CPI Data and Wireless Host-Based Distributed Systems

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Abstract

This paper evaluates how the quality of the Consumer Price Index (CPI) can be improved by converting from a dial-up client-server distributed system (DCDS) to a wireless host-based distributed system (WHDS). Findings are based on Internet research, white papers, and information technology books. In addition, interviews were conducted with senior IT personnel at the BLS and IT professionals and users to gain an understanding of the current data collection process and future wireless capabilities. The paper recommends that the BLS adopt a WHDS system.

Introduction

Education is only good if it produces educated students; transportation is only good if it transports people. Every system, like education and transportation, is a function of what it produces. Technology is not a system. But once it is planned, organized, and distributed, it becomes a distributed system. Distributed systems are designed to store, process, and route data. Therefore, they are only as good as the data they store, process, and route.

CPI Economists only concern themselves with such systems to the extent that they will produce better data. This paper discusses the business side of data collection by considering the future business changes that integrating each technology will offer. Specifically, the objective is to evaluate technological ways to obtain better data; data that is *superior* in Administrative Efficiency, Data Efficiency, Data Quality, Cost of Data, and Data Security.

The Compare and Contrast section compares and contrasts differences in CPI data using a dial-up client-server distributed system (DCDS) with those using a wireless host-based distributed system (WHDS). The Results and Benefits section discusses whether superior CPI data can be produced using WHDS. The Recommendations section recommends the distributed system that produces superior CPI data. Finally, the Appendices provide useful supplementary information that is relevant to the overall topic but not vital to the objective. They recount how the present DCDS system was implemented (Appendix S1); address the future implementation and integration of WHDS including which lifecycle model is most appropriate (Appendix S2); consider the wireless component (Appendix S3); and provide detail and spike down into the technical specifics that make systems integration possible (Appendices T1 to T6).

Background

Explaining DCDS

The Bureau of Labor Statistics (BLS) has developed software that allows data collectors in the field to collect Consumer Price Index (CPI) data on a computer. The BLS implemented a dial-up client-server distributed system (DCDS) that uses fat clients[1] to process the data. The software resides on the hard drive of about 300 handheld tablet PCs[2]. We call these computers “Data Collection Instruments.” With these instruments, data collectors collect and transmit pricing data electronically during each pricing period[3].

Our current data replication process involves multiple layers. There are three layers of databases: the individual databases that reside on each tablet PC, the ASA Consolidated database, and the ASE Consolidated database. Each Data Collection Instrument is involved in a data replication process that starts with the information stored on the tablet PC's hard drive. Once the data is collected, each computer dials into the BLS network via a telephone line and transmits the pricing data to the consolidated databases in Washington. Data is exchanged between the database layers using replication[4]. Data located in the last database layer is then downloaded to the mainframe. Finally, the mainframe uploads[5] the data back to the replication databases for transmission back to the field and the whole process starts over again.

Explaining WHDS

The BLS implemented a dial-up client-server distributed system (DCDS), but CPI data could also be collected and processed using a wireless host-based distributed system (WHDS). This paper will lay out more detail about WHDS in subsequent sections and in the Appendices. However, it is good to at least have a general definition: a WHDS is a system whose components are connected without physical phone or network lines. The wireless network is sustained through an infrastructure similar to the one used by mobile phones; only designated devices and users are allowed access. Additionally, the software that is used on the network is "host-based" meaning the software resides on the host server; none of it resides on the clients connected to the network. For this reason it is considered "thin" … which is why the term "thin client" is given to any user device on the network.

Compare and Contrast

This section compares and contrasts CPI data using a DCDS system[6] with CPI data using a WHDS system[7]. Depending on which system is used, CPI data will differ in its Administrative Efficiency, Data Efficiency, Data Quality, Cost of Data, and Data Security.

Administrative Efficiency[8]

Using fat clients in a DCDS system present challenges to maintaining administrative efficiency as illustrated by the way software is deployed and daily management of the user.

The process by which organizations purchase, test and *deploy off-the-shelf applications* under a DCDS system can be extremely time-consuming and labor intensive[9]. The process is exacerbated by the sheer variety of fat client configurations that must be tested to ensure that applications function properly[10]. Another challenge is that software upgrades often need to be scheduled over an extended period of time to ensure that sufficient IT staff is available to perform the upgrades. This is especially critical for the tablet PCs in the field, because they must be shipped back and forth across the country to perform the upgrade.

Thin clients[11] in a WHDS system contribute to a vastly smoother and easier software deployment process. First, new versions of applications only need to be installed once on the server[12] to be made available to the thin clients on the network; the need to ship tablet PCs to Washington for upgrades is eliminated. Second, if the application works on one thin client, it will work on all of them.[13] Finally, because off-the-shelf software installed on the server is automatically running on every thin client[14], the organization does not have to deal with supporting users using multiple versions of the software.

The process by which the BLS develops, tests and *deploys its in-house data collecting software applications* is time-consuming and labor intensive for the reasons listed above. It is also time-sensitive and complicated. It is time-sensitive because data collectors only have 5 days in a pricing period to collect and transmit the collected prices. It is complicated because tablet PCs are deployed all across the country including Hawaii and Alaska[15], and they are being used outside in the public where they are not physically connected to the BLS network. Therefore, deploying in-house data collection software under a DCDS system is a challenge. The staff that performs routine back-end maintenance for our systems must actually do so for two completely separate systems, while the deployment is being conducted. Both the old and new systems have to be kept “alive” until everything is converted over to the new system. And even then there are still problems. For example, a defect was found in the executable code in the recently-deployed Transmission Retrieval software[16] near the end of a pricing period. The defect prevented all 300 data collectors in the field from sending in their prices. Within six hours, 300 installation CDs were shipped overnight to the field, so that field staff could install the fix and deliver their prices on time. In a separate incident, a software release designed to improve data collection failed installation on the table PCs. 300 CDs were shipped to data collectors overnight, in an effort to fix the problem with the first installation, but the CDs also failed. As a result, the upgrade was cancelled for almost a year. This ordeal was an enormous inconvenience to IT staff in Washington and staff in the field. Because of the 5-day pricing period, these problems must be resolved in a timely manner, otherwise a delay in publishing the CPI may result.

A WHDS system using thin clients would make deployment of in-house data collection software easier, and alleviate problems like the ones illustrated above. In the above example, the problem discovered in the executable code could have been fixed in less than a day because the new compiled software could be: (1) tested on a single thin client, (2) deployed in minutes across the physical network to the server, and (3) made available instantly to all thin clients wirelessly connected to the network, without any effort from users in the field.[17]

A DCDS system presents a challenge for *daily management of network users* because tablet PCs are being used outside in the public where they are not physically connected to the BLS network. For example, when a user's smartcard fails, the only solution is for the HELP DESK to mail another smartcard and smartcard reader to the user. Then, the user has to go through the long process of reassigning their *current* password to the *new* smartcard and smartcard reader[18]. Additionally, when users have trouble transmitting data, even with the use of remote connection software like PC Anywhere[19], it can take the HELP DESK several hours to resolve the issue. Nonetheless, the decision is sometimes made to send in the tablet PC for a replacement.[20] Replacing the unit may take several days; thus, preventing the data collector from completing the assignment by the end of the 5-day pricing period.

A WHDS system using thin clients as the data collection hardware would make daily management of the user much easier and more efficient. Problems like the smartcard failures[21] would not occur because smartcards are not necessary. Thin client sessions do not occur on the client; they occur on the server within the physical confines of the BLS network. Therefore, access trouble resulting from locked or forgotten passwords are remedied in seconds because they are handled on the server not on the tablet PC; remote connection software is not necessary; copying databases[22] for hours is not necessary; and data collectors could use their home phone to call the HELP DESK and still stay connected.

Data Efficiency

Using fat clients under DCDS also presents challenges to maintaining data efficiency as illustrated by replication of the CPI data through the databases, size and weight of the tablet PCs, and heat and battery life.

DCDS creates problems with data efficiency because the *data replication* process is complicated and time-consuming; repeated phone calls and multiple database layers are necessary to move data from the field to the mainframe (see Background).

WHDS improves data efficiency by simplifying data replication. WHDS permanently moves data from being collected on 300 different databases on 300 different hard drives to one database on one server. The central host stores all the data, processes the data, and controls all thin clients. All processing (logic) is done on the central host while the user interface is displayed on the thin clients[23].

Size and weight of the data collection instrument is currently an issue in DCDS. Data collectors must carry the tablet PC into every pricing location along with additional supplementary paper forms. For this reason, some data collectors simply leave the units in their cars and walk into the store without them. Then, returning back to their cars to input the data. This is a violation of our procedures and is becoming an ever-increasing problem.

In a WHDS system, problems of abandoning the unit during pricing would be reduced. Size and weight is generally improved because thin clients have no processor, hard disk or moving parts.[24] In addition, the thickness of the unit generally decreases because thin clients are “Windows-based terminals with no local processing” and therefore “are the thinnest of thin-client/server hardware devices.”[25] It is obvious that carrying units under a WHDS system becomes less burdensome overall.

The DCDS system using fat clients presents a *heat and battery life* problem for data collection. The tablet PCs tend to get hot and sometimes actually melt smartcards[26], making them useless and preventing password access for data collection. In hot climates like Florida and Atlanta, tablet PCs can simply stop functioning after being used in the heat and being in and out of cars as the data collector moves from one location to another[27]. Battery life is only 2 hours[28], causing frequent switching and stops to the car to recharge the battery. Problems with heat and battery life adversely affect the efficiency of collecting CPI data.

The heat and battery life problems are eliminated using WHDS. Thin clients produce far less heat[29], thereby improving comfort, reliability, and lifespan. In addition, battery life improves substantially (Fujitsu 3400 @ 2hrs vs. Winterm 3820TX @ 8hrs)[30] as a result of fewer moving parts, meaning a collector can visit more pricing locations before having to recharge the unit; thus, increasing data efficiency.

Data Quality

CPI data quality is ensured by reviewing prices individually for accuracy and completeness. Under the current DCDS system, the data collection software reviews the prices while they are being collected in the field (Field Review[31]), and Commodity Analysts in Washington review the prices *after* they are collected and sent to Washington (CA Review[32]). Commodity Analysts do not have the opportunity to review prices on a flow basis because they are not sent from the field until three days after the pricing period begins, and then again on the final day of pricing. This makes CA Review a challenge for CA's because their workload spikes on those days, causing increases in hours and decreases in the quality of their review resulting from long hours[33]. Sometimes the decision can be made to not use the data if it cannot be reviewed in time, but this reduces the quality of that month's Index (a single price has caused delay in publishing the regional index *twice* within the last 6 months[34]).

CPI data collected under a WHDS system would improve data quality. Under a WHDS system, prices would be available sooner in Washington; literally seconds after the data collector inputs the data into the system. The need to go home and connect the unit to a telephone line to send prices is eliminated. Prices would be sent when the data collector prices the very first outlet on the very first day, instead of three days after the pricing period begins. This would bring prices to CA Review faster and on a flow basis. CA's could review prices throughout the pricing period on a daily basis starting with the first day of pricing instead of the 3rd day. This would give them flexibility, consistency, and time. Data quality would improve as the CA's spend more time reviewing the data.

Cost of Data

A DCDS system requires hardware upgrades every three years to keep pace with upgrades in the network server software. Increases in capability in the network can only be realized when the hardware is also upgraded for every client. This affects the cost of data. For our system, this means that we must replace 300 tablet PCs every three years. The cost of this is estimated at $1.1 million.[35]

A WHDS system would eliminate the need to upgrade hardware. Thin clients, unlike fat clients, do not need to be upgraded as server-side improvements are made. Most of the cost savings come from increases in simplicity and reliability resulting from two primary factors: (1) elimination of the moving parts and local storage that are the most likely to fail, and (2) elimination of a complex local operating system and local application software (Appendix T1). "Gartner Group reports a thin client TCO [Total Cost of Ownership] of at least 25% *less* than unmanaged or poorly managed PCs."[36] "The cost … advantages of thin client computing make a compelling business and technology case,"[37] making it obvious that money can be saved. (See Appendix T2 for real-world examples of cost savings.)

Data Security

In a DCDS system, data security on the client is problematic. Local hard drives present enormous potential for data compromise or damage[38]. Diskettes and CD-ROMs provide opportunity for introduction or removal of data or software from the computer's hard drive. Data security on the network is problematic because TCP/IP traffic over a phone line is not encrypted without the use of additional software, resulting in a decrease in network performance[39]. In addition, the threat of a virus is strong because (1) they can be introduced to the hard drive via diskette or CD-ROM and propagated to the network at the time of electronic transmission, and (2) virus definitions for anti-virus software must be updated on every client regularly in order for it to be effective.

In a WHDS system, the lack of hard drives in thin clients removes the threat of unintended data access. The lack of a diskette and CD-ROM eliminates the threat of data theft even if the unit itself is actually stolen. Data security on the network is improved because network traffic is encrypted up to 128-bit via ICA[40] or RDP[41] protocols. The threat of a virus through the diskette or CD-ROM is also eliminated; virus protection only needs to be maintained on the server[42]. Viruses cannot propagate down from the server to the client because thin clients have no hard drive. Additionally, there is no risk of data being lost in the field as a result of a stolen tablet PC because they don't store any of the data (i.e., no hard drive). All data resides on the server so the data is always secure; plus, data can be instantly accessed from another thin client if one of them is ever stolen. Therefore, security in a WHDS is very robust compared to that of the DCDS system.[43]

Results and Benefits

A wireless host-based distributed system (WHDS) provides significant benefits to the system already in place. In the long run, transitioning from a DCDS system to a WHDS system will improve Administrative Efficiency, Data Efficiency, Data Quality, Cost of Data, and Data Security. WHDS improves administrative efficiency by (1) eliminating the need to deploy software to the field, and (2) simplifying daily management of the user in the field. WHDS improves data efficiency by (1) simplifying the data replication process, (2) reducing the size and weight of each data collection instrument, (3) reducing heat generated by the unit, and (4) improving the battery life of the unit. WHDS improves data quality by making prices available for review sooner. WHDS reduces the cost of data collection by eliminating hardware upgrades. WHDS improves data security on the client and security on the BLS network by (1) decreasing the potential for data theft via diskette, CD-ROM or hard drive, and (2) reducing the threat of a virus.

Recommendation

The research discussed herein suggests that the BLS can produce superior CPI data by adopting a wireless host-based distributed system (WHDS). This is the recommendation of this paper.

Conclusion

As much of this paper has already detailed, the advantages of thin client computing make a compelling business and technology case. The advantages are sufficiently compelling that market research firm IDC projects thin client terminal sales to reach nearly 9 million per year in 2005, up from approximately 1.3 million in 2001. Some departments within the BLS have already configured access to email using the very same technical architecture (i.e. the Citrix ICA protocol) suggested here. Therefore, it should come as no surprise that we also recommend this technology for CPI data collection. "In the end, thin-client computing combines the security and control of a mainframe with the interface and function of a PC. And as IT organizations seek to stay lean and mean, it seems inevitable that many will cut out the fat in favor of a thin-client solution."[44]

Endnotes

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[1] A **fat client** is usually a PC or workstation that has local storage for data and software, a local processor and the ability to communicate with both local and remote computers. Source: Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 5.

[2] Fujitsu 3400 (see Appendix T3)

[3] A pricing period is a 5-day time period during which data collectors collect their prices. There are three pricing periods per month and they help ensure consistency in prices over time.

[4] Replication is only possible when all the databases are structured similarly; changes in data from one layer are propagated to contiguous layers.

[5] Data that was previously collected is uploaded from the mainframe at the end of each month (Collection Period).

[6] For the remainder of the paper, it is assumed that references to a DCDS system include the use of fat clients in that system.

[7] It is assumed for the remainder of the paper that WHDS uses thin clients as a part of the system.

[8] Administrative efficiency is defined as the ease to which data is delivered from one part of the system to another. It does not mean the data collection process itself is more efficient.

[9] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 4.

[10] On November 18, 2003, the Director of the Pen Lab stated he was concerned about workload in his department and staffing problems resulting from testing new versions of the data collection software; as a result he was 3 months behind in submitting his department’s monthly status reports.

[11] A **thin client** is a terminal device that includes a monitor, keyboard and mouse, like a PC or workstation; however, it typically lacks a hard drive, floppy disk, CD-ROM and central processing unit (CPU). Software required to make the thin client function is stored within the device on a read only memory (ROM) chip; however, the majority of user software runs on a server in another location. Thin terminals employ a graphical user interface but can revert to a character-mode interface for compatibility with legacy applications. Most thin clients do not support attachment of external devices, though higher-end terminals may support add-ons like biometric devices or cash drawers that are connected via parallel ports, serial ports, PCI cards or Universal Serial Bus (USB). Source: Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 5.

[12] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 8.

[13] The design of the technical architecture of a WHDS system makes this statement always true. Therefore, the need to test various configurations of the user device is eliminated.

[14] Kanter, Joel P. (1998). Understanding Thin-Client/Server Computing. Page 4.

[15] BLS collects data in 87 different geographical areas across the United States.

[16] Transmission Retrieval (TR) software is responsible for actually sending the electronic prices from the field to Washington.

[17] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 8.

[18] This means initializing the smartcard, rebooting the computer, connecting to the network to perform a password utility, and rebooting the computer again.

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[19] David Izumi, Supervisory Technician, HELP DESK for the CPI Program, BLS: It takes the HELP DESK 2 hours to copy a typically sized database (20mb) from a data collectors tablet PC. For managers with larger databases (40mb), it takes them 4 hours. (For more information about constraints of using PC Anywhere, see Appendix T4.)

[20] Replacing units within a pricing period was a serious concern for the CPI Production Team when tablet PCs were first used. The team asked the HELP DESK to become a permanent member of the team to be accountable for access problems that delay data collection.

[21] Smartcard failures occur when the plastic card itself becomes damaged, usually as a result of heat from inside that tablet PC that melts small metal chip on the card that holds the security information for the user. When this happens, the user cannot log in to the software.

[22] Most databases residing on tablet PCs are very large (i.e., 40 megabytes) and cannot be copied over the phone line.

[23] Harwood, Ted. (1999). *Windows NT Terminal Server and Citrix Metaframe*. Page 4.

[24] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 12.

[25] Kanter, Joel P. (1998). *Understanding Thin-Client/Server Computing*. Page 75.

[26] This happened to a coworker preparing for a trip to the field 2 days before departure; the department had to rush and provide a new smartcard and smartcard reader. (Stephen Widener, BLS).

[27] This happened to coworker during a field trip to Florida, the system ceased to operate and the assignment was never collected. (Stephen Widener, BLS).

[28] Fujitsu 3400 (see Appendix T3)

[29] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 5.

[30] Fujitsu 3400 (See Appendix T3) and Winterm 3820TX (See Appendix T6).

[31] Field Review is performed by software that checks each field record before it is transmitted to Washington. The software checks for common mistakes like the lack of a price, incomplete descriptions, etc.

[32] CA Review can only be done after the data collector visits the pricing location, records the price, returns home, and plugs the tablet into the phone line to transmit the price to Washington. Then, the prices are moved from the micro databases to the mainframe, and then into the Commodity Analyst Review System (CARS) for CA Review. CA's look for more complicated mistakes like mismatched and incorrect item descriptions.

[33] CA's frequently skip meetings on these days.

[34] The Philadelphia regional CPI index was suppressed in July; and San Francisco regional CPI index was delayed in November.

[35] The price of each Fujitsu 3400 is $3,559 MSRP. Therefore, the estimated total replacement cost is $1,067,700 ($3,559 x 300).

[36] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 11.

[37] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 5.

[38] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 7.

[39] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 7.

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[40] ICA protocol (see Appendix T5)

[41] RDP protocol (see Appendix T5)

[42] Harvard Computing Group (2002). *Security and Desktop Client Architectures* (white paper). Page 7.

[43] See the NASA Case Study in the Appendices for a perfect real-life example of benefits to security.

[44] Thin Planet, Common Sense About Thin Clients, www.thinplanet.com/tech/generic.asp?f=Tfnumber&k&-s&d=TD34202.

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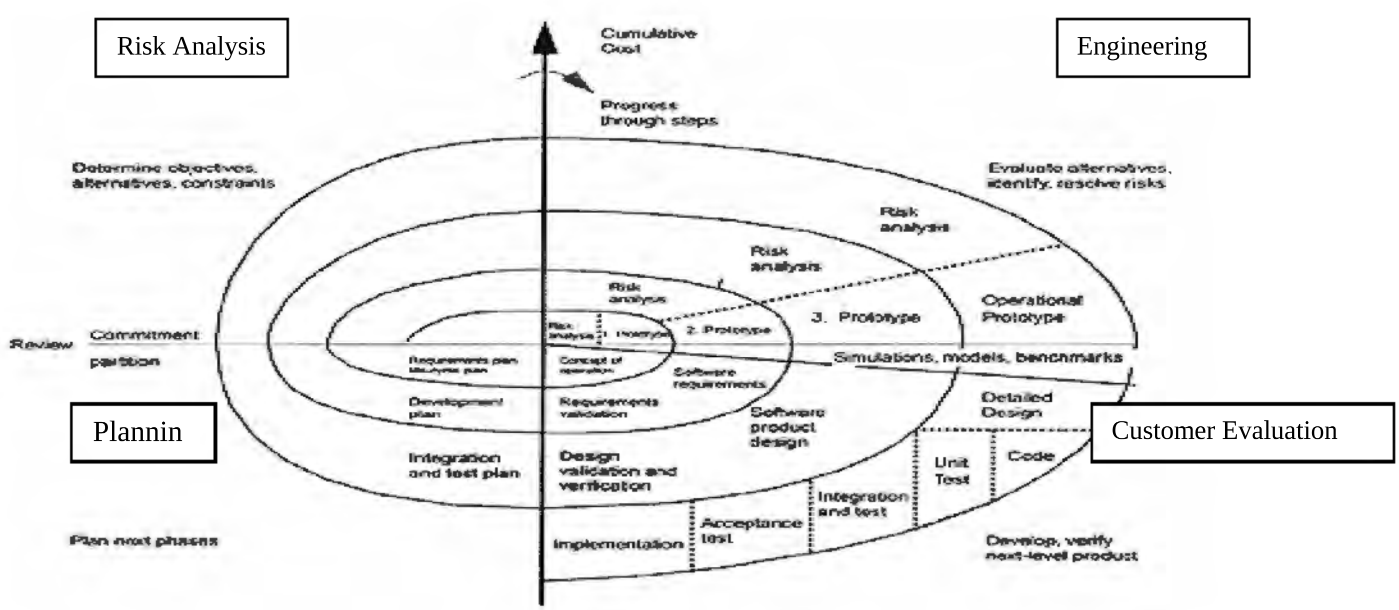
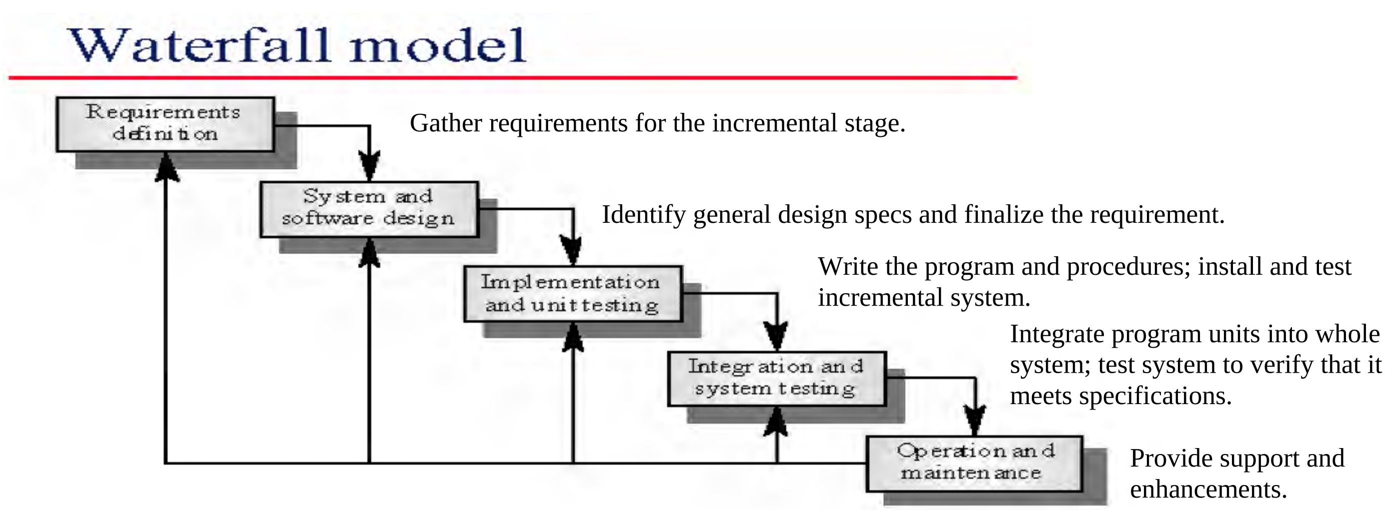
Appendix S1 – Historical Perspective – Implementing the DCDS

Originally, CPI prices were collected using printed, paper forms. Then, the CPI program spent several years conceptualizing, planning, developing, testing, and finally implementing a dial-up client-server distributed system (DCDS) to collect data electronically. Fujitsu 3400 Tablet PCs were used to accomplish this. An iterative life cycle model, the spiral model, was used for the software development process.



The software development process involved multiple incremental stages; each stage used the waterfall model in continuous loop back to manage risk and provide feedback.



Each incremental stage proceeds through phases. The phases include: 1) requirement definition, 2) system and software design, 3) implementation and unit testing, 4) integration and system testing, and 5) operation and maintenance. Each phase must be completed before one can proceed to the next phase. The advantages of completing the waterfall model for each incremental stage of the software development process is that it provides enforced discipline and documentation. In addition, the product/prototype is tested at multiple stages, ensuring greater stability and quality. The disadvantages of the waterfall model (lack of feedback and outdated requirements documents) are avoided because the overall software development process is iterative, not linear.

All things being considered, the success of a dial-up client-server distributed system (DCDS) was partly due to extensive testing and users' involvement. At each stage, the program office wrote, modified, and submitted requirements to internal developers who implemented features in order of decreasing priority. At the final stage, it became obvious that more support was needed, so additional team members were hired, trained, and placed on testing teams.

The success of the DCDS implementation was also due to the CPI program's previous experience with collecting electronic prices. CPI housing prices, a smaller portion of the index, have been collected on a handheld computer for some time. However, Economists struggled to conceptualize how to accomplish the same thing for the remaining commodities and services prices (accounting for over half of the index). Housing prices are more constant, less complicated, few in numbers, and have a 30-day pricing period. Commodities and services prices are less constant, difficult to collect, sometimes not available, and have a 5-day pricing period. While this was a challenge, the problematic and less sophisticated housing implementation brought valuable experience to the commodities and services effort. After deployment, new problems were logged in a Wish List (for developers to incorporate into future versions). Less than 2% of all prices are now collected on paper.

In conclusion, the effort was a success and brought the program one step closer to a WHDS implementation.

Appendix S2 – Implementing the WHDS

A wireless host-based distributed system (WHDS) implementation is the next step to produce superior CPI data. However, the software development process (spiral model) used for the dial-up client-server distributed system (DCDS) implementation would not be appropriate. The spiral model should not be used when extending functionality to already existing systems because risk analysis will take up too much time. Additionally, experienced IT professionals warn against using such a model.[1] When considering thin clients, CIOs need to find an area in their organization where they can deploy approximately 50 thin clients or more to see whether they are appropriate. Because thin clients are configured at the server level, setting up 100 thin clients is as easy as setting up one.

Therefore, the rapid prototype model is the most appropriate model. Additionally, written requirements are already available from the previous DCDS implementation, so “a [rapid] prototype is arguably the most effective way to refine existing requirements and capture previously overlooked requirements.”[2]

Since the CPI program already has a working infrastructure that will not change (derived from the DCDS implementation process), the wireless component is the only other major addition for WHDS. The old test environment can be easily resurrected; a terminal server can be added to the network along with a single wireless access point and one or more wireless thin clients for testing purposes. This newly modified wireless test environment (including the thin clients) would then become the rapid prototype. The upfront feedback given to the developers by economists will come from observing this prototype; incorporating the human factor[3] (not possible in other models) will also come from observing this prototype. System design, testing, implementation, integration, operations, and retirement all follow the prototype phase. The rapid

[1] “IT managers won’t see the benefit of thin clients by testing for usability and feasibility one at a time or here and there,” says Bob O’Donnell, Research Director for Device Technology at IDC in Framingham, MA. *Source: Ware, Lorraine C (2001, October 1). Thin Clients Fatten the Bottom Line. Retrieved on November 20, 2002 from* http://www.cio.com/archive/100101/tl_numbers.html.
[2] *Classical and Object-Oriented Software Engineering: Chapter 9 – Requirements Phase*. Slide 6. Retrieved from http://engr.smu.edu/~devans/7313/chpt9.ppt.
[3] The Human Factor refers to the incorporation of features into a product that will make the product friendly and appealing to human users.

prototype model emphasizes extensive user involvement in the rapid and evolutionary construction of working prototypes of a system to accelerate the development process. It is easier to construct, understand, and modify; and it is not necessary to wait until the end of the development process to verify the functionality of the product.

However, a WHDS system is useless, even after implementation, if systems integration is not considered. In every realistic project, it is important to show appreciation for how the details fit into the continuum of systems integration. We are interested specifically in State/Level 4 (Convergent System-to-System Integration) because "business-to-business systems must integrate with existing back-end systems."[4] With the exception of the wireless component, we have already accomplished this. We have also already established an extranet[5], which is another approach to achieving convergent integration.

The CPI program has already accomplished the very important milestone of achieving State/Level 4 Convergent Integration from the dial-up client-server distributed system (DCDS) implementation. The integration of the wireless component will be an extension to this system and is the next step.

In conclusion, using the rapid prototype model for implementing WHDS is a wiser choice than the use of any other model.

[4] McNurlin, Barbara C., and Sprague, Ralph H. (2002). *Information Systems Management in Practice.* Page 92.
[5] An extranet is a private network that uses Internet protocols and the public telecommunications system to securely share part of a business's information with suppliers, vendors, partners, customers, or other businesses (in our case, with data collectors in the field). *Source: McNurlin, Barbara C., and Sprague, Ralph H. (2002). Information Systems Management in Practice. Page 92.*

Appendix S3 – Integrating The Wireless Component

A fully functioning dial-up system is already in place. With the exception of the wireless component, the CPI program has already accomplished the very important milestone of systems integration. The next step is to conduct research to consider available options and issues relevant to the wireless component. This appendix is the result of that research.

Organizations that have decided to use wireless computing have realized benefits including improved customer service, increased productivity, decreased costs, and rapid return-on-investment.[1] Wireless technology is simply a means to an end – it is one of many technologies used to solve problems. There are a number of factors to consider when implementing a wireless solution.

Coverage / Reliability – there needs to be adequate network coverage for data collectors in the field. Coverage in the U.S. is a challenge due to lack of nationwide standards and a large geographical area. However, Cellular Digital Packet Data (CDPD) is a technology available in the U.S. for transporting data wirelessly.[2] "It has been deployed by major communications carriers such as AT&T and Verizon … and provides coverage throughout North America, without roaming charges."[3]

Support Resources – there should be adequate staff to support the wireless network. This will not be a problem for a WHDS implementation because fewer support staff are needed to administer a wireless network (and to manage a thin client setup). The case study below illustrates both of these points:

> "The **University of Illinois at Chicago Medical Center** has pioneered innovations in medical treatment, technology and research to improve patient care. The hospital is comprised of a 507-bed hospital, a state-of-the-art outpatient care center, and a 715-physician group practice. Doctors, nurses, and administrators had to go to five different terminals to access applications that helped them do their jobs. In addition, the IT team was finding it difficult to support all these different devices. The hospital adopted a server-based, wireless computing solution and found that wireless LAN access to critical information improved patient care." *Source: The CIOs Guide to Mobile Wireless Computing. Page 6.*

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[1] The CIOs Guide to Mobile Wireless Computing. Page 5.

[2] In the U.S., there are currently several wWAN providers, including Sprint (1xRTT) and AT&T (GPRS), providing coverage of most major metropolitan areas. Verizon (GPRS and 1xRTT), Voice Stream (GSM/GPRS) and Nextel also operate nationwide networks. *Source: The CIOs Guide to Mobile Wireless Computing. Page 4.*

[3] Fujitsu Wireless Solutions. Page 1. Retrieved on November 10 2002 from http://www.fujitsupc.com/www/wireless.shtml?products/wireless/overview

Performance – performance should satisfy users. AT&T and Verizon's together provide a nationwide network that "operates at speeds up to 19.2 kilobits per second." [4] Performance will not be an issue for wireless access because thin client protocols are designed for low bandwidth connections (see Appendix T5). One user interviewed on November 20, 2002 had been using a thin client solution for two years:

> "I have been a remote Network user for seven years. For the past two years, I have been using Citrix for my Network access. I have not had to upgrade my laptop (due to the speed of the through put and ease of use via Dial-Up networking). My time is not wasted doing maintenance to keep my laptop working at peak speed. The use of Citrix has allowed me to read documents with ease while responding effortlessly to emails." *Source: Tom Everitt, Senior Field Account Manager, Government Division, CDW, Inc.*

Costs – the costs of access should not be prohibitive. AT&T and Verizon networks "are packet-switched wWANs that permanently connect the device to the Internet and charge a fixed rate per month."[5] Costs for coverage from Verizon is $39.95/month.[6] For 300 wireless thin clients, this is $431,460 for three years of service, compared to an ongoing three-year replacement cost (for the units we use now) of $1.1 million[7].

Impact on Existing Architecture – the impact on existing architecture can involve changes to one or more system components. *Applications* of an effective wireless solution should provide full versions (not stripped-down versions) without the need for additional cost and time to rewrite them. The system should be able to accept existing *Devices* and also allow new ones as they emerge. All necessary *Integration Points* (front-end vs back-end, etc.) should be part of the solution design. Some companies offer solutions that install wireless *Middleware* to achieve integration, but an easier remedy is to choose a solution that intrinsically allows wireless access to any device without middleware.[8] All of these are considerations for

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[4] Fujitsu Wireless Solutions. Page 1. Retrieved on November 10 2002 from http://www.fujitsupc.com/www/wireless.shtml?products/wireless/overview
[5] The CIOs Guide to Mobile Wireless Computing. Page 4.
[6] Lou Price, Sales Representative, Verizon, 800 366-0043 x3653.
[7] The price of each Fujitsu 3400 is $3,559 MSRP. Therefore, the estimated total replacement cost is $1,067,700 ($3,559 x 300). Savings would begin after the first round of unit replacements from the Fujitsu 3400 to the Winterm 2930.
[8] The CIOs Guide to Mobile Wireless Computing. Page 5.

any wireless deployment. For our wireless component: applications will be full versions, existing devices[9] can be used, integration points have already been developed, and middleware will not be necessary.[10]

Network (Convergent) Integration – our chances of achieving integration are high. This is because the wireless component necessary to achieve a wireless host-based distributed system (WHDS) is an extension of our existing DCDS system. "The easiest way to implement the wireless solution is if it can enable wireless access to existing applications over a wide variety of client platforms and operating systems."[11] In addition, "this approach provides good time to market and tends to be lower in cost."[12]

Security – security should meet all organizational guidelines for a safe network. The National Institute of Standards and Technology warns against inadequate security:

> NIST strongly recommends that the built-in security features of Bluetooth or 802.11 (data link level encryption and authentication protocols) be used as part of an overall defense-in-depth strategy. While these protection mechanisms have weaknesses described in this publication, they can provide a degree of protection against unauthorized disclosure, unauthorized network access and other active probing attacks. *(Source is listed below.)*

NIST also provides guidance for obtaining technologies that provide sufficient security:

> However, NIST notes, for agencies who have determined that certain information be protected via cryptographic means, that Federal Information Processing Standard (FIPS) 140-2 Security Requirements for Cryptographic Modules is mandatory and binding for federal agencies. As currently defined, neither the security of 802.11 or Bluetooth meets the FIPS 140-2 standard. In the above-mentioned instances, it will be necessary to employ higher level cryptographic protocols and applications such as SSH, Transport-Level Security (TLS) or IPsec with FIPS 140-2 validated cryptographic modules and associated algorithms to protect that information, regardless of whether the non-validated data link security protocols are used. *Source: Wireless Network Security, NIST Special Publication 800-48 (Page ES-4 Lines 25,30,35 – Page 11).*

The Health Services Department of a large Midwestern county was able to successfully implement a NIST approved solution. They decided that the Wired Equivalent Privacy protocol (part of 802.11b) was not sufficient. They implemented a more rigorous encryption technology (along with their wireless thin client tablet PCs) to ensure patient confidentiality. (The CIOs Guide to Mobile Wireless Computing. Page 10.)

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[9] Existing devices refer to the Fujitsu 3400s (see Appendix T3) currently in the field. While we are not recommending these devices for the WHDS thin client implementation, they are perfectly capable of being converted to thin clients and used if necessary for budgetary reasons.

[10] Most of these changes are not necessary because the thin client protocols (ICA and RDP) only require minor modifications to existing systems (see Appendix T5).

[11] The CIOs Guide to Mobile Wireless Computing. Page 9.

[12] The CIOs Guide to Mobile Wireless Computing. Page 8.

Appendix T1 – Technical Specifics & Spike Down
Relative Maintenance Costs of Fat vs. Thin Clients

Figure 3 – Relative costs for maintaining fat vs. thin clients as the number of locations increases

While the mean time between failures (MTBF) for current generation PCs may be quite good, the MTBF for thin clients is five to 10 times higher. Most of the added reliability stems from two primary hardware and software factors:

- Elimination of moving parts (which are the most likely to fail)
- Elimination of complex operating system and application software

Most organizations interviewed for this paper keep a small stock of replacement thin clients on hand for those very rare cases when one fails. Dreyer Medical, in Aurora, Illinois, maintains an inventory equal to about 4% of their thin client population for this purpose.

The Mean Time to Repair (MTTR) for thin clients is also superior to that for PCs for most types of failures. In the worst-case scenario – when the entire device must be replaced – a new thin client can be plugged in and running in less than five minutes. Installing the hardware and configuring the software for a replacement PC could take hours.

Source: Harvard Computing Group (2002). Security and Desktop Client Architectures (white paper). Page 12.

Appendix T2 – Technical Specifics & Spike Down
Case Studies in Fat vs. Thin Clients

NASA

For the National Aeronautics and Space Administration (NASA), providing basic Microsoft Office applications to 80,000 users in 12 sites nationwide is more complicated than it sounds. To aid the process, NASA officials have launched a new approach to networked applications at its Ames Research Center whose civil servants currently work on Windows, UNIX or Macintosh systems. “Some scientists have three computers sitting in their offices,” says the Chief System Administrator. “They run their UNIX database on one box and check their e-mail on another.” Last year Ames began testing Microsoft Windows Terminal Server to roll out Microsoft Office and other standard productivity tools directly from its network servers. With Windows NT Server 4.0, Terminal Server Edition, Ames’ users can transparently run Windows applications on their client machine of choice – from Macintosh to Sun or Silicon Graphics workstations – eliminating the need for multiple desktop boxes. Citrix’s MetaFrame and Windows Terminal Server also let network administrators upgrade applications at the server, cutting down support work. “When Microsoft Office 2000 arrives, I only have to install it on two servers, and every user on the network is immediately up to date,” the Chief System Administrator says. Anti-virus protection can also be administered at the server level, and the administrator has actually logged on over the weekend to install emergency anti-virus updates. If he had to install this machine-by-machine, such precautions would take days to undertake.

Source: Microsoft InFocus Magazine. Retrieved on November 20, 2002 from www.microsoft.com

Dreyer Medical Clinic

Stephen Hart of Dreyer Medical Clinic was in the middle of rolling out an upgraded version of Microsoft Internet Explorer to a nearly equal number of PCs and Wyse thin clients when he was interviewed for this report. He had just spent three days writing the script to perform the installation on each of the 500 PC clients and, despite his preparations, fully expects to encounter a variety of problems while performing the upgrades over the next several weeks. By contrast he expects it will take him about 10 minutes to apply the upgrade to the servers that drive 500 thin clients.

Conroe (TX) Independent School District

Dr. Scott Barrett, Director of Technology for the Conroe (TX) Independent School District, summed up one of the most compelling arguments for use of thin clients. After a very positive experience deploying more than 1200 Wyse thin clients in classrooms and computer labs, he began rolling out thin clients to administrators and teachers. Many long-time PC users complained at first, until Barrett said to them, “Would you rather have something that works all the time or something that works part of the time?”

A California University research lab (university unnamed)

In a dramatic example of tangible annual savings from deploying thin clients, a California University research lab has reduced their annual maintenance budget since converting to thin clients. In the past, they allocated an amount equal to 10% of their annual PC purchase budget for maintenance. Now, their annual thin client maintenance budget is 2% of their expenditures on new systems.

StayOnline

Atlanta-based StayOnline (www.stayonline.net) sells in-room Internet access solutions for the hospitality industry and will have more than 5000 Wyse® (www.wyse.com) Winterm™ thin clients in approximately 200 hotels throughout the United States by the end of 2002. Because of their concerns that one hotel guest might inadvertently (or intentionally) view web pages from a previous guest, the company uses Wyse's Rapport™ administrative software to purge the memory cache in all of the thin clients every night at 3:00 AM. They have even developed a method to purge instant messenger-style buddy lists to enhance the security of their clients' guests.

Source of above studies: Harvard Computing Group (2002). Security and Desktop Client Architectures. Page 8, 11.

Daewoo Motor Company

As Daewoo increases its authorized dealerships nationwide from 300 to 450, the company is relying on an IT infrastructure comprised of Citrix MetaFrame with Microsoft Windows 2000 Server software and Wyse Winterm Windows-based terminals to support its rapid growth. Citrix application server technology is reducing Daewoo's IT costs in several ways. The company can operate with a very lean IT staff of four, thanks to server-based application administration and training. Hendrie estimates that his department would require four times the staff if required to support dealerships locally. Further, the ability to use Wyse Windows-based terminals instead of full-function PCs saves Daewoo $500 to $600 per desktop in hardware costs.

Source: Citrix Systems, Inc (2000). Daewoo Motor America Gears Up with Citrix MetaFrame for Windows 2000 Servers. Retrieved on November 20, 2002 from http://www.citrix.com/press/news/profiles/daewoo.htm

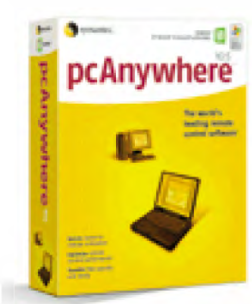
Appendix T3 – Technical Specifics & Spike Down
The Fujitsu 3400

KEY SPECIFICATIONS	
Microprocessor	Intel Pentium III 400MHz
Memory	64-192MB RAM
Storage	6GB Hard Drive, 1.44MB external floppy (opt.)
Display	10.4" XGA TFT Simultaneous support of external monitor and internal display; External max: 1024 x 768; 16M colors
Digitizer	Liquid filled, passive, low glare, palm rejection
Security	Kensington lock slot
Modem	Built-in 56K V.90
Network	Built-in 10/100 Ethernet
OTHER SPECIFICATIONS	
Battery	2.6AH Lithium-Ion battery (2 hours)
AC Adapter	Auto-sensing 100-240V 50/60Hz
Power Management	ACPI 4 1.0
Ports	USB port, Type II PC Card slot (CardBus support), IrDA 1.1 (FIR, 4Mbps), Stereo headphone jack, Microphone jack, Floppy disk drive port, IR keyboard port, DC-in jack, Serial port, Expansion connector port
Docking Station Ports	2nd USB port, Type III PC Card Slot (CardBus support), 10/100 Base-T Ethernet (RJ-45), Floppy disk drive port, PS/2 Keyboard port, PS/2 Mouse port, DC-in jack, Serial (9-pin) port, Parallel port, Stereo line-out jack
Operating Temperature	32^0 to 104^0 F (0^0 to 40^0C); Humidity: 20% to 80% (non-condensing)
Dimensions/Weight	11.2"(W) x 8.5"(D) x 1.1"(H); 3.4 lbs
SOFTWARE	
Operating Systems	Windows NT Workstation 4.0; Windows 2000 Professional; Microsoft Windows 98 Second Edition
Handwriting	Recognition CIC PenX 2.02
SERVICE	
Warranty	Three-year Limited Warranty

Source: *www.fujitsu.com*

Appendix T4 – Technical Specifics & Spike Down
Remote Control Software vs. Session Control Software
(PC Anywhere vs. Terminal Server)

Perhaps the most fundamental principle one needs to understand about Terminal Server is the difference between Remote Control and Remote Access. Terminal Server is a Remote Control operating system that differs from Remote Access Service (RAS) tremendously. Consider a program such as Microsoft Access that not a client/server application. In a RAS session, where a computer acting as a node on a network running Microsoft Access makes an entry in a table, the entire table is transferred from the server and loaded into memory on the client. On a 33.6k connection, this is an unacceptably slow operation that will cause any user to end the session. This same scenario in a remote control environment on Terminal Server executes at a perfectly reasonable speed. The reason is that **only** mouse, keyboard, and video have been transferred across the wire. None of the application or data crosses the network between the Terminal Server client and the Terminal Server.



The most widely used remote control program is PC Anywhere. If you've experienced PC Anywhere and its benefits, you understand the environment of Terminal Server except for the major difference that PC Anywhere is a single-user product. And that single-user or linear configuration typically makes PC Anywhere an unacceptable solution after five users or more. Why?

Because each PC Anywhere session requires its own PC on the host end. Whereas Terminal Server can easily support over five users on one powerful server machine, could you (for example) imagine 20 PCs stacked in a room to support 20 PC Anywhere sessions? Nope!

Indeed the financial crossover point between PC Anywhere and Terminal Server is after five users. This is based on the assumption that you would have five late model PCs running PC Anywhere in your server room versus one sufficiently powered server running Terminal Server. So below five users, PC Anywhere demands a good look as your solution. Above five users, go with Terminal Server and don't look back.

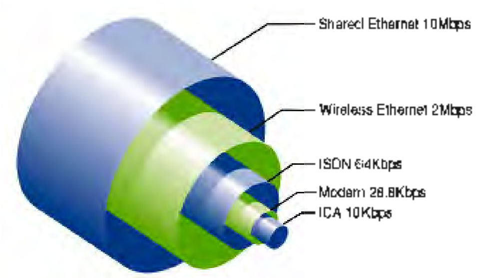
Source: Brelsford, Harry M. Microsoft Windows NT Secrets Option Pack Edition. Page 631.

Appendix T5 – Technical Specifics & Spike Down
Citrix Independent Computing Architecture (ICA) &
Remote Desktop Protocol (RDP)

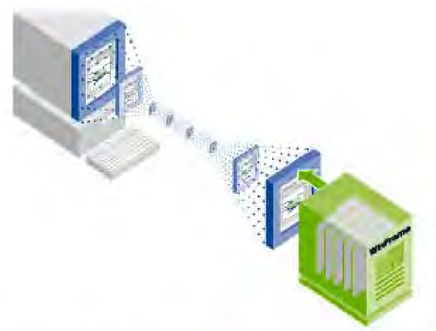
Citrix Independent Computing Architecture (ICA)

Citrix® Independent Computing Architecture (ICA®) technology provides the foundation for deploying applications and information onto any device. That's why Citrix ICA has become the de facto industry standard for delivering corporate applications across the broadest variety of desktop platforms and networks.

On the server, Citrix ICA has the unique ability to separate application logic from the user interface. On the client, users see and work with the application's interface, but 100 percent of the application executes on the server. And with ICA, applications consume as little as one-tenth of their normal network bandwidth.



ICA is optimized for connections as low as 14.4 Kbps. Only mouse clicks, keystrokes and screen updates travel the network to generate exceptional performance.



ICA separates the user interface from the application while keeping 100% of the logic on the server. By doing this, only screen updates, mouse clicks and keystrokes travel the network.

This efficiency enables the latest, most powerful Windows®, UNIX® and JavaTM applications to be accessed with exceptional performance from existing PCs, Windows-based terminals, network computers and a new generation of business and personal information appliances.

Key ICA Differentiators

Thin Resources
Citrix ICA requires an Intel® 286 processor and access to a minimum of 640 KB of RAM to operate.

Thin Wires
The Citrix ICA protocol consumes less than 20 Kb of bandwidth. This allows it to operate consistently -- even over dial-up and ISDN connections -- without regard to the robustness of the executing application.

Universal Application Client
Citrix ICA works with any Windows, UNIX or Java application. Citrix ICA takes applications designed for a wide range of deployment technologies and deploys them with only one piece of ICA-based client software.

Platform Independent
Citrix ICA is inherently platform independent and has been ported to Symbian OS, Linux®, Java, Windows CE, OS/2®, Macintosh® and other non-DOS devices to deliver Windows applications to non-Windows and specialized ICA devices.

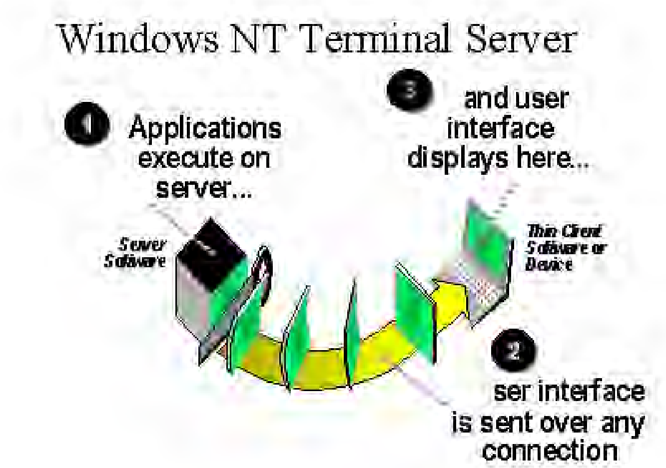
Source: [*www.citrix.com*](http://www.citrix.com)

Remote Desktop Protocol (RDP)

Remote Desktop Protocol (RDP) - A key component of Terminal Server is the protocol that allows a "super-thin client" to communicate with the Terminal Server over the network. This protocol is based on International Telecommunications Union's (ITU) T.120 protocol, an international, standard multichannel conferencing protocol (currently used in the Microsoft NetMeeting) conferencing software product. It is tuned for high-bandwidth enterprise environments and will also support encrypted sessions.

"Super-Thin" - The client software that presents, or displays, the familiar 32-bit Windows user interface on a range of desktop hardware including Windows-based terminal devices, personal computers (running Windows 95, Windows 98, Windows NT Workstation, or Windows for Workgroups v3.11).

RDP provides up to 64,000 separate channels for data transmission, as well as provisions for multipoint transmission.



RDP is designed to support many different types of Network topologies (such as ISDN, POTS, and many LAN protocols such as IPX, Netbios, TCP/IP, and so forth.). The current version of RDP only runs over TCP/IP.

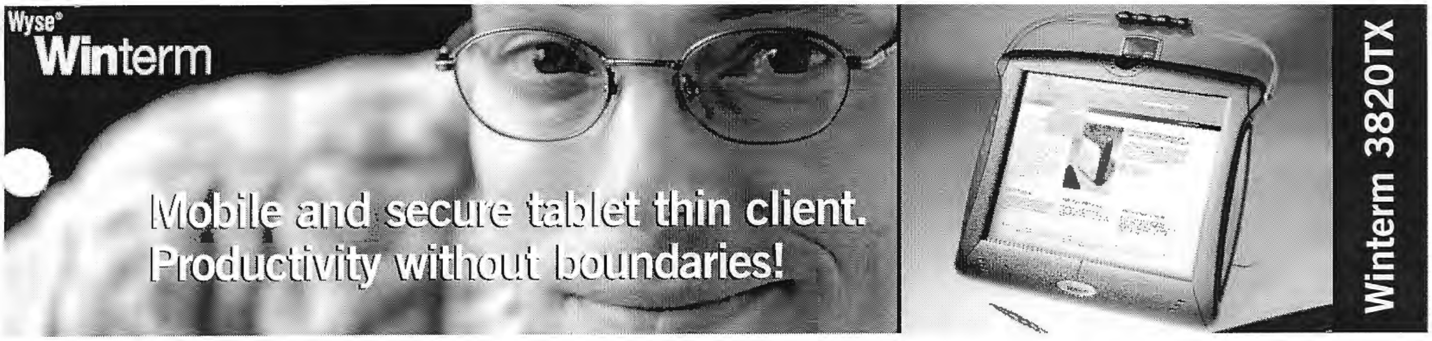
The activity involved in sending and receiving data through the RDP stack is essentially the same as the seven-layer OSI (open systems interconnection) model standards for common LAN (local area network) networking today. Data from an application or service to be transmitted is passed down through the protocol stacks, sectioned, directed to a channel (MCS), encrypted, wrapped, framed, and packaged onto the network protocol and finally addressed and sent over the wire to the client.

RDP was developed to be entirely independent of its underlying transport stack, in this case TDTCP.SYS. Other transport drivers for other network protocols can be added as customers request them, with little or no significant changes to the foundational parts of RDP. These are key elements to the performance and extendibility of RDP on the network.

One of the key points for application developers is that in using RDP, Microsoft has abstracted away the complexities of dealing with the Protocol stack. By having application developers simply write clean, well-designed 32-bit applications, then the RDP stack implemented by the Terminal Server and its client connections takes care of the rest.

Source: Cyclops Tech, UK. *http://www.cyclopstech.com.hk/rdp.htm*

Appendix T6 – Technical Specifics & Spike Down
Wyse Winterm 3820TX



SECURE, LIGHTWEIGHT TOUCHSCREEN TABLET THIN CLIENT.

Key Features	Key Benefits
Integrated support for popular LAN and radio cards	Familiar, simple, seamless integration into existing network infrastructures
12.1" viewable display screen, XGA (1024 x 768) resolution, 16 bits Active Matrix Color TFT	Mobile portal into either server or PC-based applications, with the ease of touch screen input and handwriting recognition
Weighs only 3.5 pounds*	Freedom to roam, without weighing you down
Standard Lithium-Ion battery provides up to 4 hours of use, optional extended battery up to 8 hours	Reduces the need to carry multiple back-up batteries
40/128 bit Wired Equivalent Privacy (WEP)	Permits a secure environment for sensitive information while on the move
Support for external keyboard and VGA monitor	Convenience of desktop presence when not mobile
Citrix ICA and Microsoft RDP Clients	Connectivity to almost any back-end system
Microsoft Windows CE	Proven solution with key applications on the server
Built-in Microsoft Internet Explorer	Direct web access
Two Type 2 PCMCIA slots	Convenient connection and networking options

*With standard battery

The Wyse Winterm 3820TX tablet thin client is the most reliable and secure option for mobile computing, ideal for manufacturing, healthcare, retail, government, and organizations that need mobility within their facility. With easy access to Windows applications from anywhere within their facility with a wireless LAN connection, the Winterm 3820TX is ideal for workers who need mobility and flexibility – be it on the factory floor, a nurse's station, or a conference room.

Based on Microsoft's Windows CE operating system, it allows powerful mobile access to server-based applications while providing strong security and reliability. The Winterm 3820TX supports a wide range of LAN, WAN and wireless radio cards for seamless integration into existing network infrastructures. Plus, the model Winterm 3820TX offers a built-in Internet browser for easy intranet browsing and access to web applications.

The lightweight, touch-sensitive Winterm 3820TX also provides quick desktop legacy connectivity with two Type 2 PCMCIA ports for access to an external keyboard or VGA monitor. Optional accessories, including a ruggedized case and long-life battery, make the Winterm 3820TX an ideal choice for a wide range of environments.

The attractive tablet has a bright, high resolution screen and an ergonomic handle to make carrying and using the Winterm mobile thin client a breeze. One tablet supports 2 PC cards (one for the wireless network), XGA out, audio in/out, and an optional PS/2 keyboard.

As with all Winterm thin clients, the Winterm 3820TX comes bundled with Wyse® Rapport™, the client management tool that leverages the value of your IT infrastructure for maximum ROI.

Wyse® Winterm™ thin clients are a better way to deliver Windows® and web applications to users throughout your enterprise. Mobile thin clients provide security, manageability, affordability and reliability beyond the desktop. They are easier to deploy and manage and much less expensive to buy and maintain than portable computers.

SMART™
SECURE MANAGED AFFORDABLE RELIABLE THIN CLIENTS
from Wyse, the worldwide market leader.

WYSE

Winterm 3820TX

Specifications

Mobile Windows-Based Terminal
- Based on Windows CE 3.0 operating system
- Integrated Microsoft RDP and Citrix ICA protocols
- 32Mb FLASH/64Mb RAM

Display Support
- Active matrix color TFT
- 12.1" Viewable Screen Area
- XGA (1024 x 768) Resolution
- 16 Bit Color

Audio[1]
- Stereo speakers
- Microphone
- Audio in: 1/8" mini, line in 8 bit
- Audio out: 1/8" mini, full 16 bit, 48 khz sampling rate

Input/Output/Peripheral Support
- Touchscreen with handwriting recognition (CalliGrapher®)
- Software emulated keyboard (Standard)
- VGA output
- (1) USB interface
- (2) Type II PCMCIA
- (1) PS2

Networking
- TCP/IP with DNS and DHCP
- Multiple master browser support on ICA
- Supports Citrix load balancing on ICA
- Rapport agent allows configuration of terminal settings, reporting of terminal configuration and attached devices, traps
- DHCP support for automatic firmware upgrades and unit configuration

Communications
- Built-in wireless cards supported include those from companies such as Cisco, Proxim (Orinoco), and Enterasys
- ICA remote dial-up via optional external modem
- 40/128 bit Wired Equivalent Privacy (WEP)

Range
- Range: Indoors - unlimited within network
- Outdoors - up to 1,500'[2]

Communication Protocol
- Microsoft RDP resident
- Citrix ICA resident
- IE 4.0 local browser

Server OS Compatibility/Support
- Microsoft .Net Server ready
- Microsoft Windows 2000
- Microsoft Windows NT Server 4.0, Terminal Server Edition
- Citrix MetaFrame
- Citrix WinFrame

Set-Up and Configuration
User Interface
- Local boot
- Start-up wizard for simple set-up
- International software keyboard: UK, French, German, Spanish

Configuration
- Configurable automatic login
- Individual scripting
- Remote management, configuration, and upgrades through Wyse client management software Wyse Rapport (included)

Physical Characteristics
- Height: 9.4 inches (239 mm)
- Width: 11.7 inches (297 mm)
- Depth: 1.2 inches (30 mm)
- Shipping weight: 3.5 lbs (1.54kg)

Environmental
Temperature range
- Powered on: 32° to 104°F (0° to 40°C)
- Powered off: –14° to 140°F (–10° to 60°C)
- Convection cooling, fanless design

Humidity
- 20% to 80% noncondensing

Operating altitude range
- 0 to 10,000 feet (0 to 3,050 meters)

Power
- Worldwide auto-sensing 100-240v VAC, 50/60 Hz
- AC Adapter
- Li-Ion Battery (up to 4 Hours between charges)
- Integrated Battery & Charger 100-240 VAC, 50-60 Hz

Regulatory Compliance
Safety
- EN 60950 approved

RF interference
- FCC Part 15 Class B
- CE mark
- EN55022B approved

Accessories
- Extended operation battery (up to 8 hours between charges)
- Compact external battery charger
- Nylon carrying case
- USB keyboard with 2-port USB hub
- For more available accessories, see www.wyse.com

Warranty
- One-year limited hardware warranty

WYSE

Wyse Technology Inc.
3471 North First Street
San Jose, CA 95134-1801

Or send email to:
sales@wyse.com

Wyse Sales:
800 GET WYSE
(800 438 9973)

Wyse Customer Service Center:
800 800 WYSE
(800 800 9973)

International Sales:
Australia 61 2 9319 3388
France 33 1 39 4400 44
Germany 49 89 460099 0
Taiwan 886 3 577 9261
United Kingdom 44 118 9342 200
United States 408 473 1200

Visit our websites at:
http://www.wyse.com
http://www.wyse.co.uk
http://www.wyse.fr
http://www.wyse.de
http://www.wyse.com.au
http://www.wyse.com.tw

[1]Requires support by server OS and protocol. [2]Dependent on wireless LAN card.

01/03 880924-04 Rev. A

Source: Wyse. http://www.wyse.com