

3. Follow the steps to configure the management IP address, subnet mask, and default gateway.
4. Log in to the Configuration utility using the management address. The Setup utility runs. Install the license.

   If the BIG-IP System contains a previous configuration, you can run the Setup utility by clicking **Overview** → **Welcome** → **Run the Setup Utility**.
5. Set up the basic network configuration:
   a. Enter the host name in the Host Name field.

      Important: The administrator user name and password must be the same as the existing system. If the user name and password are not set correctly, the configurations will not be synchronized.

   b. From the High Availability drop-down menu, select **Redundant Pair**.
   c. From the Unit ID drop-down menu, select **1**.
   d. Finish defining the General Properties and User Administration information.
   e. Click **Next**.
6. Under the Basic Network Configuration window, click **Next**. The Internal Network Configuration window displays.
7. Set up the internal network configuration:
   a. For the Floating IP, enter the *existing* BIG-IP System's internal address as the new internal Floating IP address (in our example, `internal_IP_1`).
   b. For the Failover IP, enter the *new* internal primary address of the peer unit in the redundant system (in our example, `internal_IP_3`).

      Important: Do not use the IP address that the existing system currently uses, because that address will be the shared and floating address for the redundant pair. Additionally, the VLAN must be on the new BIG-IP System. The name is case sensitive.

   c. Finish defining the Internal Network and VLAN configuration.
   d. Click **Next**. The External Network Configuration window appears.
8. Set up the external network configuration:
   – Enter the appropriate addresses for the Floating IP and Failover IP. For our example, the new internal Floating IP is `external_IP_1`, and the Failover IP is `external_IP_3`.

9. Complete the Setup utility.
10. Reboot the new BIG-IP System.

After the reboot, the BIG-IP System will be the standby controller in a redundant pair configuration (provided that the failover cable was connected).

Verifying and reviewing the configuration

To verify the state of the BIG-IP System, type the following command:

```
bigpipe fo
```

If the new BIG-IP System is in active mode, check to see if the failover cable is securely connected to the failover port.

Note: The failover port resembles the serial port. Both ports are labeled. The failover cable has custom pinouts, as documented in SOL1426: Failover cable pinouts for the BIG-IP and 3-DNS Controllers.

You can review the base IP configuration by typing the following command:

```
bigpipe base list
```

5.3.2 Configuring the original BIG-IP as a standby system

To configure the original BIG-IP System as the redundant standby system, perform the following procedure:

1. Log in to the Configuration utility.
2. Select **System** → **Platform**.
3. From the High Availability drop-down menu, select **Redundant Pair**.
4. From the Unit ID drop-down menu, select **2**, and click **Update**.
5. Select **Network** → **Self IPs**.
6. Edit the existing IPs, external_IP_1 and internal_IP_1, and select the Floating IP check box for each self IP.
7. Create two new self IP addresses, where external_IP_3 is the new primary external interface, and internal_IP_3 is the new primary internal interface.
8. Reboot the BIG-IP System.

Important: Rebooting the BIG-IP System results in a temporary site outage.

After you reboot, the BIG-IP System will be in a redundant pair configuration in standby mode (provided the failover cable was connected), because the new BIG-IP System is in active mode.

To fail back to the original BIG-IP and start traffic flowing, type the following command on the new BIG-IP System:

```
bigpipe fo standby
```

5.3.3 Synchronizing configurations

To synchronize the configuration between the standby system and the active system, perform the following procedure:

1. The existing BIG-IP must now be in active mode, and the new BIG-IP must be in standby mode. Verify this situation by typing the following command on each system:

   ```
   bigpipe fo
   ```

   Important: The new BIG-IP System must be in standby mode before you connect it to the network; otherwise, it might respond to Address Resolution Protocol (ARP) requests for the floating addresses, interfering with traffic currently flowing through the active system.

2. After you confirm the state of the BIG-IP Systems, connect the new BIG-IP System to the network.
3. Synchronize the configuration by typing the following command:

   ```
   bigpipe config sync all
   ```

4. Confirm that the new BIG-IP System has the correct configuration by typing the following command:

   ```
   bigpipe list
   ```

5. Verify that the `/config/bigip.conf` file is the same size on both systems.

At this point, both units have the same configuration and will failover seamlessly. F5 Networks recommends that you test the configuration synchronization and failover in both directions during the maintenance window.

5.3.4 Viewing redundancy states and synchronization status

You can globally view the current redundancy state of a unit by viewing the upper-left corner of any Configuration utility window. You can also view synchronization status in this same portion of each window, but only if you have

configured the unit to do so. (For more information about viewing synchronization status, see “Viewing synchronization status”.)

Figure 5-34 shows an example of the status information as displayed on a Configuration utility window.

Figure 5-34 Viewing redundancy state and synchronization status

Viewing redundancy state

Each unit in a redundant system is in either an active or a standby state at any given time. The current state of a unit depends on the unit's redundancy state preference, and whether the unit is available or unavailable to accept connections. You can use the Configuration utility in two different ways to determine the current state of a unit.

One way to view the redundancy state of a BIG-IP unit is by checking the status display that appears in the upper-left corner of every Configuration utility window.

The other way to view the redundancy state of a unit is to use the following procedure. To view the redundancy state of a unit:

1. On the Main tab of the navigation pane, expand System, and click **High Availability**. The Redundancy Properties window opens.
2. View the value of the Current Redundancy State setting, either Active or Standby.

Viewing synchronization status

As you learned in 5.3.3, “Synchronizing configurations” on page 111, it is essential that an active unit share its current configuration data with its peer to ensure that failover can occur successfully. Configuration data on a unit can change for a variety of reasons (such as when adding a virtual server or modifying a profile), so it is important that you can monitor synchronization status at any given time, and re-synchronize the units if necessary.

You can view either detailed synchronization information about the current unit and its peer, or you can view general synchronization status on every Configuration utility window.

Viewing detailed synchronization status

You can view detailed configuration synchronization status, such as the internal static self IP addresses that the two units use when synchronizing data, by displaying the ConfigSync window of the Configuration utility. This window is available from the Redundancy Properties window.

Table 5-4 lists and describes the status-related settings that the ConfigSync window displays.

Table 5-4 Status information on the ConfigSync window

Status setting	Description
ConfigSync Peer	Displays the internal static self IP address that the BIG-IP System uses to determine the peer unit for synchronization.
Status message	Displays the state of the peer, that is, active or standby. May also report the status as unknown if connectivity problems exist.
Last Change (Self)	Displays the day, date, and exact time that the configuration date of the unit you are configuring was last changed.
Last Change (Peer)	Displays the day, date, and exact time that the configuration data of the peer unit was last changed.
Last ConfigSync	Displays the day, date, and exact time that a user synchronized the configuration data between the two units.

For additional information, refer to support.f5.com:

https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys/9_0_xSystemMgmtGuide-13-1.html

5.3.5 Validate standby BIG-IP failover

After you set up and configure the standby BIG-IP, you need to validate the active BIG-IP failing over or being manually failed over to the standby. Manual failover can be used for upgrading BIG-IP software versions or for other BIG-IP maintenance. Table 5-5 on page 114 summarizes the test methods for both manual and disaster failover to validate the setup.

Table 5-5 Test cases to validate BIG-IP standby failover

Test case	Test	Expected result
Test 1	Manually failover via GUI from active to standby.	Standby will take over traffic and change will be visible in GUI. All systems should perform as normal.
Test 2	Simulate disaster failover by manually unplugging the active BIG-IP	Standby will take over traffic and change will be visible in GUI. All systems should perform as normal.

It is beyond the scope of this book to detail the testing procedure for standby failover. For detailed information, refer to support.f5.com:

https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys/9_0_xSystemMgmtGuide-13-1.html

5.4 Set up administrative partitions for P8

An important part of managing the BIG-IP System is configuring the extent to which other BIG-IP System users can access various system objects. Access in this case refers to performing certain actions, such as creating, viewing, modifying, and deleting system objects. Examples of system objects that users might want to access are virtual servers, load balancing pools, health monitors, nodes, and user accounts.

If you have the Administrator or User Manager user role assigned to your BIG-IP System user account, you can control other users' access to objects by using a feature known as administrative partitions. An administrative partition is a logical container that you create, containing a defined set of BIG-IP System objects. When a specific set of objects resides in a partition, you can then give certain users the authority to view and manage the objects in that partition only, rather than to all objects on the BIG-IP System. This gives a finer granularity of administrative control.

Creating administrative partitions for P8 is optional. However, a significant benefit to administrative partitions is that they allow you to place administrative ownership of an application into the hands of the business units that actually run the applications.

Figure 5-35 on page 115 shows an example of partitions that we create on the IBM FileNet P8 BIG-IP System. Partition fnha_dba contains objects that pertain to a DB2 cluster, which allows the DB2 administrators to manage its properties themselves (note that only db2_pool, part of the fnha_dba partition is enabled for

deletion, a task only a manager or an administrator can perform), and partition a local user account the BIG-IP System, called fnha_dba, who has the User Manager access role.

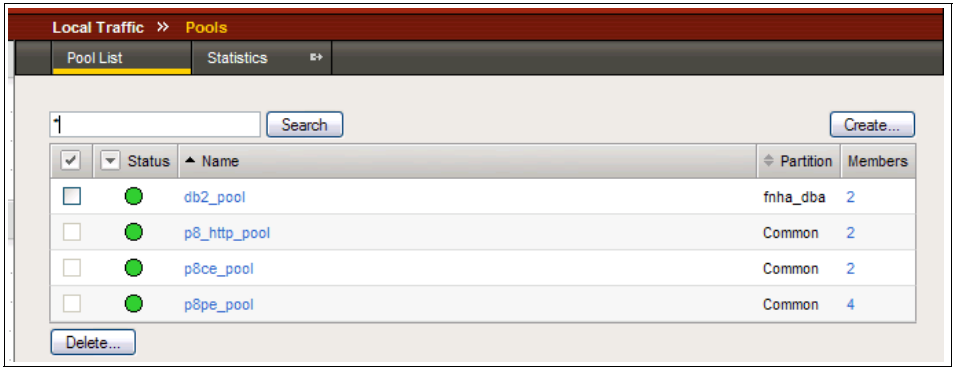


Figure 5-35 Pools clearly distinguished by partition names

The steps to define a HA Administrative partition is as follows:

1. We create a new partition by selecting **System** → **Partitions** → **Create,** as shown in Figure 5-36.

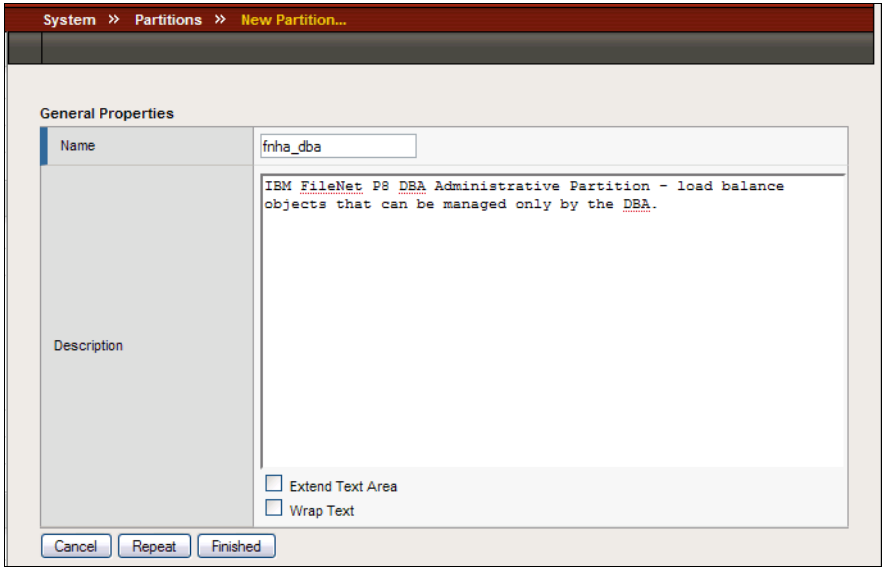


Figure 5-36 Define a HA Administrative Partition

2. Create a new user to use the access the partition created above. We do this by selecting **System** → **Users** → **Create,** as shown in Figure 5-37 on page 116.

Figure 5-37 Create a User in an Administrative Domain - DBA

3. Create two database nodes in the partition. These nodes are the database servers we want to monitor. We do this by selecting **Local Traffic** → **Nodes** → **Create,** as shown in Figure 5-38. Note that the two check boxes for nodes, 9.30.188.110 and 9.30.188.80, are enabled while all other check boxes are disabled for this user.

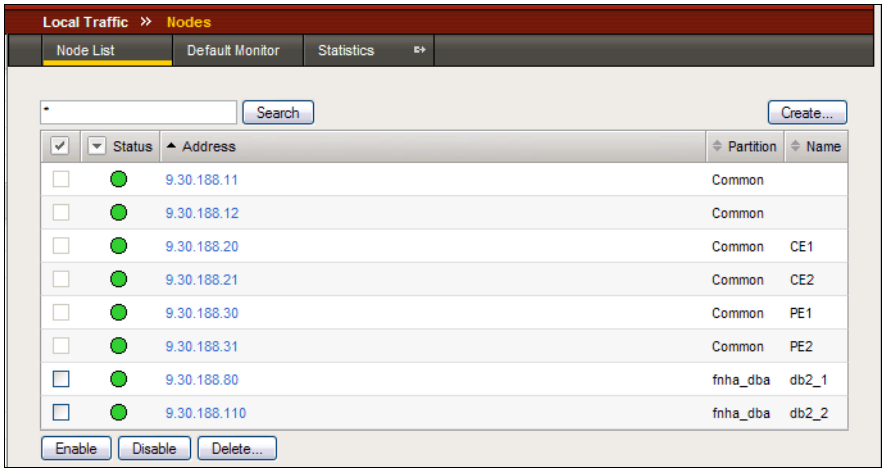


Figure 5-38 Create Nodes in the DBA Partition

4. Create a pool by selecting **Local Traffic** → **Pools** → **Create**, as shown in Figure 5-39 on page 117.

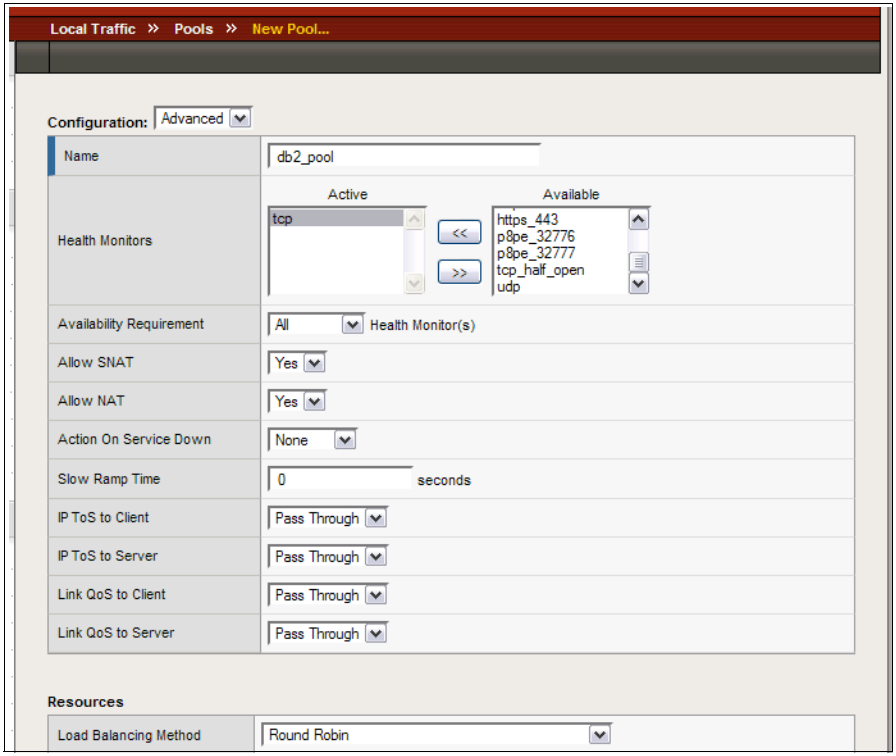


Figure 5-39 Create a Pool for DBA Partition

6

Web tier implementation

This chapter describes the Web tier setup for a highly available FileNet P8 environment.

We discuss the following topics:

- Introduction
- Hardware components
- Software components
- Failover test at the Web tier level
- Maintenance recommendations

6.1 Introduction

FileNet P8 provides Web interfaces that allow users to access and manage content and processes in FileNet P8 systems. Workplace, as part of FileNet P8 Application Engine (AE), is an easy-to-use Web application that enables users to interact with the FileNet P8 system.

The Web interfaces offer the following key features:

- Secure access to content management: By offering Lightweight Directory Access Protocol (LDAP) authentication into the P8 systems.
- Wizard-driven content contribution: Eliminates entry errors (add or check-in) and ensures accuracy with intuitive, easy-to-use content entry templates.
- Document review and approval workflow: Streamlines approval processes and expedites Web content publishing through preconfigured process templates that provide a common procedure for content approval and publishing. Actively maintains audit trails to comply with regulatory mandates and corporate governance standards.
- Comprehensive page and document management: Manages all types of unstructured content (including paper documents, HTML, XML, rich media, PDF, and e-mail) and complex content.
- Customized features: Based on user preferences, such as search templates, paging, appearance, behavior, and security.

FileNet P8 Web interfaces can run within a WebSphere application server. We recommend that you deploy the HTTP servers outside of a application server. Decoupling the Web tier from the WebSphere application server layer allows for better server manageability (for example, the HTTP servers can be located in their own security zone, or DMZ) and for easier horizontal scalability (for example, just add HTTP servers as needed).

We use a Web server farm for our high availability configuration. Web server farms provided through hardware or software load-balancing technology enable high availability at the Web server tier. A *farm* is a set of load-balanced servers that are clones of each other, each actively providing the same service, with the same applications and same binding to servers in the tiers beneath them. Farms are best practice for server tiers that are relatively static in terms of content, which makes it easy to maintain the servers as clones of each other.

The FileNet P8 Web-based components have been certified to operate within Web and application server farms, such as IBM WebSphere clusters. These types of farms provide for server redundancy with the added value of scalability, because all of the servers in the farm are active. Application server farms can be

combined with hardware-based load-balancing solutions, such as F5 Networks BIG-IP load balancer or software-based solutions, such as IBM Load Balancer, which is part of WebSphere Edge Components.

A load-balanced Web server farm provides both better availability and better scalability than a single Web server. When a Web server fails, the load balancer automatically detects the failure and redirects user requests to another server in the farm, thereby keeping the service available. Administrators can increase Web site performance and capacity by simply adding servers to the farm.

6.2 Hardware components

In our case study, we assume P8 system is accessed only by AE Workplace Web applications from browsers which, in general, can be anywhere in the world.

We assume the firewalls, Domain Name System (DNS), and LDAP server components are already highly available. We therefore do not repeat their configuration in this book.

We use the following P8 Web tier hardware components:

- Two load balancers
- Two HTTP server nodes

Figure 6-1 on page 122 illustrates the Web tier components and their placement in a DMZ.

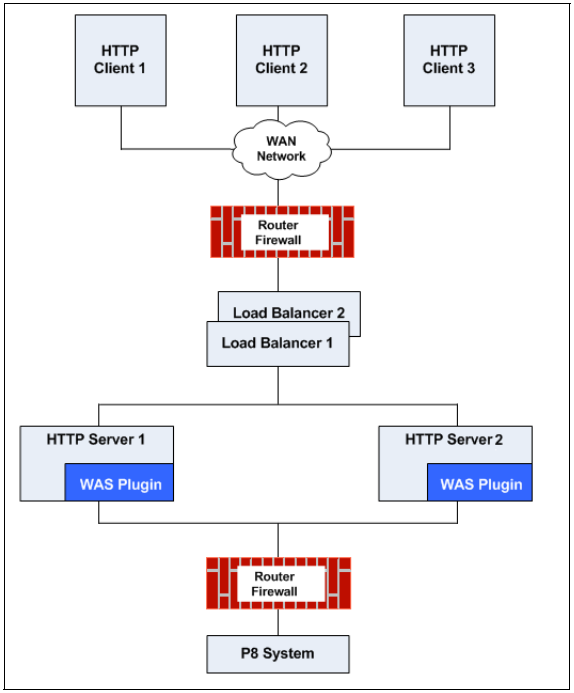


Figure 6-1 Web tier topology

In our case study environment, we use the following nodes for Web servers:

- HTTP server 1 host name is `fnl1`.
- HTTP server 2 host name is `fnl2`.

6.2.1 Load balancers

For the Web tier, you can use a pair of software load balancers or a pair of hardware load balancers to direct HTTP client access to HTTP servers in the DMZ.

Because Process Engine requires a hardware load balancer, and we use BIG-IP 6800 system for the Process Engine farm, at the Web tier, we also use the BIG-IP 6800 hardware load balancer for ease of setup and to take advantage of the many benefits that the system has to offer. The BIG-IP 6800 system is a port-based, multi-layer switch that supports virtual local area network (VLAN) technology. Because hosts within a VLAN can communicate at the data-link layer, a BIG-IP System reduces the need for routers and IP routing on the network. These capabilities provide comprehensive and simplified traffic

management and security for FileNet P8 components, such as the Web servers, Content Engine servers, and Process Engine servers.

Chapter 5, “Hardware load balancer implementation (F5 BIG-IP)” on page 73 provides extensive coverage of the BIG-IP hardware load balancer. Refer to that chapter for its features and capabilities, setup, and configuration.

6.3 Software components

The Web tier consists of the following software components:

- IBM HTTP Server Version 6.1.0.17
- Web server plug-ins for IBM WebSphere Application Server Version 6.1.0.17

As illustrated in Figure 6-1 on page 122, we use the F5 BIG-IP as the hardware load balancer for the HTTP servers, and the HTTP servers serve as the load balancer for AE using Web server plug-ins.

6.3.1 IBM HTTP Server system requirements

The IBM HTTP Server software is available along with IBM WebSphere Application Server (although we install it on a separate host for our case study).

To support the basic installation of IBM HTTP Server, the minimum operating system and hardware requirements for the application server must be met on the Web server system. You can find the latest prerequisites at:

http://www.ibm.com/support/docview.wss?rs=180&uid=swg27006921

6.3.2 HTTP server and plug-in setup and management overview

For our case study, the IBM HTTP Servers and the WebSphere Application Server Network Deployment that manage the IBM HTTP Servers run on separate machines.

We assume that WebSphere Application Server Network Deployment is already installed and configured on the FileNet P8 Application Engine nodes, and IBM HTTP Server has to be installed on two machines, fnl1 and fnl2, in DMZ. We describe the installation process performed on fnl1. The installation procedure for fnl2 is the same.

Web servers are defined to the WebSphere Application Server. A Web server can reside on a managed or unmanaged node. If located on a managed node in a distributed server environment, a node agent is installed on the Web server

system and belongs to a WebSphere Application Server administrative cell. The administrative tools communicate with the Web server through the node agent. If the Web server is located on an unmanaged node, the Web server is defined to the cell, but it does not have a node agent running to manage the process. In either case, the Web server definition allows you to generate the plug-in configuration file for the Web server. We install Web server on an unmanaged node.

Figure 6-2 illustrates a HTTP server topology.

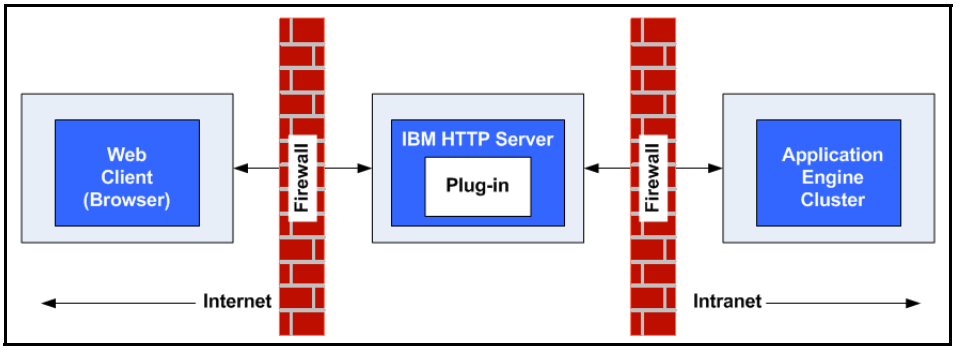


Figure 6-2 HTTP server topology detail

6.3.3 Web tier component installation preparation

You can install all of the WebSphere Application Server components using the X11 interface. For remote clients that use the ssh protocol to log in to AIX machines, X11 forwarding must be enabled in order for the DISPLAY variable to be defined. For our case study, on fnl1 and fnl2, we edit the `etc/ssh/config_sshd` file and uncomment these two lines:

```
X11Forwarding yes
X11DisplayOffset 10
```

Note: Restart **`sshd`** after making the change:

```
stopsrc –s sshd
startsrc –s sshd
```

The client needs to be configured to perform X11 forwarding, as well (use **`ssh –X`** for command line clients, or an option in a GUI dialog for clients, such as PuTTY).

IBM HTTP Server and WebSphere plug-in package

IBM HTTP Server V6 is bundled with WebSphere Application Server V6. The administrative functionality is integrated into WebSphere Application Server to provide remote administration through the administrative console. This enhanced administrative function is only available for the IBM HTTP Server.

The IBM HTTP Server installation package is delivered as a CD or downloaded as a `tar` file image.

We use the image file `C88TMML.tar.gz` (WebSphere Application Server Network Deployment V6.1 Supplements for AIX 5L V5, 64-bit Support, Application Client, HTTP Server, Web Server Plug-ins, Installation Factory, Migration Tool, IBM Support Assistant and Update Installer, Multilingual).

The `C88TMML.tar.gz` file is approximately 390 MB. We place it in a temporary file system.

Before starting the installation, we log in as root and issue the following commands to untar the file from our temporary file system (for our case study, we use `/fnsw`, although you will probably put the `C88TMML.tar.gz` file in a special temporary directory):

```
# gunzip C88TMML.tar.gz
# mkdir C88TMML
# cd C88TMML
# tar -xvf ../C88TMML.tar
```

Fix Pack 17 installation package

We download Fix Pack 17 (`6.1.0-WS-IHS-AixPPC64-FP0000017.pak` file in our case) to the directory `/fnsw` and untar it in the directory `/fnsw/FP17`.

Fix Pack 17 contains the fix pack installation utility called UpdateInstaller. This utility is also included in *WebSphere Application Server Network Deployment V6.1 Supplements*. Use the UpdateInstaller utility that comes with the fix pack to install the fix pack.

On the download page for the fix pack, the Installation Instructions section has a link to the appropriate version of UpdateInstaller. We download the UpdateInstaller file (`download.updii.61017.aix.ppc64.zip` for our case study) to the `/fnsw` directory, unzip it under `/fnsw/fp17` directory, and install UpdateInstaller:

1. Log in as root on fnl1.

2. Issue the following commands:

```
# cd /fnsw/fp17/UpdateInstaller
# ./install
```

The default installation directory is `/usr/IBM/WebSphere/UpdateInstaller`. We use the default.

6.3.4 IBM HTTP Server installation steps

To start the installation wizard, log in as root and issue the commands:

```
# cd /fnsw/C88TMML/IHS
# ./install
```

Follow the wizard to install IBM HTTP Server on an unmanaged node running IBM HTTP Server administration server:

1. Enter the installation location. The default is `/usr/IBM/HTTPServer`.
2. Enter the port value assignment for the HTTP daemon and for the HTTP administration server daemon. The defaults are 80 for the HTTP daemon and 8008 for the administration server.
3. Enter the HTTP administrator user and password. Select the checkbox for user creation if you need to create a user.
4. Enter administrator user and group to set up HTTP server administration. Select the checkbox for user/group creation if you need to create them.
5. Choose to install the HTTP server plug-in. Enter the Web server name and application server deployment management name.
6. Review the installation parameters in the installation summary window (Figure 6-3 on page 127), and click **Next** to begin the installation.

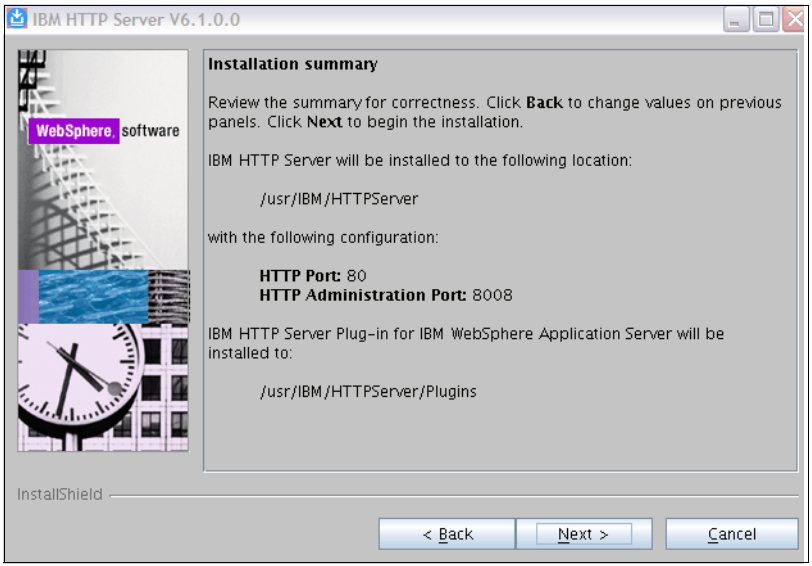


Figure 6-3 Installation summary window

6.3.5 Web server plug-ins installation steps

Web server plug-ins for IBM WebSphere Application Server are packaged in the same file with IBM HTTP Server. To start the installation wizard, issue these AIX commands:

```
# cd /fnsw/C88TMML/plugin
# ./install
```

The Web server plug-in installation provides a wizard that takes you through the installation process. The wizard defines and installs the plug-in, configures the Web server, and defines the Web server to WebSphere.

The wizard also creates a script file that you can copy to WebSphere Application Server Network Deployment server to run against the WebSphere Application Server Network Deployment server to define the Web server for the deployment manager.

Follow these steps to install the plug-in:

1. Select **IBM HTTP Server V6** or **IBM HTTP Server V6.1**.
2. Select **Remote installation**.

   Enter an installation directory. By default, the location is `/usr/IBM/HTTPServer/Plugins`. We use the default. We use *<plugin_home>* to refer to the plug-in installation location on the following steps.

3. Enter the Web server configuration file and port. By default, the configuration file is `/usr/IBM/HTTPServer/conf/httpd.conf`, and port 80 is used. We use the default settings.
4. Enter a name for the Web server definition. We use p8websrv1, which is the *<Web_server_home>* directory.
5. Select the location for the plug-in configuration file. By default, the location is under the directory `config` in the plug-in installation directory (*<plugin_home>*`/config/`*<Web_server_name>*`/plugin-cfg.xml`). We use the default file name.
6. Enter the application server host name. We use fnl3.
7. Check the summary installation parameter window and start the installation if the parameters are correct. The installation performs the following tasks:
   a. Creates a temporary plug-in configuration file and places it in the specified location.
   b. Updates the Web server configuration file with the plug-in configuration, including the location of the plug-in configuration file.
   c. Generates a script to define the Web server and an unmanaged node to WebSphere Application Server. The script is located in *<plug-in_home>*`/bin/configure`*<Web_server_name>*.
8. At the end of the installation, start the HTTP administrator by using the command **`adminctl start`** from the `/usr/IBM/HTTPServer/bin` directory.
9. Copy the script to the *<was_home>*`/bin` directory of the deployment manager machine. Start the deployment manager and execute the script.
10. Run both the IBM HTTP Server and WebSphere Application Server plug-in installations on fnl2, and run the generated script in the deployment manager machine.
11. From AE, go to the WebSphere Application Server Network Deployment Web Server administrator panel (**Servers** → **Web Servers**) to propagate the HTTP Server plug-in from the WebSphere Application Server Network Deployment administrator console. Click **Propagate Plug-in** from the Web servers administrative panel. See Figure 6-4 on page 129.

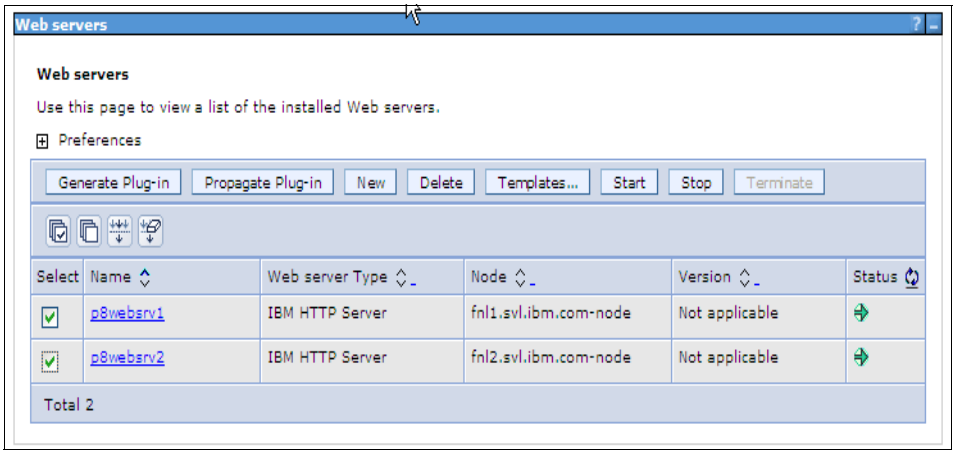


Figure 6-4 WebSphere Application Server Network Deployment Web servers administrative panel

6.3.6 Fix Pack 17 installation steps

Perform these steps to install Fix Pack 17:

1. At the end of the HTTP server configuration, stop both Web servers from the AE administration console, and then, stop the IBM HTTP Server administration server on fnl1 and fnl2 by issuing the commands:

   ```
   # cd /usr/IBM/HTTPServer/bin
   # adminctl stop
   ```

2. On both fn11 and fn12, install WebSphere Application Server Network Deployment Fix Pack 17 by issuing these commands:

   ```
   # cd /usr/IBM/WebSphere/UpdateInstaller
   # ./update.sh
   ```

3. To update WebSphere Application Server Network Deployment to Fix Pack 17, enter the `/fnsw/FP17` directory to be the directory containing fix pack packages in the installation wizard panel.
4. Restart the IBM HTTP Server administrative server on both Web server machines.
5. Restart the Web server from the AE Web server administrative console.

For more information about IBM HTTP Server installation and management, see Chapter 8 of *WebSphere Application Server V6 System Management & Configuration Handbook*, SG24-6451.

6.4 Failover test at the Web tier level

The Web tier faileover test involves these network components: F5 BIG-IP and HTTP servers.

F5 BIG-IP failover test

Refer to 5.2.6, “Validate load balancing” on page 97 for the detailed failover test results.

HTTP server failover test

There are two ways to test failure for one of the HTTP servers:

- Log in as root and issue **`sync; sync; halt -q`** from the command line.
- Stop the HTTP server from the WebSphere Application Server administrative console.

The **`halt`** command is self-explanatory. Follow these steps from the WebSphere Application Server Network Deployment administrative console to stop the HTTP server:

1. Go to the WebSphere Application Server Network Deployment administrative console by selecting **Server** → **Web servers**.
2. Select the Web server that you want to stop; see Figure 6-5.
3. Click **Stop**.

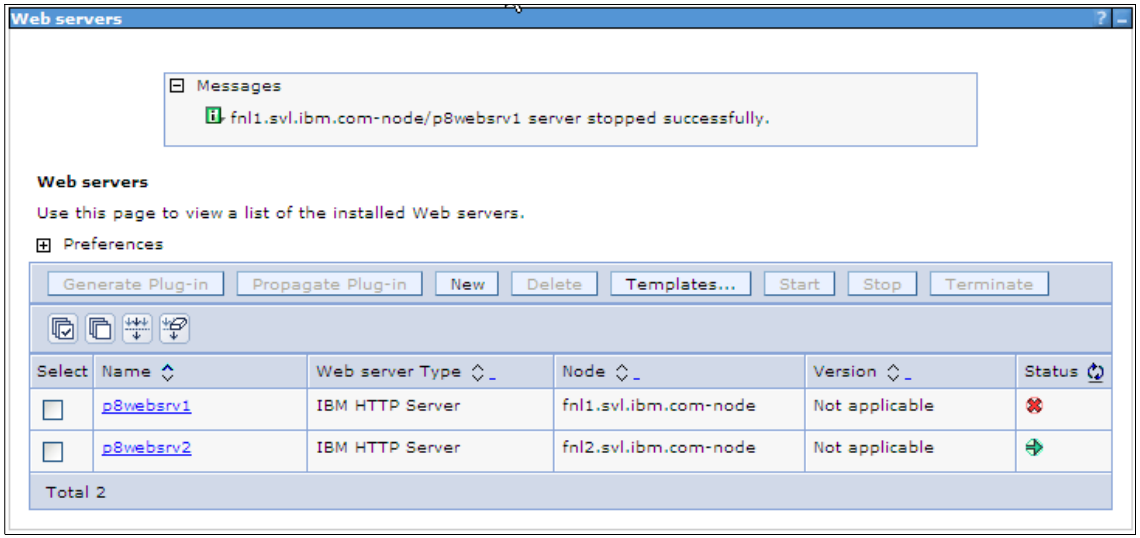


Figure 6-5 Web server stop panel

Regardless the way that is used to simulate a node failure, the following steps show the procedure to test the HTTP server down event:

1. Start the P8 system. Verify that from a browser, you can log into the AE Workplace Web application. (This step applies to log in only. At this point, you cannot actually perform tasks in Workplace, because the other components are not installed yet.)
2. Simulate the failure for the first HTTP server.
3. Verify that a user can perform all the activities from a Web browser.
4. Restart the closed or halted HTTP server.
5. Simulate the failure for the second HTTP server.
6. Verify that a user can perform all the activities from Web browsers.
7. Restart the closed or halted HTTP server.

6.5 Maintenance recommendations

For maintenance, we recommend that you keep the software level of the HTTP Server and Web server plug-ins for IBM WebSphere Application Server the same as the software level of the WebSphere Application Server Network Deployment administration server.

7

Application Engine implementation

This chapter describes the high availability options for Application Engine and our case study setup in relation to Application Engine. We also describe the practical, step-by-step procedures that we use to implement high availability for Application Engine.

We discuss the following topics:

- Introduction
- High availability options for Application Engine
- Design for the case study
- Setup for active/active Application Engine cluster (farm)
- High availability tests at the Application Engine level

7.1 Introduction

Application Engine (AE) is the presentation layer for the IBM FileNet P8 core components: Process Engine (PE) and Content Engine (CE). Application Engine hosts the Workplace or WorkplaceXT Web application, Workplace Java applets, and custom Web applications. It is critical that you provide high availability for Application Engine in the overall high availability of the IBM FileNet P8 solution.

For an overview of Application Engine and its components, refer to 2.4, “Application Engine” on page 29.

7.2 High availability options for Application Engine

Application Engine must be highly available. If Application Engine fails, even if Content Engine and Process Engine are still functional, users cannot access the content or the workflow process within the IBM FileNet P8 solution. Application Engine failure results in disruption to normal business operations.

Application Engine runs within a Java 2 Platform, Enterprise Edition (J2EE) application server. You can exploit all the scalability and high availability options that are available for a J2EE application server.

High availability options

The following options are available to make Application Engine highly available:

- Active/active cluster

  In an active/active cluster (farm) configuration, two or more application server instances are configured to share the same application’s workload. These application server instances can reside on the same physical machine or separate machines. You can front end the active/active cluster by using a hardware load balancer and redirect the traffic over to any active instance. In an active/active cluster with more than one instance available, the load sharing is more effective and the hardware cost is more justifiable.

- Active/passive cluster

  In an active/passive cluster, only one instance of the application server is running. The specific node that hosts the application load in an active/passive cluster is called the *active node*. The secondary node that can potentially host the application load is called the *passive node*. In an active/passive cluster at any point in time, there is only one node that is active to cater to the application load.

7.3 Design for the case study

For the case study that we implemented in this book, we choose the active/active cluster configuration to make the Application Engine highly available.

Table 7-1 lists the case study environmental details.

Table 7-1 Application Engine case study setup

Scenario	Active/active cluster
Operating system	IBM AIX 5.3 Technology Level 8 Service Pack 3: 5300-08-03-0831
Database	IBM DB2 UDB 9.5 Fix Pack 1
Application server	IBM WebSphere Application Server 6.1.017 IBM WebSphere Network Deployment 6.1.0.17
Hardware load balancer	BIG-IP F5

Figure 7-1 shows the Application Engine in an active/active cluster.

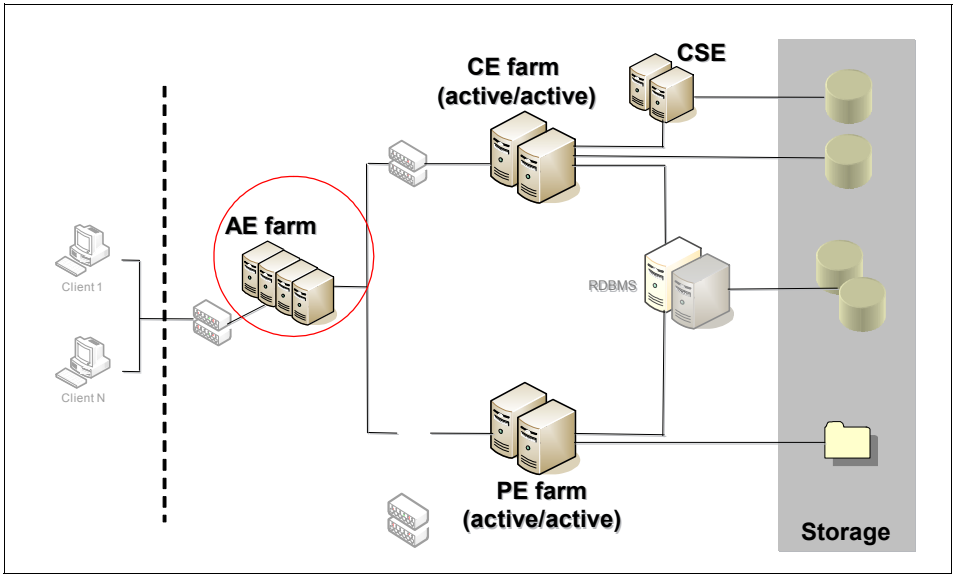


Figure 7-1 Application Engine in an active/active cluster (farm) configuration

7.4 Setup for active/active Application Engine cluster (farm)

This section shows the detailed steps taken to implement high availability for Application Engine in our case study. We set up Application Engine in an active/active clustered (farm) environment with Application Engine binaries and the configuration installed in a shared, highly available file system. The system setup, wherever necessary, also shows the windows from the standard Application Engine installation, where certain changes are required to make Application Engine highly available.

Table 7-2 shows the host names and IP addresses that are used in this implementation. We use these host names and IP addresses from now on in this chapter.

Table 7-2 System setup summary

Node	Host name	IP address
CE1	fnl10.svl.ibm.com	9.30.188.20
CE2	fnl11.svl.ibm.com	9.30.188.21
AE1	fnl3.svl.ibm.com	9.30.188.13
AE2	fnl4.svl.ibm.com	9.30.188.14
PE1	fnl20.svl.ibm.com	9.30.188.30
PE2	fnl21.svl.ibm.com	9.30.188.31
AE Virtual		9.30.188.90
P8CE (Virtual CE)	p8ce.svl.ibm.com	9.30.188.91
P8PE (Virtual PE)	P8PE.svl.ibm.com	9.30.188.92
Lightweight Directory Access Protocol (LDAP) server	fnl110.svl.ibm.com	9.30.188.120

7.4.1 Procedure for Application Engine cluster setup

To set up an Application Engine cluster, you must install and set up the prerequisites, and you must perform the Application Engine installation. The steps that we provide here are sequential in nature and need to be executed in order.

Installing and setting up the prerequisites

Installing and setting up the prerequisites include the installation of the WebSphere Application Server Network Deployment software, the configuration of the WebSphere Application Server Network Deployment environment, and the setup of the Application Engine cluster.

For our case study, we perform the following steps to install and create the active/active Application Engine cluster:

1. Install WebSphere Application Server Network Deployment 6.1.0.17 on AE1.

   WebSphere Application Server Network Deployment only needs to be installed on one of the nodes within a cluster. A nodeagent needs to be on every node. A nodeagent is installed as part of the WebSphere Application Server server.

   At the WebSphere Application Server Network Deployment installation time, avoid any cell, deployment manager, and application server definition. These tasks are carried out subsequently.

   From the WebSphere Application Server Network Deployment 6.1.0.0 installation wizard, we use the following options:

   – No sample applications selected for install.

   – The default installation directory chosen is `/usr/IBM/WebSphere`.

   – No profile definition.

   – No profile for deployment manager definition, which also means no security definitions.

   The summary panel (Figure 7-2 on page 138) from the installation program shows the summary of choices that were selected. This window is the last options window from the installation program.

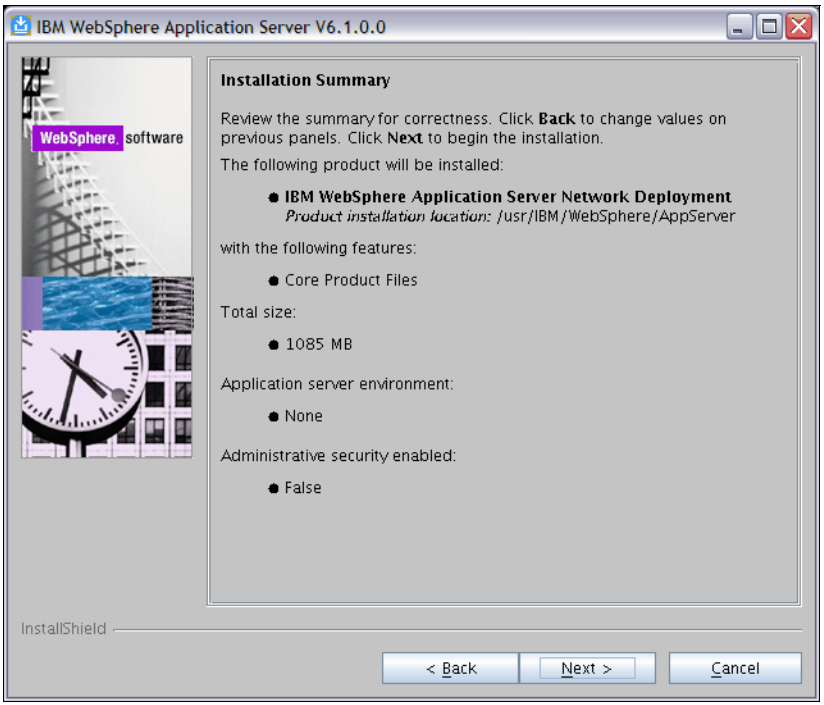


Figure 7-2 WebSphere Application Server Network Deployment 6.1.0.0 Installation Summary panel

2. Apply WebSphere Application Server Network Deployment Fix Pack 17 without any special settings:

```
# cd /usr/IBM/WebSphere/UpdateInstaller
# ./update.sh
```

3. Create the Network Deployment Manager profile.

   In our setup, the fnl3 and fnl4 nodes participate in the Application Engine cell. We define and start Network Deployment Manager on fnl3 by logging in as root and issuing the following commands:

```
# cd /usr/IBM/WebSphere/AppServer/bin
# ./manageprofiles.sh -create -profileName Dmgr1 -templatePath
/usr/IBM/WebSphere/AppServer/profileTemplates/dmgr -cellName AECell
-hostName fnl3
# cd /usr/IBM/WebSphere/AppServer/profile/Dmgr1
# ./startManager.sh
```

4. Integrate WebSphere Application Server security with the Directory Server. In Figure 7-3 on page 139, the WebSphere Application Server Administrative console window shows that the administrative security is enabled.

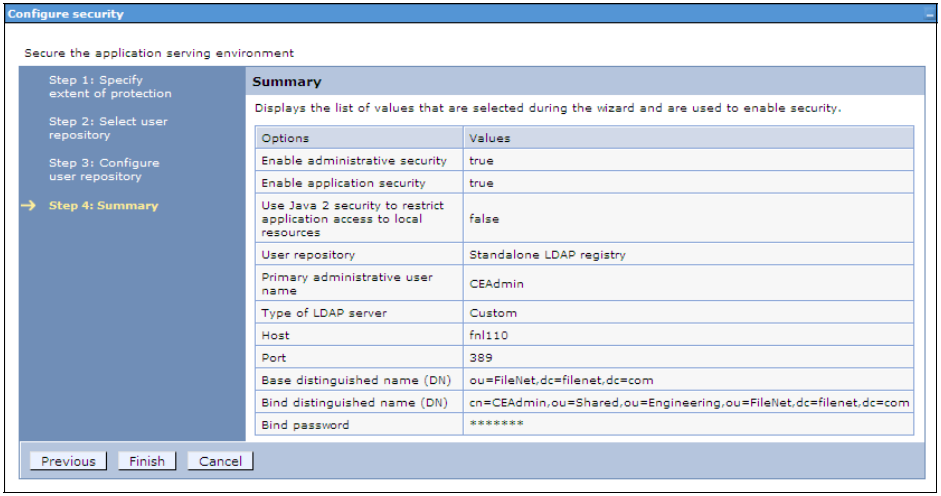


Figure 7-3 Enabling Security with Directory Server Summary panel

5. Create WebSphere Application Server Nodes and WebSphere Application Servers.

   On both participating Application Engine servers included in the WebSphere Application Server Network Deployment cell, create profiles and federate new nodes to the deployment manager defined in fnl3 by issuing the following commands:

```
# cd /usr/IBM/WebSphere/AppServer/bin
# ./manageprofiles.sh -create -profileName server1 -templatePath
/usr/IBM/WebSphere/AppServer/profileTemplates/default  -hostName
fnl3
# cd /usr/IBM/WebSphere/AppServer/profiles/server1/bin
# ./addNode.sh fnl3
```

   Run the following commands on node fnl4:

```
# cd /usr/IBM/WebSphere/AppServer/bin
# ./manageprofiles.sh -create -profileName server2 -templatePath
/usr/IBM/WebSphere/AppServer/profileTemplates/default  -hostName
fnl4
# cd /usr/IBM/WebSphere/AppServer/profiles/server2/bin
# ./addNode.sh fnl3
```

   Note: In the `addNode.sh` command, the host name argument (fnl3) is not changed, because the host refers to where the WebSphere Application Server Network Deployment Manager runs. In this case, it is fnl3.

6. Align the ports for both application servers.

   After the profiles are created and the nodes are added, these two application servers can now be managed under the WebSphere Application Server Network Deployment Manager administrative interface.

   In our architecture, the Application Engine Web application is deployed on both nodes as clones. Therefore, to allow all Application Engine instances to communicate with other P8 components, these application servers have to use the same ports on AIX machines.

   Manually, align the port numbers through WebSphere Application Server Network Deployment administrative console by selecting **Application server** → ***<server_name>*** → **Ports**. Figure 7-4 shows the port numbers that are used in our scenario.

Port Name	Port
BOOTSTRAP_ADDRESS	19811
SOAP_CONNECTOR_ADDRESS	18881
SAS_SSL_SERVERAUTH_LISTENER_ADDRESS	19404
CSIV2_SSL_SERVERAUTH_LISTENER_ADDRESS	19405
CSIV2_SSL_MUTUALAUTH_LISTENER_ADDRESS	19406
WC_adminhost	19060
WC_defaulthost	19080
DCS_UNICAST_ADDRESS	19355
WC_adminhost_secure	19043
WC_defaulthost_secure	19443
SIP_DEFAULTHOST	15062
SIP_DEFAULTHOST_SECURE	15063
SIB_ENDPOINT_ADDRESS	17276
SIB_ENDPOINT_SECURE_ADDRESS	17287
SIB_MQ_ENDPOINT_ADDRESS	15559
SIB_MQ_ENDPOINT_SECURE_ADDRESS	15579
ORB_LISTENER_ADDRESS	19100

Figure 7-4 Application Engine server port numbers

7. Define the WebSphere Application Server Network Deployment cluster for the Application Engine application.

   To deploy Application Engine on both nodes (fnl3 and fnl4), include them in the WebSphere Application Server Network Deployment cluster definition.

   The WebSphere Application Server Network Deployment administrative console manages the cluster definition. From the administration console, select **Servers** → **Clusters** → **New** to create a new cluster definition. Follow the responses on the window, and accept the default values. Figure 7-5 on page 141 shows the summary of settings for the cluster before it is created.

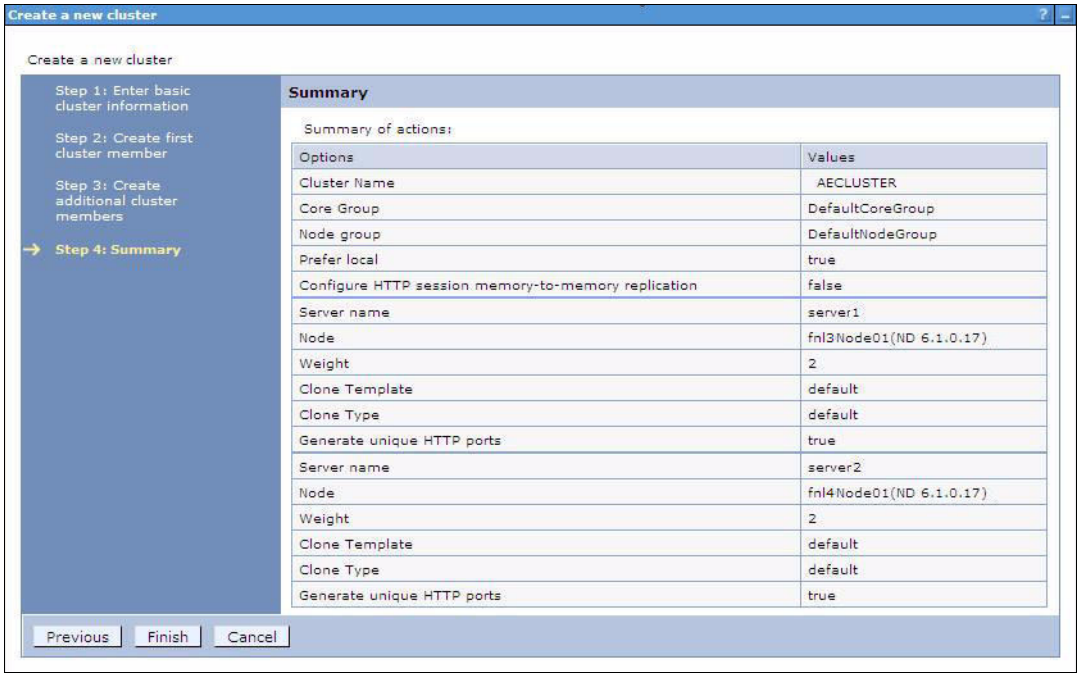


Figure 7-5 Cluster definition Summary panel

Application Engine installation and configuration

After the prerequisites are set up, perform the Application Engine installation and configuration. Install the Application Engine software and any “hot” or important fixes if required, install the Content Engine client and Process Engine client on both Application Engine nodes, and configure both nodes.

Perform these steps for the Application Engine installation and configuration:

1. Install Application Engine 4.0.0.

   For our case study, the shared Application Engine binaries and configuration will be stored on a highly available file system mounted as the default IBM FileNet P8 install location of `/opt/FileNet`. As a result, we accept all the defaults on the installation panels, except these two options:

   – Installation Type: We choose **Custom install** and select **Workplace Source Code** component to be installed.

   – J2EE Application Server and version: For Application Server, we choose **IBM WebSphere Application Server**. For Version, we select **6.x**.

   Figure 7-6 on page 142 shows the user selections.

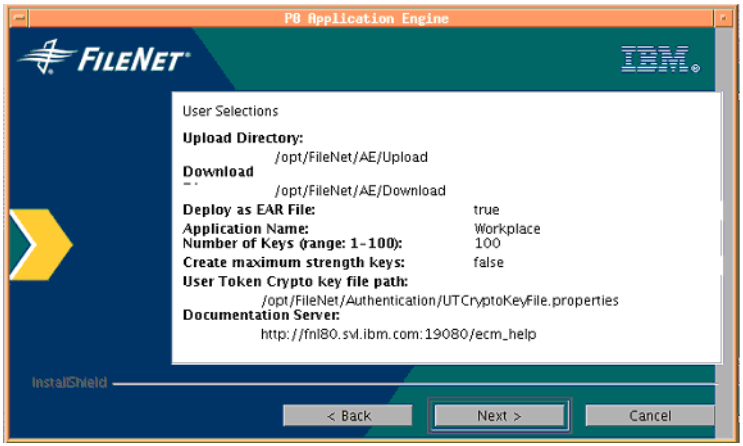


Figure 7-6 Application Engine 4.0.0 User Selections panel

Figure 7-7 presents the installation summary window.

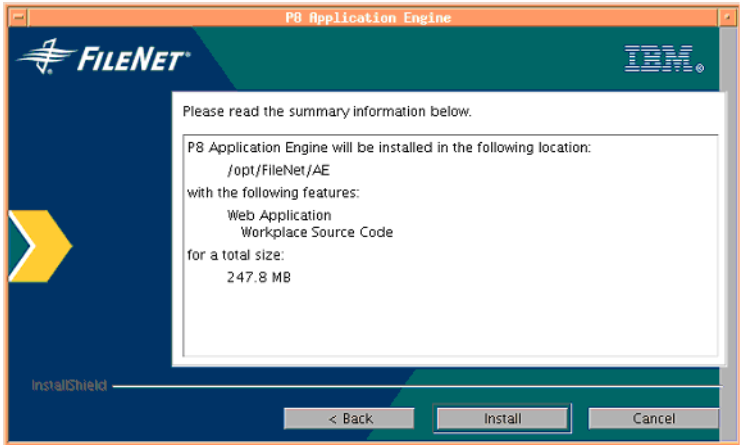


Figure 7-7 Application Engine 4.0.0 installation summary

Figure 7-8 on page 143 illustrates the installation success window.

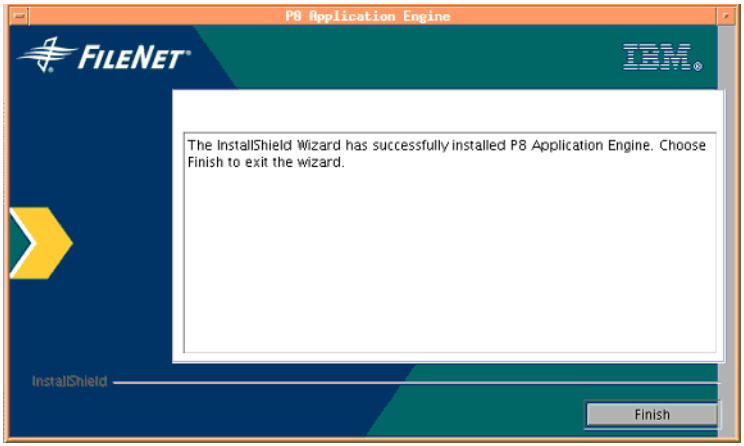


Figure 7-8 Application Engine 4.0.0 installation success

2. Apply the Application Engine 4.0.1 hot fix.

   For our case study, we use all the defaults on the installation panels.

3. Install Content Engine client 4.0.1-001 and Process Engine client 4.0.3.

   For our case study, we use all the defaults and complete these client installations successfully.

4. Enable Application Engine in high availability mode.

   To enable Application Engine in high availability mode and make it aware of both Content Engine nodes, change the `WcmApiConfig.properties` file at two locations:

   – /opt/FileNet/AE/CE_API/lib2

   – /opt/FileNet/AE/Workplace/WEB-INF

   You can also make this change when providing the Content Engine address in the Application Engine installer panel instead of changing the files after the fact.

   In the `WcmApiConfig.propertiesfile`, for our case study, we make the following change:

```
RemoteServerUrl =
cemp:corbaloc::fnl10.svl.ibm.com:19811,:fnl11.svl.ibm.com:19811/cell
/clusters/CECLUSTER/FileNet/Engine
RemoteServerUploadUrl =
cemp:corbaloc::fnl10.svl.ibm.com:19811,:fnl11.svl.ibm.com:19811/cell
/clusters/CECLUSTER/FileNet/Engine
```

```
RemoteServerDownloadUrl =
cemp:corbaloc::fnl10.svl.ibm.com:19811,:fnl11.svl.ibm.com:19811/cell
/clusters/CECLUSTER/FileNet/Engine
```

5. Configure Application Engine for WebSphere.

   Using the WebSphere Application Server Network Deployment administrative console, we make the following changes:

   – On both nodes, add the following line to the Generic Java virtual machine (JVM™) argument:

     ```
     -Djava.security.auth.login.config=/opt/FileNet/AE/CE_API/config/j
     aas.conf.WebSphere
     ```

   – Create a new custom property named client.encoding.override and set it to UTF-8.

     Figure 7-9 shows the window for creating the custom property.

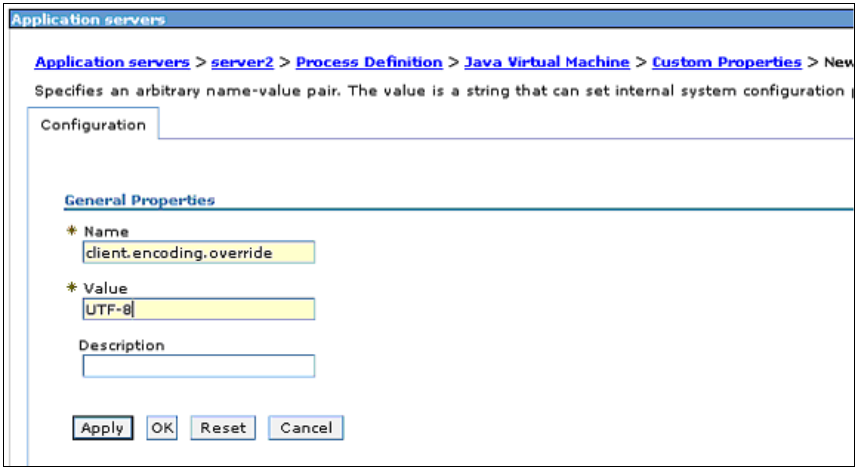


Figure 7-9 Create a custom property for Application Engine

   – Create another MIME type. Figure 7-10 on page 145 shows the MIME type creation window.

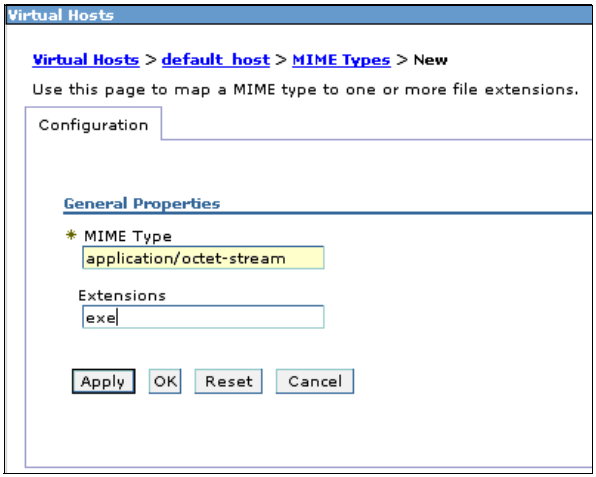


Figure 7-10 Additional MIME type creation

6. Synchronize both nodes and restart both JVMs in the AECLUSTER.
7. Reset the security on both nodes for Internet Inter-ORB Protocol (IIOP).

   For our case study, we perform the following steps using WebSphere Application Server Network Deployment administrative console:

   a. Go to **Security** → **Secure administration** → **Applications** → **Infrastructure** → **RMI/IIOP Security** → **CSIv2 inbound authentication**. Change the Client certificate authentication from Supported to **Never**.

   b. Go to **Security** → **Secure administration** → **Applications** → **Infrastructure** → **RMI/IIOP Security** → **CSIv2 inbound transport**. Change the Transport from SSL-supported to **TCP/IP**.

   c. Use the WebSphere Application Server administrative console to save the configuration setting. Apply the Master configuration. Exit from the WebSphere administrative console. Restart WebSphere Application Server.

   d. Verify that the Content Engine is up.
8. Copy the `/opt/FileNet/Authentication/UTCryptoKeyFile.properties` file to each of the Application Engine nodes.
9. Use the deployment method that is described in *IBM FileNet Installation and Update Guide*, GC31-5488, to redeploy the Application Engine to the cluster AECLUSTER. Accept the default values.
10. Bootstrap the Application Engine server.

7.5 High availability tests at the Application Engine level

After you complete the setup of each component in the high availability P8 environment, make sure that you perform component testing before continuing with the rest of the implementation.

In this section, we discuss the failover tests at the Application Engine component level. Table 7-3 shows the high availability tests that we performed for our case study in the lab and the results of these tests.

Table 7-3 Application Engine component-level high availability test scenarios

Sr. No.	Test	Expected result	Actual result
Test 1	Basic availability test: Test the Workplace application by going to the Workplace URL `http://9.30.188.90/Workplace`. Note: Use the Application Engine virtual IP address for testing.	The URL works. Response is from either one of the Application Engine nodes.	See 7.5.1, "Application Engine basic availability test" on page 146.
Test 2	Node availability test 1: Test the Workplace application while Application Engine node 2 (AE2) is down. Use the same URL as test 1.	The URL works. Response is from AE1.	See 7.5.2, "Application Engine node availability test 1" on page 148.
Test 3	Node availability test 2: Test the Workplace application while Application Engine node 1 (AE1) is down.	The URL works. Response is from AE2.	See 7.5.3, "Application Engine node availability test 2" on page 149.

7.5.1 Application Engine basic availability test

The basic test to see whether Application Engine is available is by testing the Workplace application (with the assumption that the load balancer and IBM HTTP Server are installed correctly and successfully). When launching the Workplace application through the URL, if you get to the Workplace login window, Application Engine is up and running. If you do not get to the login window, Application Engine is not running.

Note: Without the database and Content Engine, we only see and test the login window. We get an error if we try to carry out the actual login operation.

To launch the Workplace application, enter the following URL:

`http://9.30.188.90/Workplace`

Workplace is accessed.

The IP address that is used here needs to be the virtual IP address of the Application Engine.

The WebSphere Application Server Network Deployment administrative console shows that both nodes of AECLUSTER are up and running. See Figure 7-11.

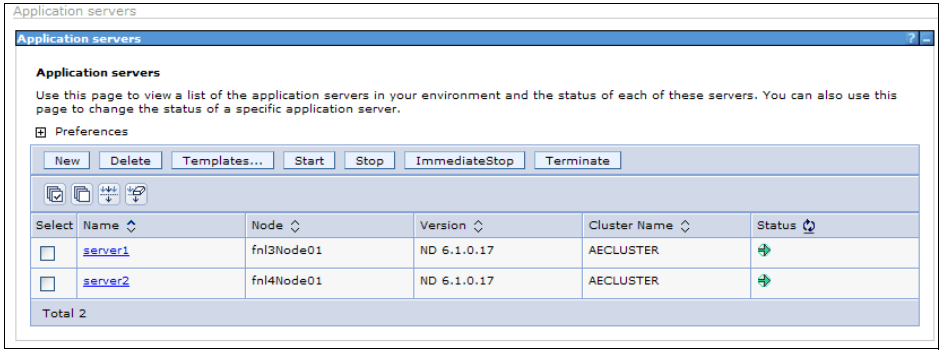


Figure 7-11 WebSphere Application Server Network Deployment administrative console showing both Application Engine nodes up

Figure 7-12 shows the Workplace login window after we enter:

`http://9.30.188.90/Workplace`

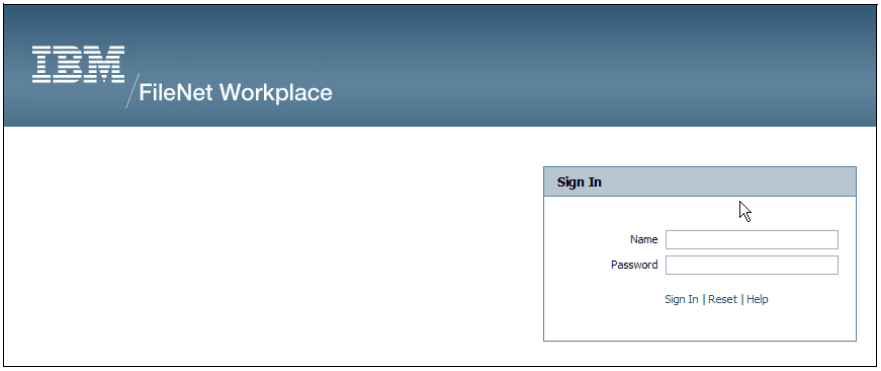


Figure 7-12 Workplace login window

This test concludes that Application Engine is up and running.

7.5.2 Application Engine node availability test 1

In this test, bring down Application Engine node 2 (AE2) from the AECLUSTER. We still can get the login window, because Application Engine node 1 (AE1) is still up and running.

Figure 7-13 shows the WebSphere Application Server Network Deployment administrative console. Notice that AE2 is down and AE1 is up.

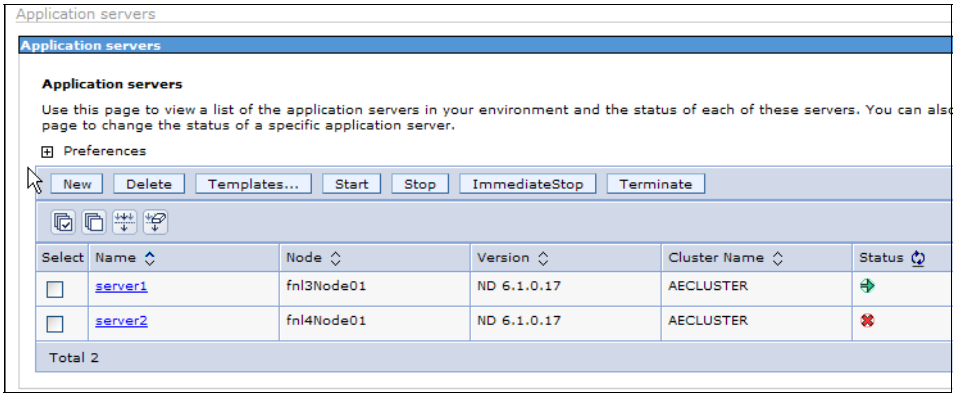


Figure 7-13 WebSphere Application Server Network Deployment administrative console showing node AE2 is down

When we use the URL to launch the Workplace application, 7.5.3, “Application Engine node availability test 2” on page 149 shows that we can still access Workplace.

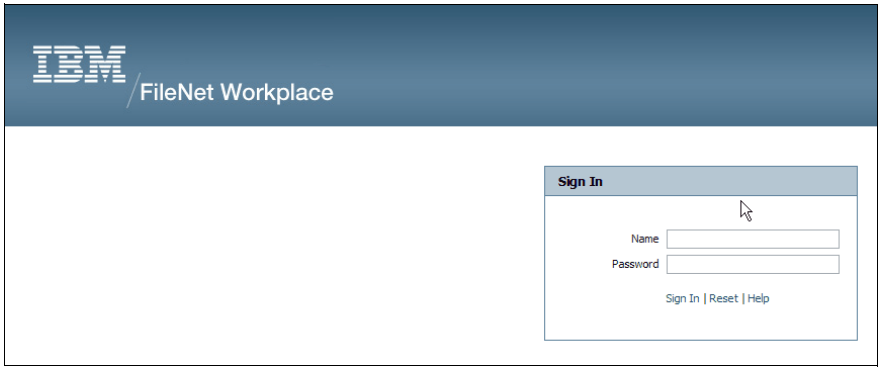


Figure 7-14 Workplace login window when node AE2 is down

7.5.3 Application Engine node availability test 2

In this test, bring down AE1 node. We still can access Workplace.

Figure 7-16 shows the WebSphere Application Server Network Deployment administrative console window. Notice that AE1 is down and AE2 is up and running.

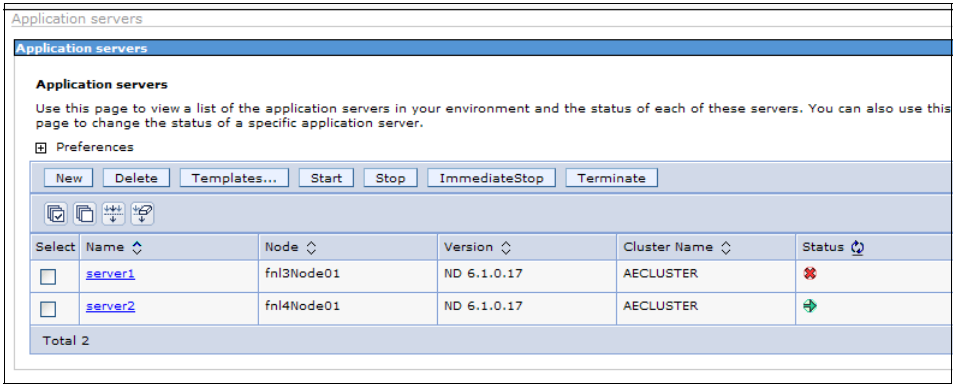


Figure 7-15 WebSphere Application Server Network Deployment administrative console showing node AE1 is down

When we try to launch the Workplace application through its URL, Figure 7-16 shows the Workplace login window. Even when the AE1 node is down, we can still access Workplace. Therefore, Application Engine is still working.

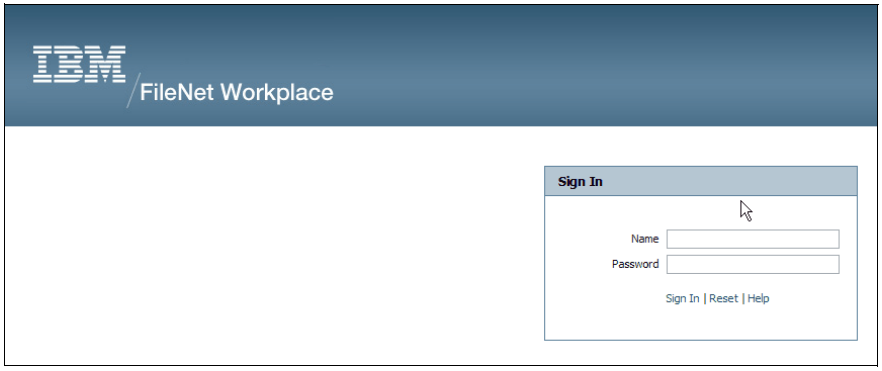


Figure 7-16 Workplace login window when node AE1 is down

8

Content Engine implementation

This chapter describes the high availability (HA) options for Content Engine (CE) and our case study setup in relation to it. We also discuss the practical, step-by-step procedures that we use to implement high availability for Content Engine.

We discuss the following topics:

- Introduction
- High availability options for Content Engine
- Case study design
- Setting up the active/active Content Engine cluster (farm)
- High availability tests at the Content Engine level

8.1 Introduction

Content Engine provides access, storage, and other management for content. It is designed to handle the heavy demands of a large enterprise. Content Engine is capable of managing enterprise-wide workflow objects, custom objects, and documents by offering powerful and easy-to-use administrative tools. Using these administrative tools, an administrator can create and manage the classes, properties, storage, and metadata that form the foundation of an Enterprise Content Management (ECM) system. It is critical to provide high availability for Content Engine in the overall high availability of the IBM FileNet P8 solution.

For an overview of Content Engine, its features and architecture, refer to 2.2, “Content Engine” on page 21.

8.2 High availability options for Content Engine

Content Engine is the central point of the IBM FileNet P8 repository. Content Engine must be highly available. If Content Engine fails, users no longer have access to existing content, and they cannot add new content. This inaccessibility occurs from API-based programs, as well as from other components, such as the Application Engine (AE) and Process Engine (PE). The importance of Content Engine must be a key factor in creating any IBM FileNet P8 HA environment.

When Content Engine is unavailable, neither the content nor the processes can be routed (although in certain cases, there are still operations that will succeed, at least for users who are already logged in). In comparison, if a Process Engine fails, the users can still ingest and retrieve content from the repository. If an Application Engine fails, the Workplace application cannot be accessed; however, the repository or Content Engine can still be accessed through a custom, API-based application. In the case of a Content Engine failure, the entire repository becomes inaccessible.

Because Content Engine is implemented as a Java 2 Platform, Enterprise Edition (J2EE) application running within a J2EE application server, it can exploit all the scalability and high availability options that are available for J2EE application servers.

The following options are available for making Content Engine highly available:

- Active/active cluster

  In an active/active cluster (farm) configuration, two or more application server instances are configured to serve the same application workload. These application server instances can reside on the same physical machine or

separate machines. The active/active cluster can be front-ended by using a load balancer. And, the traffic can be redirected over to any of the active instances. In an active/active cluster, because there are more than one instance available, the load sharing is more effective and the hardware cost is more justifiable to the business.

- Active/passive cluster

  In an active/passive cluster, only one instance of the application server is running. The specific node that hosts the application load in an active/passive cluster is called the *active node*. The secondary node that can potentially host the application load is called the *passive node*. In an active/passive cluster at any time, there is only one node active to cater to the application load.

The application metadata that is stored in a Content Engine database must also be made highly available in both scenarios.

The file storage areas for Content Engine must be accessible to all Content Engines in a P8 domain, whether those Content Engines are farmed or not. Typically, the file storage areas are accessed in a shared network, such as Common Internet File System (CIFS), Network File System (NFS), or Distributed File Service (DFS).

In a high availability deployment, each file storage area must be deployed on highly available storage that has built-in redundancy for all components, so that the file storage area is not a single point of failure (for example, RAID arrays for storage redundancy, redundant network heads, and redundant power supplies).

It is beyond the scope of this book to describe the details of providing highly available storage. Refer to your storage vendor for more information.

8.3 Case study design

For our case study setup, we choose the recommended active/active cluster (farm) configuration for making the Content Engine highly available. There are two nodes running the Content Engines. Both nodes run the IBM AIX operating system.

Table 8-1 shows the high availability environment details.

Table 8-1 Content Engine case study setup

Scenario	Active/active cluster
Operating system	IBM AIX 5.3 Technology Level 8 Service Pack 3: 5300-08-03-0831

Scenario	Active/active cluster
Database	IBM DB2 UDB 9.5 Fix Pack 1
Application server	IBM WebSphere Application Server 6.1.017 IBM WebSphere Network Deployment 6.1.0.17
Hardware load balancer	BIG-IP F5

Figure 8-1 illustrates the Content Engine in an active/active cluster.

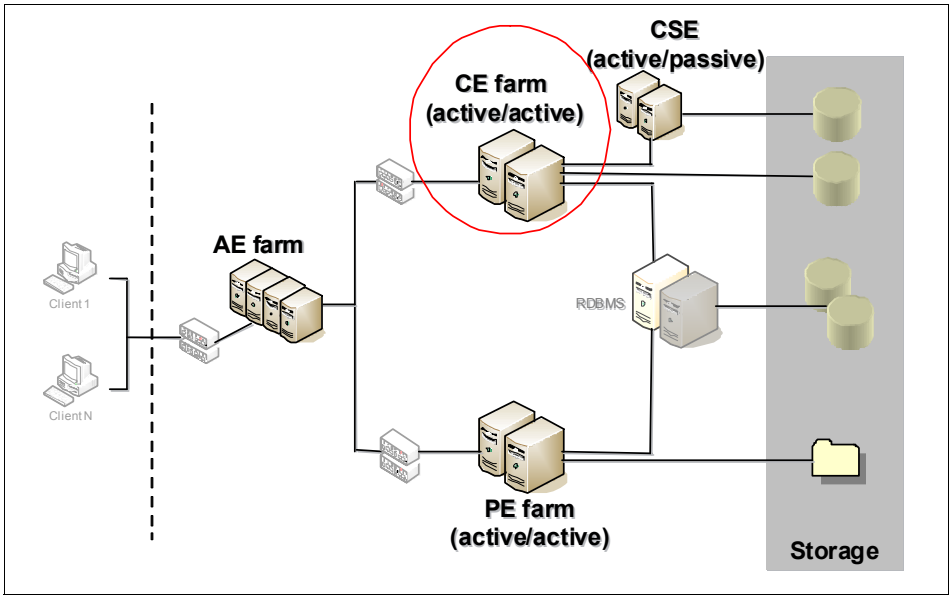


Figure 8-1 Content Engine in an active/active cluster (farm) configuration

8.4 Setting up the active/active Content Engine cluster (farm)

This section shows the detailed steps taken to implement high availability for Content Engine in our case study. We set up Content Engine in an active/active cluster (farm) environment. The system setup, wherever necessary, also shows the windows from the standard Content Engine installation, where certain changes are required to make Content Engine highly available.

Table 8-2 on page 155 shows the host names and IP addresses that are used in this setup. We refer to these host names and IP addresses from now on in this chapter.

Table 8-2 System setup summary

Node	Host name	IP address
CE1	fnl10.svl.ibm.com	9.30.188.20
CE2	fnl11.svl.ibm.com	9.30.188.21
AE1	fnl3.svl.ibm.com	9.30.188.13
AE2	fnl4.svl.ibm.com	9.30.188.14
PE1	fnl20.svl.ibm.com	9.30.188.30
PE2	fnl21.svl.ibm.com	9.30.188.31
P8CE (Content Engine virtual)	p8ce.svl.ibm.com	9.30.188.91
P8PE (PE virtual)	P8PE.svl.ibm.com	9.30.188.92

8.4.1 Procedure for the Content Engine cluster setup

To set up the Content Engine cluster, you have to install and set up the prerequisites, perform the Content Engine installation and upgrade, install the Process Engine client, and configure the Content Engine nodes. The steps we provide here are sequential in nature and must be executed in order.

Installing and setting up the prerequisites

Installing and setting up the prerequisites include the installation and creation of a cluster in a WebSphere Application Server Network Deployment environment.

For our case study, we perform the following steps to install and create the Content Engine active/active cluster:

1. Install the CE database.

   For details, refer to Chapter 12, “DB2 implementation” on page 369.

2. Install WebSphere Application Server Network Deployment 6.1.0.17.

   Avoid any cell, deployment manager, and application server definition at installation time. These tasks are carried out subsequently.

   From WebSphere Application Server Network Deployment 6.1.0.0 installation wizard, we use the following options:

– No sample applications are selected for installation.
– The installation directory is the default: `/usr/IBM/WebSphere`
– No profile is defined.
– No profile for the deployment manager is defined. No security definitions are defined.

The summary panel (Figure 8-2) from the installation program shows the summary of the selections. This window is the last options window from the installation program.

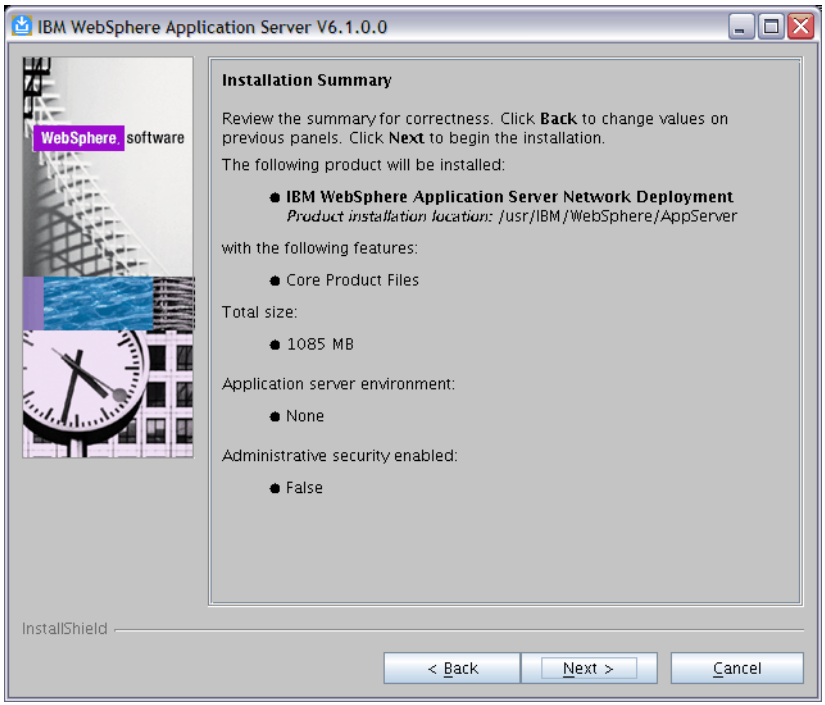


Figure 8-2 WebSphere Network Deployment 6.1.0.0 Installation Summary window

3. Apply the WebSphere Application Server Network Deployment fix pack without special settings:

```
# cd /usr/IBM/WebSphere/UpdateInstaller
# ./update.sh
```

4. Create the Network Deployment Manager profile.

   In our setup, the nodes that participate in the Content Engine cell are fnl10 and fnl11. We define and start Network Deployment Manager on fnl10 by logging in as root and issuing the following commands:

```
# cd /usr/IBM/WebSphere/AppServer/bin
```

```
# ./manageprofiles.sh -create -profileName Dmgr1 -templatePath
/usr/IBM/WebSphere/AppServer/profileTemplates/dmgr -cellName CECell
-hostName fnl10
# cd /usr/IBM/WebSphere/AppServer/profile/Dmgr1
# ./startManager.sh
```

5. Integrate WebSphere Application Server security with the Directory Server. In Figure 8-3, the WebSphere Application Server administrative console window shows that the administrative security is enabled.

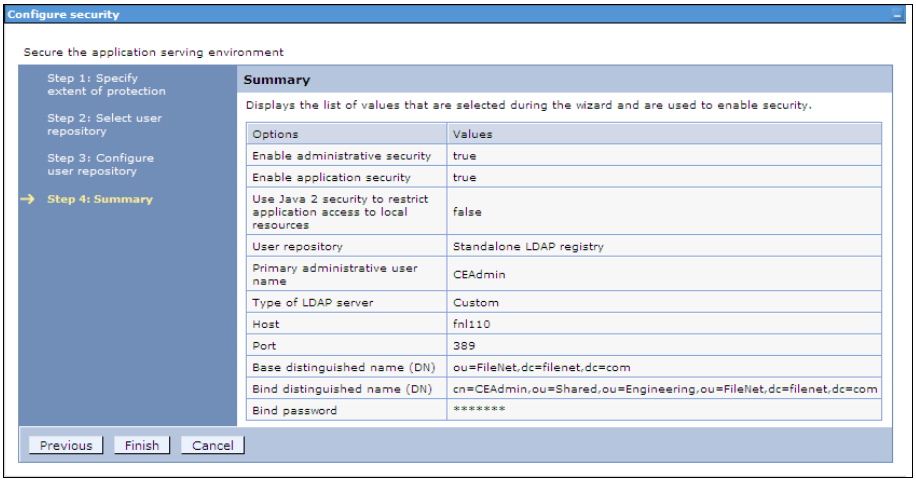


Figure 8-3 Enabling security with Directory Server

6. Create WebSphere Application Server nodes and WebSphere application servers.

   On both participating Content Engine servers included in the WebSphere Application Server Network Deployment cell, create profiles and federate new nodes to the deployment manager that was defined in fnl10 by issuing the following commands:

```
# cd $WASHOME/bin
# ./manageprofiles.sh -create -profileName server1 -templatePath
/usr/IBM/WebSphere/AppServer/profileTemplates/default  -hostName
fnl10
# cd $WASHOME/profiles/server1/bin
# ./addNode.sh fnl10
```

   Run the following commands on node fnl11:

```
# cd $WASHOME/bin
```

```
# ./manageprofiles.sh -create -profileName server2 -templatePath
/usr/IBM/WebSphere/AppServer/profileTemplates/default  -hostName
fnl11
# cd $WASHOME/profiles/server2/bin
# ./addNode.sh fnl10
```

Note: In the **addNode.sh** command, the host name argument (fnl10) is not changed, because the host refers to where the WebSphere Application Server Network Deployment Manager runs. In this case, it is fnl10.

7. Align the ports for both application servers.

   After the profiles are created and the nodes are added, the two application servers can now be managed under the WebSphere Application Server Network Deployment Manager administrative interface.

   Because in our architecture, the Content Engine Web application is deployed on both nodes as clones, these application servers must use the same ports on the AIX machines to allow all Content Engine Web application instances to communicate with other P8 components.

   Manually align the port numbers through the WebSphere Application Server Network Deployment administrative console by selecting **Application server** → ***<server_name>*** → **Ports**. Figure 8-4 shows the port numbers that are used in our scenario.

Port Name	Port
BOOTSTRAP_ADDRESS	19811
SOAP_CONNECTOR_ADDRESS	18881
SAS_SSL_SERVERAUTH_LISTENER_ADDRESS	19404
CSIV2_SSL_SERVERAUTH_LISTENER_ADDRESS	19405
CSIV2_SSL_MUTUALAUTH_LISTENER_ADDRESS	19406
WC_adminhost	19060
WC_defaulthost	19080
DCS_UNICAST_ADDRESS	19355
WC_adminhost_secure	19043
WC_defaulthost_secure	19443
SIP_DEFAULTHOST	15062
SIP_DEFAULTHOST_SECURE	15063
SIB_ENDPOINT_ADDRESS	17276
SIB_ENDPOINT_SECURE_ADDRESS	17287
SIB_MQ_ENDPOINT_ADDRESS	15559
SIB_MQ_ENDPOINT_SECURE_ADDRESS	15579
ORB_LISTENER_ADDRESS	19100

Figure 8-4 WebSphere Application Server port numbers that are used

8. Define the WebSphere Application Server Network Deployment cluster for the Content Engine application.

To deploy the Content Engine application on both nodes (fnl10 and fnl11), include them in the WebSphere Application Server Network Deployment cluster definition.

The WebSphere Application Server Network Deployment administrative console manages the cluster definition. From the administrative console, select **Servers** → **Clusters** → **New** to create a new cluster definition. Follow the responses on the window and accept the default values. Figure 8-5 shows the summary of the settings for the cluster before it is created.

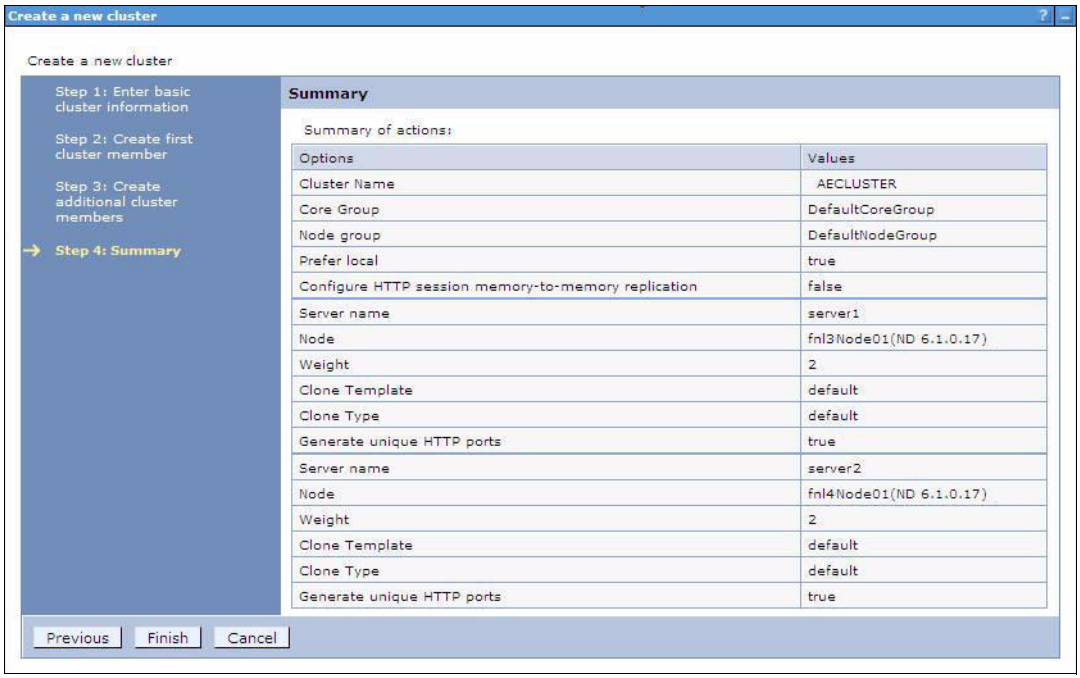


Figure 8-5 Content Engine cluster definition Summary panel

Content Engine installation and upgrade

After the prerequisites are set up, you need to install and configure the Content Engine nodes. You install the Content Engine software, verify that the installation is successful, and upgrade the Content Engine software if required.

Installing Content Engine

Follow these steps to install Content Engine 4.0.0:

1. To install Content Engine 4.0.0, for our case study, we accept all the default values until we get to the WebSphere Information window.

2. Set up the WebSphere profile information. Figure 8-6 on page 160 shows our setup.

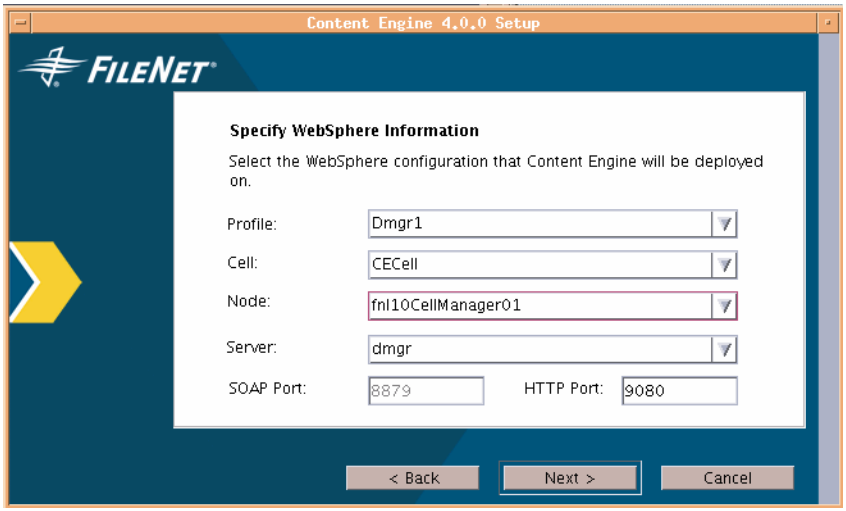


Figure 8-6 Content Engine installation: WebSphere Profile information panel

3. Enter the WebSphere administrator user name and password. Figure 8-7 shows our setup.

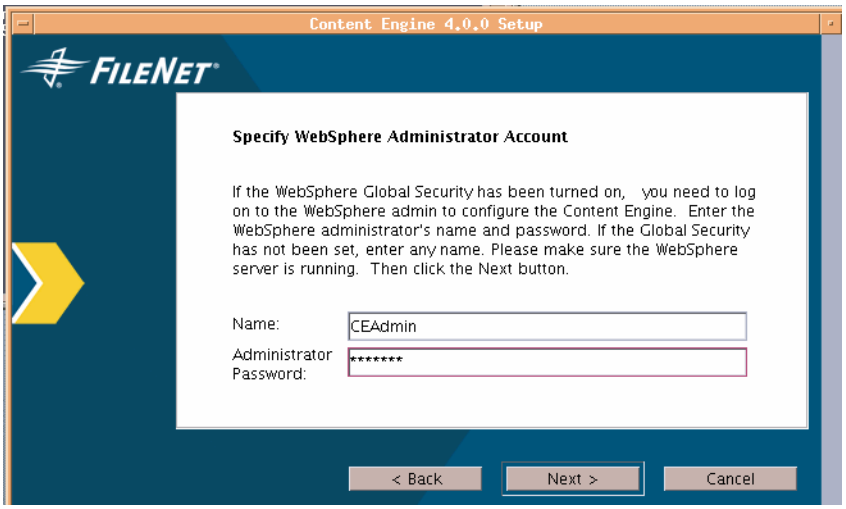


Figure 8-7 Content Engine Installation panel for WebSphere Administrator Account

4. Accept the defaults on the Global Configuration Database (GCD) Java Naming and Directory Interface (JNDI) configuration and select **DB2** on the Configure Java Database Connectivity (JDBC™) window.
5. Set up the JDBC connection pools information. Figure 8-8 on page 161 shows our setup.

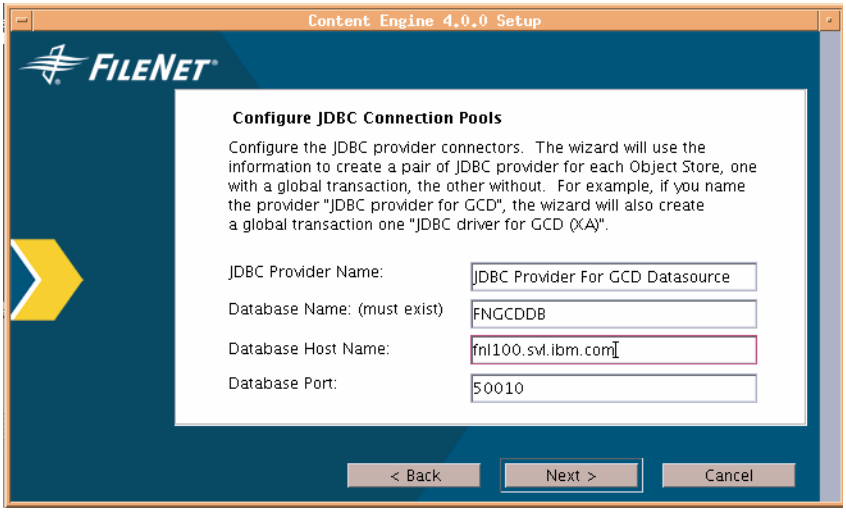


Figure 8-8 Content Engine installation: Configure JDBC Connection Pools panel

6. For the remaining installation windows (Specify Database user, Setup Content Engine Bootstrap Properties, and GCD Master Key), enter environment-specific values.
7. Figure 8-9 shows the summary window for the Content Engine installation. Click **Install** to start the installation process.

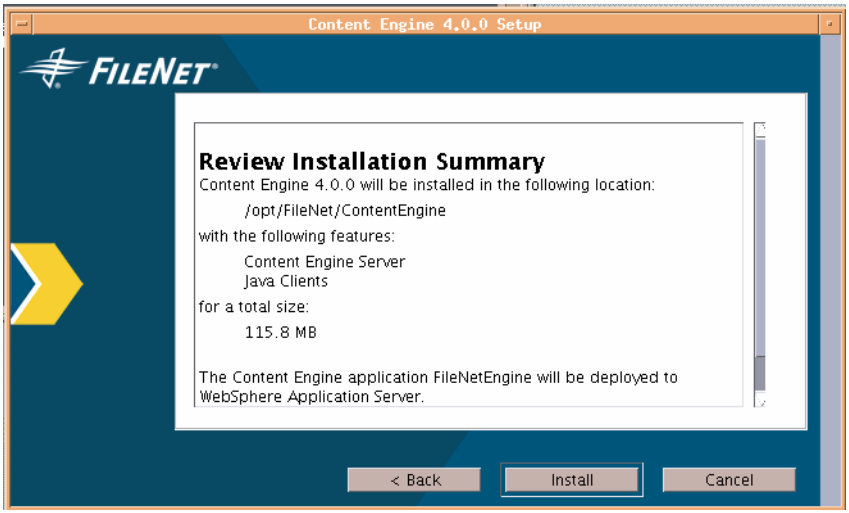


Figure 8-9 Content Engine Installation: Review Installation Summary panel

The Verify Installation window (Figure 8-10 on page 162) shows the successful installation.

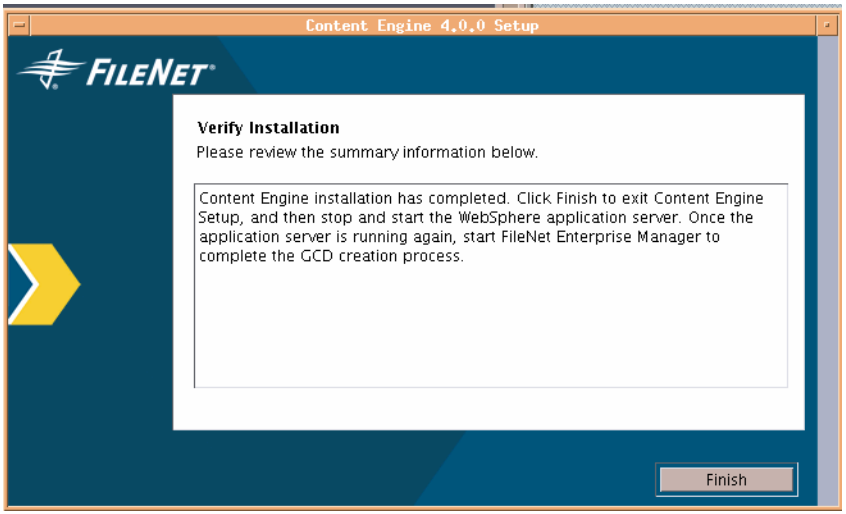


Figure 8-10 Content Engine Installation: Verify Installation panel

After the installation for Content Engine is complete, restart the nodes in the CECLUSTER and the Network Deployment Manager, dmgr.

Confirm that the JDBC connection to the connection pool works.

Log in to the WebSphere Application Server Administrative Console by using user CEAdmin and check the following setup:

1. Select **Resources → JDBC → JDBC providers → JDBC Provider For GCD Datasource → Data sources → FNGCDDS**. See Figure 8-11.

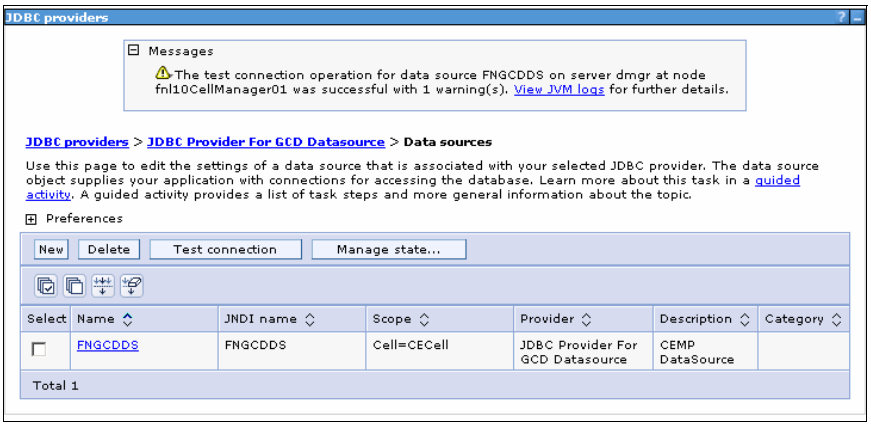


Figure 8-11 JDBC Connection to FNGCDDS

2. Select **Resources → JDBC → JDBC providers → JDBC Provider For GCD Datasource (XA) → Data sources → FNGCDDSXA**. See Figure 8-12.

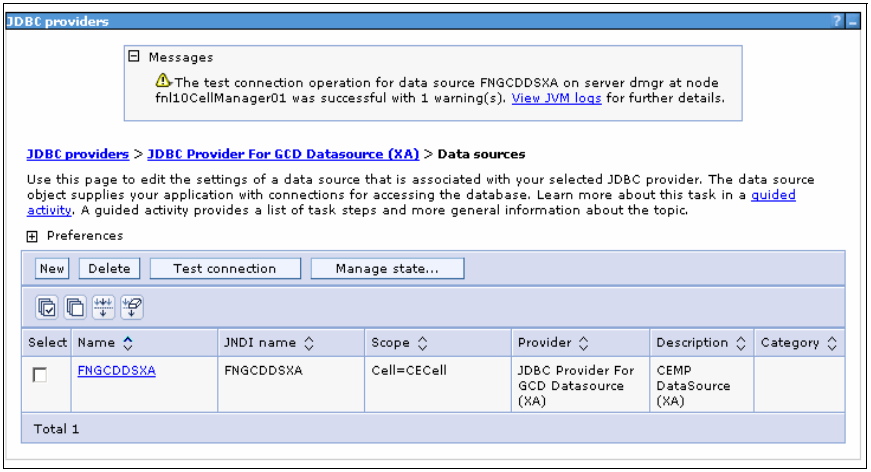


Figure 8-12 JDBC connection to FNGCDDSXA

Redeploy the FileNetEngine application from WebSphere. The target, by default, is pointing to dmgr instead of CECLUSTER, which, for IBM FileNet P8 Version 4.5, is no longer necessary.

Note: For Network Deployment configurations, deploy the Content Engine application to all server instances and Web servers that will run the Content Engine application.

Deploy the newly modified WebSphere `EAR` file for the Content Engine. The modified file is called `Engine-ws.ear` file. Follow these steps to deploy the Content Engine application:

1. From the WebSphere administrative console, navigate to **Applications** → **Install New Application**.

   From the EAR/WAR/JAR module page, perform these steps:

   a. In the Remote file system, browse to the location of the new `Engine-ws.ear` file, select it, and click **Next**.

   b. Accept the default values, except in step 3 (of the WebSphere Administrative console) deployment process, select both **Engine-init.war** and **FileNet CE-MP WebService**, and set their values to **default_host**.

   c. Save your changes to the master configuration.

2. Complete the post-deployment configuration on WebSphere 6.1.*x*:

   a. From the WebSphere administrative console, navigate to **Applications** → **Enterprise Applications** → **FileNetEngine** → **Manage Modules** → **FileNet P8 Connector** → **Resource Adapter** → **J2C connection factories**.

   b. Click **New** to create a new J2EE Connector architecture (J2C) connection factory.

   c. Fill in the connection factory properties, and then, click **Apply**:

      - Name: `FileNetConnectionFactory`
      - JNDI Name: `FileNet/Local/ConnectionFactory`

   d. Under Container-managed authentication, change the following three entries to **None**, and click **Apply**:

      - Container-managed authentication alias
      - Authentication preference
      - Mapping-configuration alias

   e. Click **Connection Pool Properties**, enter the values for the following properties, and then, click **Apply**:

      - Max Connections: `100`
      - Min Connections: `10`
      - Save the changes to the master configuration.

3. Continue from the WebSphere administrative console, change the class loading, and update the detection settings:
   a. Navigate to **Applications** → **Enterprise Applications** → **FileNet Engine** → **Class Loading and update detection**.
   b. Set the following configuration settings, and then, click **Apply**:
      - Change the polling interval to 3 (seconds).
      - Change the Class loader order to **Classes loaded with application class loader first**.
      - Change WAR class loader policy to **Single class loader for application**.
      - Save changes to the master configuration.
4. Continue from the WebSphere administrative console, change the FileNet CEMP Web Service setting:
   a. Navigate to **Applications** → **Enterprise Applications** → **FileNetEngine** → **Manage Modules** → **FileNet CEMP Web Service**.
   b. Change the class loader order to **Classes loaded with application class loader first**.
   c. Click **Apply**.
   d. Save changes to the master configuration.
5. Stop and start the application server.

Verify the Content Engine installation

Always test whether Content Engine is running on both nodes before you continue with the rest of the setup.

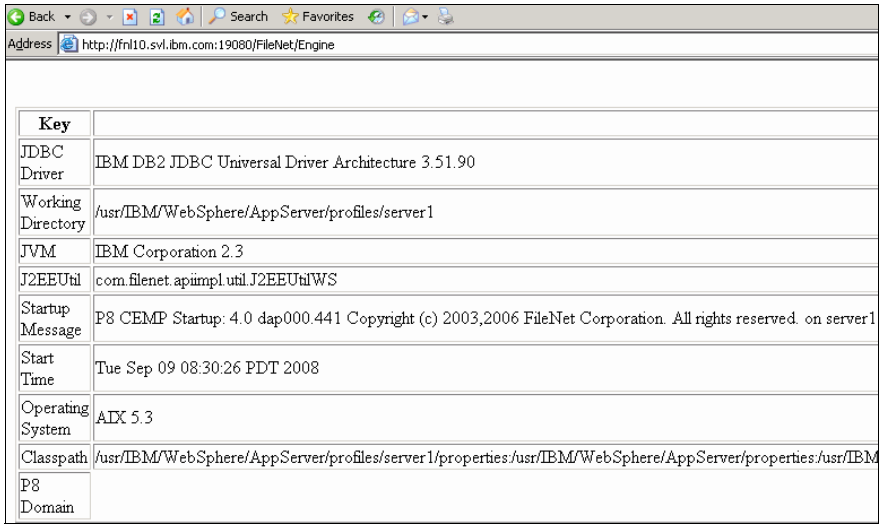
From a browser, enter the following URL:

`http://<Content Engine host name>:19080/FileNet/Engine`

For our case study, we use the following URL to verify whether the Content Engine node 1 (CE1, fnl10) installation is successful:

`http://fnl10.svl.ibm.com:19080/FileNet/Engine`

Figure 8-13 shows that Content Engine is up and running on node CE1.



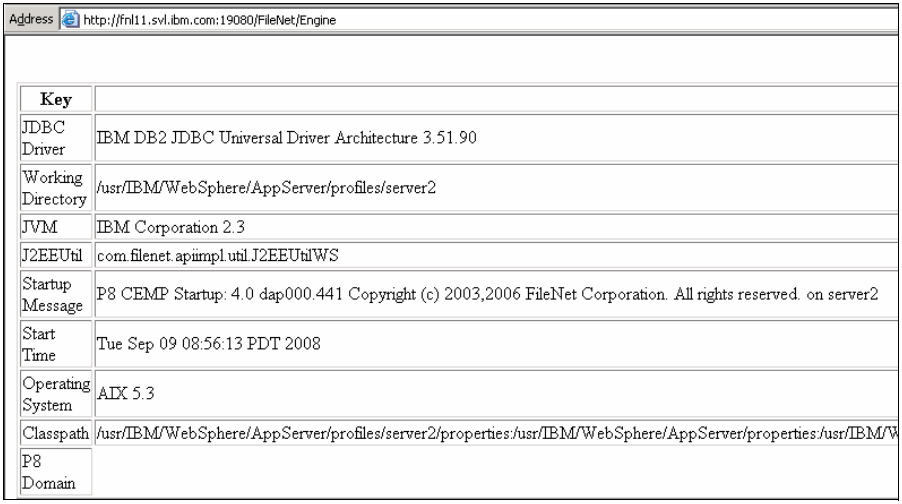
Key	
JDBC Driver	IBM DB2 JDBC Universal Driver Architecture 3.51.90
Working Directory	/usr/IBM/WebSphere/AppServer/profiles/server1
JVM	IBM Corporation 2.3
J2EEUtil	com.filenet.apiimpl.util.J2EEUtilWS
Startup Message	P8 CEMP Startup: 4.0 dap000.441 Copyright (c) 2003,2006 FileNet Corporation. All rights reserved. on server1
Start Time	Tue Sep 09 08:30:26 PDT 2008
Operating System	AIX 5.3
Classpath	/usr/IBM/WebSphere/AppServer/profiles/server1/properties:/usr/IBM/WebSphere/AppServer/properties:/usr/IBM
P8 Domain	

Figure 8-13 Content Engine up and running on Node CE1

For our case study, we use the following URL to verify whether the Content Engine node 2 (CE2, fnl11) installation is successful:

`http://fnl11.svl.ibm.com:19080/FileNet/Engine`

Figure 8-14 on page 166 shows that Content Engine is up and running on node CE2.



Key	
JDBC Driver	IBM DB2 JDBC Universal Driver Architecture 3.51.90
Working Directory	/usr/IBM/WebSphere/AppServer/profiles/server2
JVM	IBM Corporation 2.3
J2EEUtil	com.filenet.apiimpl.util.J2EEUtilWS
Startup Message	P8 CEMP Startup: 4.0 dap000.441 Copyright (c) 2003,2006 FileNet Corporation. All rights reserved. on server2
Start Time	Tue Sep 09 08:56:13 PDT 2008
Operating System	AIX 5.3
Classpath	/usr/IBM/WebSphere/AppServer/profiles/server2/properties:/usr/IBM/WebSphere/AppServer/properties:/usr/IBM/W
P8 Domain	

Figure 8-14 Content Engine up and running on node CE2

Upgrade Content Engine

Depending on the Content Engine version that you use, you might need to upgrade it to the next level. For our case study, we upgrade Content Engine 4.0.0 to the next level, 4.0.1, and apply the fix pack.

Using the Content Engine Setup wizard, follow these steps for the Content Engine upgrade:

1. Accept the default on the first two windows. Figure 2 on page 167 shows our value for the Select Content Engine Server to Upgrade panel.

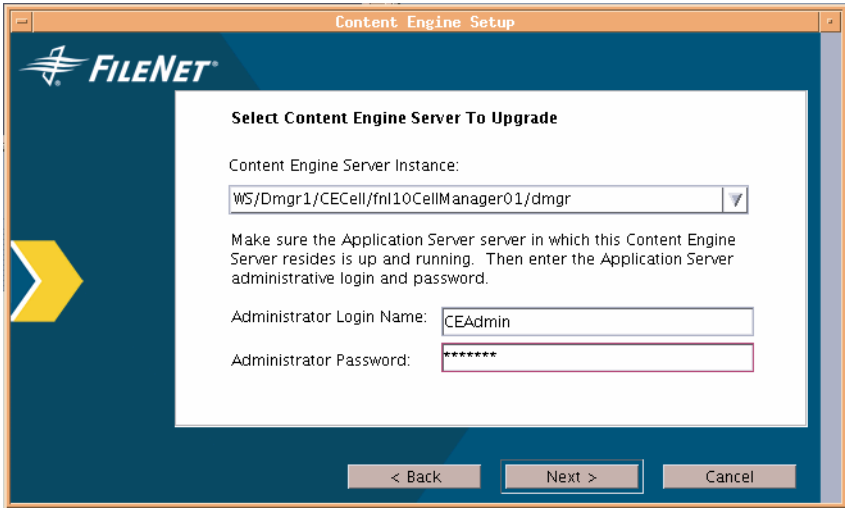


Figure 8-15 Content Engine 4.0.1 Install panel

2. Apply Fix Pack 4, CE4.0.1-004. Use the correct cell to apply the patch. Figure 8-16 shows the panel from our setup.

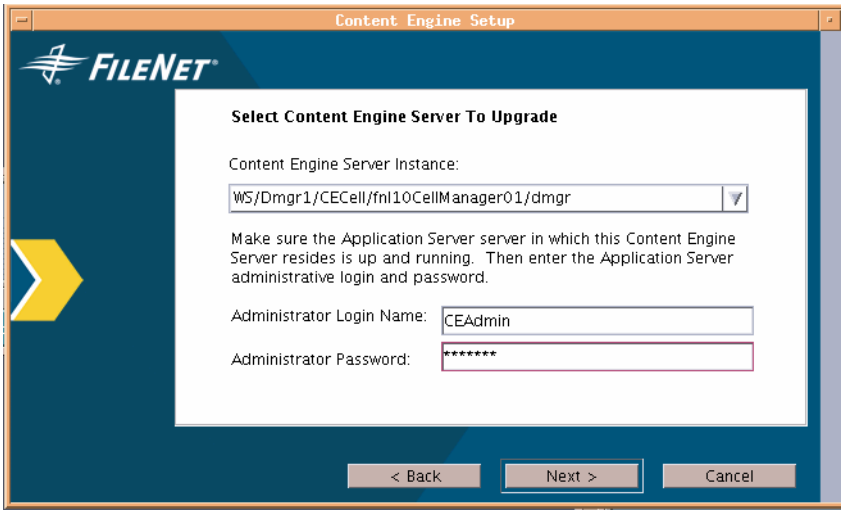


Figure 8-16 Content Engine 4.0.1-004 install panel

Process Engine client 4.0.3 installation

We need to install Process Engine (PE) client 4.0.3 according to *IBM FIleNet P8 4.0 Installation and Upgrade Guide*, GC31-5488. The following windows show the Process Engine Client Updater. Other windows from the installation use the default values. We include the windows here for completeness.

Figure 8-17 shows the update selection.

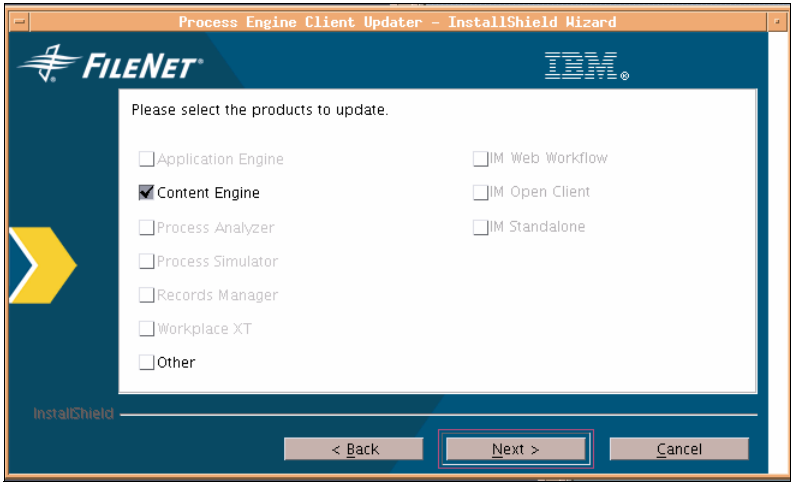


Figure 8-17 PE Client 4.0.3 updater for Content Engine: Product update window

Figure 8-18 shows the cell selection.

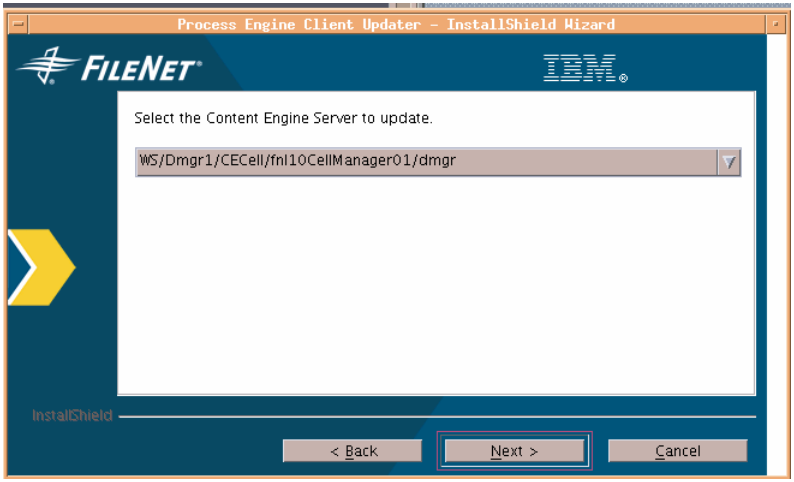


Figure 8-18 PE Client 4.0.3 Updater for Content Engine: Cell selection window

Copy the latest Content Engine application

The `Engine-ws.ear` file that is under the following directory is the most recent `Engine-ws.ear` file:

```
/opt/FileNet/ContentEngine/lib/Dmgr1_CECell_fnl10CellManager01_dmgr
```

Copy the `Engine-ws.ear` file from that directory to the following directory:

```
/opt/FileNet/ContentEngine/lib/
```

Redeploy the Content Engine application

Because the Process Engine Client Updater updates and creates a new `Engine-ws.ear` file, we have to redeploy the Content Engine (FileNetEngine) application with the new file by uninstalling the old application, copying the application file, and deploying the new application file.

Note: We documented all the steps that we have taken for our case study in this book. Actually, there is at least one undeploy and redeploy cycle here that can be skipped. There is no need to undeploy from dmgr and redeploy on the cluster if you are going to turn around and redeploy again after running the Process Engine Client installer.

Uninstall the old Content Engine application

To uninstall the old Content Engine, log in to the WebSphere Application Server Administrative console using the URL:

```
https://fnl10.svl.ibm.com:9044/ibm/console/logon.jsp
```

Figure 8-19 shows the FileNetEngine application uninstallation window.

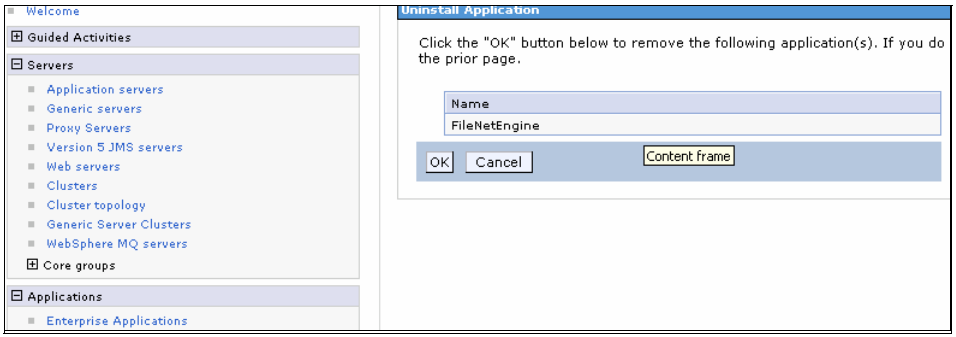


Figure 8-19 Uninstalling Content Engine application: FileNetEngine

After the Content Engine application is uninstalled, save the master configuration and fully synchronize both the nodes. Figure 8-20 on page 170 shows the WebSphere Application Server Administrative console window after the nodes are fully synchronized.

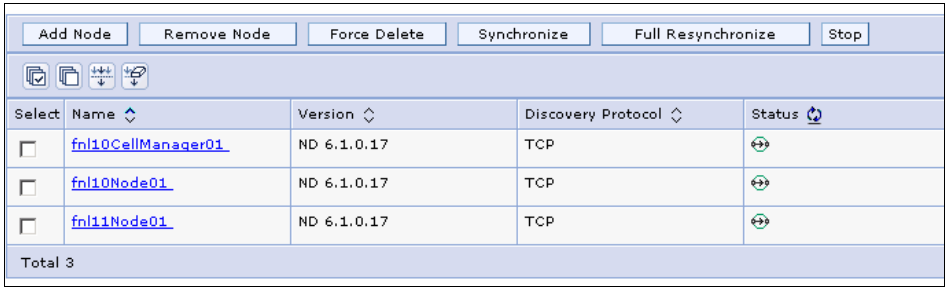


Figure 8-20 CECLUSTER nodes synchronized after CE is uninstalled

Deploy the new Content Engine application

After the new Content Engine application is copied into the proper directory, perform the following steps to deploy the new Content Engine application. From the WebSphere Application Server administrative console, select **Enterprise Application Install**. We use the Remote Path location:

```
/opt/FileNet/ContentEngine/lib/Engine-ws.ear
```

We deploy the Content Engine application:

1. Select the installation options.

   Figure 8-21 on page 171 shows our setup for the Content Engine application deployment.

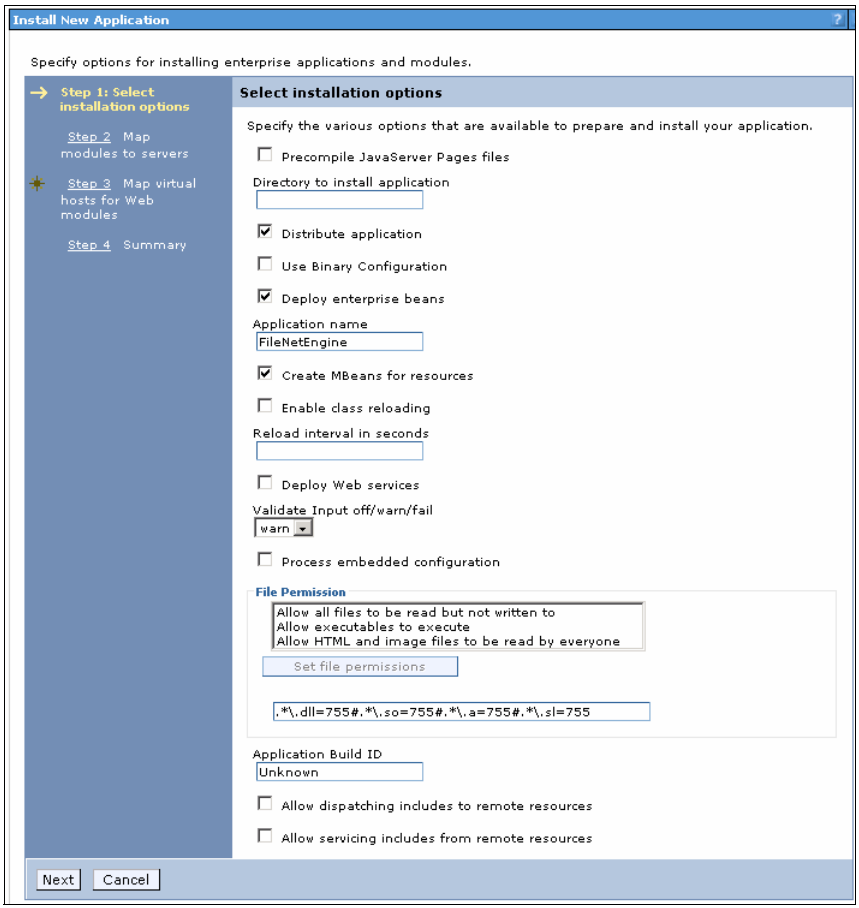


Figure 8-21 Content Engine Application Deployment: Step 1

2. Map the modules to the servers.

   Figure 8-22 on page 172 shows our setup for our case study.

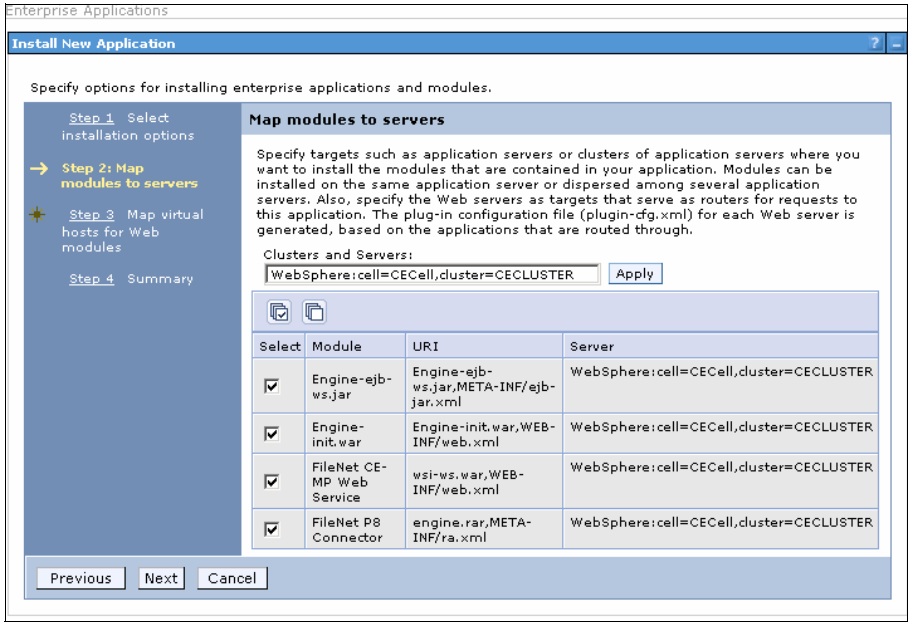


Figure 8-22 Content Engine Application Deployment: Step 2

3. Map the virtual hosts for the Web modules.

   Figure 8-23 shows our setup for our case study.

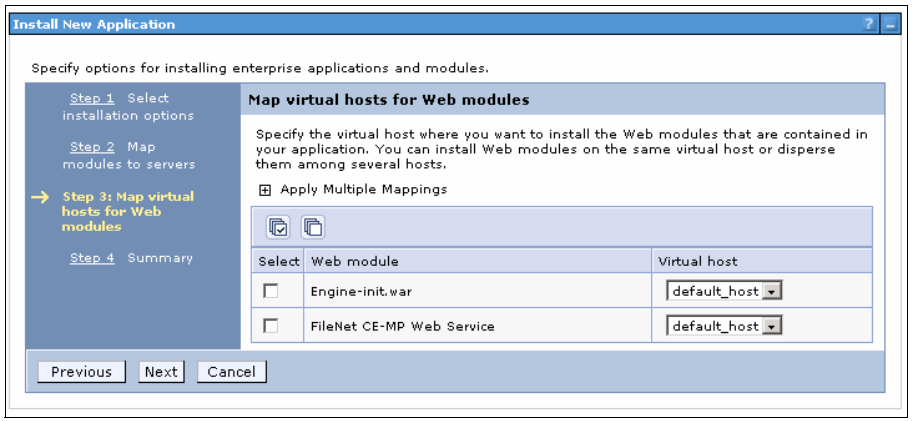


Figure 8-23 Content Engine Application Deployment: Step 3

4. Review the summary of the settings, and click **Finish**.

   Figure 8-25 on page 174 shows the summary of our case study setup.

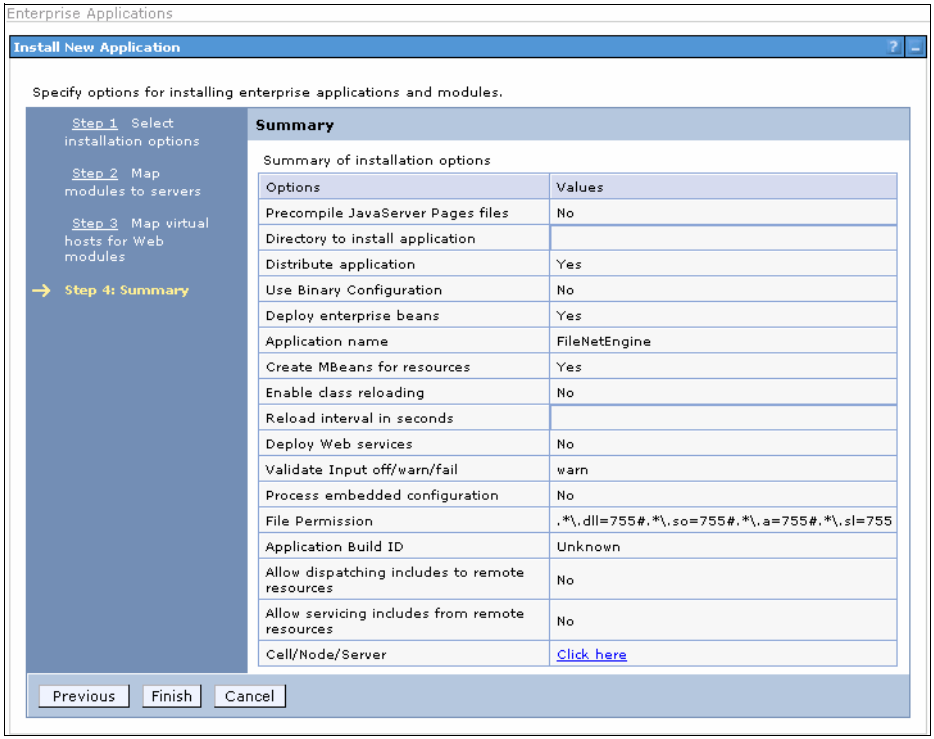


Figure 8-24 Content Engine Application Deployment: Step 4

5. Save the master configuration.

Figure 8-25 on page 174 shows the output window while the Content Engine application is being deployed.

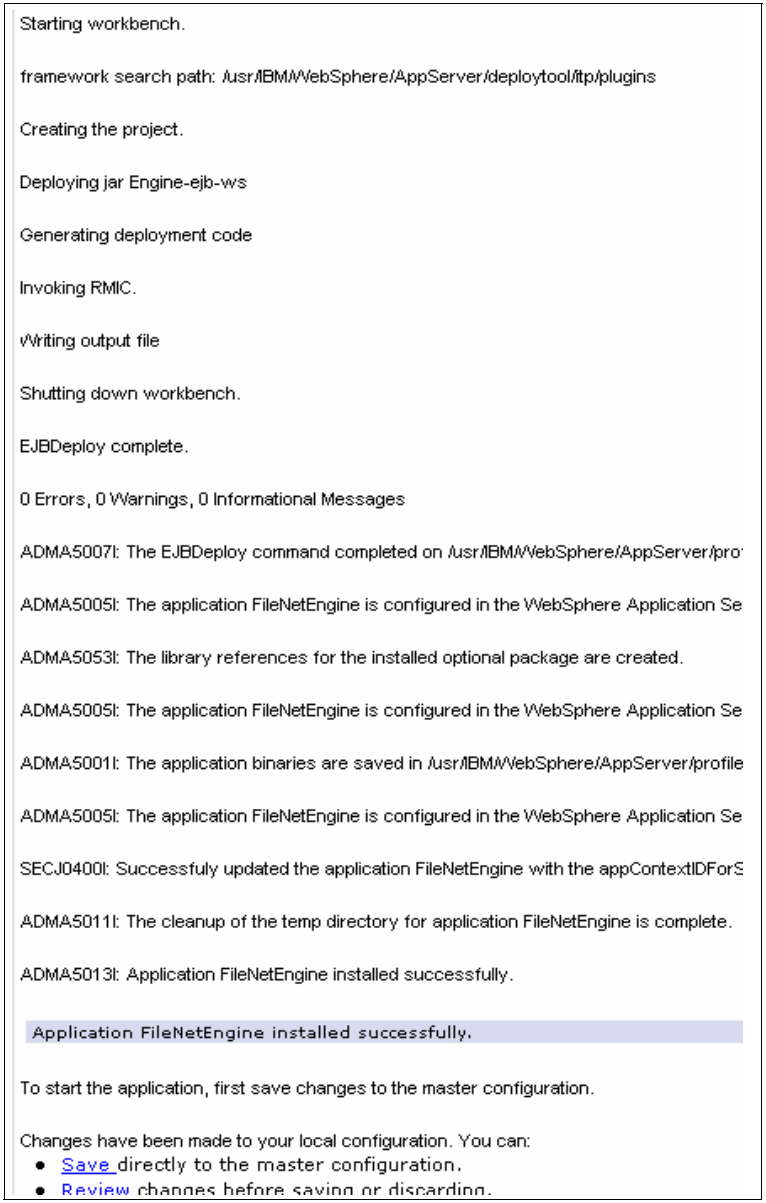


Figure 8-25 Content Engine Application Deployment: Output window

Post-deployment configuration

Continuing following in the documentation (*IBM FileNet P8 4.0 Installation and Upgrade Guide,* GC31-5488), we complete the post-deployment tasks for WebSphere 6.1.*x*:

1. From the WebSphere Administration console, navigate to **Applications** → **Enterprise Applications** → **FileNetEngine** → **Manage Modules** → **FileNet P8 Connector** → **Resource Adapter** → **J2C connection factories**.
2. Click **New** to create a new J2C connection factory.
3. Enter the connection factory properties, and then, click **Apply**:
   - Name: `FileNetConnectionFactory`
   - JNDI Name: `FileNet/Local/ConnectionFactory`
4. Under the Container-managed authentication, change the following three entries to **None**, and click **Apply**:
   - Container-managed authentication alias
   - Authentication preference
   - Mapping-configuration alias
5. Click **Connection Pool Properties**, enter the values for the following properties, and then, click **Apply**:
   - Max Connections: `100`
   - Min Connections: `10`
6. Save the changes to the master configuration.
7. From the WebSphere administrative console, navigate to **Applications** → **Enterprise Applications** → **FileNet Engine** → **Class Loading and update detection**.
8. Set the following configuration settings, and then, click **Apply**:
   - Change the polling interval to 3 (seconds).
   - Change the Class loader order to **Classes loaded with application class loader first**.
   - Change the WAR class loader policy to **Single class loader for application**.
9. Save the changes to the master configuration.
10. From the WebSphere administrative console, navigate to **Applications** → **Enterprise Applications** → **FileNetEngine** → **Manage Modules** → **FileNet CEMP Web Service**.
11. Change the class loader order to **Classes loaded with application class loader first**, and then, click **Apply**.
12. Save the changes to the master configuration.

13. Synchronize the nodes fully.
14. Stop and start the application server (Network Deployment Manager, dmgr node server).

Verify the setup

After the setup is complete, verify that both nodes in the CECLUSTER work properly by visiting the URL `http://<CE node>/FileNet/Engine` in a browser. Figure 8-26 shows node CE1 working.

Key	
JDBC Driver	IBM DB2 JDBC Universal Driver Architecture 3.51.90
Working Directory	/usr/IBM/WebSphere/AppServer/profiles/server1
JVM	IBM Corporation 2.3
J2EEUtil	com.filenet.apiimpl.util.J2EEUtilWS
Startup Message	P8 CEMP Startup: 4.0.1-004 dap435.046 Copyright IBM Corp. 2003, 2008 All rights reserved on server1
Start Time	Tue Sep 09 10:19:42 PDT 2008
PCH Listener	4.0.1.004 pch420.004
Process Engine	4.0.3.0 pui430.052
Operating System	AIX 5.3
Classpath	/usr/IBM/WebSphere/AppServer/profiles/server1/properties:/usr/IBM/WebSphere/AppServer/properties:/usr/IB
P8 Domain	

Figure 8-26 Check to see that node CE1 is up and running after applying 4.0.1-004

Figure 8-27 on page 177 shows node CE2 working.

Key	
JDBC Driver	IBM DB2 JDBC Universal Driver Architecture 3.51.90
Working Directory	/usr/IBM/WebSphere/AppServer/profiles/server2
JVM	IBM Corporation 2.3
J2EEUtil	com.filenet.apiimpl.util.J2EEUtilWS
Startup Message	P8 CEMP Startup: 4.0.1-004 dap435.046 Copyright IBM Corp. 2003, 2008 All rights reserved on server2
Start Time	Tue Sep 09 10:21:06 PDT 2008
PCH Listener	4.0.1.004 pch420.004
Process Engine	4.0.3.0 pui430.052
Operating System	AIX 5.3
Classpath	/usr/IBM/WebSphere/AppServer/profiles/server2/properties:/usr/IBM/WebSphere/AppServer/properties:/us
P8 Domain	

Figure 8-27 Check to see that node CE2 is up and running after applying 4.0.1-004

Installing the Content Search Engine client

After the Content Engine cluster set is complete, we proceed with installing Content Search Engine (CSE) Client Updater on the Content Engine machines in the Content Engine cluster.

Note: When installing the CSE client on CE, it is *not* required that the CSE server is installed first. The CSE client installer can still be run on the CE (even if the remote CSE server is not installed yet), which installs the necessary client for CE to connect to CSE.

We apply the CSE updater patch 4.0.1-003 with the defaults. Figure 8-28 on page 178 shows the installation summary panel.

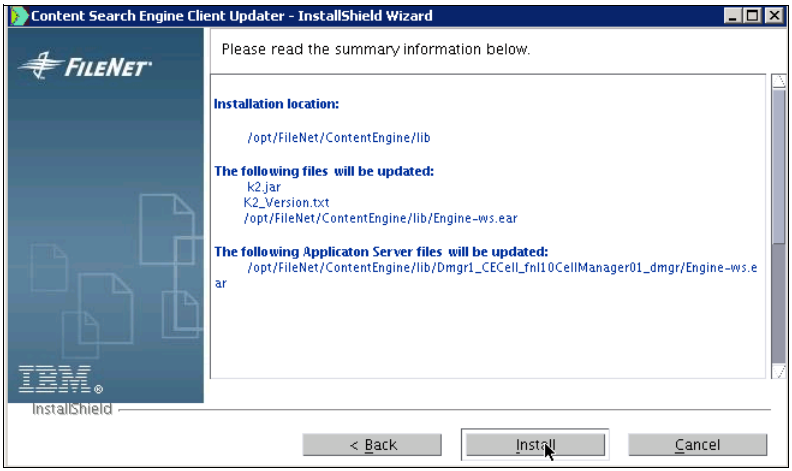


Figure 8-28 Content Engine CSE Client Updater 4.0.1-003 installation summary panel

After the installation is complete, the output looks similar to Figure 8-29.

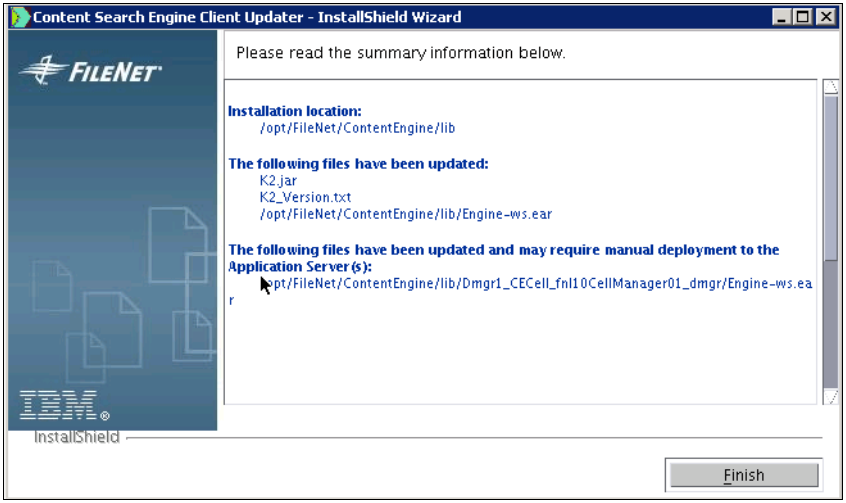


Figure 8-29 Content Engine CSE Client Updater 4.0.1-003 installation complete panel

Because the CSE Client Updater also updates and creates a new `Engine-ws.ear` file, we are required to redeploy the Content Engine (FileNetEngine) application from the CECLUSTER again by uninstalling the old application and deploying the new application. We use the WebSphere Application Server administrative console. This process is similar to the steps that are shown in “Redeploy the Content Engine application” on page 169.

If you did not install CSE, there is no need to redeploy the Content Engine application.

Deploy the Content Engine application

We deploy the Content Engine (FileNetEngine) application to the CECLUSTER. Go to the WebSphere Application Server administrative console remote file option, and select **Engine-was.ear** file. See Figure 8-30.

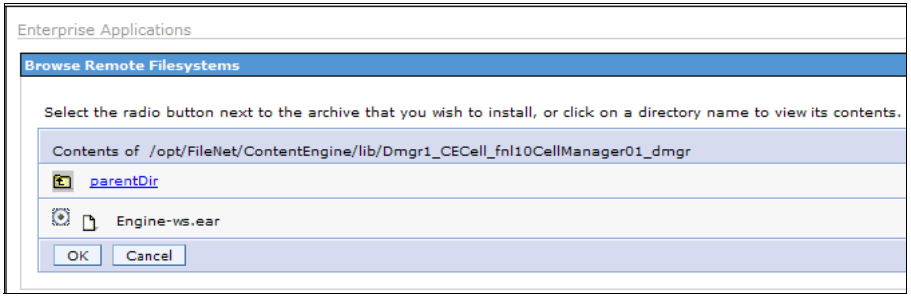


Figure 8-30 Content Engine deployment after CSE Client Updater: Select file

In the Preparing for the application installation panel (Figure 8-31 on page 180), we keep the default selections.

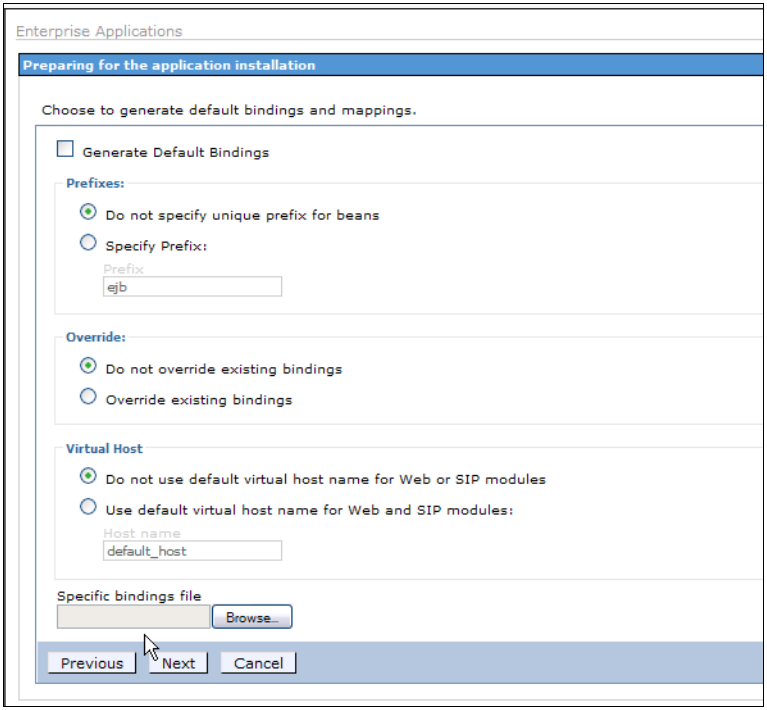


Figure 8-31 Content Engine deployment after CSE Client Updater: Preparation

To perform the WebSphere Application Server deployment:

1. In the Install New Application window (Figure 8-32), we use the default selection. In terms of the WebSphere Application Server deployment series, this step is step 1.

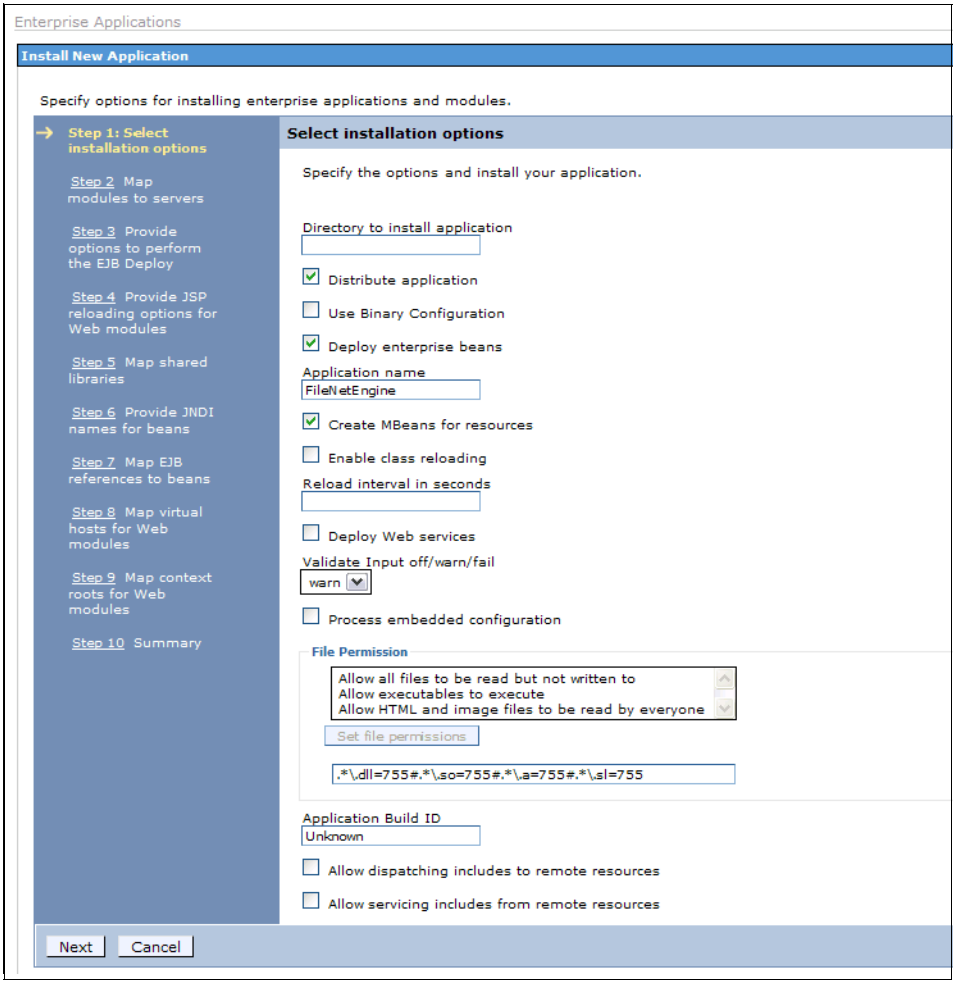


Figure 8-32 Content Engine Deploy after CSE Client Updater: Step 1

2. Map the modules to the servers. See Figure 8-33 for our setup.

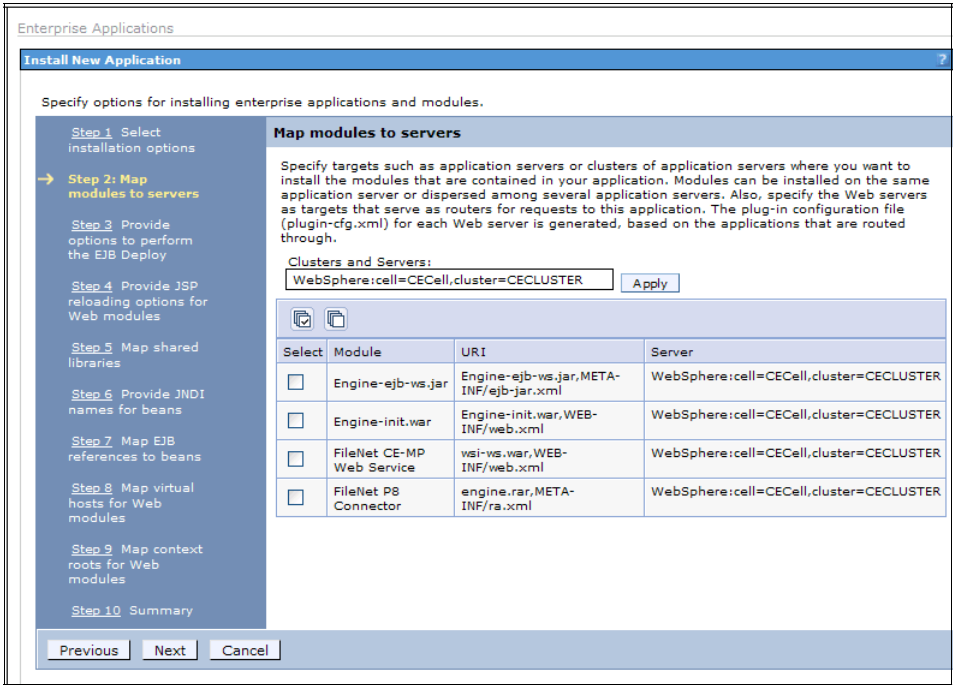


Figure 8-33 Content Engine Deploy after CSE Client Updater: Step 2

3. Provide the options to perform the Enterprise JavaBeans (EJB) deployment. See Figure 8-34 for our setup.

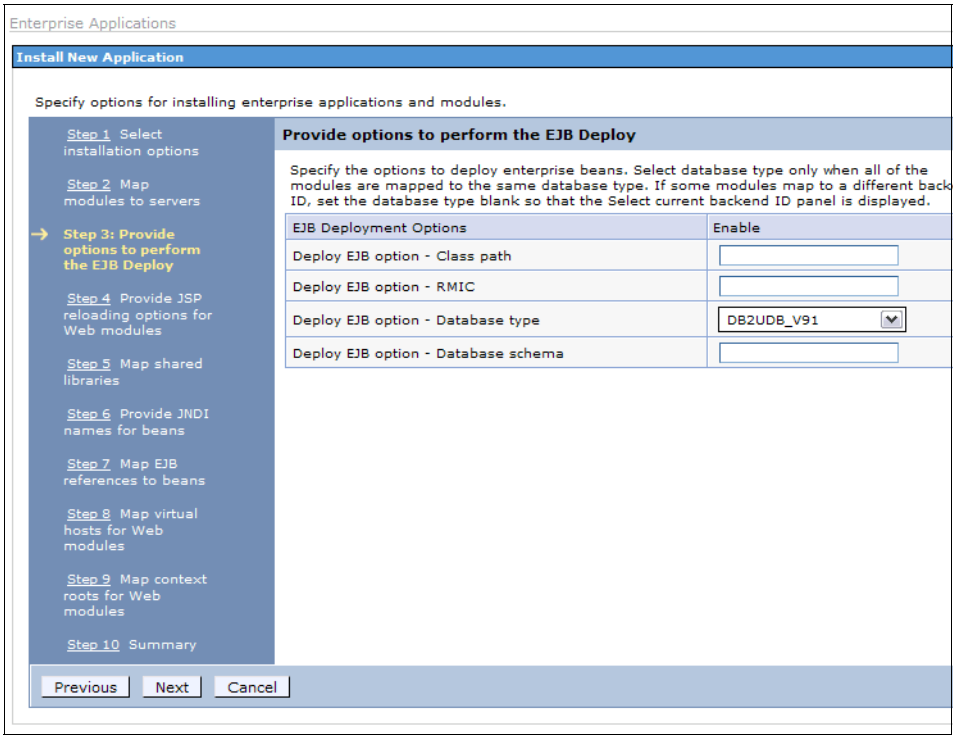


Figure 8-34 Content Engine Deploy after CSE Client Updater: Step 3

4. Provide the JavaServer Pages (JSP™) reloading options for Web modules. See Figure 8-35 for our setup.

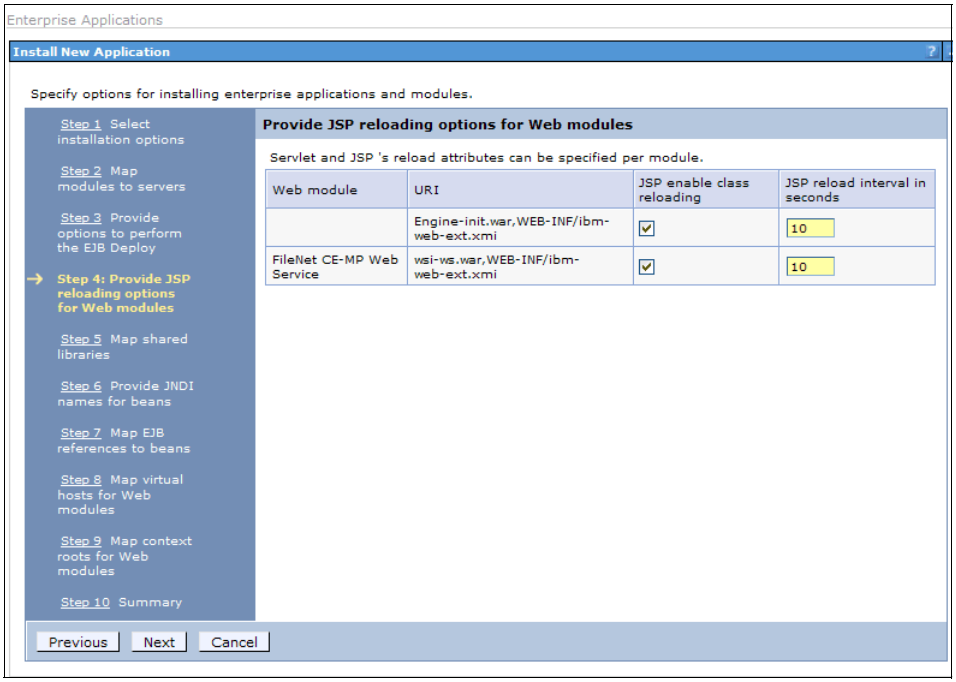


Figure 8-35 Content Engine Deploy after CSE Client Updater: Step 4

5. Map the shared libraries. See Figure 8-36 for our setup.

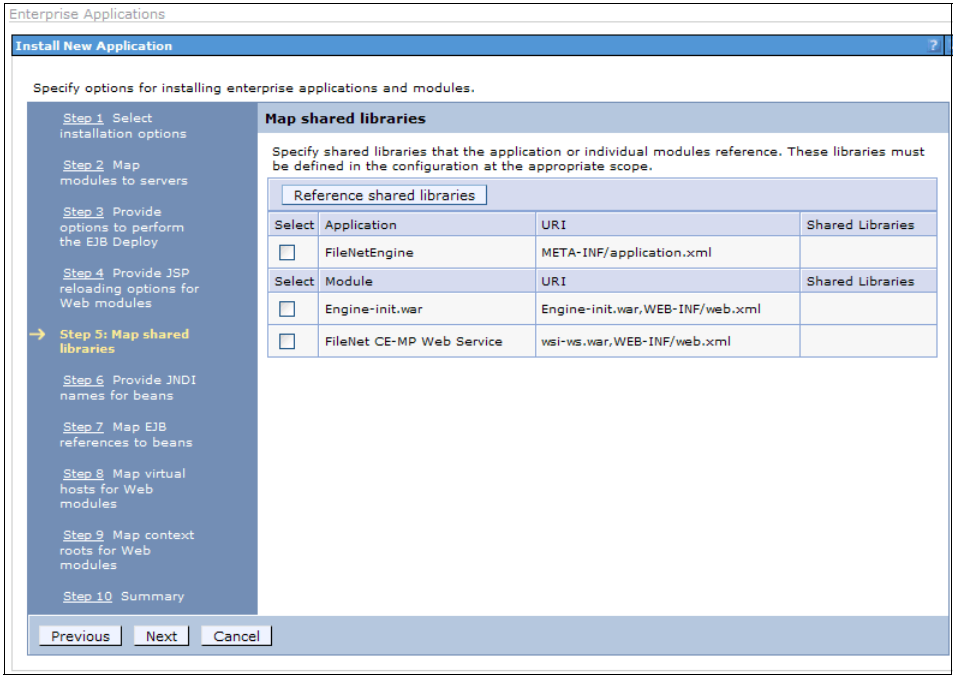


Figure 8-36 Content Engine Deploy after CSE Client Updater: Step 5

6. Provide the JNDI names for the beans. See Figure 8-37 for our setup.

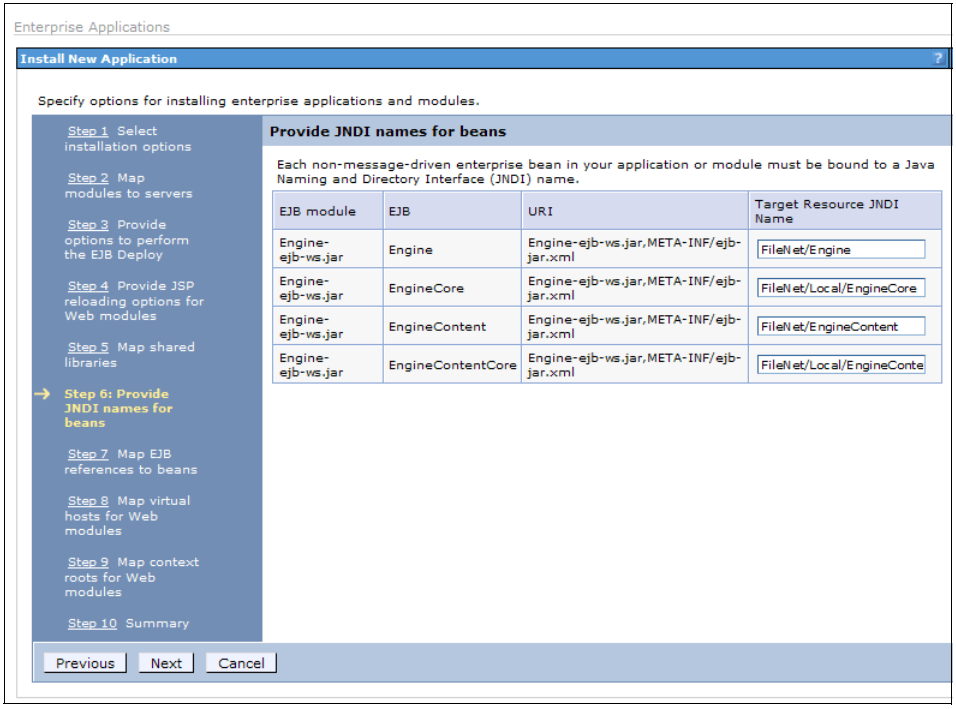


Figure 8-37 Content Engine Deploy after CSE Client Updater: Step 6

7. Map the EJB reference to the beans. See Figure 8-38 for our setup.

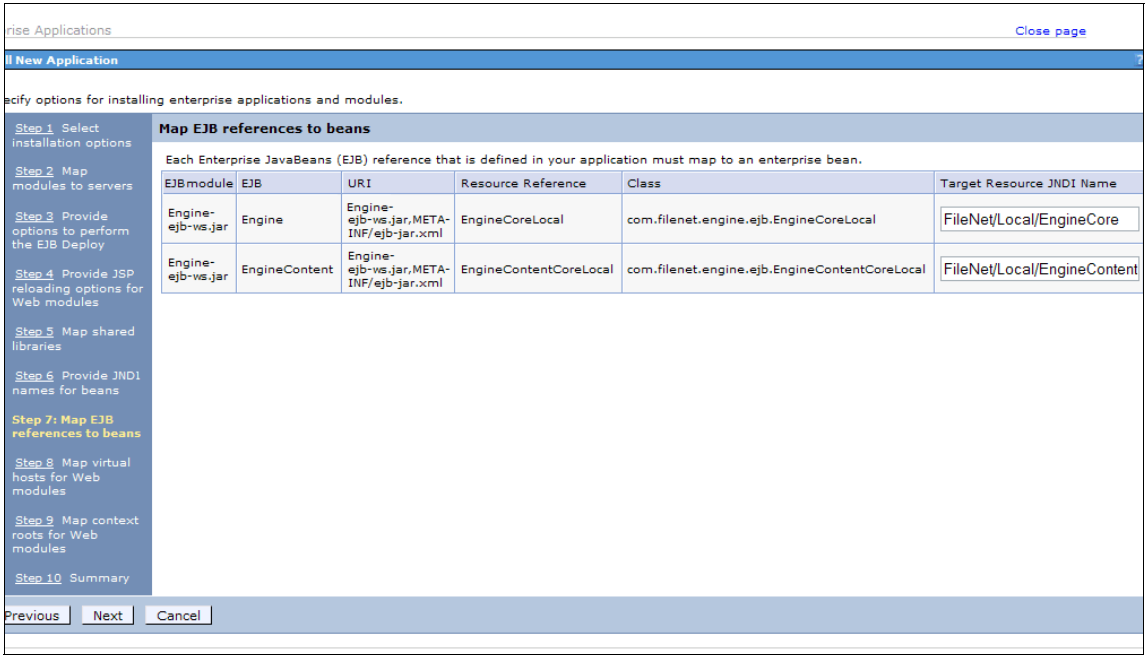


Figure 8-38 Content Engine Deploy after CSE Client Updater: Step 7

8. Map the virtual hosts to the modules. See Figure 8-39 for our setup.

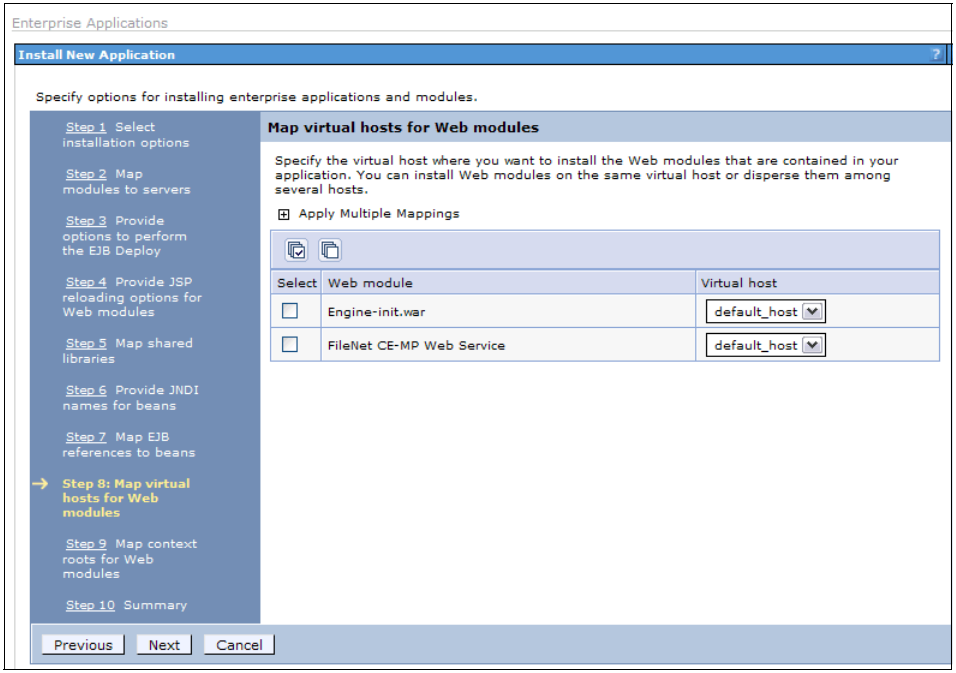


Figure 8-39 Content Engine Deploy after CSE Client Updater: Step 8

9. Map the context root to the modules. See Figure 8-40 for our setup.

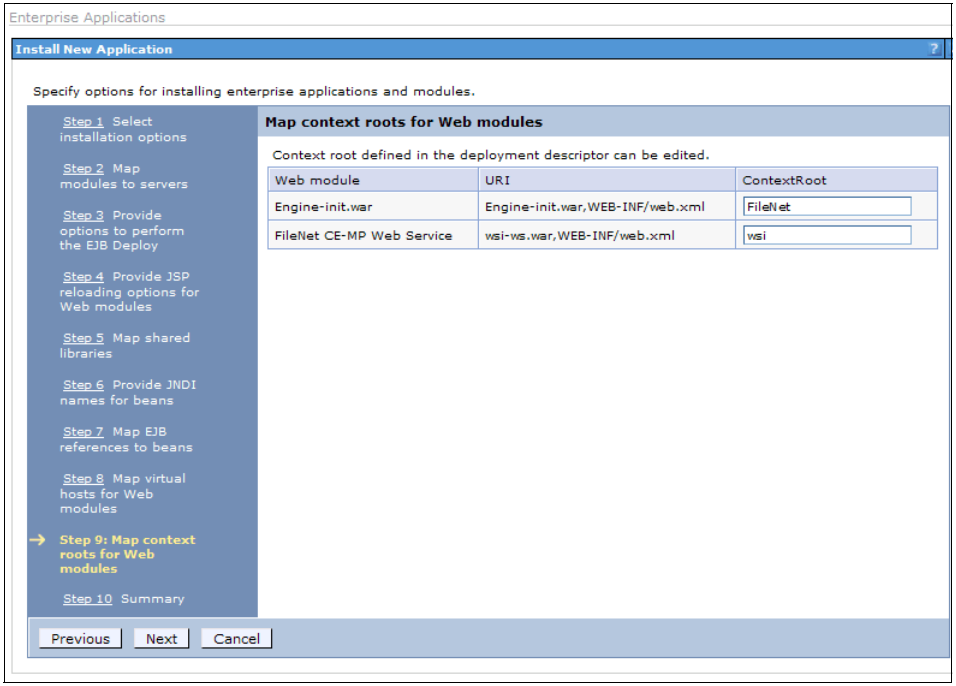


Figure 8-40 Content Engine Deploy after CSE Client Updater: Step 9

10. Review the summary with all the settings, and click **Finish**. Figure 8-41 shows the summary of our setup.

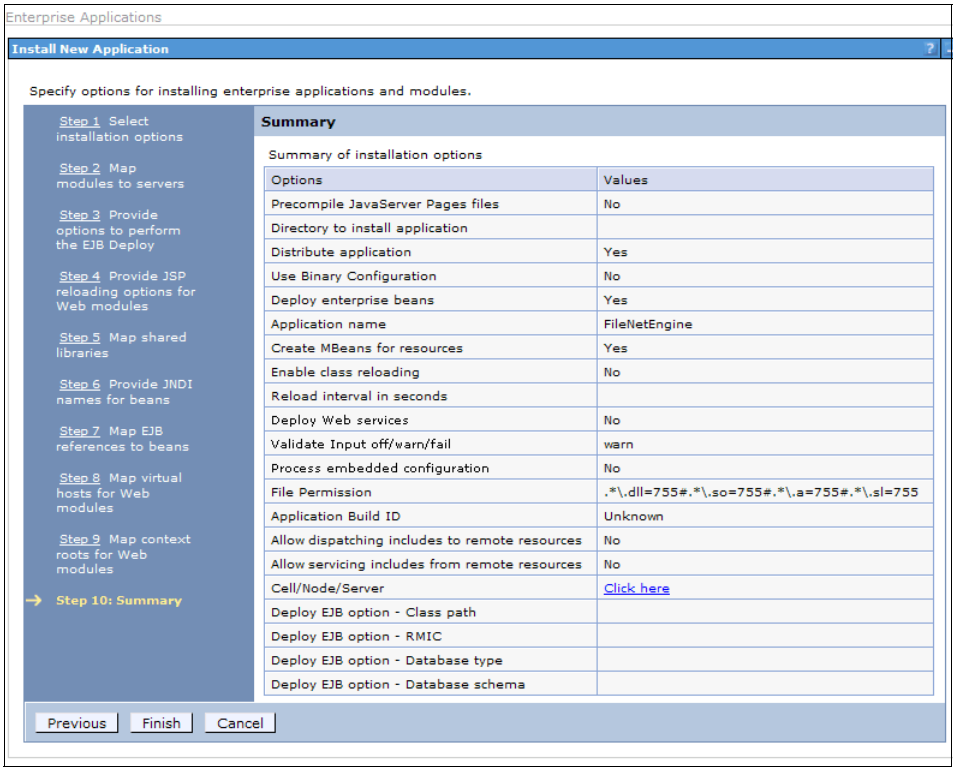


Figure 8-41 Content Engine Deploy after CSE Client Updater: Step 10

Figure 8-42 shows the output from our setup while the Content Engine application is deployed.

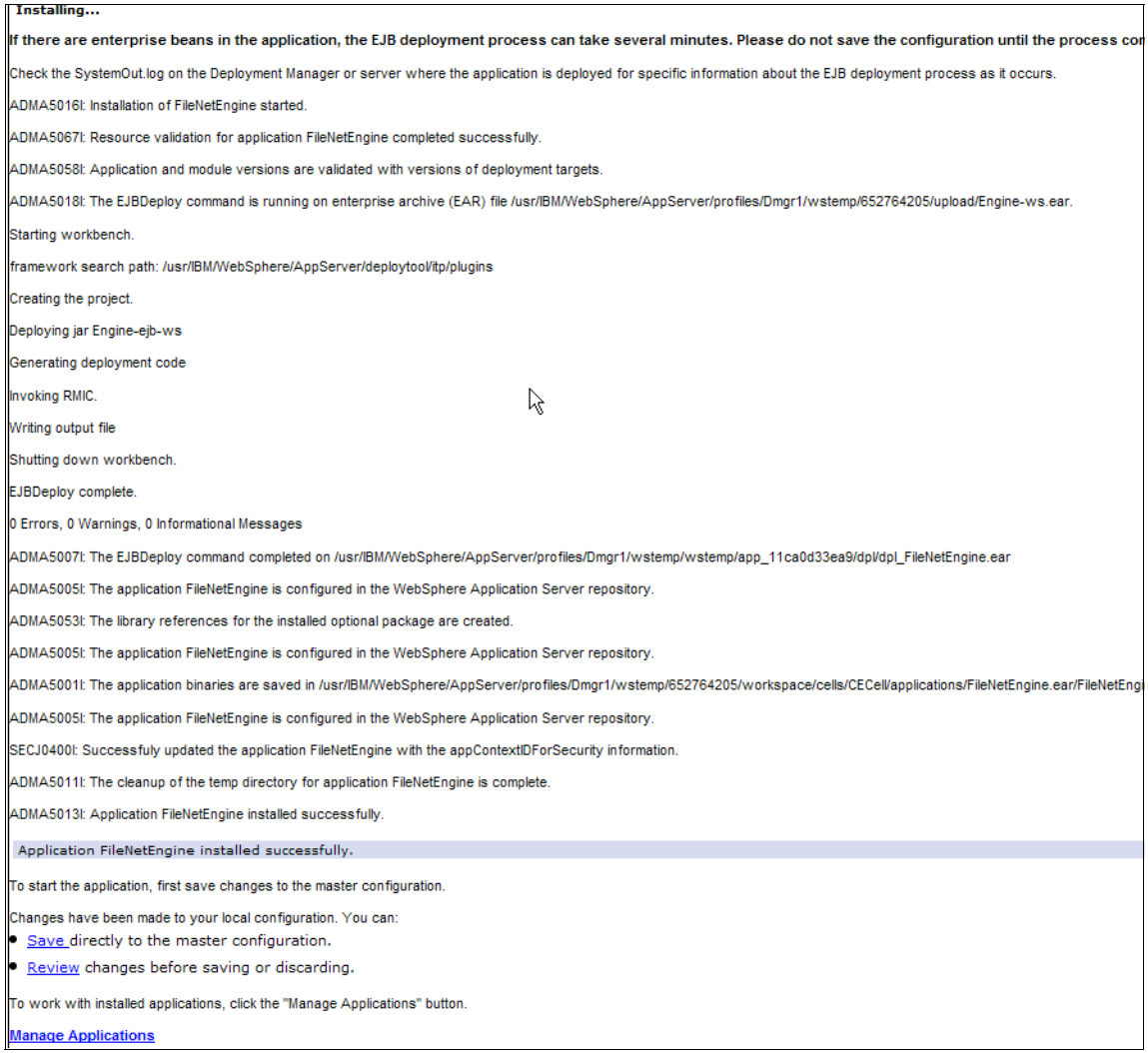


Figure 8-42 Content Engine Successful deployment after CSE Client Updater

11. Save the configuration to the master configuration.

Synchronize the nodes

This is a post-installation task for WebSphere 6.1.*x*. We describe this procedure in “Post-deployment configuration” on page 175.

We bring the cluster up as shown in Figure 8-43. This step completes the setup.

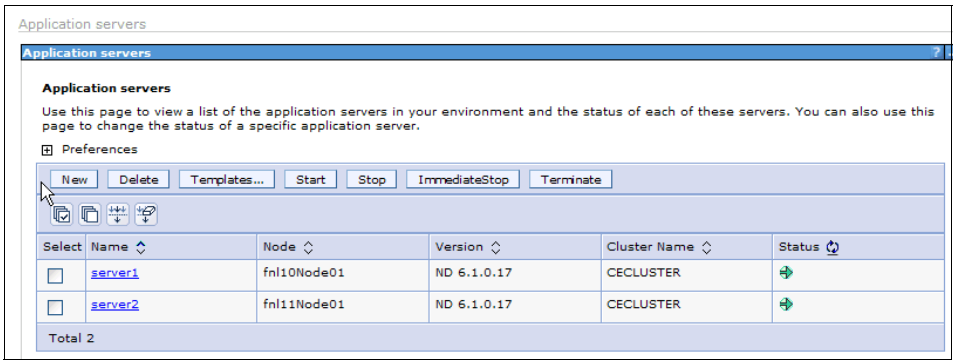


Figure 8-43 Content Engine after deployment with both nodes up and running

8.5 High availability tests at the Content Engine level

After you complete the setup of each component in the high availability P8 environment, make sure that you perform component testing before continuing with the rest of the implementation.

In this section, we discuss the failover tests at the Content Engine component level. Table 8-3 on page 193 shows the high availability tests that we performed for our case study in the lab and the results of these tests.

Table 8-3 Content Engine-level high availability test scenarios

Sr. no.	Test	Expected result	Actual result
Test 1	Basic availability test: Test the Content Engine using the following URL: `http://9.30.188.91:19080/FileNet/Engine` Note, use the Content Engine virtual IP address for testing.	The URL works. Response is from either one of the Content Engine nodes.	See 8.5.1, "Content Engine basic availability test" on page 193.
Test 2	Node availability test 1: Test the Content Engine while Content Engine node 1 (CE1) is down. Use the previous test's URL.	The URL works. Response is from CE2.	See 8.5.2, "Node availability test 1" on page 195.
Test 3	Node availability test 2: Test the Content Engine while Content Engine node 2 (CE2) is down. Use the same URL.	The URL works. Response is from CE1.	See 8.5.3, "Node availability test 2" on page 197.
Test 4	High Availability Test: Test the Content Engine with two simultaneous connections. Use the same URL.	The URL works. Responses are from both Content Engine nodes.	See 8.5.4, "Load balance test" on page 199.

8.5.1 Content Engine basic availability test

The basic test to see whether Content Engine is available is by going to the following URL:

`http://9.30.188.91:19080/FileNet/Engine`

The IP address used here must be the virtual IP address of Content Engine.

Use the load balancer console to show the Content Engine node's status. In our case, we use the BIG-IP F5 as the load balancer. Figure 8-44 on page 194 shows the application status from the BIG-IP F5 console window (as it monitors).

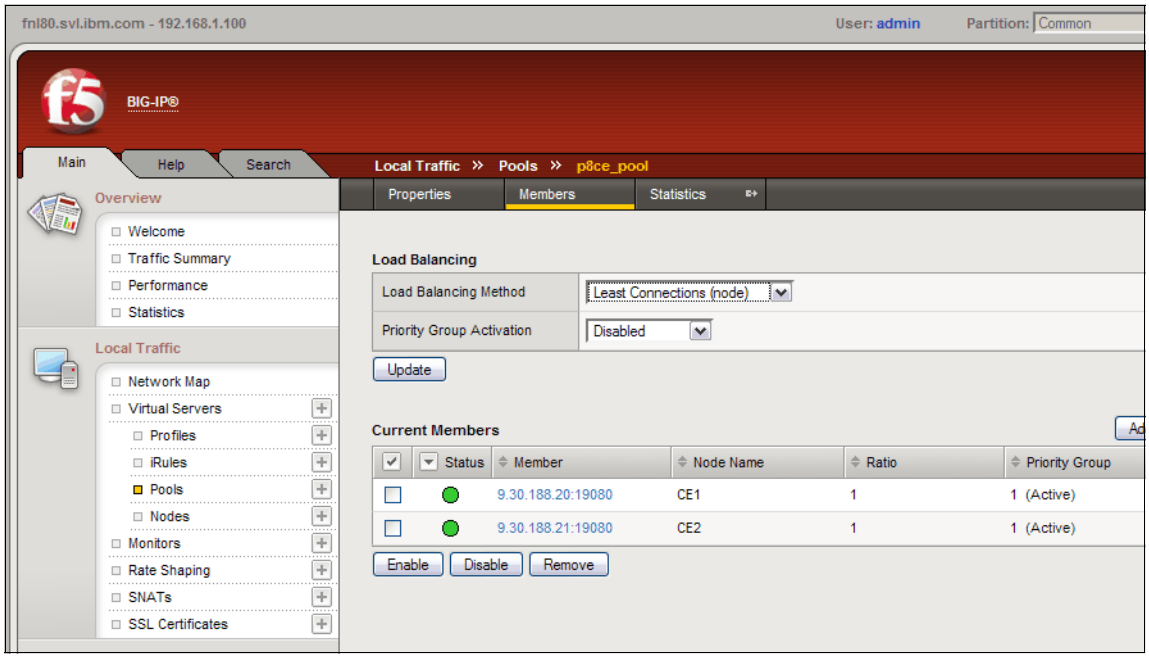


Figure 8-44 Content Engine application status as shown by BIG-IP F5 console window

Figure 8-45 shows the application status from the WebSphere Application Server Network Deployment administrative console window. Notice that both nodes are up and running.

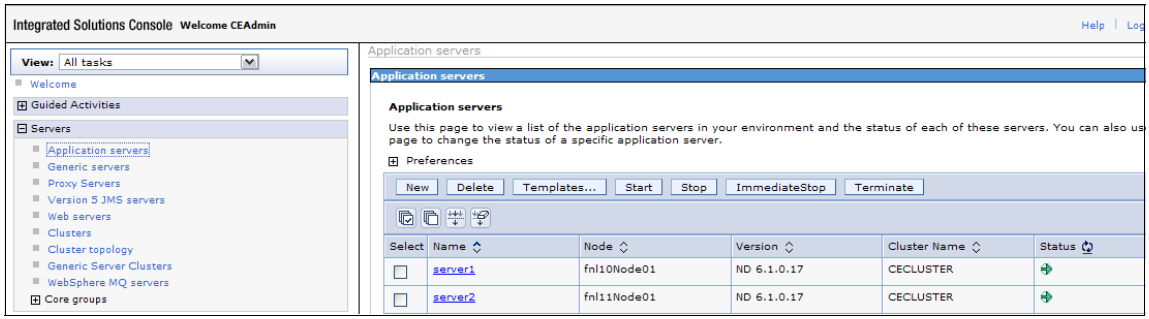
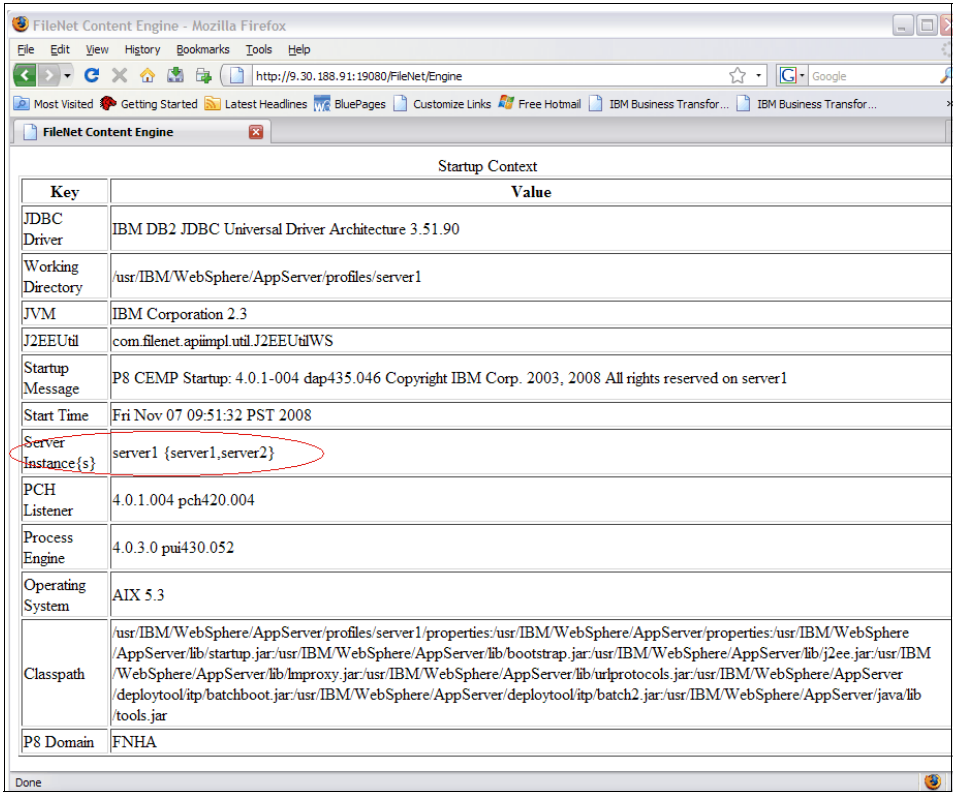


Figure 8-45 Content Engine application status as seen from WebSphere Application Server Network Deployment administrative Console window

The Content Engine Application, when accessed from the virtual IP address, shows that the service request was sent to the first node, CE1, which responded. See Figure 8-46 on page 195.



Startup Context

Key	Value
JDBC Driver	IBM DB2 JDBC Universal Driver Architecture 3.51.90
Working Directory	/usr/IBM/WebSphere/AppServer/profiles/server1
JVM	IBM Corporation 2.3
J2EEUtil	com.filenet.apiimpl.util.J2EEUtilWS
Startup Message	P8 CEMP Startup: 4.0.1-004 dap435.046 Copyright IBM Corp. 2003, 2008 All rights reserved on server1
Start Time	Fri Nov 07 09:51:32 PST 2008
Server Instance{s}	server1 {server1,server2}
PCH Listener	4.0.1.004 pch420.004
Process Engine	4.0.3.0 pui430.052
Operating System	AIX 5.3
Classpath	/usr/IBM/WebSphere/AppServer/profiles/server1/properties:/usr/IBM/WebSphere/AppServer/properties:/usr/IBM/WebSphere /AppServer/lib/startup.jar:/usr/IBM/WebSphere/AppServer/lib/bootstrap.jar:/usr/IBM/WebSphere/AppServer/lib/j2ee.jar:/usr/IBM /WebSphere/AppServer/lib/lmproxy.jar:/usr/IBM/WebSphere/AppServer/lib/urlprotocols.jar:/usr/IBM/WebSphere/AppServer /deploytool/itp/batchboot.jar:/usr/IBM/WebSphere/AppServer/deploytool/itp/batch2.jar:/usr/IBM/WebSphere/AppServer/java/lib /tools.jar
P8 Domain	FNHA

Figure 8-46 Response for the Content Engine application URL

8.5.2 Node availability test 1

In this test, we bring down one Content Engine node (CE1) and use the same Content Engine virtual IP address to see whether the URL is being serviced.

Figure 8-47 on page 196 from the WebSphere Application Server Network Deployment administrative console shows that node CE1 is down.

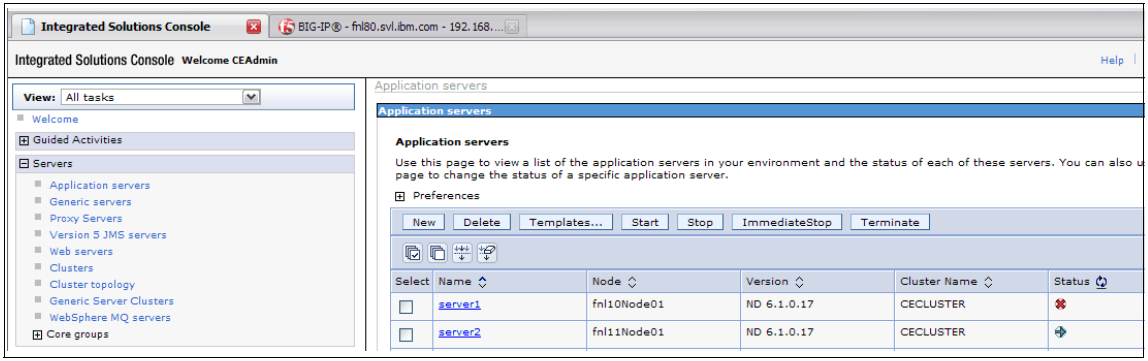


Figure 8-47 Content Engine node CE1 is down as seen from WebSphere Application Server administrative console

The same result is reflected by the BIG-IP F5 console window (Figure 8-48).

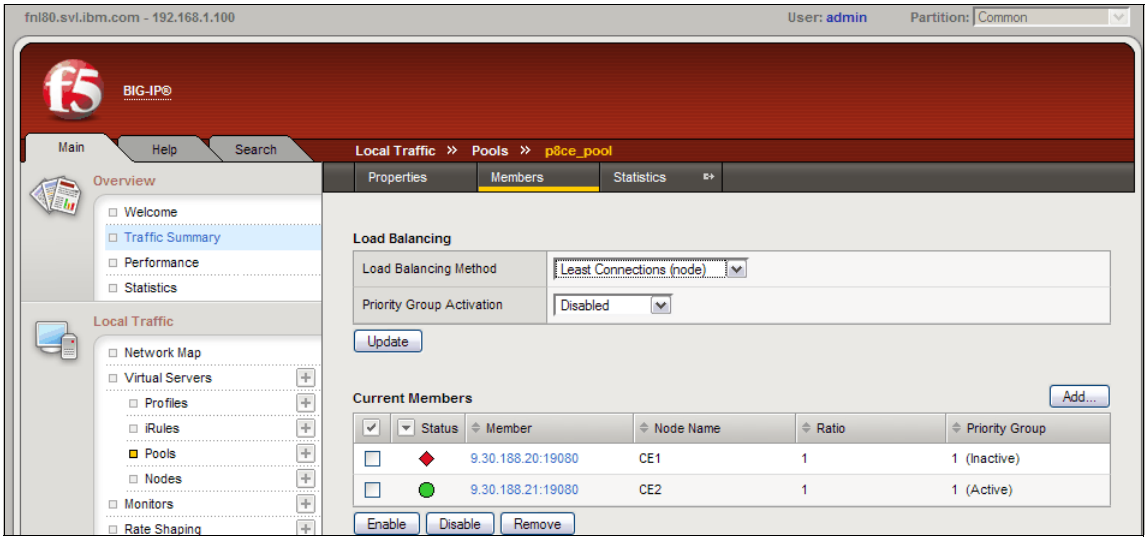


Figure 8-48 Content Engine node CE1 is down as reflected by BIG-IP F5 console

Figure 8-49 on page 197 shows the output from the Content Engine URL that is accessed when node CE1 is down. Server2 is up and running. That is, Content Engine node 2, CE2, responded and serviced this request.

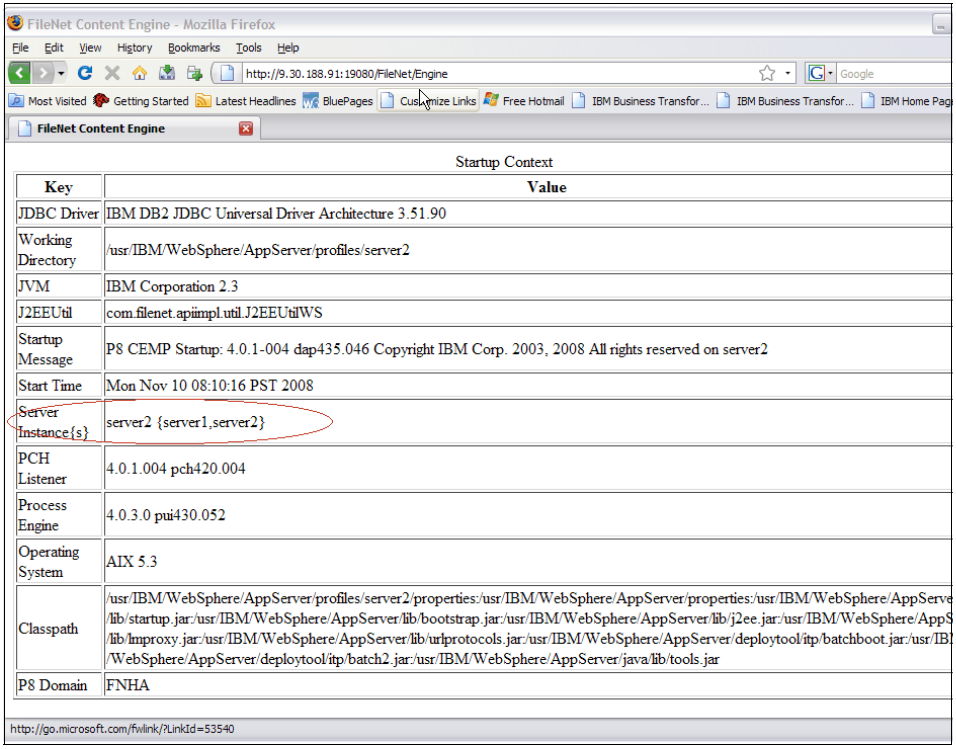


Figure 8-49 Content Engine URL output when Content Engine node CE1 is down

8.5.3 Node availability test 2

In this test, we shut down Content Engine node 2 (CE2) and access the Content Engine URL. As in the previous test, Content Engine node CE2 is down as seen from the WebSphere Application Server Network Deployment administrative console (Figure 8-50 on page 198).

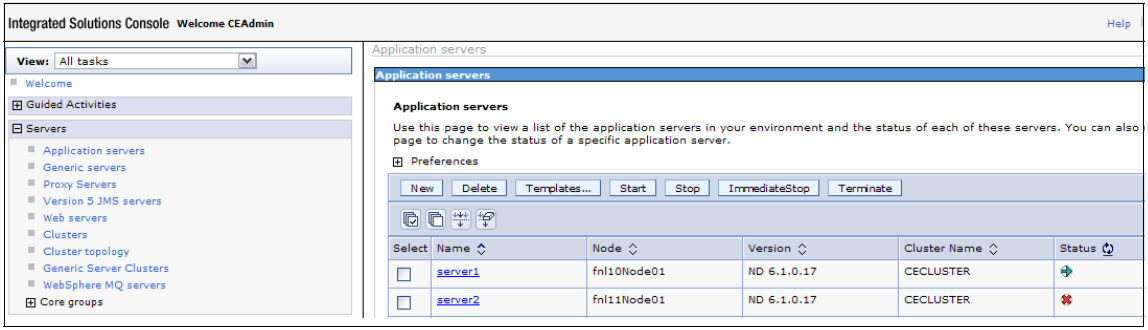


Figure 8-50 Content Engine node CE2 is down as seen from WebSphere Application Server administrative console

From the BIG-IP F5 console monitor, CE2 is marked as down, as well. See Figure 8-51.

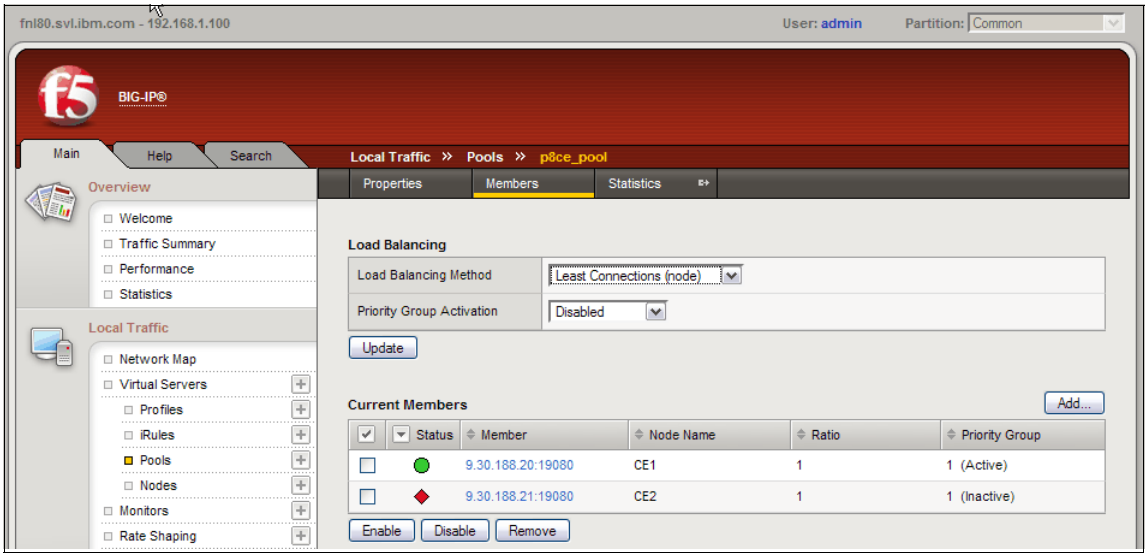
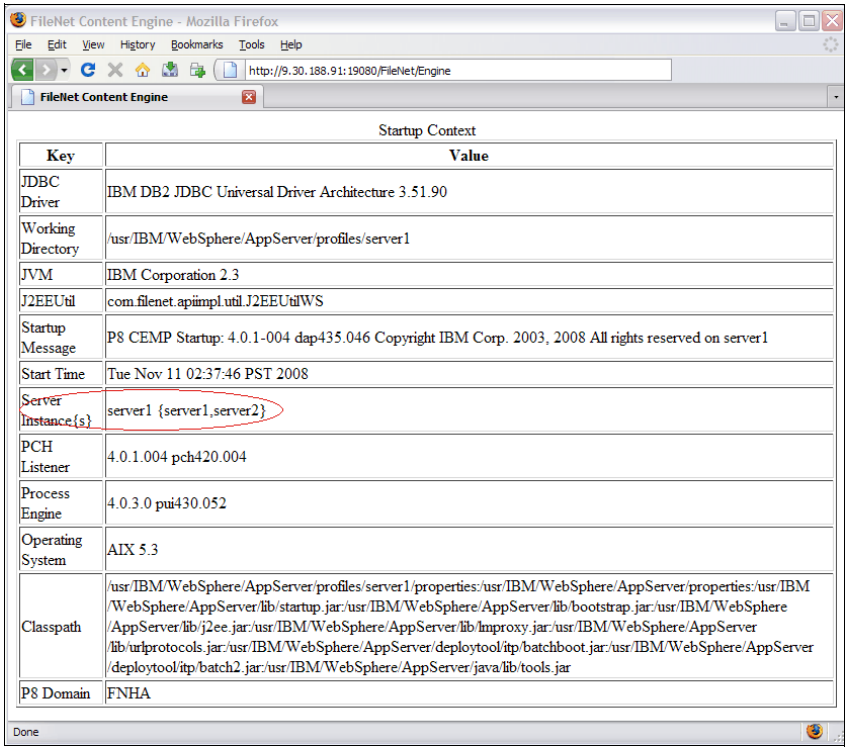


Figure 8-51 Content Engine node CE2 is down as reflected by the BIG-IP F5 console

Figure 8-52 on page 199 shows, as expected, the request is now serviced by Content Engine node 1, server1.



Startup Context

Key	Value
JDBC Driver	IBM DB2 JDBC Universal Driver Architecture 3.51.90
Working Directory	/usr/IBM/WebSphere/AppServer/profiles/server1
JVM	IBM Corporation 2.3
J2EEUtil	com.filenet.apiimpl.util.J2EEUtilWS
Startup Message	P8 CEMP Startup: 4.0.1-004 dap435.046 Copyright IBM Corp. 2003, 2008 All rights reserved on server1
Start Time	Tue Nov 11 02:37:46 PST 2008
Server Instance{s}	server1 {server1,server2}
PCH Listener	4.0.1.004 pch420.004
Process Engine	4.0.3.0 pui430.052
Operating System	AIX 5.3
Classpath	/usr/IBM/WebSphere/AppServer/profiles/server1/properties:/usr/IBM/WebSphere/AppServer/properties:/usr/IBM/WebSphere/AppServer/lib/startup.jar:/usr/IBM/WebSphere/AppServer/lib/bootstrap.jar:/usr/IBM/WebSphere/AppServer/lib/j2ee.jar:/usr/IBM/WebSphere/AppServer/lib/lmproxy.jar:/usr/IBM/WebSphere/AppServer/lib/urlprotocols.jar:/usr/IBM/WebSphere/AppServer/deploytool/itp/batchboot.jar:/usr/IBM/WebSphere/AppServer/deploytool/itp/batch2.jar:/usr/IBM/WebSphere/AppServer/java/lib/tools.jar
P8 Domain	FNHA

Figure 8-52 Content Engine URL output when Content Engine node CE2 is down

8.5.4 Load balance test

This test shows that both Content Engine nodes are simultaneously accessible when two separate requests are sent over to the Content Engine URL and both requests are serviced at the same time by separate Content Engine nodes.

The following two windows show that both Content Engine nodes are up and running. The first window is from the WebSphere Application Server Network Deployment administrative console (Figure 8-53 on page 200) and the second window is from the BIG-IP F5 console (Figure 8-54 on page 200).

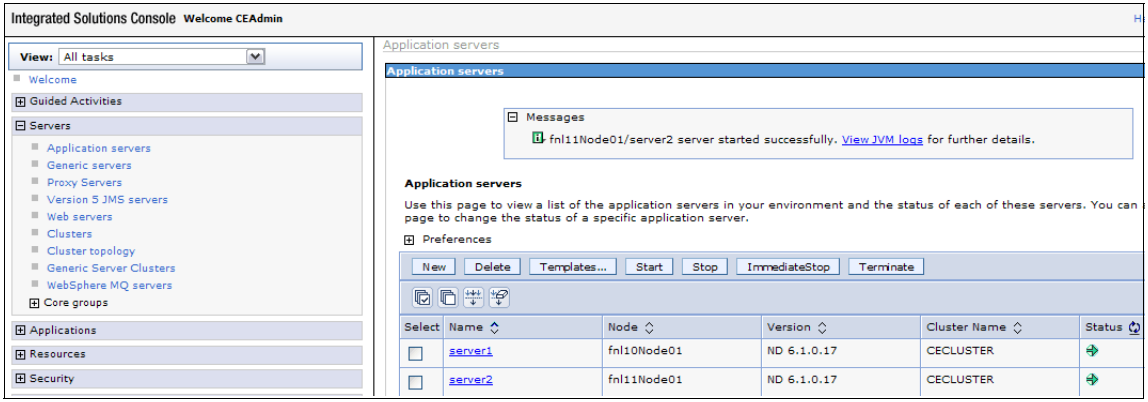


Figure 8-53 Both Content Engine nodes available to service requests as seen from WebSphere Application Server Network Deployment

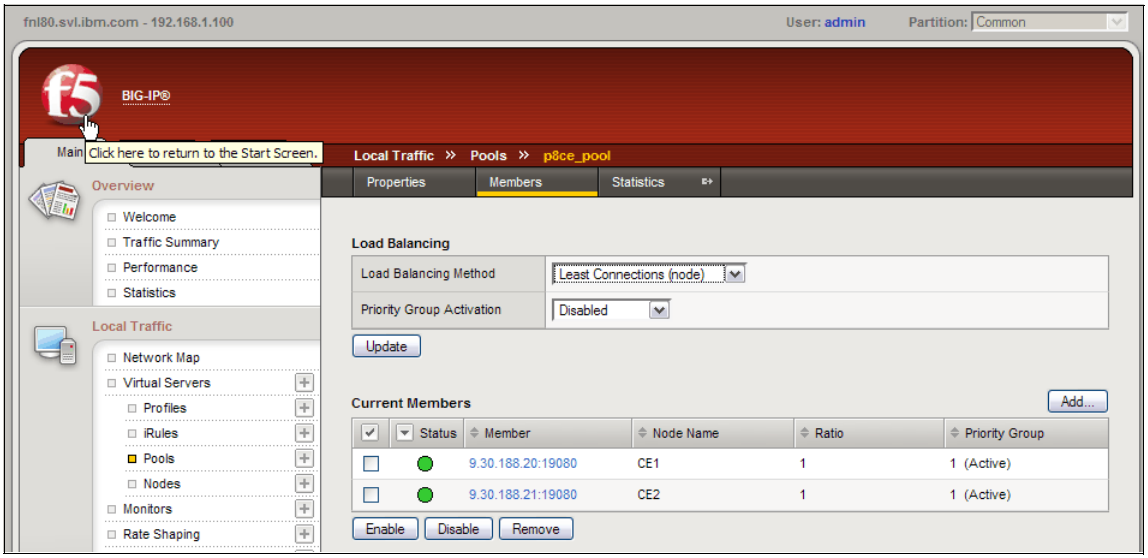


Figure 8-54 Both Content Engine nodes are marked available by BIG-IP F5 console

Figure 8-55 on page 201 shows both Content Engine nodes servicing the requests simultaneously.

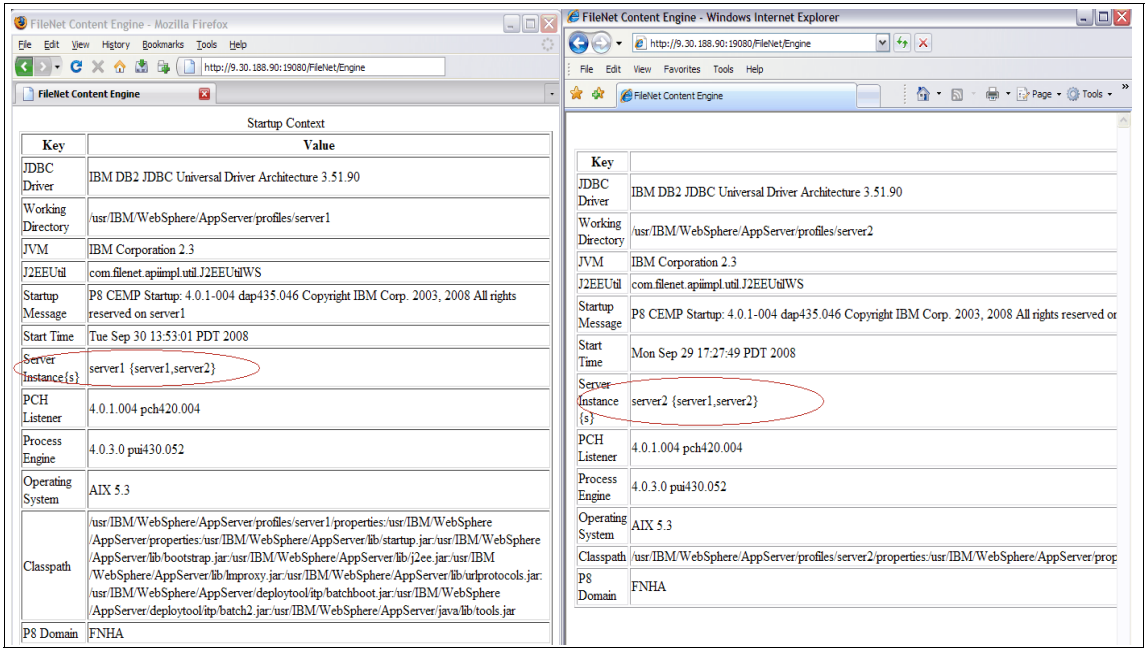


Figure 8-55 Both Content Engine nodes servicing the requests simultaneously

9

Process Engine implementation

This chapter describes the high availability options for Process Engine and our case study setup in relation to it. We also describe the practical, step-by-step procedures that we use to implement high availability for Process Engine.

We discuss the following topics:

- Introduction
- High Availability options for Process Engine
- Design for the case study
- Setup for active/active Process Engine cluster (farm)
- High availability tests at the Process Engine level

9.1 Introduction

FileNet P8 Process Engine (PE) lets you create, modify, manage, analyze, and simulate business processes (also referred to as *workflows*). These workflows are performed by applications, enterprise users, and external users, such as partners and customers. It is critical to provide high availability for Process Engine in the overall high availability of the IBM FileNet P8 solution.

For an overview of Process Engine, refer to 2.3, “Process Engine” on page 26.

9.2 High Availability options for Process Engine

As Process Engine (PE) stores the information about the workflow process, when PE is unavailable, neither IBM FileNet P8 Application Engine (AE) nor IBM FileNet P8 Content Engine (CE) can retrieve any workflow process-related data. All the processes in the system remain at their current state until AE or CE can reconnect to PE and continue the work.

The aim of making PE highly available is to make it available to run and service the requests (from either AE or CE) even if one of the PEs in the farm or cluster is unavailable.

PE can be made highly available in one of two ways:

- Active/active cluster:

  An *active/active cluster (farm)* is a configuration where multiple PE servers are available to service a request. Each machine in a highly available configuration is called a *node*. In an active/active cluster, in case a node goes down or is unavailable, the requests are routed automatically to the other available nodes. A hardware-based load balancer is needed for balancing the load that is sent to the nodes. Depending on the load balancer, the load can be sprayed on the nodes using various algorithms, such as round-robin and least connections.

- Active/passive cluster:

  An *active/passive cluster* is a configuration where an active PE server is available to service client (AE or CE) requests. The passive node is running in a listening mode. The second node is always synchronized with the active node in terms of application configuration and application data. In the case of a failure in the active node, the passive node assumes the responsibility and becomes the active node. In this scenario, all the subsystems are defined as resources for the cluster that, in case of a node failure, fail over to the passive node. The cluster services are provided by operating system vendors, for

example, IBM PowerHA for AIX (HACMP - formerly IBM High Availability Cluster Multi-Processing).

The application data is stored in a Process Engine database, which is also made available in a highly available mode in both scenarios.

9.3 Design for the case study

For our case study setup, we choose the recommended active/active cluster (farm) configuration for making the Process Engine highly available. There are two nodes running the Process Engines. Both nodes run the IBM AIX operating system.

All the PEs in a farm share the same database instance. The individual machines do not know about each other nor do they communicate in any way, except for isolated region initialization, transfer of configuration, and transfer of process definitions. That is, when a workflow process or a configuration is transferred, all of the machines in the farm are notified to update their configuration with the information of the newly transferred workflow process. The server, which can be any of the servers in the farm, that received the transfer remote procedure call (RPC) is the one that communicates with the other servers. It finds the other servers by looking at the database for the names and addresses of the other servers and then sends them a message (if they are active). Each server checks the database for a transfer in process when the server starts up.

All servers in the PE farm must have the same hardware word size and word boundaries, as well as they must have the same byte order (big-endian as opposed to little-endian).

Each machine in the PE farm is an exact replica of the other machines and, as such, is capable of carrying out all possible PE transactions. Additionally, each server in the farm is actively participating in handling the workload. Therefore, even if one of the PE machines in the farm goes down, all of the other machines continue to actively process work. Thus, the PE systems as a whole remain up as an active/active, highly available configuration.

All the servers in a PE farm can be managed from *one* Process Task Manager.

Figure 9-1 on page 206 shows the PE farm in an active/active mode.

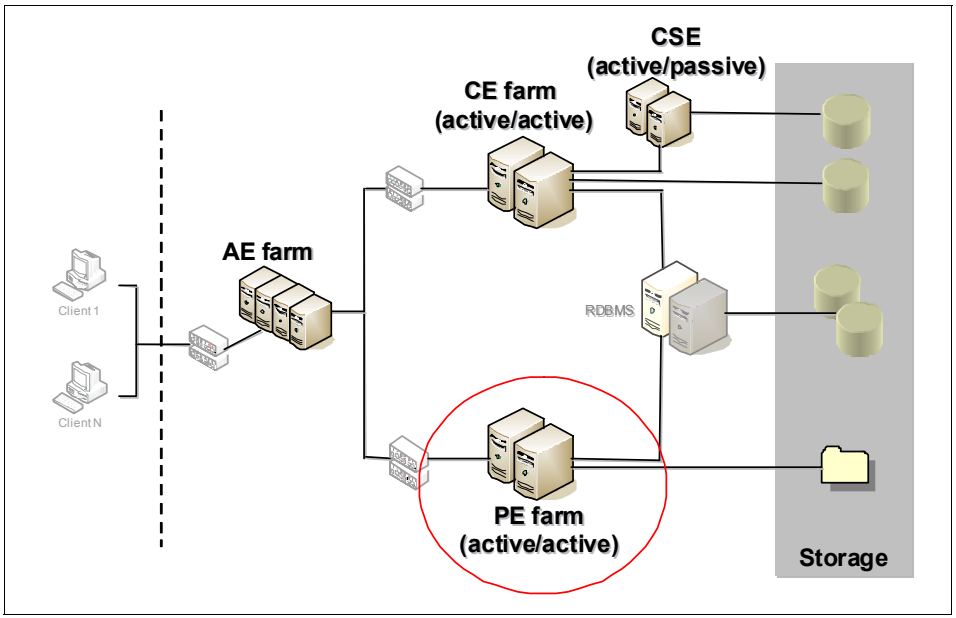


Figure 9-1 PE in an active/active cluster (farm) configuration

9.4 Setup for active/active Process Engine cluster (farm)

This section shows the system setup that is necessary for PE to run an active/active cluster (farm). The operating system that is used for all of the machines in the PE farm is the IBM AIX operating system.

Table 9-1 on page 207 shows the host names and IP addresses that are used in the setup. We reference these host names and IP addresses from now on in this chapter.

Table 9-1 System setup summary

Node	Host name	IP address
CE1	fnl10.svl.ibm.com	9.30.188.20
CE2	fnl11.svl.ibm.com	9.30.188.21
AE1	fnl3.svl.ibm.com	9.30.188.13
AE2	fnl4.svl.ibm.com	9.30.188.14
PE1	fnl20.svl.ibm.com	9.30.188.30
PE2	fnl21.svl.ibm.com	9.30.188.31
P8CE (Content Engine virtual)	p8ce.svl.ibm.com	9.30.188.91
P8PE (PE virtual)	P8PE.svl.ibm.com	9.30.188.92

9.4.1 Procedure for PE active/active cluster (farm) setup

Most of these steps, both prerequisites and the actual installation steps, are the same steps that are described in *IBM FileNet P8 4.0 Installation and Upgrade Guide,* GC31-5488. We include them here for ease of reference and for the completeness of our setup. In certain cases, there are specific options that are used for creating the active/active PE farm.

The steps that we provide here are sequential in nature and need to be executed in order.

Installing and setting up the prerequisites

The prerequisite installation includes installing DB2 client instances on the PE nodes, cataloging the database node and the database, creating the appropriate file systems, and creating raw partitions.

For our case study, we perform the following steps before installing PE:

1. Install the PE database.

   For details, refer to Chapter 12, “DB2 implementation” on page 369.

2. Install the IBM DB2 Client instance on both nodes.

   It is mandatory to install the DB2 Version 8 Client instance, even if the database server is DB2 Version 9.*x*. We use DB2 for Linux, UNIX and Windows Server Version 9.5 Fix Pack 1.

3. After the installation is complete, catalog the database node and the database, for example:

   ```
   db2 catalog tcpip node dbnode remote 9.30.188.79 server 50010
   db2 catalog database vwdbha at node dbnode
   ```

   Figure 9-2 shows the cataloged database information on PE1.

```
db2v8cli@fnl2O[/home/db2v8cli]db2 connect to vwdbha user f_sw
Enter current password for f_sw:

Database Connection Information
      Database server        = DB2/AIX64 9.5.1
      SQL authorization ID   = F_SW
      Local database alias   = VWDBHA
```

Figure 9-2 PE database information

Note: The database machine's virtual IP address is used while cataloging the node.

4. Create two file systems, `/fnsw` and `/fnsw/local`, on each node. Each of these file systems can be small, for example, 2 GB.
5. Create two raw partitions on each node. Each of these raw partitions are 64 MB. Use the following command to create the raw partitions:

   ```
   /usr/sbin/mklv -y 'fn_sec_db0' -t raw datavg 64M
   /usr/sbin/mklv -y 'fn_sec_rl0' -t raw datavg 64M
   ```

   Figure 9-3 shows the two raw partitions that are created.

```
fnl2O.svl.ibm.com(root)/fnsw> lsvg -l datavg
datavg:
LV NAME             TYPE       LPs     PPs     PVs  LV STATE      MOUNT
POINT
datalv              jfs        319     319     1    open/syncd    /data
loglv01             jfslog     1       1       1    open/syncd    N/A
fn_sec_db0          raw        1       1       1    open/syncd    N/A
fn_sec_rl0          raw        1       1       1    open/syncd    N/A
```

Figure 9-3 Raw partitions that are created for PE

Note: Make sure that the names of the raw partitions are exactly the same as specified. They must be fn_sec_db0 and fn_sec_rl0.

6. The network settings on both nodes must match with those network settings recommended in the *IBM FileNet P8 4.0 Installation and Upgrade Guide*, GC31-5488. We recommend that these settings are included during the initial boot sequence so that they are set across the reboot. Use the file `/etc/tunables/nextboot` to store these settings.

Process Engine installation

After the prerequisites are set up, you need to install and configure the Process Engine nodes.

Follow these steps to install and configure Process Engine:

1. Install PE on the first node.

   Install PE on the first node of the farm using the detailed steps that are provided in *IBM FileNet P8 4.0 Installation and Upgrade Guide,* GC31-5488:

   – Make sure that you write down the name of the Network Clearinghouse domain. This name must be different on each node.

   – On the Java API Assembly installation window, where it asks for the Content Engine API Configuration, make sure that the Content Engine's virtual name is used. Figure 9-4 shows the CE virtual name that is used in our configuration.

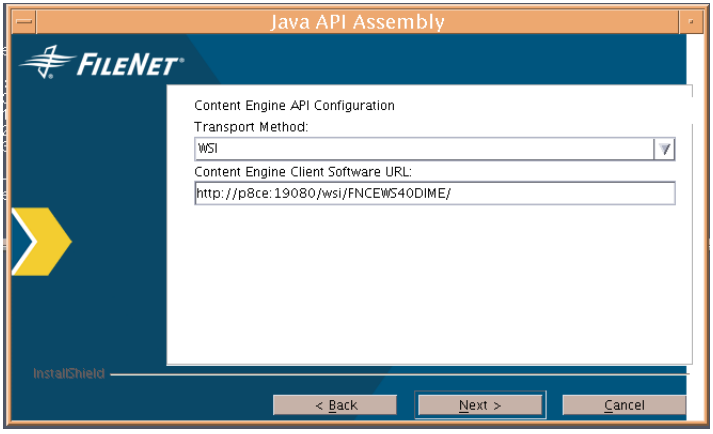


Figure 9-4 CE virtual name used during PE installation

2. Configure the load balancer.

   After the installation is complete on Node 1, proceed with the load balancer configuration. For our case study, we perform these steps:

   a. Configure the F5 BIG-IP hardware load balancer. Define the PE virtual server, PE pool, and PE monitors for both nodes on ports 32776 and

32777. For detailed configuration steps, refer to Chapter 5, “Hardware load balancer implementation (F5 BIG-IP)” on page 73.

b. For each PE node, set the hardware load balancer virtual IP name to the IP address of that PE node.

Figure 9-5 shows the file content of the `/etc/hosts` file from the PE1 node with IP address 9.30.188.30.

```
# Virtual IP for F5 load balancer.
9.30.188.91     p8ce.svl.ibm.com p8ce
# Here we point the virtual IP to itself.
9.30.188.30     P8PE.svl.ibm.com P8PE
```

Figure 9-5 PE1 node /etc/hosts file snippet

Figure 9-6 shows the relevant content of the `/etc/hosts` file from the PE2 node with IP address 9.30.188.31.

```
# Virtual IP for F5 load balancer.
9.30.188.91     p8ce.svl.ibm.com p8ce
# Here we point the virtual IP to itself.
9.30.188.31     P8PE.svl.ibm.com P8PE
```

Figure 9-6 PE2 node /etc/hosts file snippet

c. Modify the `/etc/hosts` files on each node for CE and AE to include the proper PE IP address. On all nodes, refer to PE by using that PE’s virtual IP address. In our case, it is `P8PE.svl.ibm.com`.

Figure 9-7 shows the relevant file content for the CE and AE nodes.

```
# THE LOAD BALANCER SETUP
9.30.188.91     p8ce.svl.ibm.com p8ce
9.30.188.92     P8PE.svl.ibm.com P8PE
# END
```

Figure 9-7 CE and AE nodes and /etc/hosts file snippet

Important: Verify that the name resolution configuration file (`nsswitch.conf`) is configured so that it resolves host names using the local host’s file first.

3. Install PE on the second node.

   Use the instructions that are provided in *IBM FileNet P8 4.0 Installation and Upgrade Guide,* GC31-5488. Make sure that you write down the name of the Network Clearinghouse and that the name is different than the name of the first node.

4. Add the virtual name and property on PE node 1.

   After the second PE node is installed, complete the following steps on the first node of the PE farm.

   Note: These steps are only required on the first node of the PE farm.

   Use the information that is provided in the “Configure Process Task Manager” section of the *IBM FileNet P8 Platform Installation and Upgrade Guide,* GC31-5488, to perform these tasks:

   a. Using the Process Task Manager (**vwtaskman**) on the server’s node, add the virtual name of the hardware load balancer. See Figure 9-8.

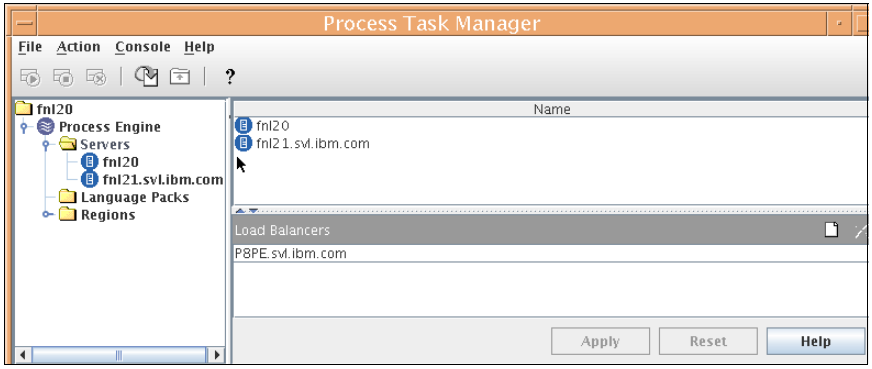


Figure 9-8 Process Task Manager with the virtual name of the hardware load balancer

   b. Use the Process Task Manager, at the Process Engine level, and select the **Advanced** tab. Add the following property:

      `vworbbroker.endPoint = giop:tcp:P8PE.svl.ibm.com:32777`

      Note that the virtual name is used. See Figure 9-9 on page 212.

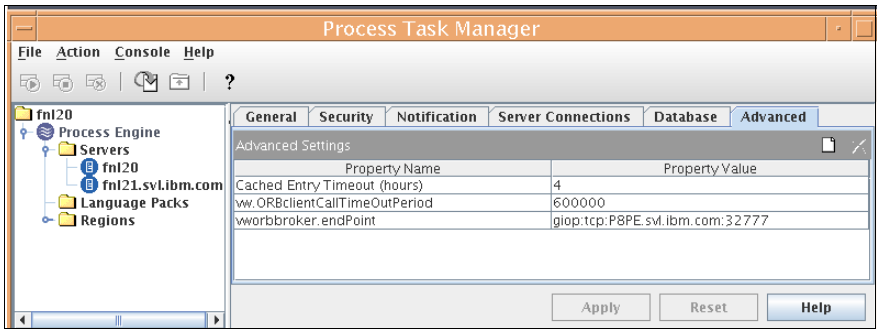


Figure 9-9 Process Task Manager: Add property

Verifying the Process Engine installation

The Process Engine installation is complete. Verify that it starts and runs. For our case study, we can see that both nodes appear in the Process Task Manager as shown in Figure 9-10.

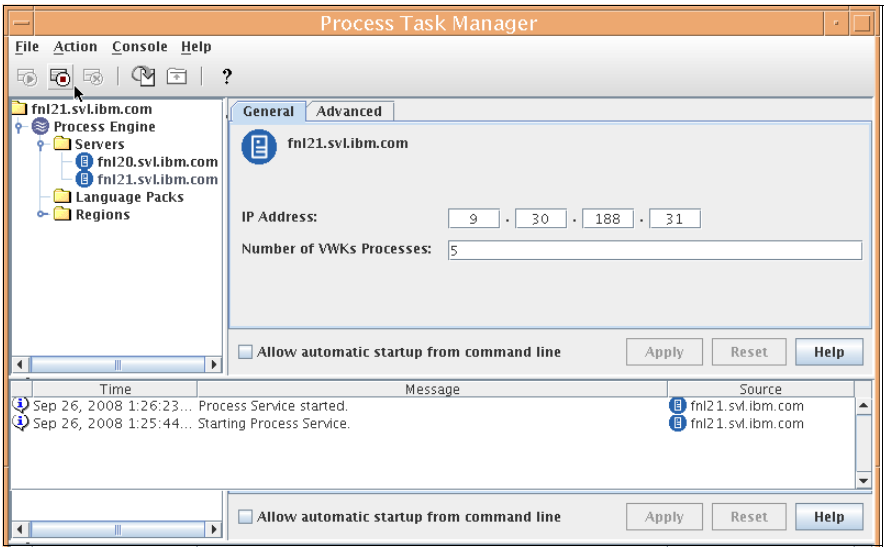


Figure 9-10 Process Task Manager: Showing both PE nodes

Content Engine client installation

After installing and configuring Process Engine software on both nodes, you need to install the Content Engine Client Updater on both PE nodes:

1. Use the following command to install Content Engine Client Updater 4.0.1 for AIX from the `/data/software/CE_Client` directory for the first PE node:

   ```
   ./CEClientUpdater-4.0.1.AIX.bin
   ```

Make sure to select the PE component to be updated. See Figure 9-11.

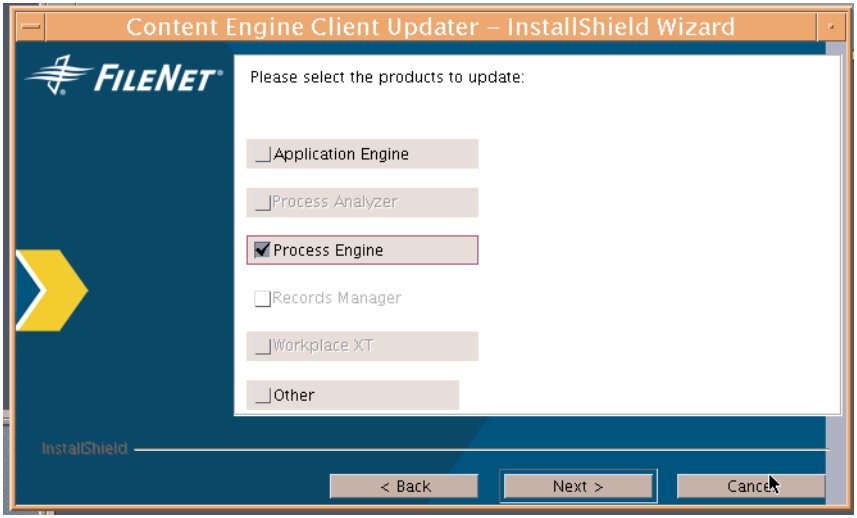


Figure 9-11 CE Client Updater on PE nodes

Figure 9-12 shows that the CE Client Updater installation is successful.

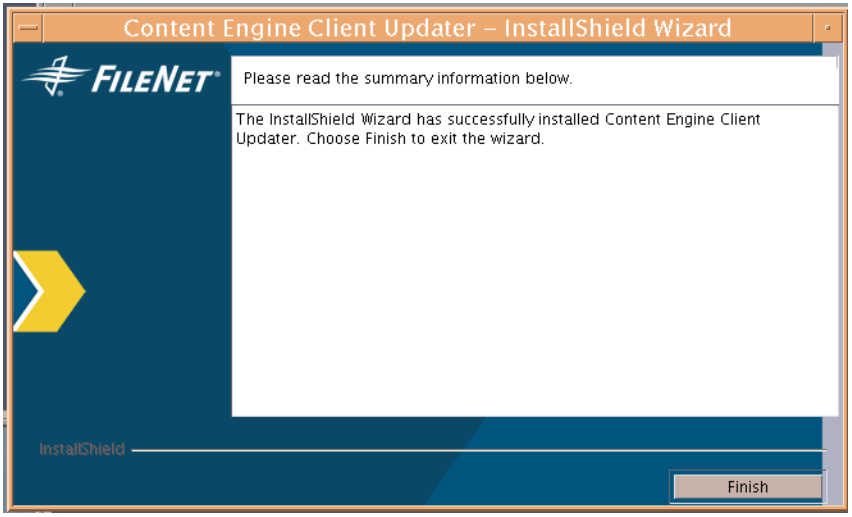


Figure 9-12 CE Client Updater installed successfully

2. Repeat the same Content Engine Client Updater step for the second PE node.

After the CE Client Updater is successfully installed, the installation for PE is complete.

9.5 High availability tests at the Process Engine level

After you complete the setup of each component in the high availability P8 environment, make sure that you perform component testing before continuing with the rest of the implementation.

In this section, we discuss the failover tests at the Process Engine component level. Table 9-2 shows the high availability tests that we performed for our case study in the lab and the results of these tests.

Table 9-2 Process Engine-level high availability test scenarios

Test scenario number	Test	Expected result	Actual result
Test 1	Basic availability test: Test the Process Engine using the following URL: http://9.30.188.92:32776/IOR/ping Note: Use the Process Engine virtual IP address for testing.	The URL works. Response is from either of the Process Engine nodes.	See 9.5.1, “Process Engine basic availability test” on page 214.
Test 2	Node availability test 1: Test the Process Engine while PE1 is down. Use the same URL as test 1.	The URL works. Response is from PE2.	See 9.5.2, “Node availability test 1” on page 216.
Test 3	Node availability test 2: Test the Process Engine while PE2 is down. Use the same URL as test 1.	The URL works. Response is from PE1.	See 9.5.3, “Node availability test 2” on page 217.
Test 4	High Availability Test: Test the Process Engine with two simultaneous connections. Use the same URL as test 1.	The URL works. Responses are from both PE nodes.	See 9.5.4, “High availability test” on page 218.

9.5.1 Process Engine basic availability test

To conduct this test, we look at the console of the F5 load balancer. The F5 load balancer monitors the nodes in each pool. If it does not find the node responsive,

that is, if the application is not responding on that node on the specified port, the F5 marks the node unreachable or unavailable.

Figure 9-13 shows the F5 console window showing that both PE nodes are available.

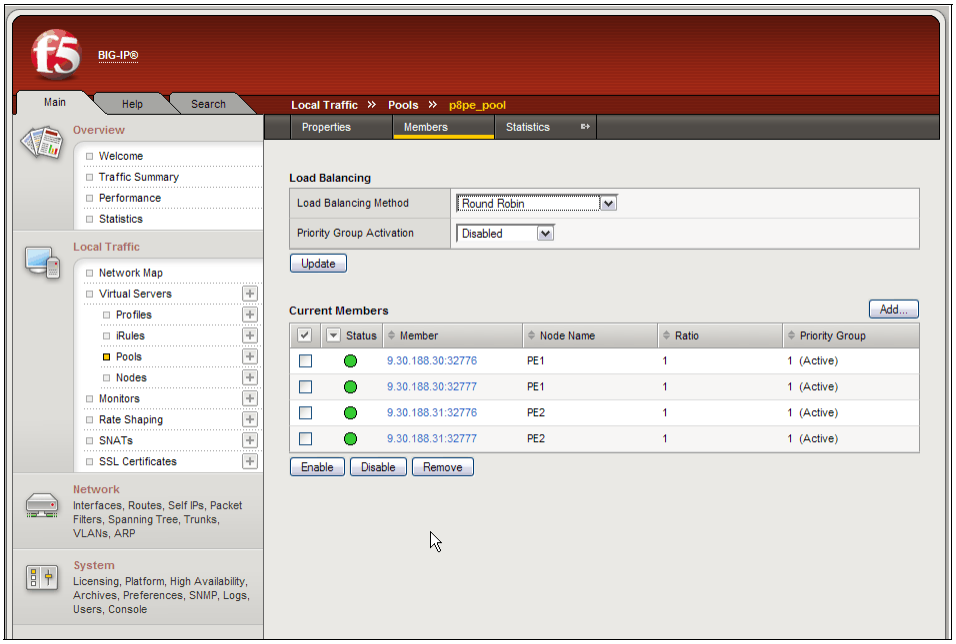


Figure 9-13 F5 console window showing both PE nodes available

Figure 9-14 shows the response from pinging the PE URL. In this case, the request is sent over to the PE2 node (fnl21.svl.ibm.com).

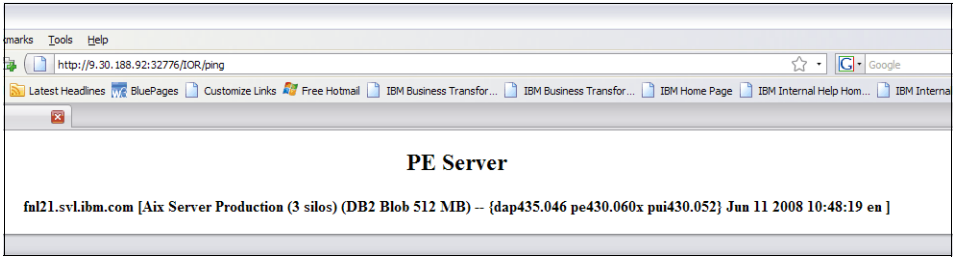


Figure 9-14 PE URL ping response: The request is sent over to the PE2 node

9.5.2 Node availability test 1

In this test, we bring down one PE node, PE1 (IP: 9.30.188.30). We expect that the URL ping request will be served by PE2.

Figure 9-15 Figure 9-14 shows that the PE is brought down on PE node1.

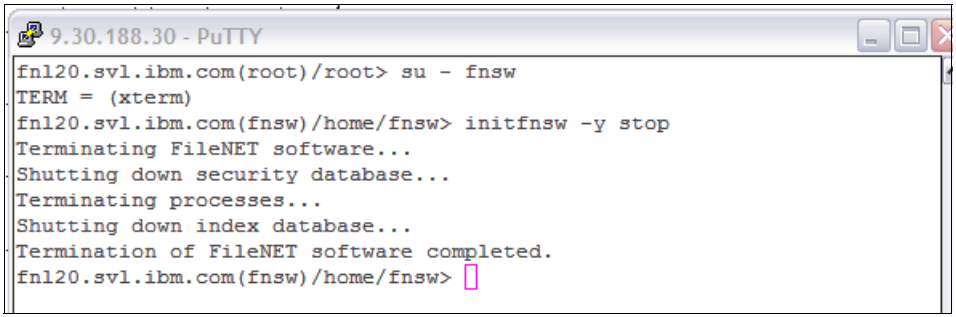


Figure 9-15 PE1 is brought down

Figure 9-16 shows the F5 console showing PE1 is stopped.

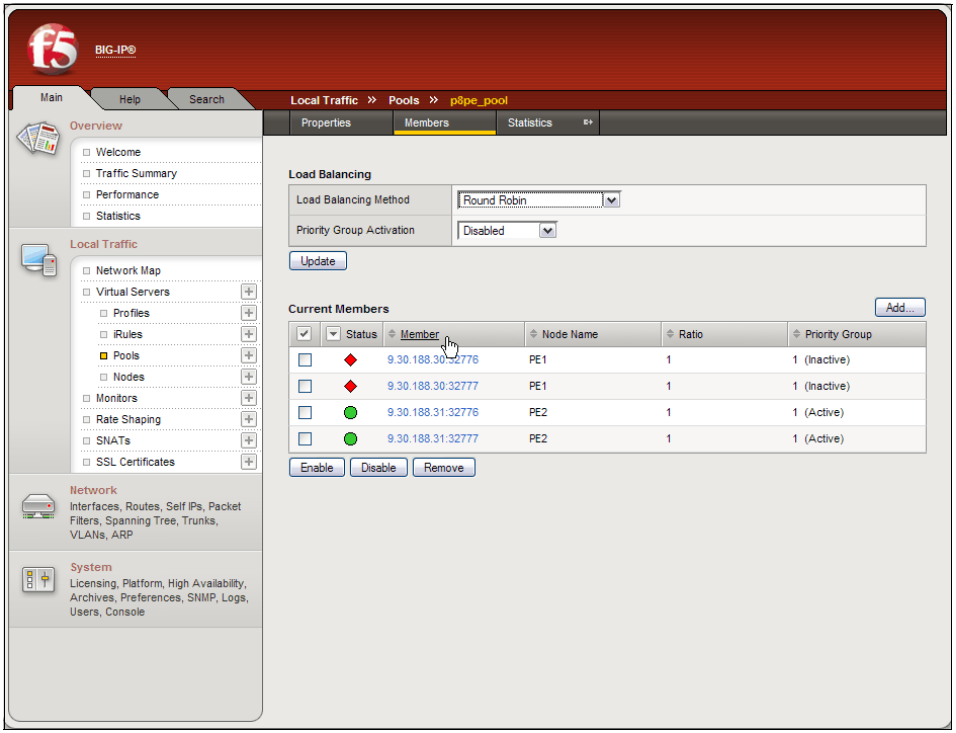


Figure 9-16 F5 console showing PE1 is down

Figure 9-17 shows the URL ping response when PE1 is stopped. In this case, PE2 (fnl21.svl.ibm.com) served the URL ping request.

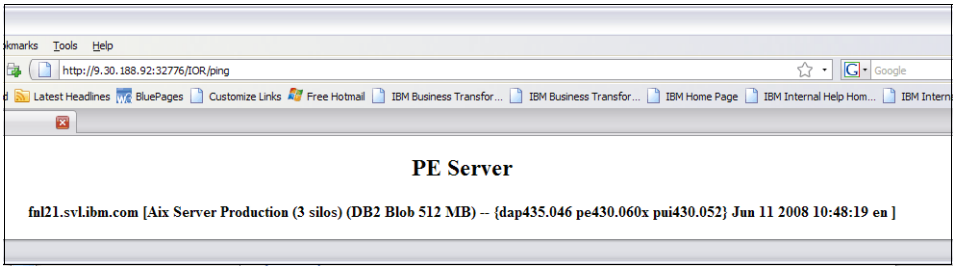


Figure 9-17 PE ping response from PE farm with PE node 1 down

9.5.3 Node availability test 2

This test is similar to test 2; however, this time we stop PE2 and bring PE1 back up (using the Process Task Manager).

Figure 9-18 shows that PE2 is stopped.

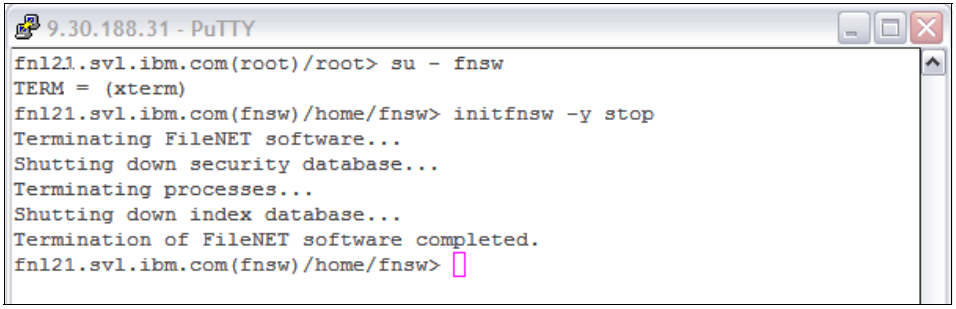


Figure 9-18 PE2 is brought down

Figure 9-19 on page 218 shows F5 console showing PE2 is stopped.

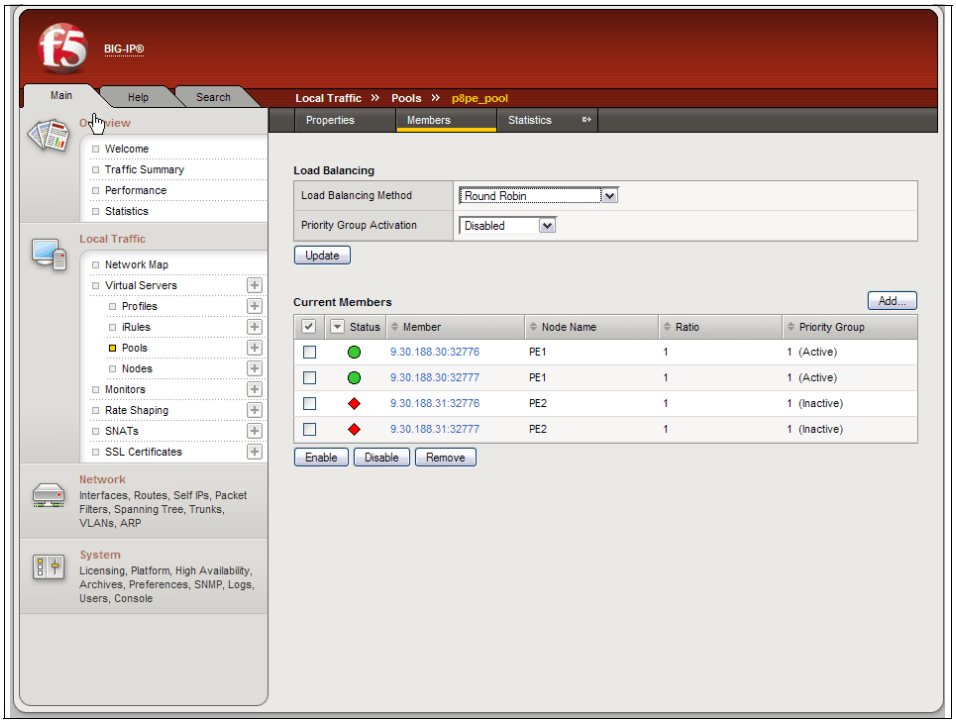


Figure 9-19 F5 console window showing PE2 is down

Figure 9-20 shows the URL ping response from PE farm when node2 is stopped. In this case, PE1 (fnl20.svl.ibm.com) responded from the URL ping request.

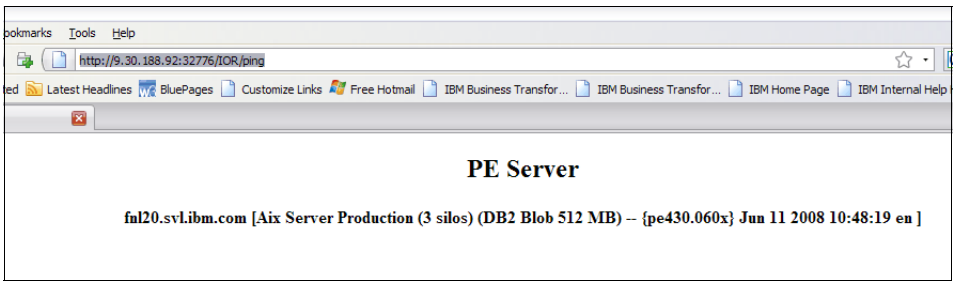


Figure 9-20 Ping response from PE farm when PE node2 is stopped

9.5.4 High availability test

For this test, we test with more than one simultaneous connections to the PE farm and try to see whether we can see connections being load balanced across both nodes.

In Figure 9-21, the console window shows that both PE nodes are available to service requests.

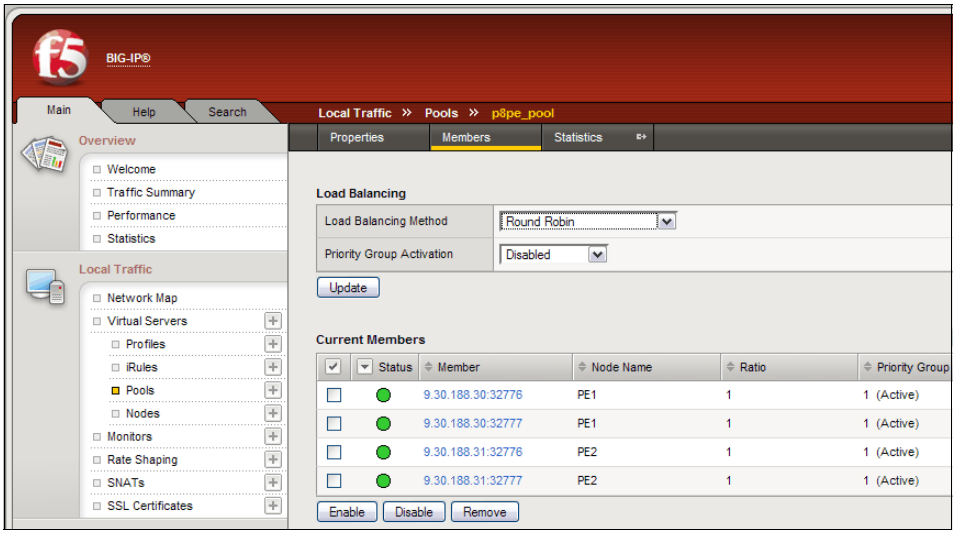


Figure 9-21 Both PE nodes are available

Figure 9-22 shows the requests being sent over to both PE nodes.

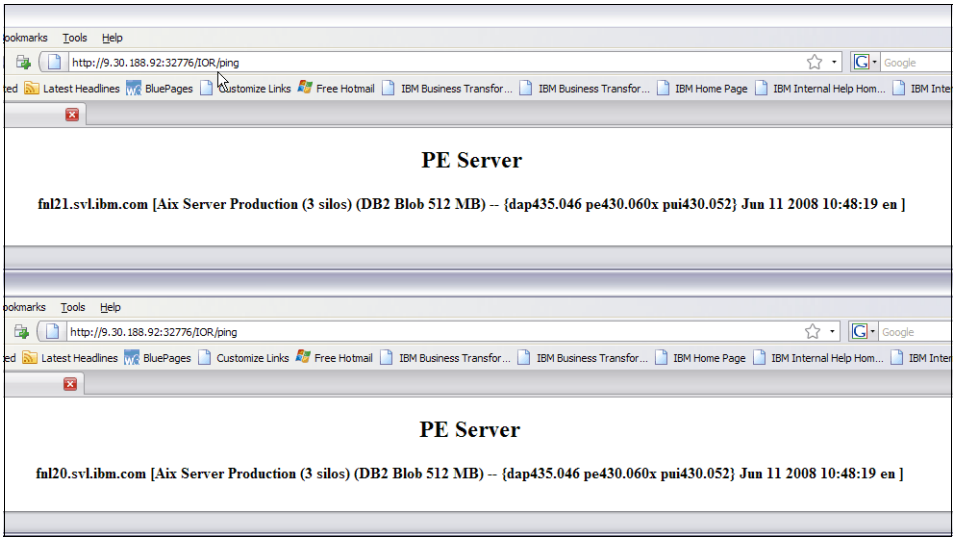


Figure 9-22 Requests being sent over to both PE nodes in the farm

10

Content Search Engine implementation

This chapter describes a Content Search Engine (CSE) high availability strategy, our case study installation, and the practical, step-by-step, procedures that we use to implement the solution. In addition, we also describe updating the Content Engine server farm to use a highly available Content Search Engine.

We discuss the following topics:

- Introduction
- Content Search Engine high availability strategy
- Design for the case study
- Installing and configuring the CSE components
- High availability tests at the CSE level
- Troubleshooting the Content Search Engine

10.1 Introduction

The IBM FileNet P8 platform relies on Autonomy's K2 Enterprise technology for its content-based retrieval (CBR) functionality. This functionality is also referred to as the *Content Search Engine*, which is not to be confused with the IBM FileNet P8 Content Engine.

The K2 Enterprise Search Engine's main function is to search, classify, and personalize large bodies of enterprise information for content-based search capabilities. Indexing is the process of ingesting and storing content (including CBR-enabled string properties of the document and any annotations) and building the appropriate data structures that support the querying of that content. To accomplish this task, Content Engine (CE) servers send indexing requests to the Content Search Engine, which, in turn, stores indexing data in collections for a particular object store. A *collection* is a separate file system that stores the references to all indexed documents and a list of all words contained within the text of the documents. In general, collections are much smaller than the total size of the documents that they represent.

For CBR-enabled objects, the indexing is performed asynchronously in batches when the objects are added to the object store. Therefore, newly added content is not immediately available for searches, and users can experience a delay in time before the documents can be searched through CBR.

All FileNet P8 clients, such as Workplace, communicate with the Content Search Engine through Content Engine, which manages the search operations and the creation and deletion of indexes.

Note: *Autonomy* refers to the various Content Search Engine services as servers.

The *K2 Getting Started Guide Version 6.0* is available at this Web site:

`http://www.sassafras.com/hrl/6.0/upgrade.html`

This guide describes the K2 Distributed Deployment brokered architecture concepts, such as parallel querying, failover, and collection mirroring.

Figure 10-1 on page 223 illustrates a typical P8 core environment with the CSE component. The CSE configuration described in this chapter has all of the K2 services running on the same logical partition (LPAR).

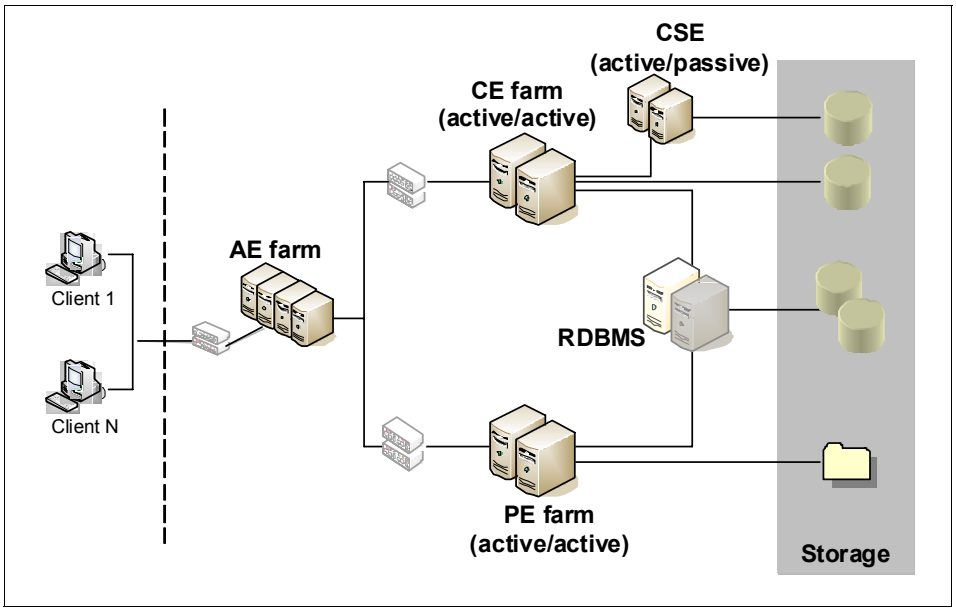


Figure 10-1 Basic P8 architecture with a Content Search Engine component

For additional information about Content Search Engine, refer to 2.6, “Content Search Engine” on page 36.

10.2 Content Search Engine high availability strategy

To achieve high availability, eliminating single points of failure in the Content Search Engine is the critical consideration behind any strategy. Single points of failure encompass both hardware and software components. You can implement the K2 brokered distributed server architecture, active-passive clustering, or a combination of both to provide horizontal scalability and fault tolerance across an Autonomy K2 Enterprise domain. Brokering Content Engine requests across multiple search and index servers can improve both query performance and simultaneous user response times.

For document ingestion, IBM requires that each K2 Index server must host its collections directories on locally attached storage (direct-attached or storage area network (SAN)). Index servers hosting their collections directories on network-attached storage (NAS), which is accessed through the Network File System (NFS), is not supported. However, sharing these same collections directories to multiple K2 Search Servers, through NFS, is supported. It is important to note that a shared file system or “CSE temporary directory” is

required for CSE. Both the Content Engine (all nodes within the farm) and Content Search Engine servers must have access to this file system. As the CSE indexes documents, temporary files are created as content is passed from the Content Engine to Content Search Engine.

The Autonomy K2 domain supporting P8 is controlled by a single instance of the K2 Master Administration server. The Master Administration Server manages communications across the K2 domain, creates new collections directories as needed, and is used to perform ongoing administration. This service can only run on a single host and, thus, constitutes a single point of failure in the system. Therefore, this component must be configured in an active/passive clustered configuration.

Note: If the machine hosting the K2 Master Administration Server stops responding, or the Master Administration Server is otherwise unavailable, new content can still be ingested by the P8 Content Engine. When the Master Administration Server becomes available again, indexing operations resume automatically.

The exception to this rule is a situation where a collection directory is full and a new collection ID cannot be assigned. In this case, new documents cannot be added to the CE. The CE running the K2 Dispatcher Queue logs errors while the CSE is down.

10.3 Design for the case study

For our case study setup, we use an active/passive IBM PowerHA for AIX (HACMP - formerly IBM High Availability Cluster Multi-Processing) cluster configuration for making the Content Search Engine highly available. Two nodes, running identical versions of the IBM AIX operating system, are used to configure an active/passive cluster. Only the currently active node runs the CSE software, providing all the K2 services to the Content Engine farm.

Figure 10-2 on page 225 illustrates how the CSE cluster and CE farm are configured. The K2 Dispatcher process can only run on a single Content Engine server.

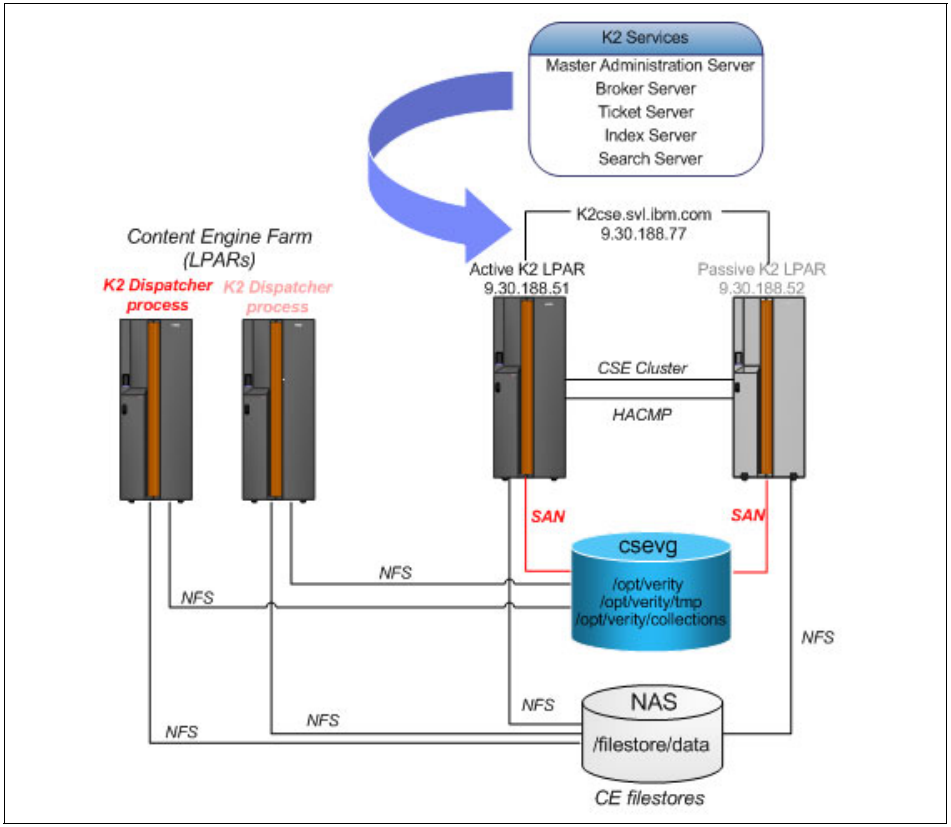


Figure 10-2 Highly available CSE cluster servicing a P8 Content Engine farm

10.4 Installing and configuring the CSE components

The following section describes how to install and configure the Autonomy K2 software in an HACMP clustered environment.

10.4.1 System prerequisites

Before installing the Autonomy Content Search Engine software, configure and install AIX and HACMP according to IBM guidelines. Additionally, you must install an identical (supported) version of Java for the CSE on each node.

Run the following commands on each node to ensure that the operating systems and HACMP/Java file set levels are identical:

```
oslevel
lslpp -L *cluster.*
lslpp -L *Java*
```

The Content Engine servers are considered as K2 clients of the Autonomy K2 Master Server. The P8 Content Engine servers communicate directly with the K2 Broker server as a K2 Java API client. This communication uses an AIX user account to serve as the security link between the two systems. The K2 users and group have to be created on both nodes of the CSE cluster, and it is important to keep the K2 user and group IDs the same across all of the CSE servers.

For our use case configuration, we also created the K2 users and group on each Content Engine server. We keep the K2 user and group IDs the same across all of the servers.

In general, this uniformity is not a requirement as long as you configure the Content Engine's Verity Domain Configuration tab with the correct user name and password for the K2 user on Content Search Engine. You must also make sure that the NFS permissions on the shared file system (the Content Search Engine's temporary directory) allow access to both Content Engine and Content Search Engine.

File system creation

Before installing the CSE software, you must create the file systems. You must create these file systems in the shared volume group that will be controlled by HACMP.

For our case study, we create a shared volume group called csevg. Figure 10-3 shows the logical volumes and file systems that are contained inside the csevg shared volume group.

```
root@fnl41:/opt/verity>lsvg -l csevg
csevg:
LV NAME             TYPE LPs PPs PVs  LV STATE      MOUNT POINT
cseloglv            jfs2log 1 1 1    open/syncd    N/A
csedata1lv          jfs2 80 80 1    open/syncd    /opt/verity/collections
csedata2lv          jfs2 16 16 1    open/syncd    /opt/verity
csedata3lv          jfs2 16 16 1    open/syncd    /opt/verity/tmp
```

Figure 10-3 List logical volume groups

Tip: Make sure that the default system umask is set to 022 before creating the underlying mount points and mounting the file systems. If the default umask is not set to 022, the K2usr account will experience permission problems when attempting to access the mounted file systems.

Virtual IP address and host name creation

Create a virtual IP address and corresponding host name for the Content Search Engine. Update the local `/etc/hosts` file on both nodes of the cluster and on all Content Engine servers.

Figure 10-4 shows the CSE name (k2cse.svl.ibm.com) and IP address as configured in the `/etc/hosts` file on the case study servers.

```
# more /etc/hosts
#CSE - P8 - service address - pub net 9.30.188.0/24
9.30.188.77     k2cse.svl.ibm.com       k2cse

9.30.188.51     fnl41.svl.ibm.com fnl41 c2
10.0.3.51       fnl41-hs03.svl.ibm.com fnl41-hs03
10.0.4.51       fnl41-hs04.svl.ibm.com fnl41-hs04
10.0.5.51       fnl41-hs05.svl.ibm.com fnl41-hs05
10.254.240.51   fnl41-hmcp.svl.ibm.com fnl41-hmcp
#
9.30.188.52     fnl42.svl.ibm.com fnl42 c3
10.0.3.52       fnl42-hs03.svl.ibm.com fnl42-hs03
10.0.4.52       fnl42-hs04.svl.ibm.com fnl42-hs04
10.0.5.52       fnl42-hs05.svl.ibm.com fnl42-hs05
10.254.240.52   fnl42-hmcp.svl.ibm.com fnl42-hmcp
```

Figure 10-4 Content of the /etc/hosts file

Table 10-1 on page 228 lists the configuration attributes, which are used in our case study, for the active/passive Content Search Engine cluster.

Table 10-1 Active/passive Content Search Engine server's attributes

Attribute	Active node	Passive node
Host name	fnl41.svl.ibm.com	fnl42.svl.ibm.com
IP address	9.30.188.51	9.30.188.52
Virtual IP address	9.30.188.77	N/A
AIX version	5.3.0.0	5.3.0.0
HACMP version	5.4.1 with latest PTFs	5.4.1 with latest Program Temporary Fixes (PTFs)
JAVA version	Java SE Runtime Environment (JRE™) 1.5.0 64 bit	JRE 1.5.0 64 bit
CSE version	CSE 4.0.1-003	N/A
K2 version	6.1.4	N/A
Default umask	022	022
Shared volume group	csevg	N/A
Shared file systems	/opt/verity /opt/verity/tmp /opt/verity/collections	N/A
Exported file system (shared to all CE servers)	/opt/verity/tmp	N/A
Remote mounts (NFS)	fnl45:/CEFileStore /opt/FileNet/FileStore	fnl45:/CEFileStore /opt/FileNet/FileStore

Table 10-2 on page 229 lists the configuration attributes, which are used in our case study, for the active/active Content Engine servers.

Table 10-2 Active/active Content Engine servers' attributes

Attribute	Content Engine 1	Content Engine 2
Host name	fnl10.svl.ibm.com	fnl11.svl.ibm.com
IP address	9.30.188.20	9.30.188.21
CSE client version	P8CSE-4.0.1-003	P8CSE-4.0.1-003
Remote mounts (NFS) (*storage area directory*) (*K2 temp directory*)	fnl45:/CEFileStore /opt/FileNet/FileStore k2cse:/opt/verity/tmp /opt/verity/tmp	fnl45:/CEFileStore /opt/FileNet/FileStore k2cse:/opt/verity/tmp /opt/verity/tmp

10.4.2 Installing Autonomy K2 on IBM AIX 5.3.0

After the system prerequisites are met, you can install the Autonomy K2 software. Install the software using the K2 Operating System User account (k2usr) on the active node of the cluster. Because the Autonomy software is installed on a shared file system, it is not necessary to perform any installation steps on the passive node. Because the Autonomy software stores dynamic configuration data in various directories throughout the `/opt/verity` file system, it is not possible to install the product locally on each node of the cluster. Unlike other products, such as Image Services, the binary and configuration directories are not logically separated.

The installation process does not make any updates to the AIX Object Data Manager (ODM). However, you must perform certain prerequisite steps on both nodes of the cluster. The installation steps described next are not intended to replace the standard installation procedures that are detailed in the *IBM P8 Platform Installation and Upgrade Guide*. Rather, we include these installation steps to enhance the existing procedures for installing the product in a clustered environment.

You can download the *IBM P8 Platform Installation and Upgrade Guide* from this Web site:

`http://www.ibm.com/support/docview.wss?rs=3278&uid=swg27010422`

Important: When upgrading and applying fix packs to the CSE software in the future, we recommend that you perform the installation steps on the cluster node where the software was originally installed.

Follow these steps to install Autonomy K2 software:

1. Create the following user accounts and group on *both* nodes of the cluster:
   - K2 Operating System User
   - K2 Security User
   - K2 Security Group

   You must create the exact same user on *both* nodes. Create the same password for the same user account on each node.

   For our case study, we create these users and this group:

   - k2usr (for K2 Operating System User)
   - k2sec (for K2 Security User)
   - k2secgrp (for K2 Security Group)

   Verify that the user accounts are identical by comparing the outputs of the following command:

```
# grep k2usr /etc/passwd
k2usr:!:1000:214::/home/k2usr:/usr/bin/ksh
# grep k2sec /etc/passwd
k2sec:!:1001:214::/home/k2sec:/usr/bin/ksh
# grep k2secgrp /etc/group
k2secgrp:!:214:k2usr,k2sec
```

2. Ensure that the shared file systems are mounted on the active node and that they have the following ownership and permissions:

```
# df -k | grep verity
/dev/csedata2lv    4194304   2742488 35% 17351 6% /opt/verity
/dev/csedata1lv   20971520  11733584 45% 126 1%
/opt/verity/collections
/dev/csedata3lv    4194304   4192936 1% 14 1% /opt/verity/tmp
# ls -l /opt | grep verity
drwxr-xr-x    8 k2usr    k2secgrp       4096 Oct 02 16:50 verity
# ls -l /opt/verity
drwxrwxr-x    5 k2usr    k2secgrp       4096 Oct 10 08:49
collections
drwxr-xr-x    2 k2usr    k2secgrp        256 Sep 19 14:08 lost+found
drwxrwxr-x    6 k2usr    k2secgrp        256 Oct 09 16:44 tmp
```

Tip: When creating the logical volume for `/opt/verity/collections`, refer to the Autonomy K2 documentation for proper sizing and capacity planning considerations.

3. Install Content Search Engine Version 4.0.0 general availability (GA) as described in the *IBM P8 Platform Installation and Upgrade Guide*:

   a. Execute Task 11, “Install and Configure Content Search Engine” (see the AIX platform section of the *IBM P8 Platform Installation and Upgrade Guide*):

   ```
   $ cd /opt/verity
   $ gzip -d K2-AIX.tar.gz
   $ tar -xvf K2-AIX.tar
   ```

   b. Edit the main K2 configuration file. When editing `/opt/verity/config.vncf`, use the virtual name of the CSE cluster. Do not use the server’s host name when replacing the <*myLocalHostName*> and <*myMasterHostName*> variables.

   Example 10-1 shows our `config.vncf` file content.

Example 10-1 Config.vncf content snippet

```
[K2]
Components= k2admin odbcgateway key k2services k2serviceconfig k2dashboard sse
k2doc
DataDir= /opt/verity/data
HostName= k2cse.svl.ibm.com
WebServerType= b
JavaHome= /usr/java5_64
AddDataDir1=
AddDataDir1Access= r
AddDataDir2=
AddDataDir2Access= r
AddDataDir3=
AddDataDir3Access= r
AddDataDir4=
AddDataDir4Access= r
AddDataDir5=
AddDataDir5Access= r
AddDataDir6=
AddDataDir6Access= r
CreateWarningLog=yes


[K2Admin]
Alias= k2cse.svl.ibm.com
Host= k2cse.svl.ibm.com
Description=
Email=
SMTPHost=
Port= 9950
Mode= Master
MasterHost= k2cse.svl.ibm.com
MasterPort= 9950
NTServiceName= K2 6.1.1 Administration Server
```

```
Authenticate= yes
ServiceNotify= no
JobNotify= no


[K2ServiceConfig]
cmdline1= reset "k2cse.svl.ibm.com" default_value 50 100 y y y exit
cmdline2= ritypeset doc 1 "Contains the profiles of documents in a collection"
default_value default_value default_value y exit
cmdline3= ritypeset query 1 "Reserved type used in K2 APIs" default_value
default_value default_value y exit
cmdline4= ritypeset user 1 "Contains the profiles of a group of sample users"
default_value default_value default_value y exit
cmdline5= rityperelset doc query u 1 default_value y exit
cmdline6= rityperelset user query u 1 default_value y exit
cmdline7= rityperelset user doc u 1 50 y exit
cmdline8= rityperelset doc query r 1 50 y exit
cmdline9= rityperelset user query r 1 50 y exit
cmdline10= rityperelset doc doc r 1 50 y exit
cmdline11= rityperelset user doc r 1 50 y exit
cmdline12= rityperelset doc user r 1 50 y exit
cmdline13= styleset 1 "Def_FileSystem_Secure" filesys default_value "Default
secure File System style files" y exit
cmdline14= styleset 1 "Def_FileSystem" filesys default_value "Default File System
style files" y exit
cmdline15= styleset 1 "Def_HTTP_Secure" Web default_value  "Default secure HTTP
style files" y exit
cmdline16= styleset 1 "Def_HTTP" Web default_value "Default HTTP style files" y
exit
cmdline17= styleset 1 "Def_FileSystem_PushAPI" filesys default_value "Default
File System style files to be used with ODK Collection Indexing API" y exit
cmdline18= serverset 1 "_docserver" 9948 "K2 Documentation and Samples Server." y
y y default_value "k2cse.svl.ibm.com" "/opt/verity/k2/common" default_value 200 2
n 300000 900000 default_value default_value default_value y exit
cmdline19= servercpuset "_docserver" 0 0 y exit
cmdline20= profileset "_docserver" "_docserver_prfsvc" 1 1 default_value
default_value s uni/en Def_FileSystem Def_HTTP default_value default_value
default_value default_value y exit
cmdline21= profilenetset "_docserver" "_docserver_prfsvc" 1 "_docserver_prfnet"
default_value default_value 1 n y exit
cmdline22= querylogset "_docserver" s y default_value 1024 default_value
default_value default_value default_value default_value default_value
default_value default_value default_value default_value default_value
default_value default_value default_value default_value default_value
default_value default_value default_value default_value default_value
default_value default_value default_value default_value default_value y
cmdline23= spiderset k2cse.svl.ibm.com indexer1 default_value 9801 9899
k2cse.svl.ibm.com_spider default_value 9800 y exit
cmdline24= collset k2cse.svl.ibm.com k2_doccoll 1 default_value f Def_FileSystem
0 default_value "K2 Documentation Collection" default_value default_value y exit
cmdline25= indexvdkset k2cse.svl.ibm.com k2_doccoll c n default_value
default_value default_value default_value default_value default_valueuni/en
default_value default_value default_value default_value default_value  y exit
cmdline26= indexattach k2_doccoll c "_docserver" 1 2 2 y exit
```

```
cmdline27= riset k2cse.svl.ibm.com k2_doccoll 1 doc uni default_value
default_value y exit
cmdline28= risourceset k2cse.svl.ibm.com k2_doccoll k2_doccoll 1 default_value
default_value y exit
cmdline29= indexattach k2_doccoll r "_docserver" 1 2 default_value y exit
cmdline38= wsadd "k2cse.svl.ibm.com" "_docserver" 20 1
"/opt/verity/k2/_rs6k43/bin/k2server" "-alias _docserver" y exit
cmdline40= wsadd "k2cse.svl.ibm.com" k2cse.svl.ibm.com_spider 20 1
"/opt/verity/k2/_rs6k43/bin/k2spider_srv" "-port 9800 -controller" y exit
cmdline41= adminsignal "k2cse.svl.ibm.com" 4 y exit


[K2Dashboard]
VirtualDir= k2_dashboard
WebServerType= t
WebServerHostName= k2cse.svl.ibm.com
WebServerPort= 9990
SSL= no
WebSiteName= No websites
```

4. Update the k2usr and k2sec users environment by adding the following environment variables to `/home/k2usr/.profile` and `/home/k2sec/.profile` on the active node. Uncomment any commands that display mail messages to the command prompt (the $MAIL section). Example 10-2 shows the k2usr user's `.profile` file (`/home/k2usr/.profile`) with the updated environment variables (shown under the "settings for K2" comment).

Example 10-2 The k2usr .profile file (/home/k2usr/.profile)

```
PATH=/usr/bin:/etc:/usr/sbin:/usr/ucb:$HOME/bin:/usr/bin/X11:/sbin:/home/k2usr:.

export PATH

#if [ -s "$MAIL" ]           # This is at Shell startup.  In normal
#then echo "$MAILMSG"        # operation, the Shell checks
#fi                          # periodically.

#########################
#  settings for K2      #
#########################

JAVA_HOME=/usr/java5_64
PATH=$PATH:/opt/verity/k2/_rs6k43/bin:/usr/java5_64/bin:/opt/verity/k2/common
LIBPATH=$LIBPATH:/opt/verity/k2/_rs6k43/bin
VERITY_CFG=/opt/verity/k2/common/verity.cfg

export JAVA_HOME
export PATH
export LIBPATH
export VERITY_CFG
```

Note: HACMP File Collection is used to keep the `.profile` files on both nodes synchronized on an ongoing basis. Any changes to these files are automatically replicated to the other node.

5. Run the K2 post-installation script. After this step completes, the Autonomy K2 product will be installed and started. Verify that the K2 start and stop scripts are working properly after running the post-installation script:

   ```
   $ cd /opt/verity
   $ /opt/verity/k2/_rs6k43/bin/vconfig -cfg "/opt/verity/config.vncf"
   -dir "/opt/verity" -verbose -log log.txt
   ```

   Stop the K2 services:

   ```
   $ /opt/verity/k2/_rs6k43/bin/k2adminstop
   ```

   Make sure that all the K2 processes have stopped:

   ```
   $ ps -ef | grep k2
   ```

   Tip: If the vendor-supplied stop script (k2adminstop) does not shut down the k2admin process and all child processes, you must create a custom script to manually end the k2 processes. Example 10-5 on page 240 shows an example script.

   Start the K2 services:

   ```
   $ /opt/verity/k2/_rs6k43/bin/k2adminstart
   ```

6. Access the K2 Dashboard, and configure Autonomy K2 for content-based retrieval. Refer to Task 11, step 10 in the *IBM P8 Platform Installation and Upgrade Guide*. After these steps complete, the K2 Dashboard shows all the K2 servers in the Running state (Figure 10-5 on page 235 for our case study).

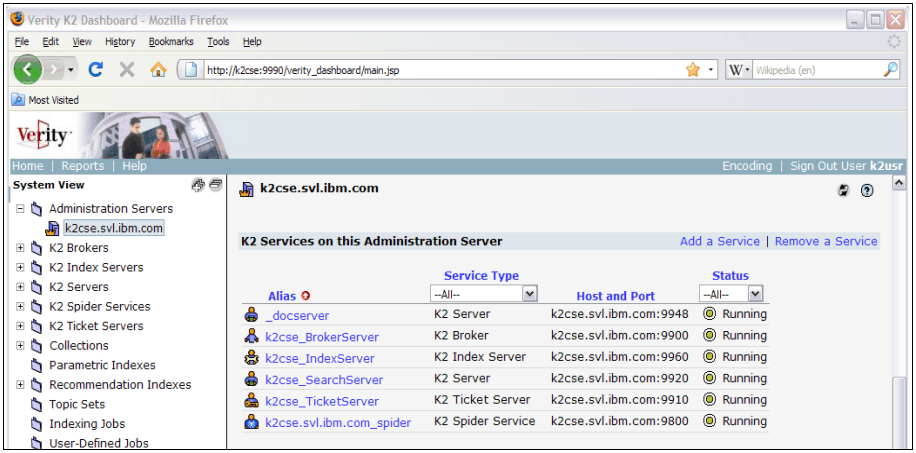


Figure 10-5 K2 Services status

7. As the root user, change the permissions and ownership on the `vspget` file. This change is necessary, so that the K2 software can run as k2usr instead of root.

   As the k2usr, stop the K2 software:

   ```
   $ k2adminstop
   ```

   Run the following commands as root:

   ```
   # chown root:k2secgrp /opt/verity/k2/_rs6k43/bin/vspget
   # chmod 770 /opt/verity/k2/_rs6k43/bin/vspget
   # chmod +s /opt/verity/k2/_rs6k43/bin/vspget
   ```

   As the k2usr, stop the K2 software:

   ```
   $ k2adminstart
   ```

   If the file ownership and permissions are incorrect on this file, the k2usr is unable to log in as administrator to the K2 Ticket Server, and an error message displays in the K2 Dashboard.

   Figure 10-6 on page 236 shows the error that is displayed on the K2 Admin console if `vspget` has incorrect ownership and file permissions.

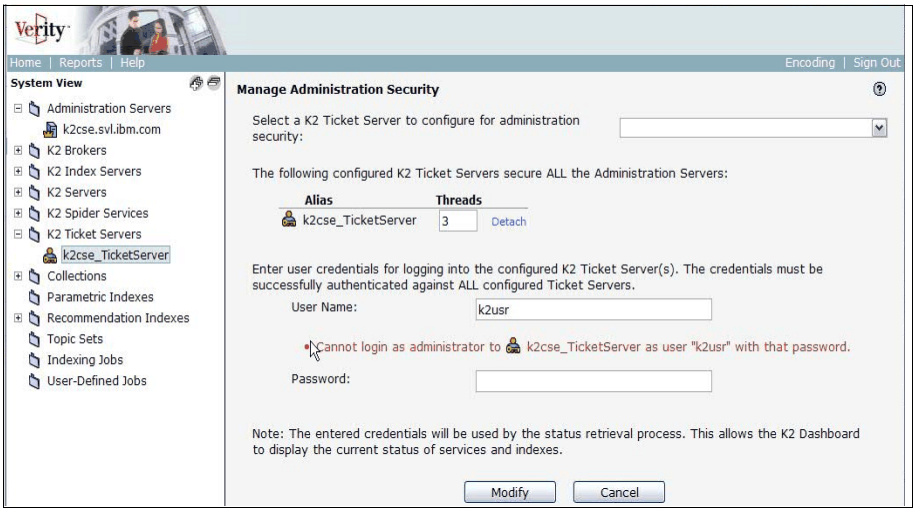


Figure 10-6 Error message

The Ticket Server log file displays the following error if the `vspget` file has incorrect ownership and permissions:

```
$ cat /opt/verity/data/services/k2cse_TicketServer/log/status.log
2008-09-22 19:44:41 Fatal: Root Privileges are needed by vspget
2008-09-22 19:44:41 Status: [K2TkSvc]User k2usr login as admin
failed
```

Tip: Check the ownership and permissions of the `vspget` file after you complete all of the CSE upgrade and fix pack activities.

8. Back up the `/opt/verity` file system, and install the Content Search Engine Service Pack 4.0.1.
9. Install the latest Hot Fix Pack for the CSE (P8CSE-4.0.1-004), and verify the update by checking the status of the K2 servers in the K2 Dashboard. Check the K2 status log for errors:

   ```
   $ more /opt/verity/data/host/log/status.log
   ```

10. Update the `verity.cfg` file to add the new collections path. Use the next available alias for the Content Engine. Restart the K2 application after the update.

    The following example shows the updated `/opt/verity/verity.cfg` file:

    ```
    alias6=path1
    mapping6=/opt/verity/collections
    dirmode6=rw
    ```

Validating the installation

At this point, the Autonomy K2 software is fully functional and ready for use. Perform the following steps to validate the environment:

1. Create a collection, and index a document.

   Example 10-3 indexes the `verity.cfg` file to a collection called Test. Use the rcvdk utility to perform a null search on the new document, and then, view the document's contents.

   Example 10-3 Indexing the verity.cfg file

```
$ mkvdk -collection Test /opt/verity/k2/common/verity.cfg
mkvdk - Verity, Inc. Version 6.1.4
Initializing dataset 00000001.ddd, index 00000001.did
Totals (1 documents): 5 para  2 sent  238 word  (1680 Kb used)
Optimizing database layout
(214 ms) Indexed 1 docs into Test/parts/00000001
Writing partition index data
mkvdk done

$ rcvdk Test
rcvdk  Verity, Inc. Version 6.1.4
Attaching to collection: Test
Successfully attached to 1 collection.
Type 'help' for a list of commands.
RC> s
Search update: finished (100%).  Retrieved: 1(1)/1.
RC> v
1:              /opt/verity/k2/common/verity.cfg
[Master Admin Server]
host=k2cse.svl.ibm.com
port=9950
[Admin Server]
alias=k2cse.svl.ibm.com
host=k2cse.svl.ibm.com
port=9950
[Launch]
launch1=mmc
launch2=k2server
launch3=k2broker
.....rest of document is displayed.....
RC> quit
```

2. Remove the Test collection.

```
$ mkvdk -collection Test -purge
```

If necessary, update the Content Engine servers with the latest P8CSE client version. You can verify the fix pack dependencies between the CSE and CE servers in the *Fix Packs and Compatibility Matrices* document, which you can download from this Web site:

http://www.ibm.com/support/docview.wss?uid=swg27010422

Tips: You can obtain the current version of the CSE client that is installed on the Content Engine servers from the Content Engine installation directory.

Example**:**

```
# cat /opt/FileNet/ContentEngine/lib/k2_Version.txt
P8CSE-4.0.1-003 K2.jar Verity Version 6.1.4 dated April 30th, 2008
```

Important: After applying the appropriate fix packs on the CSE and CE servers, verify that the `k2.jar` files are identical on all of the servers.

Content Engine Servers:

```
# ls -l
/usr/IBM/WebSphere/AppServer/profiles/server1/installedApps/CECell/F
ileNetEngine.ear/APP-INF/lib/k2.jar
-rw-r--r--   1 root     system      2429374 Sep 26 15:42 k2.jar
```

Autonomy K2 Server:

```
# ls -l /opt/verity/k2/jars/k2.jar
-rwx------   1 k2usr    k2secgrp    2429374 Sep 26 15:42 k2.jar
```

In our case study, the Content Engine server farm was built before the CSE cluster. The CSE client was applied to both Content Engine servers during the initial installation. Upon completion of the CSE cluster installation, and depending upon the version of the CSE that is being used, the CSE client software on each Content Engine might *require an upgrade* (see the compatibility matrix from the product documentation). In our case setup, we updated the CSE client software on both Content Engine servers to P8CSE-4.0.1-003.

Note: When upgrading the CSE client software on each Content Engine, the patch introduces a new `Engine-ws.ear` file. Therefore, the original file must be backed up, then undeployed. The new `Engine-ws.ear` file contained in the P8CSE-4.0.1-003 Fix Pack is then deployed (see the Fix Pack `readme` file for further details).

For additional information about Content Engine and CSE dependencies and compatibility, refer to the following documents at this Web site

http://www.ibm.com/support/docview.wss?rs=3278&uid=swg27010422:

- *IBM FileNet P8 Hardware and Software Requirements Guide*
- *Fix Packs and Compatibility Matrices*

10.4.3 Configure an HACMP resource group for CSE

After the Autonomy K2 software is installed and validated, it can be placed under the control of HACMP. This section describes the steps that are necessary to configure CSE within HACMP.

A single HACMP resource group is required for the CSE cluster. This group contains a shared volume group to host the shared file systems, a service IP label used by the Autonomy K2 software, and a CSE application server resource.

Three custom scripts are created to manage the K2 application within HACMP. These scripts are used by the cluster software to stop, start, and monitor the K2 application. Describing the details of installing and configuring HACMP topologies is outside the scope of this book. You can obtain these steps and other best practices at the following links:

- IBM PowerHA for AIX (HACMP) library:

  http://publib.boulder.ibm.com/infocenter/clresctr/vxrx/index.jsp?topic=/com.ibm.cluster.hacmp.doc/hacmpbooks.html

- *Implementing High Availability Cluster Multi-Processing (HACMP) Cookbook*, SG24-6769

  http://www.redbooks.ibm.com/abstracts/sg246769.html

Use the following steps to configure CSE within HACMP:

1. Create the start, stop, and monitor shell scripts that HACMP calls to manage the Content Search Engine. There are many possible ways to write the scripts to accomplish the function.

The following scripts were implemented successfully in our lab environment. We provide them here as examples for your reference:

– Example 10-4 shows the start script for CSE.

  The script first checks to ensure that the `/opt/FileNet/FileStore` NFS is mounted before running k2adminstart. If the file system is not mounted, the script exits with a status=1, and K2 is not started.

  Example 10-4 Start script

```
root@fnl41:/root>cat /opt/FileNet/ha_scripts/cse_start.sh

#!/bin/ksh

CEFS="/opt/FileNet/FileStore"

echo "Checking if the CE filestore is mounted ..."
mount | grep -w "$CEFS"
if [ $? -ne 0 ]; then echo "ERROR: FileStore not mounted!!!!\n Exiting
without starting CSE!"; exit 1 ; fi

echo "Starting Content Search Engine ....."

############################################################
#           Run the K2 start script                        #
############################################################
su - k2usr "-c /opt/verity/k2/_rs6k43/bin/k2adminstart"

exit 0
```

– Example 10-5 shows the stop script for CSE.

  The script first stops the k2admin process, and then, the remaining k2usr child processes. After these processes are stopped, Catalina Tomcat is stopped.

  Example 10-5 Stop script

```
root@fnl41:/root>cat /opt/FileNet/ha_scripts/cse_stop.sh

#!/bin/ksh
DATA_DIR="/opt/verity/data"
# The process ID is kept in the k2admin.pid file under
$DATA_DIR/host/log
PLATFORM="_rs6k43"
VERITY_DIR="/opt/verity"
VERITY_LOG="$DATA_DIR/host/log"
VERITY_BIN="$VERITY_DIR/k2/$PLATFORM/bin"
VERITY_COMMON="$VERITY_DIR/k2/common"
VERITY_CFG="/opt/verity/k2/common/verity.cfg"
```

```
PATH=$VERITY_BIN:$PATH; export PATH
LIBPATH=$VERITY_BIN:$LIBPATH;export LIBPATH
TOMCAT_HOME="/opt/verity/appserver"; export TOMCAT_HOME
CATALINA_HOME="/opt/verity/appserver"; export CATALINA_HOME
if [ -z "$JAVA_HOME" ]; then
JAVA_HOME="/usr/java5_64"; export JAVA_HOME
fi

echo "Stopping Content Search Engine ....."

pidk2adm=`cat $VERITY_LOG/k2admin.pid`
if [ `ps -e | grep "k2admin" | grep $pidk2adm | grep -v grep | grep -v
k2adminstop | wc -l ` -gt 0 ]; then
if [[ $pidk2adm != "" ]]; then kill -HUP "$pidk2adm" ; fi
fi

sleep 10

pidsk2=`ps -fu k2usr | grep "$pidk2adm" | grep -v "k2admin" | grep -v
grep | awk '{print $2}'`
for i in $pidsk2
do
kill -9 $i
done
if [ `ps -e | grep "k2admin" | grep $pidk2adm | grep -v grep | grep -v
k2adminstop | wc -l ` -gt 0 ]; then
if [[ $pidk2adm != "" ]]; then kill -9 "$pidk2adm" ; fi
fi

sleep 10
if [ -f $VERITY_DIR/appserver/bin/catalina.sh ]; then
     $VERITY_DIR/appserver/bin/catalina.sh stop -force >/dev/null
fi

if [ `ps -p "$pidk2adm $pidsk2" 2>/dev/null |tail +2 |wc -l` -ne 0 ]
 then
 echo "K2 processes still running!!!!\nCheck the application status!!!"
fi

exit 0
```

– Monitor script for CSE.

The monitor script checks to see if the following seven critical K2 server processes are running:

```
/opt/verity/k2/_rs6k43/bin/k2admin
/opt/verity/k2/_rs6k43/bin/k2index -ualias k2cse_IndexServer
/opt/verity/k2/_rs6k43/bin/k2server -ualias k2cse_SearchServer
```

```
/opt/verity/k2/_rs6k43/bin/k2server -ualias _docserver
/opt/verity/k2/_rs6k43/bin/k2ticket -ualias k2cse_TicketServer
/opt/verity/k2/_rs6k43/bin/k2broker -ualias k2cse_BrokerServer
/opt/verity/k2/_rs6k43/bin/k2spider_srv
```

Example 10-6 shows the monitor script. If the k2admin process is not running, the script exits with a status code=1, which causes HACMP to attempt to restart the K2 application. If any of the other six processes are not running, HACMP logs the error but does not attempt to restart the application. This logic allows for the possibility that any of these six child processes might periodically need to be stopped and started. For example, an administrator might make a change to one of the K2 servers using the K2 Dashboard. After the change, the service has to be restarted. However, it is important to know if one of the processes goes down unexpectedly. In this case, the error is logged, and ideally, an administrator is notified.

Example 10-6 Monitor script

```
root@fnl41:/root>cat /opt/FileNet/ha_scripts/cse_mon.sh

#!/bin/ksh
DATA_DIR="/opt/verity/data"
# The process ID is kept in the k2admin.pid file under
$DATA_DIR/host/log
PLATFORM="_rs6k43"
VERITY_DIR="/opt/verity"
VERITY_LOG="$DATA_DIR/host/log"
VERITY_BIN="$VERITY_DIR/k2/$PLATFORM/bin"
VERITY_COMMON="$VERITY_DIR/k2/common"
VERITY_CFG="/opt/verity/k2/common/verity.cfg"

PATH=$VERITY_BIN:$PATH; export PATH
LIBPATH=$VERITY_BIN:$LIBPATH;export LIBPATH
TOMCAT_HOME="/opt/verity/appserver"; export TOMCAT_HOME
CATALINA_HOME="/opt/verity/appserver"; export CATALINA_HOME
if [ -z "$JAVA_HOME" ]; then
JAVA_HOME="/usr/java5_64"; export JAVA_HOME
fi

#Predefine variables for service monitoring with HACMP
NUM_EXPECTED_PROCS=7
LOGFILE=/opt/FileNet/ha_scripts/cse_mon.log

pidk2adm=`cat $VERITY_LOG/k2admin.pid`
pidcat=`ps -fu k2usr | grep catalina | grep -v grep | awk '{print $2}'`
pidsk2=`ps -fu k2usr | grep "$pidk2adm" | grep -v k2admin|grep -v grep |
awk '{print $2}'`
```

```
if [ `ps -e | grep "k2admin" | grep $pidk2adm | grep -v grep | grep -v
k2adminstop | wc -l ` -eq 0 ]; then
logger -i -p notice -t $0 "cse_mon: No k2admin process found!"
exit 1
fi

if [ `ps -p "$pidcat $pidsk2" 2>/dev/null |tail +2 |wc -l` -ne
${NUM_EXPECTED_PROCS} ]
 then

 echo "Number of expected procs is $NUM_EXPECTED_PROCS" > $LOGFILE
 echo "Number of k2 processes running is not the same as the number of
expected processes !!!!" >> $LOGFILE
 echo "Status of the K2 server process currently running:" >> $LOGFILE
 echo
"================================================================================
==========================" >> $LOGFILE
 ps -p "$pidcat $pidsk2" >> $LOGFILE 2>/dev/null
 echo
"================================================================================
==========================" >> $LOGFILE
 logger -i -p notice -t $0 -f $LOGFILE

fi

exit 0
```

Before incorporating the start, monitor, and stop scripts into HACMP, ensure that they can be successfully run (as root) from the command line.

Run **cse_mon.sh** while K2 is up and running. An exit status=0 indicates that the script detected all of the processes running:

```
root@fnl41:/opt/FileNet/ha_scripts>./cse_mon.sh
root@fnl41:/opt/FileNet/ha_scripts>echo $?
0
```

Stop the K2 processes. The cse_mon.sh script returns an Exit status=1:

```
root@fnl41:/opt/FileNet/ha_scripts>./cse_stop.sh
Stopping Content Search Engine .....
root@fnl41:/opt/FileNet/ha_scripts>ps -ef | grep k2
    root  839704 1077348   2 14:34:20  pts/1  0:00 grep k2
root@fnl41:/opt/FileNet/ha_scripts>./cse_mon.sh
root@fnl41:/opt/FileNet/ha_scripts>echo $?
1
```

Example 10-7 on page 244 shows the K2 processes starting after issuing the start script. We can verify if all the processes have successfully started using the **ps -ef | grep k2** command.

Example 10-7 Run start script

```
root@fnl41:/opt/FileNet/ha_scripts>./cse_start.sh
Checking if the CE filestore is mounted ...
fnl45.svl.ibm.com /CEFileStore     /opt/FileNet/FileStore nfs3   Oct 09
14:13 bg,soft,intr,sec=sys,ro
Starting Content Search Engine .....
SUCCESS: Created with process ID: 897094
         Please use the k2adminstop script to terminate process
Using CATALINA_BASE:   /opt/verity/appserver
Using CATALINA_HOME:   /opt/verity/appserver
Using CATALINA_TMPDIR: /opt/verity/appserver/temp
Using JAVA_HOME:       /usr/java5_64

root@fnl41:/opt/FileNet/ha_scripts>ps -ef | grep k2
   k2usr  532550  897094   0 14:34:48  pts/1  0:00
/opt/verity/k2/_rs6k43/bin/k2server -ualias _docserver
    root  622696 1077348   2 14:35:04  pts/1  0:00 grep k2
   k2usr  835684  897094   0 14:34:50  pts/1  0:00
/opt/verity/k2/_rs6k43/bin/k2ticket -ualias k2cse_TicketServer
   k2usr  839720  897094   0 14:34:49  pts/1  0:00
/opt/verity/k2/_rs6k43/bin/k2broker -ualias k2cse_BrokerServer
   k2usr  897094       1   1 14:34:43  pts/1  0:00
/opt/verity/k2/_rs6k43/bin/k2admin
   k2usr  925788  897094   3 14:34:50  pts/1  0:00
/opt/verity/k2/_rs6k43/bin/k2spider_srv -controller -port 9800 -recover
-workpath /opt/verity/data/host/spider
   k2usr  954590  897094   0 14:34:52  pts/1  0:00
/opt/verity/k2/_rs6k43/bin/k2index -ualias k2cse_IndexServer
   k2usr 1064982       1 309 14:34:47  pts/1  0:21 /usr/java5_64/bin/java
-Dverity.configuration=/opt/verity/k2/common/verity.cfg
-DVERITY_VCOMPONENTS_CONFIG=/opt/verity/k2/vcomponents/config -Xmx1g
-Xms1024M -Xmx1024M
-Djava.endorsed.dirs=/opt/verity/appserver/common/endorsed -classpath
/usr/java5_64/lib/tools.jar:/opt/verity/appserver/bin/bootstrap.jar:/opt/ve
rity/appserver/bin/commons-logging-api.jar
-Dcatalina.base=/opt/verity/appserver -Dcatalina.home=/opt/verity/appserver
-Djava.io.tmpdir=/opt/verity/appserver/temp
org.apache.catalina.startup.Bootstrap start
   k2usr 1069162  897094   1 14:34:51  pts/1  0:00
/opt/verity/k2/_rs6k43/bin/k2server -ualias k2cse_SearchServer
```

The catalina servlet container component of the CSE application runs the K2 Dashboard application. Catalina can be stopped and started independently of the K2 servers and is not required to be up and running to service CE indexing and retrieval operations. Therefore, the K2 Dashboard is not considered a critical process that needs to be highly available. If this process is down, HACMP logs the error, but it does not restart it.

Example 10-8 shows the catalina process running on the active node of the cluster.

Example 10-8 Catalina process

```
$ ps -ef | grep catalina
k2usr  839682       1  /usr/java5_64/bin/java
-Dverity.configuration=/opt/verity/k2/common/verity.cfg -
DVERITY_VCOMPONENTS_CONFIG=/opt/verity/k2/vcomponents/config -Xmx1g
-Xms1024M -Xmx1024M -
Djava.endorsed.dirs=/opt/verity/appserver/common/endorsed -classpath
/usr/java5_64/lib/tools.jar:/opt/verity/appserver/bin/bootstrap.jar:/opt/ve
rity/appserver/bin/commons-logging-api.jar -
Dcatalina.base=/opt/verity/appserver -Dcatalina.home=/opt/verity/appserver
-Djava.io.tmpdir=/opt/verity/appserver/temp
org.apache.catalina.startup.Bootstrap start
```

You can stop and start the K2 Dashboard (as k2usr) using the following commands:

```
$ /opt/verity/appserver/bin/catalina.sh stop
$ /opt/verity/appserver/bin/catalina.sh start
```

Figure 10-7 on page 246 illustrates a successful logon to the K2 Application Server (K2 Dashboard) after running the **`catalina.sh start`** command.

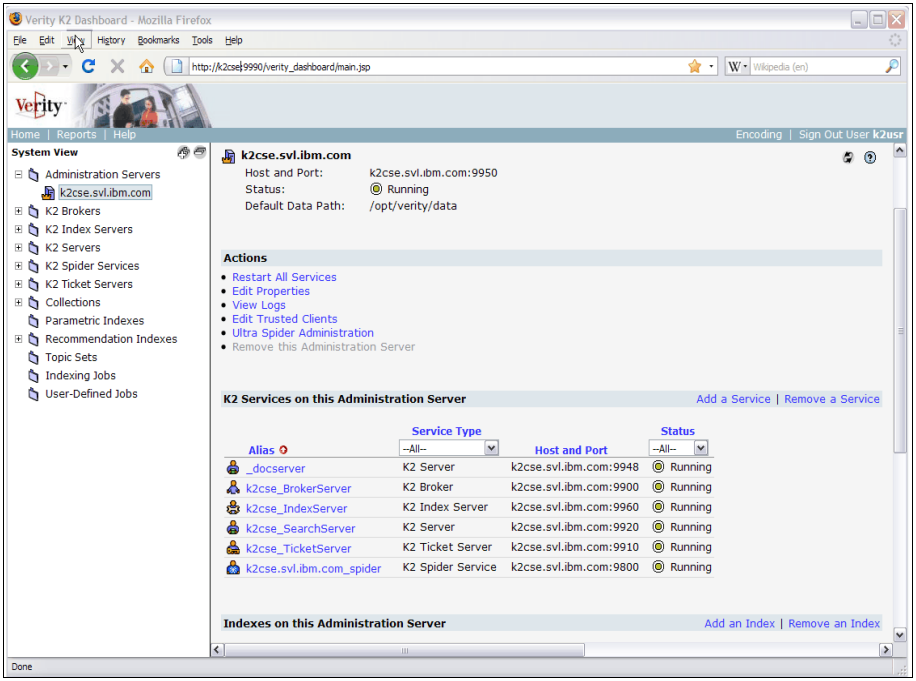


Figure 10-7 K2 Services in the Running state

2. Create a new HACMP resource group with the configuration attributes as shown in bold in Example 10-9.

Example 10-9 HACMP resource group

```
root@fnl41:/root> clshowres

Resource Group Name                                 cse_rg
Participating Node Name(s)                          fnl41 fnl42
Startup Policy                                      Online On First
Available Node
Fallover Policy                                     Fallover To Next
Priority Node In The List
Fallback Policy                                     Never Fallback
Site Relationship                                   ignore
Dynamic Node Priority
Service IP Label                                    k2cse
Filesystems                                         ALL
Filesystems Consistency Check                       fsck
Filesystems Recovery Method                         sequential
Filesystems/Directories to be exported (NFSv2/NFSv3) /opt/verity/tmp
Filesystems/Directories to be exported (NFSv4)
Filesystems to be NFS mounted
```

```
Network For NFS Mount
Filesystem/Directory for NFSv4 Stable Storage
Volume Groups                                          csevg
Concurrent Volume Groups
Use forced varyon for volume groups, if necessary      false
Disks
GMVG Replicated Resources
GMD Replicated Resources
PPRC Replicated Resources
ERCMF Replicated Resources
SVC PPRC Replicated Resources
Connections Services
Fast Connect Services
Shared Tape Resources
Application Servers                                    cse_app_srv
Highly Available Communication Links
Primary Workload Manager Class
Secondary Workload Manager Class
Delayed Fallback Timer
Miscellaneous Data
Automatically Import Volume Groups                     false
Inactive Takeover
SSA Disk Fencing                                       false
Filesystems mounted before IP configured               true
WPAR Name
Run Time Parameters:
Node Name                                              fnl41
Debug Level                                            high
Format for hacmp.out                                   Standard
Node Name                                              fnl42
Debug Level                                            high
Format for hacmp.out                                   Standard
```

3. Configure the `/opt/verity/tmp` directory as an exported file system.

   The temporary directory has to be accessed by all of the Content Engine Servers in the farm. This file system is exported through NFS when HACMP brings the resource online. Each Content Engine server requires that this file system is added to its `/etc/filesystems` file so that it is mounted at boot time.

   Example:

```
root@fnl41:> exportfs
/opt/verity/tmp
-sec=sys:krb5p:krb5i:krb5:dh,rw,access=fnl10:fnl11:p8ce,root=fnl10:f
nl11:p8ce
```

Note: HACMP exports `/opt/verity/tmp` and grants read-write access for root to all of the Content Engine Servers in the farm.

4. Both the active and passive nodes of the CSE cluster need to have the Content Engine FileStore directory added to their respective `/etc/filesystems` file. If you use filestores, it is mandatory that this file system is mounted in order for CSE indexing and searching operations to work properly. Otherwise, search operations will succeed and return references to documents, but you will not be able to retrieve the documents to which they refer. This file system is mounted at boot time and therefore is not an HACMP resource. The HACMP start script for the K2 application checks to determine if the `/opt/FileNet/FileStore` NFS is mounted before starting the application. If the file system is not mounted, an error is logged, and HACMP does not attempt to start the application. In this scenario, operator intervention is required to investigate the problem, get the file system mounted, and manually bring the resource (cse_app_srv) online.

   Example of the `/etc/filesystems` entry for CSE active and passive nodes:

```
/opt/FileNet/FileStore:
        dev             = /CEFileStore
        vfs             = nfs
        nodename        = fnl45.svl.ibm.com
        mount           = true
        options         = bg,soft,intr,sec=sys,ro
        account         = false

root@fnl41:> df -k|grep FileNet
fnl45.svl.ibm.com:/CEFileStore
15859712 15569860  2% 13877 1%  /opt/FileNet/FileStore
```

10.4.4 Configure an HACMP application server for CSE

Perform these steps to configure an HACMP application server for CSE:

1. Create an HACMP Application Server resource.

   This resource places the CSE software under the control of HACMP. HACMP is responsible for the stopping, starting, and monitoring of the application. The HACMP's Custom Application Monitor provides detailed configuration information about how HACMP monitors the health of the application and what automatic actions will be initiated if the resource is determined to be offline. If HACMP detects that the CSE software is down, the desired behavior is to restart the CSE on the same node. Assuming all other resources are online, a full resource group failover to the passive node is not necessary.

Create an application server called “cse_app_srv” for the Content Search Engine. A custom application monitor, cse_app_mon, is also required. This monitor uses a custom shell script to monitor the critical K2 processes.

Figure 10-8 shows the CSE HACMP Application Server attributes that are configured in the AIX System Management Interface Tool (SMIT).

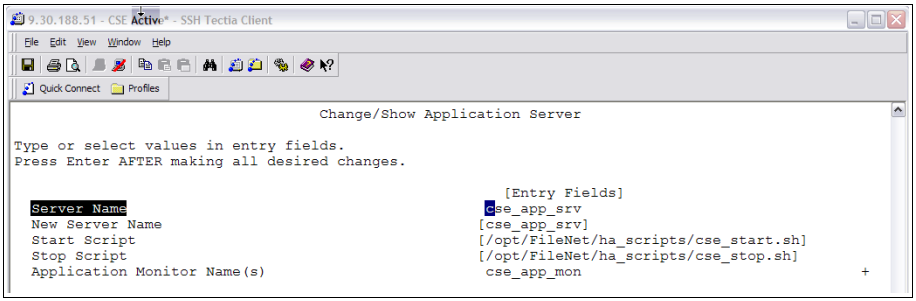


Figure 10-8 Application server configuration for Content Search Engine

Figure 10-9 shows the CSE HACMP custom application monitor attributes configured in the AIX System Management Interface Tool.

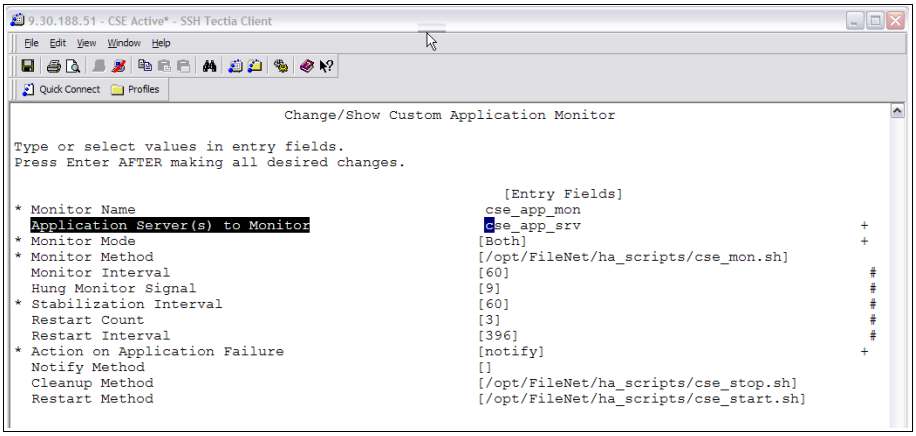


Figure 10-9 Custom Application Monitor for the Content Search Engine

After the application server and application monitor resources are created, a basic working cluster configuration is in place.

2. Run the **cldisp** command to validate the application and topology settings as shown in Example 10-10 on page 250.

Example 10-10 Validate application and topology settings

```
root@fnl41:/root>cldisp

Cluster: cse
   Cluster services: active
   State of cluster: up
      Substate: stable

#############
APPLICATIONS
#############
   Cluster cse provides the following applications: cse_app_srv
      Application: cse_app_srv
         cse_app_srv is started by /opt/FileNet/ha_scripts/cse_start.sh
         cse_app_srv is stopped by /opt/FileNet/ha_scripts/cse_stop.sh
         Application monitor of cse_app_srv: cse_app_mon
            Monitor name: cse_app_mon
               Type: custom
               Monitor method: user
               Monitor interval: 60 seconds
               Hung monitor signal: 9
               Stabilization interval: 60 seconds
               Retry count: 3 tries
               Restart interval: 396 seconds
               Failure action: notify
               Notify method:
               Cleanup method: /opt/FileNet/ha_scripts/cse_stop.sh
               Restart method: /opt/FileNet/ha_scripts/cse_start.sh
         This application is part of resource group 'cse_rg'.
            Resource group policies:
               Startup: on first available node
               Fallover: to next priority node in the list
               Fallback: never
            State of cse_app_srv: online
            Nodes configured to provide cse_app_srv: fnl41 {up}  fnl42 {up}
               Node currently providing cse_app_srv: fnl41 {up}
               The node that will provide cse_app_srv if fnl41 fails is: fnl42
            Resources associated with cse_app_srv:
               Service Labels
                  k2cse(9.30.188.77) {online}
                     Interfaces configured to provide k2cse:
                        fnl41-bt1 {up}
                           with IP address: 10.10.10.51
                           on interface: en2
                           on node: fnl41 {up}
                           on network: net_pub_1 {up}
                        fnl42-bt1 {up}
                           with IP address: 10.10.10.52
                           on interface: en2
                           on node: fnl42 {up}
                           on network: net_pub_1 {up}
               Shared Volume Groups:
                  csevg
```

```
#############
TOPOLOGY
#############
   cse consists of the following nodes: fnl41 fnl42
      fnl41
         Network interfaces:
            fnl41_vpath0_01 {up}
               device: /dev/vpath0
               on network: net_diskhb_01 {up}
            fnl41-hs03 {up}
               with IP address: 10.0.3.51
               on interface: en3
               on network: net_priv_1 {up}
            fnl41-bt1 {up}
               with IP address: 10.10.10.51
               on interface: en2
               on network: net_pub_1 {up}
      fnl42
         Network interfaces:
            fnl42_vpath0_01 {up}
               device: /dev/vpath0
               on network: net_diskhb_01 {up}
            fnl42-hs03 {up}
               with IP address: 10.0.3.52
               on interface: en3
               on network: net_priv_1 {up}
            fnl42-bt1 {up}
               with IP address: 10.10.10.52
               on interface: en2
               on network: net_pub_1 {up}
root@fnl41:/root>
```

3. Configure HACMP File Collection to keep the CSE user profiles and application scripts synchronized across the active/passive nodes:

   - /home/k2usr/.profile
   - /home/k2sec/.profile
   - /opt/FileNet/ha_scripts/cse_start.sh
   - /opt/FileNet/ha_scripts/cse_stop.sh
   - /opt/FileNet/ha_scripts/cse_mon.sh

   Figure 10-10 on page 252 shows the file collection settings for the CSE custom scripts.

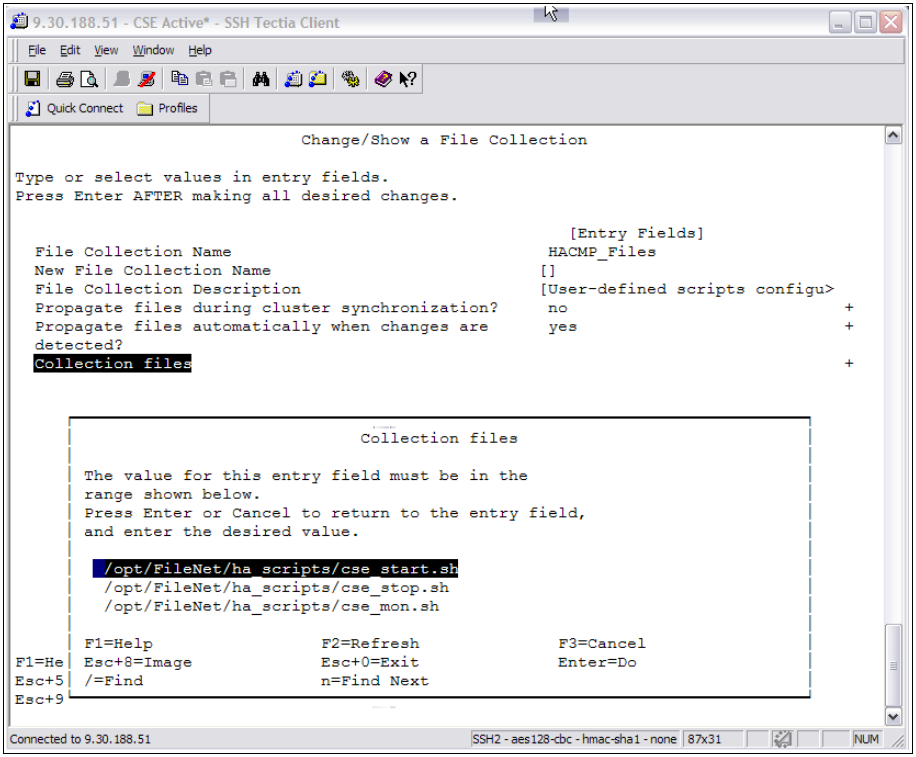


Figure 10-10 File collection settings for CSE cluster scripts

Figure 10-11 on page 253 shows the file collection settings for the K2 users.

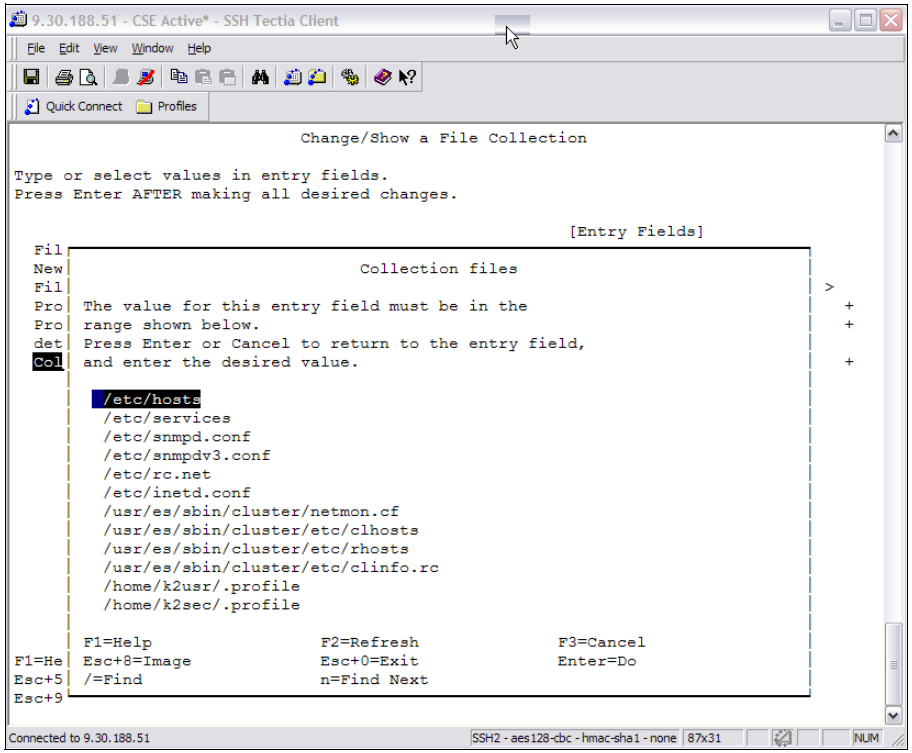


Figure 10-11 File collection configuration for the Autonomy K2 user profiles

10.4.5 Updating the Content Engine Server farm

In a highly available Content Engine farm, only one server at a time can be selected to work the content-based retrieval (CBR) dispatcher queue. This process runs as a background thread within the CE Java 2 Platform, Enterprise Edition (J2EE) application. This component is responsible for submitting index requests to the K2 domain for processing. The Enable Dispatcher property must be set for one of the Content Engine servers using the IBM FileNet Enterprise Manager. The remaining CE servers in the farm must have this property disabled.

If the CE hosting the K2 CBR dispatcher queue fails and cannot restart, another server in the farm must be manually reconfigured to resume operations (for versions prior to Version 4.5). In this situation, the administrator enables the CBR dispatcher queue on one of the surviving CEs in the farm. After the CE is enabled, the ongoing batch indexing operations resume automatically. If an administrator submitted a manual index job earlier, the manual operation will not resume after the CE is enabled. The administrator has to manually delete these

jobs from the Index jobs list control and resubmit them after the dispatcher queue is up and running again.

For pre-4.0.1-004 versions of the Content Engine, the CBR dispatcher represents a single point of failure (SPOF) requiring manual intervention after the hosting CE fails. Starting from Version 4.0.1, index jobs automatically recover. Starting from Version 4.5, the dispatcher automatically starts on another working Content Engine server. The Content Engine picks one of the CBR-enabled servers that is up and running to perform the dispatcher function.

See the “Configure CBR” section of ECM Help and the *P8 Platform Installation Guide* for detailed procedures about how to configure and enable CBR. All of the P8 product documentation can be found at the following Web site:

http://www.ibm.com/support/docview.wss?rs=3278&uid=swg27010422

Before configuring content-based retrieval within IBM FileNet Enterprise Manager, validate that each Content Engine server has a supported version of the P8CSE client installed. Also, ensure that all CE servers in the farm have the K2 `temp` directory mounted. Add this NFS mount to the `/etc/filesystems` file on each Content Engine server.

Perform these steps to update the CE servers:

1. Add the remote K2 `temp` directory on each Content Engine server to `/etc/filesystems`.

   The following example shows our filesystems file content:

```
root@fnl10[/root] tail /etc/filesystems
   /opt/verity/tmp:
           dev             = "/opt/verity/tmp"
           vfs             = nfs
           nodename        = k2cse
           mount           = true
           type            = verity
           options         = bg,soft,intr,sec=sys
           account         = false

root@fnl10[/root] df -k|grep verity
k2cse:/opt/verity/tmp   2097152 2096468   1%   14   1%   /opt/verity/tmp
```

2. Configure the K2 domain configuration information in IBM FileNet Enterprise Manager.

   Use the virtual name of the CSE cluster when specifying the Hostname for the K2 Master Admin Server Information.

Figure 10-12 shows our setup information. The `k2usr` account is used for the K2 Username.

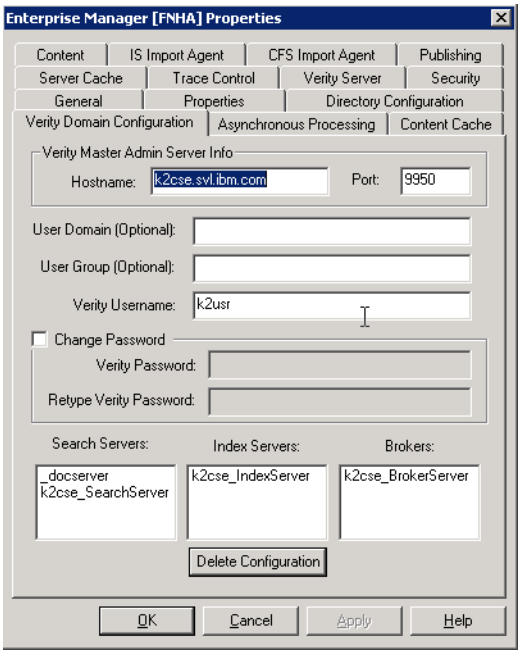


Figure 10-12 K2 Domain Configuration pointing to the virtual name of CSE cluster

3. From the K2 Server tab, select the Broker that is created during the K2 installation. Figure 10-13 on page 256 also shows that the Enable Dispatcher option is selected by default.

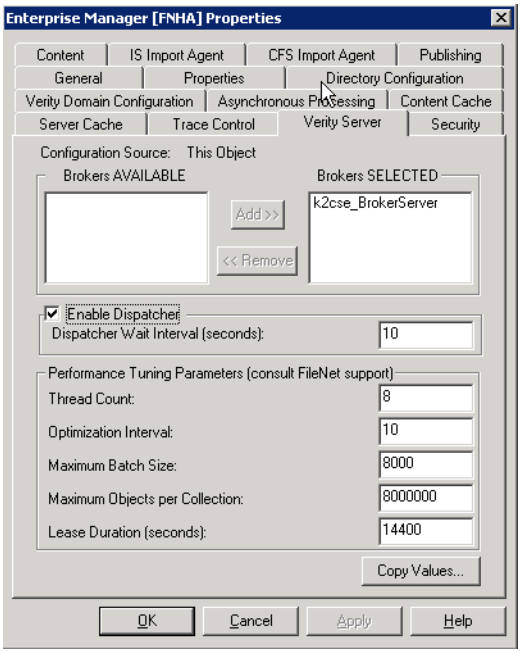


Figure 10-13 Select the configured Broker

4. Because the K2 Dispatcher can only run on one Content Engine at a time, it must be disabled at the server level for all remaining servers in the farm. Figure 10-14 on page 257 shows that server2 does not have the Enable Dispatcher option selected. You must clear the check mark from the “Override inherited settings” check box before you can deselect Enable Dispatcher. Therefore, only one CE server runs the K2 Dispatcher process.

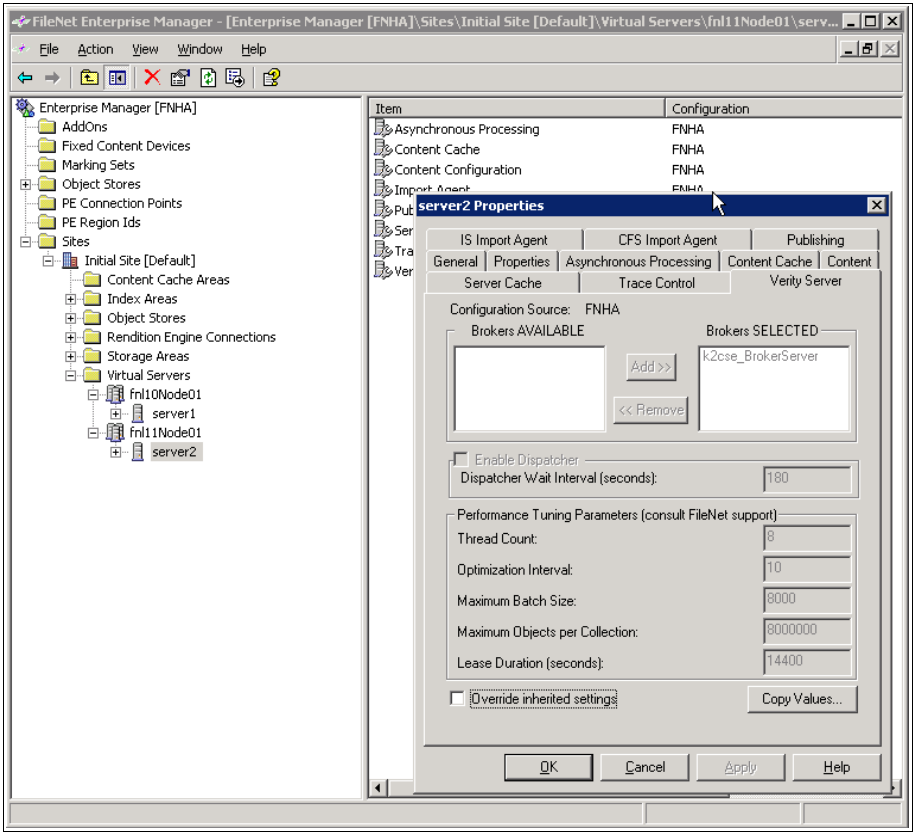


Figure 10-14 K2 Dispatcher disabled on all other CE servers

If the K2 Dispatcher is enabled on more than one CE server in the CE farm and you use a version prior to 4.5, the following error is logged in the P8 CE server log:

```
2008-09-23T12:27:56.305Z 5BB85BB8 CBR  - ERROR The CBR dispatcher was
not started for full text indexing because it is enabled for more than
one server on site 'Initial Site'.  Disable the CBR dispatcher for all
but one server, and then restart all Content Engine and Content Search
Engine servers
```

If you use Version 4.5, this error message does not occur, because the dispatcher is auto-assigned.

If the CE farm is configured properly, with only one server, running the K2 Dispatcher, the following messages are logged in the CE server log file when running the Dispatcher:

```
2008-10-10T00:48:01.462Z 4E3C4E3C CSTG - INFO ContentQueueDispatcher
[FNOS] Session Id={BB811FC1-3ECA-4C9D-8BF1-1BF7BC713739}

2008-10-10T00:48:01.489Z 567F567F CBR  - INFO Starting CBR queue
dispatching for FNOS
```

Important: If the CE server that is running the K2 Dispatcher process (ContentQueueDispatcher) fails and is unable to be brought back online, this service must be manually reconfigured to run one of the surviving CE servers in the farm. Use IBM FileNet Enterprise Manager, and select the Enable Dispatcher option at the server level for one of the surviving CE servers. Be sure to disable the Dispatcher option at the server level on the failed node.

For Version 4.5, the system automatically fails over the K2 Dispatcher queue from a failed node to a working server in the CE farm. No manual reconfiguration is required.

10.4.6 Configuring document classes and properties for CBR

Before users can perform content-based searches, you must use the FileNet Enterprise Manager to configure the individual CE object store components for content-based retrieval. Each object store that is configured to support CBR requires the creation of full-text indexes. A CE full-text index area is represented by an IndexArea object in the CE database and contains the name of the file system that is used to hold the full text indexing data. The CBR Enabled option for the class definitions and property templates is grayed out until an Index Area is created. See Figure 10-15 on page 259.

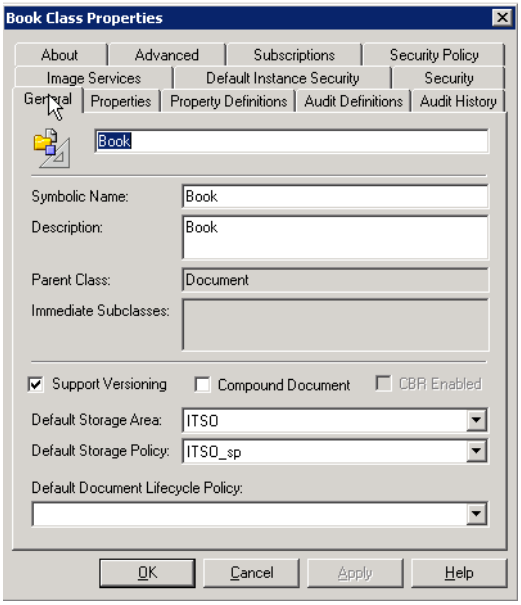


Figure 10-15 Unable to select the CBR Enabled property

For detailed information about creating index areas and configuring CBR, see the *IBM P8 Platform Installation and Upgrade Guide* and ECM Help.

For our case study, we use the following procedures to create an index area and configure CBR for a Document Class:

1. Set the object store Default Locale to **en-us** (English) as shown in Figure 10-16 on page 260.

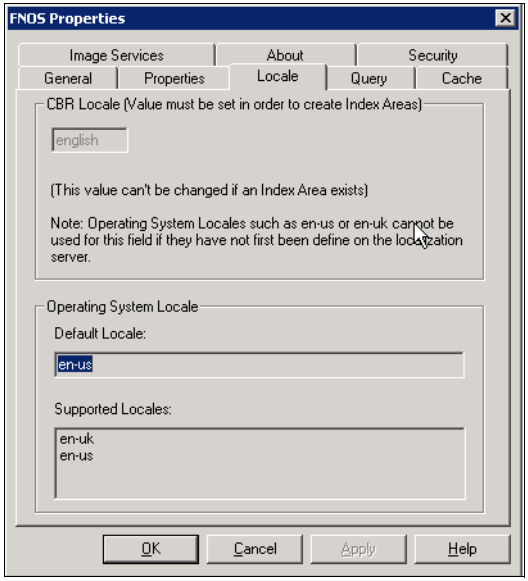


Figure 10-16 CBR Locale for the FileNet operating system (FNOS) object store

Figure 10-17 shows the error that is returned if you attempt to create a new Index Area before setting the default locale.

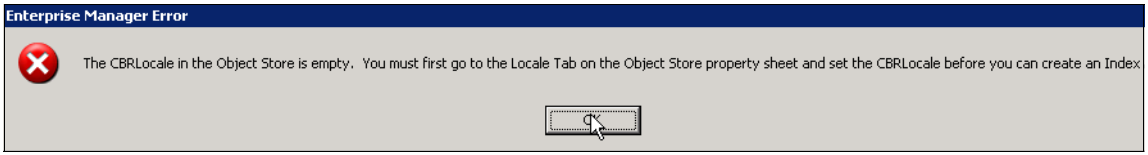


Figure 10-17 Error returned if default locale is not set

2. Create a new Index Area.

   From IBM FileNet Enterprise Manager:

   a. Select **Sites** → **Index Areas** → **New Index Area** (see Figure 10-18 on page 261).

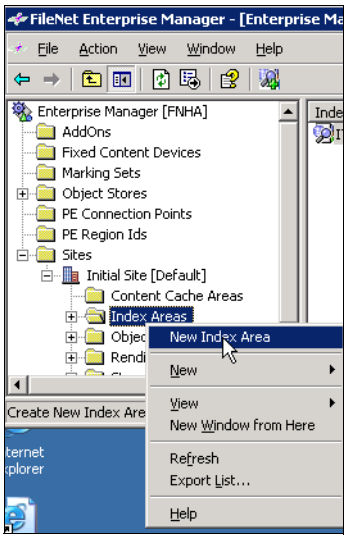


Figure 10-18 Creating a new index area

b. Fill in the properties for the new index area (Figure 10-19).

   The File system root directory is the collections directory (on the CSE cluster) that is created for this Index Area. The temporary directory is the NFS mount from the CE to the CSE that is created in 10.4.5, “Updating the Content Engine Server farm” on page 253.

c. In Figure 10-19, click **Create Index Area**.

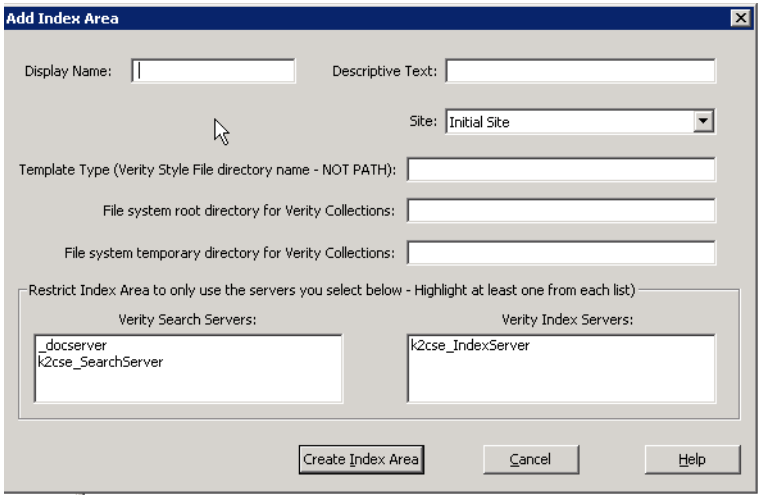


Figure 10-19 Add new index area dialog box

Figure 10-20 illustrates the newly created index area. It is online and ready for use.

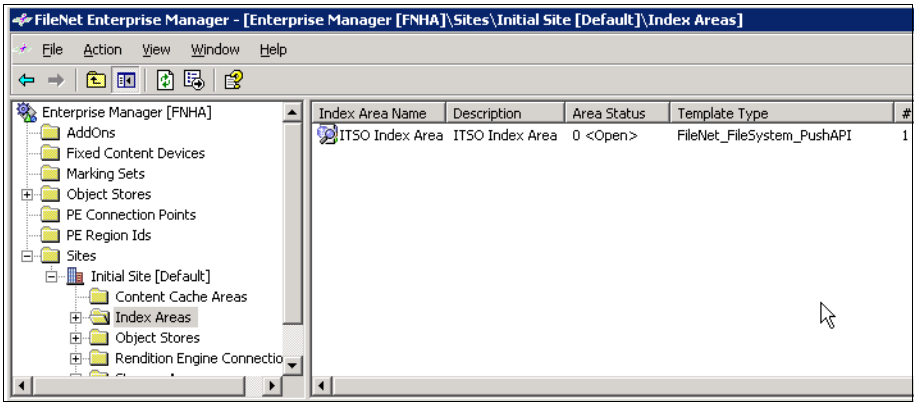


Figure 10-20 ITSO Index Area configured for the FNOS object store

Figure 10-21 shows the General attributes of the ITSO Index Area.

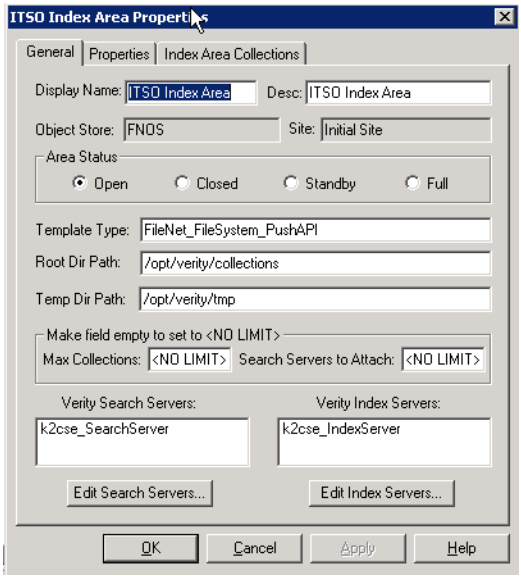


Figure 10-21 General Properties of the new index area ITSO

When the new index area is created, it connects to the CSE cluster and creates the new K2 collection. The Index Area Collections tab (Figure 10-22 on page 263) shows the name of the newly created collection.

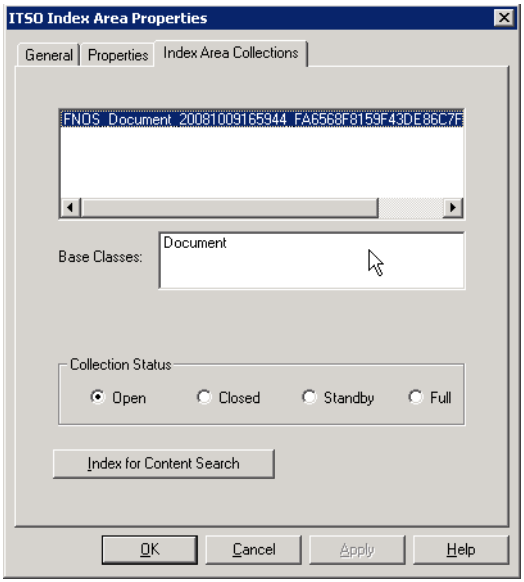


Figure 10-22 Newly created collection

Figure 10-23 on page 264 shows the newly created collection as seen from the K2 Dashboard.

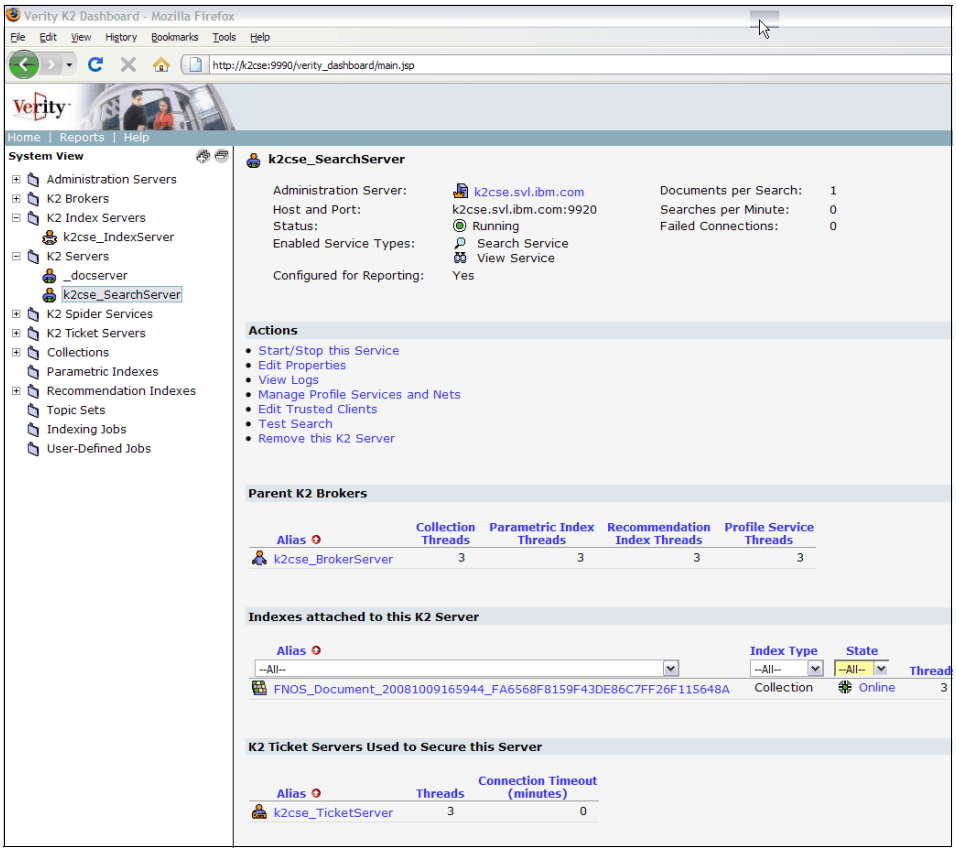


Figure 10-23 New K2 Collection (Index) as seen from the K2 Dashboard

3. Configure the classes and properties for CBR using the FileNet Enterprise Manager.

   Table 10-3 lists the objects that were configured for our case study.

   Table 10-3 Objects that were configured for CBR

Document class	Property template
Book	Document Title
	BookAuthor
	BookISBN
	BookTitle

Figure 10-24 shows the Book document class with the CBR Enabled option checked.

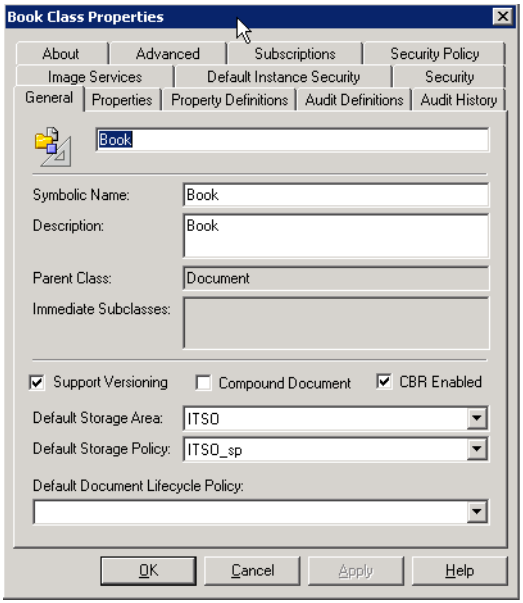


Figure 10-24 CBR-enabled document class named Book

Figure 10-25 on page 266 shows the BookAuthor property enabled for CBR on the Book document class.

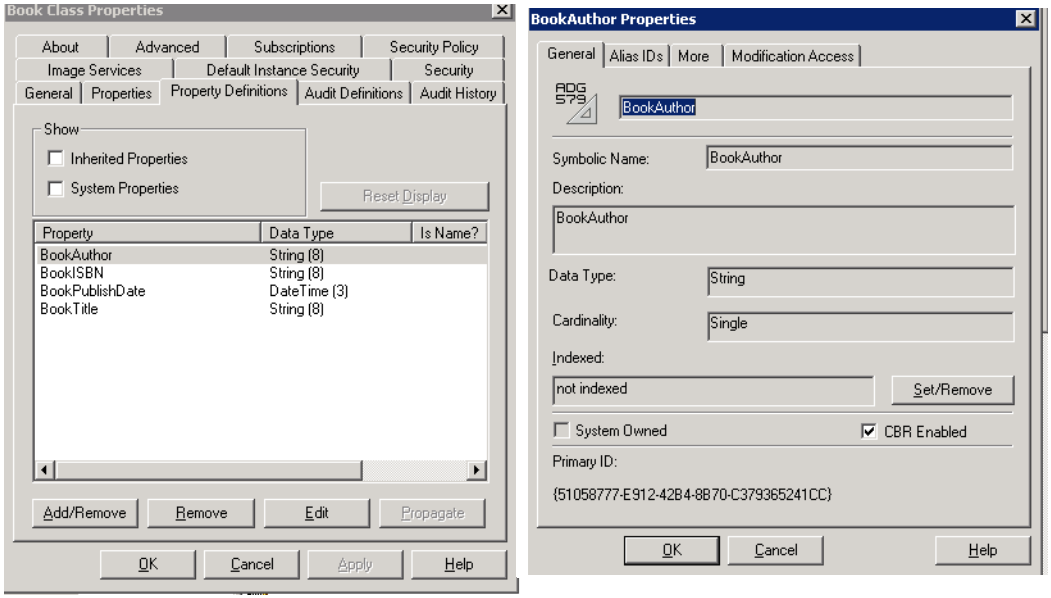


Figure 10-25 To enable Property Definitions for CBR, select the property and check CBR Enabled

After the previous steps are complete, you can add new documents to the document class, and you can validate basic indexing and searching operations.

10.4.7 Validate basic indexing and searching operations

Before performing failover testing of the CSE cluster, conduct a basic indexing and search operation to ensure that CSE works properly. A basic test consists of adding a new document from Workplace to a CBR-enabled document class, and validating that you can retrieve the document from the K2 Dashboard, Workplace, and IBM FileNet Enterprise Manager.

Follow these steps to perform a basic test:

1. Add a new document to the Book document class from Workplace:
   a. Browse to FNOS object store's CBR Docs folder (Figure 10-26 on page 267) and click **Add Document**.

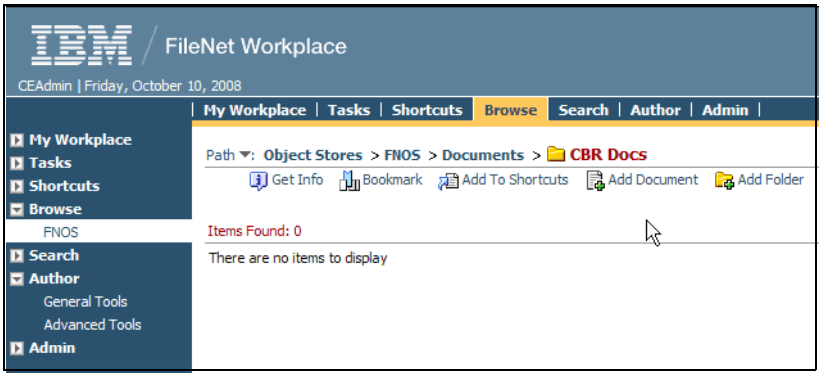


Figure 10-26 Add a new document to the CBR Docs folder

b. Select the Book document class from the FNOS object store. See Figure 10-27.

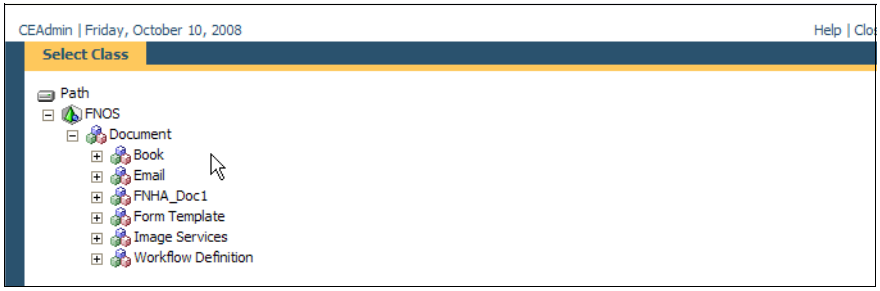


Figure 10-27 Choose the CBR-enabled Book document class

c. Fill in the property values for the new document. See Figure 10-28 on page 268.

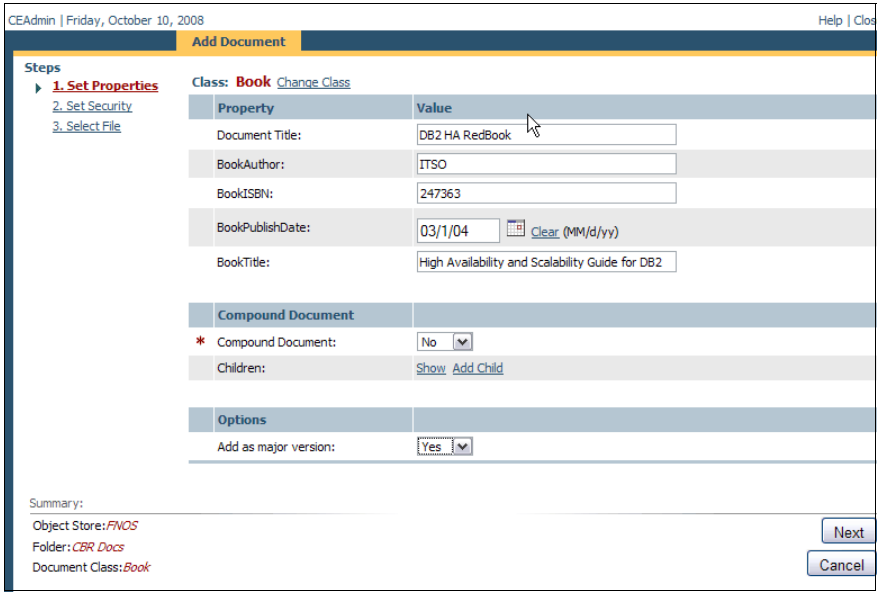


Figure 10-28 Assign the property values to the new document

Important: In order for a document to be CBR searchable, it must be a *major*-version document. Otherwise, Workplace does not display the document during a CBR search. Minor-versioned documents can be promoted to major version to make them CBR searchable.

d. Accept the default security settings. See Figure 10-29.

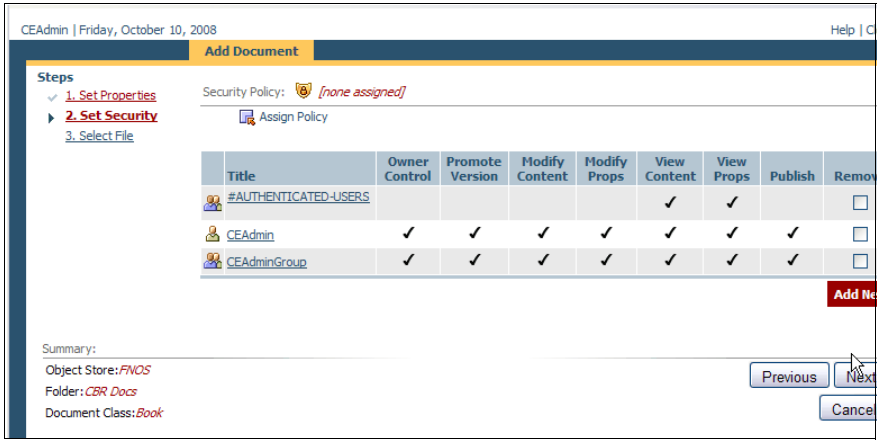


Figure 10-29 Click Next to accept the default security policy

e. Select a file to add to the Book document class. See Figure 10-30.

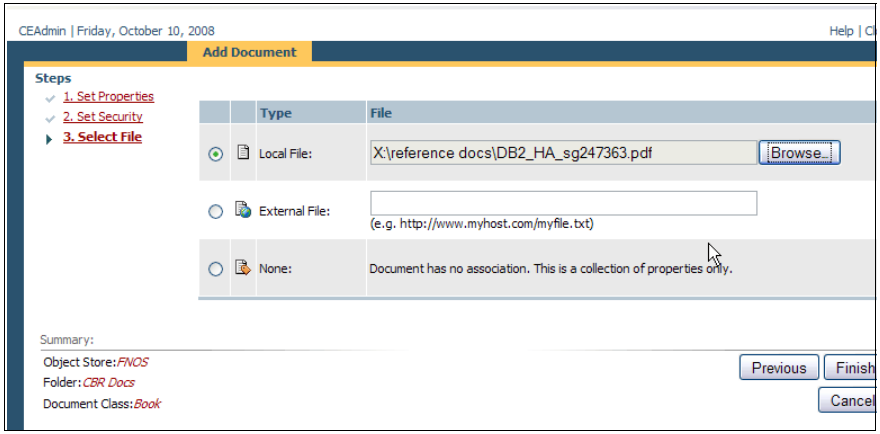


Figure 10-30 Browse to a file and click Finish to add the new document

f. Click **OK** to add the new document. See Figure 10-31.

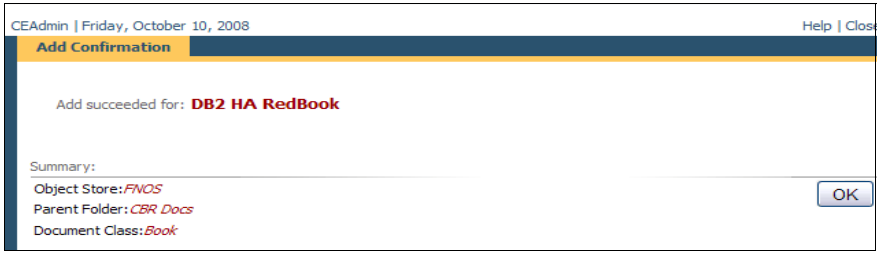


Figure 10-31 Confirm the addition of the new document

Figure 10-32 shows the newly added document

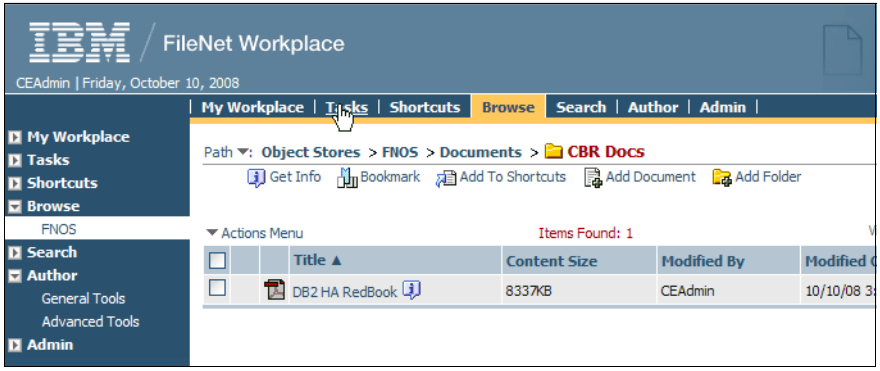


Figure 10-32 The newly added document

Figure 10-33 Shows the logging information that is produced by the K2 Dispatcher process when a CBR enabled document is added to the Content Engine. Trace logging must be enabled via FileNet Enterprise Manager.

The trace logs for our CE farm are located in:

CE1:

/usr/IBM/WebSphere/AppServer/profiles/server1/p8_server_trace_log

CE2:

/usr/IBM/WebSphere/AppServer/profiles/server2/p8_server_trace_log

```
2008-10-10T22:07:06.858Z 567F567F CBR  - Dispatching 3 indexing requests for object store FNOS in 11 msecs,
#loops=117, #executors=1
2008-10-10T22:07:06.858Z 567F567F CBR  - CBR dispatcher not waiting
2008-10-10T22:07:06.859Z 74357435 CBR  - Starting indexing
2008-10-10T22:07:06.861Z 567F567F CBR  - CBR dispatcher waiting for 10 seconds
2008-10-10T22:07:06.894Z 74357435 CBR  - CBR prepare update #1: targetId={C89EF04E-8E4D-4378-91F6-
074E6AEBA3E5}, elem seq#=0, status=NotStarted, times(msecs): startup=0, get object=15, get content
overhead=7, get content=0, get property=0, overhead2=0
2008-10-10T22:07:06.903Z 74357435 CBR  - CBR prepare update #2: targetId={C89EF04E-8E4D-4378-91F6-
074E6AEBA3E5}, elem seq#=999999999, status=NotStarted, times(msecs): startup=0, get object=0, get content
overhead=0, get content=0, get property=9, overhead2=0
```

Figure 10-33 Trace logging showing the activity of the K2 Dispatcher process

Figure 10-34 Shows the “Trace Control” tab for CE1. Check **Search** to enable tracing for all CE searches (including CBR).

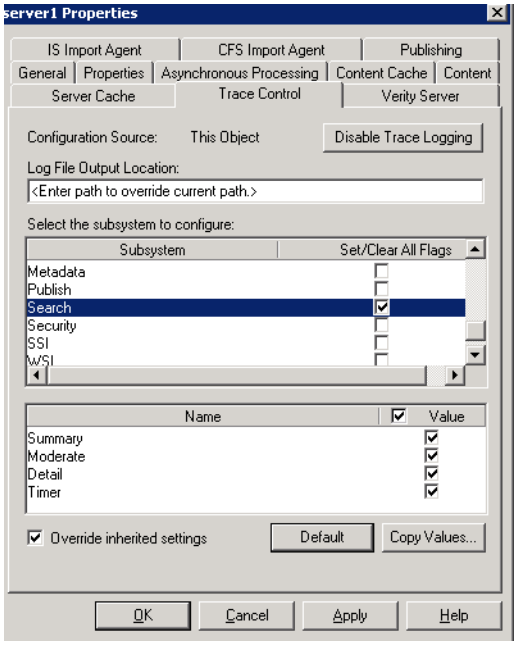


Figure 10-34 To enable tracing for CE searches, check the Search Subsystem

Figure 10-35 shows that tracing is enabled for server1 for the CBR subsystem.

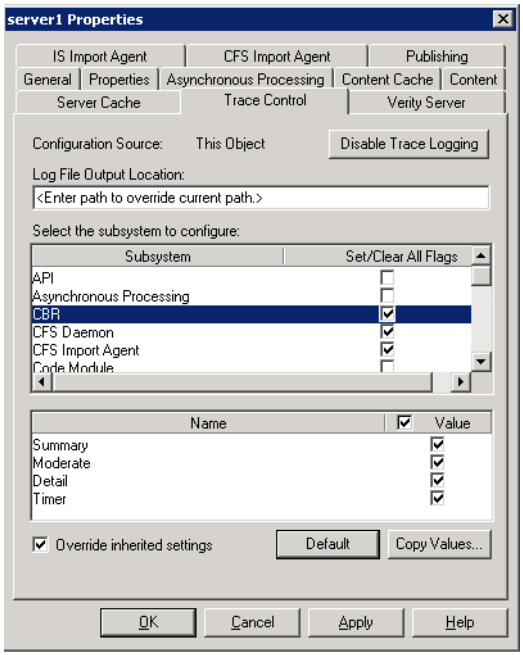


Figure 10-35 Tracing is set for the CBR, CFS Daemon, and CFS Import Agent

Figure 10-36 on page 272 shows a second document that is added to the Book document class. Note the yellow icon next to the document title. This document is not added as a major version, and therefore, it will not be returned when performing content-based retrievals. Note also that the Major Version attribute for this type of document is equal to 0. Only documents with Major Version equal to 1 will be returned when performing CBR searches from Workplace (if they satisfy the CBR search criteria).

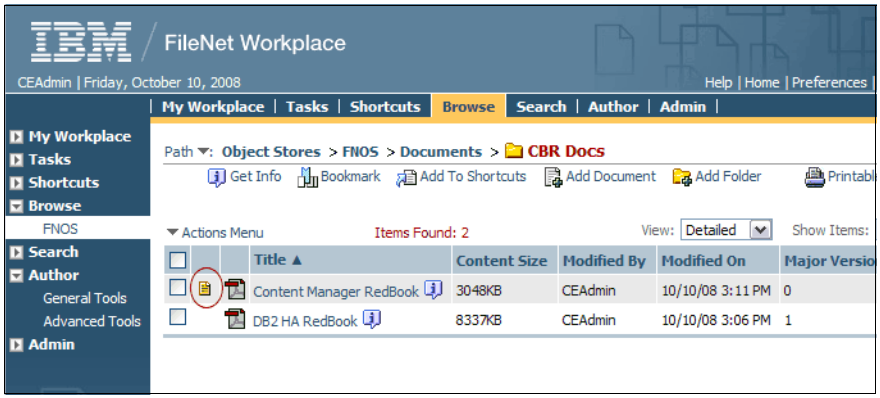


Figure 10-36 Document was not added as a major version

To promote a document version, right-click the document and select **Promote Version** from the context menu (Figure 10-37).

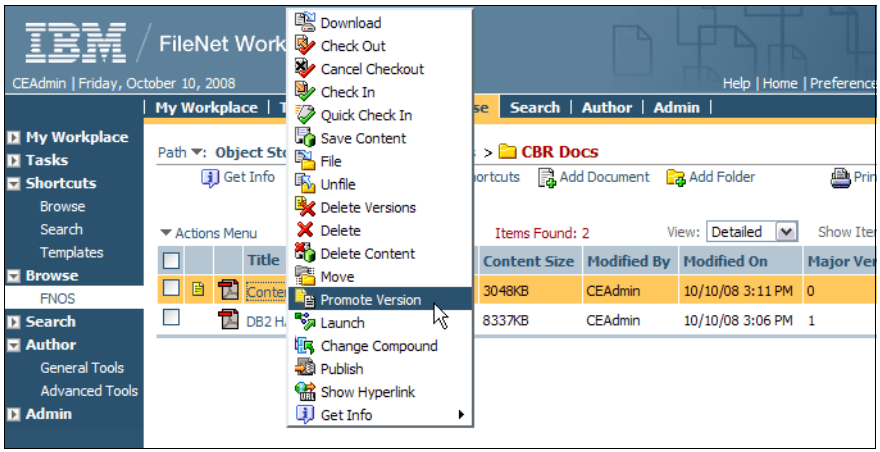


Figure 10-37 Promoting a document to major version=1

2. Use the Workplace Search Designer to create a search template for the Book document class. See ECM Help for details about how to create a new search template.

   For our case study, we create a search template called CBR ITSO Book Search3. See Figure 10-38 on page 273.

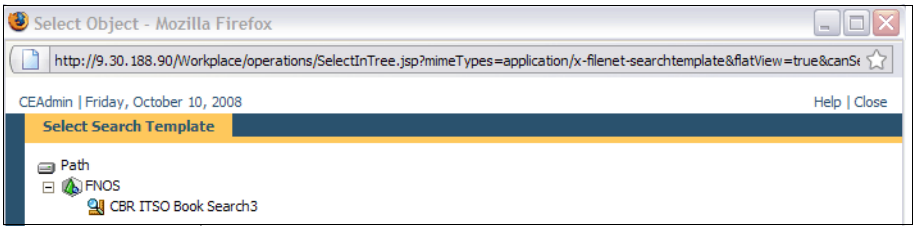


Figure 10-38 Select a search template to perform CBR searches

3. Perform a CBR search from Workplace.

   For our case study, we perform a search on the word “Insourced.” Figure 10-39 shows that the document (which we added earlier) is found.

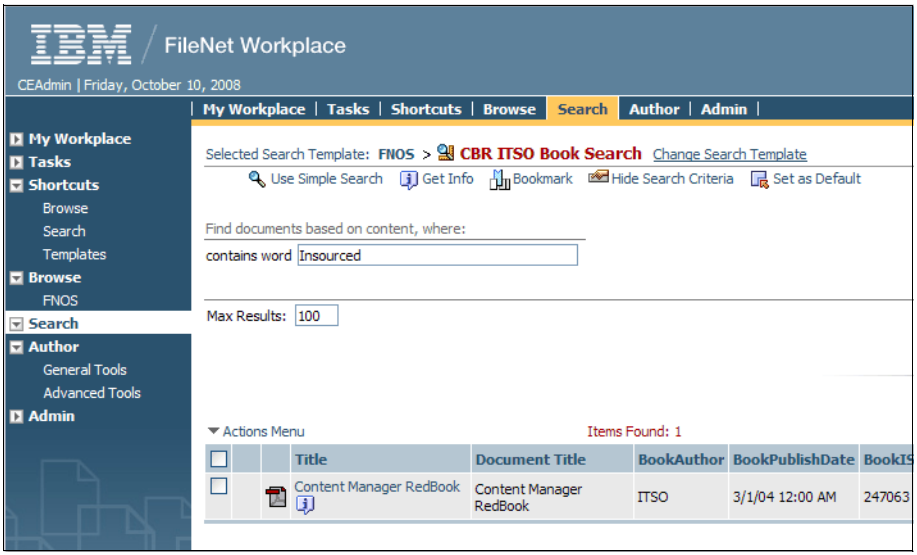


Figure 10-39 A document was found

Figure 10-40 on page 274 shows the document that is found with the searched word “Insourced” highlighted.

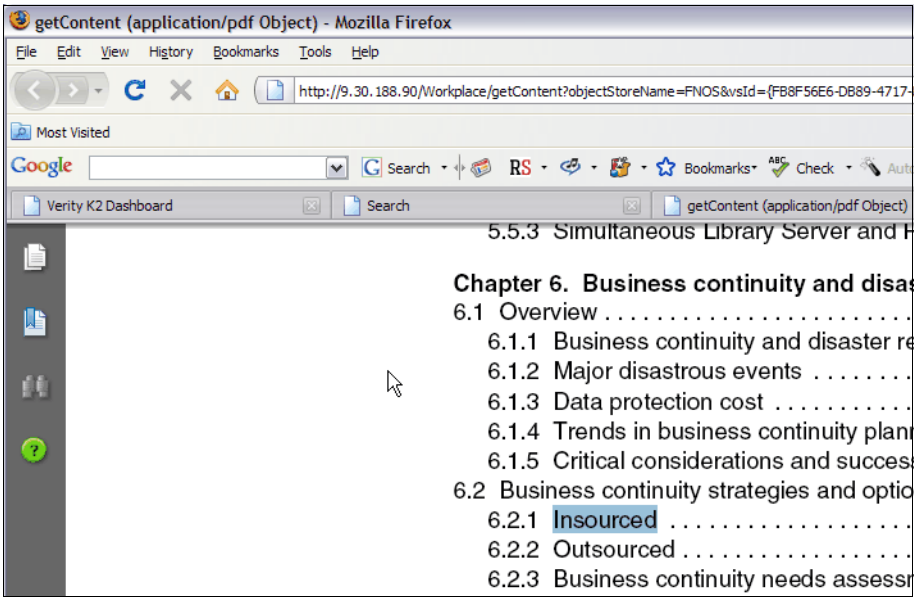


Figure 10-40 The word Insourced is found in the document

If CBR Search tracing is enabled in FileNet Enterprise Manager, all user CBR requests are logged. Figure 10-41 shows the log entries for a search on "Insourced," showing that 1 row was returned. The "where" clause on the select statement limits the results that are displayed to the user to only those results with a "VersionStatus=1."

```
2008-10-10T22:18:18.334Z 6BAD6BAD CBR  - Full text search on class Document, with search clause
'<Stem>Insourced', and property 'null', for collections:
FNOS_Document_20081009165944_FA6568F8159F43DE86C7FF26F115648A, with broker: k2cse.svl.ibm.com:9900,
DocsStart: 1, #rows returned: 1, msecs: 41
2008-10-10T22:18:18.338Z 6BAD6BAD CBR  - Object #1, Rank=1.0000,
K2DocKey='IZ1010DF93080B4EEFBE798CC687ABFDB7X0@FNOS_Document_20081009165944_FA6568F8159F43DE86C7FF26F115648A
', Summary='46 iv Content Manager Backup/Recovery and High Availability 2.6.1 Stopping Content Manager
activity . . . . . 2 Content Manager Backup/Recovery and High
Availability 1.1 Introducing Content Manager This section introduces the IBM DB2 Content Manager Version 8
product (Content Manager) and its components that are covered in this redbook as they relate to backup, high
availability, and disaster recovery.  2.1.6 Backup of Content Manager supporting ...'
2008-10-10T22:18:18.351Z 6BAD6BAD SRCH - Server query time = 65 msecs for 0 records for: 'select TOP 100
x.[DocumentTitle], x.[BookAuthor], x.[BookPublishDate], x.[BookISBN], x.[BookTitle], x.[BookPublishDate],
x.[LastModifier], x.[BookISBN], x.[BookAuthor], x.[DateLastModified], x.[Creator], x.[DocumentTitle],
x.[BookTitle], x.[ClassDescription], x.[IsCurrentVersion], x.[IsReserved], x.[MimeType], x.[VersionStatus],
x.[MajorVersionNumber], x.[MinorVersionNumber], x.[VersionSeries], x.[Id] from [document] x inner join
[contentsearch] [c] on x.this=c.queriedobject where ((contains(content,'<Stem>Insourced')) and
x.VersionStatus=1)'
```

Figure 10-41 Logging details produced in the p8_server_trace_log of a CBR search

4. You can further verify the successful addition of the new document by performing the same CBR search from the K2 Dashboard. See Figure 10-42 on page 275.

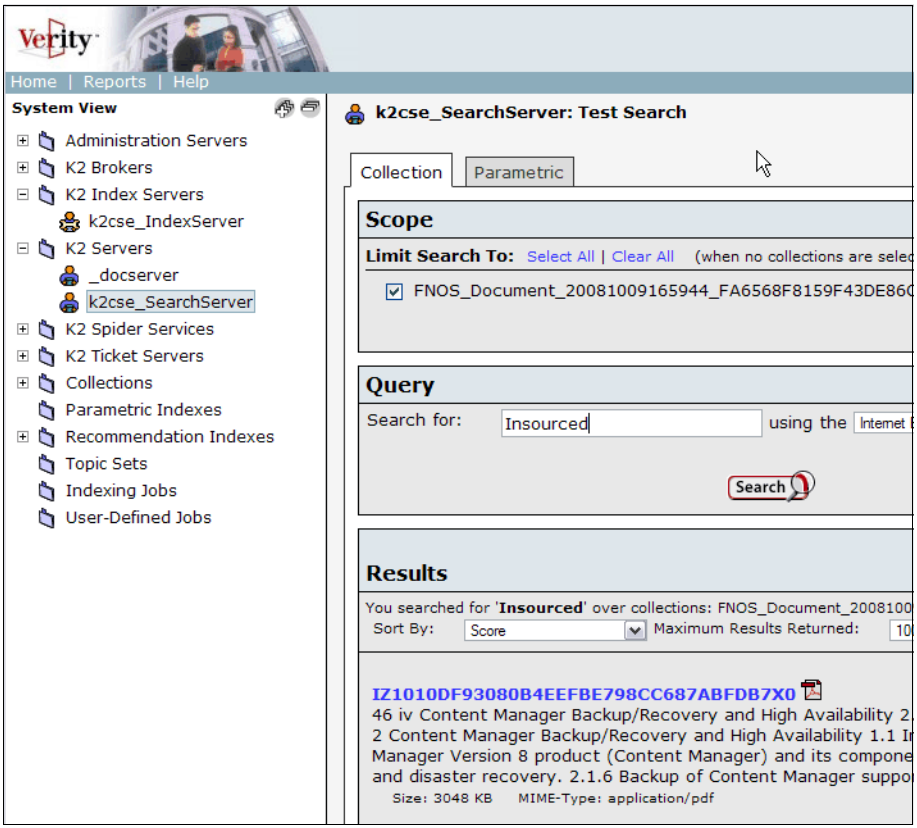


Figure 10-42 The same document search performed from the K2 Dashboard

5. You can also perform the same search from IBM FileNet Enterprise Manager (right-click the object store that you want to search and select **New** → **Search**). After the Content Engine Query Builder window is displayed, click **View** → **SQL View** menu. Figure 10-43 on page 276 shows how to use the Content Engine Query Builder search utility to build a search query.

   See the “Run CBR Query” section of ECM Help for more information about performing CBR searches within FileNet Enterprise Manager.

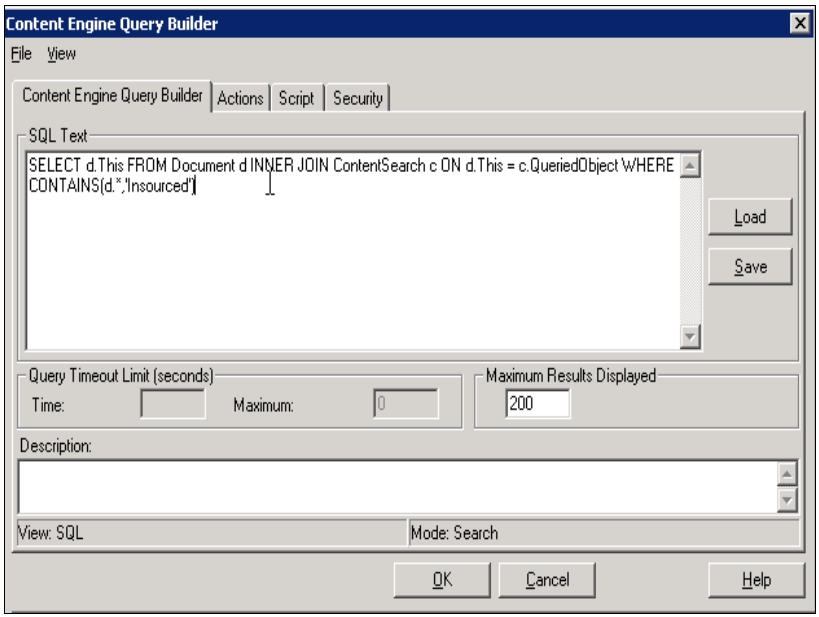


Figure 10-43 CBR search for Insourced performed in FileNet Enterprise Manager

Figure 10-44 shows that the same document is found containing the word `Insourced` in the Book document class.

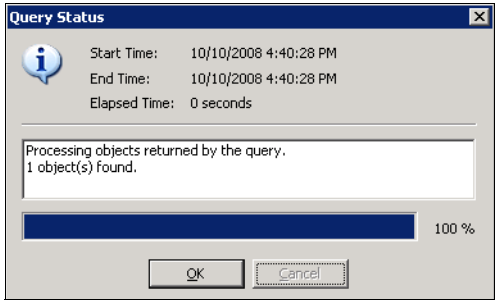


Figure 10-44 CBR Search Query Status from within FileNet Enterprise Manager

10.5 High availability tests at the CSE level

After you have validated the basic indexing and searching operations, you can perform failover testing of the CSE cluster. You can repeat the steps described in 10.4.7, “Validate basic indexing and searching operations” on page 266 after failovers to validate that the CSE services work properly. Repeated testing and

validation ensure that the highly available Content Search Engine cluster is operationally ready. The following sections give examples of how to test both the CSE cluster and CE Dispatcher Queue process.

10.5.1 CSE planned failover and failback procedures

The first test is a planned or *graceful* failover of the Content Search Engine. After the CSE cluster resources are switched over to the passive node, perform the basic indexing and search operations.

To perform graceful failover, follow these steps:

1. Use smitty to bring the CSE resource group offline on the active node (Figure 10-45).

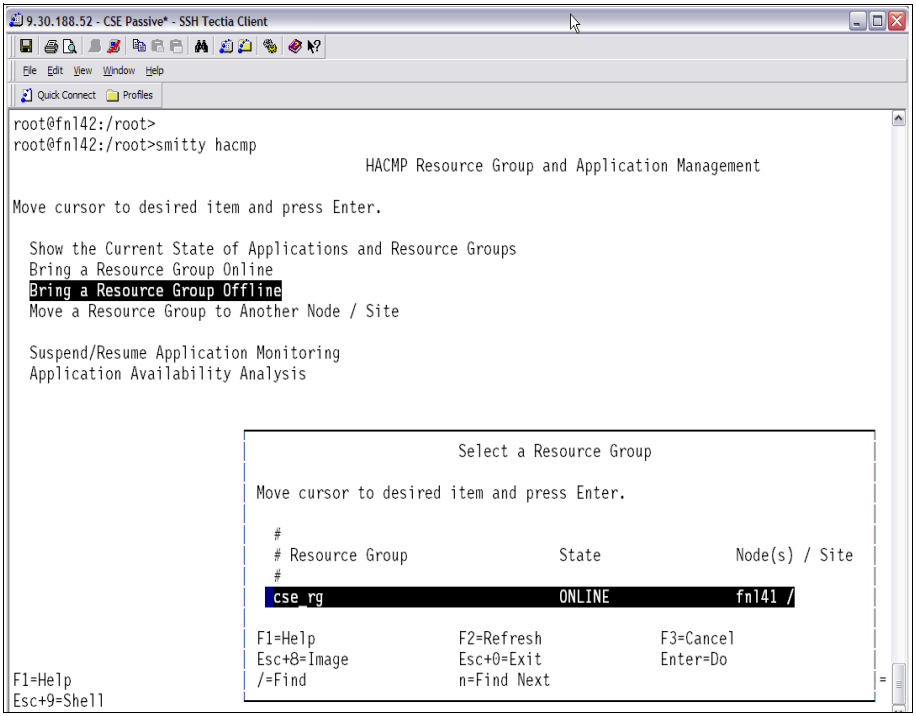


Figure 10-45 Bring the cse_rg resource group offline

2. Perform a CBR search from Workplace. Because the CSE is down, an error message appears as shown in Figure 10-46 on page 278. This error message might also display during failover within the CSE cluster.

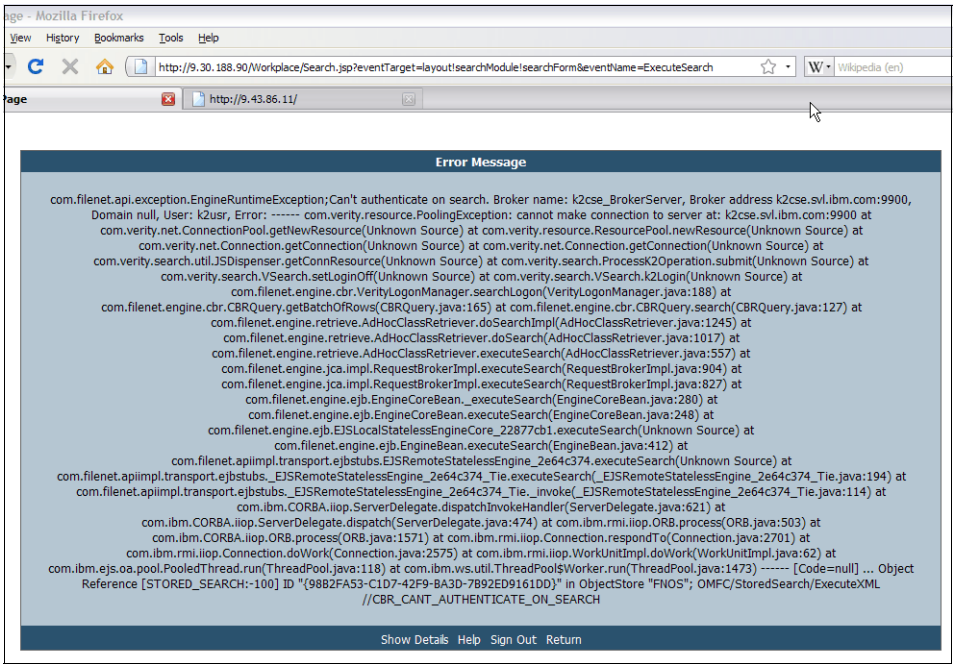


Figure 10-46 Error message when performing a CBR search while the CSE is down

3. Use smitty to bring the CSE back online on the passive node (Figure 10-47 on page 279).

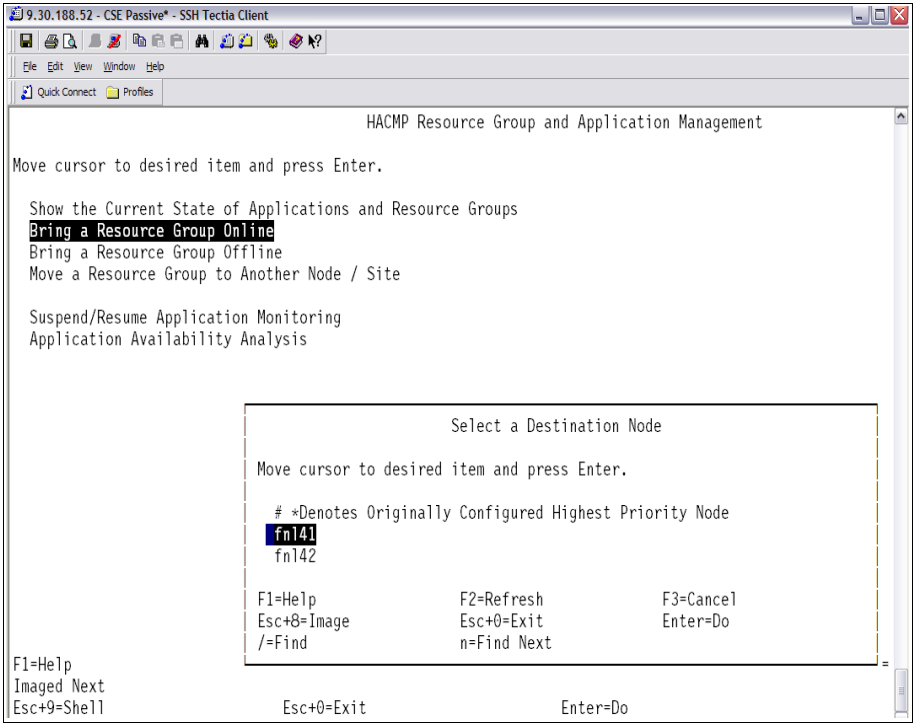


Figure 10-47 Bring the CSE resource group online on the passive node

4. After the CSE resource group is online on the passive node, perform the basic index and search operations to validate the functionality of the Content Search Engine.
5. Use smitty to fail the CSE back to the other node by clicking **Move the resource group to another Node / Site**. After this task completes, perform the basic search and index operations again.

10.5.2 CSE unplanned failover and failback procedures

Although system failures and cluster takeover tests can be simulated in a number of ways, we provide the following procedure as a starting point for your testing. Conduct an unplanned or ungraceful failure of the CSE by performing the these steps:

1. Force the shutdown of the currently active CSE node without gracefully stopping any running processes or applications:

```
# sync;sync;sync;reboot -q
```

2. After the takeover of the resource group completes, perform the basic searching and indexing operations again. Also, ensure that the rebooted node successfully joins the cluster as it comes back online.

> **Note:** The K2 Dispatcher Queue logs errors while the CSE is down. You can view these errors in the Content Engine error log.
>
> For our case study, the log file for CE1 is located in the `/usr/IBM/WebSphere/AppServer/profiles/server1/FileNet/server1/p8_server_error.log` file.

Repeated testing of both planned and unplanned failures, along with basic index and search validation, validates that the Content Search Engine runs reliably in the HACMP active/passive environment. This type of configuration protects the CSE against server failures with minimal disruption to the users.

10.5.3 Content Engine failures: K2 Dispatcher Queue

As described in 10.4.5, “Updating the Content Engine Server farm” on page 253, the K2 Dispatcher Queue can only run on a single Content Engine. Additionally, the current CE architecture does not automatically fail over the K2 Dispatcher Queue if the server running this function fails (for versions prior to Version 4.5). In this scenario, an administrator has to manually move this function to another CE in the farm by using the FileNet Enterprise Manager. Component testing needs to include moving this function to another CE in the farm, followed by the basic index and search operations. Moving the K2 Dispatcher Queue from one CE to another CE does not require restarting the CE J2EE application.

Perform the following steps to move the K2 Dispatcher Queue from one CE to another CE:

1. Open up the properties for the failed server that was running the K2 Dispatcher and clear the check mark in the Enable Dispatcher option. See Figure 10-48 on page 281.

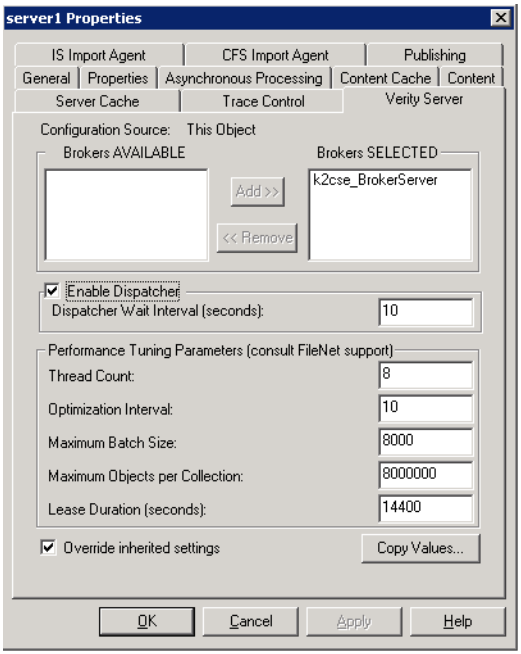


Figure 10-48 Deselect the "Enable Dispatcher" check box on the failed CE server

2. Open up the properties for one of the working CE servers in the CE farm, and enable the K2 Dispatcher Queue by selecting the Enable Dispatcher option. Depending on your inherited settings, you might have to select "Override inherited settings" first. After the K2 Dispatcher Queue thread has been enabled, check the CE error log for the following messages:

```
2008-10-08 09:34:33,312  INFO [CBRDispatcher_FNOS_#9] - Starting CBR
queue dispatching for FNOS
2008-10-08 09:34:33,314  INFO [CBRDispatcher_FNOS_#9] - FNOS
({A52594C3-3413-4DA5-B406-00F82CC6978A}) is enabled
```

3. Perform basic index and search operations to ensure that the K2 Dispatcher Queue has successfully migrated.

10.6 Troubleshooting the Content Search Engine

This section provides troubleshooting quick references (in no particular order) to use when debugging the CE and the CSE:

- The Autonomy K2 Dashboard URL launches successfully after the k2adminstart script has been run. Example:

  ```
  http://k2cse.svl.ibm.com:9990/verity_dashboard/main.jsp
  ```

- The Autonomy K2 servers (processes) log all of their activity in separate directories. Example:

  ```
  /opt/verity/data/host/log/status.log
  /opt/verity/data/services/_docserver/log/status.log
  /opt/verity/data/k2cse_IndexServer/log/status.log
  /opt/verity/data/k2cse_TicketServer/log/status.log
  ```

- In order to obtain the current version of the CSE client on the Content Engine, run these commands:

  ```
  $ cd /opt/FileNet/ContentEngine/lib
  $ cat k2_Version.txt
  ```

- The CE server trace and error logs are located in these files:

  ```
  /usr/IBM/WebSphere/AppServer/profiles/server1/FileNet/server1/p8_server_error.log

  /usr/IBM/WebSphere/AppServer/profiles/server1/FileNet/server1/p8_server_trace.log
  ```

- In addition to using the K2 Dashboard, you can run the following command line utilities on the CSE to search the collections directories:

  ```
  $ rcvdk
  $ rck2
  ```

- What if a Workplace search does not return any documents? You might want to ask the following questions:
  - Is CSE running on the active node of the cluster?
  - Have you waited long enough and adjusted the wait interval?
  - Have you enabled CBR on the document class that you are searching?
  - Is your collections directory listed in `/opt/verity/k2/common/verity.cfg`?
  - Do you need to re-index?
  - Do you see any activity in the CE trace log (tracing must be enabled)?
  - Can you perform the same search from the K2 Dashboard?

- Can you perform the same search using the rcdvk command line utility?
- Can you perform the same search from FileNet Enterprise Manager?
- Did you check the K2 Search server log file?
- Are all of the necessary file systems mounted?

11

Image Services implementation

This chapter describes the high availability options for Image Services (IS) and the requirements for planning and implementing a highly available cluster for IS. In addition, we provide the practical, step-by-step procedures that we use to install IS in an existing IBM PowerHA for AIX cluster. IBM PowerHA for AIX was previously known as IBM High Availability Cluster Multi-Processing (HACMP). We also briefly discuss the required steps to make an existing IS part of a new HACMP cluster.

We discuss the following topics:

- High availability options for Image Services
- Installing IS in a high availability environment
- High availability test for IS cluster
- IS maintenance in HACMP clusters

11.1 High availability options for Image Services

This section discusses high availability options for Image Services (IS). It describes the prerequisites and the principle of operation of an active/passive high availability cluster with IS.

For an overview of Image Services, refer to 2.5, “Image Services and CFS-IS” on page 32.

11.1.1 High availability for Image Services

IBM FileNet Image Services (IS) stores and manages an enterprise-level volume of fixed content from multiple sources. It can either work stand-alone, or it can represent the base of the Image Manager component of an IBM FileNet P8 system.

Due to the business-critical nature of the content stored on IS systems, demand for high availability (HA) solutions is increasing. IS systems can be made highly available by creating active/passive HA clusters (asymmetric clusters), that is, one cluster server (node) runs IS, while another node is idle standby. If the active node fails, IS is started on the idle standby node. IS systems cannot be farmed for HA purposes, because there can be only one active “Root/Index” server per domain.

An active/passive HA cluster with IS requires the following components:

- Two cluster nodes running a cluster software (for example, HACMP)
- Shared storage for IS, as well as Magnetic Storage and Retrieval (MSAR)
- A common local or remote database (for example, DB2)
- A regular and an additional HA IS license

You create a cluster by installing and configuring high availability cluster software on all participating nodes. When operational, the cluster presents a virtual IP address, which is bound to the currently active cluster node, to the clients. This node is also the owner of all of the resources that are needed to run IS, such as shared disks, IS file systems, and so on.

The HA cluster is useful for planned downtime (maintenance) and for unplanned downtime (for example, due to failure) of a cluster node. The takeover can be initiated manually or automatically in case of a failure.

11.1.2 IS cluster takeover example

In our example, during normal operation, only node 1 runs IS, while node 2 is idle standby.

The active node is the owner of the virtual IP address (service address), the shared disks (including shared volume groups with logical volumes and file systems), and the application (IS).

Figure 11-1 illustrates a typical active/passive cluster configuration for IS.

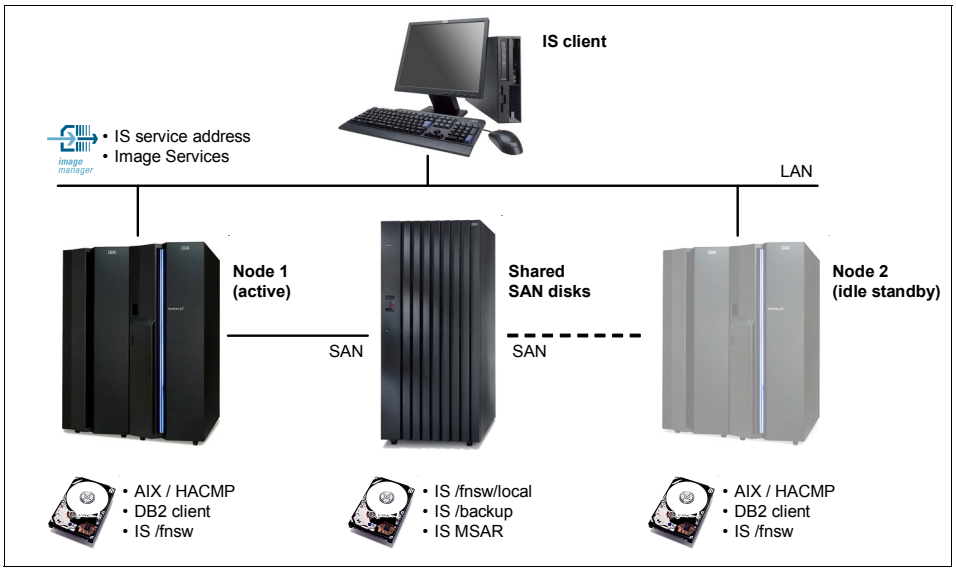


Figure 11-1 Typical active/passive cluster configuration for IS

When a software or hardware failure occurs on node 1 that cannot be corrected (for example, by restarting IS), the cluster fails over all resources that are required to run IS to node 2 of the cluster. See Figure 11-2 on page 288.

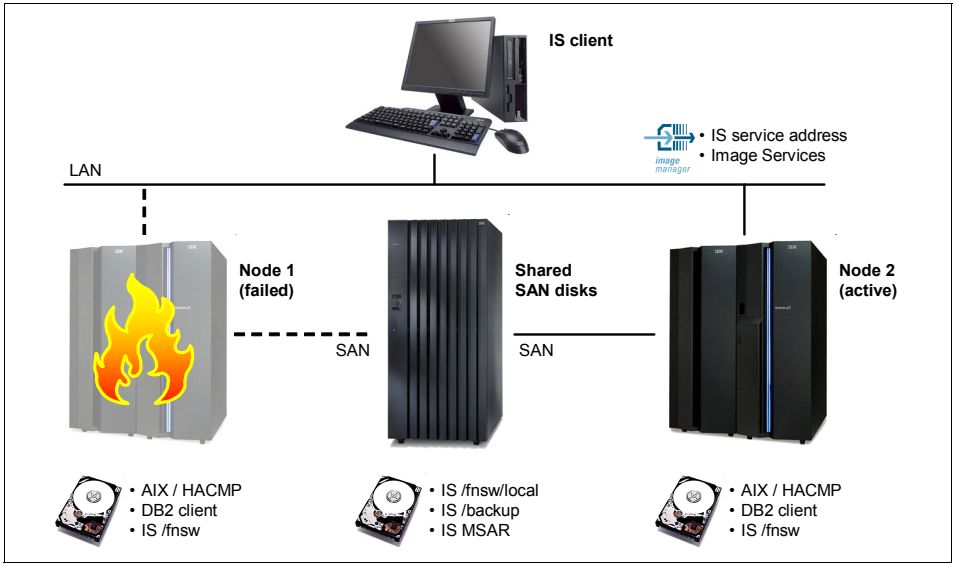


Figure 11-2 Node 2 replaces node 1 in the case of a failure

As illustrated in Figure 11-2, IS starts on node 2 of the cluster, minimizing the downtime of the IS system from a client's perspective.

For our case study, we use HACMP on AIX as the high availability cluster software.

11.1.3 High availability considerations for IS

It is important to note that HA solutions do not provide 100% uptime as fault tolerant environments. They are designed to keep the application running (for example, by replacing a failed network interface card (NIC)) and to make it available again as soon as possible in the case of a failure. For example, HA solutions can restart the application on the same node or fail the application over to another node. In case of a takeover, the application is unavailable until restarted by the cluster on the standby node.

An HA system must have no single point of failure (SPOF) that can make the system unavailable. The system design must try to eliminate SPOFs that are not covered by the cluster, typically by providing redundant components. HA clusters take care of one SPOF, that is, two failures at the same time might not be recoverable depending on the nature of the failures. Failures of SPOFs, such as shared disks or remote databases, cannot be fixed by the cluster.

Table 11-1 on page 289 lists several typical SPOFs and possible solutions.

Table 11-1 Selected SPOFs and common remedies

SPOF	Possible solution
Power failure	Redundant circuits and UPSs
Server failure	HA cluster (multiple nodes)
Network failure	Redundant network infrastructure
Network adapter failure	Redundant NICs + HA cluster
Disk failure	Redundant/mirrored disks
Disk controller failure	Redundant controllers/multipathing
Database failure	HA (clustered) database

For the reliable operation of an HA cluster, it is imperative - but unfortunately often neglected - to plan and exercise cluster takeover tests and training sessions for cluster administrators. We also recommend that you employ a clustered test system so critical maintenance tasks can be practiced without affecting production.

At times, clients seek to use the nonproductive idle standby node as a test, or even as a production system. We discourage using the standby node for other than the intended purpose, that is, being the standby in the case of a takeover.

These problems can occur when the standby node is also in use:

- IS and applications on the standby node have (or might have in the future) contradictory prerequisites (patches, OS level, settings, and so on).
- Testing on the standby node might render the server unable to start IS, for example, because of stopped processes, blocked ports, corrupted shared memory, untested dependencies/patches, and so on.
- In the case of a takeover, the performance of the standby node might not be sufficient to run both applications. Stopping the interfering application might not always work as desired.

In particular, the backup node must not be used as a test or production IS system. Because two IS systems cannot run on the same server at a time, the IS on the backup node must be stopped at takeover time. This task at least prolongs the downtime, or even inhibits the takeover, if there is a problem with stopping the IS.

Finally, note that HA and disaster recovery (DR) requirements and concepts are not identical. Trying to combine HA and DR in a single solution can compromise either availability, disaster recovery, or both.

11.2 Installing IS in a high availability environment

This section describes the steps that are necessary to install IS in an existing HACMP cluster for the case study that we set up for this book. We also briefly describe the steps to make an existing IS part of a new HACMP cluster.

11.2.1 IS HA support and documentation

Image Services provides documentation and support for Microsoft Cluster Service (MSCS) and Veritas Cluster Server (VCS). Clients have also successfully implemented IS on IBM HACMP (AIX) clusters, Sun Solaris Cluster (Solaris), and HP Serviceguard (HP-UX).

We recommend the following IS documentation that we used for this project:

- *IBM FileNet Image Services, Version 4.1, Microsoft Cluster Server Installation and Upgrade Procedures for Windows Server*, GC31-5531-01
- *IBM FileNet Image Services, Version 4.1, VERITAS Cluster Server and VERITAS Volume Replicator Guidelines*, GC31-5545
- *IBM FileNet Image Services, Version 4.1, Installation and Configuration Procedures for AIX/6000*, GC31-5557-01
- *IBM FileNet Image Services, Version 4.1, Release Notes*, GC31-5578-03
- *IBM FileNet P8 Content Federation Services for Image Services, Version 4.0, Guidelines*, GC31-5484-01
- *IBM FileNet Image Services, Hardware and Software Requirements,* GC31-5609-04
- *IBM FileNet Image Services, OSAR Cable Tool*, 2008-07-22

IS by itself is not “cluster-aware,” that is, IS does not directly communicate with the cluster software. It can, however, be easily integrated into HA clusters as a “Generic Service” (MSCS) or by means of start, stop, and monitor scripts.

IS has been designed to run in HA cluster environments. Provisions have been made so that current logons are carried over and “most” users stay connected during a cluster takeover. Certain processes require logging in again (for example, current IDM Find queries) or require the user to repeat the last work performed (for example, re-scan the last batch with Capture Professional). Recent upgrade wizards for installing IS patches and release updates support updating the second node of an IS cluster.

IS supports (as of IS Version 4.1.2) remote clustered databases. Previous versions were unable to reconnect to the database if it had been restarted or if a

remote clustered database had failed over to another node. Only “combined” IS Servers (Root-Index-MSAR/Optical Storage and Retrieval (OSAR) are supported with HA clusters. Any additional application server needs to be restarted whenever the Root/Index server is started or fails over to another cluster node, which prolongs the takeover and endangers the availability of the IS system.

To find a suitable and supported HA configuration for IS, consult the IS *IBM FileNet Image Services, Version 4.1, Installation and Configuration Procedures for AIX/6000*, GC31-5557-01, *IBM FileNet Image Services, ISRA, and Print Hardware and Software Requirements*, GC31-5609-04, and the *IBM FileNet Image Services, OSAR Cable Tool*, 2008-07-22. The IS *IBM FileNet Image Services, Version 4.1, Release Notes*, GC31-5578-03, *IBM FileNet Image Services, Version 4.1, Microsoft Cluster Server Installation and Upgrade Procedures for Windows Server*, GC31-5531-01, and *IBM FileNet Image Services, Version 4.1, VERITAS Cluster Server and VERITAS Volume Replicator Guidelines*, GC31-5545, also contain valuable information regarding supported configurations.

Note these support limitations:

- Maximum number of cluster nodes (currently, two)
- Combined or dual-server IS (currently, combined only)
- Local or remote database (for example, DB2 remote only)
- Support of virtualization technologies (for example, logical partition (LPAR) with MSAR only)

For this case study, we choose a two-node HACMP cluster with a remote (clustered) DB2 database.

11.2.2 Fresh installation of IS on HACMP

The installation of IS on the HACMP cluster follows these steps:

1. Plan the system layout and parameters.
2. Verify the prerequisites and cluster resources.
3. Install the DB2 client on node 1.
4. Install the general availability (GA) IS, IS Service Pack (SP), and IS Fix Pack (FP) on node 1.
5. Switch cluster resources over to cluster node 2.
6. Install the DB2 client on node 2.
7. Install the GA IS, IS SP, and IS FP on node 2.
8. Test the IS installation and cluster takeover behavior.

IS installation planning

The preferred way to install IS in an HA environment is to set up the HA cluster first and then to install IS with the cluster, providing all of the resources that are necessary to run IS.

The cluster controls the following resources that are required by IS:

- Virtual IP address (service address)
- Access to shared disks, including:
  - Volume groups
  - Logical volumes
  - File systems

We configure IS to use the shared IP address instead of an address that is bound to an individual server. HACMP moves this service address to the node where IS will be started.

The HA installation of IS uses both local and shared disks. The local disks on each cluster node contain the `/fnsw` file system with all of the subdirectories, except for the `/fnsw/local` subdirectory. Table 11-2 lists the important subdirectories located in the/`fnsw` file system.

Table 11-2 Selected subdirectories of /fnsw file system

Directory	Use/Remark
`/fnsw/bin`	IS binaries
`/fnsw/client`	Optional: IS Toolkit (ISTK) default location
`/fnsw/dev`	Links to DB datasets and OSAR drivers
`/fnsw/etc`	The serverConfig file, for example
`/fnsw/lib`	Shared objects in shobj and a link to the database (client), for example, db2lib or oracle, for example
`/fnsw/procs`	One file per IS process that is running

IS also modifies selected files on the local `rootvg` directory during installation, such as `/etc/inittab`, `/etc/services`, and the AIX Object Data Manager (ODM) (Software Vital Product Data (SWVPD)).

The configuration and log files of IS are kept in the `/fnsw/local` file system, so this file system must be located on a shared disk. Table 11-3 on page 293 lists the important subdirectories that are located in the/`fnsw/local` file system.

Table 11-3 Selected subdirectories of /fnsw/local

Directory	Use/Remark
/fnsw/local/logs	IS log files, for example, elogs, perf, EBR, and log
/fnsw/local/sd	Various configuration files, for example: conf_db/IMS_*.cdb (IS configuration database), NCH_db0 (IS Network Clearing House (NCH) database), snt.chkpt (Scalar numbers from permanent DB), and checkpoint.osa (OSAR checkpoint file)

The shared disks also have to contain the file systems that are used for MSAR (for example, /msar1) so that the MSAR surface files are available after takeover on the standby node.

The backup directory for Enterprise Backup and Restore (EBR) backups (for example, /backup) and any other directory that is needed by the application must also be placed on the shared disks. Do not modify the EBR sample scripts in the /fnsw/lib/ebr directory. Make sure that you use them in their original directory.

We recommend that you use this distribution and not place the /fnsw file system on the shared disk for several reasons:

- In the case of a takeover, the cluster has to unmount the shared file systems. If an IS process stops, the /fnsw file system cannot be unmounted, and the cluster takeover might not work.
- Update wizards must be run on all cluster nodes, because they might update or modify local files that are required for takeover functionality.
- A shared /fnsw file system can have unforeseen side effects, for example, aixterm does not start with the IS provided .Xdefaults file, because the /fnsw/etc/FileNet_i.bmp file is missing on the inactive node.

Table 11-4 on page 294 lists the basic parameters that we choose to set up IS with HACMP for this book. The HACMP installation requires further configuration parameters, but the table sufficiently describes our setup.

Table 11-4 IS parameters for the book

Parameter		Node 1	Node 2
Hostname		fnl43.svl.ibm.com	fnl44.svl.ibm.com
IP address (persistent address)		9.30.188.53	9.30.188.54
Local Volume Group (VG)		rootvg	rootvg
OS version		AIX 5.3.0 (08-03-0831)	AIX 5.3.0 (08-03-0831)
HA version		HACMP 5.4.1.3	HACMP 5.4.1.3
IS Resource Group (RG)	IS service address	9.30.188.78 Alias: fnis.svl.ibm.com fnis-filenet-nch-server	
	Shared VG	fnvg	
	Application Server (AS)	fnis_app_srv	
	AS start script	/opt/FileNet/ha_scripts/fnis_start.sh	
	AS stop script	/opt/FileNet/ha_scripts/fnis_stop.sh	
	AS monitor script	/opt/FileNet/ha_scripts/fnis_mon.sh	
	IS version	IS 4.1.2.18	
	ISTK version	ISTK 4.1.2.18 (optional)	
	Home directory	/fnsw	/fnsw
	Network Clearing House (NCH) domain	FNIS:FileNet	
Remote database	Host name	fnl70.svl.ibm.com	fnl100.svl.ibm.com
	IP address	9.30.188.80	9.30.188.110
	Service address	9.30.188.79 Alias: fndb2.svl.ibm.com	
	DB version	DB2 9.5.1	
	Home directory	/opt/IBM/db2/V9.5	/opt/IBM/db2/V9.5
	Database name	INDEXDB	

All cluster nodes must be on the same software level, that is, AIX, HACMP, DB2 client, and IS/ISTK must be the same version, including patch levels.

Although we definitely recommend identical cluster nodes (from a hardware perspective), the cluster nodes are not required to be completely identical unless an OSAR is connected to the cluster. In that case, the Small Computer System Interface (SCSI) adapters that are used on all nodes must provide the exact same hardware path (bus, slot, and so on). Otherwise, the OSAR is recognized as a separate library on each cluster node. Changing the IS configuration (Configuration Database (CDB)) during takeovers is not supported and is a risk to the availability of IS on the standby node.

It is extremely important that the user ID (UID) and group ID (GID) of the IS application owner (fnsw) are identical on both cluster nodes. If the IDs are not identical, IS will not work properly after a takeover, because it is no longer the owner and, therefore, cannot access its own files.

Cluster configuration for IS

Before the IS installation starts, you must configure the cluster resources and make them available. The HACMP Resource Group (RG) controls the service address and the shared volume group with the raw logical volumes and file systems. The IS installation also requires common users and groups and a local `/fnsw` file system on each of the cluster nodes.

HACMP resource group

We configure the HACMP cluster to provide the resources required to run IS as shown in Table 11-5.

Table 11-5 HACMP configuration for IS

HACMP parameter			Book lab installation
Resource group (RG)			`fnis_rg`
	Participating nodes		`fnl43 fnl44`
	Service address		`9.30.188.78`
	Application server (AS)		`fnis_app_srv`
		AS start script	`/opt/FileNet/ha_scripts/fnis_start.sh`
		AS stop script	`/opt/FileNet/ha_scripts/fnis_stop.sh`
		AS monitor script	`/opt/FileNet/ha_scripts/fnis_mon.sh`
	Volume group (VG)		`fnvg`

You can verify the HACMP configuration with the **cldisp** command as shown in Example 11-1.

Example 11-1 HACMP cluster info

```
# cd /usr/es/sbin/cluster/utilities
# cldisp
Cluster: fnis
   Cluster services: active
   State of cluster: up
      Substate: stable

#############
APPLICATIONS
#############
   Cluster fnis provides the following applications: fnis_app_srv
      Application: fnis_app_srv
         fnis_app_srv is started by /opt/FileNet/ha_scripts/fnis_start.sh
         fnis_app_srv is stopped by /opt/FileNet/ha_scripts/fnis_stop.sh
         Application monitor of fnis_app_srv: fnis_app_srv
            Monitor name: fnis_app_mon
               Type: custom
               Monitor method: user
               Monitor interval: 60 seconds
               Hung monitor signal: 9
               Stabilization interval: 120 seconds
               Retry count: 3 tries
               Restart interval: 594 seconds
               Failure action: fallover
               Cleanup method: /opt/FileNet/ha_scripts/fnis_stop.sh
               Restart method: /opt/FileNet/ha_scripts/fnis_start.sh
         This application is part of resource group 'fnis_rg'.
            Resource group policies:
               Startup: on home node only
               Fallover: to next priority node in the list
               Fallback: never
            State of fnis_app_srv: online
            Nodes configured to provide fnis_app_srv: fnl43 {up}  fnl44 {up}
               Node currently providing fnis_app_srv: fnl43 {up}
               The node that will provide fnis_app_srv if fnl43 fails is: fnl44
            Resources associated with fnis_app_srv:
               Service Labels
                  fnis(9.30.188.78) {online}
                     Interfaces configured to provide fnis:
                        fnl43-bt1 {up}
                           with IP address: 10.10.10.53
                           on interface: en2
                           on node: fnl43 {up}
                           on network: net_pub_1 {up}
                        fnl44-bt1 {up}
                           with IP address: 10.10.10.54
                           on interface: en2
                           on node: fnl44 {up}
```

```
                        on network: net_pub_1 {up}
               Shared Volume Groups:
                  fnvg

#############
TOPOLOGY
#############
   fnis consists of the following nodes: fnl43 fnl44
      fnl43
         Network interfaces:
            fnl43_vpath0_01 {up}
               device: /dev/vpath0
               on network: net_diskhb_01 {up}
            fnl43-hs03 {up}
               with IP address: 10.0.3.53
               on interface: en3
               on network: net_priv_1 {up}
            fnl43-bt1 {up}
               with IP address: 10.10.10.53
               on interface: en2
               on network: net_pub_1 {up}
      fnl44
         Network interfaces:
            fnl44_vpath0_01 {up}
               device: /dev/vpath0
               on network: net_diskhb_01 {up}
            fnl44-hs03 {up}
               with IP address: 10.0.3.54
               on interface: en3
               on network: net_priv_1 {up}
            fnl44-bt1 {up}
               with IP address: 10.10.10.54
               on interface: en2
               on network: net_pub_1 {up}
```

You can use these additional commands to view the HACMP cluster configuration and status:

- /usr/es/sbin/cluster/utilities/cltopinfo
- /usr/es/sbin/cluster/utilities/cllsres
- /usr/es/sbin/cluster/utilities/clshowres
- /usr/es/sbin/cluster/clstat -ao
- /usr/es/sbin/cluster/utilities/clRGinfo -v
- /usr/es/sbin/cluster/utilities/clRGinfo -m

For the installation of IS, we disable all application server (AS) scripts on both nodes by adding `exit 0` as the second line of the following scripts. The first line must be the shebang ("`#!`"), which is the magic number of shell scripts. The monitor script fails if you use anything else for the first line, for example, `exit 0`.

See Example 11-2 on page 298:

- `/opt/FileNet/ha_scripts/fnis_start.sh`
- `/opt/FileNet/ha_scripts/fnis_stop.sh`
- `/opt/FileNet/ha_scripts/fnis_mon.sh`

The scripts are not required and actually cause problems during installation. If the scripts do not exist, you must create them later when IS is completely installed.

Example 11-2 Disabled AS scripts for IS installation

```
#!/bin/ksh
exit 0
[...]
```

Users and groups

The ID of the IS groups (GID) and users (UID) must be identical on all cluster nodes. You can create the users and groups by using Cluster-Single Point Of Control (C-SPOC) to achieve the uniqueness of the IDs on both cluster nodes. It is a good practice to choose one of the cluster nodes for all HACMP-related changes and to synchronize the cluster "one way" only at all times.

To add the group and user ID, using smitty:

```
# smitty hacmp
```

Click **System Management (C-SPOC) → HACMP Security and Users Management → Groups in an HACMP cluster → Add a Group to the Cluster**.

You must leave the Group ID field blank to have C-SPOC generate the ID.

Click **System Management (C-SPOC) → HACMP Security and Users Management → Users in an HACMP cluster → Add a User to the Cluster**.

You must leave the User ID field blank to have C-SPOC generate the ID.

Alternatively, you can create the groups and users manually on each node with specific unique IDs that are not used on any node. See Example 11-3.

Example 11-3 Manual creation of users and groups

```
# cut -d ":" -f 3 /etc/group | sort -n
[...]
211
212
4294967294

# lsgroup -a id ALL | awk '$2~"id=300|id=301|id=302" {print $1}'
No groups returned: GIDs 300-302 are available on this node

# mkgroup id=300 fnusr
# mkgroup id=301 fnop
# mkgroup id=302 fnadmin

# cut -d ":" -f 3 /etc/passwd | sort -n
[...]
227
228
4294967294

# lsuser -a id ALL | awk '$2~"id=300" {print $1}'
No users returned: UID 300 is available in this node

# mkuser pgrp=fnusr groups=fnadmin,fnop home=/home/fnsw gecos="FileNet
IS Admin" id=300 fnsw
```

Also, you must make the user root (UID 0) part of the newly created fnusr and fnadmin groups.

IS service address

The IS service address is configured as an IP alias, which HACMP IP address takeover (IPAT) moves together with the IS resource group.

IPAT using IP aliases is the default when HACMP networks are configured in SMIT, for example, the public network, that is shared with the clients:

```
# smitty hacmp
```

Click **Extended Configuration** → **Extended Topology Configuration** → **Configure HACMP Networks** → **Change/Show a Network in the HACMP Cluster**.

Enter these values:

- Network Name: `net_pub_1`

- Network Type: `ether`
- Netmask: `255.255.255.0`
- Enable IP Address Takeover via IP Aliases: `Yes`
- Network attribute: `Public`

IPAT using IP aliasing is faster and more reliable with cluster takeovers than IPAT using IP address replacement. However, IPAT using IP address replacement is required with certain types of networks that cannot process Address Resolution Protocol (ARP) cache updates and that require a Hardware Address Takeover (HWAT) of the NIC's hardware or Media Access Control (MAC) address. HWAT was often used with the old IS client, WorkForce Desktop (WFD). For descriptions of the two types of IPAT, refer to *HACMP for AIX, Planning Guide, Version 5.4.1*, SC23-4861-10.

With IPAT using IP aliasing, the IS service address alias (9.30.188.78) can be brought up on any of the boot interfaces that are defined for the cluster. If the current network interface card (NIC) fails, HACMP will move the alias with an adapter swap to another interface. If the whole node fails, HACMP will move the alias as part of the resource group to the standby node. Example 11-4 shows the IS service address (9.30.188.78) as an alias to the boot interface en2 of node fnl43.

Example 11-4 IS service address as an IP alias

```
# ifconfig en2
en2:
flags=1e080863,480<UP,BROADCAST,NOTRAILERS,RUNNING,SIMPLEX,MULTICAST,GR
OUPRT,64BIT,CHECKSUM_OFFLOAD(ACTIVE),CHAIN>
        inet 10.10.10.53 netmask 0xffffff00 broadcast 10.10.10.255
        inet 9.30.188.53 netmask 0xffffff00 broadcast 9.30.188.255
        inet 9.30.188.78 netmask 0xffffff00 broadcast 9.30.188.255
         tcp_sendspace 262144 tcp_recvspace 262144 rfc1323 1
```

Local file system /fnsw

We create the `/fnsw` file system with 1 GB in the local `rootvg` directory on each cluster node as shown in Example 11-5.

Example 11-5 Creation of local /fnsw file system

```
# lsvg rootvg | grep "PP SIZE"
VG STATE:           active                   PP SIZE:        128
megabyte(s)

# mklv -y fn_fnsw -t jfs2 rootvg 8   #  8PP*128MB/PP=1GB
fn_fnsw
```

```
# crfs -v jfs2 -d fn_fnsw -m /fnsw -Ay -p rw -a agblksize=4096
File system created successfully.
1048340 kilobytes total disk space.
New File System size is 2097152

# mount /fnsw
```

Note: Do not forget to mount /fnsw immediately on each cluster node. Otherwise, the /fnsw/local mount point will be created in the / (root) file system later, not in /fnsw.

Shared volume group fnvg

The shared volume group (VG) fnvg was created as an “enhance concurrent capable” volume group on shared storage area network (SAN) disks to speed up the takeover process. A unique major number (100) was chosen for the VG to enable NFS mounts on this VG in the HACMP cluster. An identical free major number was determined on all cluster nodes by issuing **lvlstmajor** on each node.

Example 11-6 shows that major number 50 is used, but for example, 100 is available on this node.

Example 11-6 Querying available major numbers on each node

```
# cd /etc
# lvlstmajor
39..49,51...
```

The VG can be simultaneously created on both cluster nodes using C-SPOC:

```
# smitty hacmp
```

Click **System Management (C-SPOC) → HACMP Concurrent Logical Volume Management → Concurrent Volume Groups → Create a Concurrent Volume Group**.

Enter these values:

- Node Names: fnl43 and fnl44
- VOLUME GROUP name: fnvg
- Physical partition SIZE in megabytes: 256
- Volume group MAJOR NUMBER: 100
- Enhanced Concurrent Mode: True

After creation, we turn off the Quorum and change the VG, so it does not automatically vary on when the server is started. HACMP takes care of the

volume group when active. We had to run the **chvg** command on the other cluster node later, as well. See Example 11-7.

Example 11-7 Disabling auto varyon and turning off the Quorum of fnvg

```
# varyonvg -c fnvg # vary on fnvg in concurrent mode
# chvg -an -Qn fnvg # disable auto vary on and turn off Quorum
0516-1804 chvg: The quorum change takes effect immediately.
```

Vary on the shared VG in concurrent mode on the current node as shown in Example 11-8.

Example 11-8 Enhanced capable volume group fnvg

```
# lsvg fnvg | grep Concurrent
Concurrent:         Enhanced-Capable         Auto-Concurrent: Disabled
VG Mode:            Concurrent
```

Shared logical volumes in fnvg

On the shared VG fnvg, logical volumes (LVs) were created for file systems (FSs) and for the raw partitions that are required by IS. Table 11-6 lists the shared logical volumes that were created.

Table 11-6 Shared logical volumes in fnvg

LV	Type	Size	Mount point
fnvg_jfs2log	jfs2log	256 MB (1PP x 256 MB/PP)	N/A
fn_local	jfs2	2048 MB (8PP x 256 MB/PP)	/fnsw/local
fn_msar1	jfs2	10 GB (40PP x 256 MB/PP)	/msar1
fn_backup	jfs2	5 GB (20PP x 256 MB/PP)	/backup
fn_sec_db0	raw	256 MB (1PP x 256 MB/PP)	N/A
fn_sec_rl0	raw	256 MB (1PP x 256 MB/PP)	N/A
fn_perm_db0	raw	2048 MB (8PP x 256 MB/PP)	N/A
fn_perm_rl0	raw	1024 MB (4PP x 256 MB/PP)	N/A
fn_trans_db0	raw	2048 MB (8PP x 256 MB/PP)	N/A

LV	Type	Size	Mount point
fn_trans_rl0	raw	1024 MB (4PP x 256 MB/PP)	N/A
fn_cache0	raw	16 GB (64PP x 256 MB/PP)	N/A

We recommend that you add all of the file systems on shared VG fnvg to a common mount group of the same name (fnvg) to facilitate mounting all file systems manually. The FSs will not be mounted with a **mount -a** command, because they have been deactivated for auto mounting.

You can create the LVs on the shared VG using C-SPOC:

```
# smitty hacmp
```

Click **System Management (C-SPOC)** → **HACMP Logical Volume Management** → **Shared Logical Volumes** → **Add a Shared Logical Volume**.

Enter these values:

- VOLUME GROUP name: fnvg (RG fnis_rg)
- PHYSICAL VOLUME names: vpath0
- Logical volume NAME: fn_local
- Number of LOGICAL PARTITIONS: 8
- Logical volume TYPE: jfs2

Example 11-9 shows the logical volumes that were created.

Example 11-9 Logical volumes

```
# lsvg -l fnvg
fnvg:
LV NAME             TYPE       LPs     PPs     PVs  LV STATE      MOUNT
POINT
fnvg_jfs2log        jfs2log    1       1       1    closed/syncd  N/A
fn_local            jfs2       8       8       1    closed/syncd  N/A
fn_msar1            jfs2       40      40      1    closed/syncd  N/A
fn_backup           jfs2       20      20      1    closed/syncd  N/A
fn_sec_db0          raw        1       1       1    closed/syncd  N/A
fn_sec_rl0          raw        1       1       1    closed/syncd  N/A
fn_perm_db0         raw        8       8       1    closed/syncd  N/A
fn_perm_rl0         raw        4       4       1    closed/syncd  N/A
fn_trans_db0        raw        8       8       1    closed/syncd  N/A
fn_trans_rl0        raw        4       4       1    closed/syncd  N/A
fn_cache0           raw        64      64      1    closed/syncd  N/A
```

Note: Before file systems are created in the next step, you must initialize the journaled file system (JFS) log, or AIX will create a new JFS log LV. To initialize the JFS log, enter:

```
# logform /dev/fnvg_jfs2log
```

The shared file systems can be created in the previously defined LVs using C-SPOC. All shared file systems must have auto mount disabled, because HACMP will control on which node an FS is mounted. AIX must not try to mount the shared file systems during startup from `/etc/filesystems`. FSs created with C-SPOC will automatically have the correct "`mount = false`" stanza in `/etc/filesystems`:

```
# smitty hacmp
```

Click **System Management (C-SPOC) → HACMP Logical Volume Management → Shared File Systems → Enhanced Journaled File Systems → Add an Enhanced Journaled File System on a Previously Defined Logical Volume**.

Enter these values:

- LOGICAL VOLUME name: `fn_local` (nodes fnl43 and fnl44)
- MOUNT POINT: `/fnsw/local`

The matching JFS log (`fnvg_jfs2log`) is automatically being used by cl_crfs.

To manually add the file system to the fnvg mount group (and to disable the auto mount of the FS), enter `# chfs -An -u fnvg /fnsw/local`.

When all logical volumes and file systems have been created, the FSs can be mounted, and the shared VG is ready for the IS installation. In the future, HACMP will vary on/off the VG and mount/unmount all FSs in that VG.

Example 11-10 shows the shared VG fnvg in our system.

Example 11-10 Shared VG fnvg with all LVs and FSs

```
# mount -t fnvg
# lsvg -l fnvg
fnvg:
LV NAME             TYPE       LPs     PPs     PVs  LV STATE      MOUNT
POINT
fnvg_jfs2log        jfs2log    1       1       1    open/syncd    N/A
fn_local            jfs2       8       8       1    open/syncd
/fnsw/local
```

```
fn_msar1            jfs2       40      40      1    open/syncd
/msar1
fn_backup           jfs2       20      20      1    open/syncd
/backup
fn_sec_db0          raw        1       1       1    closed/syncd  N/A
fn_sec_rl0          raw        1       1       1    closed/syncd  N/A
fn_perm_db0         raw        8       8       1    closed/syncd  N/A
fn_perm_rl0         raw        4       4       1    closed/syncd  N/A
fn_trans_db0        raw        8       8       1    closed/syncd  N/A
fn_trans_rl0        raw        4       4       1    closed/syncd  N/A
fn_cache0           raw        64      64      1    closed/syncd  N/A
```

Whenever the HACMP configuration has been changed on one cluster node, the changes must be synchronized to the other cluster node with “cldare”:

```
# smitty hacmp
```

Click **Extended Configuration** → **Extended Verification and Synchronization**.

Image Services installation

After planning and setting up the HACMP cluster, you can install IS on each cluster node.

Note: The IS installation generally follows the standard installation manual. The following section only highlights the configuration steps that are required for the cluster and that differ from the documented procedure.

AIX prerequisites for IS

According to the *IBM FileNet Image Services, Version 4.1, Installation and Configuration Procedures for AIX/6000*, GC31-5557-01, documentation, the following prerequisites were checked:

- AIX oslevel and kernel bitmode
- AIX software bundles required for IS:
  - App-Dev
- AIX filesets required for IS:
  - `bos.adt.debug`
  - `bos.adt.libm`
  - `bos.adt.base`
  - `bos.adt.lib`
  - `bos.perf.perfstat`
  - `X11.fnt.iso1`

- Simple Network Management Protocol (SNMP) daemon Version 1 (Version 3 is not supported.)
- Size of paging space
- Time zone setting
- Maximum number of processes per user
- Real memory allowed for MBUFS

IS uses ports that are officially registered with the Internet Assigned Numbers Authority (IANA):

http://www.iana.org/assignments/port-numbers

Unfortunately, certain programs occupy the ports that are required by IS, so Image Services cannot start properly and fails to communicate with its clients. To work around this issue, you must modify the network options (no) of AIX as shown in Example 11-11.

Example 11-11 Ephemeral ports in /etc/tunables/nextboot

```
# no -po tcp_ephemeral_high=65535
# no -po tcp_ephemeral_low=42767
# no -po udp_ephemeral_high=65535
# no -po udp_ephemeral_low=42767

# no -a | grep ephemeral
       tcp_ephemeral_high = 65535
        tcp_ephemeral_low = 42767
       udp_ephemeral_high = 65535
        udp_ephemeral_low = 42767
```

Certain programs, however, start even before `/etc/tunables/nextboot` takes effect and block the ports that are needed by IS, for example, rpc.ttdbserver (inetd) and dtlogin (Common Desktop Environment (CDE)). A work-around for this problem is to add the `no` parameters also to `/etc/rc.dt` (if CDE is installed) or create a suitable entry in `/etc/rc.d/`. See Example 11-12.

Example 11-12 Ephemeral ports in /etc/rc.dt

```
# vi /etc/rc.dt
[...]
# IBM FileNet Image Services ephemeral ports
/usr/sbin/no -o tcp_ephemeral_high=65535
/usr/sbin/no -o tcp_ephemeral_low=42767
/usr/sbin/no -o udp_ephemeral_high=65535
/usr/sbin/no -o udp_ephemeral_low=42767
```

```
# IBM FileNet Image Services End
[...]
```

AIX honors the port reservations for IS and reflects the reserved names and ports in its `/etc/services` file. Unfortunately, IS installers sometimes fail if the entry reads `filenet-tms` instead of `tms`. Therefore, we advise you to comment out existing `filenet-tms`, `filenet-rpc`, and `filenet-nch` entries in `/etc/services` before the IS installation starts. See Example 11-13.

Example 11-13 The /etc/services file with ports added by the IS installer

```
# egrep "32768|32769|32770" /etc/services
# filenet-tms      32768/tcp              # Filenet TMS
# filenet-tms      32768/udp              # Filenet TMS
# filenet-rpc      32769/tcp              # Filenet RPC
# filenet-rpc      32769/udp              # Filenet RPC
# filenet-nch      32770/tcp              # Filenet NCH
# filenet-nch      32770/udp              # Filenet NCH
tms     32768/tcp
cor     32769/tcp
nch     32770/udp
```

You can use the **rmsock** command to find a process that is using the IS port. See Example 11-14 for an example of a process blocking IS port 32768.

Example 11-14 Process blocking IS port 32768

```
# netstat -Aan | grep 3276 | grep tcp
f100020003932b98 tcp4       0      0  *.32768          *.*
LISTEN
f100020003940b98 tcp4       0      0  *.32769          *.*
LISTEN

# rmsock f100020003932b98 tcpcb
The socket 0x3932808 is being held by proccess 827454 (rpc.ttdbserver).
```

Just before the IS installation, the NCH entry for IS domain FNIS:FileNet was added to `/etc/hosts`. This entry points to the (virtual) IS service address, which the HACMP Resource Group provides. By using the highly available service address for IS, the clients will connect to the correct (active) node of the cluster.

Example 11-15 NCH entry in /etc/hosts

```
# vi /etc/hosts
[...]
9.30.188.78 fnis.svl.ibm.com fnis fnis-filenet-nch-server
```

```
[...]
```

In Example 11-15, these fields are defined this way:

- fnis.svl.ibm.com / fnis: Host name / alias for IS service address
- fnis-filenet-nch-server: IP alias for IS NCH domain “FNIS:FileNet”

See *IBM FileNet Image Services, Version 4.1, System Administrator’s Companion for UNIX*, GC31-5544-00, for details about how to convert the NCH domain name to a host name.

DB2 client installation

IS uses the DB2 client to connect to the remote clustered DB2 server. The DB2 client has to be installed locally on each cluster node. While the DB2 server is running DB2 9.5.1 (64 bit), the client must run a 32-bit database instance, because IS uses 32-bit libraries to access the DB2 client.

The client is configured to talk to the DB2 server shown in Table 11-7.

Table 11-7 DB2 database parameters

Parameter	Node 1	Node 2
Hostname	fnl70.svl.ibm.com	fnl100.svl.ibm.com
IP address	9.30.188.80	9.30.188.110
Service address	9.30.188.79 Alias: fndb2.svl.ibm.com	
DB name	INDEXDB	
DB version	DB2 9.5.1 (64 bit)	
Tablespace for IS	USERSPACE1	

On the DB2 server side (fndb2.svl.ibm.com), the database users were created and granted permissions as shown in Example 11-16.

Example 11-16 DB2 server database user creation

```
# mkuser pgrp=p8_igrp groups=p8_igrp,staff home="/data/db2/f_sw" id=303 f_sw
# mkuser pgrp=p8_igrp groups=p8_igrp,staff home="/data/db2/f_maint" id=304
f_maint
# mkuser pgrp=p8_igrp groups=p8_igrp,staff home="/data/db2/f_sqi" id=305 f_sqi
# mkuser pgrp=p8_igrp groups=p8_igrp,staff home="/data/db2/f_open" id=306
f_open

# su - p8inst
```

```
$ db2

db2 => grant createtab, bindadd, connect on database to user f_sw
DB20000I  The SQL command completed successfully.
db2 => grant createtab, bindadd, connect on database to user f_sqi
DB20000I  The SQL command completed successfully.
db2 => grant createtab, bindadd, connect on database to user f_open
DB20000I  The SQL command completed successfully.
db2 => grant dbadm on database to f_maint
DB20000I  The SQL command completed successfully.

db2 => quit
DB20000I  The QUIT command completed successfully.

$ db2set DB2_SNAPSHOT_NOAUTH=on
```

Example 11-17 shows the DB2 server configuration settings that are required to configure the DB2 client.

Example 11-17 DB2 server configuration

```
# su - p8inst
$ db2 list node directory

 Node Directory

 Number of entries in the directory = 1

Node 1 entry:

 Node name                      = DB2_B
 Comment                        =
 Directory entry type           = LOCAL
 Protocol                       = TCPIP
 Hostname                       = fnl70
 Service name                   = 50010

$ db2 list db directory

 System Database Directory

 Number of entries in the directory = 10
[...]
Database 8 entry:

 Database alias                       = INDEXDB
 Database name                        = INDEXDB
 Local database directory             = /data/db2/p8_inst
 Database release level               = c.00
 Comment                              =
 Directory entry type                 = Indirect
```

```
 Catalog database partition number    = 0
 Alternate server hostname            = 9.30.188.80
 Alternate server port number         = 50010
[...]
```

```
$ db2 connect to indexdb

   Database Connection Information

 Database server        = DB2/AIX64 9.5.1
 SQL authorization ID   = P8INST
 Local database alias   = INDEXDB
```

```
$ db2 list tablespaces

          Tablespaces for Current Database

 Tablespace ID                        = 0
 Name                                 = SYSCATSPACE
 Type                                 = Database managed space
 Contents                             = All permanent data. Regular table space.
 State                                = 0x0000
   Detailed explanation:
     Normal

 Tablespace ID                        = 1
 Name                                 = TEMPSPACE1
 Type                                 = System managed space
 Contents                             = System Temporary data
 State                                = 0x0000
   Detailed explanation:
     Normal

 Tablespace ID                        = 2
 Name                                 = USERSPACE1
 Type                                 = Database managed space
 Contents                             = All permanent data. Large table space.
 State                                = 0x0000
   Detailed explanation:
     Normal

 Tablespace ID                        = 3
 Name                                 = SYSTOOLSPACE
 Type                                 = Database managed space
 Contents                             = All permanent data. Large table space.
 State                                = 0x0000
   Detailed explanation:
     Normal

 Tablespace ID                        = 4
 Name                                 = SYSTOOLSTMPSPACE
 Type                                 = System managed space
 Contents                             = User Temporary data
 State                                = 0x0000
```

```
Detailed explanation:
  Normal
```

During the DB2 9.5 Client installation, we only choose the default settings.

Example 11-18 on page 311 shows how to start the DB2 client installation wizard.

Example 11-18 Starting the DB2 client installation wizard

```
# umask 022
# export DISPLAY=$(who am i|awk '{gsub("\\(|\\)",""); print $NF":0"}')
# export DB2INSTANCE="fnsw" # avoid "_" in instance owner names!
# cd /instsrc/DB2/95/DB2_RTC_V95_AIX
# db2setup
[...]
```

Figure 11-3 shows the DB2 client installation options that we choose.

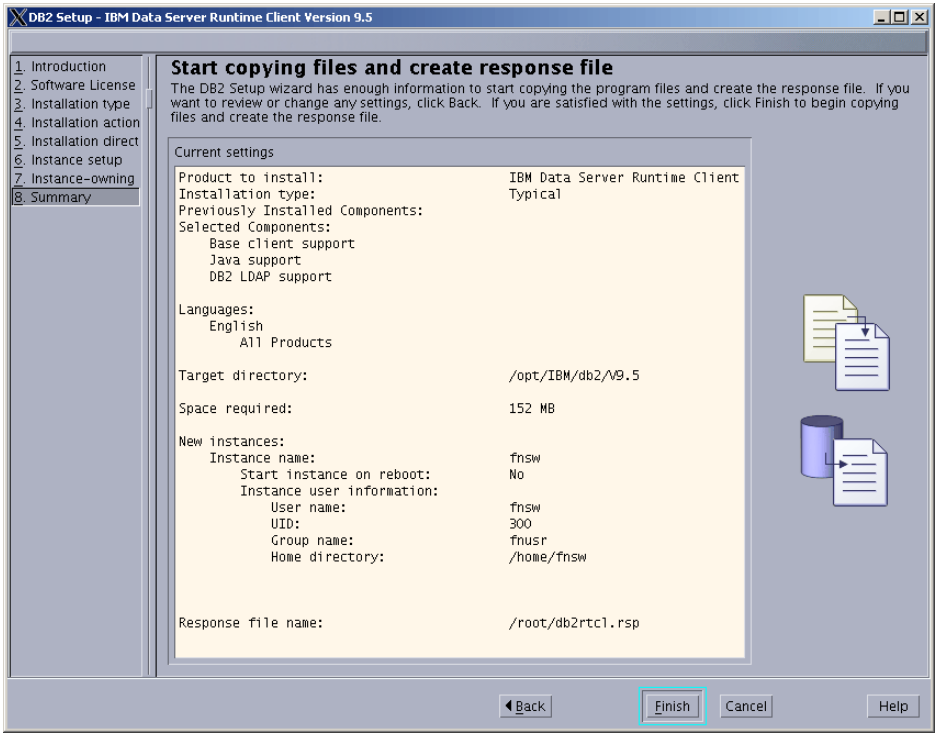


Figure 11-3 Summary of the DB2 client installation options

After the installation completed, we configure the connection to the DB2 cluster server, and we create the local DB2 database catalog on each node. See Example 11-19.

Example 11-19 Creation of DB2 database catalog

```
# su - fnsw

$ db2 catalog tcpip node FNDB2 remote fndb2.svl.ibm.com server 50010
DB20000I  The CATALOG TCPIP NODE command completed successfully.
DB21056W  Directory changes may not be effective until the directory cache is
refreshed.

$ db2 catalog database INDEXDB as INDEXDB at node FNDB2
DB20000I  The CATALOG DATABASE command completed successfully.
DB21056W  Directory changes may not be effective until the directory cache is
refreshed.

$ db2 terminate
DB20000I  The TERMINATE command completed successfully.

$ db2 list node directory
 Node Directory

 Number of entries in the directory = 1

Node 1 entry:

 Node name                      = FNDB2
 Comment                        =
 Directory entry type           = LOCAL
 Protocol                       = TCPIP
 Hostname                       = fndb2.svl.ibm.com
 Service name                   = 50010

$ db2 list database directory
 System Database Directory

 Number of entries in the directory = 1

Database 1 entry:

 Database alias                       = INDEXDB
 Database name                        = INDEXDB
 Node name                            = FNDB2
 Database release level               = c.00
 Comment                              =
 Directory entry type                 = Remote
 Catalog database partition number    = -1
 Alternate server hostname            = 9.30.188.79
 Alternate server port number         = 50010
```

Image Services installation

Image Services normally requires three installations. For example:

- Image Services 4.1.0 General Availability (GA)
- Image Services 4.1.0 Service Pack 2 (SP on top of GA) IS 4.1.2
- Image Services 4.1.2 Fix Pack 3 (FP on top of SP) IS 4.1.2 FP 3

For this book, IS 4.1.2 (4.1.2.18, no FP) was installed using the SP installation wizard only. This Service Pack installs IS even without an existing GA installation. A Fix Pack was not available for this release.

In Example 11-20, we use the SP installation wizard to install IS 4.1.2.

Example 11-20 Installing IS 4.1.2

```
# mount -t fnvg # make sure the target file systems are mounted
# mount | grep fnsw
         /dev/fn_fnsw     /fnsw            jfs2   Sep 24 10:04
rw,log=/dev/hd8
         /dev/fn_local    /fnsw/local      jfs2   Sep 25 11:26
rw,log=/dev/fnvg_jfs2log

# export DISPLAY=$(who am i|awk '{gsub("\\(|\\)",""); print $NF":0"}')
# cd /instsrc/IM/IS412-18
# is_4.1.2_aix.bin

InstallShield Wizard
Initializing InstallShield Wizard...
Preparing Java(tm) Virtual Machine...
Running InstallShield Wizard...
```

Figure 11-4 shows the installation summary of IS on our lab system.

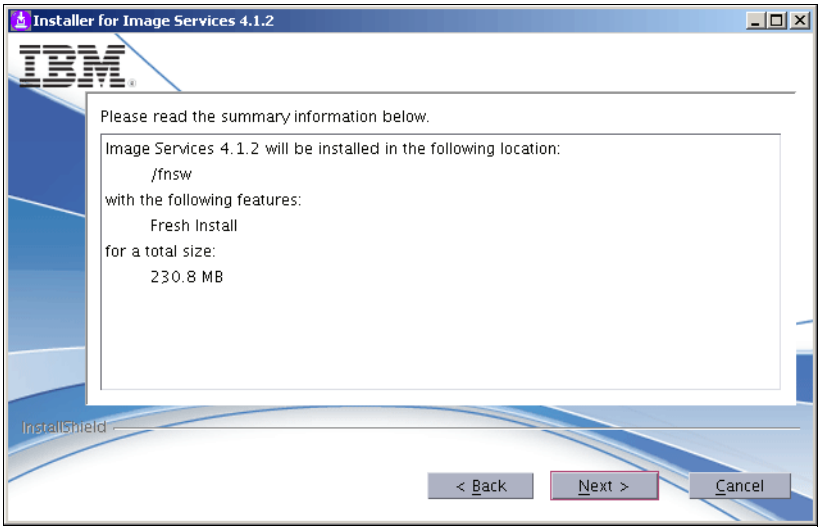


Figure 11-4 Summary of the IS installation options

When the setup wizard completes, the installation is verified by checking the log files as shown in Example 11-21.

Example 11-21 Check the installation log

```
# grep copied /fnsw/local/logs/install/4.1.2/IS_4.1.2.log
Thu Oct 02 21:52:37 PDT 2008      1162 files of 1162 have been copied
to the target

# grep Exit /fnsw/local/logs/install/4.1.2/IS_4.1.2.log
Thu Oct 02 21:53:04 PDT 2008    Exit status: SUCCESS
Thu Oct 02 21:53:04 PDT 2008    Exit code, message, and explanation:
SUCCESS(0): The IS Installer has successfully installed Image Services
4.1.2. For additional information on the installation, please review
the Install log at  /fnsw/local/logs/install/4.1.2/IS_4.1.2.log , and
check the CSS Web site at http://www.css.filenet.com for additional
information regarding this release.
```

Immediately after the IS installation, all IS-related entries in `/etc/inittab` must be disabled, because IS must not be started by AIX at boot time, but by HACMP, when the current node becomes active.

Example 11-22 shows the entries disabled using the following command:

```
# vi /etc/inittab
```

Example 11-22 Disabled IS entries in /etc/inittab

```
:: IBM FileNet Image Services disabled for HACMP
:: rcfn:234:wait:/bin/sh /etc/rc.initfnsw </dev/console >/dev/console 2>&1
:: rcfnext:2:once:/etc/rc.fnext 2>&1 | alog -tboot >/dev/console 2>&1
:: rcfnodd:2:wait:/etc/rc.fnodd 2>&1 | alog -tboot >/dev/console 2>&1
:: rcsingle:1:wait:/etc/rc.single 2>&1 | alog -tboot >/dev/console 2>&1
:: dupip:2:wait:/fnsw/etc/dupip
:: IBM FileNet Image Services End
```

Note: The best way to disable inittab entries is by adding a colon (`:`) in front of the line, or by changing the action to "`off`" instead of "`once`" or "`wait`".

The IS installer creates an entry `rcfn` with `#` as a first character, but this action will not comment out the line. This entry must also be disabled by adding a colon (`:`).

The profile of the fnsw user (and optionally also of the root user) must be updated to include the environment variable required for IS as shown in Example 11-23.

Example 11-23 Modification of fnsw's .profile for IS

```
# su - fnsw
# /fnsw/etc/inst_templates

# . ~/.profile # or "exit" and "login" to activate .profile

# env | grep DB2
DB2_HOME=/home/fnsw/sqllib
DB2INSTANCE=fnsw
DB2_INST=fnsw
```

The profiles of fnsw (`$HOME/.*`) must match on all cluster nodes to make sure that IS starts with the same environment.

Image Services configuration

The first step to configure IS is to run **`fn_setup`** as fnsw user as shown in Example 11-24. There is no cluster-related parameter in this part of the configuration.

Example 11-24 IS configuration with fn_setup

```
# su - fnsw
# export DISPLAY=$(who am i|awk '{gsub("\\(|\\)",""); print $NF":0"}')

# fn_setup
```

```
Is this the NCH server (1=yes, 2=no) [1]:
Enter NCH server name []: FNIS:FileNet
Enter system serial number [0]: 110012345
Enter the relational database type configured on this server
        (0=None, 1=Oracle, 2=DB2) [0]: 2
Enter the relational database home directory [/home/fnsw/sqllib]:
          This is the setup configuration:
                    NCH server name: FNIS:FileNet
                    SSN: 110012345
                    Relational database type: db2
                    Relational database home: /home/fnsw/sqllib
Do you want to continue (y/n) [y]: y
fn_setup: Creating file /fnsw/local/setup_config
fn_setup: Creating file /fnsw/local/sd/root_station
fn_setup: Creating file /fnsw/local/ssn
fn_setup: Creating file /fnsw/local/sd/nch_domain
fn_setup: Changing permission on FileNET IS software and databases
fn_setup: Creating file /fnsw/local/sd/NCH_db0
fn_setup: Running "/fnsw/bin/fn_util initnch"
fn_util: creating NCH database.
fn_setup: Running "/fnsw/bin/nch_update FNIS:FileNet"
fn_setup: Installing Image Services license.
Successfully installed license data !
fn_setup: Changing permission on FileNET IS software and databases
```

The fn_setup program also installs the Universal SLAC Key (license code) into the IS NCH database. Because this key works on any server, there is no longer a dedicated “HA/DR” license key required for IS to run on separate hosts.

If the system had an optical storage library (OSAR) connected, the fnsod.install script must be run on AIX and Solaris servers after all IS service packs (SPs) and fix packs (FPs) have been applied:

```
# /fnsw/bin/fnsod.install
```

The IS Configuration Editor (fn_edit) has to be used on node 1 of the cluster only, because its configuration files (`/fnsw/local/sd/conf_db/IMS_*.cdb`) are located on the shared disks and will be switched over to the standby node by HACMP. Example 11-25 shows the IS configuration with fn_edit.

Example 11-25 IS configuration with fn_edit

```
# su - fnsw
$ export DISPLAY=$(who am i|awk '{gsub("\\(|\\)",""); print $NF":0"}')

$ fn_edit

$ fn_build -a
```

The only cluster-related entry in fn_edit really is the IP address in the Network Addresses tab (see Figure 11-5).

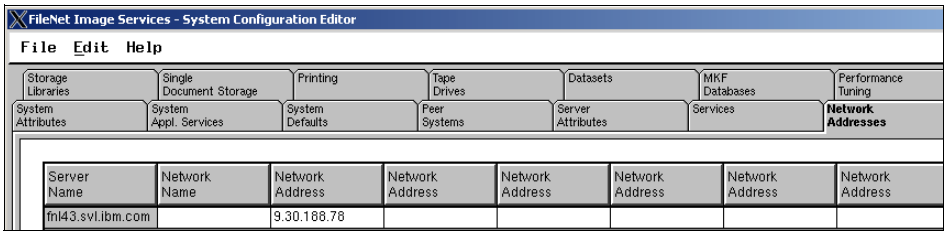


Figure 11-5 HACMP service address that is used for IS

IS requires links in `/fnsw/dev/1` that point to shared logical volumes in `/dev`, which will be used as raw devices for Multi-Keyed File (MKF) databases and document cache. See Table 11-8 on page 317.

The links might be realized as soft links (ln -s) or through the character device file using the major and minor number of the raw device (mknod). The soft links are the preferred way to link to the raw devices and need to be created with the **`fn_util mk_links`** command.

The links to OSAR A (osara) and OSAR A drive 1 and 2 (odda*) only exist when an OSAR is attached to the system, and **`fnsod.install`** has been run previously.

Table 11-8 Local links from /fnsw/dev/1 to shared raw devices

Local link	Shared LV/Device	Use
/fnsw/dev/1/sec_db0	/dev/rfn_sec_db0	Security database
/fnsw/dev/1/sec_rl0	/dev/rfn_sec_rl0	Security redo log
/fnsw/dev/1/permanent_db0	/dev/rfn_perm_db0	Permanent database
/fnsw/dev/1/permanent_rl0	/dev/rfn_perm_rl0	Permanent redo log
/fnsw/dev/1/transient_db0	/dev/rfn_trans_db0	Transient database
/fnsw/dev/1/transient_rl0	/dev/rfn_trans_rl0	Transient redo log
/fnsw/dev/1/cache0	/dev/rfn_cache0	Document cache
/fnsw/dev/1/osara	/dev/fnsod.5,0,4,0	OSAR “A” Robotic Arm
/fnsw/dev/1/odda1	/dev/fnsod.5,0,3,0	OSAR “A” Drive 1
/fnsw/dev/1/odda2	/dev/fnsod.5,0,2,0	OSAR “A” Drive 2

The links to the databases and OSAR drivers in /fnsw/dev/1 are created locally with **fn_util mk_links** and also have to be created on the standby node later, because this directory is located on the local disks (in /fnsw). See Example 11-26.

Example 11-26 Creation of links in /fnsw/dev/1

```
# su - fnsw
$ fn_util mk_links
fn_util: done

$ ls -l /fnsw/dev/1
total 0
lrwxrwxrwx    1 fnsw     fnusr            15 Oct 02 22:18 cache0@ -> /dev/rfn_cache0
lrwxrwxrwx    1 fnsw     fnusr            17 Oct 02 22:18 permanent_db0@ ->
/dev/rfn_perm_db0
lrwxrwxrwx    1 fnsw     fnusr            17 Oct 02 22:18 permanent_rl0@ ->
/dev/rfn_perm_rl0
lrwxrwxrwx    1 fnsw     fnusr            16 Oct 02 22:18 sec_db0@ -> /dev/rfn_sec_db0
lrwxrwxrwx    1 fnsw     fnusr            16 Oct 02 22:18 sec_rl0@ -> /dev/rfn_sec_rl0
lrwxrwxrwx    1 fnsw     fnusr            18 Oct 02 22:18 transient_db0@ ->
/dev/rfn_trans_db0
lrwxrwxrwx    1 fnsw     fnusr            18 Oct 02 22:18 transient_rl0@ ->
/dev/rfn_trans_rl0
```

The link to the DB2 client is also local to rootvg and has to be created on the standby node, as well. See Example 11-27.

Example 11-27 Creating link to DB2 client

```
# su - fnsw
$ fn_util linkrdb
fn_util: done

$ ls -l /fnsw/lib/shobj/db2lib
lrwxrwxrwx    1 fnsw     fnusr            23 Oct 02 22:19 /fnsw/lib/shobj/db2lib@ ->
/home/fnsw/sqllib/lib32/
```

After configuring the DB2 passwords, the database has to be initialized, which creates the IS tables. This task must only be done one time from node 1 of the cluster. See Example 11-28.

Example 11-28 Initialization of the DB2 database

```
# su - fnsw
$ fn_setup_rdb -f # make DB passwords known to IS
------------------------------------------------------------
fn_setup_rdb - Install version
------------------------------------------------------------
Upgrade IS. Running fn_migrate ...
```

```
Running fn_build -a
RDBMS type: DB2
Please enter the f_maint user password (note: password will not echo):
Please enter the f_maint user password again for verification:
Please enter the f_sw user password (note: password will not echo):
Please enter the f_sw user password again for verification:
Please enter the f_sqi user password (note: password will not echo):
Please enter the f_sqi user password again for verification:
Please enter the f_open user password (note: password will not echo):
Please enter the f_open user password again for verification:
fn_util: Special RDB password file is created
fn_util: done
Successfully verifying logons for the above users.
Execution complete.

# fn_util init # This will create or replace (DELETE) existing objects!
[...]
```

If the system requires an adapted configuration for the Pooled Process Manager (PPM), you must modify `/fnsw/etc/serverConfig` now. This configuration file is also located on the local disks of node 1 and must be copied over to node 2 later:

```
# vi /fnsw/etc/serverConfig
```

IS Toolkit installation

We install the IS Toolkit (ISTK) 4.1.2 locally on each IS cluster node, because it might be useful for creating a customer-specific application monitor. The ISTK is optional, but it might also be required for applications, such as DART, HPII, MRII, BatchIt, and for customer-created applications that act as a client for IS. See Example 11-29.

Example 11-29 Installation of the IS Toolkit

```
# export DISPLAY=$(who am i|awk '{gsub("\\(|\\)",""); print $NF":0"}')
# cd /instsrc/IM/ISTK412-18/
# ./istk_4.1.2_aix.bin

InstallShield Wizard
Initializing InstallShield Wizard...
Preparing Java(tm) Virtual Machine...
Running InstallShield Wizard...

# more /fnsw/client/logs/install/4_1_2/install_ISTK_Runtime_log.txt

# rm -r /fnsw/client_backup
```

If you install and use ISTK, start and stop it with the IS application server scripts.

Because ISTK is installed locally (in `/fnsw/client`), it does not interfere with the IS takeover. However, because it is a client to IS, it will be affected by the takeover and must be restarted with IS.

ISTK applications and IS are often started on the same node (by the IS start script), because usually when IS needs to fail over to the standby node, there is a problem, and ISTK also might not work properly any longer. Then again, ISTK might be started on the "inactive" node to create a form of load balancing and an active (IS)/active (ISTK) cluster. This approach works only if each node has a local copy of the `/fnsw` file system.

CFS-IS configuration

We configure Content Federation Services for IS (CFS-IS), so that the Content Engine (CE) of the P8 system can use IS as a repository and IS can federate new documents to CE.

The CFS-IS documentation, *IBM FileNet P8 Content Federation Services for Image Services, Version 4.0, Guidelines*, GC31-5484, states that "*IS systems with remote clustered databases are not supported."* This statement is out-of-date and no longer true with IS 4.1.2, as shown in this book.

We create the following configuration in Xapex for CFS-IS:

- Security:
  - User: `CFSADMIN`
  - Group: `CFSRMGRP`
  - Max. Logons: `100`
- Media family:
  - Tranlog 1: `CFSTEST_T_M_8G (Tranlog) – MSAR a (/msar1)`
  - Primary: `CFSTEST_P_M_8G (Primary) – MSAR a (/msar1)`
- Document class
  - Class Name: `Contracts`
- Indexes
  - LastName: `IS: String (25), key – CE: String (26)`
  - FirstName: `IS: String (25) – CE: String (26)`
  - SSN: `IS: String (11), key – CE: String (12)`
  - Income: `IS: Numeric – CE: Float`
  - Approver: `IS: String (25), key – CE: String (26)`
  - Approval: `IS: String (2), key – CE: String (3)`

One of the first steps of the CFS-IS configuration is to run the IS Record Management (RM) utility, as shown in Example 11-30.

Example 11-30 CFS-IS RM configuration

```
# su - fnsw
# SEC_rm_config

Image Services Record Management Configuration Utility

Command line options:

 d     Display current configuration settings
 e     Edit configuration settings
 s     Save configuration settings
 p     Print Menu
 q     Quit

Enter command => d

Current Image Services Configuration:
Record Security Level     : READ_ONLY
RM Group                  : UNDEFINED
RM Log Level              : MINIMAL

Current User Selected Configuration:
Record Security Level     : READ_ONLY
RM Group                  : UNDEFINED
RM Log Level              : MINIMAL

Enter command => e

Edit Record Level Security

s   READ_ONLY
w   APPEND_ONLY
n   NO_CHANGE
Enter Record Level Security [READ_ONLY] => n

Edit Record Manager Group

Enter Record Manager Group Name [UNDEFINED] => CFSRMGRP

Edit Activity Log Level

m   MINIMAL
v   VERBOSE
Enter Activity Log Level [MINIMAL] => m

Enter command => s

Saving Record Management control table information...
SEC_rm_config: Record Management settings have been successfully updated

Enter command => d

Current Image Services Configuration:
```

```
Record Security Level     : NO_CHANGE
RM Group                  : CFSRMGRP
RM Log Level              : MINIMAL

Current User Selected Configuration:
Record Security Level     : NO_CHANGE
RM Group                  : CFSRMGRP
RM Log Level              : MINIMAL

Enter command => q

Exiting...
```

On the Content Engine (CE), we add the NCH entry `fnis-filenet-nch-server` to `C:\WINDOWS\system32\drivers\etc\hosts` on both CE servers.

In Enterprise Manager (EM) on the CE, we create the document class Contracts as a sub-class of FNIS (IS system), which is again a sub-class of the Image Services parent document class by using **Image Services** → **FNIS** → **Contracts**.

After we configure CFS-IS on both IS and CE, we start the CFS Agents for Import and Export of documents (in EM on the CE).

The CFS-IS error log is located on each of the CE servers:

```
# cd /usr/IBM/WebSphere/AppServer/profiles/server1/FileNet/server1/
# pg p8_server_error.log
```

For troubleshooting, CFS-IS tracing can be (temporarily) enabled in EM for the whole system, click **Enterprise Manager [FNHA]** → **Properties** → **Trace Control.**

You can also enable tracing individually for each server (for example, server1) by clicking **Enterprise Manager [FNHA]** → **Sites** → **Initial Site [Default]** → **Virtual Servers** → **fnI10Node01** → **server1** → **Properties** → **Trace Control**.

Enable tracing for the CFS Daemon and the CFS Import Agent.

The trace log that is created on the CE server is `p8_server_trace.log`:

```
# cd /usr/IBM/WebSphere/AppServer/profiles/server1/FileNet/server1/
# pg p8_server_trace.log
```

CFS-IS was tested as part of the IS takeover tests and did not show a problem when IS was restarted due to the takeover.

Cluster node 2 installation

You must repeat the installation and configuration steps that were performed on node 1 of the IS cluster on node 2, but certain steps (such as initializing the database) can be omitted.

Running all installers (DB2 client and Image Services GA/SP/FP) again on the standby node is the only way to ensure that all scripts are run and that all changes to the local system (for example, modifications to AIX Object Data Manager (ODM) and `/etc/services`) are made, that are required to start IS. We cannot predict the type of modifications that current or future installation wizards will make.

Switch cluster resources to standby node

In our lab, the IS resource group was switched to node 2 with HACMP, so the required resources (particularly IS service address and volume group) were available on the standby node for the installations.

These application server (AS) scripts were still disabled on both nodes, so IS was not started on node 2 by the takeover:

- `/opt/FileNet/ha_scripts/fnis_start.sh`
- `/opt/FileNet/ha_scripts/fnis_stop.sh`
- `/opt/FileNet/ha_scripts/fnis_mon.sh`

Because the IS stop script was disabled on node 1, IS had to be brought down manually for the HACMP takeover as shown in Example 11-31.

Example 11-31 Stopping IS manually on node 1

```
# su - fnsw
$ initfnsw -y stop # terminate IS

$ killfnsw -yASD # clean up remaining processes

# umount -t fnvg # verify /fnsw/local can be unmounted
```

With the IS application down, the resource group can be moved to the standby cluster node:

```
# smitty hacmp
```

Click **System Management (C-SPOC)** → **HACMP Resource Group and Application Management** → **Move a Resource Group to Another Node / Site** → **Move Resource Groups to Another Node**.

Enter these values:

- Resource Group: `fnis_rg`
- Destination Node: `fnl44`
- `tesxt`

You can monitor the takeover process can be monitored on both nodes with this command:

```
# tail -f /var/hacmp/log/hacmp.out
```

After the takeover completes, the IS resource group fnis_rg and the IS service address fnis must be up on node 2. See Example 11-32.

Example 11-32 Verifying the HACMP cluster state after takeover

```
# cd /usr/es/sbin/cluster
# clstat -ao

               clstat - HACMP Cluster Status Monitor
               -------------------------------------

Cluster: fnis   (1222565798)
Sun Nov  2 10:06:59 PST 2008
               State: UP               Nodes: 2
               SubState: STABLE

        Node: fnl43             State: UP
           Interface: fnl43-bt1 (2)            Address: 10.10.10.53
                                               State:   UP
           Interface: fnl43_vpath0_01 (0)      Address: 0.0.0.0
                                               State:   UP
           Interface: fnl43-hs03 (1)           Address: 10.0.3.53
                                               State:   UP

        Node: fnl44             State: UP
           Interface: fnl44-bt1 (2)            Address: 10.10.10.54
                                               State:   UP
           Interface: fnl44_vpath0_01 (0)      Address: 0.0.0.0
                                               State:   UP
           Interface: fnis (2)                 Address: 9.30.188.78
                                               State:   UP
           Interface: fnl44-hs03 (1)           Address: 10.0.3.54
                                               State:   UP
           Resource Group: fnis_rg                     State:  On line

# ifconfig -a | grep 9.30.188.78
```

```
        inet 9.30.188.78 netmask 0xffffff00 broadcast 9.30.188.255

# mount | grep fnvg
         /dev/fn_local    /fnsw/local      jfs2   Nov 02 09:03
rw,log=/dev/fnvg_jfs2log
         /dev/fn_msar1    /msar1           jfs2   Nov 02 09:03
rw,log=/dev/fnvg_jfs2log
         /dev/fn_backup   /backup          jfs2   Nov 02 09:03
rw,log=/dev/fnvg_jfs2log
```

Installation steps on node 2

When the IS service address and fnvg volume group are available on node 2, you must repeat all of the installation steps from node 1 on the standby node.

With the following exceptions, you must repeat all of the steps in “Image Services installation” on page 305:

- You must make a backup of the latest IS Configuration Database (CDB) in `/fnsw/local/sd/conf_db` *in advance*.
- DB2 server users already exist and are not required to be created again.
- You are not required to run the IS Configuration Editor (fn_edit) again. If the latest CDB file is missing, restore it from the previous backup. You do have to run the steps following **`fn_build`** again.
- You must *not* initialize the databases another time with **`fn_util init`**.

The `/fnsw/etc/serverConfig` file was created locally on node 1 during the initial installations. It might be copied over from node 1 to node 2 so that it does not have to be created another time.

The following files from node 1 might be copied partially or with extreme care to node 2. Use the IS-related entries only:

- `/etc/hosts`
- `/etc/inittab`
- `/etc/tunables/nextboot`
- `/etc/rc.dt`

IS cluster scripts for HACMP

IS is integrated into the HACMP resource group (RG) fnis_rg by means of the application server (AS) fnis_app_srv. The AS uses the following start, stop, and monitor scripts to control the IS application:

- /opt/FileNet/ha_scripts/fnis_start.sh # Start script
- /opt/FileNet/ha_scripts/fnis_stop.sh # Stop script
- /opt/FileNet/ha_scripts/fnis_mon.sh # Monitor script

The HACMP application server and its monitor are created using SMIT.

For this book, we choose to restart IS three times, and then, initiate a takeover to the standby node, if the application monitor still declares IS is not working. A restart count of `3` is the default. However, in a production environment, it might be better to switch to the other node already after one unsuccessful restart of IS. If one restart does not fix the problem, chances are another two restarts will not fix the problem either. However, a takeover is the last chance for the cluster to make IS available again.

Use this command:

```
# smitty hacmp
```

Click **Extended Configuration** → **Extended Resource Configuration** → **HACMP Extended Resources Configuration** → **Configure HACMP Application Servers** → **Configure HACMP Application Servers** → **Add an Application Server**.

Enter these values:

- Server Name: `fnis_app_srv`
- Start Script: `/opt/FileNet/ha_scripts/fnis_start.sh`
- Stop Script: `/opt/FileNet/ha_scripts/fnis_stop.sh`

Use this command:

```
# smitty hacmp
```

Click **Extended Configuration** → **Extended Resource Configuration** → **HACMP Extended Resources Configuration** → **Configure HACMP Application Servers** → **Configure HACMP Application Monitoring** → **Configure Custom Application Monitors** → **Add a Custom Application Monitor**.

Enter these values:

- Monitor Name: `fnis_app_mon`
- Application Servers to Monitor: `fnis_app_srv`
- Monitor Mode: `Long-running monitoring`
- Monitor Method: `/opt/FileNet/ha_scripts/fnis_mon.sh`
- Monitor Interval: `60 # run fnis_mon.sh every 60 seconds`
- Stabilization Interval: `120 # wait 60 seconds before monitoring IS`
- Restart Count: `3 # restart IS 3 times on this node before takeover`
- Action on Application Failure: `fallover`

After the application server is defined, it must be integrated into the IS resource group using this command:

```
# smitty hacmp
```

Click **Extended Configuration** → **Extended Resource Configuration** → **HACMP Extended Resource Group Configuration** → **Change/Show Resources and Attributes for a Resource Group**.

Enter these values:

- Resource Group Name: `fnis_rg`
- Participating Nodes (Default Node Priority): `fnl43 fnl44`
- Startup Policy: `Online On Home Node Only`
- Fallover Policy: `Fallover To Next Priority Node In The List`
- Fallback Policy: `Never Fallback`
- Service IP Labels/Addresses: `fnis`
- Application Servers: `fnis_app_srv`
- Volume Groups: `fnvg`

The modified HACMP configuration must be synchronized to the other node:

```
# smitty hacmp
```

Click **Extended Configuration** → **Extended Verification and Synchronization**.

IS start script

The start script will bring up IS on the active cluster node, either when the resource group is coming online, or after a takeover on the standby node.

The IS start script, in addition to obviously starting Image Services, performs additional tasks to make sure that IS can be started properly. Otherwise, the restart or takeover of the application server will not help to make IS highly available.

The start script must not assume that the stop script has been run successfully (for example, on another node), so the start script also has to perform initial “cleanup”.

We recommend for the AS start script:

- Add an entry to the `errlogger` AIX log, `sys_log` IS log, and a proprietary log. Log entries that include the current host name facilitate troubleshooting. Because the IS `elog` is located on the shared VG, it can be difficult to tell which node wrote the log entries in `/fnsw/local/logs/elogs/elog*`.

- Set permissions on IS database files in the shared VG (**chown**, **chmod**, and **/fnsw/bin/fn_setup -d /**). The LV permissions can get lost, when for example, the HACMP “lazy update” feature imports the VG after changes.
- Stop IS (**initfnsw -y stop**) and end any existing IS process (**killfnsw -ADSy**, **kill -15**, and **kill -9**). Because /fnsw is available on the standby node as well, IS processes might have been started and can stop and prevent the takeover of IS. Most IS commands on the inactive cluster node will stop. You need to end these IS commands before you can start IS on this node in the case of a takeover.
- Unlock databases after failed backups (**EBR_orreset**, **EBR_ulmk**). End the backup mode, if the takeover occurred during a database backup.
- Remove the IS Guard File (**killfnsw -y -r**). Failed processes can leave the /fnsw/etc/killfnsw guard file, which prevents IS from starting on that node.
- Reset the SCSI bus if an OSAR is attached (with a C program).
- If applicable, start local, site-controlled databases and DB listeners. Also check the DB connection before IS tries to connect.
- Start Image Services (**initfnsw start**).
- Time out and terminate stopped commands started by the script.
- Make the script reentrant, so that it can be called another time. The start script must not stop and restart IS, if it is already running.
- Return a meaningful exit code in case of errors (0 = success).

The script must time out processes that it started. A way to catch stopped processes is to start them in the background and end them after a predefined time as shown in Example 11-33.

Example 11-33 Monitoring commands in the cluster script

```
yes "" | su - fnsw -c "initfnsw -y status" 2>/dev/null & # start
command in background
PID=$!

typeset -i TIMEOUT=60 # wait 60 seconds for the command to complete
while [[ TIMEOUT=$TIMEOUT-1 -gt 0 ]]; do
  ps -p $PID >/dev/null 2>&1 || break
  sleep 1
done

ps -p $PID >/dev/null 2>&1 # if process still exists, kill it
if [[ $? -eq 0 ]]; then
  kill $PID
  sleep 3
```

```
  ps -p $PID >/dev/null 2>&1
  if [[ $? -eq 0 ]]; then
    kill -9 $PID
  fi
fi
```

HACMP runs the cluster scripts as the root user. IS-related commands, which require IS environment variables to be set, must be started with **su - fnsw -c**. Because the IS-provided profile for fnsw asks for user input (TERM), the **yes ""** command answers these questions with a (blank) line feed. We also recommend that you disable any user input in any `.profile`, but at least in the `.profile` of the fnsw user.

Example 11-34 shows a basic start script (fnis_start.sh) that was used for the book lab.

Example 11-34 HACMP start script /opt/FileNet/ha_scripts/fnis_start.sh

```
#!/bin/ksh

echo "Starting FileNet Image Services ....."
su - fnsw -c "sys_log \"HACMP Starting IS on node $(uname -n)\""

cd /fnsw/dev/1
chown fnsw:fnusr sec_* permanent_* transient_* cache*
chmod 0660 sec_* permanent_* transient_* cache*

yes "" | su - fnsw -c "initfnsw -y stop" 2>/dev/null
sleep 15
yes "" | su - fnsw -c "killfnsw -yADS" 2>/dev/null
sleep 3
yes "" | su - fnsw -c "killfnsw -yADS" 2>/dev/null
sleep 3
yes "" | su - fnsw -c "initfnsw start" 2>/dev/null

exit 0
```

IS stop script

The stop script brings down IS on the active cluster node, either when the node or resource group is going offline, or just before a takeover occurs.

The IS stop script - similar to the start script - needs to perform additional tasks to make sure that IS is stopped completely. Otherwise, the takeover can fail, for example, because a file system cannot be unmounted if a stopped IS process is blocking it.

We recommend for the AS stop script:

- Add an entry to the `errlogger` AIX log, `sys_log` IS log, and a proprietary log.
- Remove the IS Guard File (**`killfnsw -y -r`**).
- Stop Image Services (**`initfnsw -y stop`**).
- End any remaining IS process (**`killfnsw -ADSy`**, **`kill -15`**, and **`kill -9`**). The files in `/fnsw/procs` might also help to find remaining IS processes.
- If applicable, end any IS client process, for example, ISTK clients (/fnsw/client/bin/wal_purge), COLD (/fnsw/bin/cold_3770), or DART/HPII/MRII.
- End any process owned by fnsw or fnusr or any ISTK user, plus all vl -t processes (**`kill -15`** or **`kill -9`**). With X/CDE, **`aixterm -e`** might run vl -t processes that can easily be missed and have to be ended separately.
- If applicable, stop local, site-controlled databases and DB listeners.
- End any process accessing and blocking a shared file system (**`fuser -ku /dev/fn_fnsw`**). Remember to use the LV device for **`fuser`**, not the file system, to catch processes in all subdirectories of the FS, as well.
- Remove the shared memory that owned by fnsw or fnusr (ipcs and ipcrm).
- Unload unused shared libraries (**`slibclean`**).
- Time out and terminate stopped commands that were started by the script.
- Make the script reentrant, so that it can handle being called another time. The stop script might try to stop IS again (as a “clean” script), even if IS is already stopped.
- Return a meaningful exit code in case of errors (0 = success).

We recommend that you add code for troubleshooting to the stop script (such as calling **`/fnsw/bin/ipc_tool`** or **`/fnsw/support/911`**) to collect data that will be lost when IS is terminated, but to disable this code for normal cluster operation. In the case of a failure, a reliable restart or takeover of IS is usually more important than collecting debug information.

Example 11-35 shows a basic stop script called fnis_stop.sh that was used for the book lab.

Example 11-35 HACMP stop script /opt/FileNet/ha_scripts/fnis_stop.sh

```
#!/bin/ksh

echo "Stopping FileNet Image Services ....."

# Try to stop IS gracefully
```

```
yes "" | su - fnsw -c "sys_log \"HACMP Stopping IS on node $(uname
-n)\"" 2>/dev/null

# Terminate remaining IS processes
yes "" | su - fnsw -c "initfnsw -y stop" 2>/dev/null
sleep 15
yes "" | su - fnsw -c "killfnsw -yADS" 2>/dev/null
sleep 3
yes "" | su - fnsw -c "killfnsw -yADS" 2>/dev/null

# Kill all processes of user fnsw or group fnusr
for PID in $(ps -ef | awk '$1=="fnsw" {print $2}'); do
  echo "Killing process $PID ($(ps -p $PID -o comm | tail -1)) ..."
  kill $PID
  sleep 3
  ps -p $PID >/dev/null 2>&1
  if [[ $? -eq 0 ]]; then
    kill -9 $PID
  fi
done

# Clean up shared memory
ipcs -s | awk '$5=="fnsw"||$6=="fnusr" {system("ipcrm -s "$2)}'
ipcs -q | awk '$5=="fnsw"||$6=="fnusr" {system("ipcrm -q "$2)}'
ipcs -m | awk '$5=="fnsw"||$6=="fnusr" {system("ipcrm -m "$2)}'

slibclean

exit 0
```

IS monitor script

The IS monitor script tells HACMP if the application server is still working, or if a restart or takeover of the IS resource group is required.

Monitoring Image Services can be extremely tricky, because IS has many processes that are configurable in number, or start on demand only. A running process does not guarantee IS is still working properly and can be accessed by clients. The TM_daemon process, for example, rarely ends when IS stops. Therefore, we recommend that you use an HACMP Custom Application Monitor (a monitor shell script) instead of a Process Application Monitor. A Process Application Monitor is not flexible enough to handle changing numbers of processes and also cannot “talk” to IS to see if it is actually working.

The IS monitor script needs to cover all of the components of the IS server, such as network, databases, security, and document retrieval. Here are suggestions for what the monitor can cover, even though several suggestions might not apply in all IS configurations:

- Add an entry to the `errlogger` AIX log, `sys_log` IS log, and a proprietary log if a failure is detected.
- Verify that IS core processes are running, for example, TM_daemon, COR_Listen, NCH_daemon, bes_commit, or ds_init. 0 to *n* instances of a process might be running, depending on the configuration of IS. A sophisticated monitor can check the CDB for the number of processes configured.

  The process files in `/fnsw/procs` can also be used to find current processes. However, this approach is undocumented, and dead processes will immediately be removed from the directory by IS, so it cannot be used to search for missing processes.
- Verify that additional "client" IS processes are running, such as COLD, DART, HPII, MRII, and customer applications that are based on ISTK.
- Check if the DB client can connect to the database and if the DB is available. For DB2, commands, such as **`db2 connect to`**, can be used.
- Check if IS can connect to the Index database (**`GDBcheckdb -1`**).
- Log on to IS with **`fnlogon`** or an ISTK application. Create a small ISTK application that logs on, retrieves a document, and logs off. The test_logon_is.exe program is only available in ISTK on Windows.
- Verify ServiceProcess:System:System is logged in using "SEC_tool" - "who".
- Query the Security, Permanent, and Transient DB with **`MKF_tool`**. For example:

  ```
  echo "select docs doc_id=$MonitorDocID\nquit" | MKF_tool
  ```
- Prefetch a test document into page cache, for example, with **`docfetch -s $MonitorDocID`**.
- Find and retrieve the prefetched document in page cache. For example:

  ```
  echo "list 1 $(ssn) $MonitorDocID 1\nquit" | CSM_tool
  echo "objecttofile 1 $(ssn) $MonitorDocID 1
     /fnsw/local/tmp/$MonitorDocID.1.obj\nquit" | CSM_tool
  ```
- Query the NCH database with **`nch_tool`** or **`MKF_tool`**. For example:

  ```
  echo "defaultdomain\nquit" | nch_tool
  ```
- Allow the administrator to manually stop and start IS on the command line (**`initfnsw stop`** / **`initfnsw start`**) without reporting an IS failure. The IS

commands **/fnsw/local/sd/ims_stop** and **/fnsw/local/sd/ims_start** can be used to record the IS state in a file, which is queried by the monitor.

- If one test fails, skip the remaining tests to avoid unnecessary stopped processes.
- Time out and terminate stopped commands that were started by the script.
- Make the script reentrant, so that it can handle being called another time.
- Return a meaningful exit code in case of errors (0 = success).

The **initfnsw status** command is not sufficient to decide if IS is actually running. In fact, this command often stops when IS has a problem, so do not use this command for monitoring. Several of the tools that are used here are not meant for production and are not supported for use in scripts, but then, they might be the only supported way to access MFK databases or cache, for example. Use with caution.

The monitor script must complete within the “Monitor Interval” configured, or preferably well before that. Many of the IS tools suggested for monitoring might also stop when IS has a problem. These commands must be timed by the script. Otherwise, HACMP will terminate the IS application monitor if the script does not respond within the “Monitor Interval”. The monitor must also not be run too frequently to avoid problems caused by the monitor itself, such as stopped IS tools or performance implications.

For the monitor script, it might be useful to know the name of the latest IS configuration database (CDB) file. See Example 11-36.

Example 11-36 Finding the current (latest) CDB file

```
IS_CDB_FILE=$(find /fnsw/local/sd/conf_db -name "IMS_*.cdb" \
  -exec basename \{} ".cdb" \; |awk '/IMS_[1-9]*[0-9]$/ \
  { CDB= substr($0,5,length); if(CDB>MAXCDB) MAXCDB=CDB } END \
  { printf("IMS_%s.cdb", MAXCDB) }')
```

You can query the CDB to discover if a certain service is configured. See Example 11-37.

Example 11-37 Check CDB if Batch Services are configured

```
CDB_SERVER_ID=$(echo "identity" | cdb_tool | cut -f2 -d ' ')
CDB_SVC_INDEX=$(echo "find server_services
server_id=${CDB_SERVER_ID}\nget u batch_serv" | cdb_tool)
```

You can also receive the number of processes configured from the CDB. See Example 11-38.

Example 11-38 Query CDB for number of ds_notify processes

```
CDB_DOMAIN_ID=$(echo "identity" | cdb_tool | cut -f1 -d ' ')
CDB_DSNOTIFY_PROCS=$(echo "find system_appl_serv
domain_id=${CDB_DOMAIN_ID}\nget u ds_notify" | cdb_tool)
```

Example 11-39 shows a basic monitor script called fnis_mon.sh that was used for the book lab.

Example 11-39 HACMP monitor script /opt/FileNet/ha_scripts/fnis_mon.sh

```
#!/bin/ksh

MonitorUser="HAMonitorUser"
MonitorPWD="HAMonitorPwd"
MonitorDocID="100074"
ISFaulted=0

# Verify core IS processes are running
PROC_TEST=0
for PROC in TM_daemon COR_Listen ilk_daemon NCH_daemon MKF_writer \
  MKF_clean SEC_daemon CSM_daemon INXbg DOCs INXs INXu SECs
do
  ps -eo comm | grep $PROC | grep -v $$ >/dev/null
  if [[ $? -ne 0 ]]; then
    PROC_TEST=1
  fi
done
[[ $PROC_TEST -ne 0 ]] && ISFaulted=1

# Logon to IS with fnlogon
if [[ ISFaulted -eq 0 ]]; then
  yes "" | su - fnsw -c "echo \"${MonitorUser}\n${MonitorPWD}\n\n\nexit\" | \
    fnlogon;cd" 2>/dev/null | grep "fnlogon: executing" >/dev/null
  LOGON_TEST=$?
  [[ $LOGON_TEST -ne 0 ]] && ISFaulted=1
fi

# Verify ServiceProcess in SEC_tool
if [[ ISFaulted -eq 0 ]]; then
  yes "" | su - fnsw -c "echo \"who\nquit\" | SEC_tool" 2>/dev/null | \
    grep "ServiceProcess:System:System" >/dev/null
  SEC_TEST=$?
  [[ $SEC_TEST -ne 0 ]] && ISFaulted=1
fi

# Prefetch a document into page cache
if [[ ISFaulted -eq 0 ]]; then
  yes "" | su - fnsw -c "docfetch -s $MonitorDocID" 2>/dev/null | \
```

```
    grep "$MonitorDocID retrieved" >/dev/null
  PREFETCH_TEST=$?
  [[ $PREFETCH_TEST -ne 0 ]] && ISFaulted=1
fi

# Return status of tests
if [[ $ISFaulted -ne 0 ]]; then
  exit 1 # IS may have a problem
else
  exit 0 # IS is running
fi
```

Automatic synchronization

As a last step, when IS is installed and configured on all cluster nodes, you must add local scripts and configuration files to an HACMP File Collection. This way, HACMP keeps local files in sync between cluster nodes. To set up a File Collection, see “HACMP File Collection” on page 362.

11.2.3 Integrating an existing IS into HACMP

You can convert an existing IS system to an HACMP cluster.

However, we prefer a fresh installation of both cluster nodes (and a later migration of existing data), because it requires less downtime, and the cluster can be tested in more detail before being taken into production.

The following high-level steps are necessary to reconfigure the original server as node 1 and to install IS on node 2 of the new cluster:

1. Install and configure HACMP on both cluster nodes.
2. Make sure that UID and GID of the IS users and groups match on both nodes.
3. Move the `/fnsw/local`, `/msar1`, and `/backup` file systems to the shared disks of the cluster. Disable the auto varyon of the shared VG, and disable auto mount of the shared file systems on both nodes.
4. Change the IP address of IS to the service address of the RG. Alternatively, use the existing IS address as the service address.
5. Disable the autostart of IS from `/etc/inittab`.

Moving file systems to a SAN

The files in the `/fnsw/local` file system can be copied to a separate mount point on the shared VG, and then, the shared file system is mounted in place of the existing local FS. If the old and new file system cannot be mounted concurrently,

the /fnsw/local file system must be backed up and restored, for example, with the **tar** command. See Example 11-40.

Example 11-40 Copying /fnsw/local to a shared file system

```
# cd /fnsw/local
# tar cvf - . | (cd /shared/fnsw/local; tar xf -)
```

To disable the auto mount of the shared file systems and to add the file system to the fnvg mount group (and FS), enter # **chfs -An -u fnvg /fnsw/local**.

Matching UID/GID between nodes

The user ID (UID) and group ID (GID) of the fnsw user and the root user must be identical between all cluster nodes. If an ID has to be changed to make the nodes match, the permissions of all of the files that are owned by fnsw have to be updated. For native IS files, use **fn_setup -d /**. You can change other files (for example, in /msar) by using **find**. See Example 11-41.

Example 11-41 Updating permissions on IS files

```
# fn_setup -d /
fn_setup: using configuration value to set the relational database type
fn_setup: using configuration value to set the relational database home
fn_setup: Creating file /fnsw/local/setup_config
fn_setup: Changing permission on FileNET IS software and databases

# ls -l /msar1/*.dat
-rw-rw----    1 500      600        40871936 Oct 26 03:10
/msar1/003000.dat
-rw-rw----    1 500      600        40871936 Oct 26 03:10
/msar1/003002.dat

# find /msar1 -user 500 -exec chown fnsw {} \;
# find /msar1 -group 600 -exec chgrp fnusr {} \;

# ls -l /msar1/*.dat
-rw-rw----    1 fnsw     fnusr      40871936 Oct 26 03:10
/msar1/003000.dat
-rw-rw----    1 fnsw     fnusr      40871936 Oct 26 03:10
/msar1/003002.dat
```

HACMP service address for IS

To change the IP address of Image Services, use the IS Configuration Editor (**fn_edit**). See Example 11-42.

Example 11-42 IS network reconfiguration

```
# su - fnsw
$ export DISPLAY=$(who am i|awk '{gsub("\\(|\\)",""); print $NF":0"}')

$ fn_edit

$ fn_build -a
```

Figure 11-6 shows the IP address of IS in the Network Addresses tab.

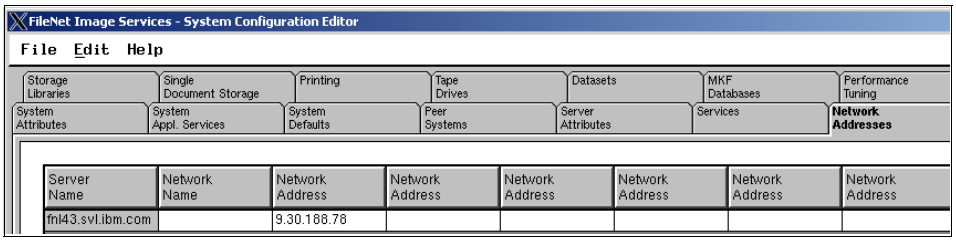


Figure 11-6 HACMP service address that is used for IS

In rare cases, you must rebuild the NCH database to change all IP addresses in the DB. Perform the following steps:

1. Stop IS: **`initfnsw -y stop ; sleep 10 ; killfnsw -ADSy`**
2. Initialize the NCH DB: **`rm /fnsw/local/sd/NCH_db0 ; fn_util initnch`**
3. Install the Software License Access Control (SLAC) key: **`lic_admin -f /fnsw/local/SLAC/uisora.key`**
4. Start IS: **`initfnsw start`**
5. Register WFL queues with NCH: **WQS_tool** → **allowupdates** → **qnch * ***

11.2.4 Connecting optical storage libraries

For this book, we only used MSAR storage libraries, which were the easiest and by far most flexible way to add storage to a clustered IS system.

Clients, who really have to connect an optical library to their HACMP cluster, must watch various dependencies that are out of the scope for this book. The following list summarizes several of the considerations that are necessary to connect a shared OSAR to the cluster:

- A shared OSAR is connected to both nodes using a singe SCSI bus.

- "Y" cables (also know as "V" cables) or "inline-terminated" cables must be used, so the bus can be disconnected from a failed node for maintenance and is still operational.
- Each node requires a unique SCSI ID on its SCSI adapter, for example, node 1 = SCSI ID 5 and node 2 = SCSI ID 6.
- Avoid SCSI ID 7 altogether (if possible), because this SCSI ID 7 is the default ID for SCSI adapters when a server boots in maintenance mode. If a cluster node is booted in maintenance mode, and SCSI ID 7 is used on another node on the same bus, the node to be booted must be disconnected from its Y cable first; otherwise, there are two conflicting SCSI IDs 7.
- When assigning SCSI IDs, observe the SCSI priorities:
  7 > 6 > 5 > 4 > 3 > 2 > 1 > 0 > 15 > 14 > 13 > 12 > 11 > 10 > 9 > 8
  In practice, the following assignment is optimal with wide SCSI addressing, which is available since IS Version 4.1.1 on AIX (provided that all devices support wide SCSI). Because all drives share a common SCSI bus, performance might be limited by the bus transfer speed:
  - SCSI Bus 1 (Priority: SCSI adapter > Arm > Drive):
    - SCSI ID 7: N/C (default for server maintenance mode)
    - SCSI ID 6: Node 2 SCSI adapter
    - SCSI ID 5: Node 1 SCSI adapter
    - SCSI ID 4: OSAR Robotic Arm
    - SCSI ID 3: OSAR Drive # 1
    - SCSI ID 2: OSAR Drive # 2
    - SCSI ID 1: OSAR Drive # 3
    - SCSI ID 0: OSAR Drive # 4
    - SCSI ID 15: OSAR Drive # 5
    - SCSI ID 14: OSAR Drive # 6
    - SCSI ID 13: OSAR Drive # 7
    - SCSI ID 12: OSAR Drive # 8
    - SCSI ID 11: OSAR Drive # 9
    - SCSI ID 10: OSAR Drive # 10
- *Narrow SCSI addressing* requires to use two SCSI busses for libraries with more than four drives. In that case, a complete separate SCSI bus is required, including all SCSI adapters, cables, and terminators:
  - SCSI Bus 1 (Priority: SCSI adapter > Arm > Drive):
    - SCSI ID 7: Not used (default for server maintenance mode)
    - SCSI ID 6: Node 2 SCSI adapter
    - SCSI ID 5: Node 1 SCSI adapter
    - SCSI ID 4: OSAR Robotic Arm
    - SCSI ID 3: OSAR Drive # 1
    - SCSI ID 2: OSAR Drive # 2

    - SCSI ID 1: OSAR Drive # 3
    - SCSI ID 0: OSAR Drive # 4
  - SCSI Bus 2 (if applicable):
    - SCSI ID 6: Node 2 SCSI adapter
    - SCSI ID 7: Node 1 SCSI adapter (use ID 5 if fewer than 10 drives)
    - SCSI ID 5: OSAR Drive # 5
    - SCSI ID 4: OSAR Drive # 6
    - SCSI ID 3: OSAR Drive # 7
    - SCSI ID 2: OSAR Drive # 8
    - SCSI ID 1: OSAR Drive # 9
    - SCSI ID 0: OSAR Drive # 10

- Each SCSI bus must be terminated on both ends (only). You might need to remove SCSI terminators on SCSI adapters, if the adapters are not auto terminating.
- If SCSI expanders, such as the Paralan MM16, are used on the shared SCSI bus, you might need to disable internal terminators.
- You must carefully watch the maximum length of the SCSI bus. All cables and devices (including the OSAR and all Y-cables) contribute to the total bus length.
- As of IS 4.1.1, all platforms support the logical unit number (LUN) mode, including the 64-bit AIX platform. However, performance of LUN mode SCSI is evidently inferior to target mode SCSI.
- HP optical libraries do not support LUN mode in clustered environments.
- Consult *IBM FileNet Image Services, OSAR Cable Tool*, 2008-07-22, when planning a supported configuration.
- Refer to *IBM FileNet Image Services, Version 4.1, Release Notes*, GC31-5578-03, which also contains important information regarding the clustering of OSARs.
- Whenever an updated fnsod driver is installed (for example, by an IS patch), you must run the **`/fnsw/bin/fnsod.install`** command on all cluster nodes.
- Use extreme caution when planning to extend shared busses with SCSI expanders (for example, from Paralan, Apcon, Blackbox, and so on). Only a few models handle the optical library SCSI command set correctly, in particular when returning sense data in case of a failure. The stability and the performance of the attached storage library is impaired with increasing cable length.

Figure 11-7 illustrates the connection of a shared OSAR with HACMP.

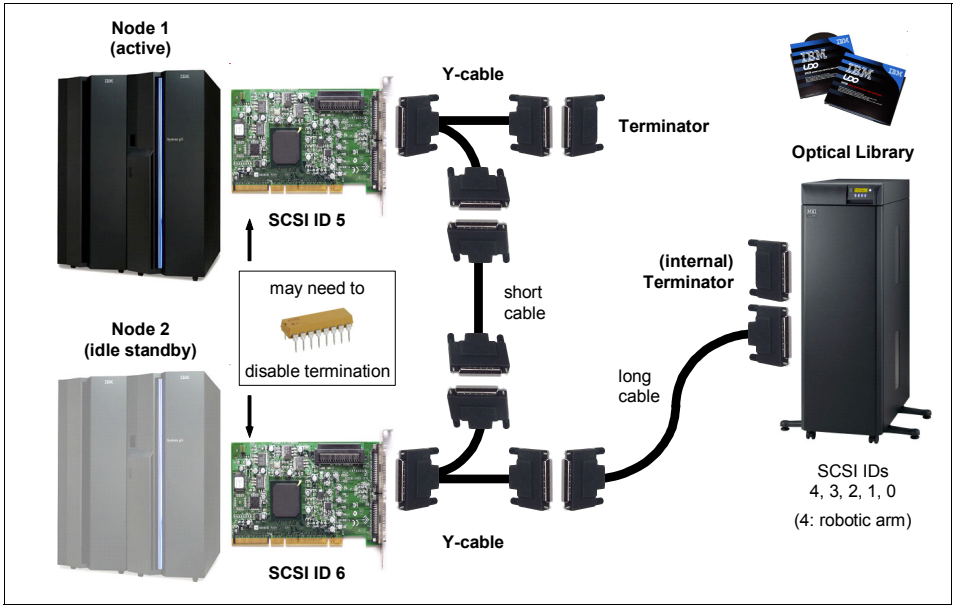


Figure 11-7 Connection of a shared OSAR with HACMP

SCSI-attached optical libraries usually also require special handling during HACMP cluster takeovers.

SCSI reserves might exist and have to be broken when starting a resource group on a cluster node, for example, by issuing a SCSI reset. With HACMP, the **`cl_scdiskreset`** command in `/usr/es/sbin/cluster/events/utils` can be used to reset the SCSI bus. On HP-UX, Image Services provides a **`busreset`** and **`devreset`** command in `/fnsw/bin`.

A SCSI bus reset can also be initiated from a small C program calling:

- `ioctl (ScsiDevice, SIOC_RESET_BUS, 0)` on HP-UX
- `ioctl (ScsiDevice, RESET_ALL, 0)` on the Solaris platform

An alternative way of connecting a shared OSAR is to place the device in between the cluster nodes, in the middle of the SCSI chain, as shown in Figure 11-8.

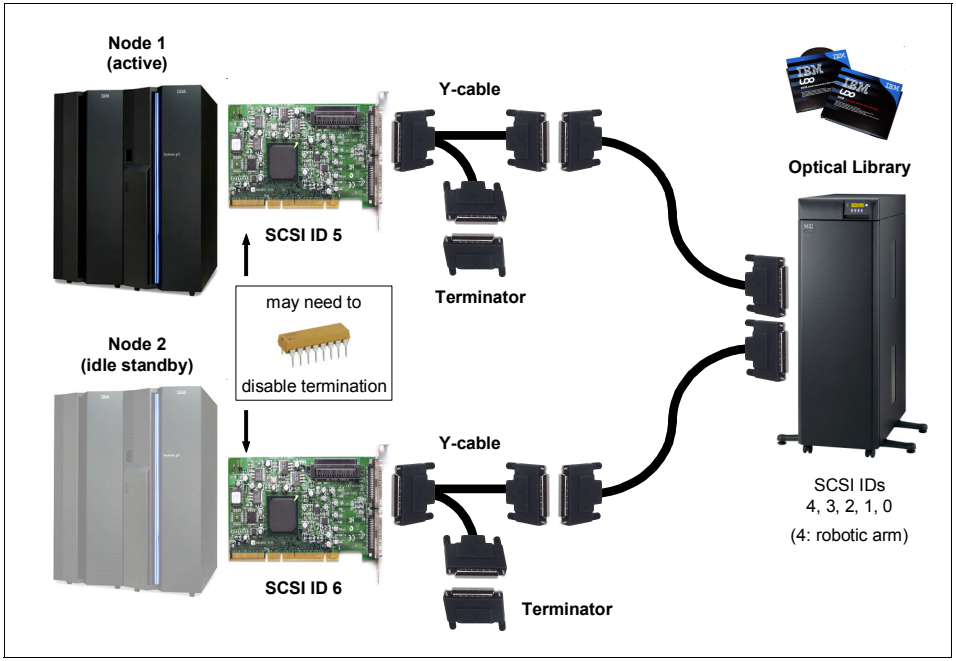


Figure 11-8 Shared OSAR in between the cluster nodes

11.3 High availability test for IS cluster

This section describes the tests that were performed for our case study to verify that the clustered IS is in fact highly available and is capable of resuming operations after a failure.

11.3.1 Restart and takeover tests

You must test the HACMP functionality after every change to the cluster, as well as at fixed intervals, for example, once every six months.

The takeover tests need to include IS server and IS client application tests. For the most part, IS users stay connected and are not required to log on again after IS has been restarted on the standby node. Users, who were only running an IDM Find query, might be required to restart. Batches that were in the process of being scanned with Capture Professional usually have to be deleted and re-scanned after a takeover.

Other applications, such as the IS Resource Adapter (ISRA), P8 Content Federation Services for IS (CFS-IS), and customer applications (for example, based on ISTK or ISRA) must be tested, and their reaction to the HACMP takeover (or IS restart for that matter) needs to be noted.

The following cluster tests were carried out successfully at our lab. With every test, the client connections from IDM Desktop (IDM-DT) and from the P8 Content Engine (CE) through CFS-IS were tested.

Takeover caused by node failure

Table 11-9 on page 343 details the automatic takeover test that we performed.

Table 11-9 Cluster test 1: Automatic takeover

Test 1	Prerequisites/Instructions	Verification/Remark
Test	Both HACMP cluster nodes (fnl43 and fnl44) are active. The IS resource group is online on fnl43, and the IS application server is running. The active cluster node fnl43 is powered off so the HACMP cluster will initiate a takeover of the resource group fnis_rg from node fnl43 to node fnl44. The IS application server fnis_app_srv is stopped. The shared file systems are unmounted. The volume group fnvg is varied off and then varied on at node fnl44, where the file systems are mounted, and IS is restarted using the service address that moved with the IS resource group.	
Initial status	HACMP is started on nodes fnl43 and fnl44: `# smitty hacmp` **System Management (C-SPOC) → Manage HACMP Services → Start Cluster Services** IS is running on node fnl43 (“primary node”): `# smitty hacmp` **System Management (C-SPOC) → HACMP Resource Group and Application Management → Bring a Resource Group Online**	# clstat -ao # lsvg -o # mount # ifconfig -a # initfnsw status IS client tests
Test case	Power off node fnl43 to make HACMP takeover the IS resource group automatically back to node fnl44. Both nodes must have the HACMP services started, or the *failback* will not succeed: `# sync; sync; halt -q`	# tail -f /var/hacmp/log/hacmp.out # vl
Result	HACMP is started on cluster node fnl43, node fnl44 is powered down. IS is running on node fnl44 (“standby node”).	# clstat -ao # initfnsw status IS client tests
After care	Power on node fnl43 and make sure that HACMP is running.	# clstat -ao

Example 11-43 shows the test result.

Example 11-43 Cluster test 1: Automatic takeover

```
# clstat -ao

               clstat - HACMP Cluster Status Monitor
               -------------------------------------

Cluster: fnis   (1222565798)
```

```
               State: UP               Nodes: 2
               SubState: STABLE

          Node: fnl43             State: UP
             Interface: fnl43-bt1 (2)            Address: 10.10.10.53
                                                 State:   UP
             Interface: fnl43_vpath0_01 (0)      Address: 0.0.0.0
                                                 State:   UP
             Interface: fnis (2)                 Address: 9.30.188.78
                                                 State:   UP
             Interface: fnl43-hs03 (1)           Address: 10.0.3.53
                                                 State:   UP
             Resource Group: fnis_rg                     State:  On line

          Node: fnl44             State: UP
             Interface: fnl44-bt1 (2)            Address: 10.10.10.54
                                                 State:   UP
             Interface: fnl44_vpath0_01 (0)      Address: 0.0.0.0
                                                 State:   UP
             Interface: fnl44-hs03 (1)           Address: 10.0.3.54
                                                 State:   UP
```

```
# sync; sync; halt -q # This will stop the node close to power off!
```

```
# clstat -ao
```

```
               clstat - HACMP Cluster Status Monitor
               -------------------------------------

Cluster: fnis   (1222565798)

               State: UP               Nodes: 2
               SubState: STABLE

          Node: fnl43             State: DOWN
             Interface: fnl43-bt1 (2)            Address: 10.10.10.53
                                                 State:   DOWN
             Interface: fnl43_vpath0_01 (0)      Address: 0.0.0.0
                                                 State:   DOWN
             Interface: fnl43-hs03 (1)           Address: 10.0.3.53
                                                 State:   DOWN

          Node: fnl44             State: UP
             Interface: fnl44-bt1 (2)            Address: 10.10.10.54
                                                 State:   UP
             Interface: fnl44_vpath0_01 (0)      Address: 0.0.0.0
                                                 State:   UP
             Interface: fnis (2)                 Address: 9.30.188.78
                                                 State:   UP
             Interface: fnl44-hs03 (1)           Address: 10.0.3.54
                                                 State:   UP
             Resource Group: fnis_rg                     State:  On line
```

```
# pg /var/hacmp/log/hacmp.out
[...]
Terminating processes...
Initializing FileNet software...
Starting index database...
Starting permanent database...
Starting transient database...
Starting security database...
Starting Courier...
Starting NCH_daemon...
Starting the Security Daemon...
Optimizing SEC database...please wait...
Starting INXbg...
Starting INXu...
Starting document services...
Starting batch entry services...
Starting print services...
Startup of FileNet software initiated.  See event log for detailed status.
[...]

# su - fnsw
# initfnsw status

Software status for host 'fnl43.svl.ibm.com' (operating system = AIX):
        Software started since 11/09/08 20:58:12
```

Manual move of IS resource group

Table 11-10 on page 346 details our second test, manual takeover.

Table 11-10 Cluster test 2: Manual takeover

Test 2	Prerequisites/Instructions	Verification/Remark
Test	Both HACMP cluster nodes (fnl43 and fnl44) are active. The IS resource group is online on fnl44, and the IS application server is running. The IS resource group fnis_rg is moved manually with C-SPOC from node fnl44 to node fnl43. The IS application server fnis_app_srv is stopped. The shared file systems are unmounted. The volume group fnvg is varied off and then on at node fnl43, where the file systems are mounted, and IS is restarted using the service address that moved with the IS resource group.	
Initial status	HACMP is started on nodes fnl43 and fnl44: `# smitty hacmp` **System Management (C-SPOC) → Manage HACMP Services → Start Cluster Services** IS is running on node fnl44 (“standby node”): `# smitty hacmp` **System Management (C-SPOC) → HACMP Resource Group and Application Management → Bring a Resource Group Online**	# clstat -ao # lsvg -o # mount # ifconfig -a # initfnsw status IS client tests
Test case	Move IS resource group manually from node fnl44 to node fnl43: `# smitty hacmp` **System Management (C-SPOC) → HACMP Resource Group and Application Management → Move a Resource Group to Another Node / Site → Move Resource Groups to Another Node**	# tail -f /var/hacmp/log/hacmp.out # vl
Result	HACMP is started on cluster nodes fnl43 and fnl44. IS is running on node fnl43 (“primary node”).	# clstat -ao # initfnsw status IS client tests
After care	N/A (cluster is ready for production)	N/A

Example 11-44 on page 347 shows the test result.

Example 11-44 Cluster test 2: Manual takeover

```
# clstat -ao

               clstat - HACMP Cluster Status Monitor
               -------------------------------------

Cluster: fnis   (1222565798)

               State: UP               Nodes: 2
               SubState: STABLE

        Node: fnl43             State: UP
           Interface: fnl43-bt1 (2)            Address: 10.10.10.53
                                               State:   UP
           Interface: fnl43_vpath0_01 (0)      Address: 0.0.0.0
                                               State:   UP
           Interface: fnl43-hs03 (1)           Address: 10.0.3.53
                                               State:   UP

        Node: fnl44             State: UP
           Interface: fnl44-bt1 (2)            Address: 10.10.10.54
                                               State:   UP
           Interface: fnl44_vpath0_01 (0)      Address: 0.0.0.0
                                               State:   UP
           Interface: fnis (2)                 Address: 9.30.188.78
                                               State:   UP
           Interface: fnl44-hs03 (1)           Address: 10.0.3.54
                                               State:   UP
           Resource Group: fnis_rg                     State:  On line


# smitty hacmp

System Management (C-SPOC) → HACMP Resource Group and Application
Management → Move a Resource Group to Another Node / Site → Move Resource
Groups to Another Node

or

# cd /usr/es/sbin/cluster/utilities
# clRGmove -s false -m -i -g fnis_rg -n fnl43

Attempting to move resource group fnis_rg to node fnl43.

Waiting for the cluster to process the resource group movement request.....

Waiting for the cluster to stabilize.............

Resource group movement successful.
Resource group fnis_rg is online on node fnl43.

Cluster Name: fnis
```

```
Resource Group Name: fnis_rg
Node                         State
---------------------------- ---------------
fnl43                        ONLINE
fnl44                        OFFLINE

# clstat -ao

               clstat - HACMP Cluster Status Monitor
               -------------------------------------

Cluster: fnis   (1222565798)

               State: UP               Nodes: 2
               SubState: STABLE

        Node: fnl43             State: UP
           Interface: fnl43-bt1 (2)             Address: 10.10.10.53
                                                State:   UP
           Interface: fnl43_vpath0_01 (0)       Address: 0.0.0.0
                                                State:   UP
           Interface: fnis (2)                  Address: 9.30.188.78
                                                State:   UP
           Interface: fnl43-hs03 (1)            Address: 10.0.3.53
                                                State:   UP
           Resource Group: fnis_rg                      State:  On line

        Node: fnl44             State: UP
           Interface: fnl44-bt1 (2)             Address: 10.10.10.54
                                                State:   UP
           Interface: fnl44_vpath0_01 (0)       Address: 0.0.0.0
                                                State:   UP
           Interface: fnl44-hs03 (1)            Address: 10.0.3.54
                                                State:   UP

# pg /var/hacmp/log/hacmp.out
[...]
Terminating processes...
Initializing FileNet software...
Starting index database...
Starting permanent database...
Starting transient database...
Starting security database...
Starting Courier...
Starting NCH_daemon...
Starting the Security Daemon...
Optimizing SEC database...please wait...
Starting INXbg...
Starting INXu...
Starting document services...
Starting batch entry services...
Starting print services...
Startup of FileNet software initiated.  See event log for detailed status.
```

```
[...]

# su - fnsw
# initfnsw status

Software status for host 'fnl43.svl.ibm.com' (operating system = AIX):
       Software started since 11/09/08 20:58:12
```

Restart of IS by monitor

Table 11-11 details the third test of triggering an IS restart by a monitor.

Table 11-11 Cluster test 3: Restart of IS triggered by a monitor

Test 3	Prerequisites/Instructions	Verification/Remark
Test	Both HACMP cluster nodes (fnl43 and fnl44) are active. The IS resource group is online on fnl43, and the IS application server is running. One of the processes watched by the IS application server monitor is ended to force a restart of IS on node fnl43. The IS application server fnis_app_srv is stopped and restarted. No takeover to node fnl44 will occur.	
Initial status	HACMP is started on nodes fnl43 and fnl44: `# smitty hacmp` **System Management (C-SPOC) → Manage HACMP Services → Start Cluster Services** IS is running on node fnl43 (“primary node”): `# smitty hacmp` **System Management (C-SPOC) → HACMP Resource Group and Application Management → Bring a Resource Group Online**	# clstat -ao # lsvg -o # mount # ifconfig -a # initfnsw status IS client tests

Test case	End the `SEC_daemon` process:
	
	`# ps -ef | grep SEC_daemon | grep -v $$`
	`# kill -9 <PID>`
		# tail -f /var/hacmp/log/hacmp.out
		# vl

Result	IS is restarted on the current node (fnl43), and no takeover occurs.	# clstat -ao # initfnsw status IS client tests
After care	N/A (cluster is ready for production)	

Example 11-45 shows the test result.

Example 11-45 Cluster test 3: Restart of IS triggered by a monitor

```
# cd /usr/es/sbin/cluster/utilities
# clRGinfo -v

Cluster Name: fnis

Resource Group Name: fnis_rg
Startup Policy: Online On Home Node Only
Fallover Policy: Fallover To Next Priority Node In The List
Fallback Policy: Never Fallback
Site Policy: ignore
Node                         State
---------------------------- ---------------
fnl43                        ONLINE
fnl44                        ONLINE

# clRGinfo -m
-----------------------------------------------------------------------------
Group Name     State                        Application state            Node
-----------------------------------------------------------------------------
fnis_rg        ONLINE                                                    fnl43
 fnis_app_srv                                ONLINE MONITORED

# cat /var/hacmp/log/clappmond.fnis_app_mon.fnis_rg.log
Nov 10 02:27:50: read_config: Called [Server=fnis_app_mon]
Nov 10 02:27:50: read_config: MONITOR_TYPE="user"
Nov 10 02:27:50: read_config: RESOURCE_GROUP="fnis_rg"
Nov 10 02:27:50: read_config: MONITOR_METHOD="/opt/FileNet/ha_scripts/fnis_mon.sh"
Nov 10 02:27:50: read_config: MONITOR_INTERVAL=60.
Nov 10 02:27:50: read_config: HUNG_MONITOR_SIGNAL=9.
Nov 10 02:27:50: monitor_by_polling: Called
        method="/opt/FileNet/ha_scripts/fnis_mon.sh"
        interval=60
        mode=(0)Nov 10 02:27:50: monitor_by_polling: Output from monitoring method is
in: /var/hacmp/log/clappmond.fnis_app_mon.fnis_rg.monitor.log

# ps -ef | grep run_clappmond | grep -v $$
    root  827570 1511630   0 02:27:50      -  0:00 run_clappmond -sport 1000
-result_node fnl43 -script_id 0 -command_id 10 -command fnis_app_mon -environment
?FAIL_COUNT=0??CLUSTER_VERSION=9??GS_NODEID=1??APPLICATION_SERVER=fnis_app_mon??MISC_DAT
A=??GROUPNAME=fnis_rg??RESOURCE_GROUP=fnis_rg??RESTART_METHOD=/opt/FileNet/ha_scripts/fn
is_start.sh??CLEANUP_METHOD=/opt/FileNet/ha_scripts/fnis_stop.sh??NOTIFY_METHOD=??MONITO
R_METHOD=/opt/FileNet/ha_scripts/fnis_mon.sh??FAILURE_ACTION=fallover??RESTART_INTERVAL=
594??HUNG_MONITOR_SIGNAL=9??RESTART_COUNT=1??STABILIZATION_INTERVAL=120??MONITOR_INTERVA
L=60??INSTANCE_COUNT=0??PROCESS_OWNER=??PROCESSES=??MONITOR_TYPE=user??HACMP_VERSION=__P
E__??PATH=/usr/bin:/etc:/usr/sbin:/usr/ucb:/usr/bin/X11:/sbin??ODMDIR=/etc/es/objrepos??
LC_FASTMSG=true??PING_IP_ADDRESS=
??LOCALNODEID=fnl43??LOCALNODENAME=fnl43??CM_CLUSTER_NAME=fnis??CM_CLUSTER_ID=1222565798
?
```

```
# /opt/FileNet/ha_scripts/fnis_mon.sh ; echo $?
0

# ps -ef | grep SEC_daemon | grep -v $$
    fnsw 1368254       1   0 02:26:26      -  0:00 SEC_daemon

# kill -9 1368254

# /opt/FileNet/ha_scripts/fnis_mon.sh ; echo $?
1

# pg/var/hacmp/log/clstrmgr.debug
[...]
Mon Nov 10 02:31:58 GetRmCtrlMsg: Called, state=ST_STABLE
Mon Nov 10 02:31:58 GetRmCtrlMsg: RM_ExitStatus msg received, status=2, RP=fnis_app_mon
Mon Nov 10 02:31:58 ResGroupList::monitorExit(): monitor fnis_app_mon, resource id 10,
pid 737480, exi
t status 2
Mon Nov 10 02:31:58 ResourceGroup::monitorExit(fnis_rg)
Mon Nov 10 02:31:58 ResourceList::monitorExit(5)
Mon Nov 10 02:31:58 Resource::monitorExit(fnis_app_mon)
Mon Nov 10 02:31:58 AppmonList::monitorExit: looking for monitor with name fnis_app_mon
and pid 737480
Mon Nov 10 02:31:58 monitor 0 is fnis_app_mon, pid 737480
Mon Nov 10 02:31:58 Appmon::clappmondExit(fnis_app_mon): Called, monitorState 11, exit
status 2
Mon Nov 10 02:31:58 umt::addAction() Called
Mon Nov 10 02:31:58 clappmondExit(fnis_app_mon): retries left (1 of 1), setting
OnlineMonitorFailed
Mon Nov 10 02:31:58 Appmon::setAppState: setting application fnis_app_mon(10) state 8
Mon Nov 10 02:31:58 setAppState: Running FSM with NEW_EVENT
Mon Nov 10 02:31:58 FSMrun: started (0) for transition [ST_STABLE][EV_NEW_EVENT]
Mon Nov 10 02:31:58 FSMrun: running state = ST_STABLE, FSM-event = EV_NEW_EVENT
Mon Nov 10 02:31:58 handleNewEvent: Called, state=ST_STABLE, new
event=TE_SERVER_RESTART, new node=1
[...]

# pg /var/hacmp/log/hacmp.out
[...]
Nov 10 02:31:59 EVENT START: server_restart fnl43 10 fnis_app_mon
[...]
HACMP Event Summary
Event: TE_SERVER_RESTART
Start time: Mon Nov 10 02:31:59 2008
End time: Mon Nov 10 02:32:32 2008
[...]
Terminating processes...
Initializing FileNet software...
Starting index database...
Starting permanent database...
Starting transient database...
Starting security database...
Starting Courier...
```

```
Starting NCH_daemon...
Starting the Security Daemon...
Optimizing SEC database...please wait...
Starting INXbg...
Starting INXu...
Starting document services...
Starting batch entry services...
Starting print services...
Startup of FileNet software initiated.  See event log for detailed status.
[...]

# /opt/FileNet/ha_scripts/fnis_mon.sh ; echo $?
0
```

Note: The manual takeover (test 2) and application failure (test 3) are of greater significance than the node failure (test 1). In test 2 and test 3, HACMP has to bring down all resources cleanly, before they can be used again on the standby node. If a resource cannot be freed (for example, a shared file system cannot be unmounted), the takeover of the whole resource group will fail. If the current node is simply powered off (test 1), all resources are free and can be moved to the other node.

11.3.2 Database reconnect test

As of Version 4.1.2, IS supports remote clustered databases and will reconnect to the database after a database cluster takeover. This new feature is extremely helpful in creating highly available IS and DB2 systems. Previous IS versions were unable to reconnect to the database if it had been restarted or a takeover had occurred, so IS had to be recycled to be able to connect to the database again.

The database reconnect feature is enabled by default in IS Version 4.1.2. You also can enable the database reconnect feature by creating additional database parameters in **fn_edit**:

```
# fn_edit
```

Click **Procedures** → **Add Relational Database Object**.

Table 11-12 on page 353 lists the database reconnect parameters in **fn_edit**.

Table 11-12 Database reconnect parameters in fn_edit

Object name	Location	Default	Remark
db_reconnect_disabled	0	0	1 disables reconnects
db_reconnect_timeout	600	600	Retries up to 10 minutes
db_reconnect_interval	10	10	Retries every 10 seconds

In Example 11-46, the IS Configuration Editor (fn_edit) is started to add the database reconnect parameters by clicking the Procedures tab.

Example 11-46 Database reconnect configuration in fn_edit

```
# su - fnsw
$ export DISPLAY=$(who am i|awk '{gsub("\\(|\\)",""); print $NF":0"}')

$ fn_edit

$ fn_build -a
```

Figure 11-9 shows the additional (optional) *db*_reconnect_* parameters in the Relational Databases tab, RDB Objects subtab of fn_edit.

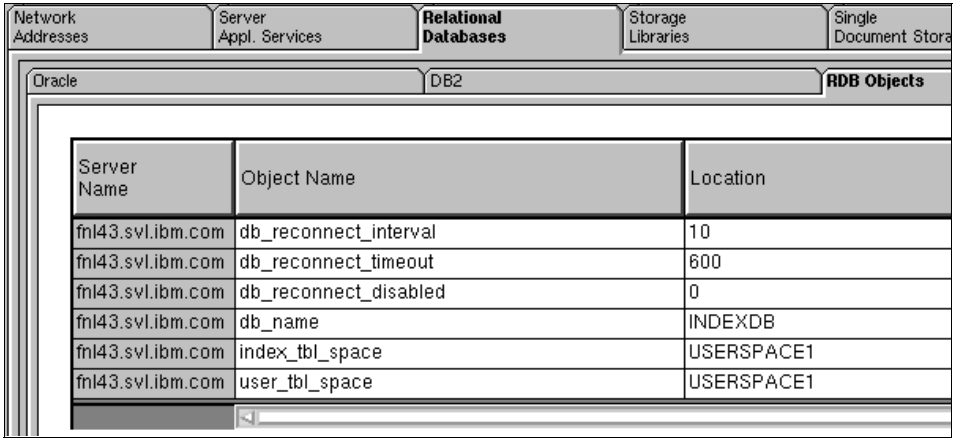


Figure 11-9 DB reconnect configuration in fn_edit

The database reconnect tests were carried out with and without the db_reconnect_* entries in fn_edit, with the same results: IS does in fact reconnect after a takeover of the database, but it also logs errors in the IS elog.

For the tests, an IDM Find query was started, and a takeover of the database cluster was forced (by stopping the current database node with **halt -q**). In most cases, the current query had to be repeated after the reconnect.

The IS `elog` did not show the expected `<121,0,41> DBMS is not available` errors, but reported `<121,9,30108> DB2 SQL30108N: A connection failed but has been re-established`. See Example 11-47.

Example 11-47 Database reconnect tests with a DB2 cluster

```
# vl # more /fnsw/local/logs/elogs/elog$(date +"%Y%m%d")
[...]
2008/10/26 02:05:14.873 121,9,30108 <fnsw> INXbg -s IndexServer  (1200182.1.28
0x125036.1) ... [SERIOUS]
Error in GDBD_exec: SQLExecute, STMT 65537 (&20073170) (../src/GDBD.c, VERSION 4.1.1.0,
@3394).
SQLSTATE = 08506, NativeError = -30108,
ErrorMsg = '[IBM][CLI Driver][DB2/AIX64] SQL30108N  A connection failed but has been
re-established. The hostname or IP address is "9.30.188.80" and the service name or port
number is "50010". Special registers may or may not be re-attempted (Reason code = "1").
SQLSTATE=08506'

2008/10/26 02:05:25.487 121,9,30108 <fnsw> INXs  (1282302.1.97 0x1390fe.1) ... [SERIOUS]
Error in GDBD_exec: SQLExecute, STMT 65537 (&20025730) (../src/GDBD.c, VERSION 4.1.1.0,
@3394).
SQLSTATE = 08506, NativeError = -30108,
ErrorMsg = '[IBM][CLI Driver][DB2/AIX64] SQL30108N  A connection failed but has been
re-established. The hostname or IP address is "9.30.188.80" and the service name or port
number is "50010". Special registers may or may not be re-attempted (Reason code = "1").
SQLSTATE=08506'
[...]

Depending on the current state of the IDM Desktop client and the current communication
between IS and DB2, there where different errors in the IS elog:

[...]
2008/10/26 02:49:33.594 90,0,12 <fnsw> INXs  (1118330.1.97 0x11107a.1) ...
query: SELECT
f_docnumber,f_docclassnumber,f_entrydate,f_archivedate,f_deletedate,f_retentbase,f_reten
tdisp,f_retentoffset,f_pages,f_doctype,f_accessrights,f_docformat,f_doclocation,f_ce_os_
id,f_accessrights_rd,f_accessrights_wr,f_accessrights_ax,a31,a32,a33,a34,a35,a36 FROM
doctaba WHERE f_docnumber = :DOC err:30108
[...]

or, in other cases:

[...]
2008/10/26 02:05:25.487 155,209,215 <fnsw> COR_Listen -pt -s32769 -t3600 -d100
(934098.1029.61 0xe40d2.405) ... [WARNING]
COR got Error in 0cor_snd, code=0

2008/10/26 02:05:25.488 155,209,217 <fnsw> INXs  (1282302.1.97 0x1390fe.1) ... [WARNING]
cor_PutPacket: connection terminated prematurely
```

```
2008/10/26 02:05:25.488 155,209,217 <fnsw> INXs  (1282302.1.97 0x1390fe.1) ... [WARNING]
cor_PutPacket failed to 9.146.118.195 [1786]

2008/10/26 02:05:25.488 155,209,217 <fnsw> INXs  (1282302.1.97 0x1390fe.1) ...
INXs: network error in parse_call
[...]
```

11.4 IS maintenance in HACMP clusters

The following section provides help with administering IS in an HA environment. It discusses controlling, updating, and troubleshooting IS with an HACMP cluster.

11.4.1 Managing IS as a cluster resource

The Image Services administrator has to realize the particularities of a clustered IS system for day-to-day administrative tasks and for system maintenance.

IS is controlled by HACMP. If the IS application is stopped manually (with **`initfnsw stop`**), the application monitor will detect a *failure* and either restart IS or take over the resource group. You can prevent this result in these ways:

- C-SPOC must be used to start or stop the IS application, not the **`initfnsw`** command.
- The HACMP application monitor must be suspended before IS is stopped manually.
- The HACMP application monitor must not return a failure (exit <> 0) if IS has been stopped manually, that is, purposefully by the administrator.

You can bring the IS resource group (fnis_rg) online and offline with C-SPOC:

```
# smitty hacmp
```

System Management (C-SPOC) → HACMP Resource Group and Application Management → Bring a Resource Group / Bring a Resource Group Offline

Enter these values:

- Resource Group to Bring Online/Offline: `fnis_rg`
- Node On Which to Bring Resource Group Online/Offline: `fnl43`

When HACMP cluster services are stopped on the active cluster node, the IS resource group can be placed in one of these states:

- Brought offline (IS is stopped, and the resource group is brought offline.)
- Moved (IS is stopped, the resource group is moved, and IS is started on another node.)
- Unmanaged (Cluster services terminate, and IS keeps running on this node.)

When HACMP cluster services are started on a node, IS will not start automatically, and it will not be failed back (moved) to this node, because of the configuration settings in SMIT:

```
# smitty hacmp
```

Click **Extended Configuration → Extended Resource Configuration → HACMP Extended Resource Group Configuration → Change/Show a Resource Group.**

Enter these values:

- Resource Group Name: `fnis_rg`
- Participating Nodes (Default Node Priority): `fnl43 fnl44`
- Startup Policy: `Online On Home Node Only`
- Fallover Policy: `Fallover To Next Priority Node In The List`
- Fallback Policy: `Never Fallback`

If an HACMP takeover is required, but you do not want the IS application started automatically on the standby node, disable the IS application server (AS) start script by adding `exit 0` as the second line of the start script on both nodes. You must disable monitoring if IS is not started by the start script. Leave the stop script as is, because it is required for a successful takeover:

```
# vi /opt/FileNet/ha_scripts/fnis_start.sh
```

Change the start script as shown in Example 11-48.

Example 11-48 Disabling the AS start script for maintenance

```
#!/bin/ksh
exit 0
[...]
```

You can suspend and resume the application monitor (fnis_app_mon) for the IS application server (fnis_app_srv) with C-SPOC:

```
# smitty hacmp
```

Click **System Management (C-SPOC) → HACMP Resource Group and Application Management → Suspend/Resume Application Monitoring → Suspend Application Monitoring / Resume Application Monitoring**.

You can also disable the IS application monitor by adding `exit 0` as the second line of the script. The monitor fails if the first line is not the shebang (“`#!`”) magic number.

Do not forget to re-enable the cluster scripts on all nodes after maintenance.

11.4.2 Overview of local and shared resources

Whenever maintenance is required with an IS cluster, it can either affect local or shared resources, or both.

It is extremely important to know the (possible) consequences of changes, for example, applying a patch, and to act upon them appropriately in the cluster. In general, everything that is changed on the local node has to be changed on the other node, as well. Changes to shared resources (for example, the `/fnsw/local` file system), have to be made from one of the cluster nodes only.

The IS Multi-Keyed File (MKF) Databases use both local and shared resources. The links to the data files are local (in `/fnsw/dev/1`) so they have to be kept in sync on both nodes, for example, when a database is expanded with a new data file. The data file raw devices (logical volumes) are shared on volume group fnvg.

Local IS resources

Changes to local resources have to be made on both cluster nodes, for example, by running an update wizard on one node after the other, or by changing a configuration file on both nodes simultaneously.

IS install or update wizards for release updates or patches (SP/FP) must be run on both cluster nodes. If an OSAR is attached, you must run the fnsod.install script (AIX/Solaris only) after the installers to install the device drivers.

Table 11-13 lists the local resources that are updated for IS on the installation process.

Table 11-13 Local resources modified for IS

Local resource	IS reference	Updated by
`/etc/`**`group`**	AIX groups (fnusr, fnop, fnadmin, and so forth)	AIX, IS (GA) installer
`/etc/`**`passwd`**	AIX users (fnsw and so forth)	AIX, IS (GA) installer

Local resource	IS reference	Updated by
/etc/security/**limits**	User process resource limits (fsize, nofiles, and so forth) {optional}	Manually for IS (GA) installation
/etc/**filesystems**	Definition of file systems and attributes (auto mount, mount group, FS log, and so forth)	AIX, HACMP
/etc/**hosts**	Host name to IP address resolution	Manually for IS (GA) installation
/etc/**resolv.conf**	Domain name-server definitions {optional}	Manually for IS (GA) installation
/etc/**netsvc.conf**	Ordering of name resolution services {optional}	Manually for IS (GA) installation
/etc/**services**	Socket and protocol definitions (tsm, cor, nch, and so forth)	IS (GA) installer, maybe IS update wizard
/etc/**rc.dt** alt: /etc/rc.d/...	CDE start script - also requires network options to be set	Manually with **vi** after IS installation
/etc/**inittab**	Auto start IS processes at system boot time - IS entries must be deactivated with HA	IS (GA) installer, maybe IS update wizard. Manually with **vi** after IS installation
/etc/tunables/**nextboot**	Configuration of network options (particularly IS *ephemeral* ports)	Manually with **no -po** after IS installation
/etc/**snmpd.conf**	Configuration file for snmpd (fnpd entry)	IS (GA) installer, maybe IS update wizard
AIX **ODM** (SWVPD, CuDv, HACMP)	LVM information (PV, LV, and so forth)	AIX, HACMP
	IS (FileNet) ISMP (InstallShield) filesets	IS (GA) installer, IS update wizard
	OSAR devices	fnsod.install
	HACMP configuration	HACMP, distributed with SMIT (**cldare**) → *no sync necessary*

Local resource	IS reference	Updated by
/home/fnsw/sqllib in combination with /opt/IBM/db2/V9.5	DB2 home directory (`$DB2_HOME`) and DB2 client installation	DB2 client installer
/fnsw/bin	IS binaries	IS (GA) installer, IS update wizard, individual IS fixes
/fnsw/dev/1	Links to DB data sets (for example, `sec_db0`, `sec_rl0`) and OSAR drivers (`osara`, `odda1`)	Manually with **fn_util mk_links** during IS installation and for maintenance later
/fnsw/etc/serverConfig	PPM request handler process configuration file	Manually with **vi** after IS installation and for maintenance later
/fnsw/etc/killfnsw	IS Guard File {temporary} Internal flag that prevents IS from starting or stopping.	IS at start/stop
/fnsw/etc/ local_permission_table	Custom IS permission table, complementing /fnsw/etc/ permission_table	Manually with **vi** after IS installation and for maintenance later
/fnsw/lib/shobj	Shared IS libraries	IS (GA) installer, IS update wizard, individual fixes
/fnsw/lib/shobj/db2lib or /fnsw/lib/shobj/oracle	A link to the database (client)	Manually with **fn_util linkrdb** during IS installation
/fnsw/procs	One (temporary) file per IS process	IS at run time, will be rebuilt at IS restart → *no sync necessary*
/fnsw/client	IS Toolkit (ISTK) default location {optional}	ISTK (GA) installer, ISTK update wizard, individual ISTK fixes
/fnsw/client/ cor_backoff_config	ISTK courier configuration {optional}	Manually with **vi** after ISTK installation
`$HOME`/**.profile** (particularly for fnsw)	User's start script with IS environment variables	Manually with **inst_templates** during IS installation and updates

Local resource	IS reference	Updated by
/dev/fnsod.*	OSAR devices {optional}, linked from: /fnsw/dev/1/osar* /fnsw/dev/1/odd*	Manually with fnsod.install and **fn_util mk_links** during IS installation and for maintenance later
/fnsw/sd/nocons	Flag file to stop console output {optional}	Manually with **touch** after IS installation

Because the /fnsw/local file system is not mounted on the inactive cluster node, IS might create subdirectories in the /fnsw/local mount point. If, for example, an IS command is issued on the standby node by mistake, a log file might be created in /fnsw/local/logs. This directory will be over-mounted (and hidden) by the /fnsw/local file system when the node takes over the IS resource group.

The administrator needs to avoid starting IS processes on the standby node and occasionally delete any files and subdirectories in /fnsw/local on this node.

The crontab entries of each node must be made “cluster ready”. Certain applications called from crontab require shared resources from the resource group. You must only start these programs on the active node. The easiest way to start shell scripts selectively on the IS node only is to test for the existence of the /fnsw/local/sd/conf_db directory at the start of the script. This way the script can be run on all nodes, but will only continue on the active node. See Example 11-49.

Example 11-49 Executing a cron job on the active cluster node only

```
if [[ ! -d /fnsw/local/sd/conf_db ]]; then
  echo "Error: /fnsw/local not mounted. Inactive cluster node?"
  exit 2
fi
```

Shared IS resources

Changes to shared resources must be made on the currently active cluster node only, that is, the node where the IS resource group is running at the moment.

The IS configuration editor (fn_edit), for example, saves its configuration files to /fnsw/local/sd/conf_db, which is located on the shared VG.

Table 11-14 on page 361 highlights only a few important examples of files that are located in the /fnsw/local file system of the shared VG fnvg.

Table 11-14 Shared resources modified for IS

Shared resource	IS reference	Updated by
/fnsw/local/filenet.podf	IS Programmable Object Data File (PODF) for IS security	Manually with **fn_pso_*** tools during IS installation and for maintenance later
/fnsw/local/sd/NCH_db0	NCH (MKF) database	IS at run time and configuration
/fnsw/local/sd/snt.chkpt	Scalar numbers from Permanent DB	IS at run time (IS start/stop) and manually for maintenance
/fnsw/local/sd/checkpoint.osa	OSAR checkpoint file	IS at run time (if an OSAR is configured)
/fnsw/local/sd/fnsod.foreign	OSAR driver exclude file {optional}	Manually with **vi** during IS installation and for maintenance later
/fnsw/local/sd/snmp.conf	SNMP configuration file	Manually with **vi** during IS installation and for maintenance later
/fnsw/local/sd/perf_mon.script	IS statistics configuration copied from `/fnsw/lib/perf` and modified	Manually with **vi** during IS installation and for maintenance later
/fnsw/local/sd/rdbup.bin	IS Index DB user passwords	Manually with **fn_setup_rdb** during IS installation and with Xapex for maintenance later
/fnsw/local/sd/conf_db/IMS_*.cdb	IS configuration database (highest-numbered file)	IS configuration editor fn_edit during IS installation and for maintenance later
/fnsw/local/sd/stop_cold.txt	COLD stop flag file {temporary}	Manually with **touch**, will be deleted when IS starts
/fnsw/local/sd/1/perflog	IS performance data	IS at run time (if “Collect Statistics” is configured)
/fnsw/local/sd/1/FNSHMSEGSZ	IS shared memory segment size configuration	Manually with **vi** during IS installation and for maintenance later

Shared resource	IS reference	Updated by
/fnsw/local/sd/1/ msar_identify_disable	Disable MSAR identify process {optional}	Manually with **vi** during IS installation
/fnsw/local/logs	IS log files, for example, `elogs`, `perf`, `EBR`, or `log`	IS at run time and during installs or updates
/msar1	MSAR target directory	IS at run time
/backup	(EBR) backup target directory	IS EBR backup/restore
/dev/rfn_*, for example: /dev/rfn_sec_* /dev/rfn_perm_* /dev/rfn_trans_* /dev/rfn_cache*	Raw devices for MKF DBs and cache, linked from: `/fnsw/dev/1/sec_*` `/fnsw/dev/1/permanent_*` `/fnsw/dev/1/transient_*` `/fnsw/dev/1/cache*`	IS at run time

Most of the (optional and undocumented) flag files for IS or for IS patches or debug modules also reside on the shared file system. These files are examples:

- `/fnsw/local/sd/cor_backoff_config`
- `/fnsw/local/sd/no_build.txt`
- `/fnsw/local/sd/1/cpu_bind`
- `/fnsw/local/sd/1/bind_debug`
- `/fnsw/local/sd/1/max_tli_elog`
- `/fnsw/local/trigger/no_hint`

HACMP File Collection

You can automate the task of keeping local files in sync between cluster nodes by using the File Collection feature of HACMP. All files in the File Collection are automatically synchronized to the other node, when changed (by default, every 10 minutes). Use C-SPOC to configure a File Collection for IS:

```
# smitty hacmp
```

Click **System Management (C-SPOC)** → **HACMP File Collection Management** → **Manage File Collections** → **Add a File Collection**.

Enter these values:

- File Collection Name: `filenet`
- Propagate files during cluster synchronization?: `no`
- Propagate files automatically when changes are detected?: `yes`

Click **System Management (C-SPOC) → HACMP File Collection Management → Manage Files in File Collections → Add Files to a File Collection**.

Enter these values:

- File Collection Name: `filenet`
- New File: At least add the files in Table 11-15

Table 11-15 lists local files that need to be synchronized by HACMP.

Table 11-15 HACMP File Collection for IS

Collection file	Owner	Remark
/etc/**hosts**	AIX	
/etc/**services**	AIX	
/etc/**snmpd.conf**	AIX	
/etc/snmpdv3.conf	AIX	optional, IS uses SNMPv1
/etc/**rc.net**	AIX	
/etc/**inetd.conf**	AIX	
/usr/es/sbin/cluster/**netmon.cf**	HACMP	
/usr/es/sbin/cluster/etc/**clhosts**	HACMP	
/usr/es/sbin/cluster/etc/**rhosts**	HACMP	
/usr/es/sbin/cluster/etc/**clinfo.rc**	HACMP	
/opt/FileNet/ha_scripts/**fnis_start.sh**	HACMP/IS	IS cluster start script
/opt/FileNet/ha_scripts/**fnis_stop.sh**	HACMP/IS	IS cluster stop script
/opt/FileNet/ha_scripts/**fnis_mon.sh**	HACMP/IS	IS cluster monitor script
/fnsw/etc/**serverConfig**	IS	PPM configuration
/fnsw/etc/**local_permission_table**	IS	custom permission_table
/home/fnsw/**.profile**	AIX/IS	Profile of fnsw user

Note: You must enter the collection file names with an absolute path (start with a /). Symbolic links in /fnsw/dev/1 and raw devices and OSAR drivers in /dev cannot be synchronized with an HACMP File Collection.

The HACMP configuration is stored in the local AIX Object Data Manager (ODM), but it is automatically copied to the other cluster node, when the HACMP Verification and Synchronization is run from SMIT (**cldare**):

```
# smitty hacmp
```

Click **Extended Configuration** → **Extended Verification and Synchronization**.

11.4.3 IS update procedures with HACMP

Patches for Image Services typically come in the form of service packs (SP) or fix packs (FP) that are packaged in an installation wizard. Problem Management Records (PMRs) sometimes produce individual fixes that consist of single files.

These minor release patches usually do not require you to update the Index database (DB2 or Oracle) or any of the MKF databases, but to simply replace binaries in `/fnsw` and `/fnsw/local` and perhaps run additional scripts.

IS major release updates usually require you to update the Index DB in advance, or they will update the database as part of the procedure. This action obviously has to be done only one time, during the update of the first node.

There is no rolling update with IS clusters. You must apply updates to all cluster nodes at the same time.

We recommend the following sequence to update IS in a cluster:

- **Cluster node 1**:
  a. Suspend HACMP application monitoring for IS (**smitty hacmp**).
  b. Disable the IS start script on both nodes by adding a line `exit 0` on top.
  c. Stop all IS clients, and clear ISTK shared memory (**wal_purge**).
  d. Stop Image Services (**initfnsw -y stop** and **killfnsw -ADSy**), verify `/fnsw/procs` is empty, and end the remaining processes and purge `/fnsw/procs.`
  e. Create a full backup of IS:
     - AIX backup (bootable) of `rootvg`, for example, with **mksysb** (both nodes, optional for minor releases and single patches)
     - Backup of Index DB (DB2) on the remote database server
     - EBR backup of MKF DBs (Security/Permanent/Transient DB) and Cache

- A **savevg** backup of fnvg or (at least) `tar` archive of `/fnsw` and `/fnsw/local`

f. Update the Index DB version of the (remote) server and the (local) client, if required.

g. Run the SP/FP installation wizard or copy a single patch to target directory.

h. Run fnsod.install, if the patch includes an updated /fnsw/bin/fnsod driver.

i. Verify or revert any changes to local resources:

- `/fnsw/etc/serverConfig`
- `/fnsw/etc/permission_table`
- `/fnsw/lib/perf/reports`
- `/fnsw/lib/perf/perf_mon.script`
- `/fnsw/support/911`
- `/etc/inittab` {All IS-related entries in `inittab` must be disabled.}

j. Move IS resource group to node 2; IS must not start automatically.

► **Cluster node 2**:

a. Stop Image Services (**initfnsw -y stop** and **killfnsw -ADSy**). Just in case, verify that `/fnsw/procs` is empty, end the remaining processes, and purge `/fnsw/procs`.

b. Update the Index DB version of the (local) client, if required.

c. Run the SP/FP installation wizard, or copy a single patch to the target directory. If necessary, update any files in the `/fnsw/local` file system another time from node 2 of the cluster. If the wizard does not allow you to update IS another time “to the same level”, you can alternatively delete the local `/fnsw` part of the IS installation and all traces of previous updates (log files and ODM). Now, you can start a fresh installation on node 2, instead of an IS update. Remember not to run **fn_edit** or to initialize the databases on this cluster node.

d. Run fnsod.install, if the patch includes an updated /fnsw/bin/fnsod driver.

e. Verify or revert any changes to local resources:

- `/fnsw/etc/serverConfig`
- `/fnsw/etc/permission_table`
- `/fnsw/lib/perf/reports`
- `/fnsw/lib/perf/perf_mon.script`
- `/fnsw/support/911`
- `/etc/inittab` {All IS-related entries in inittab must be disabled.}

f. Move the IS resource group to node 1; IS must not start automatically.

g. Start IS manually with **initfnsw start**, and perform system and application tests.

h. Re-enable the IS start script on both nodes by removing `exit 0` from line 1.

i. Resume HACMP application monitoring for IS (**smitty hacmp**).

j. Perform cluster tests, and move IS resource group to node 2, and then, to node 1.

k. Restart all IS clients, return to *production mode.*

Cluster and application tests are mandatory after every change to the IS installation or environment, such as AIX, HACMP, or DB2. Changes that affect the IS configuration (in the database) only might be transparent and require less effort.

11.4.4 Troubleshooting and log files

To troubleshoot problems in a highly available Image Services system, you must analyze both the IS error logs (`elogs`) and the cluster logs. To verify the status of a clustered IS, you must check both the cluster and IS.

Requesting status information

You can check the current status of IS in an HACMP cluster with the **clstat -ao** (HACMP) and **initfnsw status** (IS) command.

HACMP status

The most useful command for an overview of the cluster configuration is the # **/usr/es/sbin/cluster/utilities/cldisp** command.

You can verify the current status of the cluster with the # **/usr/es/sbin/cluster/clstat -ao** command.

The **clstat** command shows if nodes and interfaces are up or down and if the IS resource group is *online* and on which node (for example, fnl43). The Cluster Information Daemon (clinfoES) must be running for **clstat** to work. See Example 11-50.

Example 11-50 Running clstat for the current cluster status

```
# cd /usr/es/sbin/cluster
# clstat -ao

clstat - HACMP Cluster Status Monitor
               -------------------------------------
```

```
Cluster: fnis   (1222565798)
Sun Nov  9 20:41:40 PST 2008
               State: UP               Nodes: 2
               SubState: STABLE

        Node: fnl43             State: UP
           Interface: fnl43-bt1 (2)             Address: 10.10.10.53
                                                State:   UP
           Interface: fnl43_vpath0_01 (0)       Address: 0.0.0.0
                                                State:   UP
           Interface: fnis (2)                  Address: 9.30.188.78
                                                State:   UP
           Interface: fnl43-hs03 (1)            Address: 10.0.3.53
                                                State:   UP
           Resource Group: fnis_rg                      State:  On line

        Node: fnl44             State: UP
           Interface: fnl44-bt1 (2)             Address: 10.10.10.54
                                                State:   UP
           Interface: fnl44_vpath0_01 (0)       Address: 0.0.0.0
                                                State:   UP
           Interface: fnl44-hs03 (1)            Address: 10.0.3.54
                                                State:   UP
```

Image Services status

You can view the status of IS with the **# /fnsw/bin/initfnsw status** command.

Because the **initfnsw** command does not always correctly report if IS is actually working (or if it is stopped or inaccessible by clients), we recommend that you also look at the IS error log by using this command: **# /fnsw/bin/vl**.

Log files for troubleshooting

Table 11-16 on page 368 lists the log files that can be consulted in the case of HA-related problems with IS.

Table 11-16 HA-related log files for IS

Log file/Command	Owner	Use
# **errpt** [-a]	AIX	AIX system log
/var/hacmp/log/**hacmp.out** old: /tmp/hacmp.out	HACMP	Event script log, including IS application server start/stop
/var/hacmp/log/**clutils.log**	HACMP	HACMP utility log, including File Collection propagation
/var/hacmp/log/**clstrmgr.debug**[.long] old: /tmp/clstrmgr.debug	HACMP	[Detailed] HACMP cluster manager daemon log
/var/hacmp/log/**cspoc.log** old: /tmp/cspoc.log	HACMP	C-SPOC command log
/var/hacmp/log/**clappmond.fnis_app_mon.fnis_rg.log**	HACMP	IS application monitor log
/var/hacmp/log/**clappmond.fnis_app_mon.fnis_rg.monitor.log**	HACMP	Output of IS application monitor (usually empty)
/var/hacmp/clcomd/**clcomd.log**	HACMP	HACMP cluster communication daemon log
/var/hacmp/clcomd/**clcomddiag.log**	HACMP	Cluster communication daemon trace log
/var/hacmp/clverify/**clverify.log**	HACMP	DARE synchronization log
/var/ha/log/*	HACMP	HACMP topology and group services log files
/fnsw/local/logs/elogs/**elog**$(date +"%Y%m%d")	IS	IS errorlog (elog) View with **vl** command
/fnsw/local/logs/TM_daemon/**TM_daemon.log**	IS	IS TM_daemon log
/fnsw/client/logs/**wal**$(date +"%Y%m%d")	ISTK	ISTK error log

12

DB2 implementation

Content Engine and Process Engine have their own databases. In addition, Image Services also has its own database. To ensure the high availability of an IBM FileNet P8 solution, we must ensure that the database component is also highly available.

This chapter describes the following topics:

- DB2 high availability strategies for FileNet P8
- Setting up DB2 high availability for FileNet P8
- High availability tests for DB2
- Maintenance and upgrade recommendations for DB2

12.1 DB2 high availability strategies for FileNet P8

This section provides an overview of DB2 high availability (HA) strategies for FileNet P8. For a FileNet environment, the database server is a key functional component. The Content Engine (CE), the Process Engine (PE), and Image Services (IS) use the database server for storing data.

The DB2 high availability scenario for a FileNet environment that we consider in this section is based on an active/passive cluster. In a scenario of two nodes, only one DB2 server is available for client access. The second DB2 server is not active, because it is a hot standby server. It is activated only when the primary node fails.

The DB2 9.5 High Availability (HA) feature supports the IBM Data Server with cluster management software, such as IBM PowerHA for AIX, formerly IBM High Availability Cluster Multi-Processing (HACMP), IBM Tivoli System Automation for Multiplatforms, and Microsoft Windows Server® Cluster. In DB2 9.5, IBM Tivoli System Automation for Multiplatforms Base Component is integrated with IBM Data Server on AIX and Linux as part of the DB2 High Availability feature. When you install DB2 9.5 on AIX or Linux, you have the option to install this feature, which automatically installs IBM Tivoli System Automation for Multiplatforms. The DB2 High Availability Configuration Utility (db2haicu) provided by DB2 for configuring DB2 with IBM Tivoli System Automation for Multiplatforms greatly simplifies the clustering configuration.

The DB2 High Availability feature enables the database manager to automatically request cluster manager configuration changes whenever you perform certain database manager instance configuration and administration operations. The DB2 cluster manager API defines a set of functions that enables the database manager to communicate configuration changes to the cluster manager.

The DB2 Data Server High Availability and Disaster Recovery (HADR) feature provides data replication, which can be used (together with clustering software, such as IBM Tivoli System Automation for Multiplatforms or HACMP) to provide high availability. HADR protects against data loss by replicating data changes from a source database, called the *primary*, to a target database, called the *standby.*

For more details about DB2 HA strategies, refer to *High Availability, Scalability, and Disaster Recovery for DB2 on Linux, UNIX, and Windows*, SG24-7363.

12.1.1 Database considerations for FileNet P8

The following FileNet components use the database layer for their functionality:

- Content Engine (CE):

  CE is the major component of the FileNet P8 application, and it requires two repositories: Global Configuration Database (GCD), which stores global system configuration information for all servers in the IBM FileNet P8 domain, and the object store, which stores the objects in an IBM FileNet P8 environment. There can be one or multiple object stores. Each object store manages a database (CE database) for metadata. Each object store can have one or more storage areas that represent the physical storage area location.

  Note: The file storage areas for Content Engine must be deployed on highly available storage that has built-in redundancy for all components. Refer to your storage vendor for details.

- Process Engine (PE):

  PE uses a database for storing all process-related data.

- Image Services (IS):

  IS uses a database to store metadata for the documents that are archived in IS, such as document classes and document properties, called *indexes*. During normal operations, the index database updates are synchronized with the permanent database, which is called *Multi-Keyed File (MFK)*, in IS that stores the storage locations of the documents.

In a DB2 environment, databases can share an instance or can have a dedicated instance for each database. The IBM FileNet P8 components can be configured in both shared and dedicated configurations. When choosing the database configuration, you might take into consideration a few factors: the estimated size and load of the databases, the requirements of the CE, PE, and IS components, as well as maintenance and backup of the databases. Refer to the requirements of each component for the version you are installing.

In a larger environment, consider using separate systems for each FileNet component's databases.

This list contains several recommendations and restrictions for DB2 databases in a FileNet P8 environment:

- Use separate Content Engine and Process Engine databases for ease of maintenance and support.
- Use Database Managed Space (DMS) for user and user temporary tablespaces for both Content Engine and Process Engine.
- The Content Engine Global Configuration Database (GCD) and every object store must have dedicated databases.
- Process Engine supports only the remote DB2 database. A database is local if it is installed on the same machine with Content Engine or Process Engine. A database is remote if it is on a separate server from the component using that database.
- If you plan to use the region recovery feature of Process Engine, each region configured for recovery must reside in a dedicated data, binary large object (BLOB), and index tablespace, which is separate from the default data tablespace.
- Process Engine setup allows only alphanumeric and underscore characters for database, tablespace, and user names.
- Starting with Image Services Version 4.1.2, remote database reconnect is supported; thus, DB2 can be used as a remote database server for IS in an HA configuration.

For more details regarding the DB2 database configuration for FileNet, refer to *FileNet P8 Version 4 Installation and Upgrade Guide,* GC31-5488.

12.1.2 Scenarios for DB2 high availability

There are many ways to implement DB2 high availability for the FileNet application. Because software and hardware technologies vary across platforms, you can consider various options for creating a highly available DB2 solution that performs well. A broader discussion about DB2 high availability solutions is beyond the scope of this section. For more details about this topic, refer to *High Availability, Scalability, and Disaster Recovery for DB2 on Linux, UNIX, and Windows*, SG24-7363.

For the DB2 HA scenario in a FileNet environment, we present two options:

- DB2 in a shared storage environment with HA clustering software
- DB2 in a non-shared storage environment using HADR

DB2 in a shared storage environment using HA software

DB2 in a shared storage environment using HA software is a typical active/passive cluster based on a single copy of data, which is activated on the node running DB2. You implement this option based on a system clustering software, such as HACMP or Tivoli System Automation for Multiplatforms.

In the HA cluster solution, the physical database is stored on a shared storage system. Only one system owns and manages the shared disk storage at a time. If there is a failure on the server, the database server processes can be moved from the machine to a backup system. To accomplish this task, the cluster software moves all the necessary resources to the standby system. These resources include the disk resources of the physical database, the network resources, and the database server resources, including the code and the configuration files.

Because there is only one image of the database on the shared disk, there is no need to synchronize the data with other copies.

Figure 12-1 shows a shared storage scenario for DB2.

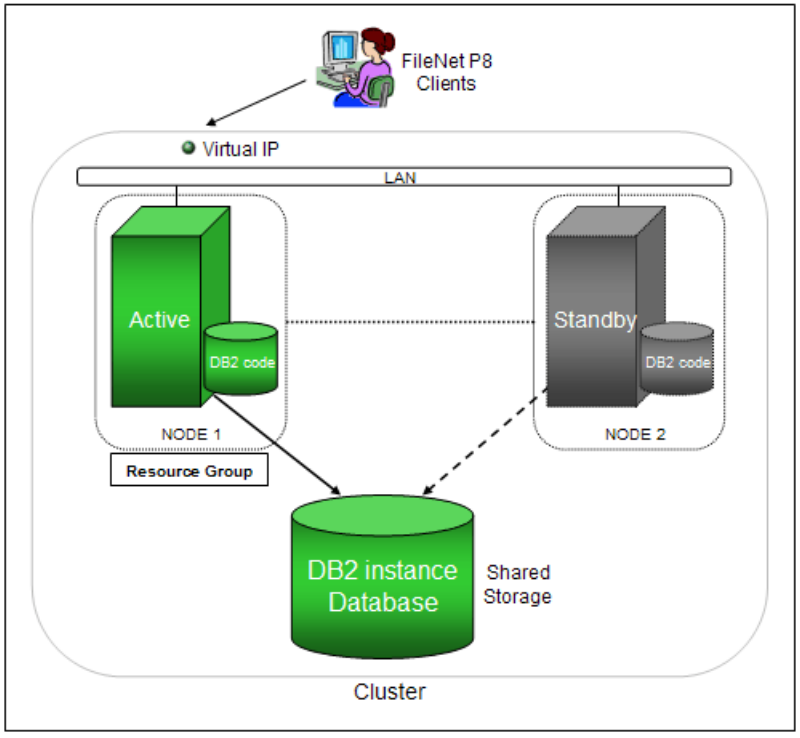


Figure 12-1 DB2 in a shared storage environment

You have to consider a few aspects regarding the cluster resources for the DB2 database:

- Storage resource: It refers to the disks, raw devices, or file systems that are used by DB2 to hold the database environment, which consists of these components:
  - DB2 code: It is the location where DB2 software is installed. Typically, it is located on the local disks of each node. For DB2 Version 8, the code is installed in a predefined location. Staring from DB2 Version 9, you can define the location for the DB2 installation.
  - Database instance: The database files for an instance are common to all nodes of the cluster; thus, they need to be placed on the shared storage.
- Network resource: A virtual IP address resource can be used for the client access to the database. In case of a failure, the IP address is activated on the standby node, so the clients do not need to change their connection configuration. For an environment using multiple DB2 instances, you can use multiple virtual IP addresses.
- Database server resource: It usually consists of scripts to start, stop, and monitor the instance and database. The cluster software uses these scripts to monitor the database environment and transparently fail the active node over to the standby node in case the active node fails.

When a failure is detected, ownership of the storage is moved from the primary system to the standby system. The network resources are moved, as well. Finally, the database server resources are started on the standby node and the database is made available as shown in Figure 12-2 on page 375.

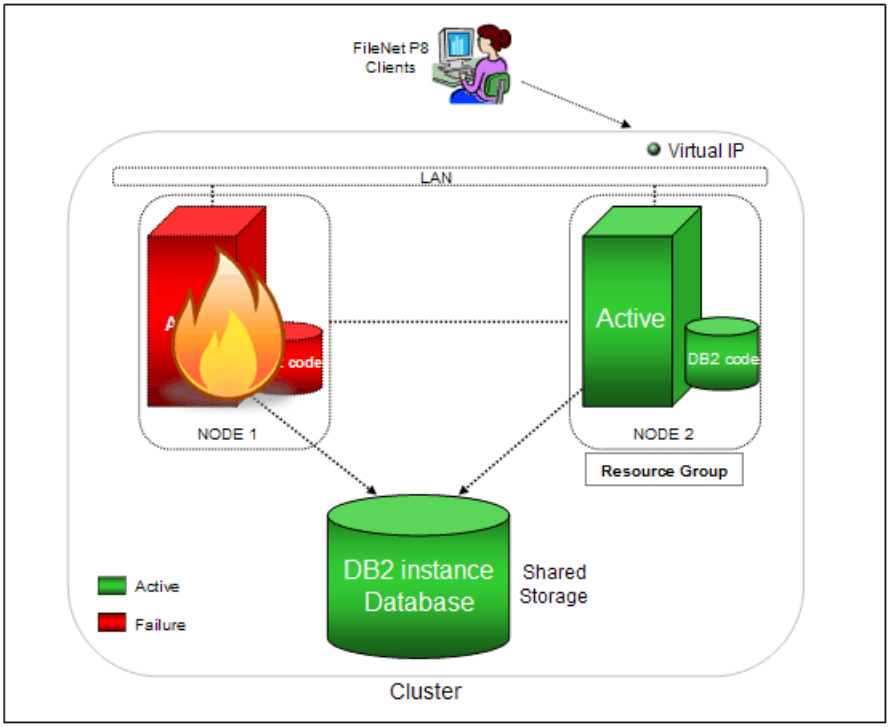


Figure 12-2 DB2 failure in a shared storage scenario

After a failover, DB2 always performs crash recovery, because the database was not shut down properly. During the crash recovery, the database engine processes the log files, making sure that all committed transactions are written to the disk and that the uncommitted transactions are rolled back. The time that is required to perform this operation depends on the amount of open work in the database logs at the point of failure. The failover process duration can vary, depending on the number of transactions that need to be processed from the logs.

When a failure occurs on the primary system, all applications are disconnected, and a communication error is returned to the application. When the database becomes available on the standby system, the application simply needs to reconnect to the database, and then, it can continue to work as before. The DB2 automatic client reroute (ACR) feature can be used to automatically route or reconnect the client connection to the active database instance. With the ACR, DB2 will route application connections to the failover server, and there is no need for the applications to reconnect. The ACR function is supported by DB2 Version 8.2 and later.

In a basic, two-node hot-standby configuration, the resources of the two nodes do not need to be identical. Because the standby node is used only in failover or maintenance cases, it can be configured with less CPU and memory.

Note: In an environment that supports partitioning, such as System p, the resources of logical partitions can be dynamically changed at the failover time with or without the assistance of the clustering software.

The basic hot-standby scenario can be extended to a mutual takeover configuration where both servers are actively hosting separate databases. Each machine is prepared to take over the workload of its peer node in the event of a failure.

Table 12-1 summarizes the advantages and disadvantages of a shared disk environment in an HA environment, compared with other HA solution options, including options that we do not discuss in this book. For more details, refer to *Implementing high availability with DB2 9.5* at this Web site:

http://www.ibm.com/developerworks/db2/library/techarticle/dm-0807wright/

Table 12-1 Shared storage advantages and disadvantages

Advantages	Disadvantages
► Database copies are always consistent. ► No changes to the application or to the client are needed. ► No user interaction is needed to detect and initialize failover. ► There is no performance degradation due to HA solution design.	► Extra software is needed to create and configure the solution. ► Data is not duplicated, providing less redundancy. ► External storage is required that must meet certain HA standards. ► There are distance limitations due to storage requirements.

DB2 in a non-shared storage system with HADR

This scenario is based on the DB2 High Availability Disaster Recovery (HADR) feature. The DB2 HADR is a high performance database replication system that is based on the DB2 logging mechanism. An HADR scenario consists of two independent systems, a primary and a standby. The primary system serves the client connections, performs the transactional work, and replicates the database changes to the standby system. In a HADR configuration, each node runs its own DB2 instance and database on its own storage. See Figure 12-3 on page 377.

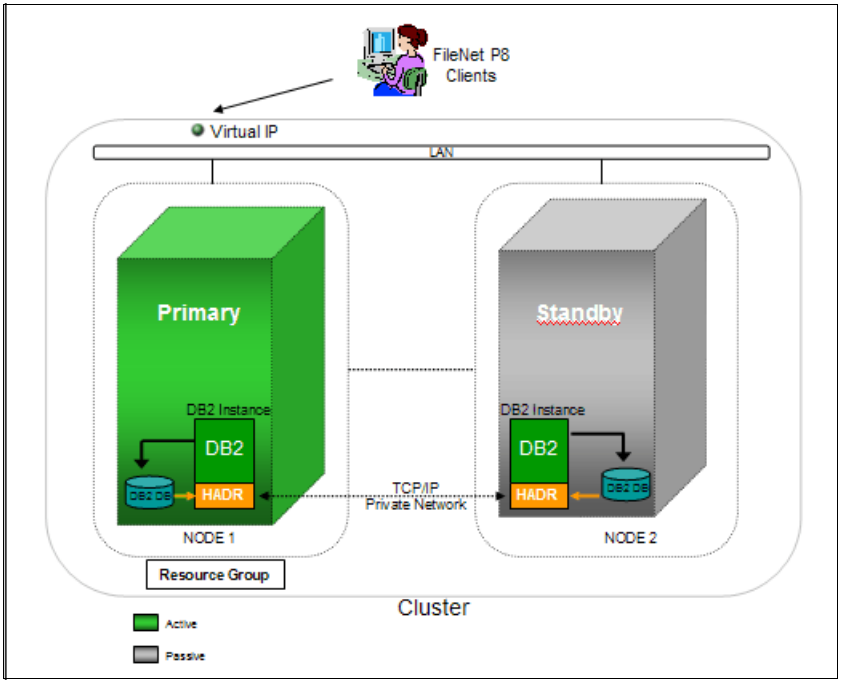


Figure 12-3 Both DB2 nodes in a non-shared storage scenario using HADR

HADR supports three synchronization modes:

- Synchronous

  The log write is considered successful only when the data was written to both the primary's and standby's log files. This mode guarantees no data loss as long as the HADR replication pair is active.

- Near-synchronous

  In this mode, the log write is successful when the primary's log buffer has been written to log files on the primary and an acknowledgement is received that the log buffer has been received on the standby. This mode is the default option.

- Asynchronous

  In this mode, a log write is successful when logs have been written to the disk on the primary and log data has been delivered to the TCP/IP layer. In case of a failure, transactions in the log's files that have not been sent to the standby system cannot be recovered, and data loss can occur.

Choosing the synchronization mode depends on various factors, such as the database log generation rate and the network bandwidth. Configuring various aspects of your database system, including network bandwidth, CPU power, and buffer size, can improve the performance of your HADR databases.

For the highest level of data replication protection, we recommend using the synchronous mode for configuring DB2 in a highly available solution for FileNet. For further details concerning the HADR synchronization modes, consult the DB2 documentation.

In the event of a failure, the standby's role can be switched to primary with a single command. To automate the takeover roles for the HADR database pair in case the primary node fails, you can use a clustering software, such as IBM Tivoli System Automation for Multiplatforms or HACMP. A DB2 HA with HADR consists of these cluster resources:

- Network resources: A virtual IP address can be used to facilitate the client access to the database. In case of a failure, the IP address is moved to the standby system, and the clients do not need to change the connection configuration.

  Automatic Client Reroute (ACR) is an alternative feature, which enables DB2 clients to reconnect automatically to the standby system on an alternate IP address configuration. In that case, a virtual IP address is not required.

- Database server resources: These resources refer to the methods that are used by the cluster software to start, stop, and monitor database environment on a system and to enable the client access to the database in the failover cases. Consider these resource types:

  – Database instance resource: The database instance in this case runs on each node of the cluster at the same time. In case of a failure, the database instance is already activated on the standby node, so this resource is local to each node. It does not move to another node, such as in the shared environment case.

  – HADR resource: This resource is created in the cluster to manage the HADR relationship between the primary and the standby databases.

In case of a failure on the primary node, the virtual IP address is moved to the standby node and the standby databases are switched to the primary role. See Figure 12-4 on page 379.

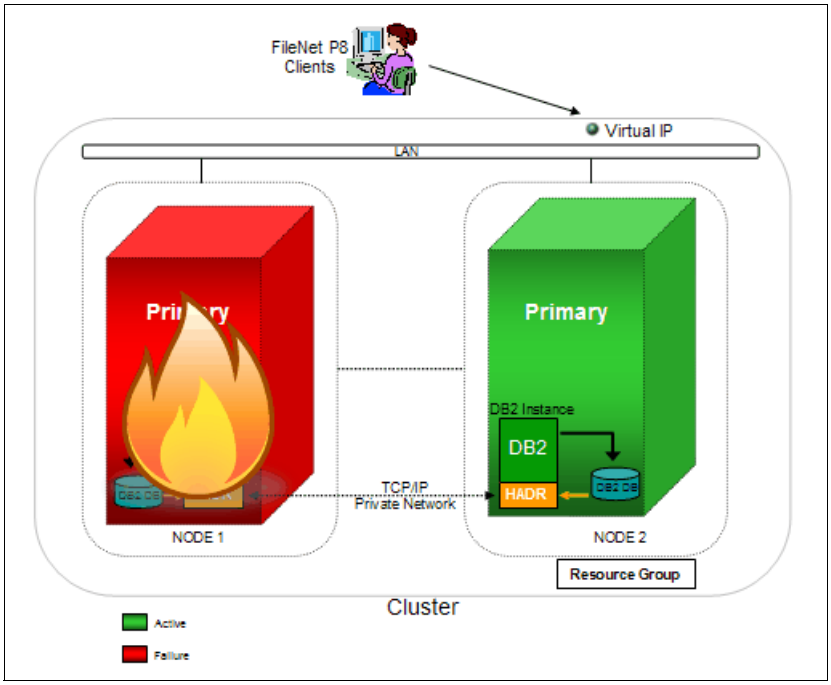


Figure 12-4 DB2 failover in a non-shared storage scenario

DB2 HADR also increases the availability by allowing you to perform database code rolling upgrades. The roles of the primary and the standby can be switched at will as long as they are in a synchronized state. In the event that you want to perform a system maintenance task, an upgrade, or a DB2 fix installation, you can turn the HADR off.

The DB2 HADR feature provides advantages and disadvantages for an HA environment. Table 12-2 on page 380 lists several of them.

Table 12-2 HADR advantages and disadvantages

Advantages	Disadvantages
► Database copies are always consistent. ► No changes to application or client are needed. ► Installation and maintenance are easy. ► Failover automation is ready to use and available for AIX and Linux. ► The impact on performance is negligible. ► You have the ability to perform DB2 fix pack rolling upgrades.	► There are additional server and storage requirements. ► The standby system is not currently available for database operations. ► Non-logged operations are not replicated.

12.2 Setting up DB2 high availability for FileNet P8

This section describes the procedure of using the DB2 High Availability feature for FileNet P8 in an high availability environment. For our case study, we implement the DB2 HA features, HADR and integrated IBM Tivoli System Automation for Multiplatforms, for the FileNet P8 DB2 environment.

12.2.1 The lab environment

Before setting up the DB2 HA environment, we start by planning the cluster infrastructure.

Note: For the HADR, the primary and the standby databases are independent databases that usually reside on separate storage devices.

For our case study in the lab, we use the following configuration:

- AIX 5.3 Technology Level 8, with RSCT Version 2.4.9
- DB2 Enterprise Server Edition Version 9.5, Fix Pack 1
- IBM Tivoli System Automation for Multiplatforms Version 2.2 provided in DB2 9.5
- Two System p nodes or logical partitions (LPARs) with appropriate memory, CPU, and storage resources (see DB2 requirements in the DB2 product manual)

Figure 12-5 on page 381 illustrates our HADR configuration.

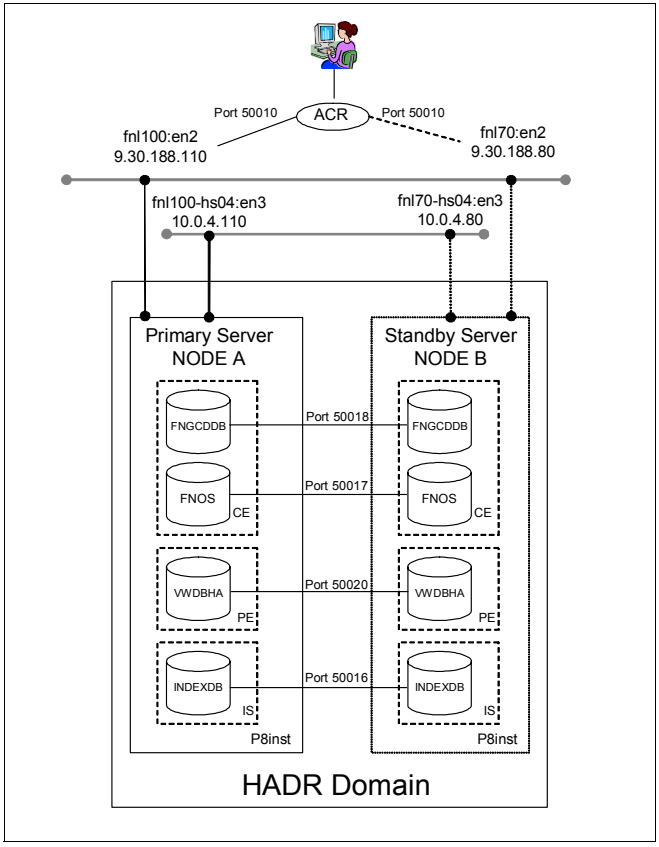


Figure 12-5 HADR configuration in our lab environment

Each DB2 server for FileNet P8 contains one instance (`p8inst`) for all of the databases that are used by the FileNet components:

- Content Engine databases:
  - Global Configuration Database (`FNGCDDB`)
  - One object store database (`FNOS`)
- Process Engine database: `VWDBHA`
- Image Services database: `INDEXDB`

We use two networks in the cluster configuration:

- A public network that is used for client communication with the database servers
- A private network for HADR replication traffic

Table 12-3 shows the host names and the IP addresses for the public and private interfaces on each node.

Table 12-3 Host name and IP addresses

Host name	HADR role	Interface: Public IP	Interface: Private IP
fnl100	Primary	en2:9.30.188.110	en3:10.0.4.110
fnl70	Standby	en0:9.30.188.80	en3:10.0.4.80

HADR data replication feature works at the database level. For each database pair that is involved in an HADR relationship, a pair of TCP/IP ports is required for communication. In our case study, we use the same port number on both servers. Each port number has an associated service name in the `/etc/services` file. Table 12-4 describes the TCP/IP port configuration for HADR communication.

Table 12-4 HADR ports and service names for FileNet DB2 databases

FileNet component	Database name	Service name	Port number
Image Services	INDEXDB	p8_INDEX	50016
Content Engine	FNOS	p8_FNOS	50017
Content Engine	FNGCDDB	p8_GCD	50018
Process Engine	VWDBHA	p8_VWDBHA	50020

In an HADR pair, one system is the primary system (fnl100) that holds the active databases currently accessed by the clients for their database operations. The other system is the standby system (fnl70) and has a passive role. Each database has a standby copy on the standby system. To replicate, for each database pair, we have set the HADR synchronization mode (`HADR_SYNCMODE`) to SYNC.

Each DB2 server has a TCP/IP port number to communicate with the clients. In our case study, we use 50010 for both nodes. You might also consider using separate ports, because DB2 instances on primary and standby nodes work independently of each other.

We use the ACR feature on the DB2 server to enable automatic recovery for the client connection in case of primary server failure. A Virtual IP address is not a requirement when using the ACR feature and is not used in our environment.

To integrate HADR with the IBM Tivoli System Automation for Multiplatforms cluster, we use the **db2haicu** tool available in DB2 9.5. The tool configures the cluster by defining the resource groups, resources, equivalencies, and relationships and uses the IBM Tivoli System Automation for Multiplatforms policy scripts, which are provided with DB2, to control the application resources.

12.2.2 Prepare the DB2 setup

Before installing DB2 Enterprise Server, perform these steps:

1. Make sure that the hardware and software requirements are met. For details, refer to the IBM Web site:

   http://www.ibm.com/software/data/db2/9/sysreqs.html

   Note: DB2 Version 9 requires the 64-bit kernel of the AIX system.

2. Create the required user IDs and group.

   Table 12-5 shows the required users and groups for the DB2 instance that we create.

   The integrated IBM Tivoli System Automation for Multiplatforms configuration tool, **db2haicu**, which is provided by DB2, uses underscore (_) as part of the naming convention for resource and resource group. We recommend not using underscore in your DB2 instance name to avoid possible conflict with **db2haicu**.

   Table 12-5 Users for DB2 instance

User	Group	Home directory	Description
p8inst	p8_igrp	/data/db2/p8inst	DB2 instance owner
p8_finst	p8_ifgrp	/data/db2/p8_finst	Fenced user

   Table 12-6 on page 384 shows the users that are specific to the FileNet application from our environment.

Table 12-6 Users for FileNet P8 components

User	Group	Home directory	Description
p8_ce	p8_igrp	/data/db2/p8_ce	CE runtime user
f_sw	p8_igrp	/data/db2/f_sw	PE and IS runtime user
f_maint	p8_igrp	/data/db2/f_maint	PE and IS maintenance user
f_sqi	p8_igrp	/data/db2/f_sqi	IS user
f_open	p8_igrp	/data/db2/f_open	IS user

3. Create and verify the disk space that is required to accommodate the DB2 installation and the FileNet databases.

   For our case study, we use the following layout:

   – The DB2 installation directory is `/opt/IBM/db2/V9.5_FNP8`. We reserve 2 GB of free space in the `/opt` file system. The *DB2 9.5 Installation Guide* also recommends to have 2 GB of free space in `/tmp` for the installation process.The installation guide is available from the online information center:

     `http://publib.boulder.ibm.com/infocenter/db2luw/v9r5/index.jsp`

   – The DB2 instance and user home directories are located in `/data/db2`.

   – The DB2 Enterprise Server Edition installation kit is located in the directory `/data/db2/software`.

   – For the databases, we use the `/data` file system on each database node containing the database instance and the databases with free space of 30 GB.

4. Reserve the TCP/IP ports that are required for the instance and HADR configuration. For our environment, see the allocated ports in Table 12-4 on page 382.

12.2.3 Install DB2 server

Use the following guidelines to install and verify the DB2 Server installation for FileNet on both nodes:

- Locate the installation media. Copy the DB2 installation package to a local file system, and unpack it in the desired directory. Allocate at least 2 GB for the archive and the uncompressed files.
- Install the DB2 software. Content Engine, Process Engine, and Image Services require 64-bit instances on the UNIX® servers. A single instance can be shared by all of the FileNet components.
- When the installation has finished, check the status report or go to the `/tmp` directory to verify that the DB2 installation logs did not contain any errors.

Make note of the TCP/IP port numbers that are assigned to the instance or instances. They are required for the DB2 client configuration.

The following procedure details the steps that we performed to install the DB2 Server for the FileNet applications:

1. As the root user, change the directory to where the DB2 installation package is located and launch the **`db2setup`** program. A Welcome window is displayed as shown in Figure 12-6.

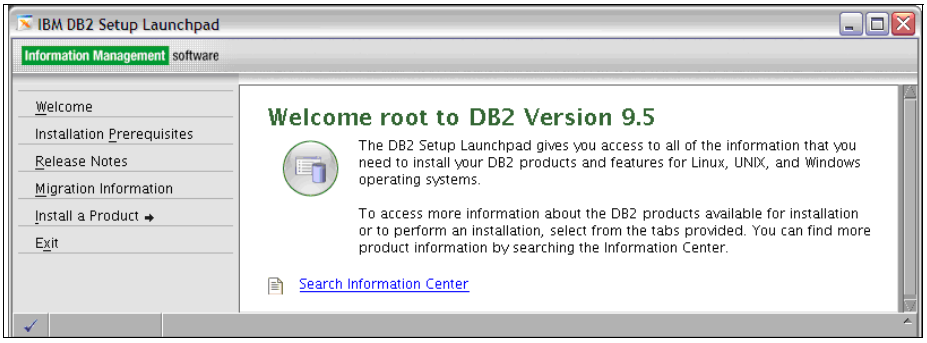


Figure 12-6 DB2 setup: Welcome window

2. Select **Install a product**, and then select **Installing DB2 Enterprise Server Edition Version 9.5**. The DB2 setup window is launched. See Figure 12-7.

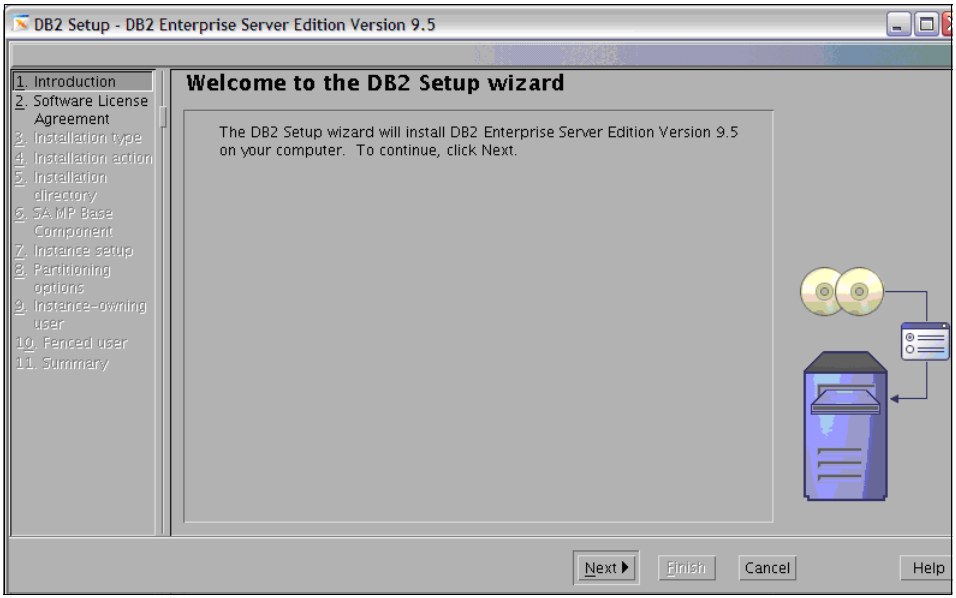


Figure 12-7 DB2 setup menu

3. Accept the license agreement. See Figure 12-8.

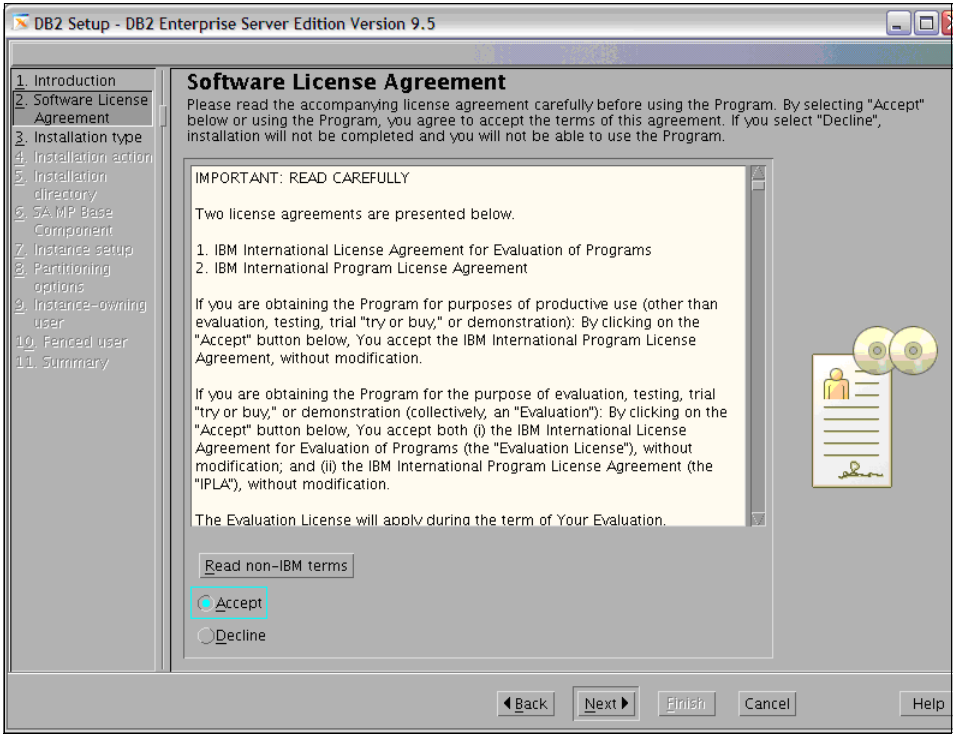


Figure 12-8 License agreement

4. Choose the installation type. We choose **Typical: 980 - 1180 MB**. See Figure 12-9.

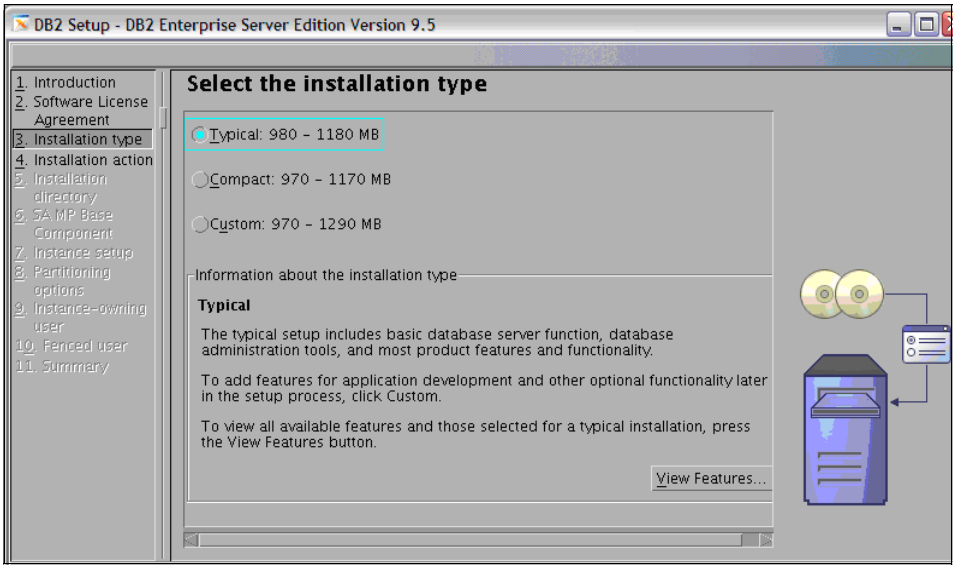


Figure 12-9 Selecting the installation type

5. In the installation action step, we choose the option to install the product and create the response file as shown in Figure 12-10.

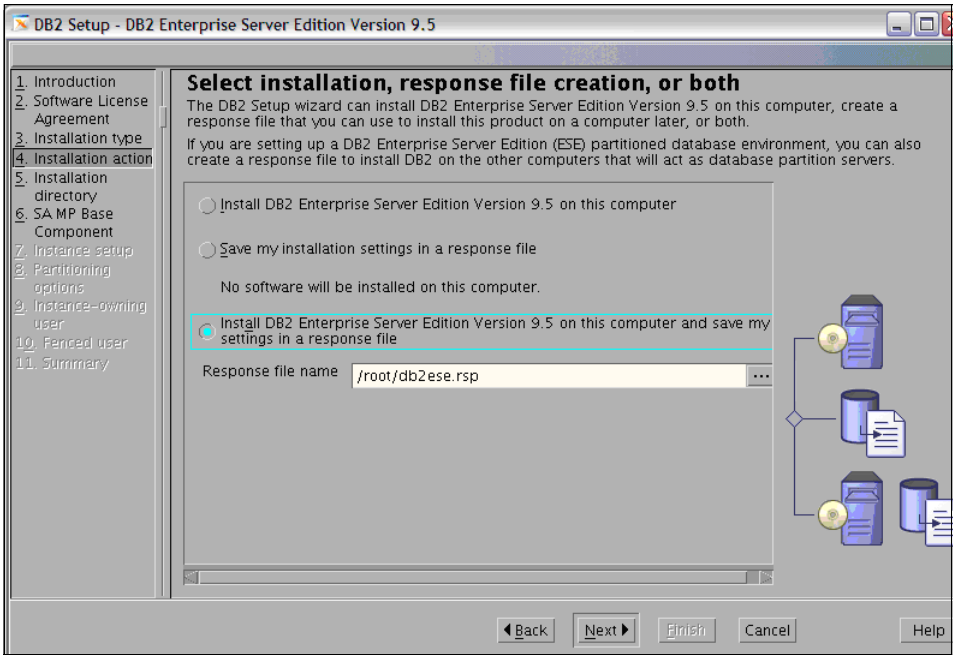


Figure 12-10 Select the response file

6. Figure 12-11 shows our installation directory. Note that starting with DB2 9.5, you can change the installation directory to a user-defined directory.

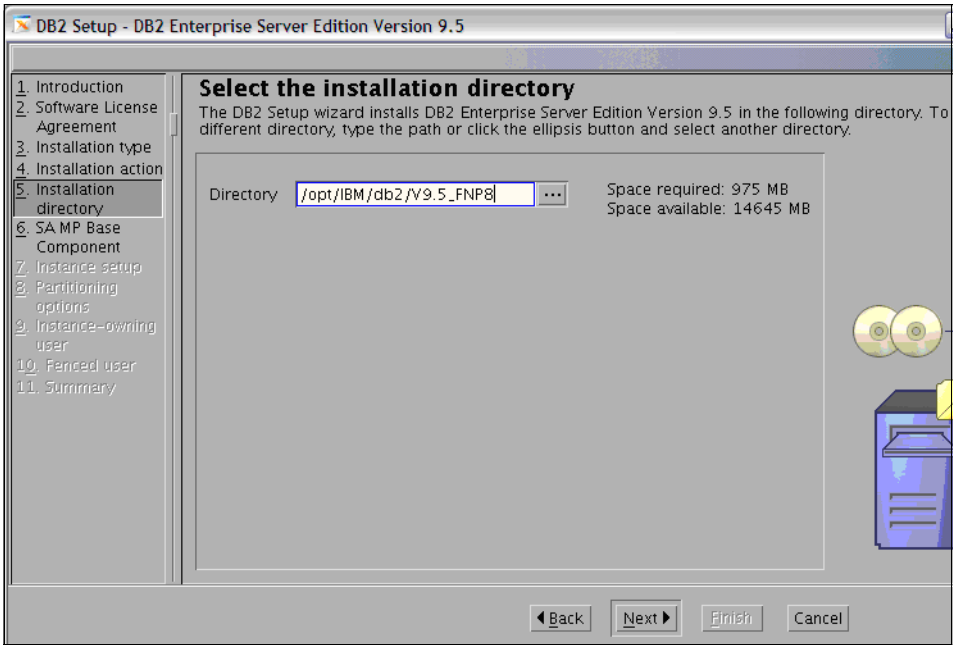


Figure 12-11 Select the installation directory

7. In the next window, we choose the option to install the IBM Tivoli System Automation for Multiplatforms component. See Figure 12-12 on page 391. The IBM Tivoli System Automation for Multiplatforms version to be installed depends on the DB2 version and the fix pack that are currently being installed. We recommend using the IBM Tivoli System Automation for Multiplatforms version that shipped with the DB2 package.

> **Note:** We recommend applying the latest DB2 fix pack supported by the FileNet components for an updated version of the IBM Tivoli System Automation for Multiplatforms and policy scripts.

When installing the IBM Tivoli System Automation for Multiplatforms component, a prerequisite verification is performed first. Then, the setup program installs the IBM Tivoli System Automation for Multiplatforms packages and policies that are shipped with the current version of DB2. You can perform this step later using the scripts that are provided with the DB2 package. For more details about the manual IBM Tivoli System Automation

for Multiplatforms installation procedure, see 12.2.6, “Integrating DB2 HADR and IBM Tivoli System Automation for Multiplatforms” on page 401.

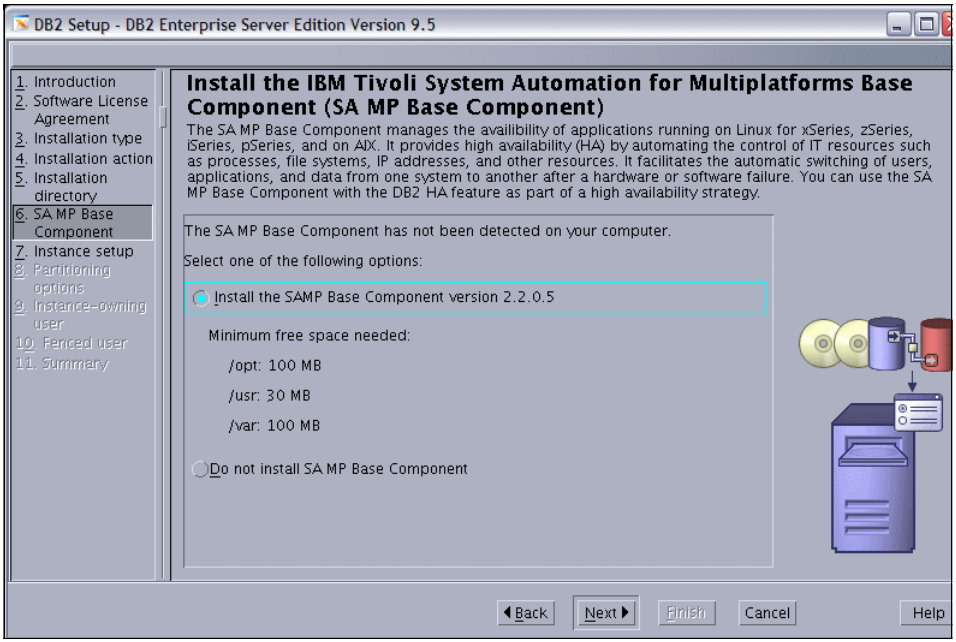


Figure 12-12 IBM Tivoli System Automation for Multiplatforms install menu

8. In the instance setup step (Figure 12-13), we choose not to create the instance, because we create the instance in a later step.

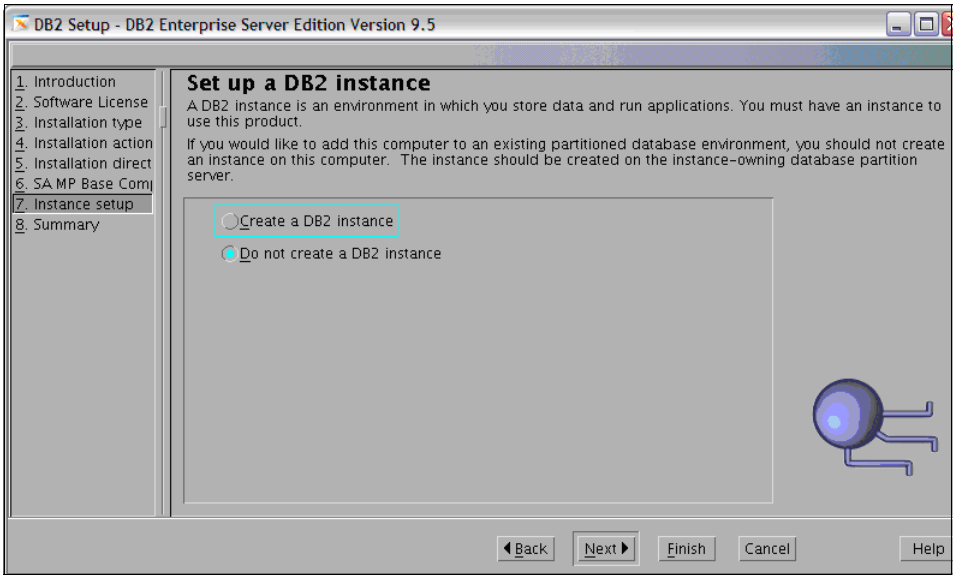


Figure 12-13 Instance creation

9. The next window summarizes the options and prepares to perform the installation as shown in Figure 12-14.

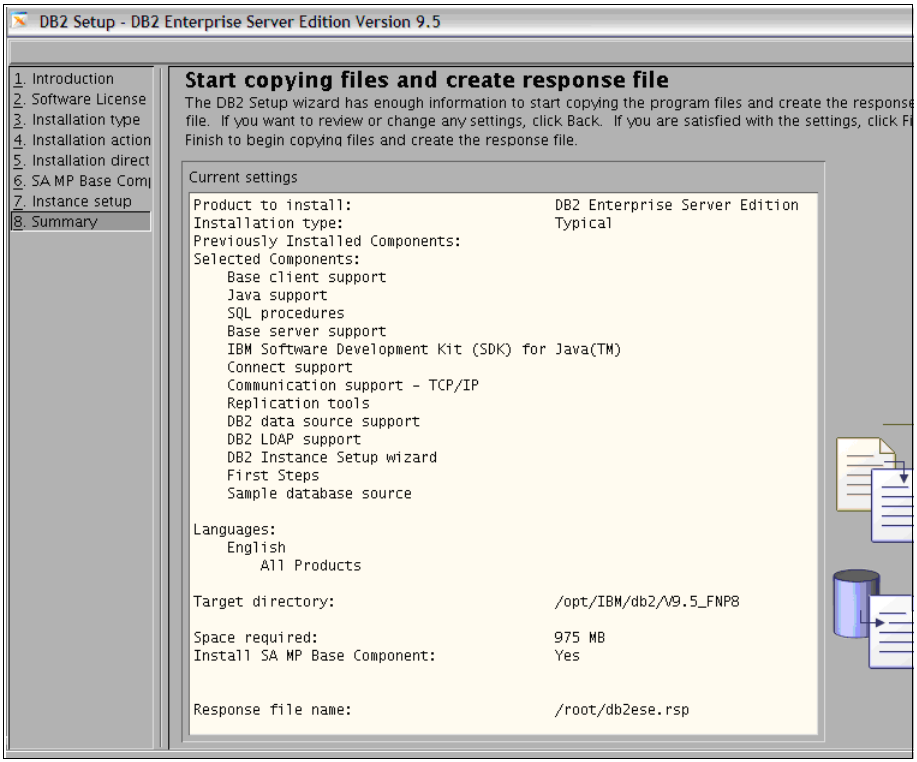


Figure 12-14 Installation summary

12.2.4 DB2 configuration for FileNet P8

In this section, we detail the configuration of the DB2 instance, databases, and the required tablespaces for the FileNet components that are installed in our environment.

Table 12-7 on page 394 lists the databases and their associated user-defined tablespaces for our environment.

Table 12-7 Databases, user, and temp tablespaces

FileNet component	Databases	System page size	Tablespaces	Size (MB)
Content Engine	FNGCDDB	32 KB	GCD_TS USRTMP1	256 50
	FNOS	32 KB	CEDATA_TS USRTMP1	800 50
Process Engine	VWDBHA	8 KB	VWDATA_TS USRTMP1	300 50
Image Services	INDEXDB	32 KB	USERSPACE1	200

We use a default configuration with one data tablespace for PE. If region recovery is used, an additional data, BLOB, and index tablespace for each region is required for recovery.

Use the following steps to configure the DB2 for FileNet:

1. Check that the DB2 communication protocol is TCP/IP. See Example 12-1.

   Example 12-1 DB2 communication protocol

   ```
   p8inst@fnl100 $db2set -all
   [i] DB2COMM=tcpip
   [g] DB2SYSTEM=fnl100
   [g] DB2INSTDEF=p8inst
   ```

2. Create the DB2 instances for CE, PE, and IS, if they do not already exist. CE, PE, and IS require a 64-bit instance on a UNIX server. Each of the engines can have its own instance, or they can share an instance. In our environment, we use a single DB2 instance for all of the FileNet components.

   Example 12-2 shows how we create the database instance.

   Example 12-2 Creating the database instance

   ```
   p8inst@fnl100 $cd /opt/IBM/db2/V9.5_FNP8/instance
   p8inst@fnl100 $./db2icrt -a SERVER -s ese -p 50010 -u p8_finst
   p8inst
   DBI1070I  Program db2icrt completed successfully.
   ```

   Note: The port 50010 is used for client connection to the database. It is identified by the database configuration parameter SVCENAME.

3. Create the CE, PE, and IS databases and their associated tablespaces.

   We create the databases and the tablespaces that are listed in Table 12-7 on page 394. We use Database Managed Space (DMS) tablespaces for each defined user space and user temporary space.

   Example 12-3 shows how we create the databases and tablespaces for the Content Engine.

Example 12-3 Creating the databases and the tablespaces for CE

```
create database FNGCDDB automatic storage yes on
'/data/db2/p8inst/p8inst/NODE0000/FNGCDDB' dbpath on
'/data/db2/p8inst/p8inst/NODE0000/FNGCDDB' alias FNGCDDB using
codeset utf-8 territory us collate using system pagesize 32768

create tablespace gcd_ts managed by database using (file
'/data/db2/p8inst/p8inst/NODE0000/FNGCDDB/gcd_ts/C00.CAT' 256M)"
create user temporary tablespace usrtmp1 managed by database using
(file '/data/db2/p8inst/p8inst/NODE0000/FNGCDDB/usrtmp1/C00.CAT'
50M)"


create database FNOS automatic storage yes on
'/data/db2/p8inst/p8inst/NODE0000/FNOS' dbpath on
'/data/db2/p8inst/p8inst/NODE0000/FNOS' alias FNOS using codeset
utf-8 territory us collate using system pagesize 32768

create tablespace p8_ce managed by database using (file
'/data/db2/p8inst/p8inst/NODE0000/FNOS/cedata_ts/C00.CAT' 800M)
create user temporary tablespace usrtmp1 managed by database using
(file '/data/db2/p8inst/p8inst/NODE0000/FNOS/usrtmp1/C00.CAT' 50M)
```

For any database to be used by Content Engine object store, update the database configuration parameter `APPLHEAPSZ`. Set the value to at least 2560.

Example 12-4 shows how to configure and check the database configuration parameter `APPLHEAPSZ`.

Example 12-4 Update the parameter APPLHEAPSZ

```
p8inst@fnl100 $db2 update db cfg for fnos using APPLHEAPSZ 2560
DB20000I  The UPDATE DATABASE CONFIGURATION command completed
successfully.

p8inst@fnl100 $db2 get db cfg for fnos | grep APPLHEAPSZ
Default application heap (4KB)             (APPLHEAPSZ) = 2560
```

Example 12-5 shows how we create the database and tablespaces for the Process Engine.

Example 12-5 Creating the database and the tablespaces for PE

```
create database VWDBHA automatic storage yes on
'/data/db2/p8inst/p8inst/NODE0000/VWDBHA' dbpath on
'/data/db2/p8inst/p8inst/NODE0000/VWDBHA' alias VWDBHA using codeset
utf-8 territory us collate using system pagesize 8192

create tablespace vwdata_ts managed by database using (file
'/data/db2/p8inst/p8inst/NODE0000/VWDBHA/vwdata_ts/C00.CAT' 300M)
create user temporary tablespace usrtmp1 managed by database using
(file '/data/db2/p8inst/p8inst/NODE0000/VWDBHA/usrtmp1/C00.CAT' 50M)
```

Example 12-6 shows how we create the database for Image Services. We use the default tablespace USERSPACE1 for the IS configuration. No additional tablespaces are defined at this time.

Example 12-6 Creating the database for Image Services

```
create database INDEXDB automatic storage yes on
'/data/db2/p8inst/p8inst/NODE0000/INDEXDB' dbpath on
'/data/db2/p8inst/p8inst/NODE0000/INDEXDB' alias INDEXDB using
codeset utf-8 territory us collate using system pagesize 32768
```

12.2.5 Setting up HADR

We set up the HADR for each database that is used in the FileNet configuration. In our scenario, we created databases for the CE, PE, and IS components.

HADR requires that both the primary server and the standby server have the same database configuration. For this purpose, we recommend that you set up the standby system by restoring the database from a backup image of the primary system.

We perform these steps to set up the HADR:

1. Set the required database configuration parameters.

   Activate the log archiving mode for the databases. See Example 12-7.

   Example 12-7 Activating the database log archiving on disk

   ```
   db2 update db cfg for fngcddb using LOGARCHMETH1
   'DISK:/data/db2/p8inst/archive'
   ```

```
db2 update db cfg for fnos using LOGARCHMETH1
'DISK:/data/db2/p8inst/archive'
db2 update db cfg for vwdbha using LOGARCHMETH1
'DISK:/data/db2/p8inst/archive'
db2 update db cfg for indexdb using LOGARCHMETH1
'DISK:/data/db2/p8inst/archive'
```

Set the `LOGINDEXBUILD` parameter to `ON` to ensure that the complete information for index creation, recreation, and reorganization is logged, as well as shipped to the standby database during HADR replication. See Example 12-8.

Example 12-8 Enable LOGINDEXBUILD for HADR database

```
db2 update db cfg for fngcddb using LOGINDEXBUILD ON
db2 update db cfg for fnos using LOGINDEXBUILD ON
db2 update db cfg for vwdbha using LOGINDEXBUILD ON
db2 update db cfg for indexdb using LOGINDEXBUILD ON
```

2. For each database, perform an offline database backup on the primary system and restore the backup to the standby system.

   Example 12-9 shows how we take an offline backup of the database fngcddb on the primary system fnl100. *Make sure that you write down the timestamp of the database backup, because you must use it as an input parameter for the restore process.*

Example 12-9 Backup up the fngcddb database on the primary system

```
db2 deactivate db fngcddb
DB20000I  The DEACTIVATE DATABASE command completed successfully.

db2 backup db FNGCDDB to /data/db2/p8inst/backup

Backup successful. The timestamp for this backup image is :
20081002173801

cd /data/db2/p8inst/backup
ls -l *20081002173801*
-rw-------    1 p8inst   p8_igrp   234958848 Oct 02 17:38
FNGCDDB.0.p8inst.NODE0000.CATN0000.20081002173801.001
```

We copy the backup image using the **scp** command to our standby system fnl70 to the `/data/db2/p8inst/backup` directory. The database is then restored as shown in Example 12-10 on page 398.

Example 12-10 Restore fngcddb database on the standby system fnl70

```
db2 restore db FNGCDDB from /data/db2/p8inst/backup taken at
20081002173801 replace history file
DB20000I  The RESTORE DATABASE command completed successfully.
```

3. Configure the Automatic Client Reroute feature for each database.

   In our case study, on the primary server fnl100, we define the alternate server as fnl70. On the standby server fnl70, we define the alternate server as fnl100. See Example 12-11.

Example 12-11 Configure the automatic client reroute

```
On primary server fnl100:
db2 update alternate server for database fngcddb using hostname
fnl70 port 50010
db2 update alternate server for database fnos using hostname fnl70
port 50010
db2 update alternate server for database vwdbha using hostname fnl70
port 50010
db2 update alternate server for database indexdb using hostname
fnl70 port 50010


On standby server fnl70:
db2 update alternate server for database fngcddb using hostname
fnl100 port 50010
db2 update alternate server for database fnos using hostname fnl100
port 50010
db2 update alternate server for database vwdbha using hostname
fnl100 port 50010
db2 update alternate server for database indexdb using hostname
fnl100 port 50010
```

4. Set up the HADR parameters for each database.

   Example 12-12 on page 399 illustrates how to configure the HADR-related database configuration parameter using the FileNet CE Global Configuration Database (fngcddb) on the primary system fnl100, as an example.

   Set the HADR_PEER_WINDOW configuration parameter to a large enough value to ensure that the peer state is kept long enough for the standby machine to take over the HARD primary role. In our environment, 300 seconds is sufficient to ensure the peer state is kept long enough for the standby machine to take over the HARD primary role.

Example 12-12 Set up HADR parameters on primary node fnl100

```
db2 update db cfg for fngcddb using HADR_LOCAL_HOST 10.0.4.110
db2 update db cfg for fngcddb using HADR_LOCAL_SVC p8_GCD
db2 update db cfg for fngcddb using HADR_REMOTE_HOST 10.0.4.80
db2 update db cfg for fngcddb using HADR_REMOTE_SVC p8_GCD
db2 update db cfg for fngcddb using HADR_REMOTE_INST p8inst
db2 update db cfg for fngcddb using HADR_SYNCMODE SYNC
db2 update db cfg for fngcddb using HADR_TIMEOUT 120
db2 update db cfg for fngcddb using HADR_PEER_WINDOW 300
```

Example 12-13 shows the HADR configuration parameter setup on the fngcddb database of the standby system fnl70.

Example 12-13 Set up HADR parameters on standby system fnl70

```
db2 update db cfg for fngcddb using HADR_LOCAL_HOST 10.0.4.80
db2 update db cfg for fngcddb using HADR_LOCAL_SVC p8_GCD
db2 update db cfg for fngcddb using HADR_REMOTE_HOST 10.0.4.110
db2 update db cfg for fngcddb using HADR_REMOTE_SVC p8_GCD
db2 update db cfg for fngcddb using HADR_REMOTE_INST p8inst
db2 update db cfg for fngcddb using HADR_SYNCMODE SYNC
db2 update db cfg for fngcddb using HADR_TIMEOUT 120
db2 update db cfg for fngcddb using HADR_PEER_WINDOW 300
```

Notes: The HADR_LOCAL_SVC and HADR_REMOTE_SVC are the ports that are used by HADR for the primary and standby servers. The value for the HADR_LOCAL_SVC parameter of both the primary and the standby systems cannot be the same as the value of SVCENAME on their respective nodes. Issue the **db2 get dbm cfg** command to get the service name value of the instance.

The name that we choose is shown in Table 12-4 on page 382 and was added previously to the `/etc/services` file.

5. Activate the HADR relationship.

   On each database, start the HADR on the standby system first, and then, on the primary system. In Example 12-14 on page 400, we activate the HADR on the fngcddb database.

Example 12-14 Activate the HADR relationship

```
On the standby machine fnl70:
db2 deactivate db fngcddb
db2 start hadr on db fngcddb as standby

On the primary machine fnl100:
db2 deactivate db fngcddb
db2 start hadr on db fngcddb as primary
```

Check the HADR status for each database using the db2pd utility on both the primary and standby servers as shown in Example 12-15. The Role field shows *primary* for fnl100 and *standby* for fnl70. Check also the state of the HADR relationship in the db2pd output, which needs to be *Peer* and the status of the connection needs to be *Connected*.

Example 12-15 Checking the HADR status

```
HADR status on primary system fnl100:

p8inst@fnl100 $db2pd -db fngcddb -hadr

Database Partition 0 -- Database FNGCDDB -- Active -- Up 0 days 02:25:55

HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Primary Peer                Sync     0                  0

ConnectStatus ConnectTime                           Timeout
Connected     Fri Oct 24 16:16:02 2008 (1224890162) 120

PeerWindowEnd                       PeerWindow
Fri Oct 24 17:39:02 2008 (1224895142) 300

LocalHost                               LocalService
10.0.4.110                              p8_GCD

RemoteHost                              RemoteService      RemoteInstance
10.0.4.80                               p8_GCD             p8inst

PrimaryFile  PrimaryPg  PrimaryLSN
S0000038.LOG 943        0x000000001BF3772D

StandByFile  StandByPg  StandByLSN
S0000038.LOG 943        0x000000001BF3772D


HADR status on standby system fnl70:
p8inst@fnl70 $db2pd -db fngcddb -hadr

Database Partition 0 -- Database FNGCDDB -- Active -- Up 0 days 01:19:08
```

```
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Standby Peer                Sync     0                  0

ConnectStatus ConnectTime                           Timeout
Connected     Fri Oct 24 16:16:02 2008 (1224890162) 120

PeerWindowEnd                         PeerWindow
Fri Oct 24 17:40:02 2008 (1224895202) 300

LocalHost                                LocalService
10.0.4.80                                p8_GCD

RemoteHost                               RemoteService      RemoteInstance
10.0.4.110                               p8_GCD             p8inst

PrimaryFile  PrimaryPg  PrimaryLSN
S0000038.LOG 943        0x000000001BF3772D

StandByFile  StandByPg  StandByLSN
S0000038.LOG 943        0x000000001BF3772D
p8inst@fnl70 $
```

12.2.6 Integrating DB2 HADR and IBM Tivoli System Automation for Multiplatforms

DB2 9.5 provides the DB2 High Availability Instance Configuration Utility db2haicu to facilitate IBM Tivoli System Automation for Multiplatforms configuration for DB2. You can use db2haicu to configure IBM Tivoli System Automation for Multiplatforms with DB2 in both shared disk and HADR environments.

Prepare the IBM Tivoli System Automation for Multiplatforms cluster environment

Perform the following steps to prepare the cluster configuration:

1. Install the IBM Tivoli System Automation for Multiplatforms code and policies.

   If the IBM Tivoli System Automation for Multiplatforms code was not installed along with the DB2 installation process, you can manually install it from the installation package:

   a. As a root user, change the current directory to *<DB2_installation_package>*/db2/aix/tsamp

   b. Run **prereqSAM** from the directory to verify the installation prerequisites for IBM Tivoli System Automation for Multiplatforms installation.

c. Run the script installSAM to install IBM Tivoli System Automation for Multiplatforms.

d. Apply the IBM Tivoli System Automation for Multiplatforms policies for DB2 by running the script db2cptsa, which is located in the directory *<DB2_installation_package>*/db2/aix/install. The DB2 scripts for the cluster are installed in the directory /usr/sbin/rsct/sapolicies/db2.

2. Synchronize the date and time on the cluster nodes.

   You need to synchronize the time and dates on the standby and the primary nodes as closely as possible. This synchronization is absolutely critical to ensure a smooth failover during primary node failures. We recommend using an external Network Time Protocol (NTP) server and configuring the NTP on both cluster nodes. For more details, consult the NTP documentation for your platform.

3. Configure secure shell (SSH).

   Secure shell is used in our environment for remote command execution for the root user across the cluster nodes. For IBM Tivoli System Automation for Multiplatforms cluster configuration with **ssh**, we set up root access between nodes without prompting for a password.

   Perform the following steps for a quick SSH setup:

   a. Log on as the root on one node of the cluster.

   b. Generate a public key/private key pair:

      ```
      #ssh-keygen -t rsa
      ```

      When prompted for input, press Enter. Do not enter a passphrase.

   c. To enable the new key pair for use with **ssh**, execute the following commands:

      ```
      #cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys

      #chmod 644 ~/.ssh/authorized_keys
      ```

   d. Use the ssh-keyscan utility to gather the public host key for each cluster host. Substitute the IP addresses in the commands with your IP addresses.

      ```
      #ssh-keyscan -t rsa fnl100,9.30.188.110,fnl70,9.30.188.80 >>
      ~/.ssh/known_hosts
      ```

   e. Copy the ~/.ssh directory from the local host to all hosts in the cluster. Assuming the SSH setup was performed on fnl100 node, we copy the directory to fnl70 node:

      ```
      #scp -p ~/.ssh fnl70:~/.ssh
      ```

f. Test that password-less ssh is now enabled. We run the **ssh** command to cross-check the remote execution of a command without prompting in Example 12-16.

Example 12-16 Test ssh execution between cluster nodes without prompting

```
root@fnl100 # ssh fnl70 ssh fnl100 date
Sun Nov  2 05:21:10 PST 2008
```

4. Perform the initial configuration:

On all nodes, set the environment variable `CT_MANAGEMENT_SCOPE` (peer domain scope). All IBM Tivoli System Automation for Multiplatforms users need to permanently set `CT_MANAGEMENT_SCOPE` to `2` in the root profile:

```
#vi /.profile
export CT_MANAGEMENT_SCOPE=2
```

On each cluster node, run the **preprpnode** command as root to prepare the local node for joining the domain:

```
# preprpnode fnl100 fnl70
```

We recommend that you configure the `netmon.cf` file on each cluster node. This configuration is needed to help Reliable Scalable Cluster Technology (RSCT) services (IBM Tivoli System Automation for Multiplatforms infrastructure) distinguish between adapter and network failure in a single adapter per node per network (equivalency class) configuration. The `netmon.cf` file is used if broadcast ping is disabled on the system. In this file, supply IBM Tivoli System Automation for Multiplatforms with the IP addresses that are used for the quorum device. This file must contain the IP addresses that can be pinged from both nodes as shown in Example 12-17. The IP addresses that you can choose are the default gateway or the other servers in your system. When the heartbeat stops, IBM Tivoli System Automation for Multiplatforms pings these addresses to determine whether it is a network interface failure or a partner node failure. In Example 12-17, we select the IP addresses `9.30.188.1`(default gateway) and other two hosts on the network: `9.30.188.51` and `9.30.188.53`.

Example 12-17 Adding hosts on the network in the netmon.cf file

```
# cat /usr/sbin/cluster/netmon.cf
9.30.188.1
9.30.188.51
9.30.188.53
```

Configure the TSA cluster using db2haicu

Perform these steps to configure the IBM Tivoli System Automation for Multiplatforms cluster using the db2haicu utility:

1. Before running db2haicu, start the DB2 instances on both nodes, and check the HADR status using the **db2pd** command. The pairs must be in the *Peer* state before proceeding.
2. Run **db2haicu** as database owner user. You must first run the db2haicu utility on the standby instance, and then, on the primary instance for the configuration to complete.

   Example 12-18 shows that we invoke db2haicu on the standby node fnl70, create the peer domain, and add the nodes in the domain.

   Example 12-18 Creating the peer domain and adding the cluster nodes

```
p8inst@fnl70: $db2haicu
Welcome to the DB2 High Availability Instance Configuration Utility
(db2haicu).

You can find detailed diagnostic information in the DB2 server
diagnostic log file called db2diag.log. Also, you can use the
utility called db2pd to query the status of the cluster domains you
create.

For more information about configuring your clustered environment
using db2haicu, see the topic called 'DB2 High Availability Instance
Configuration Utility (db2haicu)' in the DB2 Information Center.

db2haicu determined the current DB2 database manager instance is
p8inst. The cluster configuration that follows will apply to this
instance.

db2haicu is collecting information on your current setup. This step
may take some time as db2haicu will need to activate all databases
for the instance to discover all paths ...
When you use db2haicu to configure your clustered environment, you
create cluster domains. For more information, see the topic
'Creating a cluster domain with db2haicu' in the DB2 Information
Center. db2haicu is searching the current machine for an existing
active cluster domain ...
db2haicu did not find a cluster domain on this machine. db2haicu
will now query the system for information about cluster nodes to
create a new cluster domain ...
```

```
db2haicu did not find a cluster domain on this machine. To continue
configuring your clustered environment for high availability, you
must create a cluster domain; otherwise, db2haicu will exit.

Create a domain and continue? [1]
1. Yes
2. No
1
Create a unique name for the new domain:
p8db2
Nodes must now be added to the new domain.
How many cluster nodes will the domain p8db2 contain?
2
Enter the host name of a machine to add to the domain:
fnl70
Enter the host name of a machine to add to the domain:
fnl100
db2haicu can now create a new domain containing the 2 machines that
you specified. If you choose not to create a domain now, db2haicu
will exit.

Create the domain now? [1]
1. Yes
2. No
1
Creating domain p8db2 in the cluster ...
Creating domain p8db2 in the cluster was successful.
```

3. Configure the network quorum device for the cluster. In our case study, we set the default gateway on the public network as the quorum device. See Example 12-19.

Example 12-19 Setting the quorum device

```
You can now configure a quorum device for the domain. For more
information, see the topic "Quorum devices" in the DB2 Information
Center. If you do not configure a quorum device for the domain, then
a human operator will have to manually intervene if subsets of
machines in the cluster lose connectivity.

Configure a quorum device for the domain called p8db2? [1]
1. Yes
2. No
1
The following is a list of supported quorum device types:
```

```
  1. Network Quorum
Enter the number corresponding to the quorum device type to be used:
[1]
1
Specify the network address of the quorum device:
9.30.188.1
Configuring quorum device for domain p8db2 ...
Configuring quorum device for domain p8db2 was successful.
```

4. Configure the network interfaces for the cluster for both the public and the private (HADR) networks. See Example 12-20.

Example 12-20 Configure the network interfaces

```
The cluster manager found 6 network interface cards on the machines
in the domain. You can use db2haicu to create networks for these
network interface cards. For more information, see the topic
'Creating networks with db2haicu' in the DB2 Information Center.

Create networks for these network interface cards? [1]
1. Yes
2. No
1
Enter the name of the network for the network interface card: en0 on
cluster node: fnl100
1. Create a new public network for this network interface card.
2. Create a new private network for this network interface card.
Enter selection:
2
Are you sure you want to add the network interface card en0 on
cluster node fnl100 to the network db2_private_network_0? [1]
1. Yes
2. No
2
Enter the name of the network for the network interface card: en1 on
cluster node: fnl70
1. Create a new public network for this network interface card.
2. Create a new private network for this network interface card.
Enter selection:
2
Are you sure you want to add the network interface card en1 on
cluster node fnl70 to the network db2_private_network_0? [1]
1. Yes
2. No
2
```

```
Enter the name of the network for the network interface card: en3 on
cluster node: fnl70
1. Create a new public network for this network interface card.
2. Create a new private network for this network interface card.
Enter selection:
2
Are you sure you want to add the network interface card en3 on
cluster node fnl70 to the network db2_private_network_0? [1]
1. Yes
2. No
1
Adding network interface card en3 on cluster node fnl70 to the
network db2_private_network_0 ...
Adding network interface card en3 on cluster node fnl70 to the
network db2_private_network_0 was successful.
Enter the name of the network for the network interface card: en3 on
cluster node: fnl100
1. db2_private_network_0
2. Create a new public network for this network interface card.
3. Create a new private network for this network interface card.
Enter selection:
1
Are you sure you want to add the network interface card en3 on
cluster node fnl100 to the network db2_private_network_0? [1]
1. Yes
2. No
1
Adding network interface card en3 on cluster node fnl100 to the
network db2_private_network_0 ...
Adding network interface card en3 on cluster node fnl100 to the
network db2_private_network_0 was successful.
Enter the name of the network for the network interface card: en0 on
cluster node: fnl70
1. db2_private_network_0
2. Create a new public network for this network interface card.
3. Create a new private network for this network interface card.
Enter selection:
2
Are you sure you want to add the network interface card en0 on
cluster node fnl70 to the network db2_public_network_0? [1]
1. Yes
2. No
1
Adding network interface card en0 on cluster node fnl70 to the
network db2_public_network_0 ...
```

```
Adding network interface card en0 on cluster node fnl70 to the
network db2_public_network_0 was successful.
Enter the name of the network for the network interface card: en2 on
cluster node: fnl100
1. db2_public_network_0
2. db2_private_network_0
3. Create a new public network for this network interface card.
4. Create a new private network for this network interface card.
Enter selection:
1
Are you sure you want to add the network interface card en2 on
cluster node fnl100 to the network db2_public_network_0? [1]
1. Yes
2. No
1
Adding network interface card en2 on cluster node fnl100 to the
network db2_public_network_0 ...
Adding network interface card en2 on cluster node fnl100 to the
network db2_public_network_0 was successful.
```

5. Continue the setup by configuring the cluster manager parameter in DB2 and registering the local instance to IBM Tivoli System Automation for Multiplatforms. See Example 12-21.

Example 12-21 Configure the cluster parameter in DB2 and the DB2 instance in TSA

```
Retrieving high availability configuration parameter for instance
p8inst ...
The cluster manager name configuration parameter (high availability
configuration parameter) is not set. For more information, see the
topic "cluster_mgr - Cluster manager name configuration parameter"
in the DB2 Information Center. Do you want to set the high
availability configuration parameter?
The following are valid settings for the high availability
configuration parameter:
  1.TSA
  2.Vendor
Enter a value for the high availability configuration parameter: [1]
1
Setting a high availability configuration parameter for instance
p8inst to TSA.
Adding DB2 database partition 0 to the cluster ...
Adding DB2 database partition 0 to the cluster was successful.
```

6. In the next step, you are asked to configure the HADR databases in the cluster. At this time, will you receive a message indicating that the configuration needs to be switched on the primary node as shown in Example 12-22.

Example 12-22 Ending the first phase of cluster configuration on the standby node

```
Do you want to validate and automate HADR failover for the HADR
database FNGCDDB? [1]
1. Yes
2. No
1
Adding HADR database FNGCDDB to the domain ...
The cluster node 10.0.4.110 was not found in the domain. Please
re-enter the host name.
fnl10O
The cluster node 10.0.4.80 was not found in the domain. Please
re-enter the host name.
fnl7O
Adding HADR database FNGCDDB to the domain ...
The HADR database FNGCDDB has been determined to be valid for high
availability. However, the database cannot be added to the cluster
from this node because db2haicu detected this node is the standby
for the HADR database FNGCDDB. Run db2haicu on the primary for the
HADR database FNGCDDB to configure the database for automated
failover.

.........
All cluster configurations have been completed successfully.
db2haicu exiting ...
```

7. Run **db2haicu** on the primary node fnl100, and register the instance to the cluster domain as shown in Example 12-23.

Example 12-23 Configuring cluster parameter and DB2 instance on the primary node

```
p8inst@fnl10O: $db2haicu
Welcome to the DB2 High Availability Instance Configuration Utility
(db2haicu).

You can find detailed diagnostic information in the DB2 server
diagnostic log file called db2diag.log. Also, you can use the
utility called db2pd to query the status of the cluster domains you
create.
```

```
For more information about configuring your clustered environment
using db2haicu, see the topic called 'DB2 High Availability Instance
Configuration Utility (db2haicu)' in the DB2 Information Center.

db2haicu determined the current DB2 database manager instance is
p8inst. The cluster configuration that follows will apply to this
instance.

db2haicu is collecting information on your current setup. This step
may take some time as db2haicu will need to activate all databases
for the instance to discover all paths ...
When you use db2haicu to configure your clustered environment, you
create cluster domains. For more information, see the topic
'Creating a cluster domain with db2haicu' in the DB2 Information
Center. db2haicu is searching the current machine for an existing
active cluster domain ...
db2haicu found a cluster domain called p8db2 on this machine. The
cluster configuration that follows will apply to this domain.

Retrieving high availability configuration parameter for instance
p8inst ...
The cluster manager name configuration parameter (high availability
configuration parameter) is not set. For more information, see the
topic "cluster_mgr - Cluster manager name configuration parameter"
in the DB2 Information Center. Do you want to set the high
availability configuration parameter?
The following are valid settings for the high availability
configuration parameter:
  1.TSA
  2.Vendor
Enter a value for the high availability configuration parameter: [1]
1
Setting a high availability configuration parameter for instance
p8inst to TSA.
Adding DB2 database partition 0 to the cluster ...
Adding DB2 database partition 0 to the cluster was successful.
```

8. In the next step, add each HADR database to the cluster domain as shown in Example 12-24 for the fngcddb database.

Example 12-24 Adding the HADR database to the cluster domain

```
Do you want to validate and automate HADR failover for the HADR
database FNGCDDB? [1]
1. Yes
```

```
2. No
1
Adding HADR database FNGCDDB to the domain ...
The cluster node 10.0.4.80 was not found in the domain. Please
re-enter the host name.
fnl70
The cluster node 10.0.4.110 was not found in the domain. Please
re-enter the host name.
fnl100
Adding HADR database FNGCDDB to the domain ...
Adding HADR database FNGCDDB to the domain was successful.
............
All cluster configurations have been completed successfully.
db2haicu exiting ...
```

9. After adding an HADR database, you can set up a Virtual IP address for the database. We do not configure a virtual address, because we use ACR for our setup. Finish the db2haicu setup on the primary node after adding all of the FileNet HADR databases to the cluster domain.

At the end of the configuration, the cluster resources are configured and in an active status in the cluster. The status of the resource groups can be queried using the **lssam** command as indicated in Example 12-25. For each DB2 instance, note the Online status on each node. For the HADR pairs, note the Online status on the primary node and the Offline status on the standby node.

Example 12-25 Checking the Resource groups status using lssam

```
root@fnl100 # lssam
Online IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl100_0-rs
                '- Online IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Offline IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Offline IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
                '- Offline IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
```

```
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Offline IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

Resource groups topology

After you run the db2haicu tool successfully on both of the standby and primary instances, the setup is complete.The resource groups and the resources that are created are detailed in Table 12-8.

Table 12-8 Resource groups and resources

Resource group	Resource	Description
db2_p8inst_fnl100_0-rg	db2_p8inst_fnl100_0-rs	DB2 instance fnl100
db2_p8inst_fnl70_0-rg	db2_p8inst_fnl70_0-rs	DB2 instance fnl70
db2_p8inst_p8inst_FNGCDDB-rg	db2_p8inst_p8inst_FNGCDDB-rs	FNGCDDB database
db2_p8inst_p8inst_FNOS-rg	db2_p8inst_p8inst_FNOS-rs	FNOS database
db2_p8inst_p8inst_INDEXDB-rg	db2_p8inst_p8inst_INDEXDB-rs	INDEXDB database
db2_p8inst_p8inst_VWDBHA-rg	db2_p8inst_p8inst_VWDBHA-rs	VWDBHA database

Figure 12-15 on page 413 illustrates the relationships among the resource groups.

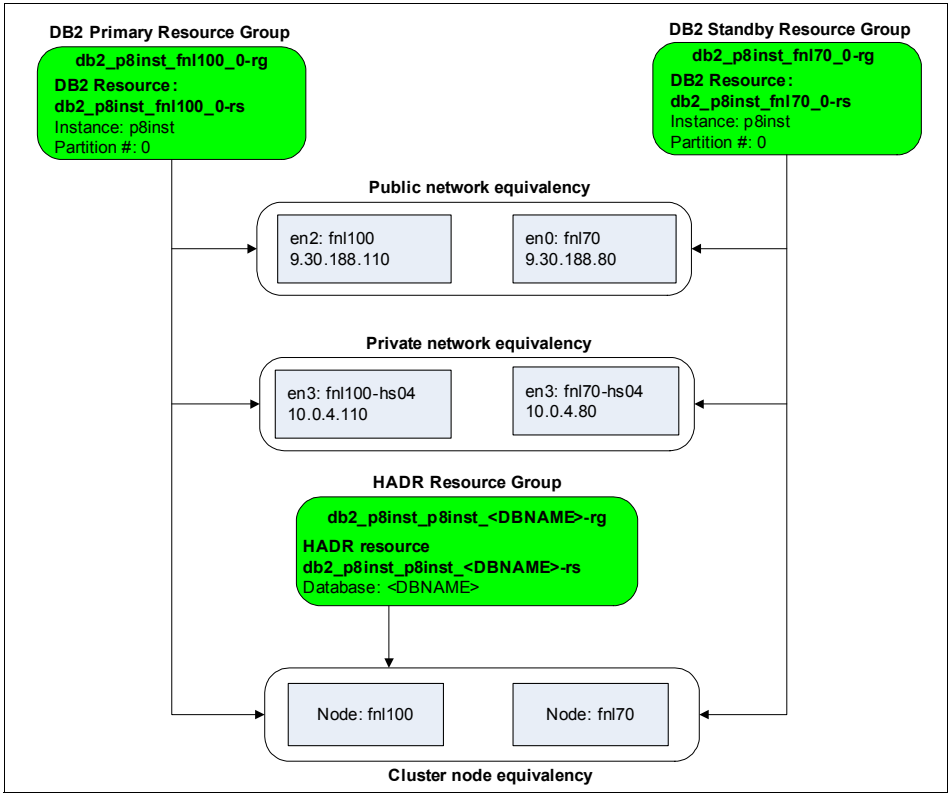


Figure 12-15 Resource group relationship

12.3 High availability tests for DB2

This section describes the tests that were performed for DB2 high availability for FileNet P8 configuration in our lab environment.

12.3.1 Test case description

For our environment, we perform the following tests:

- Simulate a DB2 software crash.

  We simulate the DB2 instance crash by renaming the *db2star2* binary that is used when starting the DB2 instance and issuing the **db2_kill** command against the instance on the primary node, fnl100. The expected result of the primary instance failure is that the standby system fnl70 takes over the primary role, and the DB2 clients are automatically reconnected to the new

server by ACR. The HADR cluster resources are activated on the new primary server, fnl70.

- Simulate a primary node failure.

  We simulate a node failure by halting the primary node fnl100 using the **halt -q** command on AIX. The HADR cluster resources are taken over to the standby node fnl70, and the databases are activated for client access.

- Simulate a network interface failure.

  We simulate a network interface failure on the public network on the primary node by bringing the interface down using the **ifconfig** command. Because we have defined a dependency between the DB2 instances on each node and the public network equivalency, we expect that this event is determined to be the primary instance failure and a takeover on the standby system results.

For each test, we perform the indicated operations to simulate the failure and provide the steps performed in our environment to reintegrate the failed node or resources back in the cluster.

For determining the cluster status, use the **lssam** command. For checking the HADR status, use the **db2pd** command. For our environment, we created a sample script, which greps the summary information status from the db2pd output, listed in Example 12-26.

Example 12-26 Sample script for checking the HADR status

```
#!/bin/ksh

DBNAME=$1
DBs="fngcddb indexdb fnos vwdbha"

if [[ $DBNAME == "" ]]; then
 echo "Usage: $0 <DBNAME|all>"
 exit 0
fi

if [[ $DBNAME == "all" ]]; then
for i in $DBs
do
echo "Summary status for $i:"
db2pd -db $i -hadr | grep -p Role
done

else
db2pd -db $DBNAME -hadr | grep -p Role
fi
```

Initial state of the cluster

The initial state of the cluster for each test assumes that the primary system for HADR is fnl100 and that the standby system is fnl70. The DB2 instances are started, and the HADR pairs are active in *Peer* state. Use **lssam** to determine the cluster state as shown in Example 12-27.

Example 12-27 Cluster initial state

```
root@fnl100 # lssam
Online IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl100_0-rs
                '- Online IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Offline IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Offline IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
                '- Offline IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Offline IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

We check the HADR pair status using the script that is provided in Example 12-26 on page 414. The result of running the script on the primary and standby servers is displayed in Example 12-28.

Example 12-28 Checking the HADR pair status

```
On primary node fnl100:
p8inst@fnl100 $checkhadr.sh all
Summary status for fngcddb:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Primary Peer                Sync     0                  0

Summary status for indexdb:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
```

```
Primary Peer                Sync     0                 0

Summary status for fnos:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Primary Peer                Sync     0                 0

Summary status for vwdbha:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Primary Peer                Sync     0                 0


On standby node fnl70:
p8inst@fnl70 $checkhadr.sh all
Summary status for fngcddb:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Standby Peer                Sync     0                 0

Summary status for indexdb:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Standby Peer                Sync     0                 0

Summary status for fnos:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Standby Peer                Sync     0                 0

Summary status for vwdbha:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Standby Peer                Sync     0                 0
```

12.3.2 Performing the tests

Here, we provide the test details and results.

DB2 instance crash

On the primary node fnl100, we move the db2star2 program and stop the DB2 processes by using the **db2_kill** command as shown in Example 12-29 on page 417.

Example 12-29 DB2 instance failure on primary node fnl100

```
p8inst@fnl100 $mv /data/db2/p8_inst/sqllib/adm/db2star2
/data/db2/p8_inst/sqllib/adm/db2star2.mv
p8inst@fnl100 $db2_kill
ipclean: Removing DB2 engine and client's IPC resources for p8inst.
p8inst@fnl100 $
```

The HADR resources are activated on the standby node fnl70, and the DB2 instance resource on fnl100 is finally marked "`Failed Offline`" as shown in Example 12-30.

Example 12-30 HADR takeover on fnl70

```
root@fnl70 # lssam
Failed offline IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Nominal=Online
        '- Failed offline IBM.Application:db2_p8inst_fnl100_0-rs
                '- Failed offline IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Pending offline IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Request=Lock
Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Pending offline IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Request=Lock
Binding=Sacrificial Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Pending offline IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Request=Lock
Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Request=Lock
Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

We also check that the primary role was successfully taken over to node fnl70. See Example 12-31 on page 418.

Example 12-31 HADR status on node fnl70

```
p8inst@fnl70 $checkhadr.sh all
Summary status for fngcddb:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Primary Disconnected        Sync     0                  0

Summary status for indexdb:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Primary Disconnected        Sync     0                  0

Summary status for fnos:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Primary Disconnected        Sync     0                  0

Summary status for vwdbha:
HADR Information:
Role    State               SyncMode HeartBeatsMissed   LogGapRunAvg (bytes)
Primary Disconnected        Sync     0                  0
```

To reintegrate the node in the cluster, we restart the failed node in the domain. We first deactivate the DB2 instance resource group and stop the node in the domain. See Example 12-32.

Example 12-32 Stopping the fnl100 node in the cluster domain

```
root@fnl70 # chrg -o Offline db2_p8inst_fnl100_0-rg
root@fnl70 # resetrsrc -s "Name like 'db2_p8inst_fnl100_0-rs' \
&& NodeNameList in {'fnl100'}" IBM.Application
root@fnl70 # stoprpnode fnl100
...
root@fnl70 # lsrpnode
Name   OpState RSCTVersion
fnl70  Online  2.4.9.4
fnl100 Offline 2.4.9.4
```

Next, we rename the db2star2 program on fnl100 and reactivate the failed node back in the domain as shown in Example 12-33 on page 419.

Example 12-33 Reintegrating the failed node in the domain

```
On fnl100:
p8inst@fnl100 $mv /data/db2/p8_inst/sqllib/adm/db2star2.mv \
/data/db2/p8_inst/sqllib/adm/db2star2

On fnl70:
root@fnl70 # startrpnode fnl100
.....
root@fnl70 # lsrpnode
Name   OpState RSCTVersion
fnl70  Online  2.4.9.4
fnl100 Online  2.4.9.4
root@fnl70 # chrg -o Online db2_p8inst_fnl100_0-rg
```

After restarting the DB2 instance on the fnl100 node, the HADR is automatically started and the node reintegrates in the HADR relationship as a standby node. The final cluster status in shown in Example 12-34.

Example 12-34 Final cluster status after reintegration of node fnl100

```
root@fnl70 # lssam
Online IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl100_0-rs
                '- Online IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

Primary node crash

This test simulates a node failure by halting the primary node, fnl100, during normal operations. We run the test by invoking the **halt -q** command on node fnl100. The cluster HADR resources are automatically taken over on the standby node fnl70, and the databases are activated for client access. See Example 12-35.

Example 12-35 Cluster status after node fnl100 failure

```
root@fnl70 # lssam
Failed offline IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Control=StartInhibited
Nominal=Online
        '- Failed offline IBM.Application:db2_p8inst_fnl100_0-rs
                '- Failed offline IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Node=Offline
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Request=Lock
Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100 Node=Offline
                '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Request=Lock Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100 Node=Offline
                '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Request=Lock
Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100 Node=Offline
                '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Request=Lock
Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100 Node=Offline
                '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

After restarting the failed node, fnl100, the node reintegrates automatically in the cluster domain. The DB2 instance starts, and the node reintegrates in the HADR relationship as standby node. Example 12-36 on page 421 shows the final cluster status.

Example 12-36 Final cluster status after restarting the node and reintegration in cluster

```
root@fnl100 # lsrpnode
Name   OpState RSCTVersion
fnl70  Online  2.4.9.4
fnl100 Online  2.4.9.4

root@fnl100 # lssam
Online IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl100_0-rs
                '- Online IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

Network interface failure

We bring down the public interface, *en2:fnl100*, on the primary node, fnl100. For test purposes, we access the node using the private network and issue the **ifconfig down** command on the public interface of node fnl100, as shown in Example 12-37.

Example 12-37 Simulate the public interface failure on primary node fnl100

```
root@fnl100 # netstat -i
Name  Mtu   Network     Address            Ipkts Ierrs    Opkts Oerrs  Coll
en0   1500  link#2      de.fc.50.1.40.4    1183425     0  1053977     0     0
en0   1500  10.254.240  fnl100-hmcp        1183425     0  1053977     0     0
en2   1500  link#3      de.fc.50.1.40.6    5237869     0  4038896     0     0
en2   1500  9.30.188    fnl100             5237869     0  4038896     0     0
en3   65390 link#4      de.fc.50.1.40.7    1467861     0  1401041     0     0
en3   65390 10.0.4      fnl100-hs04        1467861     0  1401041     0     0
lo0   16896 link#1                         1507980     0  1510605     0     0
```

```
lo0   16896 127         loopback           1507980     0  1510605     0     0
lo0   16896 ::1                            1507980     0  1510605     0     0
root@fnl100 # who am i
root         pts/3       Nov 02 19:36     (fnl70-hs04)
root@fnl100 # ifconfig en2 down
root@fnl100 # netstat -i
Name  Mtu   Network     Address            Ipkts Ierrs    Opkts Oerrs  Coll
en0   1500  link#2      de.fc.50.1.40.4    1184408     0  1054879     0     0
en0   1500  10.254.240  fnl100-hmcp        1184408     0  1054879     0     0
en2*  1500  link#3      de.fc.50.1.40.6    5238415     0  4039297     0     0
en2*  1500  9.30.188    fnl100             5238415     0  4039297     0     0
en3   65390 link#4      de.fc.50.1.40.7    1468110     0  1401253     0     0
en3   65390 10.0.4      fnl100-hs04        1468110     0  1401253     0     0
lo0   16896 link#1                         1508692     0  1511317     0     0
lo0   16896 127         loopback           1508692     0  1511317     0     0
lo0   16896 ::1                            1508692     0  1511317     0     0
root@fnl100 #
```

The DB2 instance on the fnl100 node fails due to the dependency relationship between the instance and the network equivalency. As a result, the cluster HADR resources are taken over on the standby node fnl70. The cluster status is shown in Example 12-38.

Example 12-38 Cluster status after network interface failure

```
root@fnl70 # lssam
Failed offline IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Binding=Sacrificed
Nominal=Online
        '- Offline IBM.Application:db2_p8inst_fnl100_0-rs
                '- Offline IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Pending offline IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Request=Lock
Binding=Sacrificial Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Request=Lock Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Request=Lock
Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
```

```
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Request=Lock
Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

To reintegrate the node in the cluster, we bring up the public interface on node fnl100 and check for the cluster status. See Example 12-39.

Example 12-39 Cluster status after bringing up the failed interface

```
root@fnl100 # lssam
Online IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl100_0-rs
                '- Online IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Failed offline
IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

Next, we restart the node fnl100 in the domain and reintegrate it as an HADR standby system. See the operations and the final status in Example 12-40 on page 424.

Example 12-40 Reintegrating the node fnl100 in the cluster domain as standby system

```
root@fnl70 # chrg -o Offline db2_p8inst_fnl100_0-rg
....Wait for stopping the database instance on fnl100....
root@fnl70 # lssam
Offline IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Nominal=Offline
        '- Offline IBM.Application:db2_p8inst_fnl100_0-rs
                '- Offline IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Request=Lock Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Failed offline IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Request=Lock Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Failed offline IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Request=Lock Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Failed offline IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Request=Lock Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Failed offline IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70


root@fnl70 # stoprpnode fnl100
.....
root@fnl70 # lsrpnode
Name   OpState RSCTVersion
fnl70  Online  2.4.9.4
fnl100 Offline 2.4.9.4
root@fnl70 # startrpnode fnl100
.....
root@fnl70 # lsrpnode
Name   OpState RSCTVersion
fnl70  Online  2.4.9.4
fnl100 Online  2.4.9.4


root@fnl70 # chrg -o Online db2_p8inst_fnl100_0-rg
.....
```

Final status of the cluster resources:

```
root@fnl100 # lssam
Online IBM.ResourceGroup:db2_p8inst_fnl100_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl100_0-rs
                '- Online IBM.Application:db2_p8inst_fnl100_0-rs:fnl100
Online IBM.ResourceGroup:db2_p8inst_fnl70_0-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_fnl70_0-rs
                '- Online IBM.Application:db2_p8inst_fnl70_0-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNGCDDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNGCDDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_FNOS-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_FNOS-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_INDEXDB-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl100
```

```
              '- Online IBM.Application:db2_p8inst_p8inst_INDEXDB-rs:fnl70
Online IBM.ResourceGroup:db2_p8inst_p8inst_VWDBHA-rg Nominal=Online
        '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs
                |- Offline IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl100
                '- Online IBM.Application:db2_p8inst_p8inst_VWDBHA-rs:fnl70
```

12.4 Maintenance and upgrade recommendations for DB2

This section contains high-level information about upgrading and maintaining DB2 for FileNet P8 in an HA environment. We discuss the following topics:

- DB2 upgrade for FileNet P8
- DB2 maintenance for FileNet P8

For further details about DB2 system maintenance and upgrade, see Chapter 14, “Backup and Recovery” in *High Availability, Scalability, and Disaster Recovery for DB2 on Linux, UNIX, and Windows*, SG24-7363.

12.4.1 DB2 upgrade for FileNet P8

Your DB2 installation and upgrade are simpler, because the general availability (GA) versions of DB2 V8 on Microsoft Windows platforms and DB2 V9 on UNIX platforms contain the base code for an installation in the downloadable fix pack. This combined fix pack package allows you to install the base code and apply the fix pack in one installation process, saving time and reducing potential errors that might occur during the installation.

DB2 has two types of upgrades: fix pack and version level. We describe both types.

We also provide considerations for upgrading these FileNet P8 components:

- CE, PE, and IS components that use DB2 Server as their metadata repository
- Since IS Version 4.1.2, support for DB2 Version 9.5 as the remote DB failover

DB2 fix pack rolling upgrades

A *fix pack* is a cumulative collection of Authorized Program Analysis Report (APAR) fixes. Fix packs have the following characteristics:

- They are cumulative. Fix packs for a particular release of DB2 supersede or contain all of the APAR fixes that were shipped in previous fix packs and interim fix packs for that release.

- They are available for all supported operating systems and DB2 database products.
- They contain multiple APARs.
- They are published on the DB2 Technical Support Web site and are generally available to clients, who have purchased products under the Passport Advantage® program. The DB2 Technical Support Web site is http://www-01.ibm.com/software/data/db2/support/db2_9.
- They are fully tested by IBM.
- They are accompanied by documentation that describes changes to the database products and how to install and remove the fix pack.

HADR gives you high availability while applying DB2 fix packs through rolling upgrades. Your database experiences only momentary downtime while you switch roles between your database servers. With properly written applications using standard retry logic and the proper handling of message SQL30108N if you use Automatic Client Reroute (ACR), there is effectively no loss of data, and no visible downtime to clients.

You follow these steps to perform a rolling upgrade. The HADR Primary database is never taken offline from users:

1. Check your system's HADR status.
2. Apply the fix pack on the standby system.
3. Switch the HADR roles from the standby system.
4. Apply the fix pack in the old primary system.
5. Switch the HADR roles back to the original primary system.

DB2 version upgrade

Before you perform the DB2 upgrade, we recommend that you verify the FileNet P8 components' compatibility with the DB2 version. See the installation documentation at this Web site:

http://www.ibm.com/support/docview.wss?rs=3278&uid=swg27010422

A rolling upgrade is not supported between DB2 versions or major subversion migrations, such as Version 8.2 to 9.1, or 9.1 to 9.5. For these events, plan for a database outage while the HADR primary database is updated.

The initial critical step of DB2 migrations is running the **db2ckmig** command, which checks if databases are eligible for migration to the new DB2 version.

For the further details, refer to DB2 9.5 Information Center at:

http://publib.boulder.ibm.com/infocenter/db2luw/v9r5/topic/com.ibm.db2.luw.qb.migration.doc/doc/c0023662.html

Rolling DB2 configuration parameters

In order to keep your HADR systems optimal, apply changes to both servers as quickly as possible.

Note that when updating HADR-specific database configuration parameters, DB2 will not allow you to switch HADR roles. Certain HADR parameters must always remain matched, such as HADR_TIMEOUT, for example. Therefore, you must schedule a required brief database outage while updating the parameters on the primary server and recycling the DB2 instance or deactivating/activating the database.

For the HADR Primary system, this process of role switching is not required for dynamic databases or database manager configuration parameters, that is, which require no recycling of the DB2 database or instance to take immediate effect. When a dynamic database manager or database configuration parameter update has been issued on the HADR primary, you must manually perform the update against the HADR standby, as well. Parameter configurations are not logged, and thus, are not mirrored through HADR log shipping.

For further details, refer to the DB2 9.5 Information Center at:

http://publib.boulder.ibm.com/infocenter/db2luw/v9r5/topic/com.ibm.db2.luw.qb.migration.doc/doc/c0023662.html

12.4.2 DB2 maintenance for FileNet P8

In this section, we describe high-level information about backing up and restoring DB2 databases or tablespaces. Multiple options to backup and restore DB2 exist, depending on your requirements.

DB2 allows offline and online backup of the databases. You also have options to back up the entire database or just incremental changes.

In the following paragraphs, we detail the required steps to perform a database backup for various scenarios. The commands that are shown in this section are run as the database instance owner.

Full offline backup

The easiest way to create a database backup is by using an offline backup. No application is accessing or connected to this database at this time. You can discover whether any application is connected to your database by running this command:

```
db2 list application for database <database name>
```

You need to stop the CE, PE, and IS applications first. Then, make sure that the connections to the DB2 databases are gone.

To end an application connection from DB2, use the command:

```
db2 force application <application handle>
```

To disconnect all the application connections, use:

```
db2 force application all
```

The **db2 force application all** command terminates all of the connections to all of the databases in the DB2 instance. If more than one database is defined in an instance, use this command carefully to not interrupt other applications.

If you want to ensure that no one else is working on DB2, you can optionally stop and restart the DB2 server and put the database in quiesce mode. To force DB2 to end all applications and to not let any of them log on again, use:

```
db2 quiesce database force connections
```

Remember, the user must belong to the sysadm or dbadm group.

To create an offline backup of a DB2 database, run:

```
db2 backup database <database name> to <directory>
```

To put DB2 back to its normal state, use:

```
db2 unquiesce db
```

Full online backup

The advantage of using an online backup is that no application is required to disconnect from the database and no transaction has to be stopped. The database remains accessible and is able to be updated at all times. The online backup also allows you to recover the database to the point in time of the failure. For FileNet P8, there is no need to stop CE, PE, and IS. You typically perform backups when systems need to be highly available and no amount of downtime is acceptable.

Log files are critical for the online backups. Because transactions are still in progress during the backup, the backup might contain the transactions that are in an uncommitted status. DB2 uses the information in the database backup images and the log files to restore the database to a consistent status, as well as to a specified point in time.

To perform an online backup, run this command:

```
db2 backup database <database name> ONLINE to <directory>
```

Incremental backup

DB2 provides backup facilities for data that has changed since the last offline or online database backup. This feature saves tape or disk space, but it might not reduce the amount of time to perform a backup, because DB2 still needs to read the data blocks to determine if they have changed since the last backup. Performing recovery requires both the database backup and the incremental backups to fully recover the database. Using this method can take more time to recover a database.

Incremental backups are useful for saving space, as well as for saving bandwidth, when backing up over the network.

Backing up and restoring a database with snapshot backup

DB2 9.5 provides fully integrated flash copy support. It automates the manual steps that are currently required for backup and restore with flash copy.

Many storage subsystems provide FlashCopy® or snapshot functions that allow you to make nearly instantaneous point-in-time copies of entire logical volumes or data sets.

In a traditional backup or restore operation, the database manager copies data to or from disks using operating system calls. Being able to use the storage subsystems to perform the data copying makes the backup and restore operations much faster. In addition, the impact on the ongoing operation is minimum; therefore, it is an optimal solution for a 24x7 production system.

As of Version 9.5, DB2 provides integrated support for snapshot backups through DB2 Advanced Copy Services (ACS™). DB2 ACS enables you to use the fast copying technology of a storage device to perform the data copying part of backup and restore operations.

Restoring the database

It is important to verify the requirements to restore the database, because there are multiple ways to restore a database:

- Based on the amount of time that is needed to recover the database
- Recovery based on a specific point in time

Restoring a full database backup is the fastest option. By reapplying database log files, the time that is needed increases; however, you are able to recover to a later point in time. Your strategy truly depends on your requirements.

Considerations

There are few considerations for backing up databases for FileNet P8:

- Because FileNet P8 works with multiple databases (in our case, FNGCDDB, FNOS, INDEXDB, and VWDBHA databases), we recommend that you schedule the backup for all databases on your system in the same backup window to maintain consistent data. This consideration is extremely important for the CE Global Configuration Database (GCD) and object store databases (FNGCDDB and FNOS, in this example).
- An offline backup is the preferred method for IBM FileNet P8. An offline backup insures that all application data is in a consistent state. When a restore becomes necessary, all data must be recovered to the same point in time.

13

System-level failover testing

In this chapter, we provide the details about failover testing for each of the IBM FileNet P8 components with practical step-by-step procedures in a high availability environment.

We discuss the following topics:

- System-level testing:
  - Prerequisites
  - HTTP servers
  - Application Engine: Workplace
  - Content Engine
  - Content Search Engine
  - Process Engine server farm
  - Image Services
  - Databases
- Actual testing process and results

13.1 System-level testing

The starting point for the system-level testing is making sure that all servers, the hardware load balancer, and connections are up and running normally. In the case of active/passive clusters, the active node is up and functioning, with the passive node waiting to take over the primary node's function. The objective of these tests is not to verify full functionality of the software, as in typical quality assurance (QA) testing. Instead, it is to show that service remains available after any one node goes down. It is assumed that the software has passed the QA testing, and therefore, if connectivity is still available after a failure, all functions will operate normally.

In each series of tests, the person executing the test has to authenticate (log on to) to the Application Engine (AE), typically, in the first step of the sequence. For the remaining steps in each sequence, the tester notes whether they are subsequently required to log in to AE again. In certain failover scenarios, we expect that the user will be requested to log on again, while in other failover scenarios, the user's credentials are retained so that another logon is not required.

In the cases of the HTTP server, AE, Content Engine (CE), and Process Engine (PE), the components within each tier are deployed for high availability in a server farm, with all nodes active (active/active cluster). This configuration is beneficial for scalability, as well as availability, when compared with an active/passive cluster of nodes. Under normal circumstances, all of the nodes in an active/active cluster can be used to service user requests. From a high availability (HA) standpoint, the benefit of this configuration is that there is little, if any, recovery time required after a node failure. The other nodes in the cluster are already up and operational. The only requirement is for the next tier closer to the user to detect the failure and to start directing requests to the remaining nodes. This configuration is the preferred configuration for achieving high availability.

When testing the availability of an active/active cluster in a tier, it is necessary to fail all of the nodes in the cluster one at a time. You must show that the service provided by that cluster remains available regardless of which single node in the cluster fails.

13.1.1 Prerequisites

The prerequisites that we describe here assume that we will test for all of the components that we have set up, including Image Services (IS) and Content Search Engine.

After configuring all of the hardware and software, use a population tool to create an initial set of documents within the Image Services server. These documents must have content (1 KB of random text is sufficient). The intention is to federate them using Content Federated Services for Image Services (CFS-IS) so that they are available through the Content Engine.

Second, use Enterprise Manager to create an object store, enable content-based retrieval (CBR) searches on the Document class, and populate the object store with at least five documents, each containing content. For testing convenience, file these five documents in a single folder. Verify that the documents have been successfully indexed for CBR searches.

Third, configure CFS-IS so that the documents created within the IS system will be federated into the object store. Verify that this operation has completed and that the content of these documents can be accessed through Enterprise Manager.

Each of the following sections details the steps to verify the high availability of each of the component tiers under test. Each test focuses on a specific tier in the configuration. For the system to have end-to-end high availability, each tier must demonstrate that it can continue to provide service in the event of a failure of any single node.

13.1.2 HTTP servers

The two HTTP servers operate as a farm and serve as a front end to the AE systems. They implement WebSphere Application Server-specific load balancing through the use of the HTTP Plug-in. Because both HTTP servers are able to connect to both the AE servers, the loss of either HTTP server does not cause a loss of availability, except for transactions that are in progress at the time of the failure that were directed through the failed node. The hardware load balancer ensures that new connections received from clients will be directed to one or both of the HTTP servers, depending on load and availability. Because testing availability of the hardware load balancer is outside the scope of this book, only a single load balancer is used. We assume the single load balancer is either to be implemented using high availability hardware techniques, or that a backup load balancer is available at all times to be substituted if the primary load balancer fails.

Follow these test procedure steps to verify the high availability of the HTTP server tier:

1. With both nodes running, browse the contents of the object store, and get the properties of an item. Retrieve four other documents' properties or content.
2. Shut down HTTP node 1. Repeat the browse/get properties operations to verify that service is still available.
3. Bring HTTP node 1 back up; shut down HTTP node 2. Repeat the browse/get properties operations to verify that service is still available.
4. Bring HTTP node 2 back up.

Test expectations: nodes at this tier must maintain session affinity between the clients and the AE servers, because the AE server retains logon credentials for the user in between interactions. When the node that the user was using is lost, the new node will not know which AE was servicing the user previously, and will select one, effectively at random. Therefore, there is a 50/50 chance that the user will be requested to log on again during this test.

13.1.3 Application Engine: Workplace

The AE servers form the primary Web tier for P8. They depend on the availability of CE and PE. Unlike CE and PE, which are designed to be stateless, AE maintains a state for each user, including each user's logon credentials. Therefore, connections from clients to the AEs through any load-balancing mechanism must be configured with session affinity, so that each time that a user connects (Web browser connections are typically short-lived), the connection will be directed to the same AE. Of course, this approach is impossible if that particular AE become unavailable. So, for this tier, high availability means that service continues to be available if a node in the tier fails, but users will be expected to log on again and might have to resubmit a transaction that was being created at the time of the failure.

Follow these test procedure steps for verifying high availability of the AE server tier with CE:

1. With both nodes running, browse the contents of the object store, and get the properties of an item.
2. Shut down AE node 1. Repeat the browse/get properties operations to verify that service is still available.
3. Bring AE node 1 back up; shut down AE node 2. Repeat the browse/get properties operations to verify that service is still available.

Follow these test steps to verify the functioning of AE with PE:

1. Bring AE node 2 back up. Create a two step workflow from the Process Designer.
2. Shut down AE node 1. Create a two step workflow from the Process Designer.
3. Bring up AE node 1; shut down AE node 2. Create a two step workflow from the Process Designer.
4. Bring up AE node 2. With both nodes running, launch a workflow that contains a manual step.
5. Shut down AE node 1. Complete the manual step in the workflow.
6. Bring up AE node 1; shut down AE node 2. Complete the second step of the workflow.
7. Bring up AE node 2.

13.1.4 Content Engine

Content Engine, along with Process Engine, forms the business logic tier of the P8 architecture. It depends primarily upon the availability of the databases, File Storage Areas, and or Fixed Content Devices for its operation. For CE to be highly available, each of these underlying services must be made to be highly available also, along with other infrastructure, such as the network.

CE is configured for high availability in an active/active server farm. CE is designed to be stateless, so that requests can be sent to any CE within the farm for processing. Clients of CE will access it in one of two ways. Web Services clients will connect through a load balancer (a hardware load balancer in the configuration that is used for this book). Enterprise JavaBeans (EJB) clients will use software load balancing that is provided by the application server (WebSphere Workload Manager, in the case of WebSphere Network Deployment Edition, the application server that is used for this book).

Because all CEs are normally active, testing of high availability in this tier will involve shutting down each node in the tier in turn and verifying availability of the CE service at all times. Because CEs are stateless and do not “replace” the functioning of a failed node, no failovers or failbacks are required, only verifying that service remains available regardless of which CE node might be down at a given time.

Follow these test procedure steps for verifying the high availability of Content Engine:

1. With all nodes running, log in to Workplace from a browser. Create a document with content. Browse the contents of the object store. Get the properties of a document.
2. Shut down CE node 1. Check out the document that was created in step 1.
3. Bring up CE node 1; shut down CE node 2. Check in the document that was checked out in step 2, with new content.
4. Bring CE node 2 back up.

As noted earlier, the EnableDispatcher setting in Content Engine to enable the dispatching of indexing jobs to Content Search Engine (CSE) constitutes a single point of failure in versions of the 4.*x* CE prior to 4.5. In those earlier versions, including Version 4.0.1, which is used for the testing for this book, it is necessarily to change this setting manually when a failover occurs, if indexing is to continue.

13.1.5 Content Search Engine

Content Search Engine consists of several components, and of those components, three form single points of failure:

- The Master Administration Server: There is only one Master Administration Server within a K2 domain. For high availability, it must be active/passive-clustered.
- The Index Server: For a given collection, there is only one Index Server. Furthermore, this server must have local file access, typically through a Fibre Channel connection to a storage area network (SAN) device. For high availability, each Index Server must therefore be active/passive-clustered.
- The CE that dispatches indexing jobs: In CE Versions 4.0.0 and 4.0.1, there is a distinguished CE node that performs this function. For a completely automatic failover if this node were to fail, either it must be active/passive-clustered, or the cluster management software must run a custom program that will change the EnableDispatcher setting from the failed node to another node in the farm.

In the configuration of P8 that is used for this book, all of the CSE services are deployed on one logical partition (LPAR). Consequently, that LPAR is active/passive-clustered with another LPAR that is using IBM PowerHA for AIX (HACMP - formerly IBM High Availability Cluster Multi-Processing). Therefore, testing consists of shutting down the initially active node, verifying that a failover occurs, and then, that service remains available. We also want to verify that

Content Engine will continue to accept new documents even when the service is completely unavailable.

Follow these test procedure steps for verifying the high availability of the Content Search Engine:

1. With all nodes running, log in to Workplace from a browser. Create a new document containing at least one keyword that is not contained in any other document in the repository. Wait until all of the documents have been indexed (set a low dispatcher wait interval, and check the indexing job queue to verify that the indexing has completed).
2. Create a new document with content.
3. Verify that the document is indexed and can be found in a search.
4. Shut down CSE node 1 and verify that a failover to node 2 has occurred. Perform the same test as in steps 2 and 3.
5. Perform a failback from node 2 back to node 1. Perform the same test as in steps 2 and 3.
6. Now, bring down both nodes, so that the CSE service is unavailable. Perform the same test as in step 2.
7. Finally, restore node 1 to normal operation. Now, perform the test in step 3 to verify whether the documents that were created in step 6 have been indexed now that service has been restored.

We expect that in step 6, the user will still be able to create a document, and that this document will be indexed and be searchable after the CSE nodes are brought back up in step 7.

13.1.6 Process Engine server farm

Two high availability configurations of Process Engine can be set up: either active/active server farm or active/passive cluster. For this book, we test the best practice approach, which is the active/active server farm of PEs. In this configuration, testing of its high availability is similar to the previous tests for the Content Engine server farm. Because either node in the farm must be able to handle all client requests, the tests involve alternately shutting down one or the other of the PEs in the farm, and while each node is down, performing a client operation through AE to demonstrate that users still have service during the outage.

Starting with both Process Engines in the active state, execute the following tests for verifying high availability of Process Engine:

1. Shut down PE node 1. Launch a workflow process that contains a manual intervention step.
2. Bring up PE node 1; shut down PE node 2. Complete the manual intervention step in the previously launched workflow process.
3. Bring PE node 2 back up. Complete the work item for the launched workflow with both nodes up.
4. Shut down PE node 2. Launch a workflow process with a manual intervention step.
5. Bring PE node 2 back up; shut down PE node 1. Complete the manual intervention step in the launched workflow.
6. Bring PE node 1 back up. Complete the work flow with both nodes up.

13.1.7 Image Services

In the configuration that is used for this book, we used the Image Services system as a Fixed Content Device by Content Engine. The IS system is, in turn, a client of the database. Because the IS system is configured for high availability in an active/passive cluster, only a single failover is required to test the system's HA robustness. If the IS system can fail over to the passive node, and if Content Engine can then continue to function by accessing content stored in IS, the test is successful. We have already verified that the documents within the IS system are available through Content Engine in the prerequisite steps just listed.

Use the following test procedure for verifying high availability of Image Services:

1. Shut down the active IS system. Verify that failover occurs and that HACMP brings up the passive node.
2. Verify that CE users can still access content that is stored in the IS system.
3. Perform a failback from the passive IS node to the originally active IS node.
4. Verify that CE users can still access content that is stored in the IS system.

In addition to these tests that verify that the IS system is highly available as a fixed content device through Content Engine, we also verify that the IS system remains available for its native clients:

1. Verify that the IS system is available from the IDM Desktop client by logging in and retrieving a document image.
2. Shut down the active IS system (node 1). Verify that failover occurs and that HACMP brings up the passive node (node 2).

3. Verify that the IS system is available from the IDM Desktop client by logging in and retrieving a document image. Note whether the user must reconnect or log on again.
4. Shut down node 2, and verify that HACMP brings the node 1 IS system back up.
5. Verify that the IS system is available from the IDM Desktop client by logging in and retrieving a document image. Note whether the user must reconnect or log on again.

13.1.8 Databases

Because we are using the DB2 High Availability Disaster Recovery (HADR) feature in the configuration for this book, database failover is invisible to the P8 servers (the database clients). In our test environment, all of the databases reside in a single instance of DB2. Therefore, failover testing involves shutting down the active node and observing that failover and continuity occur successfully. In the preceding tests, we have verified that the primary database is operating properly with all of its clients, so we can proceed directly to the failover testing:

1. Shut down the primary DB server.
2. Verify that failover occurs so that the passive database is brought fully online.
3. Verify that CE users can access content that is stored both in the filestore and in the IS system.
4. Use the Process Tracker to complete a work item for a launched workflow.
5. Perform a failback from the passive database node to the original active node.
6. Verify that CE users can access content that is stored both in the filestore and in the IS system.
7. Use the Process Tracker to complete a work item for a launched workflow.

13.2 Actual testing process and results

For Content Search Engine, refer to Chapter 10, “Content Search Engine implementation” on page 221, and for Image Services, refer to Chapter 11, “Image Services implementation” on page 285 for details about tests and test results. System-level failover tests involve more than one component so many P8 components are tested together under the same configuration.

For example, CE and PE are tested together for these reasons:

- They are dependent on each other for workflow.
- Workplace is the application that we use to test both engines.

13.2.1 HTTP servers

When both HTTP servers are running, client requests are spread across both of them. Figure 13-1 shows a functioning FileNet Workplace Web application, beneath which, two side-by-side command windows show the entries for the two HTTP logs, one for each server. In this case, both servers are serving HTTP GET requests successfully (that is, code 200).

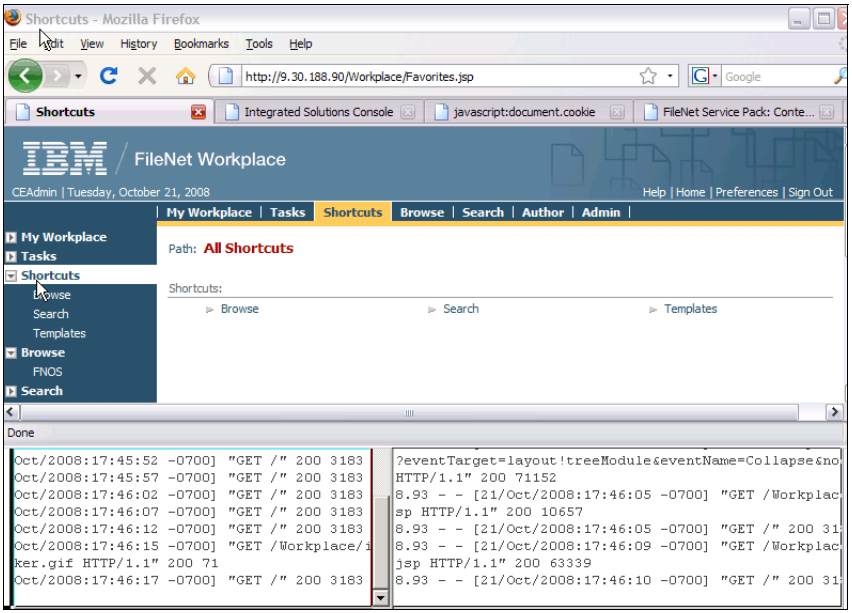


Figure 13-1 Both HTTP servers are running

We stop one of the HTTP servers by using the WebSphere administrative console, as shown in Figure 13-2 on page 441.

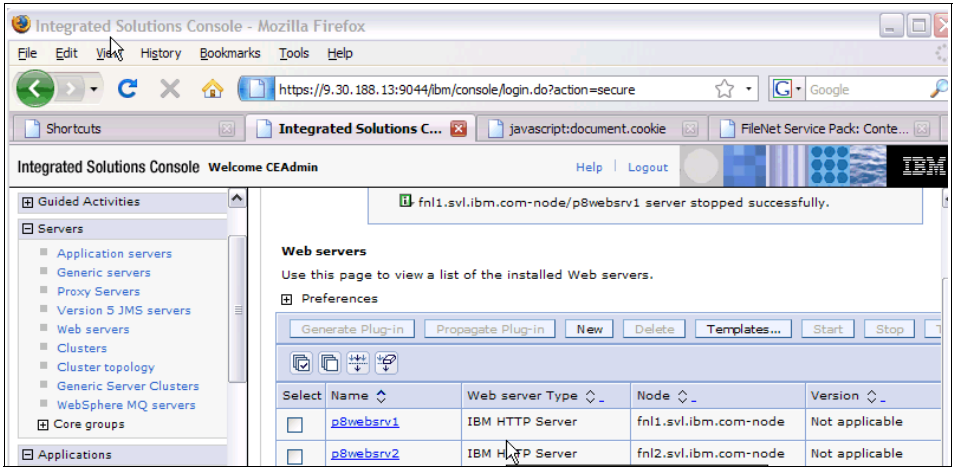


Figure 13-2 Stop HTTP Server in WebSphere administrative console

The FileNet Workplace still functions normally with one HTTP server running. In Figure 13-3, the side-by-side HTTP log windows show that only the second HTTP server is serving Workplace GET requests.

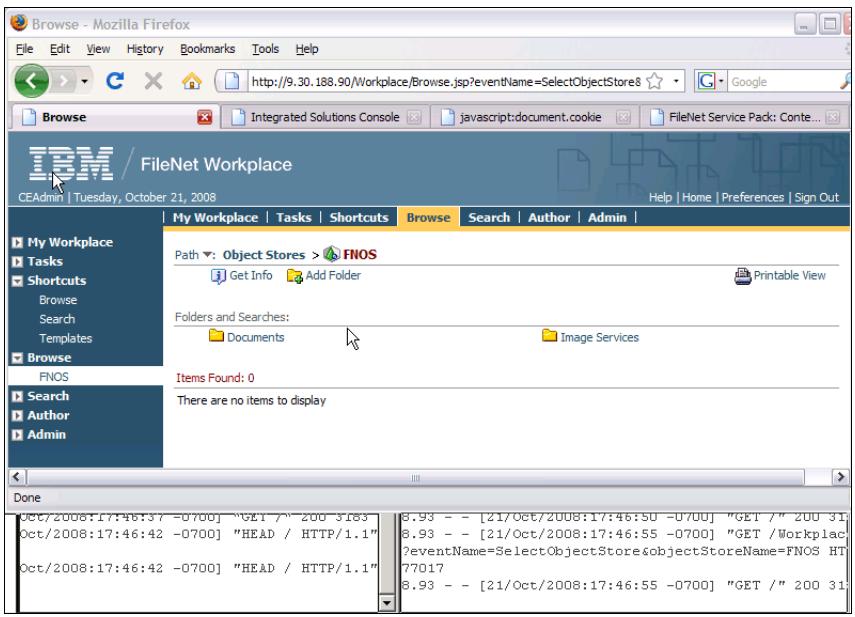


Figure 13-3 Workplace behaves normally after one HTTP stops

13.2.2 Application Engine: Workplace

AE runs as WebSphere application servers, which are managed in a cluster. The WebSphere administrative console shows the status of each server. To begin this failover test, we have two servers running first, as shown in Figure 13-4.

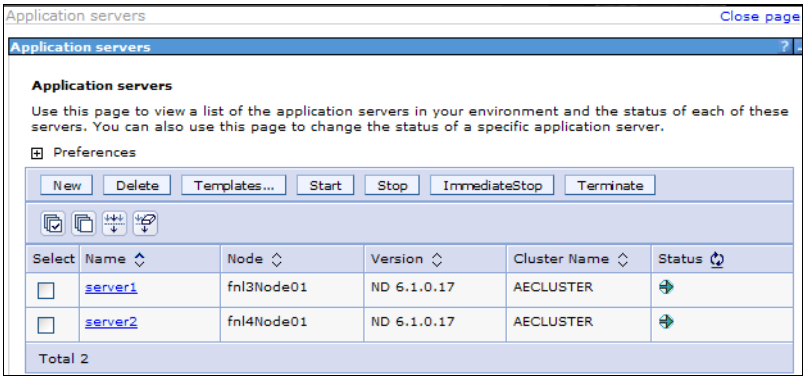


Figure 13-4 Both AE servers are running

While both AE servers are running, we can import a document into P8 through Workplace, as shown in Figure 13-5 and Figure 13-6 on page 443.

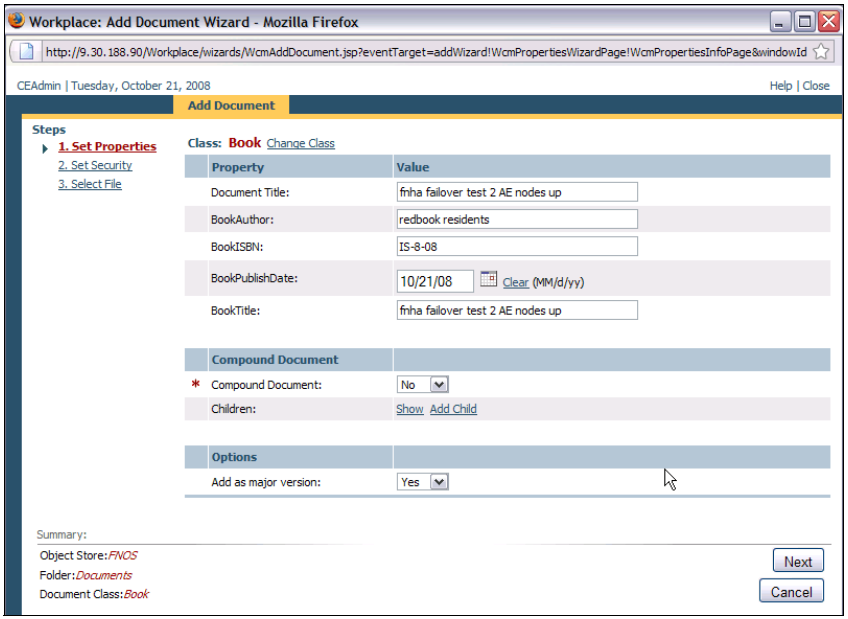


Figure 13-5 Importing a document in Workplace

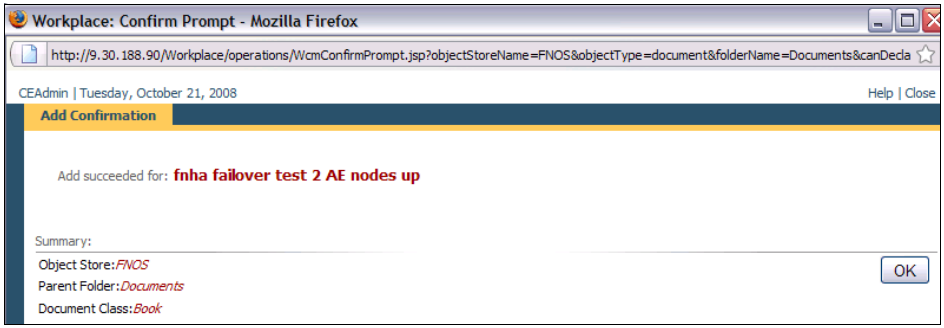


Figure 13-6 Successful Workplace import

Then, we stop one of the AE servers in WebSphere administrative console, as shown in Figure 13-7.

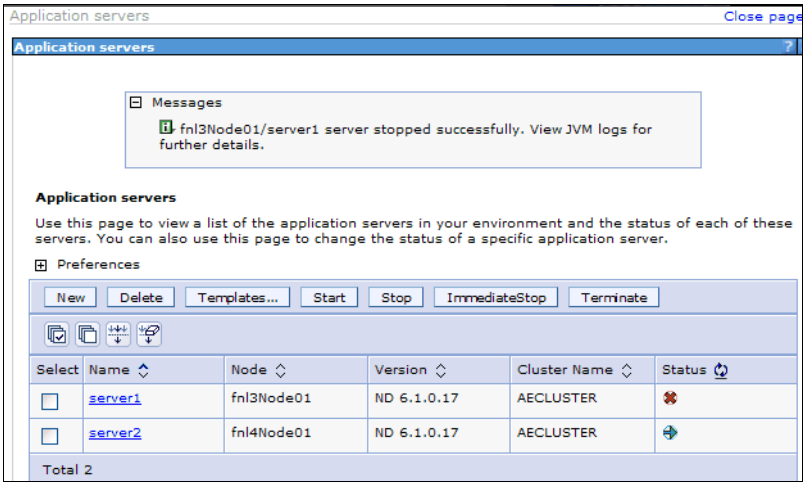


Figure 13-7 Stop an AE server

Importing a new document in Workplace functions normally on the available AE server. The user will not notice any change, because the same user happens to be on the live server. See Figure 13-8 on page 444.

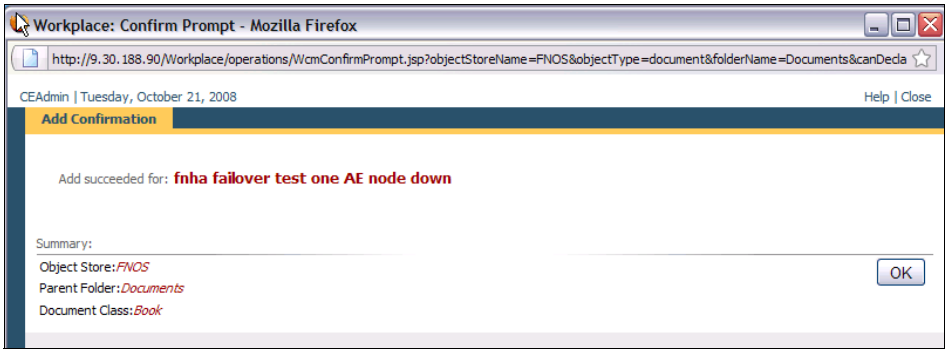


Figure 13-8 Document import successful with one AE server

A similar test shows a second user, who is using Workplace and sending requests to the AE server, which is about to go down (simulated by stopping server2). See Figure 13-9.

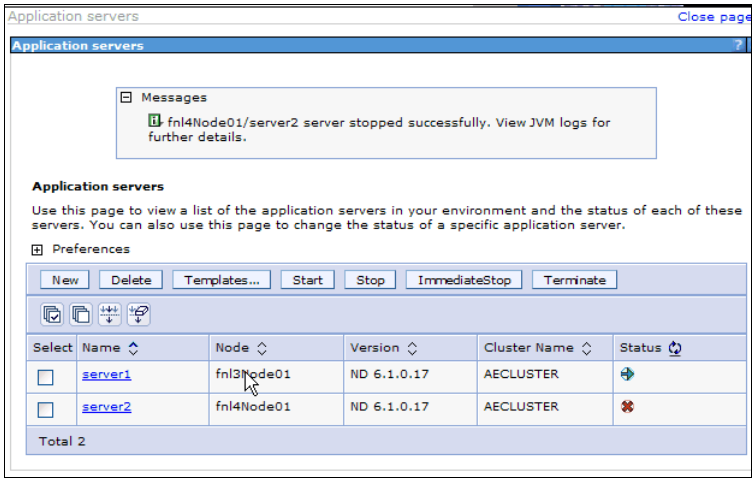


Figure 13-9 The second AE is stopped while the first AE stays up

When the same user tries to perform a document import, authentication is required again in Workplace, as shown in Figure 13-10 on page 445.

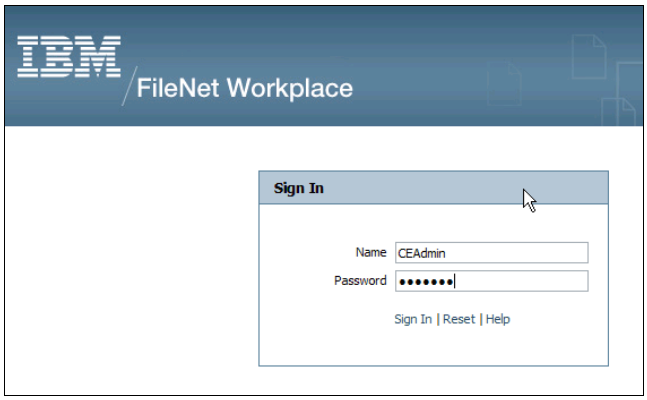


Figure 13-10 Re-authentication required for users on the AE server that is down

After the user logs in again, the same import succeeds with only one AE instance running. See Figure 13-11.

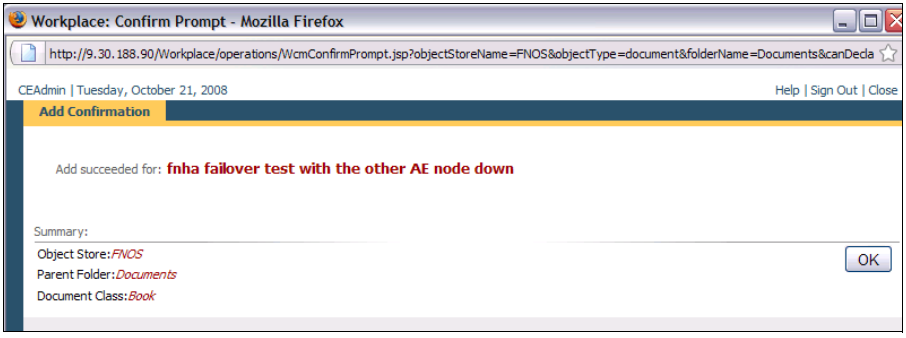


Figure 13-11 Import succeeds in Workplace on one AE instance

13.2.3 Content Engine and Process Engine

Content Engine and Process Engine both have to function for a workflow to work. We combine the two components in this system-level failover test scenario. Similar to other WebSphere servers, we stop one of the CE servers in the WebSphere administrative console, as shown Figure 13-12 on page 446.

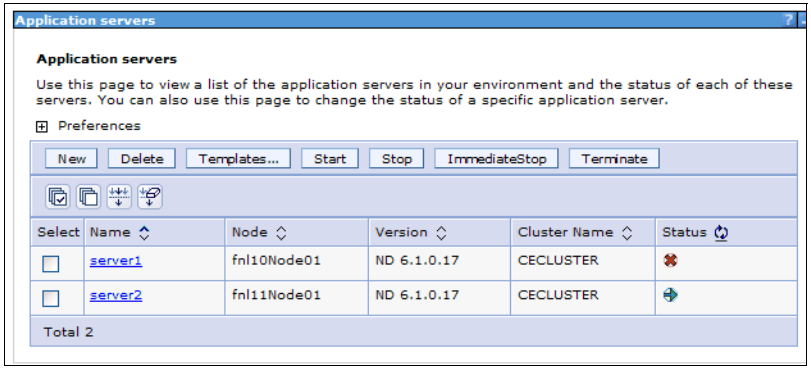


Figure 13-12 CE cluster has only one instance up

We also stop one of the PE instances in the farm setup. Overall, we can see clearly which servers are running and which servers are down in the F5 load balancer. Figure 13-13 shows the statistics for the HTTP, CE, and PE nodes. For this test, we make one HTTP server, one CE server, and one PE server available (nodes marked red are down, and nodes marked green are up).

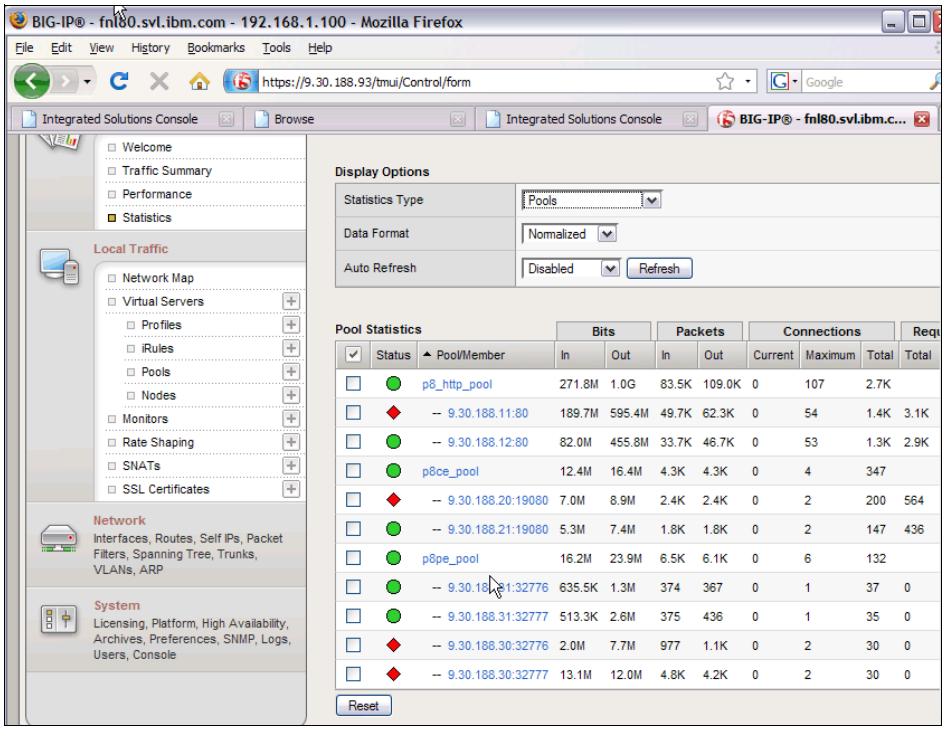


Figure 13-13 Only one HTTP, one CE server, and one PE server available

We can successfully import a document, as shown in Figure 13-14.

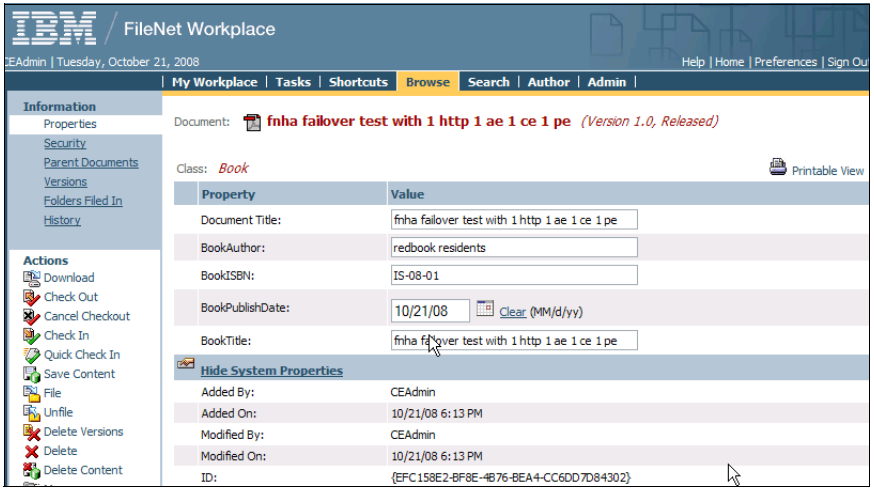


Figure 13-14 Successful import document into CE on a single HA stream

Next, we test the workflow. Before we stop PE, we launched a workflow and move one step in the workflow. Figure 13-15, Figure 13-16 on page 448, and Figure 13-17 on page 448 show what tasks we can perform up to until the PE shutdown.

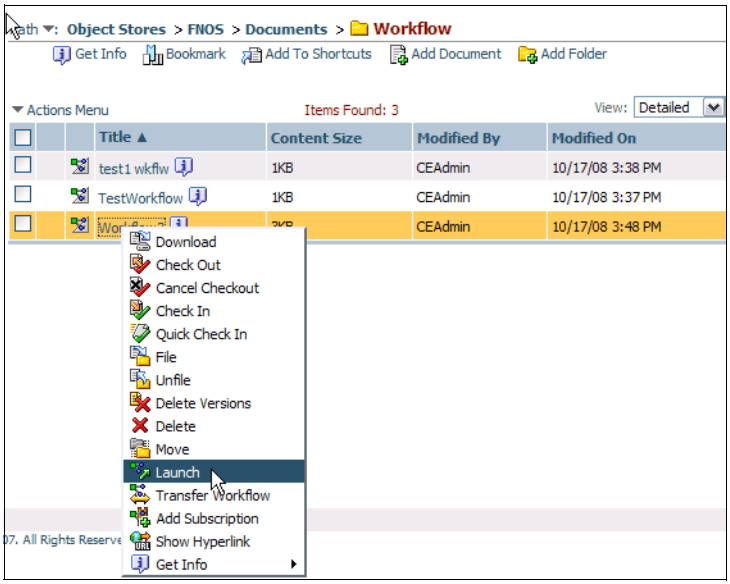


Figure 13-15 Launch a workflow in Workplace

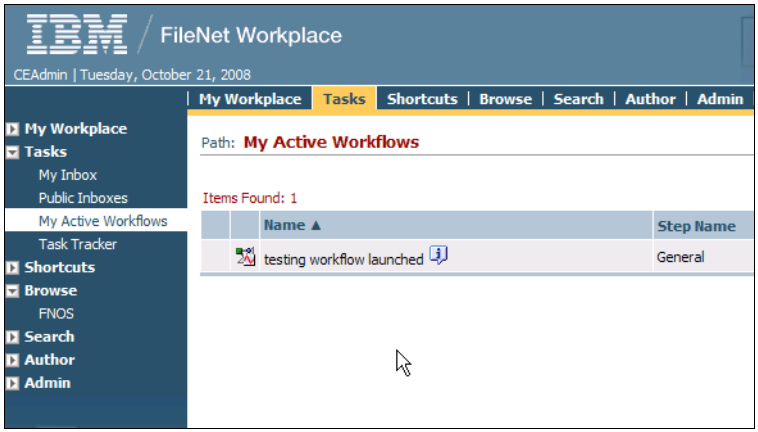


Figure 13-16 User tasks show the workflow

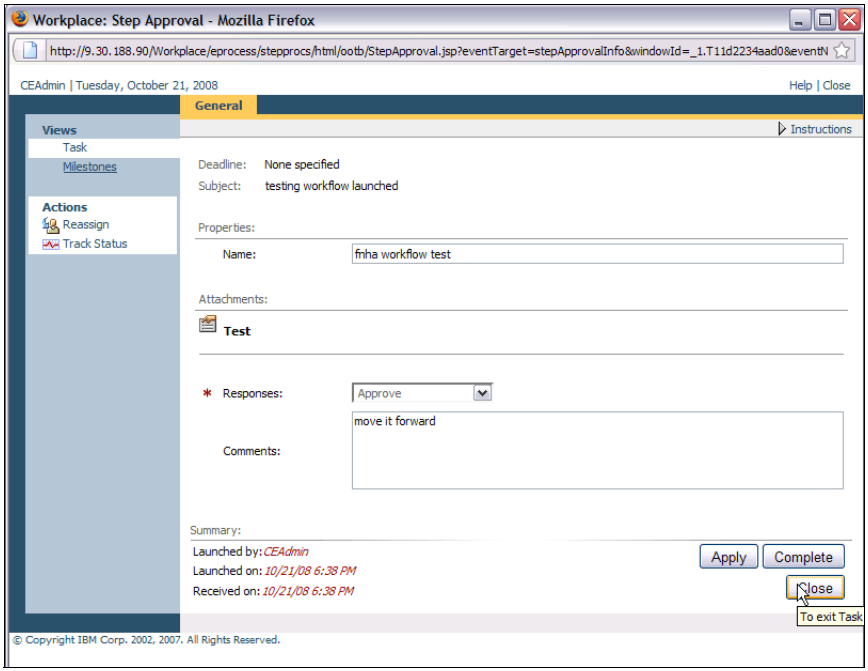


Figure 13-17 Move the workflow forward

Using the Process Tracker, we can see where we are in the workflow (at which step). Figure 13-18 on page 449 shows that we are at the “General” step in the workflow before a PE instance is shut down.

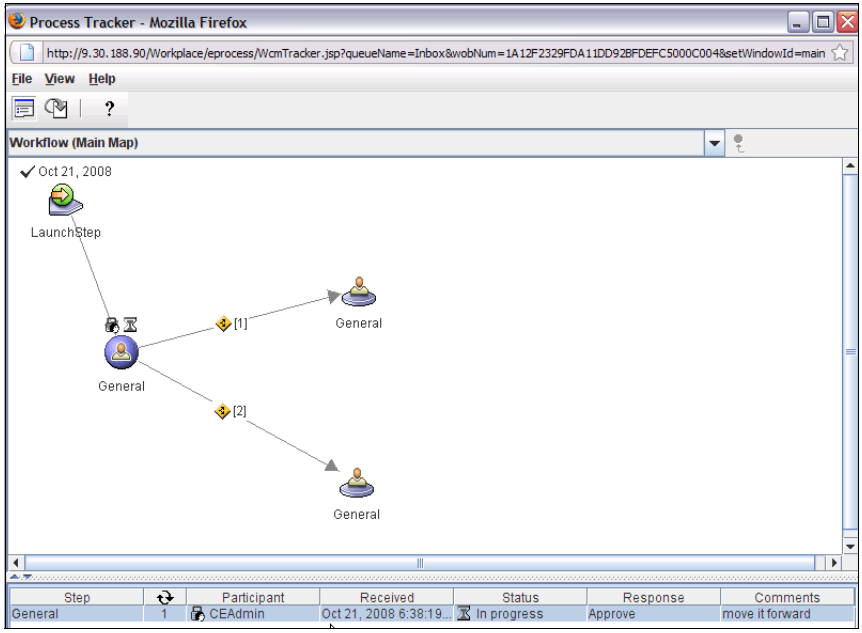


Figure 13-18 Workflow step

Now when one of the PEs is stopped, we can continue the workflow in Workplace. Figure 13-19 on page 450 and Figure 13-20 on page 450 show the successful test.

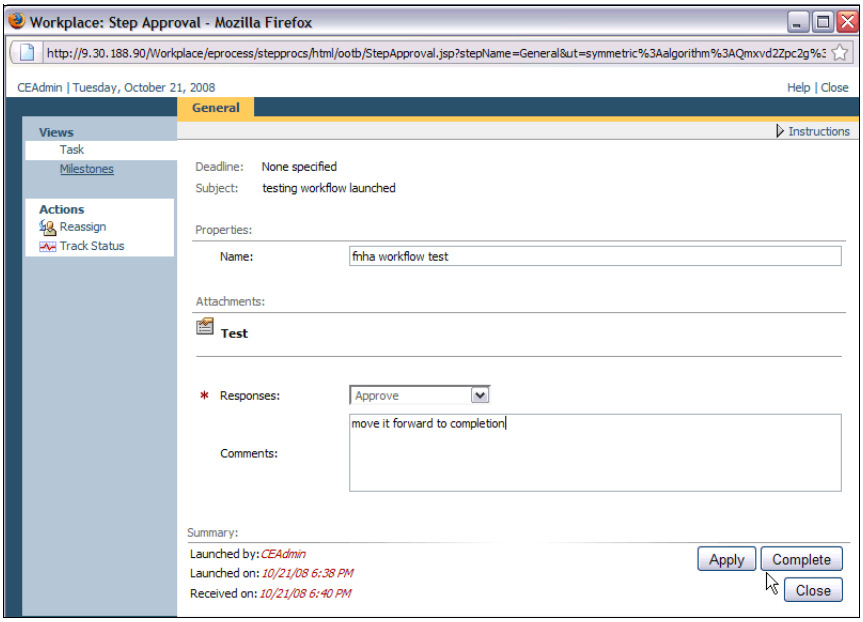


Figure 13-19 Continue workflow on one PE server

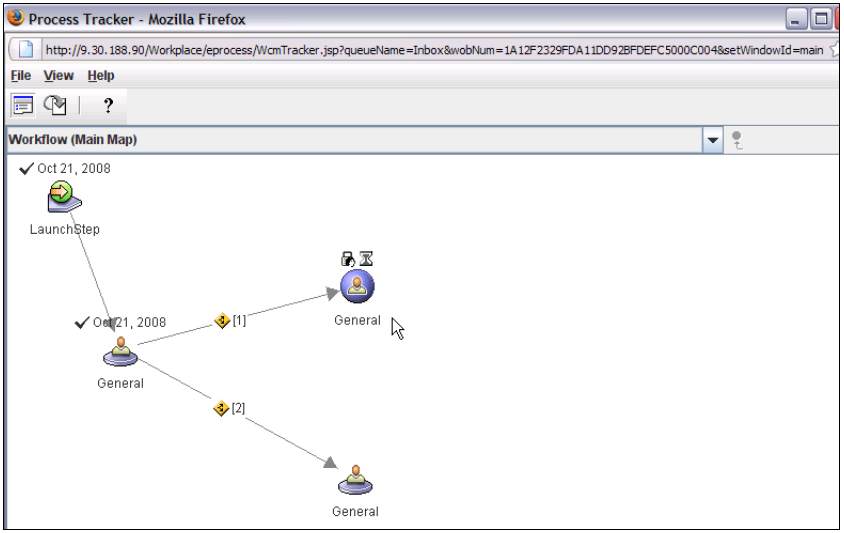


Figure 13-20 Workflow completes

13.2.4 Database failover

In this scenario, we use Image Services (IS) as part of the database failover test. We import a document into IS, as shown in Figure 13-21.

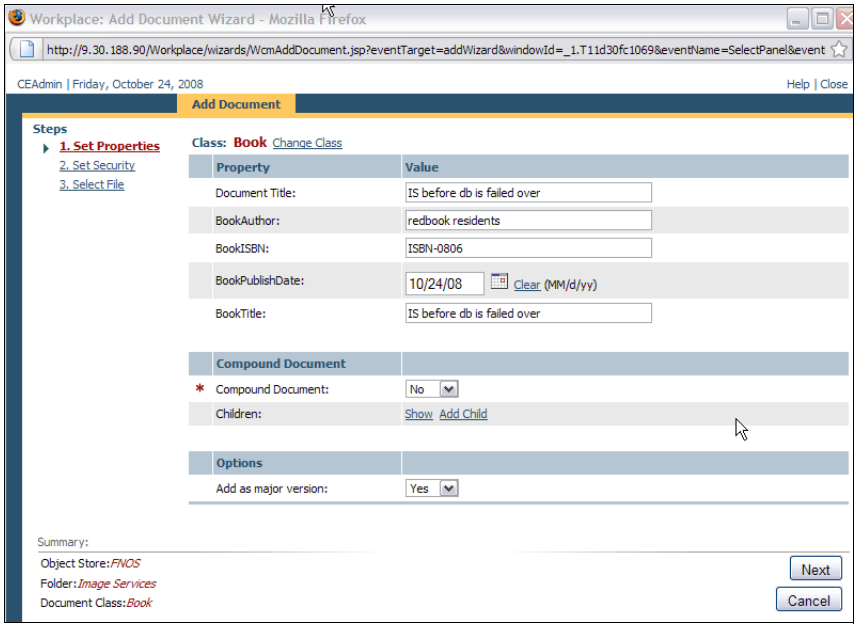


Figure 13-21 Import a book document into Image Services

Now, we fail over DB2, which runs the IS database. After the DB2 primary node fails over the standby node, we perform the same import in Workplace. See Figure 13-22 on page 452.

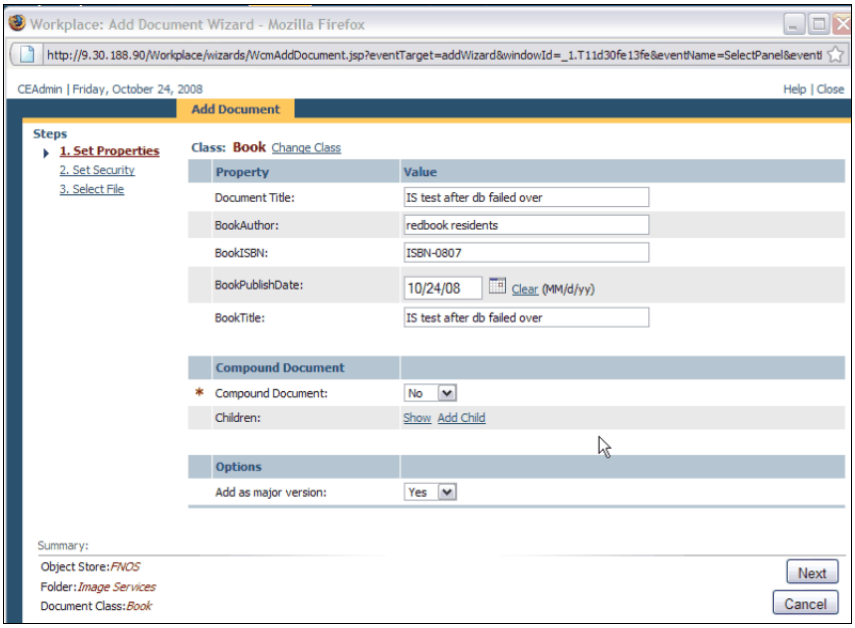


Figure 13-22 Import document into IS after database failover occurs

The error that is shown in Figure 13-23 suggests that a database connection is being re-established. We have to retry the same import request by clicking **Return**.

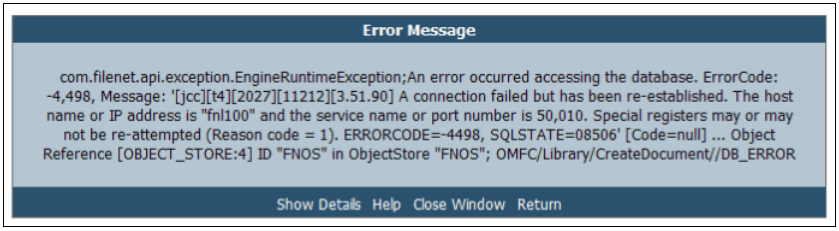


Figure 13-23 Error message seen during DB connection re-established from IS to DB2

Upon retry, the document is successfully imported into IS, as shown in the fifth document in Figure 13-24 on page 453.

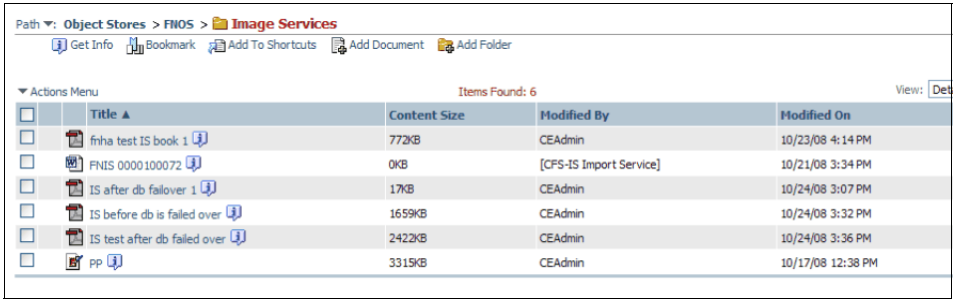


Figure 13-24 Successful import in IS after DB failover

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this book.

IBM Redbooks publications

For information about ordering these publications, see “How to get IBM Redbooks publications” on page 457. Note that several of the documents referenced here might be available in softcopy only:

- *IBM Content Manager Backup/Recovery and High Availability: Strategies Options and Procedures*, SG24-7063
- *IBM TotalStorage Solutions for Disaster Recovery*, SG24-6547
- *WebSphere Application Server V6 System Management & Configuration Handbook*, SG24-6451

Other publications

These publications are also relevant as further information sources:

- *IBM FileNet P8 System Overview*, GC31-5482
- *IBM FileNet P8 High Availability Technical Notice*, GC31-5487
- *IBM FileNet 4.0 Installation and Update Guide*, GC31-5488
- *IBM FileNet Image Services, Version 4.1, Microsoft Cluster Server Installation and Upgrade Procedures for Windows Server*, GC31-5531-01
- *IBM FileNet Image Services, Version 4.1, VERITAS Cluster Server and VERITAS Volume Replicator Guidelines*, GC31-5545
- *IBM FileNet Image Services, Version 4.1, Installation and Configuration Procedures for AIX/6000*, GC31-5557-01
- *IBM FileNet Image Services, Version 4.1, Release Notes*, GC31-5578-03
- *IBM FileNet P8 Content Federation Services for Image Services, Version 4.0, Guidelines*, GC31-5484-01
- *IBM FileNet Image Services, ISRA, and Print Hardware and Software Requirements,* GC31-5609-04

- *IBM FileNet Image Services, OSAR Cable Tool*, 2008-07-22
- *High Availability, Scalability, and Disaster Recovery for DB2 on Linux, UNIX, and Windows*, SG24-7363

Online resources

These Web sites are also relevant as further information sources:

- Product documentation for IBM FileNet P8 Platform:

  http://www.ibm.com/support/docview.wss?rs=3278&uid=swg27010422

- Product documentation for IBM FileNet Image Services:

  http://www.ibm.com/support/docview.wss?rs=3284&context=SSNVUD&uid=swg27010558

- IBM PowerHA for AIX or IBM High Availability Cluster Multi-Processing (HACMP) library:

  http://publib.boulder.ibm.com/infocenter/clresctr/vxrx/index.jsp?topic=/com.ibm.cluster.hacmp.doc/hacmpbooks.html

- DB2 Information Center:

  http://publib.boulder.ibm.com/infocenter/db2luw/v9r5/index.jsp

- DB2 database product documentation:

  http://www.ibm.com/support/docview.wss?rs=71&uid=swg27009474

- Migration to DB2 Version 9.5:

  http://publib.boulder.ibm.com/infocenter/db2luw/v9r5/topic/com.ibm.db2.luw.qb.migration.doc/doc/c0023662.html

- IBM DB2 Version 9 system requirements:

  http://www.ibm.com/software/data/db2/9/sysreqs.html

- BIG-IP System Management Guide:

  https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys.html

- Instructions for BIG-IP 5 high availability configuration in the GUI:

  https://support.f5.com/kb/en-us/products/big-ip_ltm/manuals/product/bigip9_0sys/9_0_xSystemMgmtGuide-13-1.html#wp1020826

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IBM High Availability Solution for IBM FileNet P8 Systems

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IBM High Availability Solution for IBM FileNet P8 Systems

Provides HA strategies and options for IBM FileNet P8 systems

Includes HA implementation for Content Engine, Process Engine, and Application Engine

Describes HA implementation for Content Search Engine, Image Services, and databases

Many organizations require almost continuous availability of their mission-critical, IBM FileNet P8 systems. Loss of system resources and services can translate directly into lost revenue and lost customers. The goal, therefore, is to design and implement IBM FileNet P8 systems that are highly available by compensating for both planned and unplanned system outages and eliminating single points of failure.

IBM FileNet P8 Platform provides availability features that are built-in to the core components. With these features, high availability of an IBM FileNet P8 system can be achieved through redundancy: redundant components, redundant systems, and redundant data. Hardware and software components might fail. With redundancy, the failure can be eliminated or minimized.

This IBM Redbooks publication describes strategies and options for core IBM FileNet P8 system components. In addition, the book provides detailed, step-by-step procedures that we used to implement high availability for our case study IBM FileNet P8 system. This book serves as a practical reference when you design and implement highly available IBM FileNet P8 systems.

This book is intended for IT architects, IT specialists, project managers, and decision makers identifying the best high availability strategies and integrating them into the IBM FileNet P8 system design process.

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