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Best Practices

Enterprise Geospatial Information Systems (EGIS) for Airport Asset Management Decision Support

Vision

Imagine ...

Imagine having literally at your finger tips airport asset data and key performance indicators (KPIs).

Imagine you are sitting at a meeting and you quickly use your iPhone, iPad, or similar device to get answers via user friendly "apps" (i.e., dashboard applications) of your airport business metrics.

Imagine "data fusion" from your various systems such as property lease management, maintenance management, pavement management, airfield operations management, life safety and security management, gate management, document management, and other systems.

Imagine accessing all these facets of airport asset business data by using your fingers to zoom in on the asset and drilling down on associated information.

Imagine having "Google"-like data mining capability for your airport assets and their performance, including the ability to quickly pull up their operation and maintenance procedures, blue prints, parts list, schedules, warranties, etc.

Imagine looking around at the ground through an iPhone, turning and tilting in different directions to visualize the location of buried subsurface utilities.

This is not science fiction. This is today's reality. We have the technology. We can build it for you now.

Airport Management Dashboard
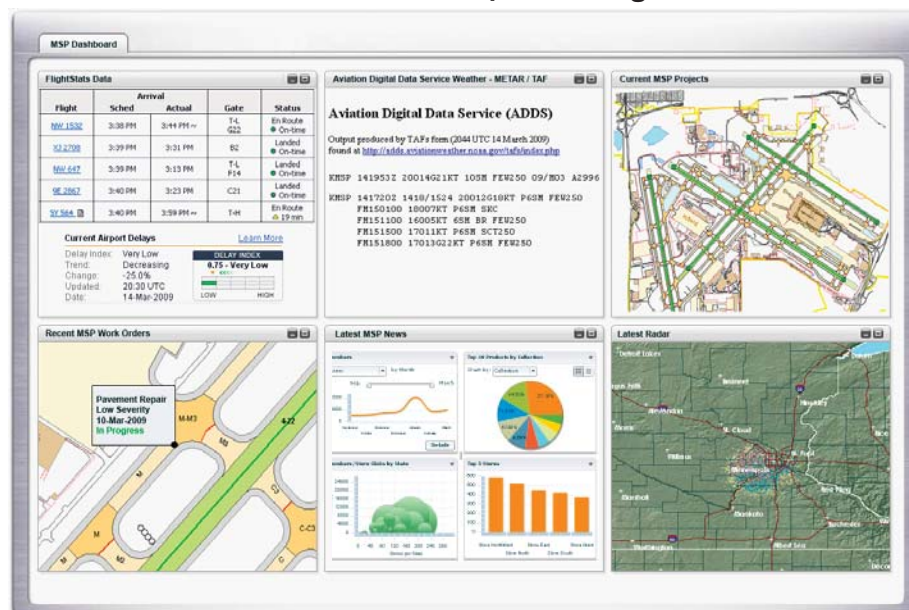
Elements

The definition of GIS is presented in the figure below. Applying GIS across an airport enterprise is referred to as an Enterprise GIS (EGIS).

EGIS facilitates the sharing of spatial data across multiple departments within an enterprise. EGIS leverages spatial data in a central data repository where data is maintained once and viewed, analyzed, and printed by many.

Implementing the hardware and software technology components of an EGIS is straight forward and a relatively minor cost of an overall EGIS Program. Collecting and consolidating data of known quality is the most costly component of an EGIS Program. The success of an EGIS Program depends most on competent people and methods.
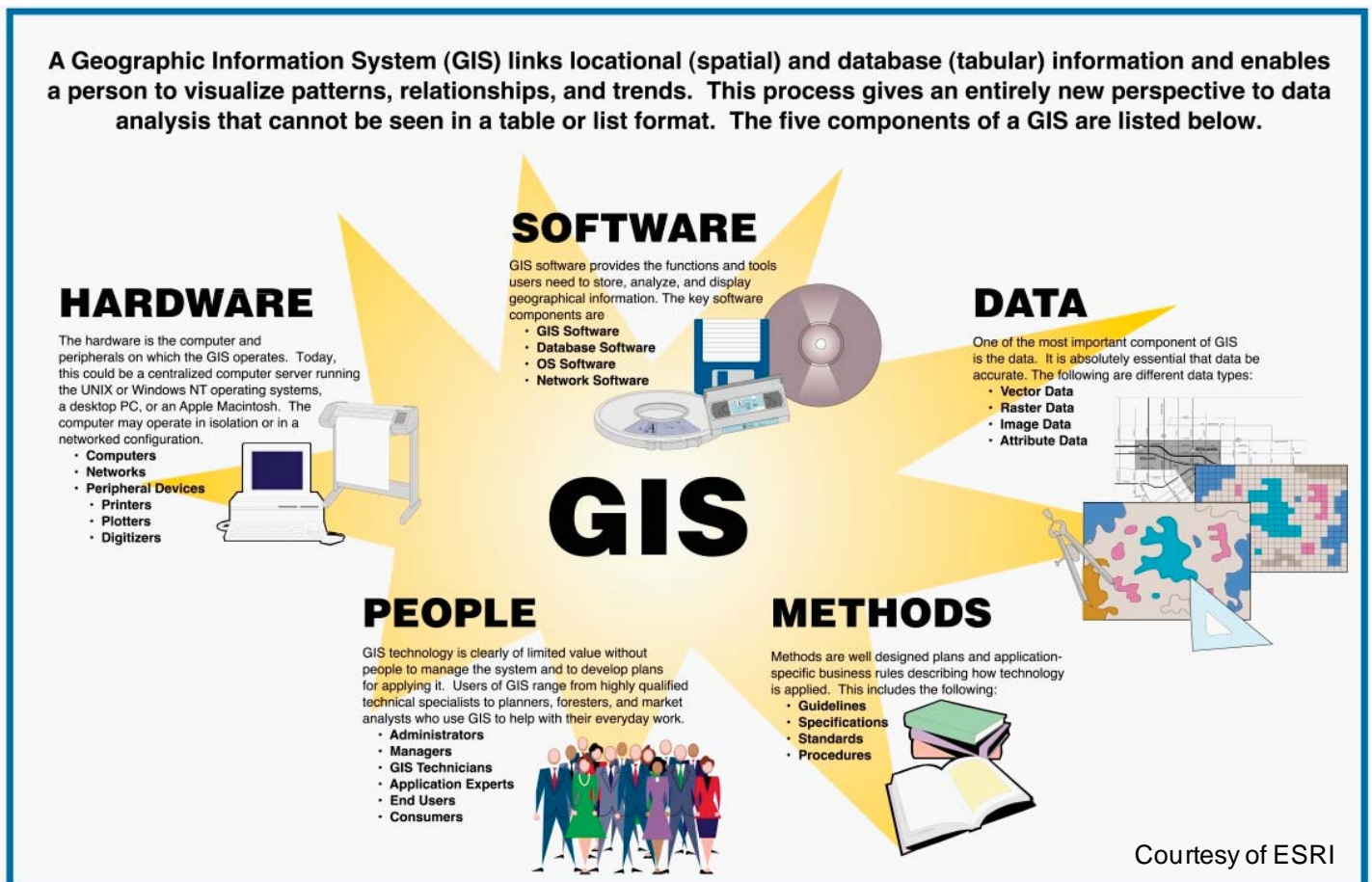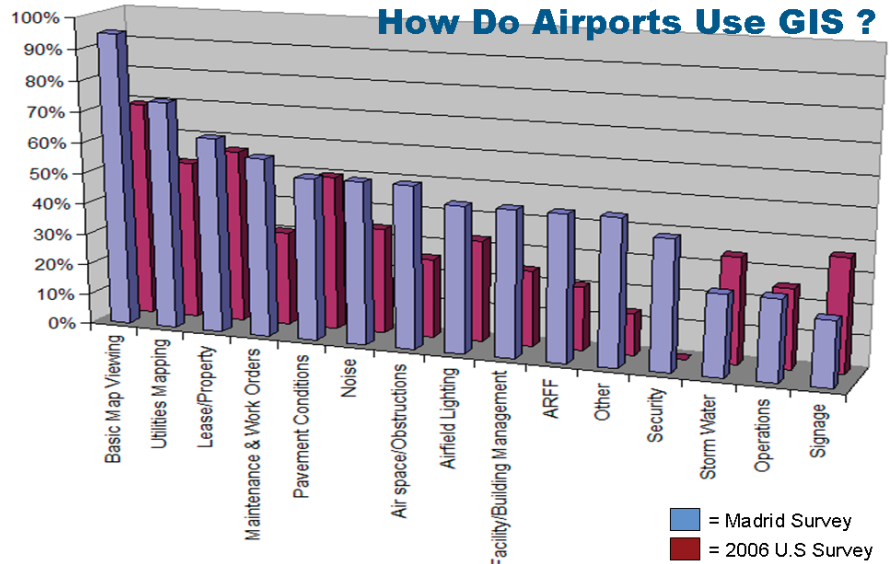
A centralized core EGIS group of people with executive backing to administer the technology, build and maintain the data, and develop and enforce the methods along with ongoing stake-holder participation is essential to a successful EGIS program.

Definition and Elements of GIS

A Geographic Information System (GIS) links locational (spatial) and database (tabular) information and enables a person to visualize patterns, relationships, and trends. This process gives an entirely new perspective to data analysis that cannot be seen in a table or list format. The five components of a GIS are listed below.

SOFTWARE

GIS software provides the functions and tools users need to store, analyze, and display geographical information. The key software components are
- GIS Software
- Database Software
- OS Software
- Network Software

HARDWARE

The hardware is the computer and peripherals on which the GIS operates. Today, this could be a centralized computer server running the UNIX or Windows NT operating systems, a desktop PC, or an Apple Macintosh. The computer may operate in isolation or in a networked configuration.
- Computers
- Networks
- Peripheral Devices
  - Printers
  - Plotters
  - Digitizers

DATA

One of the most important component of GIS is the data. It is absolutely essential that data be accurate. The following are different data types:
- Vector Data
- Raster Data
- Image Data
- Attribute Data

GIS

PEOPLE

GIS technology is clearly of limited value without people to manage the system and to develop plans for applying it. Users of GIS range from highly qualified technical specialists to planners, foresters, and market analysts who use GIS to help with their everyday work.
- Administrators
- Managers
- GIS Technicians
- Application Experts
- End Users
- Consumers

METHODS

Methods are well designed plans and application-specific business rules describing how technology is applied. This includes the following:
- Guidelines
- Specifications
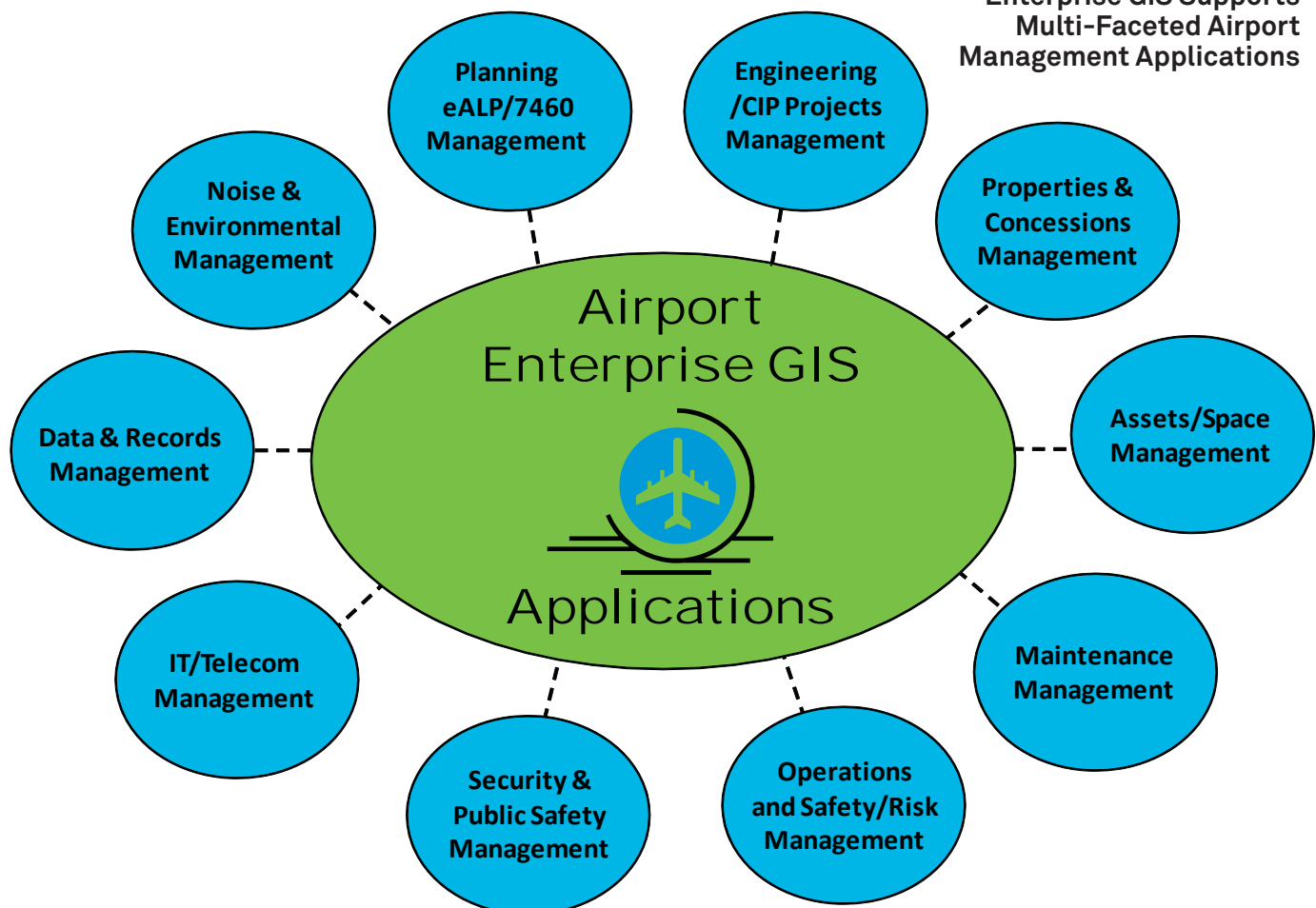- Standards
- Procedures

Courtesy of ESRI

Applications

GIS has become common place at major airports across the globe. The most common airport GIS applications are graphed to the right. This data is based on 2006 surveys done of US airports (in purple) and of global airports (in blue). Most of the top 30 US airports are in the process of evolving their enterprise GIS capabilities. The most prominent trend of GIS application priorities being currently pushed across major airports is the integration of GIS with lease management and maintenance management systems. As airlines are getting out of the facilities management business, to more efficiently concentrate on their core business of air transportation, the airport owners are inheriting facility financial asset management responsibilities, which require improved data management and decision support systems.

How Do Airports Use GIS ?

Chart axis labels (vertical): 100%, 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10%, 0%

Categories (horizontal): Basic Map Viewing, Utilities Mapping, Lease/Property, Maintenance & Work Orders, Pavement Conditions, Noise, Air space/Obstructions, Airfield Lighting, Facility/Building Management, ARFF, Other, Security, Storm Water, Operations, Signage

Legend:
- = Madrid Survey
- = 2006 U.S Survey

Enterprise GIS Supports Multi-Faceted Airport Management Applications

Airport Enterprise GIS Applications

- Planning eALP/7460 Management
- Engineering /CIP Projects Management
- Noise & Environmental Management
- Properties & Concessions Management
- Data & Records Management
- Assets/Space Management
- IT/Telecom Management
- Maintenance Management
- Security & Public Safety Management
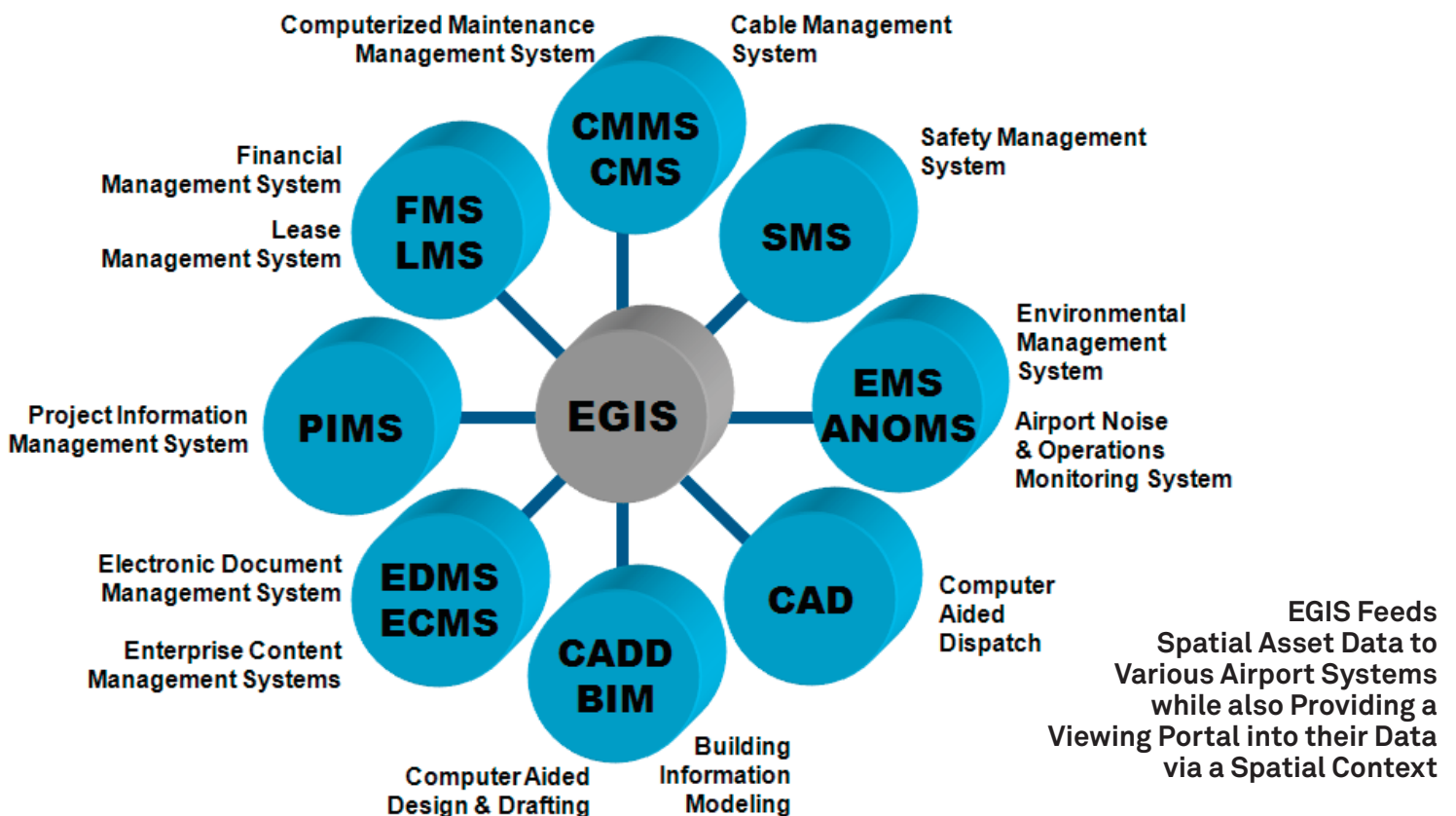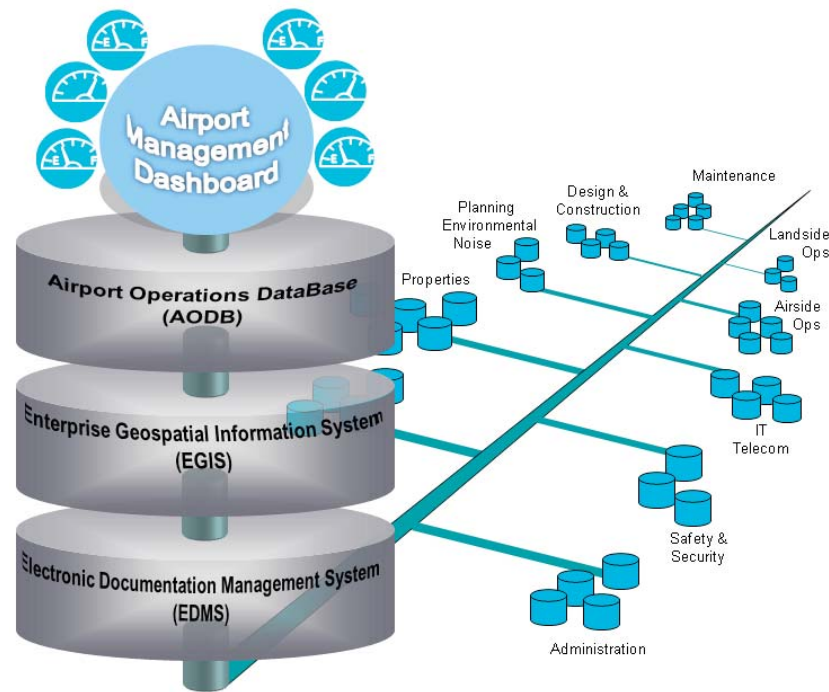- Operations and Safety/Risk Management

Data Fusion

The overall goal of an EGIS is to improve the multi-faceted aspects of airport management across the business enterprise by providing and sharing effective data for decision support.

An EGIS integrated with other airport systems enables building an "Airport Asset Management Dashboard". EGIS provides a "data fusion" mechanism whereby data from various systems describing the same airport asset can be viewed and analyzed together in a spatial context.

Airport enterprise management requires various systems which deal with different aspects of airport assets over the airport's re-occurring lifecycle of development, operation, maintenance … and re-development (i.e., expansion, renewal, replacement, etc.).

Such systems include, but are not limited to, those shown below. EGIS allows such systems to share one common updated set of asset spatial data, eliminating the need to duplicate and maintain spatial data in each system that needs it.

EGIS Feeds Spatial Asset Data to Various Airport Systems while also Providing a Viewing Portal into their Data via a Spatial Context

The following description of airport EGIS best practices is re-published here from an article by Kevin Carlson of AECOM, published in *Airport Business Magazine* in the Nov/Dec 2008 issue.

"The Power of Enterprise GIS"

It's much more than merely collecting data; it's about efficiency, productivity. The ancient Delphic oracle cautioned, "Know thyself." Good advice for airport operators awash in a glut of information. But in reflecting on the peculiarities of information, historian William Pollard noted, "Unless it is organized, processed, and available to the right people in a format for decision-making, it is a burden, not a benefit." Enterprise geographic information systems are the best way for airports to gather, organize, and use the complex information that defines airport facilities and operations - as long as one keeps Pollard's precautionary wisdom in mind.

... airports need, use, and generate a massive amount of critical geographic-based data that must be adroitly managed ...

Consider a major airport's mission. Rivaling small cities in terms of scale, scope, and diversity of assets, airports are large, complex facilities that must be operated, maintained, and upgraded regularly. Airports also manage lots of land, and must plan and execute large construction programs. To make things even trickier, they almost never close. But that is only the operational perspective. Airports also host diverse tenants - from airlines to retailers to service providers. And airports have substantial responsibilities as part of the National Airspace System (NAS). As NAS gatekeepers, airports must operate or support systems that track flight times and gate usage, manage revenue from tenant billings and facility-use charges, control security and airfield access, provide critical infrastructure to airlines for passenger and baggage processing, manage traffic and parking, and enable the Federal Aviation Administration to control aircraft movement and provide landing guidance. As well, airports are subject to aviation-specific rules and regulations on tracking and logging facility conditions; managing and reporting incidents; applying for and using federal funding; and minimizing construction impacts on aircraft movement and safety. That all adds up to one inescapable conclusion: airports need, use, and generate a massive amount of critical geographic-based data that must be adroitly managed.

"It is imperative that we have excellent reference information," explains GIS program manager Sam Console, of the Planning & Environmental Stewardship unit, Division of Aviation at Philadelphia International Airport (PHL). "I look at GIS as an integral decision-support tool. For years it was paper maps. But GIS gives us a flexible, digital, and integrative way to create maps on the fly and use that information immediately. For example, PHL must remain open during severe weather events, like snowstorms. We melt snow because we have no place to pile it. So we mapped out the underground drainage system on our GIS. Snow, ice, or debris could cover any of those drains, but we can locate and clear them quickly using GIS. We actually won an award in 2003 for using GIS to develop a snow-removal tracking application."

GIS systems provide concise, usable information for every aspect of an airport. An outstanding decision-making support tool, GIS is a central, interactive, comprehensive repository. It also allows airport managers to obtain data instantly (via an internal website), around the clock, from their desktop, laptop, or PDA.

ASSET, WORKLOAD MANAGEMENT

"GIS is all about making sense of the airport in terms of data, about connecting everything through information. In that respect, two factors drove our GIS implementation: better asset management and better work management," explains Jerry Schwinghammer, manager of technology planning for the Greater Orlando Aviation Authority. "For example, we incorporated county land-use data into GIS. We overlaid our noise-contour data. All of our data - including property information and our history and acquisition data - is integrated with GIS. And we can plan and coordinate better with surrounding municipalities because we have all of their GIS data sets in-house. We've got entire floor plans and all of the spaces within the terminal in our GIS system; and we operate about 5 million square feet of assets. But that wasn't just a lofty exercise. For janitorial contracting, for example, we can issue much better RFPs since we can track exactly what needs to be cleaned and when. We also cataloged all facility assets valued over $1,000. That started in GIS, but migrated into the maintenance
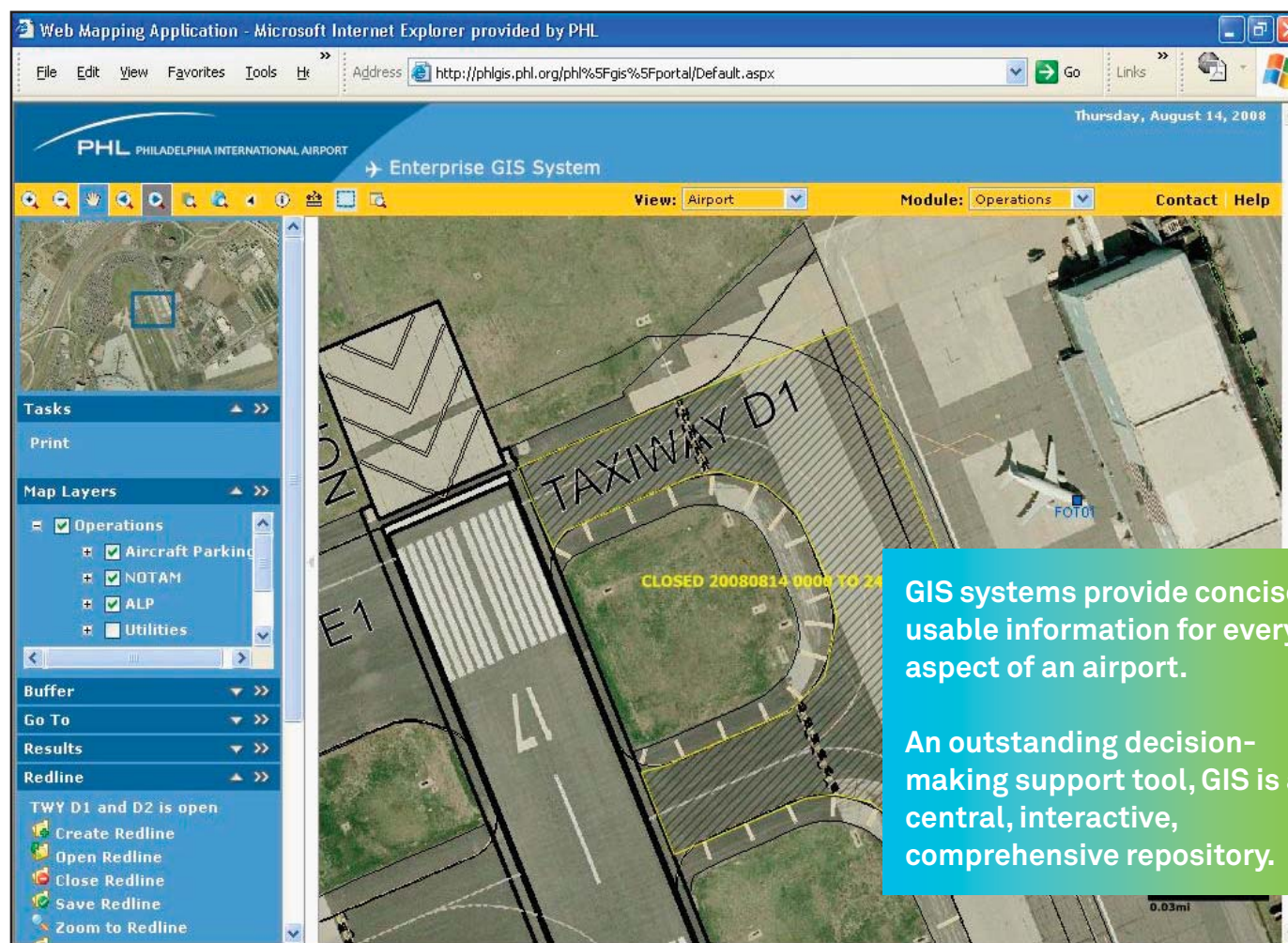
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EGIS Built by AECOM for Philadelphia International Airport
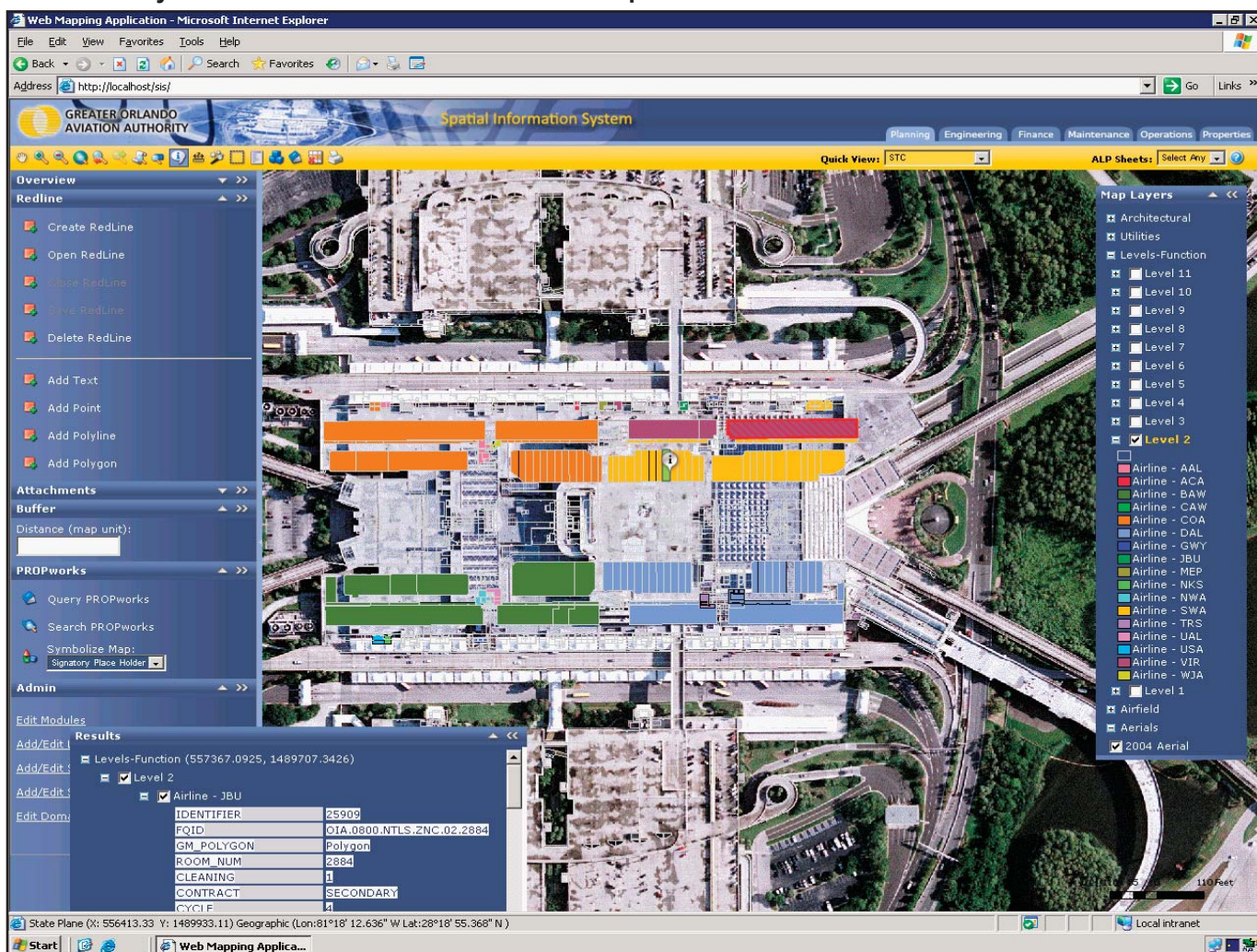
management system. However, GIS provides the link to that data. We used to only have an aggregated total of our lease data. With GIS, our lease data is depicted down to the level of individual rooms. That enables us to be more responsive to market conditions for leases, and more adept at projection modeling for lease revenue. We've eliminated the smokestacks of data and have it all in a flat, enterprise environment where we can share the data. But at its most basic level, accurate, reliable, usable data is why we use GIS and why we will continue to use it."

Every GIS system is only as good as its data. But I'll get to that momentarily. First, I would like to point out two more benefits of GIS. Once a novel concept, then a fad, and now an established standard, operating "green" has become crucial to airports. GIS provides exceptional opportunities for greening an airport. A GIS can help airport staff determine what areas of an airport are being used (or not) during any time of day or night. With that real-time data in hand they can conserve a lot of energy, particularly by manipulating HVAC systems and lighting. Another significant benefit of GIS concerns utilities. Airports change, and when they change they often have to dig. When they dig, utilities are a major concern.

... operating "green" has become crucial to airports. GIS provides exceptional opportunities for greening an airport ...

> ... GIS helps save time and money, making operations and revenue generation more efficient. But to produce those results, GIS must be implemented well, and there is an art to its implementation.

With accurate GIS data, every airport utility is known and mapped. That real-time information can easily be put into the hands of the people doing the digging, avoiding potentially dangerous accidents and costly delays. Without question, GIS helps save time and money, making operations and revenue generation more efficient. But to produce those results, GIS must be implemented well, and there is an art to its implementation.

ITEMS TO CONSIDER

Airports planning GIS implementation or expansion should keep in mind several things about GIS ...

- Looking Up Your New Address

When implementing GIS, start by establishing a common addressing system for the entire facility. Many airports have one series of numbers stamped on doors, a different array of column numbers stamped on beams, and often a grid system that engineers use on the airfield - divergent numbering systems abound. From a GIS standpoint, you need a reliable, consistent,

EGIS Built by AECOM for Minneapolis International Airport
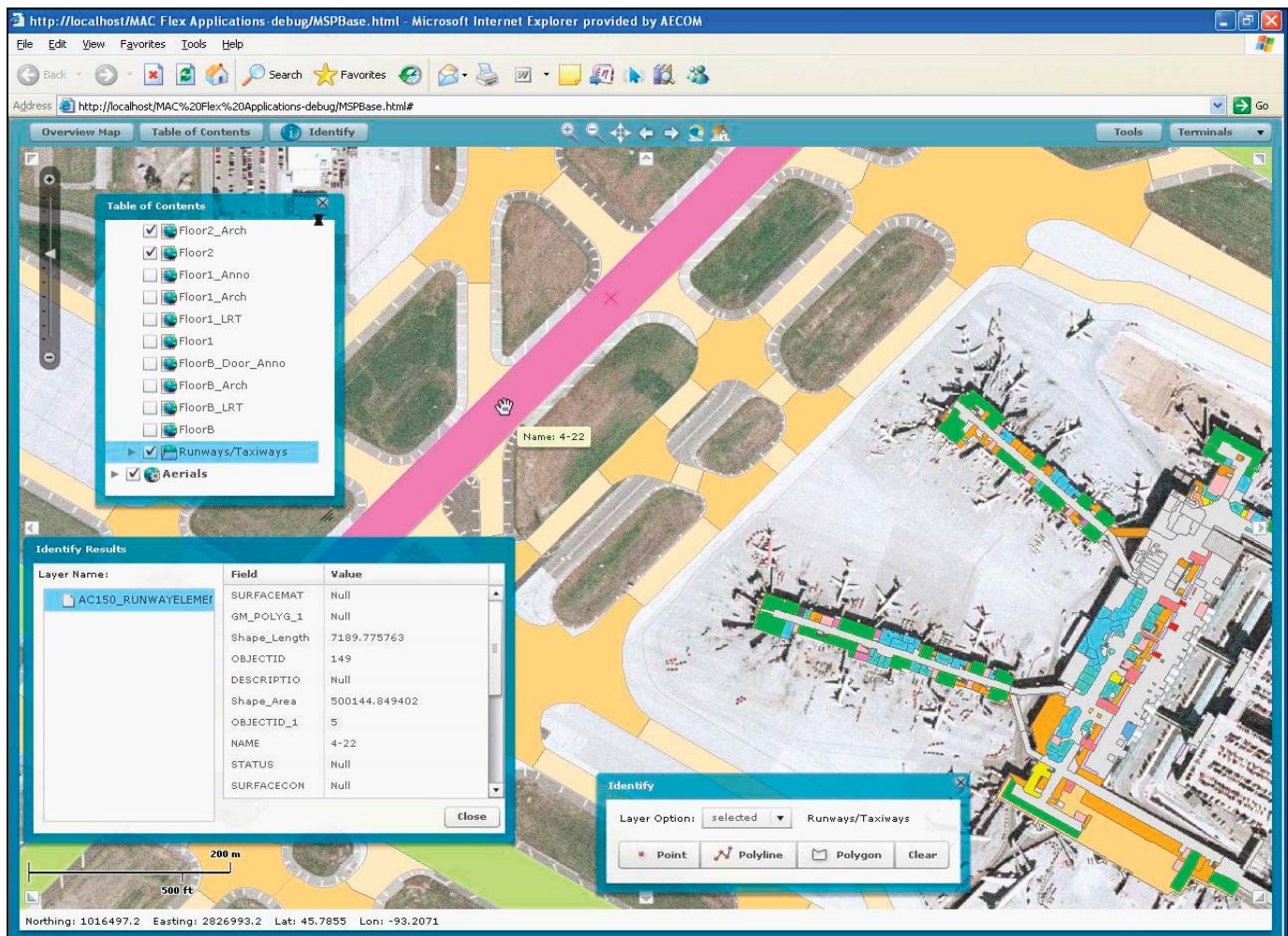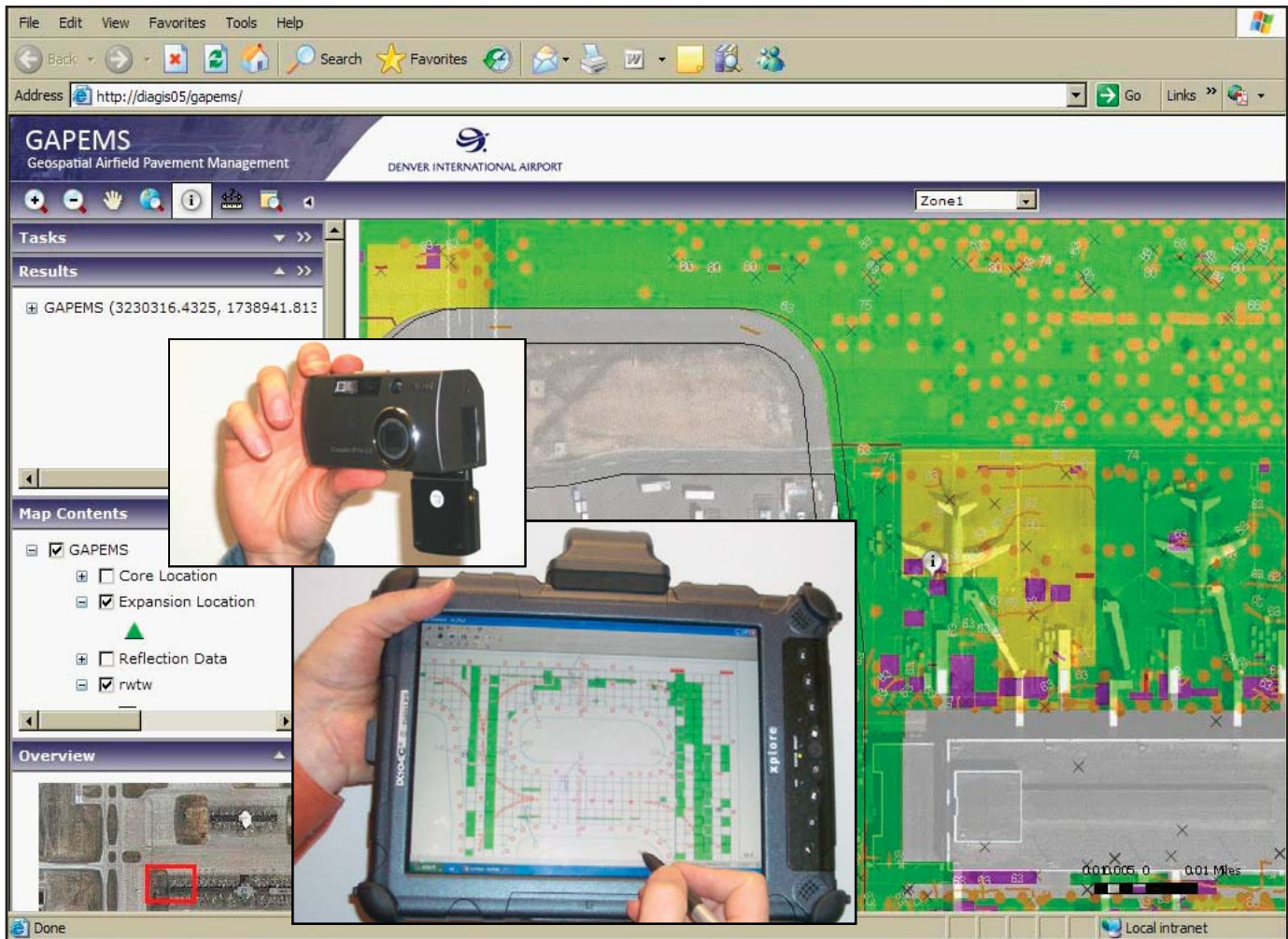
unitary system that will tell you exactly what is what. Establish a common addressing system for the entire facility.

- A System of One's Own

Operational ownership of a GIS system is as important as the system itself. But is it an IT function? A physical plant function? An engineering project? At many airports over the past decade, a particular department championed GIS; it was their baby. But once it grew into an enterprise system, the GIS actually became a source of organizational strife concerning who should own and manage it. Avoid that confusion. GIS has become an IT function, and the IT department should be the system custodian.

- Minding the Storage

Another critical element is data storage. All data should be stored in a format that is vendor-neutral. There are several well-known vendors providing excellent GIS products. But will those vendors still be there tomorrow? Five years from now? Ten? Store all data in an open-source manner that can be transferred to any brand of vendor hardware and integrated with any other airport system.

- Don't Wait Until It Is Too Late

Airports often consider GIS when pondering capital improvement programs. All too often, though, GIS isn't addressed until the tail end of

the process. GIS needs precise, current information as soon as it's available. By inputting data on a capital improvement program as it unfolds, GIS helps advance the program while obtaining data that has integrity.

- Systems that Communicate

An airport may have ten different contractors working at any one time. One firm is rehabilitating a runway, another has a fencing project, and yet another is putting a concourse on the terminal. Get standards in place, and then require those firms to submit their deliverable data in a standardized form that can be easily entered into your GIS system.

- Backing to Go Forward

Because airport GIS are enterprise systems, they must have the full backing of airport management. By definition, GIS must mesh with virtually every airport discipline. To guarantee buy-in from all quarters, executive management must make it clear that GIS is a priority.

- It's More than Data

Finally, when working with GIS it's easy to obsess about the data and lose focus as to its practical value. To sidestep that trap, consider some examples of what GIS can do: From dispatching to security to revenue generation to operational


EGIS Built by AECOM for Southwest Florida International Airport

efficiencies to precise space/location data, enterprise GIS has a unique operational value that no other database can match. FAA Advisory Circular 150/5300-18B defines a standard for storing GIS data for airports. FAA is moving toward a requirement that submissions be made electronically, and in the GIS-based format defined in the advisory. The FAA's Notice to Airmen program has also recently begun using GIS data formats for better situational awareness among air crews.

AECOM's Airport GIS Professionals bring Airport GIS Best Practices from over 40 airports including

- **Minneapolis**
- **Philadelphia**
- **Milwaukee**
- **Orlando**
- **Denver**
- **Atlanta**
- **Chicago**
- **Toronto**
- **Los Angeles**
- **Southwest Florida**

and many others …
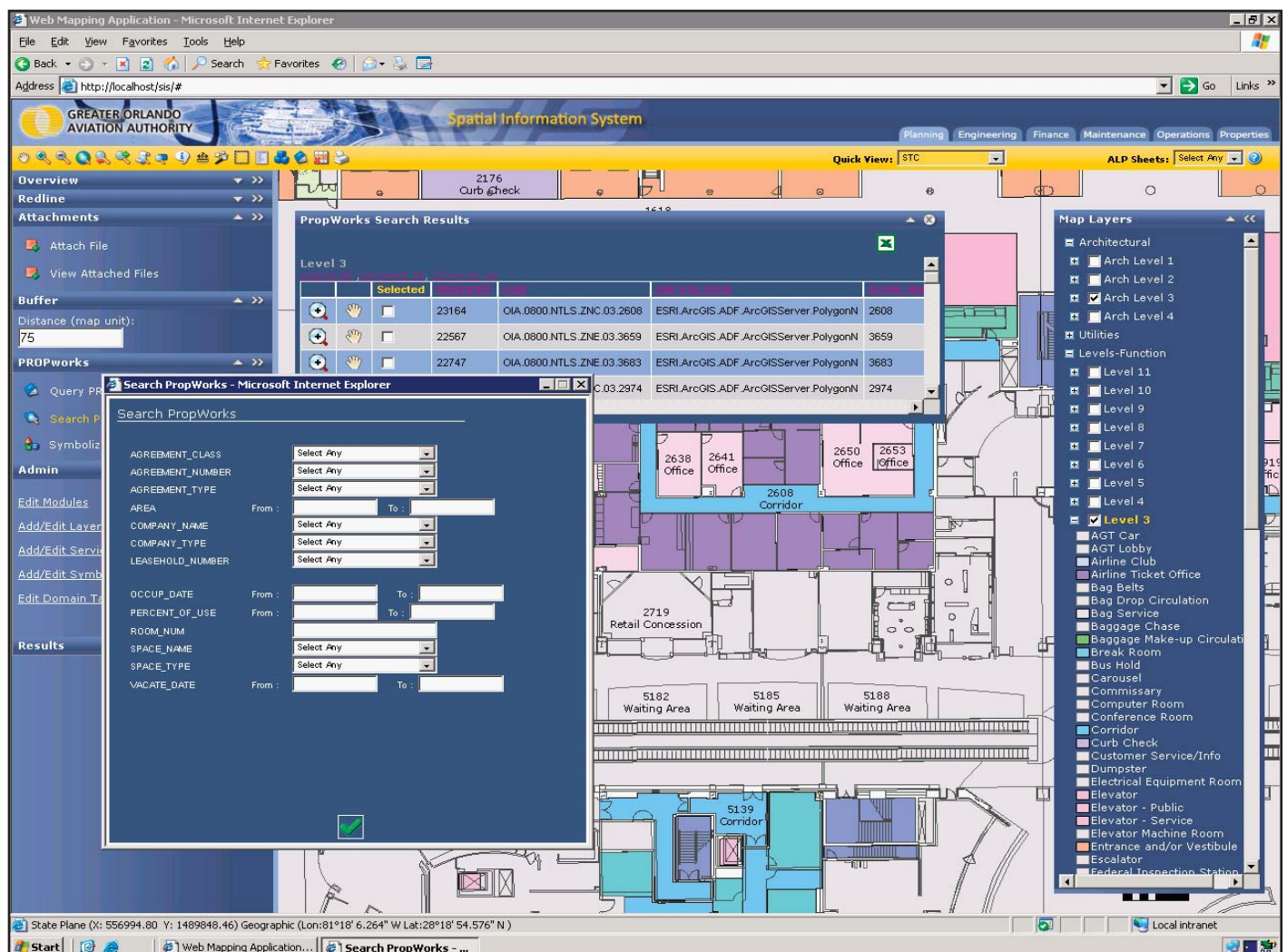
EGIS Built by AECOM for Orlando International Airport Integrated with PropWorks Lease Management

Benefits and Return on Investment

Airports ultimately have to manage themselves to the bottom line (i.e., financially). Implementing technology costs money, and money is not spent unless the technology is essential to increasing airport capacity, safety, security, level of service, and/or efficiency. There must be benefits with tangible return on investment (ROI) for airport management to support an EGIS implementation.
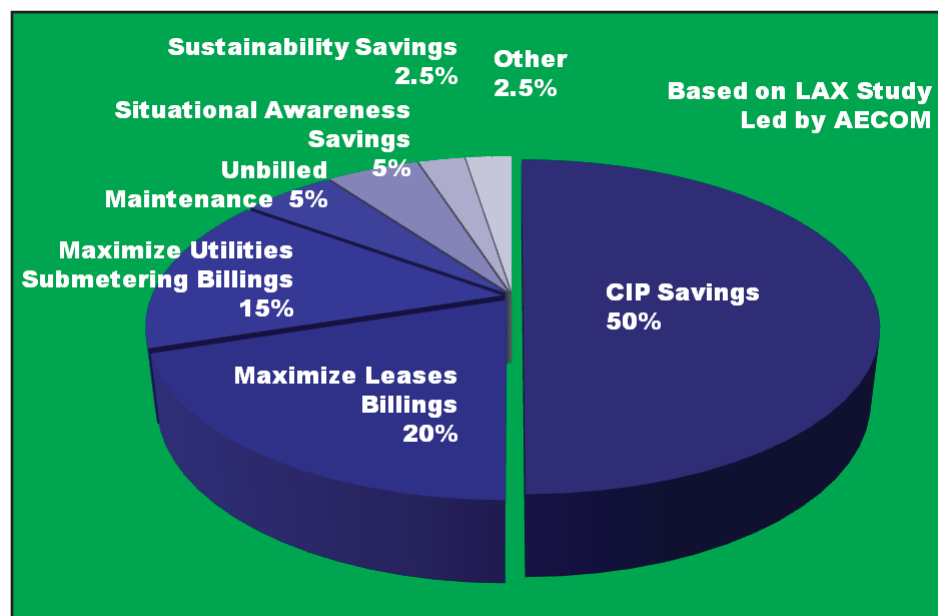
The major business drivers for an EGIS, outlined to the right, define the primary areas of benefit. The diagram below illustrates the relative ratio of various airport cost benefits from an EGIS. These cost benefits are achievable because EGIS minimizes data re-creation, minimizes data duplication and re-verification, minimizes cumbersome data retrieval and presentation, minimizes lost opportunity costs, and minimizes exposure to risk of accidents.

Business Drivers

□ **Reduce CIP Change Orders** (i.e., from unknown utilities)
  ■ Minimize Design & Construction Rework Costs
  ■ Minimize Hazards to Construction Crews
  ■ Minimize Impact to Operations and Level of Service

□ **Improve Emergency Response**
  ■ Improved Situational Awareness-Command and Control
  ■ Quickly Locate Shut-Off Valves/Switches (e.g., electric, gas, water)
  ■ Minimize Down Time
  ■ Minimize Damage
  ■ Minimize Corresponding Costs

□ **Maximize Billing Opportunities**
  ■ Lease-able Space, Billable Maintenance, Utilities Sub-Metering,

□ **Regulatory Compliance**
  ■ FAA AC 150/5300-16/17/18 for Photogrammtery, Survey, GIS Data
  ■ Noise Reporting and Environmental Mitigation Monitoring

Quantifying costs savings for each of these areas can be done through a concerted effort of record keeping. Many examples can be presented from various airports to demonstrate the cost savings potential of airport EGIS. The leading airport cost savings attributable to an EGIS are reduced construction change orders due to higher quality subsurface utilities data, increased revenues from lease space due to complete and accurate data on space use, increased reimbursements from tenants for utilities due to improved spatial sub-metering, and increased reimbursement from tenants for maintenance work due to correlation of work orders with lease space.

Pie chart:
- Sustainability Savings 2.5%
- Other 2.5%
- Situational Awareness Savings 5%
- Unbilled Maintenance 5%
- Maximize Utilities Submetering Billings 15%
- Maximize Leases Billings 20%
- CIP Savings 50%
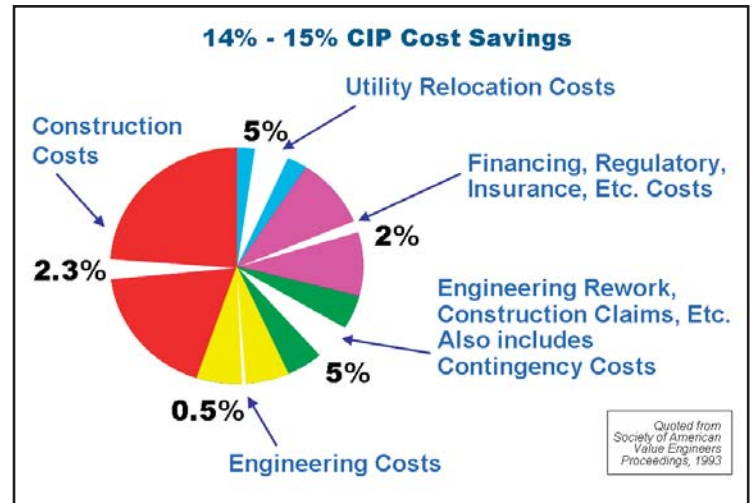- Based on LAX Study Led by AECOM

A US Department of Transportation (DOT) funded study from the 1990's demonstrated that the cost reductions due to reduced change orders from quality GIS data on subsurface utilities can reduce a Capital Improvement Program's (CIP) costs by as much as 14-15%, as illustrated in the figure to the right.

Cost savings on a significant airport CIP would pay for an Enterprise GIS many times over. Cost avoidance of a lawsuit over loss of life for a construction worker burned to death from rupturing a gas line (happened at a major US airport) would provide a significant return on investment for an EGIS (not to mention saving lives). The cost avoidance of interrupting airline operations due to a utility break would also provide a significant return on investment for an EGIS.

Moreover, airport safety and security will be among the primary beneficiaries of the type of data to be provided by an EGIS. Incidents that breach safety or security happen because of some occurrence within the physical environment of the airport (i.e., runway incursion, utility line cut, perimeter penetration, etc.). A better understanding of the airport's physical environment via an EGIS helps not only avoid future events but it can help emergency personnel respond to such events. One of the greatest testimonials to this is the extent spatial data was relied upon in the immediate aftermath of 9/11/01 and the subsequent efforts at Ground-Zero.

While difficult to quantify in terms of cost benefits, some of the key safety and security benefits that can accrue from an EGIS are listed to the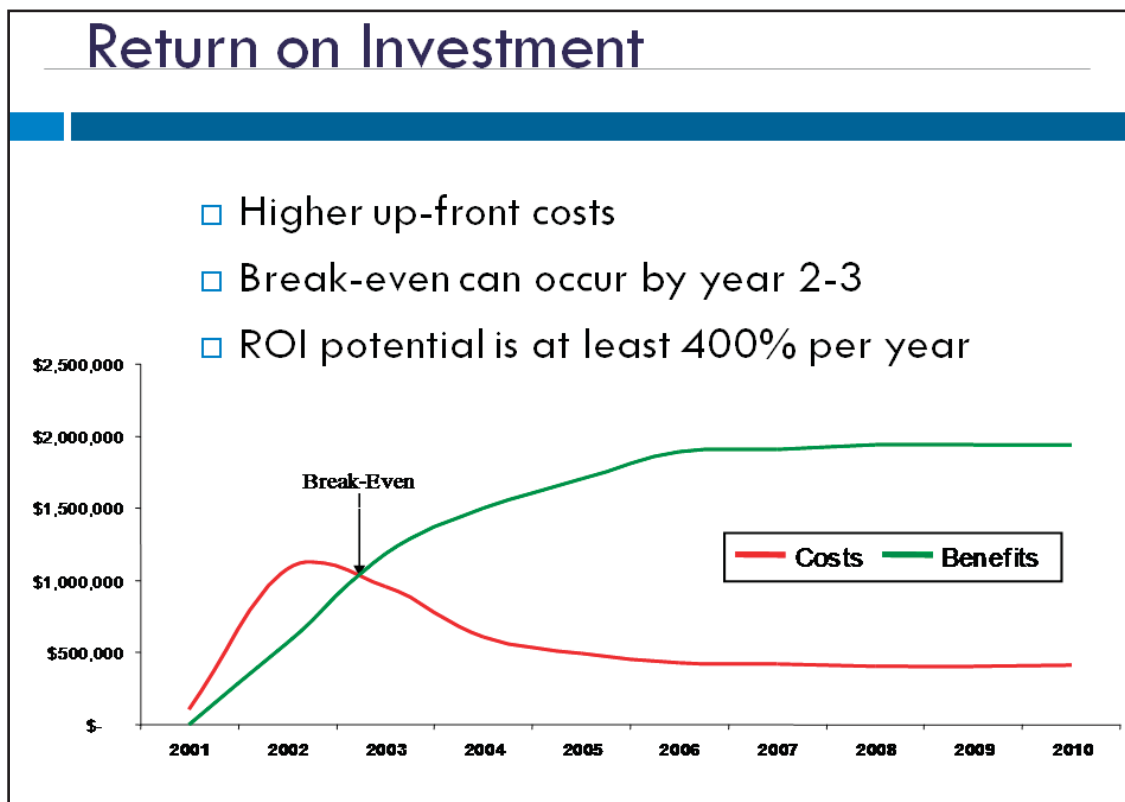 right. In each of these cases, there are past or current GIS initiatives that have addressed these real-life occurrences.

- Risk Management / Liability Reduction

- Gas Line Rupture

- Loss of Critical Facilities (Tower, Navaids, Runway Lights, Terminal)

- Crisis Management / Response

- Wayfinding

- Command Center Support

- Airport Rescue Fire Fighting (ARFF)

- TSA Requirements Implementation

- Facility Modifications

- Perimeter Security Enhancements

- CCTV and Access Control Systems

The resulting return on investment (ROI) can be estimated for any particular airport through methodical study of the potential benefit areas discussed above and others for a given airport. Typically, the ROI curve for an airport looks similar to the one presented below. There are up-front costs for setting up an EGIS, that are higher than the near-term pay back, especially in terms of data collection and processing costs of the data into the initial EGIS setup. However, these costs should be overtaken by the benefits within a couple of years. The ongoing ROI potential should be at least 400% per year as the EGIS program reaches its normalized operation and maintenance. However, the ROI can be far greater if the EGIS implementation is timed such that it generates significant cost savings for an upcoming CIP Program.

It is most cost effective to have the EGIS populated with data gradually through already funded airport improvement projects, that are naturally on-going through the lifecycle of the airport.

Return on Investment

- Higher up-front costs
- Break-even can occur by year 2-3
- ROI potential is at least 400% per year

Typical ROI for an Airport's EGIS Program