Integrating and Distributing Data to Technical and Non-Technical Users

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Abstract
A mesh of inter-related software technologies, data formats and a wide range of technical and non-technical users can make enterprise implementation a daunting task. This paper presents a system level approach for delivering GIS to an enterprise using a level approach for delivering GIS to an enterprise using ESRI technology. Applications using ArcView and ArcIMS are demonstrated as the framework for delivering data to end-users. Steps for migrating base level applications to ArcGIS using Oracle and SDE are also presented.

Background
Adams County GIS uses a multi-layered approach to providing GIS capabilities to a broad group of simple users while maintaining critical software and data development support to a core set of advanced users. All development and support revolves around the premise that even though the advanced capabilities of GIS is critical to the everyday business processes, information retrieval should be accessible and simple for everyday PC users.
Based on this model the challenge then becomes how to provide and support GIS across this diverse user group. The solution adopted by Adams County GIS is the use of Desktop and Internet map services. Desktop map services are built around desktop GIS software like ArcView and ArcGIS, while Internet Map Services are built around ArcIMS and its related technologies. Various RDBMS[1] and tools are common to both environments. This paper focuses on the Desktop Map Services but provides an overview of the Internet Map Services.

Desktop Map Services
Map services as used in the Adams County GIS, is the grouping of GIS data and tools around the business functions of specific users (user-centric) or around data querying and manipulation needs (data-centric).
This Data-Centric or User-Centric approach lends an added layer of simplification and focus to developing map services. An example description of a data-centric service is one defined with a group of tools to manipulate specific or defined data, i.e. a group of programming functions designed to manipulate census data. An example of a user-centric service would be a set of tools used by the planning department to access multiple data sources as a means of returning spatial query results or for developing a final product such as a map.

[1] Relational Database Management System

Adams County GIS Users

In developing map services, one of the keys to success is having a strong grasp of who the GIS users are. The types of services, level of complexity/detail, tools and presentation should be based on what users exist. Three identifiable groups of users exist in Adams County:

Technical Developer or Specialist[*]- This GIS user type typically has GIS in their professional title, has specialized GIS software training, and can efficiently customize GIS with little or no regular support. This group of users directly supports application or database development.

Technical Consumer or Analyst[*] **-** This GIS consumer also may have specialized training and can use GIS software out of the box, but probably requires support to efficiently access database resources for analysis and presentation purposes.

Non-Technical Consumer[*]- This is strictly a geographic or map level data consumer. They likely do not have technical expertise or training to use GIS software, might not know how to read maps well, looks for a quick answer for decision support, and is not interested in formal training or even online tutorials.

Adams County Query Application

The Adams County GIS Query Application (Query Application) is a desktop map service built around ESRI[2] ArcView 3.x environment. It is designed to be scalable and extensible, providing GIS tools and functions for all three defined GIS user types in Adams County.

As the primary tool for retrieving parcel or property information, the Query Application allows users to search properties by owner name, address or parcel identification number.

The Query Application foundation is a template that provides common data and tools for all the users as a start point. Extensions then add groups of data or tools defined around the data (data-centric) or users (user-centric). Users can then add these extensions dynamically to the Query Application as a "Service".

Query Application Template

The Query Applications base data and tools include:

Parcel Libraries: Adams County parcel or property data stored in an ArcInfo Library system. The library stores all parcel boundaries and related annotation and geometry for all incorporated and unincorporated areas of Adams County at a relative accuracy at scales of 1 inch to 400 feet.

PLSS: The Public Land Survey System (PLSS) Township and Section control lines.

Aerial Photography: Aerial images of Adams County used as a source of ground truth and reference.

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[*] An Enterprise Approach to GIS System Management and Implementation. *A case study of Adams County, Colorado. Keith Hangland, et al, 2004*

[2] Environmental Systems Research Institute

System Integration[3]

The Query Application's strength is the value it brings by being able to integrate with various RDBMS and systems. This integration extends the spatial component of the GIS by providing it with enhanced attribute data to enable more meaningful analysis and decision-making. By increasing the number of uses for the existing RDBMS, a higher return on investment is achieved. The key systems and databases that the Query Application integrates with are:

Assessor's Database - Components of the Assessor's Computer Aided Mass Appraisal (CAMA) system have been integrated to extend this GIS application with added information and search functionality. The CAMA system is used by the County to record, track, and value all taxable properties in the County.

Permit System - The Permit system is used by planners and engineers in the Development department to record, track, and process information related to use and building permits, variances and violations, and environmental requirements and hazards. All cases tracked by this system are associated with properties in the GIS and CAMA system.

Technical Components

Databases – The Query Application accesses various relational database management systems to access non-spatial data. Queries are formatted to match the appropriate database type before they are sent from the GIS. Results of the various queries are put into tables and joined to existing spatial data. The value of spatial data is increased multiple fold by this ability.

Spatial Data – A large collection of vector, raster and tabular spatial data stored in the Adams County GIS is accessible by the Query App. The data is available in all GIS formats supported by ESRI. More emphasis is currently being placed on leveraging Arc Spatial Data Engine (ArcSDE) technology to access and store this spatial data.

Reports – The Query Application supports report functions available in ESRI's ArcView 3.x. Custom reports are supported by sending a request to the ArcView/Crystal report engine with combined spatial and RDBMS data. The reports supported by the Query Application allow users to print ad hoc mailing lists or property reports with user specified attributes.

SQL Query Sender – The SQL Query Sender is the core of the Query App. It is a combination of scripts written in the ArcView programming language, Avenue. It sets up all the database connections to all external RDBMS and formats the queries sent out by the GIS to the various RDBMS. It also formats the results received such that they are used efficiently in the GIS. The critical piece of the SQL Query Sender is the implementation of Dynamic Data Exchange (DDE). DDE allows the SQL Query Sender to listen for and respond to requests from other applications and systems facilitating seamless integration with the GIS. One key example is the Assessor's department Computer Aided and Mass Appraisal (CAMA) Systems integration to the GIS. The

[3] Source: Adams County GIS User Manual

CAMA system sends parcel requests to the GIS via DDE to the SQL Query Sender, which then retrieves the requested parcel from the parcel library. Once the parcel geometry has been retrieved, an SQL request is sent to the Assessor permit system and any associated permitting information is retrieved. Users are also able to request data from other county databases in relation to the original parcel number.

Application Extensions

The individual services available in the Adams Query Application are built as individual ArcView Extensions.

[4]Extensions allow you to share customizations, documents, or any other objects in a project independent manner. The extension class is a subclass of ODB (Object Data Base). ODB objects allow you to save any ArcView objects to file and then later restore those objects to ArcView. Like an ODB object, an extension object allows you to save any ArcView objects to a file, but an extension has additional properties which allow you to define how to load and unload the extension into the current ArcView application and how to install and uninstall the objects it contains in the current project.

The Query Application uses the load and unload commands in Avenue to add or remove extensions. This loading and unloading of extensions translates to adding and removing GIS services in the Query App. A few of the existing GIS services available in the Query Application are census, parks, subdivisions, elections, Permit, etc. Three of them are described below in detail.

Census – This service, in summary, brings together tools to query and extract data from the various census summary files. On loading, it adds shapefiles for the Block (SF1), Tract (SF2) and Block Group (SF3) as well as a custom button to launch the census tool dialog.

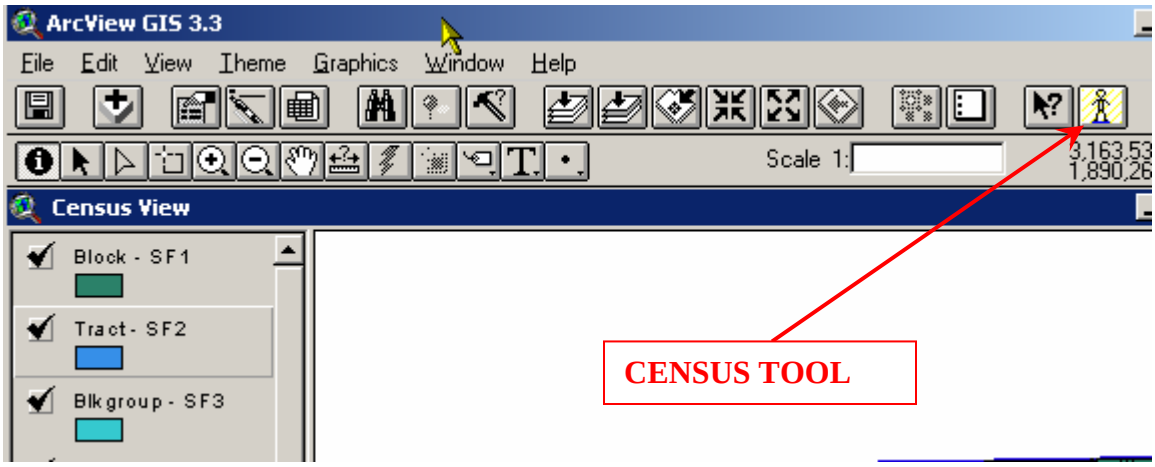

Figure 1- ArcView3.x showing census service.

Clicking the tool launches a dialog box that allows selection of what summary file to work with.

[4] ESRI ArcView 3.x Help Document, *Topic - Extensions, defined*

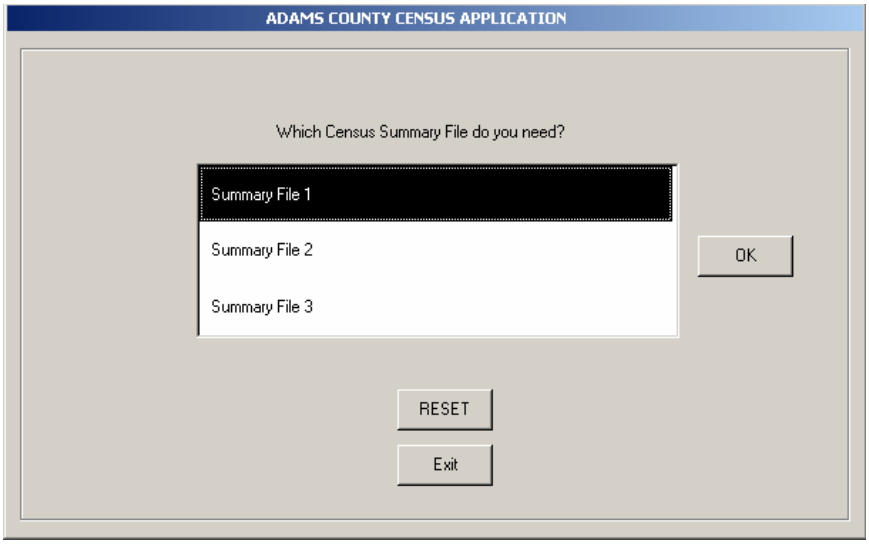

Figure 2- ArcView 3.x showing census Dialog

After selecting a summary file, a series of dialogs prompt for which summary file table or tables to work with. The "Show Fields" button returns all the fields from the selected tables. The "Select Fields" button formats the attribute tables for the summary file selected showing only the fields the user picked in the dialog boxes.

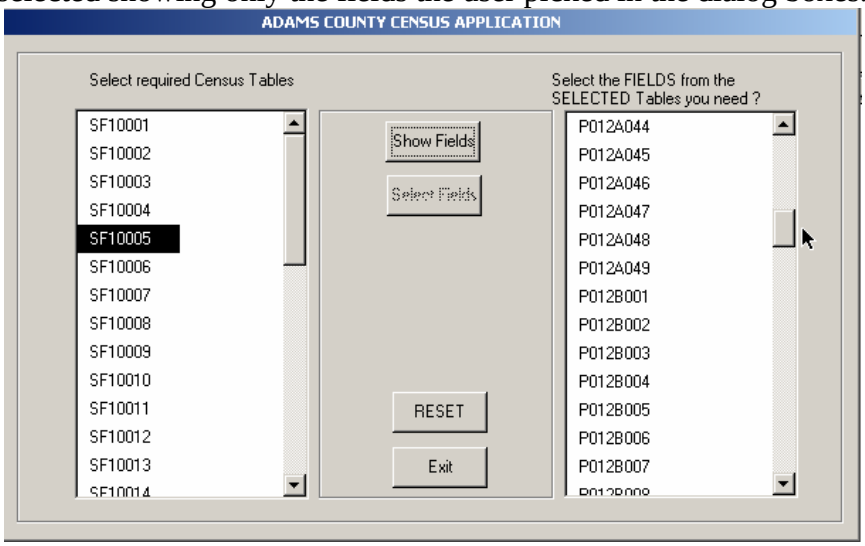

Figure 3- ArcView 3.x showing census dialog

The advantage of this tool is, it brings all the summary file tables and fields together in one dialog box and formats the result for analysis in a few easy steps.

Parks Maintenance: The parks maintenance service contains the Adams County parks and trails spatial data as well as various tools for maintaining parks boundaries, polygons and attributes. On loading, it adds shapefiles for the park and trails as well as a custom menu tools to create, delete and rebuild park polygons. There are also custom tools to query the parcel library for parcels within park boundaries as well as a web link tool that launches the web related update tool.

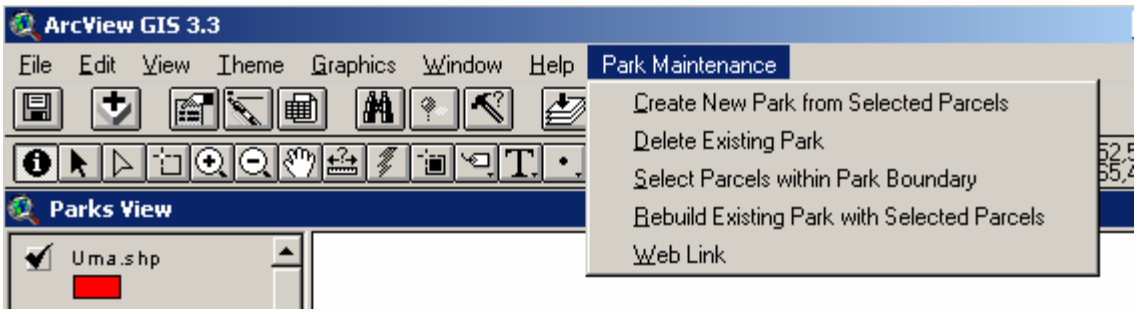

Figure 4- ArcView 3.x showing parks maintenance service

One of the key functions of this tool is the ability to build parks to match parcel boundaries or recreate an existing park to match new, updated or existing boundaries. This is achieved by constantly monitoring the selected parcels and creating or recreating the boundaries to match the outer perimeters of all selected parcels. In case of separate parcels, a multi- polygon feature is created. The advantage of a tool like this is being able to have a seamless and consistent generalized boundary for all polygon layers in the county.

Subdivision: The subdivision service contains subdivision and parcel information as well as numerous tools for querying and retrieving appraisal and tax information about parcels. It is closely tied with the county Computer Aided Mass Appraisal (CAMA) system. Once the service is loaded many tools are added to the ArcView interface, ranging from specialized query, analysis and buffer tools to local and web reporting.

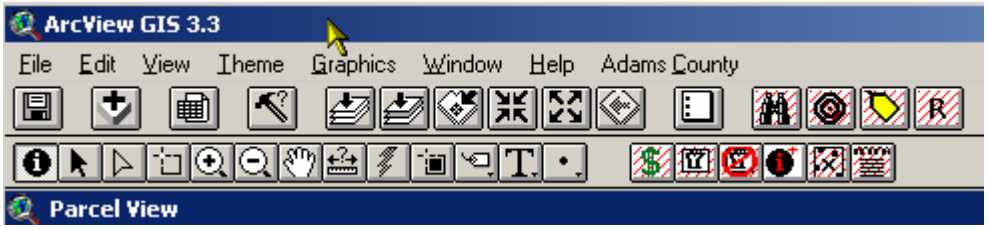

Figure 5- ArcView 3.x showing subdivision service tools

 *Primary Search Button*: This is the starting point of the Subdivision tool. It allows parcel search by parcel number, address, owner name, and PLSS.

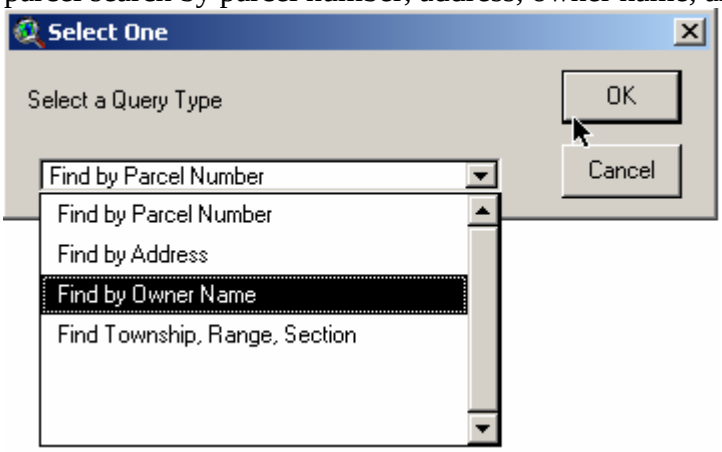

Figure 6- ArcView 3.x showing subdivision search dialog

Each search choice presents the user with other dialogs specific to the chosen query/search type. For example, a search by owner name yields the following dialogs:

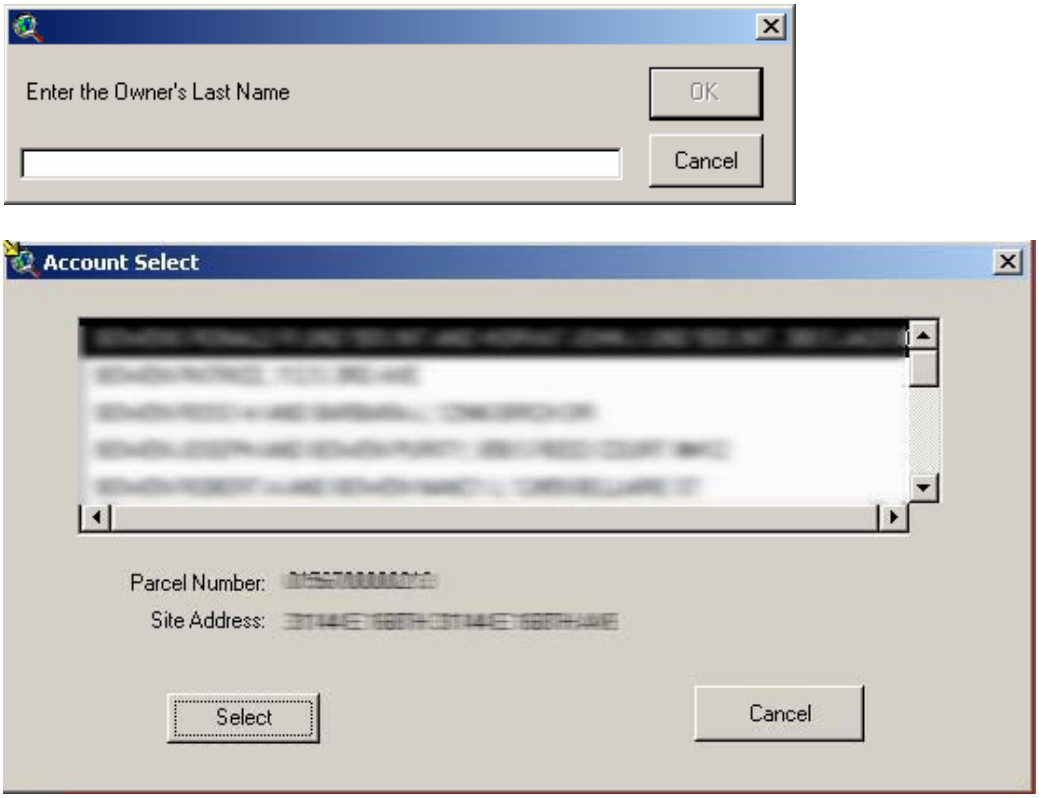

Figure 6- ArcView 3.x showing Subdivision service dialogs

Once a search criteria has been identified and parcels selected the user is prompted to specify what other attributes to retrieve for the selected parcel.

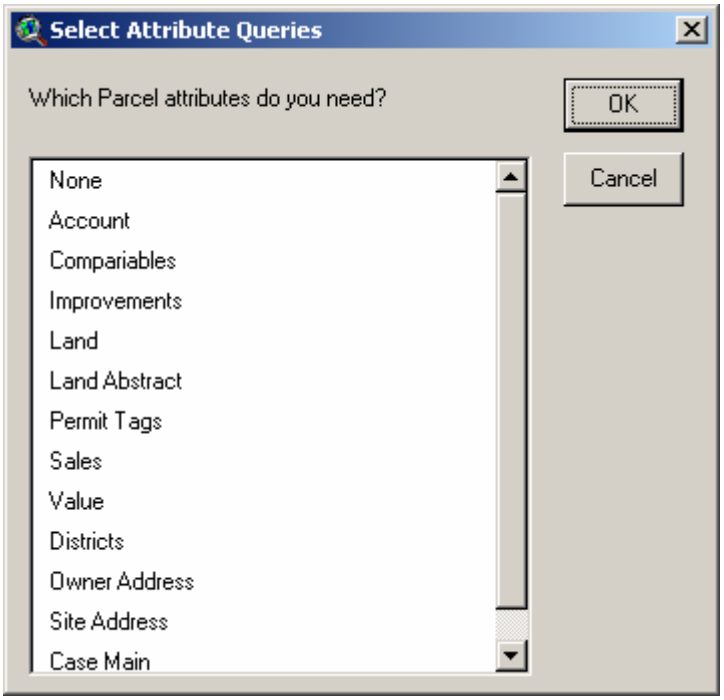

Figure 7- ArcView 3.x showing subdivision dialog

Each of the options sends queries to the county CAMA and Permits systems via the SQL Query Sender and returns the data formatted. This returned data is joined to the spatial data presenting the parcel and all the external RDBMS info seamlessly.

 *Find Neighbors Tool:* This tool allows the user to return all the parcels around the selected parcel within a specified buffer area. This is a great analysis tool, especially in carrying out property valuations and real estate queries.

 *Permit Tag Information:* This displays any parcel permit tags associated with any of the parcels selected. [5]Parcel Tags act as flags in the Permit System to notify case reviewers of a special circumstance that exists on or near a property. These tags are pulled into the GIS so they can be reviewed and interpreted.

 *Tax Area Tool:* This locates the tax district information for the selected parcel/s. It is based on queries sent to the CAMA system. Areas outside of the selected parcel/s that are inside the tax district can be drawn using the tax district code as a reverse query.

 *Select Parcels from a District:* This tool [6]queries parcels that have their center in the active theme's selected district.

[5] Source: Adams County GIS User Manual
[6] Source: Adams County GIS User Manual

 *Find Comparables:* This tool is used to identify properties that are associated by their characteristics and tax value.

 *Select Parcels with Incorrect District:* This queries selected parcels for their associated Assessor Tax Area districts to find inconsistent values.

 *Extended Identify Tool:* This tools improves on the basic ArcView identify by querying all the associated tables in the project for attributes and displaying it in a single screen. This in essence brings all the selected values of related not joined tables into the identify window.

 *Web Report:* The web report tool allows users to retrieve an Adams County property report from the County Assessor's website for selected parcels.

 *Reset Tool:* The reset tool returns [7]the application back to its original state and zoom extent. This button will not remove layers from the project but it will remove tables that you have opened from the Permit and/or Assessor databases.

Reports: From the Adams County Menu, reports can be run to create mailing labels based on the current parcel selection.

Internet Map Services[8]

Internet Map Services (aka GIS Web Services) are created to deliver information to non-technical consumers of map base information. The service is designed to deliver basic GIS functionality to County staff and the public. Generally, each map service, like the desktop map service, is designed around a specific set of data (data-centric) or user (user-centric).

A User Interface for the Adams County GIS Web (Map) Service is depicted below. Any internet browser (client software) can be used to access and use the application but IE is recommend because it is used to design, develop, and test the application.

[7] Source: Adams County GIS User Manual
[8] Source: Adams County Website:
http://www.co.adams.co.us/gis/gisdocumentation/GIS_Web_Application/Web_Services.htm

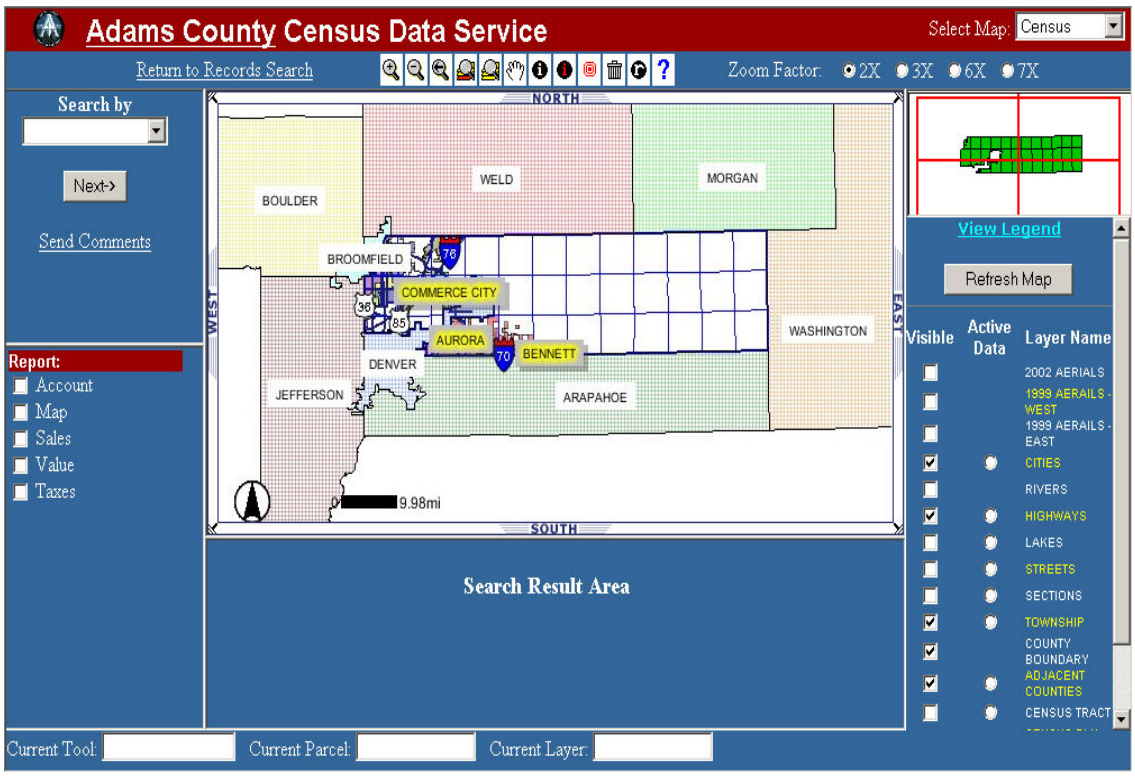

Figure 8- Adams County IMS map service

Application components are used deliver the functionality of each map service. The components are each composed of various controls that allow the user to request and display information. Each application component will remain constant regardless of the selected map service. The following components are provided by each map service:

Map View: The Map View is used to display map data and let the user "pan" in directions indicated on the edge of the view.

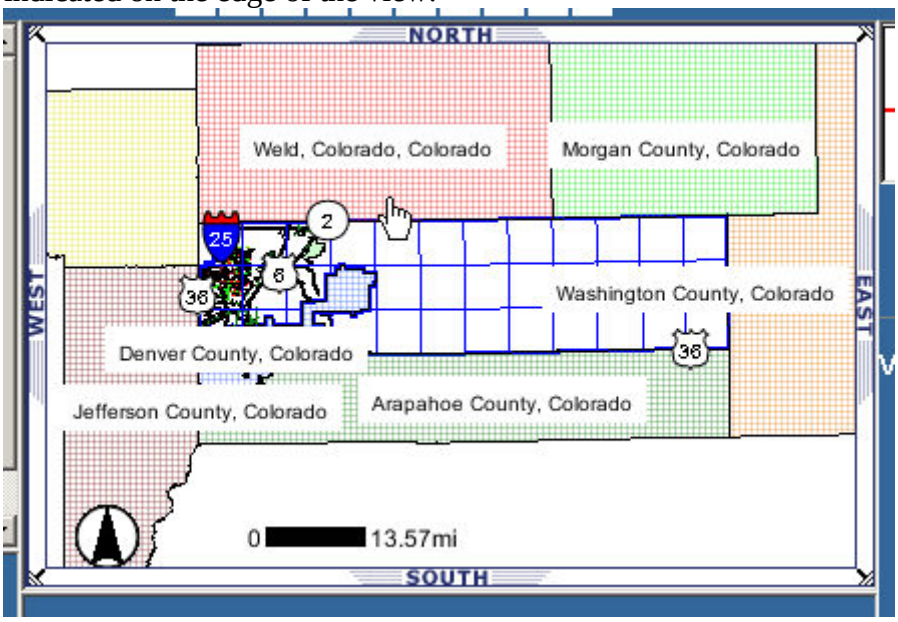

Figure 9- Adams County IMS map service map view

Map Services: This drop-down menu is the key to the whole application. It embodies the concept of services by controlling what layers, tools and reports are available to the user.

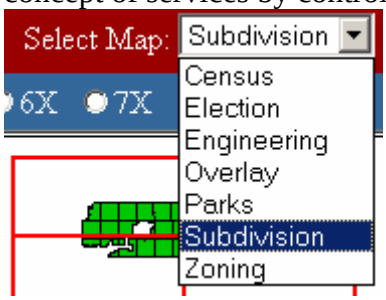

Figure10- Adams County IMS map service list

Changing service does not change the extent of the view or the look and feel of the site. This approach maintains a consistent look for the application regardless of what data is being displayed.

Search Results Area: The Search Results area in the lower center of the User Interface is used to display and select results from Search and Identify  queries.

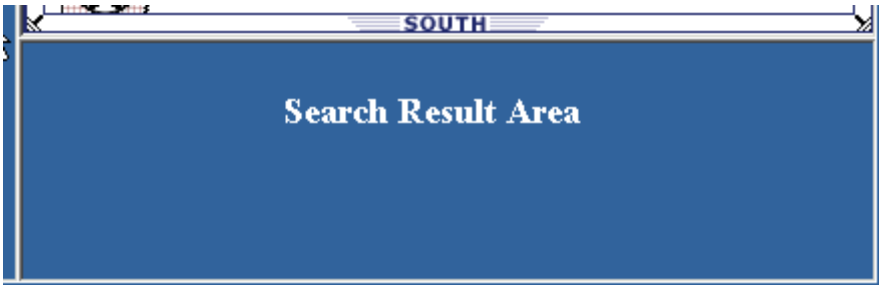

Figure 11- Adams County IMS map service results window

Table of Contents (aka Map Legend) Area: The Table of Contents is used to set and describe the content of the Map View Window. It contains the Map Overview to depict where the view extent is pointing, the Legend hyperlink View Legend to look at how the maps layers are rendered (drawn), the Refresh Map button Refresh Map to update the map view after adjusting browser window size or "visible" layers, and the Layer List to alter visible and active layer in the Map View. Layers may appear and disappear based on the scale (zoom) of the view.

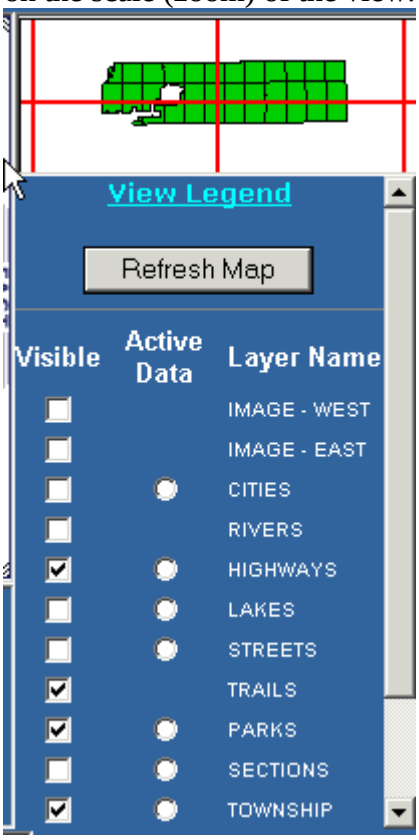

Figure 12- Adams County IMS map service legend

Report Area: The Report Area is used to identify and request reports from the system.

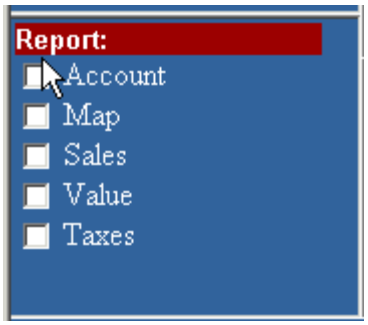

Figure13- Adams County IMS map service report options

Application Status Bar Area: The Status Bar is used to identify the current status of components in the application including the Current Tool in the Application Tool Bar, the Selected Parcel in the Map View, and the Active Layer in the Table of Contents.

Searching for the database is a built-in functionality of each Map Service. Search capabilities of each Map Service may vary slightly to reflect the data that is included. For example, the Election Map Service will contain a "Precinct" search type that the Park's Map Service does not have. Likewise, the Park Map Service will have a "Park Name" search type that the Elections service does not have. All Map Services have the ability to search using user specified criteria or geographic search tools.

Viewing or visualizing data is done with the Map View components of the application. While Map View components can be used to alter the geographic extent of the map, the Table of Contents (aka Legend) and Application Tool Bar components are available for the user to interact and alter the Map View components.

Reports are requested from the Report component area found in the lower left corner of the application User Interface. This Report area is used to list, select and request the various property reports. The Report area contains a list of property report types 

with a check box next to each one. One or many report types can be selected at a time by clicking (checking) 

the appropriate boxes. The Show Report button 

will appear only when a property (parcel) is selected from the Search Results area. Use the Search Criteria to query properties from the database or use the Identify tool 
with the Parcel layer "active" to query properties geographically. A select property will trigger the Show Report button to appear. Click the Show Report button 

to generate a report with the selected report types.

Challenges and Limitations

The major limitation facing the Adams County GIS implementation is trying to maintain a consistent toolset when using GIS regardless of whether data is accessed via the desktop or the Internet. For the most part, the implementation has been able to achieve this, but limitations and sacrifices exist with each of the technologies that prevent using the same exact tools on both sides. For example, measure tools, which are standard with the desktop products, are more challenging to implement in the Internet map service environment. Two types of viewers are available with ESRI's IMS software, Java and ActiveX. The Java viewer supports measure tools but does not have the performance of the ActiveX viewer. The Adams County Internet Map Service was built with the ActiveX viewer to take advantage of its performance notwithstanding the obvious trade-offs.

This limitation has proven itself the major challenge facing the map service approach. Workarounds have had to be created to duplicate functionality so the tools and features at least appear consistent.

Conclusions

Using the concept of uniform map services across various GIS access tools has proved a good choice for Adams County. The obvious advantages in terms of implementation, usability and user training have been tremendous. Non- technical or non-GIS types can move between the various environments with much less training and handholding. This means improved productivity and faster and broader acceptance of GIS. From the management and development perspective, such a consistent approach means less time is spent planning and developing separate user interfaces and applications. More focus is placed on functionality meaning applications and tools are produced faster.

Note that this concept of packing tools is not new, it might sound different but it is not rare in GIS. ESRI's use of extensions is the same approach, the only difference is that with the Adams County Map Services, data is an integral part of this packaging.

References:

An Enterprise Approach to GIS System Management and Implementation. *A case study of Adams County, Colorado. Keith Hangland, et al, June 2004*

Adams County GIS User Manual, *October 2003*

ESRI ArcView 3.x Help Document, *Topic - Extensions, defined*

Adams County Website:
http://www.co.adams.co.us/gis/gisdocumentation/GIS_Web_Application/Web_Services.htm, *June 23, 2004*

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