2013

System Architectural Design and GIS Software Solutions

Phase II: GIS Strategic Implementation Plan

City of Venice, Florida

Geographic Technologies Group

System Architectural Design and GIS Software Solutions

Chapter Outline

Introduction

This section of the Strategic Plan will focus on the system architecture (software, hardware, and networking) of a system design and how they interact with each other, their place in an enterprise GIS, and how these components come together within the context of the current and future City organization model in regards to a full GIS enterprise implementation.

System Architectural Design Overview

The City of Venice maintains both physical and virtual servers with the primary GIS server being a physical server (IBM x3650). The local area network (LAN) is 100MB with plans to eventually transition to gigabit Ethernet. The wide area network (WAN) is comprised of Comcast fiber (10GB) to five locations while three locations are only connected via cable modems. Desktop computers are Hewlett Packard and are on a four year replacement schedule. GIS staff; as well as, other power users are provided more robust computers with increased processing power, memory, and storage.

As recommended in the governance chapter, GIS should be run as a modified hybrid model. The Utilities Department should house the central GIS authority because of their volume of needs. Easy to use data browsers should be fully implemented that allow non-GIS users to quickly access GIS data, create their own reports, and create their own maps. This will allow the casual user to have quick and user friendly access to GIS. Implementing this distributive model, in which end users can do a majority of their own GIS tasks while relying on a central group of GIS experts for assistance with high level tasks, is optimal.

Under this model, GIS users access data from a central server and are further enabled with easy-to-use GIS applications that allow them to conduct their spatial tasks without the assistance of other divisions. The following sections will detail the recommended architecture needed to advance this model.

End User Applications

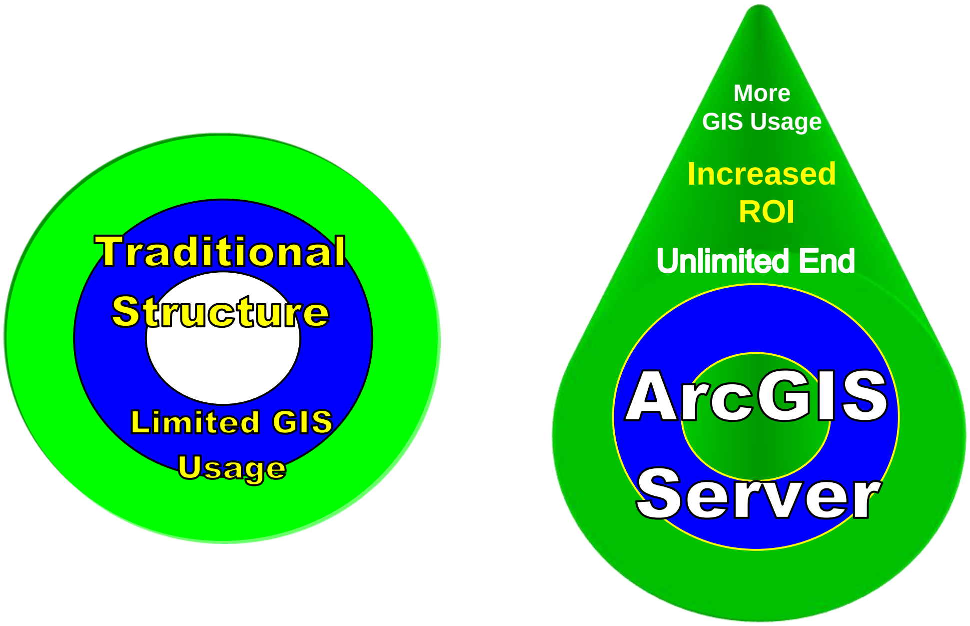
The needs assessment details each need identified and the appropriate method to meet those needs. The overall recommendation is to acquire end-user applications that utilize a central Esri compliant database. Some of these applications will be targeted to specific departments while others meet the needs of many departments. A detailed list of the end-user applications can be found later in this chapter.

Desktop vs. Web Applications

Traditionally, GIS professionals have concentrated primarily on data compilation and focused application projects, investing time in creating GIS databases and authoring geographic knowledge. Desktop-based GIS applications are used by end-users for connecting to geographic datasets via shared databases, building workflows for data compilation and quality control, authoring maps and analytical models, and documentation. Organizations commonly take advantage of the Esri Single Use or Concurrent licensing structures. The Single Use license is dedicated for each computer or network access point that has use rights for software, data or documentation. The concurrent license permits execution of the software on any computer on the network and is controlled by a license manager application. This traditional distribution structure limits GIS application usage based on a budgeted number of licenses.

ArcGIS Server Architecture

Progressively, an increased number of users have begun to use and exploit their results in numerous GIS applications and settings. The work of authoring and serving geographic data will largely remain within the domain of GIS professionals. However, these professionals will also increasingly create server-based applications that allow common users, both internal and external to the organization, to have access to the power of GIS. The influence of GIS is still growing rapidly and will provide a powerful medium for managing, visualizing and communicating information between GIS professionals and the end-users. ArcGIS Server offers enterprise level functionality, which directly addresses Single Use and Concurrent Use license limitations by offering unlimited GIS application usage via a web browser.



The implications for the City are that end users accessing GIS resources in a web browser will more actively utilize GIS enterprise-wide, become more proficient users, and be able to perform more complex GIS tasks. By incorporating this level of GIS access into an organization, the City will realize an increased return on investment (ROI) based on steady increases of internal and external GIS usage, developing server based applications and eliminating costs for desktop licensing. The City utilizes an ArcGIS Server application (ConnectGIS) thus enabling users with an intranet based application. However, the current application is limited and only serves the very basic needs of the City. Information on intranet application best practices can be found later in this chapter.

Licensing Overview

Most Esri products are licensed under the “click-wrap” license agreement included with the product. Esri generally requires signed licenses for server products, developer products, and web service products. A signed Master License Agreement (MLA) is required for some Esri products. The signature page is provided by Esri or its distributor and will incorporate the MLA Terms and Conditions. There are many different types of license agreements which Esri has placed on its software distribution to consumers. Listed below are the different types of license agreements and a description about each.

License Type	Description
Single Use License	A license dedicated for each computer or network access point that has use rights for software, data, or documentation. The licensee may make a second copy for his or her exclusive use on a portable computer so long as only one copy of the software, data, and documentation is in use at any one time.
Concurrent Use License	A license that permits execution of the software on any computer on the network. The number of simultaneous/concurrent users may be controlled by a License Manager to access and use the software, data, or documentation.
Server License	A license for server-side software that resides on a server computer and provides services to multiple users in a client/server distributed computer agreement.
Stand-alone Redistribution / Deployment License	A license which grants the licensee the right to redistribute a stand-alone application to end users provided the application is installed on each computer on which the application is run. This license requires payment of redistribution or deployment fees.
Server Deployment / Internet Redistribution License	A license which grants the right to redistribute an application via a network, the Internet, or Intranet to end users of the application. This license does not require a payment of additional deployment or redistribution fees.
Dual Use License	A license in which the software may be installed on a desktop computer and may be used simultaneously with either a PDA or handheld mobile device provided that the software in only used by a single individual at any one time.
Development and Testing Server License	A license which is specifically intended for a specific server/CPU which includes the right to develop, test, and deploy applications to end users. All developer licenses are single use licenses. This license is not intended for deployment of applications for production by end users. Licensees may use the Server software to test and deploy applications on the Internet provided the source and object code are not accessible to users of the application. Except for ArcGIS Server, the Server software administration tools may be copied and redistributed throughout the licensee's organization.

The two most common types of Esri licensing are single use and concurrent use licenses. A single use license is installed on and dedicated to a particular Personal Computer (PC). A concurrent use license permits execution of the GIS software from any PC on the network and allows multiple users to gain access at the same time. In this case there is a shared pool of "floating" licenses administered by a central license manager.

ArcGIS Product License Information

ArcGIS is an integrated collection of GIS software products for building a complete GIS. ArcGIS enables users to deploy GIS functionality wherever it is needed; on desktops, via servers, or custom applications, over the Web, or in the field. It introduces a new workflow that allows organizations to be more productive. As a complete geographic information system (GIS), ArcGIS allows agencies to author data, maps, globes, and models on the desktop, serve them to a GIS server for many others to access, and use them through web, desktop, and mobile clients. The diagram on the right highlights the interconnectivity between each of these realms within ArcGIS and their respective products.

Desktop GIS:

ArcGIS for Desktop is the primary platform for GIS professionals to compile, author, and use geographic information and knowledge. It provides a collection of software products that create, edit, import, map, query, analyze, and publish geographic information. Beginning at ArcGIS 10.1, Esri has changed the naming of their products. Previously the different licensing levels of ArcMap were: ArcView, ArcEditor, ArcInfo. Now, those products are called Basic, Standard, Advanced, respectively. ArcGIS desktop products also include ArcReader and ArcGIS Desktop Extensions. Although licensed separately, these products share the same core applications, user interface, and development environment. Each product provides additional GIS functionality, which is enabled as organizations move from ArcReader to Basic to Standard to Advanced.

ArcGIS desktop products share the same core applications (ArcMap and ArcCatalog), user interface, and development environment so users can share their work with others. Maps, data, symbology, map layers, geoprocessing models, custom tools and interfaces, reports, and metadata can be accessed interchangeably. A wide-ranging suite of optional extensions expands the functional capabilities of these products with specialized GIS tools.

Basic:

ArcGIS for Desktop Basic (previously ArcView) allows users to visualize, explore, and analyze geographic data, revealing underlying patterns, relationships, and trends. Organizations can use Basic to create maps, manage data, and perform spatial Assessment. Also, users can create and edit simple feature geometry like shapefiles, execute conversion of CAD and raster formats, and create charts and reports. Basic can be distributed by single use license or by concurrent use licenses.

Standard:

ArcGIS for Desktop Standard (previously ArcEditor) offers all the functionality of Basic and provides advanced editing, data validation, and workflow management tools to maintain the integrity of an organization’s data. With Standard, users can author quality maps and perform sophisticated spatial assessment. Additionally, organizations can use Standard to manage complex information, automate the editing workflow, and allow multiple users to update the same data simultaneously. Standard can be distributed by single use license or by concurrent use licenses.

Advanced:

ArcGIS for Desktop Advanced (previously ArcInfo) is the complete GIS product to build a comprehensive desktop GIS. The de facto standard for GIS professionals, Advanced provides additional tools for data integration and management, visualization, spatial modeling and assessment, and high-end cartography. It supports single-user and multi-user editing and automates complex workflows. Organizations can use Advanced to gather, build, and manage data, analyze geographic relationships, discover new information, and produce publication-quality maps. Advanced and its workstation extensions can be distributed by single use license or by concurrent use licenses.

ArcGIS Desktop Extensions:

ArcGIS Desktop Extensions allow organizations to perform additional tasks such as raster geoprocessing, three-dimensional visualization, manage workflows and geostatistical assessment. They can be distributed by single use license or by concurrent use licenses.

Server GIS:

ArcGIS for Server allows organizations to share GIS resources throughout the enterprise using web services — delivering GIS capabilities to large numbers of users over networks. Server empowers organizations to extend GIS beyond the desktop to other client applications, intranet and internet, and to mobile devices. This capability gives users interactive access to the GIS from anywhere. Server products allow GIS and data services to be hosted in a server-based environment. Centralized data management and application support, combined with adherence to information technology standards, make server GIS software products the key to broad use of geospatial technology with enterprise information systems.

Basically, Server GIS enables organizations to distribute their maps, models, and tools out to others in the organization in a way that fits well into business workflows. Staff in other departments and out in the field can query accurate, up-to-date data without a significant amount of training. This increases users' productivity as well as the enterprise as a whole. Server GIS complements ArcGIS Desktop by allowing GIS analysts to cost-effectively author maps, globes, and geoprocessing tasks on a desktop and publish them via a server using integrated tools. GIS functions can then be delivered as services throughout the enterprise. Server GIS allows GIS desktop applications and capabilities to be available to large numbers of users over IT networks without incurring costs associated with purchasing single use or concurrent licensing. Enterprise GIS users connect to central GIS servers using traditional desktop GIS as well as Web browsers, and mobile computing devices (Smart phones, tablets, etc.). ArcGIS for Server is IT-compliant and interoperates well with other enterprise software such as customer resource management (CRM) or enterprise resource planning (ERP) systems. It offers support for interoperability standards in both the GIS domain (Open Geospatial Consortium) as well as the broader IT domains including World Wide Web Consortium (W3C), Representational State Transfer (REST), and Simple Object Access Protocol (SOAP).

ArcGIS for Server is a complete and integrated server-based GIS. It comes with out-of-the-box ready to deploy end user applications and services for spatial data management, visualization, and spatial Assessment. Listed below are three tables which outline each of the available ArcGIS for Server editions and levels, and a list of available Extensions.

ArcGIS Server Editions	
Basic	This edition of ArcGIS for Server is essentially ArcSDE bundled together with database replication functionality. Basic does allow for deploying GIS web services and simple web mapping, smartphone and tablet applications.
Standard	This edition of ArcGIS for Server includes all of the functionalities associated with the Basic edition, standard map publishing, Globe Server for 3D map rendering, standard geoprocessing, and web editing capabilities.
Advanced	This edition of ArcGIS for Server includes all of the functionalities associated with the Standard edition, plus advanced geoproccessing, along with several extensions. These extensions include ArcGIS Spatial Analyst for Server, 3D Analyst for Server, Geostatistical Analyst for Server, and Network Analyst for Server.

ArcGIS Server Levels	
Workgroup	This level of ArcGIS for Server includes a version of ArcSDE compatible with SQL Server Express 2008 R2 and is limited

	to ten simultaneous users and 10 GB of data storage.
Enterprise	This level of ArcGIS for Server allows for unlimited users and SDE database size, but requires the use of a Database Management Service (DBMS), such as SQL Server or Oracle. It also allows for a distributed installation of components.

ArcGIS for Server Extensions	Basic	Standard	Advanced
ArcGIS Schematics for Server		Yes	Yes
ArcGIS 3D Analyst for Server			Yes
ArcGIS Spatial Analyst for Server			Yes
ArcGIS Geostatistical Analyst for Server			Yes
ArcGIS Network Analyst for Server		Optional	Yes
ArcGIS GeoEvent Processor for Server		Optional	Optional
ArcGIS Data Interoperability for Server		Optional*	Optional*
ArcGIS Data Reviewer for Server		Optional*	Optional*
ArcGIS Workflow Manager for Server		Optional*	Optional*
ArcGIS Image Extension for Server		Optional	Optional
ArcGIS for INSPIRE		Optional	Optional
ArcGIS ArcPad Extension for Server			Optional*
Portal for ArcGIS			Optional

* Windows Only

Mobile GIS:

ArcGIS for Mobile enables field-based personnel to capture, store, update, manipulate, analyze, and display geographic information with easy to use and intuitive applications. ArcGIS technology can be deployed on a range of mobile systems including Smartphones, iOS and Android Tablets, Windows laptops and tablets, and GPS devices.

Smartphones and tablets:
Esri and many business partners have developed numerous apps available to extend GIS to a broad audience. These apps allow field personnel to interact with an organization's GIS and perform a variety of tasks. Examples include collecting and updating spatial and tabular data, planning routes, capture video and pictures, and view a variety of maps. Several apps are available to download for free while others require purchasing. Currently, these apps work with Apple, Android, and Windows Mobile (depending on the app).

ArcGIS for Windows Mobile:
ArcGIS for Windows Mobile allows organizations to deploy easy to use applications to nearly any Windows device. These apps enable field personnel to view and navigate maps, collect, and edit and update GIS data. Any device running the following operating systems can utilize ArcGIS for Windows Mobile:

- Windows Embedded Handheld 6.5 Professional and Classic editions
- Windows Mobile 6.0, 6.1 and 6.5 Professional and Classic editions
- Windows 8, Windows 7, Vista, and XP

ArcPad:
ArcPad is software for mobile GIS and field mapping applications. ArcPad provides mapping, GIS, and advanced GPS integration to field users via handheld and mobile devices. Data collection with ArcPad is fast and easy and improves field-based data validation and availability. ArcPad is distributed by single use license and dual use license. It is not licensed for navigational use.

Conceptual Enterprise GIS Architecture, Functions, and Standards

It is important to understand the conceptual flow of the recommended GIS for the City. The graphic on the following page diagrams the conceptual enterprise GIS architecture. In keeping with an enterprise architectural model, GIS has been placed within five separate architecture layers as follows: access channels, applications, middleware, data and information, and technology.

Access Layer - This layer contains the methods and technologies in which end-users will access the GIS data. Optimally the GIS will serve not only employees but also be relied upon by the public, decision makers, private agencies, and other government agencies. There will be many ways that users will be able to access and utilize GIS data. Internal users will be able to access data via intranet portals, GIS editing software tools, analytical software tools, mobile tools, and hard copy map products. External users may have a host of access options including; touch screen kiosks, Internet portals, public forum mapping presentations, televised mapping products, reverse dialing notification tools, and hard copy maps.

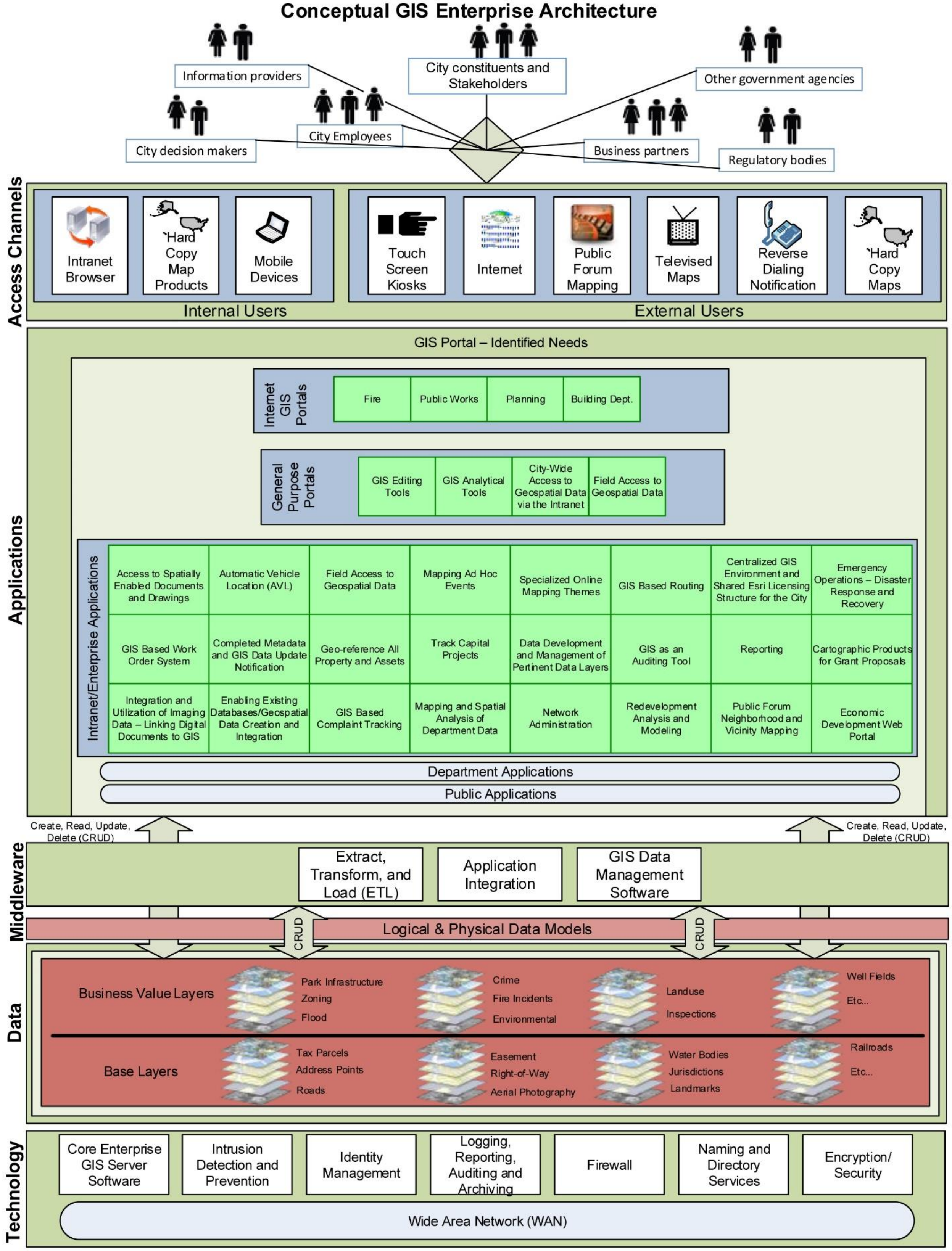
Applications Layer - Real GIS success is achieved when users are able to utilize GIS to solve their daily problems, automate a task – thus increasing efficiency –, and/or do their job more effectively and efficiently. This is accomplished through the application layer. City of Venice staff identified many GIS applications that would help them accomplish their tasks. The conceptual design identifies these as enterprise applications. Some of these applications will have utility for all departments, while others for just a few. Additionally, departments identified that the public would benefit from Internet portals into the data and from processes that their department manages. This eGovernment concept has taken root in the GIS world. Local governments are now offering specific GIS applications to the public. For instance, users could use a mapping interface to plot their address, their utilities, and their day of service or view crime statistics for their neighborhood. Additionally, general purpose portals will be available for users to access GIS data for many of their daily GIS tasks.

Middleware – This layer is managed by software tools. GIS and database management software will allow the appropriate users to access the files needed to perform their daily tasks. Appropriate users will be given access to edit and maintain certain datasets. Other users will be accessing data for viewing only.

Data and Information Layer - This layer addresses the need to manage data in a logical, orderly, and non-redundant fashion. GIS tools will manage data transactions including creating, reading, updating, and deleting. The system should be designed and implemented such that the ability to change data will only be granted to the appropriate staff. Additionally, viewing rights will only be granted to those departmental staff who need access to specific data elements. Sensitive data sets will be GIS enabled, such as some elements of crime data, customer data, and financial records. These sensitive data sets will only be accessible by approved personnel.

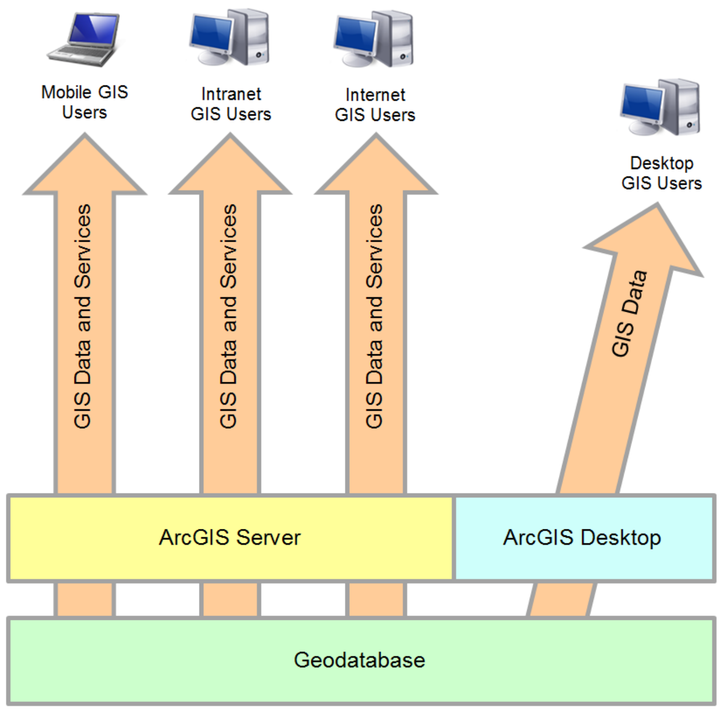
Technology Layer - This is the layer handled almost entirely by Information Technology and the Core GIS staff in the Utilities Department. This layer involves data security, networking, and a host of technical components that are critical to the GIS effort and data integrity.

Conceptual GIS Enterprise Architecture



Recommended System Architecture

It is recommended that the City continue to implement a client-server based GIS architecture that is centered on the geodatabase and ArcGIS Server. The architecture could eventually consist of multiple production class servers. As the graphic illustrates below, this centrally managed system houses all GIS data and applications. In turn, data and applications specific to the needs of each department and need will be made available to the end users through various applications.



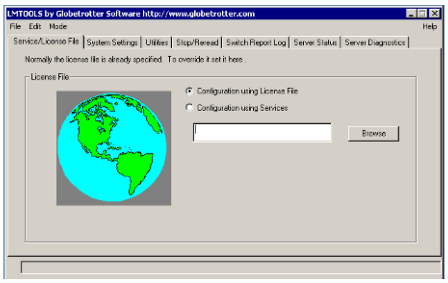
Enterprise GIS Centered on the Geodatabase and ArcGIS Server

The existence of the centrally-located enterprise geodatabase is the cornerstone component in the City's GIS program. The geodatabase is currently accessed directly through multiple desktop GIS applications, as well as various Esri ArcGIS Services. The remaining sections of this chapter detail the software, hardware, and network infrastructure needed to support the recommended system architecture.

Software

The City's GIS architecture is the Esri ArcGIS Server (AGS) suite. AGS consists of two parts (prior to version 10.1): Server Object Containers (SOCs) and the Server Object Manager (SOM). SOCs manage the interaction between the geodatabase(s) and the requests for maps or data from AGS client GIS applications. SOCs typically require the greatest amount of processing power and memory of all of the AGS components. When requests for maps or data are made through AGS client applications, the request is passed to SOCs which perform the interaction with the geodatabase(s) to extract the user's desired result. The SOM handles and transfers data and map requests by AGS client GIS applications and communicates with the SOCs.

As of the ArcGIS 10.1 for Server release, the SOM-SOC model has been replaced by the ArcGIS Server site. A site is a deployment of one or more machines (GIS servers) that have ArcGIS for Server installed and work together. The 10.1 site architecture is more robust than the SOM-SOC model. It reduces the chances of failure, and simplifies the provisioning and recovery of new machines.

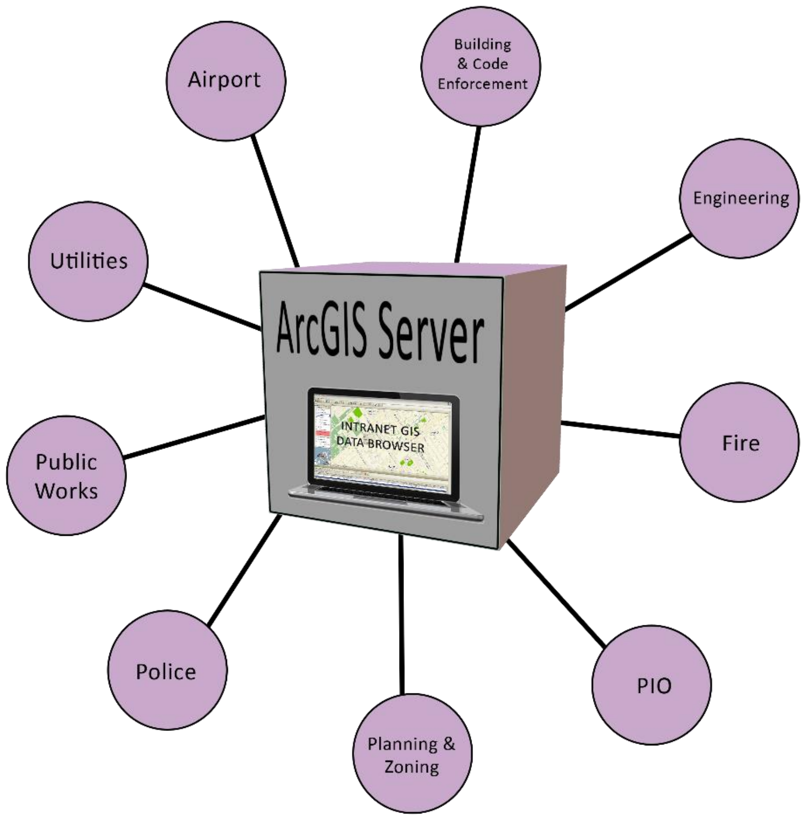


The City should continue to utilize Esri software as its primary GIS software suite. Each department expressed a need to use GIS software. The licensing repository should be managed by the recommended GIS governance authority. It is recommended that the City utilize a centralized license management protocol for Esri software. All Esri ArcGIS desktop and extension licenses are and should be managed through this centralized system. Some, if not most, of the licenses will be concurrent use licenses. This means that any number of users can have access to these licenses through a first come first serve policy. Since users do not utilize the software full time, this allows more users to utilize a lesser number of licenses. However, if all of the licenses are in use then a user trying to access the software will not be allowed. The central GIS authority should monitor the usage of GIS to ensure that the number of available licenses is not outstripped by the number of users. There is no fixed ratio of users to the number of concurrent licenses since users may vary widely in their daily usage of the products. It will be incumbent upon the central GIS authority to educate the users to report the lack of availability of licenses. Educating the users to close their desktop GIS application when not in use and scheduling usage times are short term fixes. However, consistent unavailability of licensing will require the acquisition of additional seats.

The following chart details the anticipated users of GIS at the City based on the needs assessment.

Projected GIS Software Tier-Level Users by Department				
City of Venice Departments	**Tier 1 Flagship Users**	**Tier 2 Analytical Users**	**Tier 3 Browser Users**	**Total Projected GIS Users**
Airport	0	1	7	8
Building and Code Enforcement	0	1	7	8
Engineering	1	1	4	6
Fire	1	0	41	42
PIO	0	0	1	1
Planning and Zoning	0	1	2	3
Police	0	2	50	52

Projected GIS Software Tier-Level Users by Department				
City of Venice Departments	**Tier 1 Flagship Users**	**Tier 2 Analytical Users**	**Tier 3 Browser Users**	**Total Projected GIS Users**
Public Works	0	1	42	43
Utilities	3	2	50	55
Total:	5	9	204	218



The City currently uses ConnectGIS for an intranet mapping solution. Most of the department interviews identified numerous shortcomings with this application which included lack of customization, difficult to use, poor performance, and not tailored to meet the needs of specific departments. An ArcGIS Server Enterprise intranet application should provide a robust tool that allows specific configurations for the various departments/divisions while also providing the ability to share data. Each user group would be able to access unique queries, reports and map tips specific to their needs. An added benefit would be the elimination of redundant identity stores by utilizing Windows Integrated Security which would be a benefit of switching to an Enterprise GIS intranet solution. Rather than multiple intranet solutions for each department, one enterprise-wide intranet solution would eliminate multiple directories, security identity stores (i.e. user names and passwords) and data platforms. Windows Integrated Security would enable single sign on (SSO) capability between applications resulting in less user confusion, increased productivity, and a decrease in IT support and administrative costs. A highly functional Enterprise GIS intranet application would reduce the amount of setup Citywide, require less refresher training and would allow the City to push the envelope in advancing intranet application usage throughout all departments/divisions. Per the department interviews, the ConnectGIS application does not appear to be meeting the needs of staff on a consistent basis and the replacement of this application with a more functional product should be considered. Time should be spent fully building out the functions for each department on the intranet application. A common toolset will be available for each department with specificity for their department. These departmental portals should be set-up over time and not rushed. One department at a time should be set-up to make sure their needs are met.

Much like a GIS Enterprise solution for intranet applications, various departments/divisions expressed the need for internet applications. Internet applications make sharing data with the public possible. Some examples of internet applications requested during the Needs Assessments include web portals to share permitting and code enforcement data, maps of neighborhood projects and development activity, the ability to show fire and police stations spatially, up-to-date maps that indicate road closures, maps to show parking lot locations and the ability to share event maps. All of these requests could benefit citizens and visitors within the City. Many of the benefits listed previously for an Enterprise GIS intranet application would also be achieved through a GIS Enterprise solution for an internet application.

Venice would realize substantial benefits by increasing GIS presence on the internet by developing a public facing portal for division/departmental use. Sarasota County currently hosts a public map portal that is frequently used by City staff to access GIS data. Internet applications can either be hosted from internal servers or externally hosted servers. One application currently available for the creation of Internet Applications is ArcGIS Online. ArcGIS Online is a collaborative, cloud-based platform that lets members of an organization create, share, and access maps, applications, and data, including authoritative base maps published by Esri. Through ArcGIS Online, users gain access to Esri's secure cloud, where they can manage, create, store, and access hosted web services, and because ArcGIS Online is an integral part of the ArcGIS system, organizations can use it to extend the capabilities of ArcGIS for Desktop, ArcGIS for Server and other ArcGIS based applications.

Integration of non-spatial data, development of intranet applications and the creation of internet applications was echoed by nearly every division/department throughout the City of Venice. An Enterprise GIS solution would best solve these needs and several divisions/departments have already implemented parts of Esri's Enterprise GIS solution. It is recommended that the City expand on their current investments in Esri's Enterprise Solution. Esri offers several products that would address the software needs requested throughout the City. Since Esri products already exist within several divisions/departments, an Enterprise Solution through Esri would require less implementation and training.

Each department that was interviewed during the needs assessment utilizes GIS or GIS products or has expressed an interest in using GIS tools. Additionally, each of the departments expressed the desire to expand their use of the technology. The following is a department by department overview of existing and desired GIS software. **The details of each of the needs can be found in the Needs Assessment chapter.** In some cases, a specific product is named because that is the known solution (e.g. ArcGIS Desktop). In other cases, a more general reference is used because multiple possible solutions exist (e.g. Intranet Data Browser). The following icons are utilized to denote the current status of an application as follows:

 Existing – This application has already been acquired by the City.

 Desired – This application is desired and has not yet been acquired.

 Desktop – This application is available to the user via their desktop computer.

 Embedded – This application is embedded in another application.

 Intranet – This application is available via the Intranet.

 Internet – This is an Internet application.

 Software Suite – This application is part of a software suite. Multiple software applications comprising a total software offering.

 Shared Need – This application has been requested by more than one department.

 Unique Need – This application is unique to this department.

City of Venice

Airport Department

- Intranet Data Browser (ConnectGIS) –   
  - Description - Primary portal for all staff. ArcGIS Server based with Basic Map Configuration.
  - Number of Users – 7
  - Software Cost – $15,000 to upgrade to enterprise-level application
  - Additional Cost – portal setups
- ArcGIS™ (Basic) –    
  - Description – Data Maintenance and Data Analysis
  - Number of Users – 1
  - Software Cost - $1,500 single use $3,500 concurrent use
  - Additional Cost - none

Building and Code Enforcement Department

- Intranet Data Browser (ConnectGIS) –
  - Description - Primary portal for all staff. ArcGIS Server based with Basic Map Configuration.
  - Number of Users – 7
  - Software Cost – $15,000 to upgrade to enterprise-level application
  - Additional Cost – portal setups
- Public Internet Portal (Sarasota County) –
  - Description – public facing Sarasota County web site configured for public consumption. ArcGIS Online applications should be considered to supplement this.
  - Number of Users – 7
  - Software Costs – none – already in place
  - Additional Costs – none
- ArcGIS™ (Basic) –
  - Description – Data Maintenance and Data Analysis
  - Number of Users – 1
  - Software Cost - $1,500 single use $3,500 concurrent use
  - Additional Cost - none

Engineering Department

- Intranet Data Browser (ConnectGIS) –
  - Description - Primary portal for all staff. ArcGIS Server based with Basic Map Configuration.
  - Number of Users – 4
  - Software Cost – $15,000 to upgrade to enterprise-level application
  - Additional Cost – portal setups
- Public Internet Portal (Sarasota County) –
  - Description – public facing Sarasota County web site configured for public consumption
  - Number of Users – 4
  - Software Costs – none – already in place. Augment with ArcGIS Online
  - Additional Costs – none
- ArcGIS™ (Standard) –
  - Description – Data Maintenance and Data Analysis
  - Number of Users – 1
  - Software Cost - $7,000 for either single use or concurrent
  - Additional Cost - none

Fire Department

- Intranet Data Browser (ConnectGIS) –
  - Description - Primary portal for all staff. ArcGIS Server based with Basic Map Configuration.
  - Number of Users – 41
  - Software Cost – $15,000 to upgrade to enterprise-level application
  - Additional Cost – portal setups
- Public Internet Portal (Sarasota County) –
  - Description – public facing Sarasota County web site configured for public consumption
  - Number of Users – 41
  - Software Costs – none – already in place
  - Additional Costs – none
- ArcGIS™ (Standard) –
  - Description – Data Maintenance and Advanced Data Analysis, Coordination and Support
  - Number of Users – 1
  - Software Cost - $7,000 for either single use or concurrent
  - Additional Cost - none

PIO

- Intranet Data Browser (ConnectGIS) –
  - Description - Primary portal for all staff. ArcGIS Server based with Basic Map and/or PIO Map Configuration.
  - Number of Users – 1
  - Software Cost – $15,000 to upgrade to enterprise-level application
  - Additional Cost – portal setups
- Public Internet Portal (Sarasota County) –
  - Description – public facing Sarasota County web site configured for public consumption
  - Number of Users – 1
  - Software Costs – none – already in place
  - Additional Costs – none

Planning and Zoning Department

- Intranet Data Browser (ConnectGIS) –
  - Description - Primary portal for all staff. ArcGIS Server based with Basic Map Configuration.
  - Number of Users – 2
  - Software Cost – $15,000 to upgrade to enterprise-level application

- Additional Cost – portal setups

- Public Internet Portal (Sarasota County) –
  - Description – public facing Sarasota County web site configured for public consumption
  - Number of Users – 2
  - Software Cost – $15,000 to upgrade to enterprise-level application
  - Additional Cost – portal setups
- ArcGIS™ (Standard) –
  - Description – Data Maintenance and Data Analysis
  - Number of Users – 1
  - Software Cost - $7,000 for either single use or concurrent
  - Additional Cost - none

Police Department

- ArcGIS™ (Basic) –
  - Description – data viewing and spatial analysis
  - Number of Users – 1
  - Software Cost - $1,500 single use $3,500 concurrent use
  - Additional Cost - none
- Looking Glass Crimes –
  - Description – allows for the creation of crimes pin maps and analysis of incidents by any number of variables.
  - Number of Users – 1
  - Software Cost – none – already in place
  - Additional Cost – Upgrade to latest version and training - $4,000
- Public Internet Portal (Sarasota County) –
  - Description – public facing Sarasota County web site configured for public consumption
  - Number of Users – 50
  - Software Costs – none – already in place
  - Additional Costs – none

Public Works Department

- Intranet Data Browser (ConnectGIS) –
  - Description - Primary portal for all staff. ArcGIS Server based with Basic Map Configuration.
  - Number of Users – 42
  - Software Cost – $15,000 to upgrade to enterprise-level application
  - Additional Cost – portal setups

- ArcGIS™ (Basic) –
    - Description – Data Maintenance and Data Analysis
    - Number of Users – 1
    - Software Cost - $1,500 single use $3,500 concurrent use
    - Additional Cost - none

Utilities Department

- Intranet Data Browser (ConnectGIS) –
    - Description - Primary portal for all staff. ArcGIS Server based with Basic Map Configuration.
    - Number of Users – 50
    - Software Cost – $15,000 to upgrade to enterprise-level application
    - Additional Cost – portal setups
- ArcGIS™ (Standard) –
    - Description – Data Maintenance and Data Analysis
    - Number of Users – 2
    - Software Cost - none – already in place
    - Additional Cost – none
- ArcGIS™ (Advanced) –
    - Description – Data Maintenance and Data Analysis
    - Number of Users – 1
    - Software Cost - $9,900
    - Additional Cost - none
- ArcGIS™ (Basic) –
    - Description – Data Maintenance and Data Analysis
    - Number of Users – 1
    - Software Cost - none – already in place
    - Additional Cost - none

Required GIS Functionality

The following functionality matrix is based on the data compiled from the Needs Assessment. Each department/division's GIS functionality is identified and ranked by priority and complexity. Priority identifies the mission critical nature of the functionality. Complexity identifies how difficult a function is to achieve. This will serve as a guideline for the priority of proposed software solutions to meet each department/division's needs.

●	High
■	Medium/Moderate
◆	Low

P = Priority
C = Complexity

City of Venice Departments	Airport		Fire Department		Building and Code Enforcement		Planning and Zoning		Police		Public Works		Engineering		Public Information Office		Utilities	
Mapping Functionality Parameter	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C
Pan and Zoom	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆
Map Layer Display	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆
Hard-copy Map Generation	■	■	■	■	■	■	●	■	■	■	●	■	●	■	◆	◆	●	●
Report Generation	◆	◆	■	●	■	■	●	■	●	●	◆	●	■	■	◆	◆	●	●
Graphic and Attribute Query & Browser	●	■	●	■	●	■	●	■	●	■	●	■	●	■	●	■	●	■
Buffer Generation – Overlay Techniques	◆	◆	●	●	■	■	●	■	●	●	■	●	●	■	◆	◆	●	●
Latitude / Longitude / Georeference Generator	■	■	●	■	■	■	●	■	●	■	■	■	●	■	◆	◆	●	●
Coordinate / Area / Volume / Length Calculations	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆
Feature Overlay	■	●	■	●	■	●	■	●	■	●	■	●	■	●	■	●	■	●
Hyper-linking Objects	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆	●	◆
Text and Graphics Placement	●	■	■	●	●	◆	●	●	●	●	■	●	●	◆	◆	◆	●	●
Address/ Street/ Intersection Search	●	■	●	■	●	■	●	■	●	■	●	■	●	■	●	■	●	■
Tabular and Graphic Data Import/Export	◆	◆	●	◆	◆	◆	●	■	■	◆	◆	◆	●	■	◆	◆	●	●

Business Processes

The following table identifies existing business processes along with the corresponding departments that potentially could benefit from use of the information.

The circle, in the table, indicates that the Department has an interest in the business process. Note that the business processes often cross departmental lines, thus multiple departments need to be involved when evaluating the particular business process.

Business Processes	Airport	Fire Department	Building and Code Enforcement	Planning and Zoning	Police	Public Works	Engineering	Public Information Office	Utilities
Infrastructure									
Address System		●	●	●	●	●	●	●	●
Critical Private Utility & Other Agency Utilities (ROW Management)	●	●	●	●		●	●		●
Drawing/Document Mgmt.	●	●	●	●	●	●	●		●
Facilities / Asset Mgmt.	●	●	●		●	●	●		●
Parks Mgmt.				●		●			●
Pavement Mgmt.	●					●			●
Traffic System		●			●	●	●		●
Utility Mgmt.	●					●	●		●
Planning									
Demographics / Business Geographics	●			●	●	●	●	●	●
Zoning / Land Use Planning	●		●	●		●		●	●
Permitting / Development Review		●	●				●		●

Business Processes	**Airport**	**Fire Department**	**Building and Code Enforcement**	**Planning and Zoning**	**Police**	**Public Works**	**Engineering**	**Public Information Office**	**Utilities**
Transportation System Plan	●	●		●	●	●	●	●	●
Environmental									
Environmental Mapping	●			●		●	●	●	●
Services									
Community Groups				●	●	●		●	●
Crime Analysis					●				
Crime Prevention					●				
Disaster/Emergency Planning & Response		●		●	●	●			
Police Patrol	●				●				
Waste Collection	●					●			
Public Safety	●	●			●	●			
Traffic Accident Monitoring					●	●			
Administration									
Finance/Utility Billing	●					●			●
GIS System Administration									●

Final Software Considerations

A successful GIS is measured not by the amount of money spent, the volume of data, or the GIS software utilized but by the applications made available to staff and the public. In regards to GIS, the City of Venice has historically implemented commercial off-the-shelf (COTS) applications and tools. Creating and maintaining applications in-house can still be accomplished. However, it requires the employment of a highly skilled programming team to maintain and improve these applications. Organizations run the risk of developing applications and then having the programmer in charge taking another job. This leaves the organization vulnerable. Therefore, it is recommended that the City strive to implement only off-the-shelf applications. In cases where these applications need to be augmented, then the vendor should be paid to add this functionality to the application

This plan has recommended the extensive use of ArcGIS Server intranet and Internet applications. It is important that the City insure that these solutions are all-inclusive and do not create stove pipes. In many cases, these applications serve as data viewers and provide some analytical capabilities. However, many of these solutions fall short of true enterprise-wide functionality. A true enterprise-wide solution will not only offer viewing and analytical capabilities but will allow the City to add a host of other tools that would be drop in modules to the application. The City should consider a replacement for the ConnectGIS application. A more robust solution that would allow “portalization” (i.e. customization for each department), have increased performance, and provide an easier to use interface, would provide numerous benefits to the large number of users that would be utilizing the web mapping application.

ArcGIS Online is another server based technology that is based in the Cloud. Maps and data can be published to the cloud freeing up the City’s internal resources. Map data can be deployed on mobile devices for viewing, red lining, and editing applications. ArcGIS Online is an integral part of the ArcGIS system and would allow the City to extend the capabilities of ArcGIS Desktop and Server applications.

The City should continue to use and expand its licensing for the ArcGIS Desktop product. Currently only the core GIS staff in the Utilities Department have desktop licensing (2-Standard, 1-Basic). As noted in this chapter, several departments have requested additional ArcGIS Desktop licensing. These department licensing requests should be evaluated and prioritized. Licensing could be purchased over a multi-year acquisition schedule.

Based on the needs analysis and the existing investment in Esri technology by the City, it is recommended that the City continue to invest in Esri technologies and fully implement their solutions.

Hardware

Like many organizations, the City schedules hardware upgrades. New software packages often require new computer hardware. The following sections document hardware specifications.

Servers

The City will need to periodically consider if its existing GIS server is adequately meeting the City's GIS data and server-based GIS application needs. This server needs to store and distribute spatial data to all GIS applications. For optimal performance, it is recommended that the City invest in the appropriate server/s based on the number of users. The appropriate scaling of hardware will enable the City to meet its GIS data and application serving needs adequately

The following are definitions of key terms in regards to servers utilized for ArcGIS Server:

- **SOC – Server Object Container** - This is the primary component for the ArcGIS Server (AGS) application server. The SOC is the component of ArcGIS Server (AGS) that handles the direct interaction with the GIS data.
- **SOM – Server Object Manager -** This component manages requests from users by assigning the requests to an available SOC process or by spawning a new SOC process if needed.
- **Web ADF – Web Application Development Framework.** This component provides the web services that are used to access ArcGIS Server (AGS) functionality from web pages, custom application, and ArcGIS desktop software products.
- **Cores –** Cores refer to the number of embedded processors contained internally on a single CPU. Essentially, a dual core processor is a single processor that internally contains two of the previous generations of processors working in tandem.
- **Socket –** This is a term that generally refers to a single physical processor regardless of the number of cores present within that processor.
- **Web Application Server –** A server used to host the Web ADF and SOM components of ArcGIS Server when the installation has been scaled beyond a single server.
- **Container Machines –** When AGS is installed in a multi-server configuration, this machine is dedicated entirely to the SOC component. When installed in a single server environment, this machine contains the Web ADF, SOM, and SOC components.
- **Database Server –** This server is used to host SQL Server and the underlying databases of the SDE Geodatabases.

Hardware Recommendations

Servers

Optimal server configuration for ArcGIS Server is complex and hinges on many factors. Some of the questions to be asked are as follows:

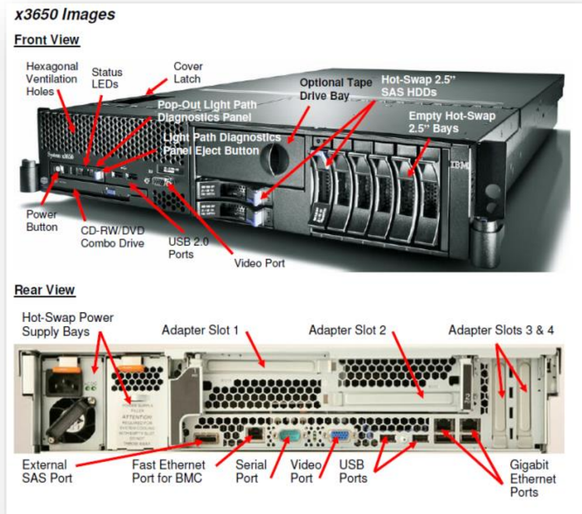
- What is the total number of simultaneous GIS Users (Internal and External)?
- When will these users come on-line?
- How will this user base scale up or down in the future?
- Are all of the users ArcGIS Server users or are some of them ArcGIS Desktop?
- Is the number of users total users or anticipated concurrent users? If they are total users, how many concurrent users are expected?
- How many of the users are expected to be internal (using something like an Intranet Viewer) and how many are public? Most likely these different types of users will be treated differently in how many requests they make per minute.
- Is an Esri enterprise licensing agreement (ELA) available for the community? The cost of ArcGIS Server is significant. Therefore, if no ELA exists then the number of users may have to be controlled based on limitations in funding for ArcGIS Server.
- Does the organization have any groups, such as Police, that should consider having their own workgroup level ArcGIS Server to allow them to not be interrupted by downtime from normal operations or unexpected incidents with the enterprise ArcGIS Server? If so, how many users will that pull off of the enterprise ArcGIS Server load?

The configuration of ArcGIS Server is complex. It is recommended that the City continue to use a dedicated server for GIS. Based on the City's projected user base, GIS computing needs, and network bandwidth, GTG recommends the following server configuration at a minimum. This recommendation is based on Esri's "System Design and Architecture" document.

The following configuration is based on five Tier 1, nine Tier 2, and 204 Tier 3 GIS users:

- One server configuration
  - One Server acting as the SOM/SOC/Web ADF & database server
- ArcGIS Server Standard Enterprise 4 cores (SOM/SOC/Web ADF)
- SDE/Database Server
- Microsoft SQL Server (2008 or 2012)
- Minimum hardware:

- Windows Server 2008
- Quad Core Xeon
- 16GB Memory
- 1TB Storage



The current IBM x3650 Server for GIS is a high performance and highly expandable server that has ample performance to support the existing and planned GIS users. As the user base increases, performance metrics should be reviewed, and if necessary, the server expanded or upgraded to maintain a high performance GIS environment.

Desktop Computers

Recommendations are given in this chapter that specify minimum and desired configuration of PCs needed to run GIS software applications. City users need to refer to these specifications to see if it will need to upgrade PCs to run specific GIS applications. Specifications will be looked at in two levels:

- **Level 1**: PCs to run robust GIS software such as Esri ArcGIS Desktop (Advanced, Standard, or Basic)
- **Level 2**: PCs to run ArcGIS Server client applications, such as an Intranet GIS Data Browsers

There is a difference between a typical PC and a GIS workstation. A typical PC for word processing is not usually configured for GIS use. A GIS workstation demands, at a minimum, a high-end processor, large amounts of RAM (memory), and large disk space.

It is important that all City personnel utilize Level 1 computers capable of effectively supporting recommended GIS applications. As more City personnel begin to use Level 1 and Level 2 GIS applications, they should have access to computers that can effectively support these applications.

Level 1 PC to Run ArcGIS Desktop

Minimum Configuration

- 2.2 GHz Pentium PC or Greater
- 2 GB of RAM or Greater
- 17” or Greater High Resolution Monitor
- DVD-ROM drive

- 320 Gigabyte hard drive or greater
- 100 MBPS Ethernet Card
- 128MB Video RAM or greater

Recommended Configuration

- 2.8 GHz Intel Quad Core Processor or Greater
- 16 GB of RAM or Greater
- 19” or Greater High Resolution Monitor
- DVD-ROM Drive
- 500 Gigabyte Hard Drive or Greater
- Gigabit Ethernet Card
- 512 MB Video RAM or Greater

Level 2 PC to Run ArcGIS Server End User Applications

Minimum Configuration

- 1GB of Ram or Greater
- 17” Monitor
- 1.6 GHz Processor or Greater
- 100 MB of Unused Disk Space, or Greater
- 100 MBPS Ethernet Card
- 128 MB Video Ram or Greater

Recommended Configuration

- 1 GB of Ram or Greater
- 19” Monitor or Greater
- 2 GHz Processor or Greater
- 100 MB of Unused Disk Space, or Greater
- 100 MBPS Ethernet Card
- 128 MB Video RAM or Greater

Field Mobility

There are basically four (4) hardware options for accessing GIS data in the field: hand-held computers, notebook computers, tablets, and smartphones. Traditionally, the recommended solution for field access to spatial data has been the use of notebook computers. The primary advantage of hand-held computers has been their small size, which allows for greater portability. The primary disadvantages of hand-held computers are their small-screen size, and limited memory capacity. Notebook computers have much more memory capacity and processing speed than hand-held computers, and also have much larger screens. The advent of tablets and smartphones provides the best of both options: greater portability with increased memory capacity, processing speed and larger screen sizes.

Still, there a considerations that must be addressed when choosing devices for field operations. Ruggedized notebook computers are optimal for field personnel operating in conditions with exposure to weather, dust/dirt, water, and the like. Mounts for notebook computers should be installed in any vehicle that will contain a notebook computer. Mounting computers in vehicles makes them much easier to access and reduces wear on the machine. The mount should not be permanent, however, as notebook computers will need to be taken out of the vehicles by field personnel for special purposed and taken out of the field periodically to update data/software. Ruggedized notebook computers are more expensive than regular notebook computers, but the cost of ruggedized notebook computers is offset by their longevity. A ruggedized notebook computer will outlast a regular notebook by three times. Analysis should be made on the continual cycle of repurchasing damaged or worn notebooks, vs. the initial purchase of a rugged version.

The following is the recommended configuration for notebook computers:

Notebook Computer – Approximate Cost = $4,500

- Ruggedized
- Weigh Less than 5 Pounds
- 1.6 GHz Processor or Greater
- 12 Inch or Greater Anti-glare Display
- CD-ROM Drive
- 2 GB RAM or Greater
- 80 GB Hard Drive Space or Greater
- 10/100/1000 MBPS Ethernet Card
- Wireless Network Adapter

In contrast, when operating conditions are such that weather and the like are not a major concern, smartphones and tablets become a viable, economical, and user friendly option. As discussed in the software chapter, many applications are available for use on these devices and can assist in making field personnel more efficient by providing them access to GIS data and giving them the capabilities to capture and edit data in the field. Today, the market has many different brands and options available for purchase. However, in general, the options are Android, iOS, or Windows based systems. Each has positives and negatives, but all three can extend the use of GIS into the field. The primary factors driving the determination of which to use involve the application (some applications are only available on certain operating systems (OS)) and the end users (some users prefer smartphones over tablets or are more comfortable with a certain OS). As Venice begins to plan for and deploy mobile GIS applications, they should compare the options available and make the selection based on their needs.

Data Capture Devices – Mapping Grade GPS Receivers

The City should evaluate the use of mapping-grade GPS receivers for in-house GPS data collection of new or modified features. However, any data that takes longer than a year for in-house staff to collect can usually be outsourced at a lower cost and the data can be used for analysis purposes sooner. This can save time and money vs. using in-house resources to collect data.

If the City decides that new GPS receivers are needed, it is recommended that the City acquire, at a minimum, the Trimble GeoXH as its mapping grade GPS receiver. The Trimble is ideal for use by utility companies and local government organizations managing assets or mapping critical infrastructure that requires spatial accuracy and data capture.

Trimble GeoXH 6000 Series – Approximate Cost = $6,000

- H-Star technology for realt-time sub-foot GPS accuracy
- Decimeter accuracy after postprocessing
- TI OMAP 3503 processor with 256 MB RAM
- Microsoft Windows Mobile version 6.0 software, allowing maximum flexibility in software choice
- 2 GB onboard data storage plus SD slots for removable storage cards
- High-resolution VGA display

- Bluetooth, WiFi compatible
- GPRS/EDGE cellular modem connectivity
- Rugged handheld with all-day battery
- GNSS capable receiver board (220 channel for GLONASS constellation pickup)
- Field swappable batteries
- Floodlight Shadow Reduction Technology (for receiving satellite data better in urban environments)

Field-mounted GPS receivers will need to be configured and linked, as needed, to the City's computing resources, including computer systems (hand-held computers, notebook/tablet computers, workstations, and servers), networks, and enterprise-wide databases.

Output Devices

Printers

It is important that the City's GIS users have the means to print maps and documentation generated from these applications. Every GIS user should have access to a high-resolution color printer, to print 8"x11", 11"x17", or 8"x14" maps. In the short-term, each GIS user should have access to at least one networked color printer, even if it is not in their immediate work space. As output demand increases, additional color printers should be purchased for appropriate departments and users.

Plotters

It is important that ArcGIS Desktop users have access to wide-format plotters. Many maps must be output onto large sheets to be properly visualized. The following are recommend specifications for wide format plotters:

Plotters – Approximate Cost = $9,000

- 36" or Greater Paper Sheet Size
- 2 GB of Built-in RAM
- 100 GB Hard-drive
- 1200 dpi Addressable Resolution
- Adobe PostScript 3 Capability

HP Plotter

Networks

The City's network is comprised of a 100MB LAN and a combination of high speed fiber (5 locations) and low speed cable modems (3 locations) for its WAN. Network performance was deemed acceptable by most of the users that were interviewed. The exception is the three locations on the WAN that are connected via cable modems – Eastside WW Plant, Airport, and Archives (Museum). These three locations are scheduled to be upgraded to Comcast Fiber by March 2014. With that exception, the current network is sufficient for GIS usage.