

Challenges and Successes of Enterprise GIS Applications: Yavapai County-GIS (YavGIS)

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Abstract

This paper discusses the challenges and successes of Enterprise-GIS Applications, YavGIS, for Yavapai County Government, Prescott, Arizona, moving from paper map to a Web-based application with Satellite Imagery. Applications of GIS for Yavapai County focus on property assessment, schools, law enforcement, land use, planning, roads, flood control, and facilities management. Property valuation, taxes, geographic reference, political resources (precinct mapping), and permit reference information are accessible over the World Wide Web to the public 24 hours a day, seven days a week through an Interactive Mapping Application using ArcIMS, ArcSDE, and Microsoft SQL Server 2000. More than 50 GIS data layers on various features have been created. The paper also mentions the problems and solutions when migrating ArcStorm in Oracle to ArcSDE using SQL Server 2000. Currently, YavGIS is migrating from ArcInfo to the new ArcGIS technology.

Introduction

Yavapai County's enterprise GIS implementation is a central service group called YAVGIS within the MIS Department. YAVGIS performs GIS services on behalf of the entire enterprise and coordinate the efforts of many diverse County departments, as well as, local governments and agencies--Cities/Towns, Fire Districts. YAVGIS serves as a core group of service-oriented individuals dedicated to providing expertise, support, training, and/or assistance to County departments, local agencies and the general public. YAVGIS also serves as a mechanism to improve GIS technology and its relationship to daily business functions.

With a focus on providing GIS services, YAVGIS is an *ENABLING* organization that establishes technical standards through consensus and facilitates GIS education through "technology transfer". It serves as a leader in advancing the automation and modernization of land administration practices and leveraging existing "location-based" projects to maximize their use across County participants. In addition to being a mechanism to improve "location-based" data management, YAVGIS facilitates strategic decision-making, and leverages existing GIS expertise in one or more participating organizations.

Under strong leadership and technical resources, YAVGIS provides several key services on behalf of the program. When performed centrally, those services eliminate duplication of effort and promote the development of agency-specific systems. Typically, YAVGIS provides the following services:

- GIS technology coordination, consulting and implementation
- GIS application development, support, and training
- GIS data design, automation, documentation, and distribution
- GIS strategic planning and system integration planning
- Database administration

Within the County, YAVGIS is currently working with the following departments in some capacity: Assessor, Board of Supervisors, County Attorney, Elections, Emergency Management, Environmental Services, Flood Control, Health, Justice Courts/Clerk of Superior Court, Parks, Planning & Building, Public Works/Roads/GPS Survey, Schools, Sheriff's Office, and Voter Registration. In addition to this, YAVGIS is currently working with neighboring towns (9), fire districts (17), and Utilities (6). YAVGIS also collaborates with Federal—Forest Service, BLM, USGS, and State Agencies—DOT, Cartography Office, House of Representative, and Land Department.

Brief History

The GIS started in late 1992 with the primary goal of creating a digital land database of all parcels in the county. The initial project addressed the issues of planimetric data acquisition, aerial flights of the county, and initial conversion of county assessor's maps to a digital format. A vendor (ASI) was chosen, and data conversion began in 1993. County survey crews established GPS control points, and a high accuracy GPS control network was set up. This network was used as a control scheme for the road edge lines/centerlines and building footprints extracted from aerial orthophotos taken of the county. Assessor maps were digitized, mosaiced, and best fit to the road centerline data. Other less accurate data was acquired from state sources. This data included hydrology, incorporated boundaries, section lines, and roads.

The original phase one area of data conversion covered a contiguous area covering approx. 1,400 square miles, and stretched from Prescott to Sedona. Data was returned to the county in 10,000 x 10,000-foot tiles that were stored in a data library structure developed in-house. Applications were developed by the GIS department to allow Cartography staff to check each tile for accuracy, and to add features such as subdivisions and mining claims that were not covered in the original data conversion contract. Figure 1 shows a brief history in time for YavGIS.

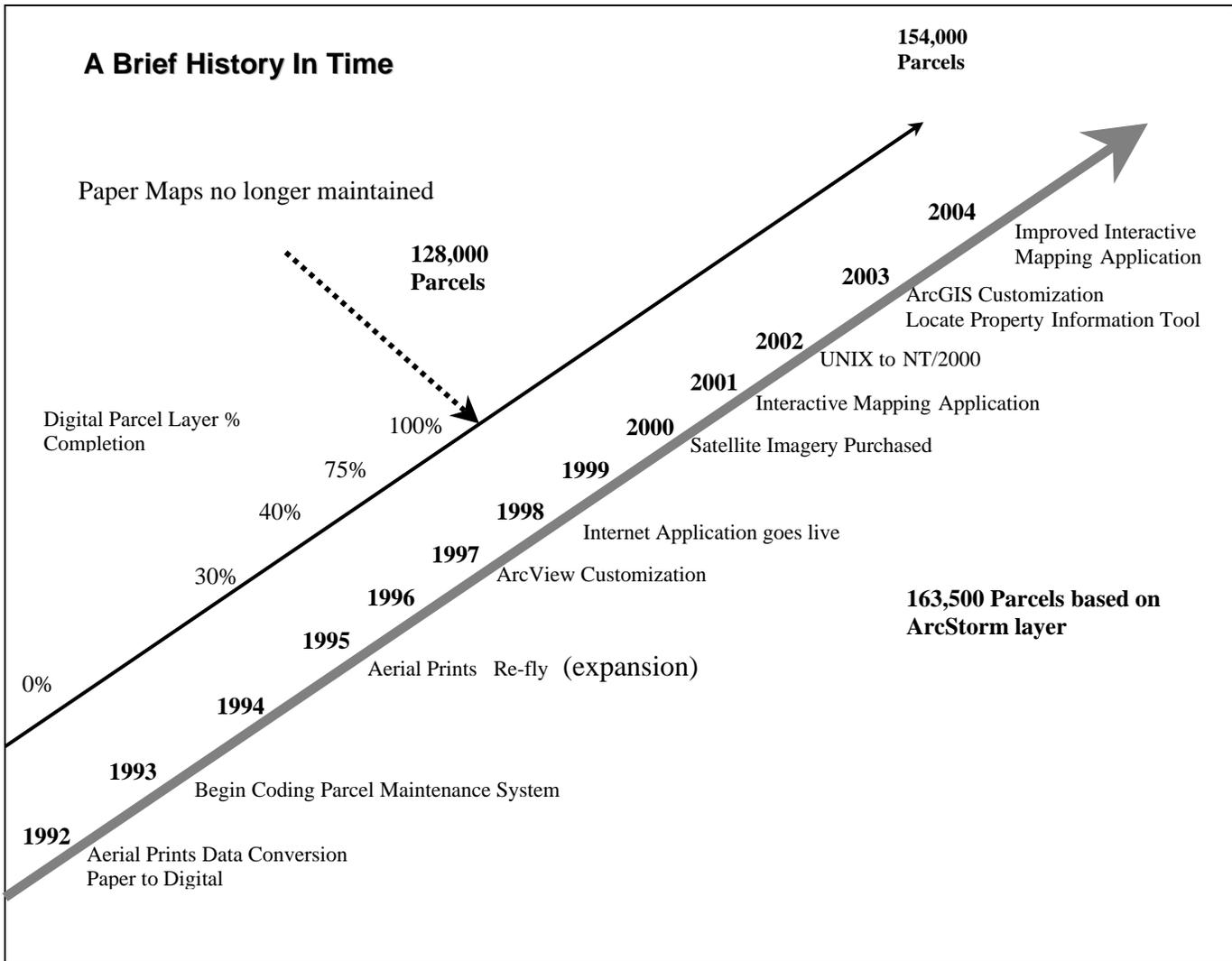


Figure 1: A brief history in timeline for YavGIS

YavGIS Program Accomplishments

Since 1992, several GIS initiatives were defined to carry out the GIS program goal and objectives. A few of the accomplishments are provided below.

1. The GIS parcel layer automation was completed in January 1998 and the Assessor's paper parcel maps are no longer maintained. In June 1998, the parcel layer database was modified to have the ability to identify public lands, right-of-way, and tax area codes. The county now has the ability to maintain one layer and generate multiple GIS layers (i.e., City boundaries, District Boundaries, Public Lands, etc.)

2. A complex ArcInfo/AML parcel maintenance application has been in place since 1996 and allows Cartography staff to maintain the parcel GIS layer in ESRI's ArcStorm (transaction management GIS database) and keeps track of the parcel history in the County's Oracle database. The applications 50,000 lines of code and 300 menus were documented in 1999 using an industry standard flow diagram model.
3. The GIS zoning layer automation was completed in April 1999 and Planning and Building's paper zoning maps are no longer maintained.
4. An ArcInfo zoning layer maintenance tool was developed in November 1998. YAVGIS is currently maintaining this layer.
5. A multi-department ArcView application was deployed in June 1998 resulting in over 300 users of GIS throughout several county departments. This application includes the ability to overlay more than 40 GIS layers and includes custom functions, data maintenance tools, and allows users to easily generate maps. The users use Terminal Servers (5) with 20 connections on each server.
6. Three Internet mapping applications have been deployed since 1999. The Property Information Tool and the Property Notification Tools were made available on the county web site in January 1999. An Election Map application was made available on the county web site in April 2000. A new ArcIMS site has been deployed in 2001 to replace the Property Notification Tool and the Election Map application, and won fourth place in the Geography Network Challenge.
7. FGDC compliant Metadata for all of the GIS layers has been documented and some of this information is available over the Internet.
8. An inventory application for the Internet has been developed for other counties or agencies to view, if they are starting a GIS system. It contains questions and answers of what a GIS system should entail.
9. NASA's growth modeling program within Yavapai County has been completed to determine the population growth and where the growth will occur in the future.
10. The 2000 Ikonos Satellite Images for the entire county has been completed. The imagery is 1 meter resolution, 5 meter horizontal accuracy. These images have improved the accuracy and planning of the county.

Internet Mapping Application Implementation

ESRI's new GIS technology revolves around three primary products: ArcGIS, ArcSDE, and ArcIMS. Desktop GIS software along with related extensions and modules is the ArcGIS that introduces a new deployment configuration for using ArcSDE. Spatial and tabular database integration is supported in ArcSDE. ArcIMS supports the delivery of web-based geographic information and map services. The long-term goal of the Yavapai County Government is to provide all spatial information as web services that can be viewed and printed by the taxpayers through an Internet browser. ArcSDE is selected because it is more stable compared to using .dbf file and access data files. It also reduces the number of files off shapefiles and coverages. Further along with ArcInfo 9.0, ArcSDE 9.0 provides better functionality such as versioning, and direct editing of spatial data. ArcIMS provides more functionality than MapObjects and it is highly customizable to meet user's need. Another benefit is that multiple users can be on one ArcIMS application. Some of the benefits of the migration to new GIS environment are improved data integrity and availability, reduced licensing costs, greater efficiency, and better system integration of spatial and attribute information.

ArcSDE data migration plan

The eventual goal of the county is to utilize ArcSDE as a central repository for spatial data. While continuing to edit and maintain the existing coverages, data are at present maintained in ArcSDE as well as in ArcStorm database. The departments modify the coverages using ArcInfo and stores in the ArcStorm database. The GIS section then implements the daily updates of the ArcSDE geodatabase, and distribution of the read-only layers to multiple users through ArcIMS. To help in editing the data, all AML and Avenue scripts are being converted to Visual Basic (ArcGIS), and custom tools are developed for each department.

Configuring SQL for ArcSDE

The county used Oracle database software until 2001. There after, MS SQL Server 2000 was adopted for its lower cost, and ease of use and administration. The DTS Import/Export wizard was used to convert road inventory data from Oracle to SQL Server. While configuring SQL Server for ArcSDE, it was made sure that size was setup correctly to be able to handle expanding data. Standards set up was followed in SQL Server. Stored procedures were created to work properly; views were created to work with ArcSDE from other SQL Server tables.

Once ArcSDE was setup, DB_Tune file was imported for installation. Db_Tune file was customized on the first installation.

System Design considerations for ArcMIS

We installed ArcIMS 3.0, when we first implemented ArcIMS. At the time of writing this paper, we are updating to ArcIMS 9.0. In ArcIMS, system design plays a big role. Servers having enough power were selected to support various applications. Careful attention also has to be paid to compatibility issues for ArcIMS 9.0 as described in the ESRI website.

Mapserver (ArcIMS, Internet and Intranet)

DELL PowerEdge 1550 2-933MHz, 1 - GB RAM, 1U rack mounted, No Tape Drive, 2@18GB-RAID1, Win2k with IIS

GIS Servers (ArcGIS, Production and Development)

Dell PowerEdge 6400 2-700 MHz , 1-GB RAM, 2@ 8GB Drive, 1 @ 100 GB Drive, Win2K

SQL Servers (ArcSDE, Production and Development)

Dell PowerEdge 6400 2-700 MHz, 1-GB RAM, 2@ 8GB Drive, 1 @ 60 GB Drive, Win2K

Designing Internet Mapping Application

When developing the Internet Mapping Application, we kept the users in mind: functionality wanted by users was incorporated in design. We also made sure enough power on the server to support applications. Scripting for Internet Mapping Application was done using ASP, VB, HTML, XML and ASP.Net and Java. About 50,000 lines of custom AML, Avenue coding are being converted to VB/ArcGIS. Some of the functionality added to Internet Mapping Application are shown below:

- Ability to search for parcels based on Parcel Number, Owner Name, Owner Address, Subdivision Name, and Parcel History
- Ability to locate parcels based on Section/Township/Range, City/Town/Place, Street Intersection, Election Precinct, Supervisor District, Legislative District, JP District, College District, School District, and Sheriff District.
- Ability to locate the $\frac{1}{4}$ $\frac{1}{4}$ $\frac{1}{4}$ location of a section.
- Ability to find a latitude and longitude on the map.

- Ability to buffer a parcel for owner/mailing notification.
- Ability to measure a distance on the map.
- Ability to link to Recorder's Map Tool Application by subdivision.
- Ability to link to Treasurer's Tax Information by parcel number
- Ability to show recent sales in a subdivision by the view comparables utility.
- Ability to type in a scale factor to zoom.
- Ability to print only the current map display.
- Ability to print a thumbnail of the parcel with owner information.

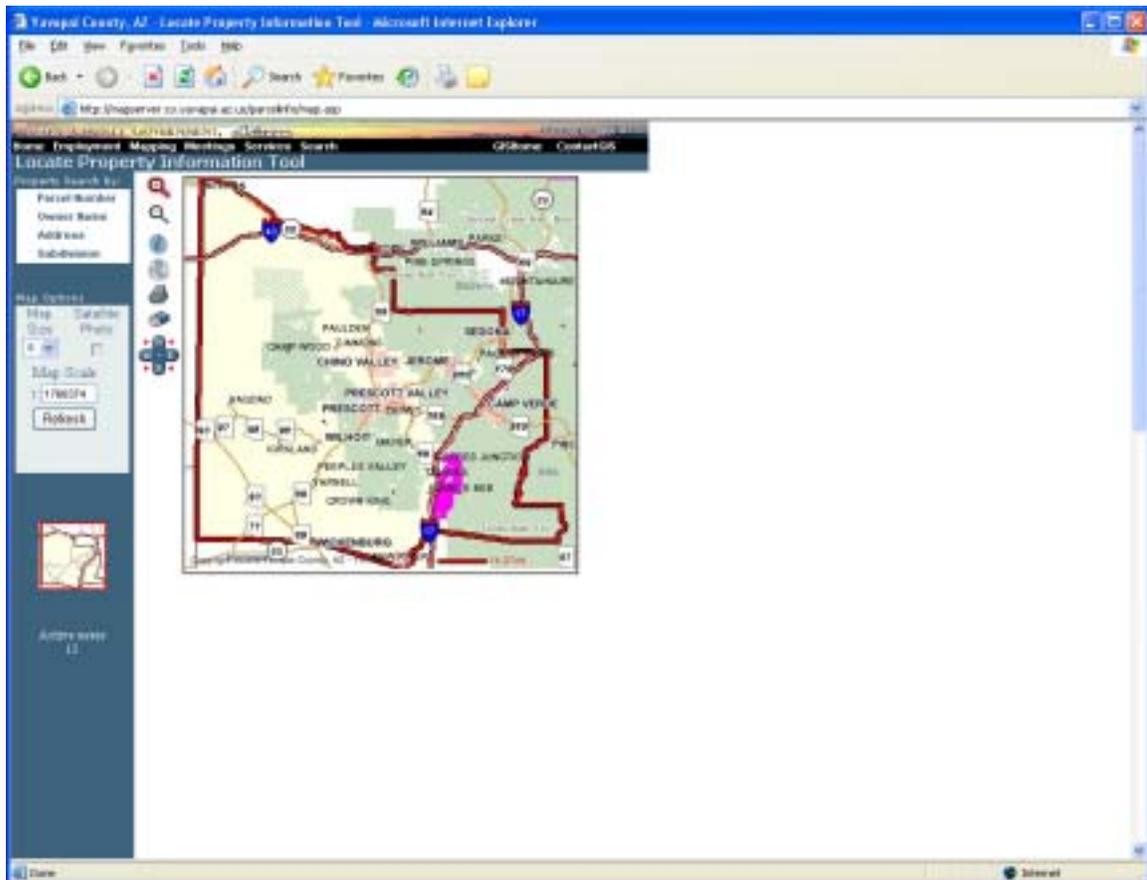


Figure 2: YavGIS Locate Property Information Tool using ArcIMS, ArcSDE and SQL server 2000

Figure 2 through Figure 7 show few screen shots of the Locate Property Information Tool. These figures show that YavGIS has interweave seamlessly the county information from various departments—Assessor’s parcel property valuation information, Recorder’s maps and land surveys, and Treasurer’s parcel property tax information.

Search by Owner Results
 Found 48 records matching
 SMITH

Parcel	Owner	Owner (Secondary)	Address
001-00-001	CAROLINA SCHWAB KELLY TRS	SMITH LILLIE W (S)	
001-00-002	FIRST AMERICAN TITLE WS CD TR 72ND	SMITH LENE W JR & KATH A RS W & WALTER DANIEL R & KATHARINE KATHY B RS (S)	SR
001-00-003	WOCOM TRUSTEE KVA	SMITH LAURA S	
001-00-004	SMITH TRS REVOCABLE TRUST	SMITH LYLE W & TRISA J TRUSTEES	8711 E MAYFLOWER LN
001-00-005	SMITH BARLETA TRUST	SMITH LARRY R & CHARLETTA TRUSTEES	1100 CROWN PINE RD
001-00-006	SMITH FAMILY TRUST	SMITH LOUIS C & LURELLE R TRUSTEES	9466 S LADY LAMPT LN
001-00-007	SMITH FAMILY TRUST	SMITH LOUIS C & LURELLE R TRUSTEES	4475 S LADY LAMPT LN
001-00-008	SMITH FAMILY TRUST	SMITH LOUIS F & LURELLE R TRUSTEES	812 S DOCKWIS ST
001-00-009	SMITH LAUREN W & MARY ROSE RS	SR	
001-00-010	SMITH LARRY C S	1930 SMITH MARY L JT	738 S RACE TRACK RD
001-00-011	SMITH LARRY D & BARLENE J RS	SR	
001-00-012	SMITH LARRY S S	BUDOP LINDA M JT	812 S FRIENDLY PINES RD
001-00-013	SMITH LARRY J & BARBARA D RS	SR	
001-00-014	SMITH LARRY R & ELLEN H RS	SR	1070 N STAR LN
001-00-015	SMITH LARRY R & ELLEN H RS	SR	4620 HORNET DR
001-00-016	SMITH LARRY W S	18 LAMB EDGAR M JT	8800 CIBOLA DR
001-00-017	SMITH LAUREN A & MICHAEL W RS	SR	8300 S WILLIAMSON VALLEY RD
001-00-018	SMITH LAUREN A & MICHAEL W RS	SR	8101 S WILLIAMSON VALLEY RD
001-00-019	SMITH LAURA S	ELLEN ROSE REED M JT	
001-00-020	SMITH LAUREN W S	SMITH MARY ROSE RS	271 BROOKSIDE PINES RD
001-00-021	SMITH LAWRENCE R & MARLENE S JT	SR	3325 W L BAR L RD
001-00-022	SMITH LAWRENCE R & MARLENE S JT	SR	SR
001-00-023	SMITH LAWRENCE R & MARLENE S JT	SR	SR
001-00-024	SMITH LAWRENCE R & MARLENE S RS	SR	SR
001-00-025	SMITH LAWRENCE R & MARLENE S RS	SR	SR
001-00-026	SMITH LAWRENCE R & MARLENE S RS	SR	SR
001-00-027	SMITH LAWRENCE R & MARLENE S RS	SR	SR
001-00-028	SMITH LEANDA JOE & DAVID R TRUSTEES	SMITH REVOCABLE LIVING TRUST	280 SEDONA RD
001-00-029	SMITH LES CONE	SR	1107 CALIFORNIA DR
001-00-030	SMITH LEO W S	SR	480 HAVYTH SPRINGS

Figure 3: Search results based on owner name (Locate Property Information Tool)

Yavapai County, AZ - Lucate Property Information Tool - Microsoft Internet Explorer

Home Employment Mapping Meetings Services Search

Lucate Property Information Tool

Property Search By:

- Parcel Number
- Owner Name
- Address
- Subdivision

Map Options:

- Map
- Scale
- Size
- Color
- Print
- Photo

Map Scale: 1:1940

Refresh

Parcel ID: **301-36-279** [Check Dept.](#) [View Topographic Map](#) [View Comparison](#)

Owner Information

Owner (Primary)	Owner (Secondary)
CAROLINA DENNIS W JULY 01 9	SMITH LESLIE A & LE

Address

1302 W GEORGIA AVE
 PHOENIX AZ 85013

Record Sale Information

No record called to report

Taxes

Year	Taxes Billed	Year	Taxes Billed
2009	\$70	2008	\$70

Parcel Information

Acres	Subdivision (Map Only)	Type	Incorporated Area
0.1	BRIDGE CANYON COUNTRY ESTATES UNIT 9	IN	PHX

School District: **Phoenix** Parcel Date: **Recorded Date**

Figure 4: Detailed parcel information for parcel #301-36-279

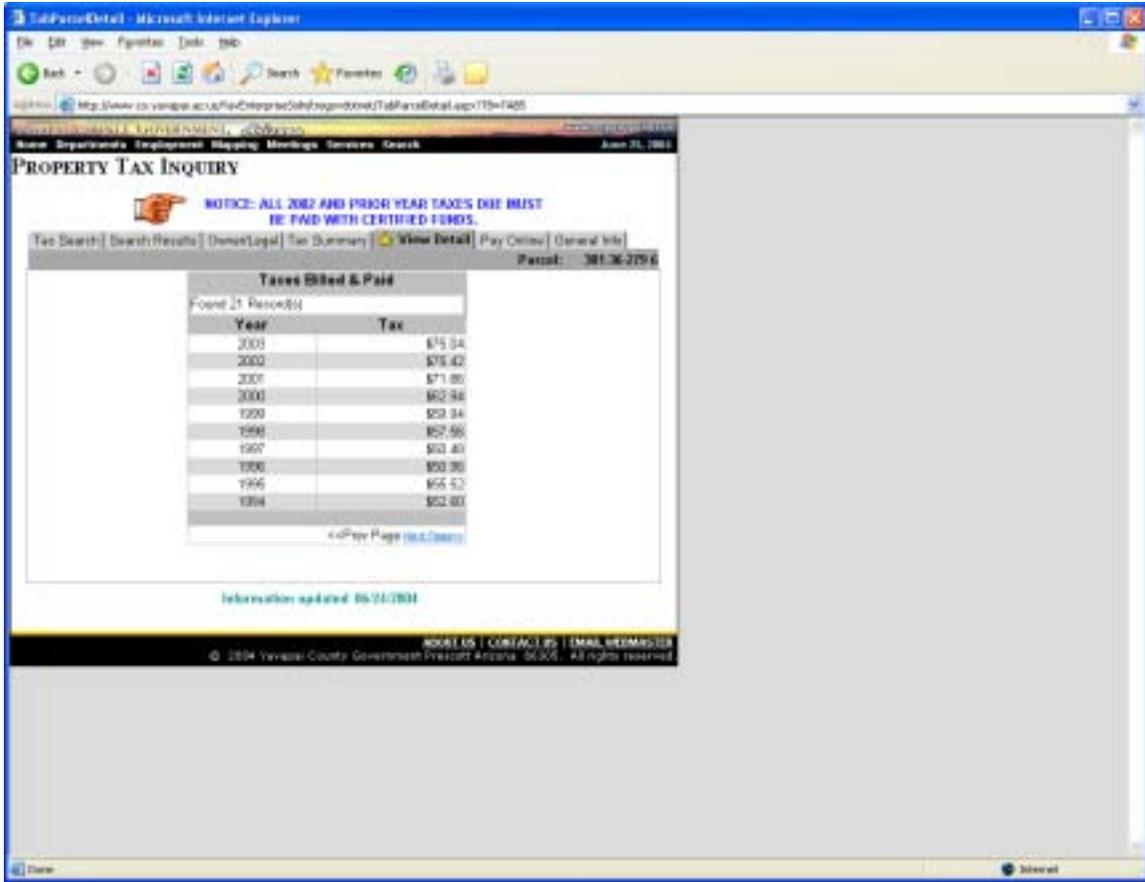


Figure 5: Tax information for parcel #301-36-279 (Link to Treasurer's Tax Inquiry)

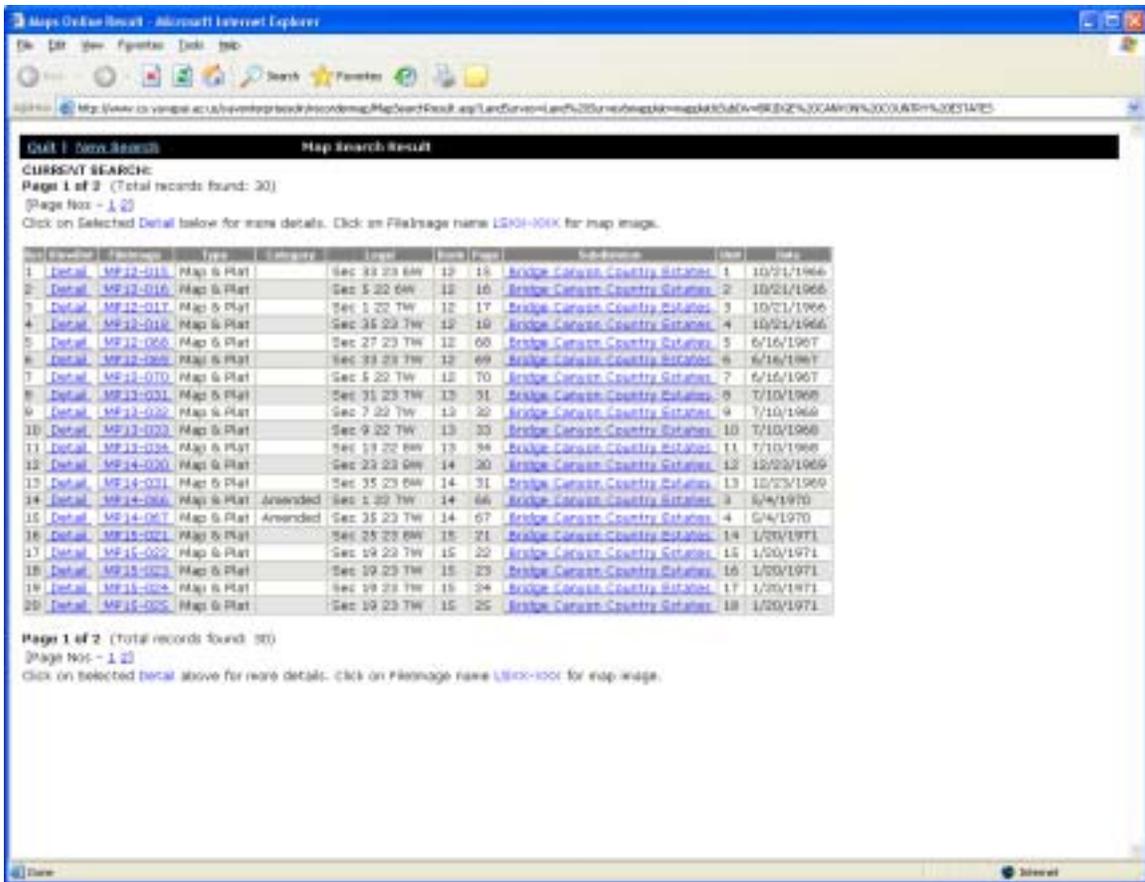


Figure 6: Map search result based on subdivisions (Link to Recorder's Maps/surveys)

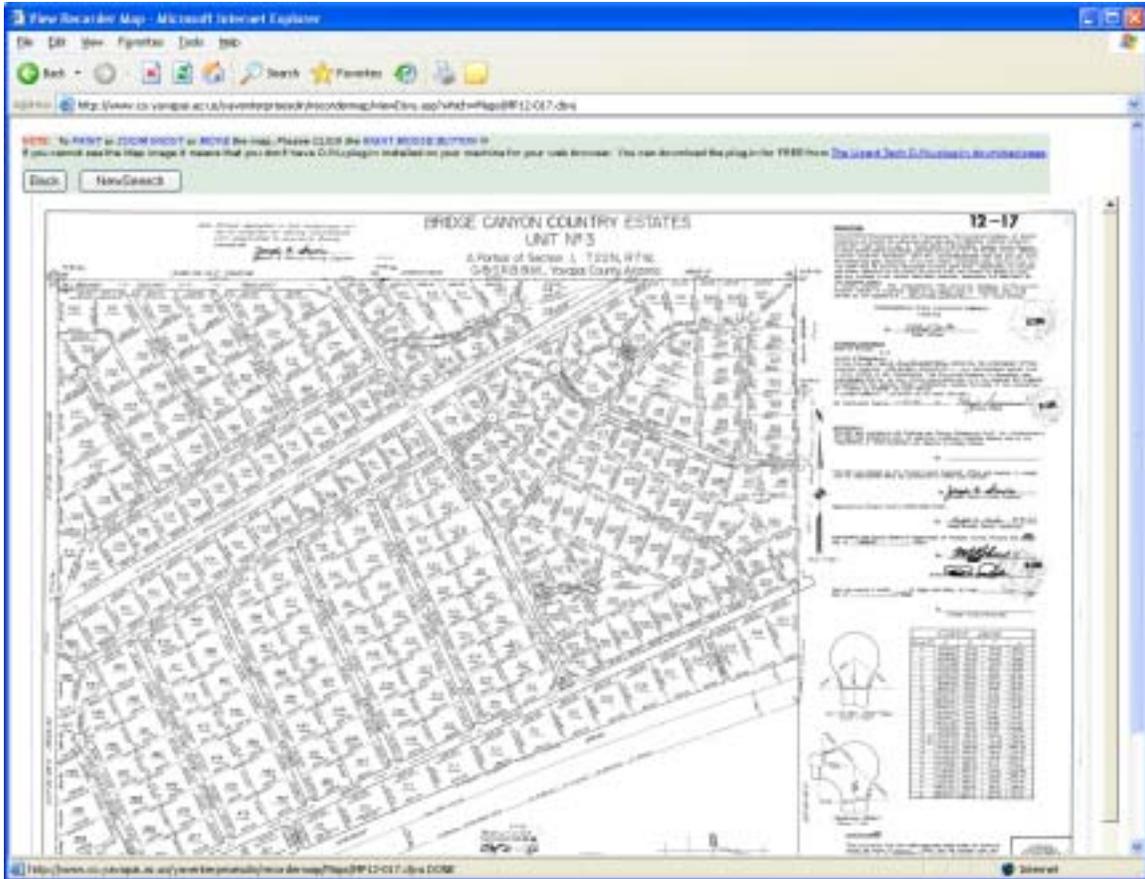


Figure 7: Map image of subdivision using DJVU plug-in

The internal applications are recreated daily at 8 PM on Monday to Thursdays; we also update Parcels, Roads, Subdivisions and Split History daily to keep the data current with the database. All other GIS layers, and SQL Server tables are updated weekly at 8 PM on Fridays. ArcIMS services and data from DOR (Department Of Revenue) through FTP site are updated biweekly. When all GIS layers are in ArcSDE, and DOR project is finished, all updates will be on daily basis. Table1 shows the layers added to our Internet Mapping Application.

Parcels (includes lot numbers and dimensions)
Historic Lot Lines
Roads
County Maintained Roads
Section/Township/Range
Cities
Hydrology Features
Mining Claims (claim name, district, mineral survey number, and corners)
Contours (20 foot)
Election Precincts

Supervisor Districts
Legislative Districts
College Districts
Sheriff Districts
Fire Districts
JP Districts
Water Districts
Hospital Districts
School Districts
Tribal Trust Lands
Schools
Building Footprints (2000)
Places on Interest Golf Courses
Airports
Subdivisions
Zoning (includes zoning layers for all incorporated cities and towns)
Public Land Use
2000 Ikonos Satellite Imagery

Table 1: Layers Used in the Internet Mapping Application

Challenges

This section describes some of the challenges faced during the YavGIS implementation. Funding is not a problem as the County Board is very receptive about emerging technology. In fact, Yavapai County is regarded as one among the pioneers of USA counties adopting new technology to provide service to taxpayers. One of the main issues was that data were collected from many different sources and accuracy was a major concern. Recollection of imagery has focused on getting the USGS DOQ's that were flown in 2004, and collecting the missing western part of the county. Updates on data from the collaborative organizations need better coordination. This is especially true for the road names; the local authorities often dedicate and modify road names without notifying the county. Somehow a method of maintaining all road names on a timely basis within GIS will have to be developed.

During the initial phase one conversion, certain aspects of the original project objective were overlooked. In order to complete the transfer from a paper to digital world, all departments relying on the Assessor's maps had to have GIS solutions of their own. This meant GIS applications and coverages needed to be developed for Planning & Building, Flood Control, and Roads. The conversion from paper to digital map has been done in three phases; some specific challenges in each phase are described below:

In 1992, all the county's parcel information were on paper maps; the move from paper to digital was started off by digitizing and Cogo'ing everything into a digital database. At that time, ArcStorm was the only database capable of storing the parcel data and being able to maintain it. A robust ArcInfo application was developed with the help from a consultant to complete the Parcel Maintenance Application System (PMAS) with 50,000 lines of AML, and over 300 Menus. The main challenge was how the county was going to have accurate data and how the data were going to be maintained. Aerial photos were taken of the urban areas only where GPS control was generated. This process was redone in 1995 to get a larger area. The cost was approximately \$500,000 a piece, which included fixing the road centerlines in the area and building footprint. But, these aerials were only prints, and no digital orthos were produced. This helped the accuracy in the urban areas, but still the accuracy in the rural areas of the county was unknown. Although the cost was high at the time, as a long term solution, the PMAS was developed on a UNIX platform using Oracle as the relational database.

In 1998, all of the paper maps were converted to digital format. YavGIS was able to develop a custom ArcView 3.0 application to run throughout the county. It started out at about 50 employees using the system loaded locally on their desktops, and connecting to the network for the data. In 2000, terminal servers were brought in to add more users to the application. The ArcView project was loaded on 5 separate terminal servers—shapefiles were copied daily to each terminal server—and 20 employees can get on at one time on one server. This reduced licensing fees, as the employees no longer need to have ArcView installed locally. Now we have more than 300 users of the application. The county also purchased digital Satellite Imagery in 2000 for the whole county at a price of about \$500,000. This was the same price as the Aerials in 1995, but this time we got it in digital format that helped to find and rectify where parcels and other layers were inaccurate.

The need to move toward the new technology is important, as ArcGIS 9.0 has become available. We have the challenges of moving from ArcInfo Workstation and ArcView 3.x world to the new ArcGIS platform. Using ArcStorm has worked great for our Cartography staff in maintaining the parcels and other GIS layers. But, it is time for us to move to an enterprise geodatabase, using ArcSDE with SQL Server. An enterprise geodatabase instead of a personal (Access) database provides more functionality and power. Once the Cartography staff gets trained, using ArcSDE will be faster and easier. The conversion being done in house is time consuming and costly in the short run than hiring a 3rd party product vendor. But, in the long run, it will help to maintain the system and to fix any problems that might arise, without having to pay maintenance on a 3rd party product. We can further reduce the number of licenses that the county requires by moving to an Internet base applications. Most of the ArcView users just view the data and do not do any analysis. By creating in-house Intranet applications, specific to each department, we can further reduce our maintenance/licensing

cost. The conversion of everything to the ArcGIS and VBA will be more compatible with other application throughout the county. The main challenge here is to keep up with the technology. Another challenge is deciding how the users are going to access the GIS data: is it going to be directly through ArcSDE, a layer file, or shapefiles. We need to make sure users are not connecting to the editable layers.

Conclusions

Despite some challenges, YavGIS has come a long way since 1992 in pursuit of its paperless map and providing spatial and related information as web services to its customers—taxpayers. Currently, it is moving to the latest version of ArcSDE 9.0 and ArcIMS 9.0. YavGIS has currently two Internet mapping applications—Locate Property Information Tool, and Interactive Mapping Application. Because of robust system design and ArcSDE database, Internet Mapping Application is able to handle many concurrent users. The taxpayers can find about their Recorder maps and land surveys, property tax information and property information anywhere globally.

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