Development of an Automated Access Management System for Highway Driveway Access

By

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ABSTRACT

In late 2000 the FHWA Research commissioned a Phase I Small Business Innovative Research project to explore methodologies for automated management of additions/deletions of driveways to highway systems. Successful execution of Phase I led to a Phase II effort to develop a prototype software system for use by various state highway departments to evaluate and monitor additions and deletions of driveways to highway systems, including fee structure, development changes, plus owner and highway agency compensation issues. The proposed approach was to use accurate 3D stereo imagery as a foundational user interface and analysis tool. Prior work with District 3, Florida DOT (FDOT) had resulted in development of accurate 3D stereo imagery for use in collection of roadway characteristics/asset information. This provided an excellent opportunity to expand the use of this imagery for a new transportation management application. Phase I of the effort investigated the current issues and challenges associated with access management permitting in District 3 FDOT. An assessment was made of the enabling technologies that would be needed to build a prototype to solve these challenges. Development of the prototype was begun in December 2002 with functional deliveries staged at 12, 16, and 22 months. Stage I development has proceeded at a satisfactory rate and initial prototype capabilities are currently being reviewed by a commercial engineering firm and at District 3 FDOT offices.

STATEMENT OF THE PROBLEM

As the United States has become more developed and urbanized, the issues related to providing driveway access to America's busy thoroughfares have become very problematic. These facts have led to the concept of "access management", the goal of which is "to achieve a safe and efficient flow of traffic along a roadway while preserving reasonable access to abutting properties". Access management goals are realized by implementing management practices in five areas. These areas are driveways, medians, median openings, traffic signals, and freeway interchanges. In general, the issue of driveway access is the most difficult since it involves the issue of balancing a property owner's right to reasonable access with the public good that comes from having efficient, well-managed traffic flow. These goals often stand in opposition to each other and access management plans seek to address the delicate balance between these two goals.

Another significant factor is that as property values have increased so have the costs of acquiring private property to implement best practices for proper access management. In the past transportation entities were able to budget flat rate numbers of around ten percent for acquisition costs for transportation projects. Some agencies are now experiencing costs approaching fifty percent for right-of-way acquisition.

Although access management is a relatively new discipline, most states have developed access management procedures and standards in an attempt to fairly and consistently manage the driveway access permitting process. Some states have developed some level of computer-automated processes for automating the driveway access permitting process. To date these systems have addressed the problems of standardizing input and tracking but have not addressed any tools to help the permitting agency analyze the permit application to reach reasonable, consistent permitting decisions.

The Federal Highway Administration (FHWA) Office of Real Estate Services (HEPR-20) looked at the driveway access permitting processes and felt that improvements are needed in current systems to improve the ability to make good driveway permitting decisions. In February of 2000 FHWA issued a research topic under the Small Business Innovative Research program seeking innovative approaches to the driveway access permitting process. The topic was as follows:

> "**Topic FH-4 Development and Implementation of Automated Management of Additions/Deletions of Highway Driveways**- Research is needed in Phase I to explore methodologies for automated management of additions/deletions of driveways to highway systems. Following successful completion of Phase I, a follow-up effort in Phase II may be undertaken to develop prototype software systems for use by various state highway departments to evaluate and monitor additions and deletions of driveways to highway systems, including fee structure, development changes, plus owner and highway agency compensation issues."

Previous efforts have focused on providing a standardized, web-based approach to permitting, but have provided very little in the way of analysis tools. The ability to "evaluate and monitor" implies a need to have an automated process with linkage to a broad range of data.

Issues and Challenges in Florida DOT District 3

The Phase I research effort focused on driveway access permitting in Florida, and more specifically within District 3 of the FDOT. District 3 is one of the most rapidly growing parts of the state. Once largely rural farmland, many parts of the district are now experiencing growth management issues akin to those of the most urbanized areas of the country. This rapid development has placed a strain on the ability of the existing infrastructure to adequately assess and permit requests for new and/or altered highway access. Florida like most states currently uses a paper-based permit application system augmented by a database tracking system called the Permit Information Tracking System (PITS). The PITS was originally developed to provide data at the state level regarding permit actions and fee related issues and was not designed to facilitate any automation to the existing access permitting system.

The access permitting process is initiated by a paper-based permit application. This permit application is fairly extensive and defines and requests all the information needed to make a proper decision. The permit application does not specify standard data or drawing formats. As a result, the required data is often not presented in a manner conducive to proper analysis. Interagency sharing of the permit application data requires extensive reproduction and non-electronic transfer that leads to delays and occasional lost data packages. Faced with the process delays and permit denials, developers and property owners often use political pressure as means of circumventing the process. This can and has led to inappropriate approval results often because the approving authority does not feel they have sufficient justification to deny access.

No comprehensive automated information resource exists for determining whether proposed new driveway connections to the roadway system are consistent with Florida's Access Management Standards or what the impacts are of proposed modifications to existing roadway connections. Proposed land development or redevelopment activity generally dictates the need for new and modified access to roadways. These land developments are initiated through the site plan review process at the local level. During this process, land use planning staffs work with engineering representatives of land developers to finalize proposed site plans to assure adherence to local land development regulations. In Florida, the State's Growth Management Laws require that local governments incorporate the FDOT driveway connection standards into local land development standards. Despite that fact, development planning is often well along before it becomes apparent that the access plan for the property is flawed. This leads to delays and plan rework since the final permitting authority for new and modified connections to the state roadway network is the Florida Department of Transportation. The decision process would be better facilitated by effective coordination among local governments and between local governments and the State Department of Transportation. Unfortunately formal process provision and tools to accomplish this coordination are lacking.

Another issue is that evaluation of adherence to the access management standards often requires evaluating conditions that extend beyond the jurisdiction of the local government and beyond what can reasonably be required of a local land developer. In practice, local governments often defer this review of the big picture to FDOT. Here again, the reviewing officials do not always have access to additional information that might have a material effect on permit approval. When this occurs the permitting office falls back on the guiding principle that the state will not deny "reasonable access". As a result, marginal and unsuitable driveway access permits are sometimes granted.

Another important shortcoming of the existing process is that "as built" inspections and post-construction documentation does not end up in any central repository. Upon completion of the driveway connection the local maintenance engineers go into the field to determine compliance with the permit. The local maintenance office is also charged with the responsibility of ensuring that the connection is entered into the state Roadway Characteristics Inventory (RCI) database. If a new connection is defined as a "major development" then the connection is entered into the RCI database upon an approved construction inspection. Otherwise, update of driveway connections are made on a five-year periodic schedule. Time and personnel constraints sometimes preclude thorough execution of this task. The "official" documentation package is filed at the local office level and no documentation is kept other than the PITS record and the RCI database.

Documentation and documentation maintenance of "as built" configurations were cited as problems by transportation officials in Tennessee, Oregon, and Colorado. Tennessee DOT personnel felt that use of periodic roadway imagery similar to that in use in FDOT District 3 could preclude the need for maintaining "as built" drawings.

From the onset of this research project, almost every person with whom we talked felt that the driveway access permitting process would benefit from some level of automation. Research was required to determine what elements are needed for an electronic permit application process. This entailed analyzing what elements are required to provide the approving authority with sufficient data to make a decision and ensuring that these data can be electronically provided by the permit applicant in commonly accepted open-architecture formats.

The issues and challenges noted in the Phase I research fell into one of three areas:

- Process issues
- Coordination issues

- Permit analysis issues

The specific element of these areas were analyzed and it was determined that many of these issues could be resolved by implementation of three automation capabilities along with related enabling technologies as noted below:

1. Electronic permitting capability to include web connectivity, web-based permitting application, automation of permit process business rules.
2. Improved automated coordination to include linkage of local and regional planning databases, automation of coordination process rules, wide access to aerial imagery databases.
3. Improved analysis tools to include development of process specific image analysis tools, ability to correlate GIS databases to imagery databases.

APPROACH

The initial prototype system approach, depicted in Figure 1 System Software Concept, postulated five system software elements. These were: 1) the basic user interface; 2)web-based automated permit processing applications; 3) automated permit analysis functions; 4) geospecific imagery database functions; and 5) automated database sharing applications. The initial concept for site connectivity is depicted in Figure 2. Figure 2 also highlights the fact that system users can include the permit applicant, the permit engineer, engineering sections supporting the permitting engineer, and local planning agencies who might need information related to current permits.

During the design process it became apparent that development challenges existed in the following areas:

- Framework for development of the user interface- The initial approach was to program the user interface using PERL script or Scalable Vector Graphics. ArcIMS provides a number of rapid development tools and was selected because it provided the highest probability for developing the user interface within the available timeframe.
- Stereo imagery service- The design postulated serving stereo imagery over the web together with visualization and analysis applications to be used in the permit analysis process. Service of stereo doubles the problem of serving imagery over the web since two images must be served for each view. A new viewer application was designed named Palantir after the “Seeing Stone” of Lord of the Rings. Palantir is based on ECW (Enhanced Compression Wavelet) technology. Of the current wavelet compression algorithms, ECW has the most robust approach to serving imagery over the web.
- Database handling and interface- The ability to access data from multiple inter-agency databases is a key enabling technology. ArcIMS provides some utility for this purpose, but extensions may need to be written to accommodate the requirements for database interoperability.

Figure 3 is a notional system design for this ArcIMS based system.

The functional implementation is taking place in a staged or incremental approach as depicted in Figure 4. This was to get working prototypes into the field at the earliest opportunity possible in order to get feedback from users.

PROJECT STATUS

Work on the Phase II prototype has been underway for one year. The application has been named ADAM for Automated Driveway Access Management. Significant progress has been made on the prototype ADAM application and is discussed in the remainder of this section.

User Interface Prototype Application

The ADAM prototype user interface is implemented in ArcIMS and currently provides the following functions:

- Allows user to access a forms application to complete a permit application.

- Allows user to access both county and FDOT data sources via geospatial map display to provide data to assist in filing applications.
- Allows user to overlay map display with relevant parcel data, roadway data, etc. to assist in filing applications.
- Allows user to store, print or transmit completed applications.
- Allows storage of permit data in the ADAM permit database for further transfer to the Florida Permit Information Tracking System and/or Florida Roadway Characteristics Inventory database.

Figure 5 and 6 are screen saves from the current ADAM user interface and depict the initial screen that a user would see.

Stereo Imagery Service

The stereo imagery service application, Palantir, is currently in a developmental stage. The preliminary version currently provides the following capabilities:

- Ability to serve ECW based stereo imagery over the web
- Ability to display ECW imagery in pure stereo, anaglyph stereo, and monoscopic modes.
- Ability to zoom, pan, and adjust image and cursor parallax for image viewing and vertical measurements..
- Ability to make linear and areal measurement as well as ability to measure elevation data.

Figure 7 is an anaglyph stereo image of the basic Palantir viewer showing imagery in stereo served over the web.

Database Handling and Interface

Database handling is complicated by a number of factors including:

- Varied data formats and the fact that not all GIS database systems are web enabled.
- Security concerns relative to allowing external access to enterprise databases.
- Data rights issues associated with enterprise databases.

The current database access structure uses a combination of web-enabled access for county-based GIS data and local “mirror” databases for such things as the FDOT Roadway Characteristics data. Current research is being conducted to determine if the ArcEngines capability of ArcGIS 9.X may provide additional flexibility in database connectivity.

Project Future Activities

The next major integration step in the project will be to provide connectivity between the Palantir application and the ArcIMS application. This connectivity will allow ArcIMS to make geospatially referenced calls to access both Palantir and its associated tools. The next major release stage is scheduled for the Summer of 2004.

SUMMARY

The project has proceeded quite well to date and implementation is on schedule. Technical hurdles still exist in integrating full measurement and vector overlay capabilities into Palantir. There are still challenges to be addressed with regard to database integration. Alternatives for solving these challenges have been explored and viable solutions exist. Prototype software capable of displaying stereo imagery data and accessing roadway and other geospatial data is currently in use by both FDOT and civil engineering users. Evaluation of these prototype tools is underway by both user groups. The civil engineering users have provided periodic input to the technical team as to what types of data, tools, and data formats would best serve their needs. FDOT is currently implementing changes to their IT policy that would allow implementation of the system on a larger scale. Both groups have been very positive about participating in the process and are assisting in defining system implementation to optimize how the tools might be used.

ACKNOWLEDGEMENTS

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FIGURES

Figure 1 System Software Components
Figure 2 System Concept Diagram
Figure 3 Notional System concept Using ArcIMS
Figure 4 Staged Functional Delivery
Figure 5 Adding RCI Data to Permit Application
Figure 6 User Permit Application Via Map Interface
Figure 7 Stereo Anaglyph Palantir Image

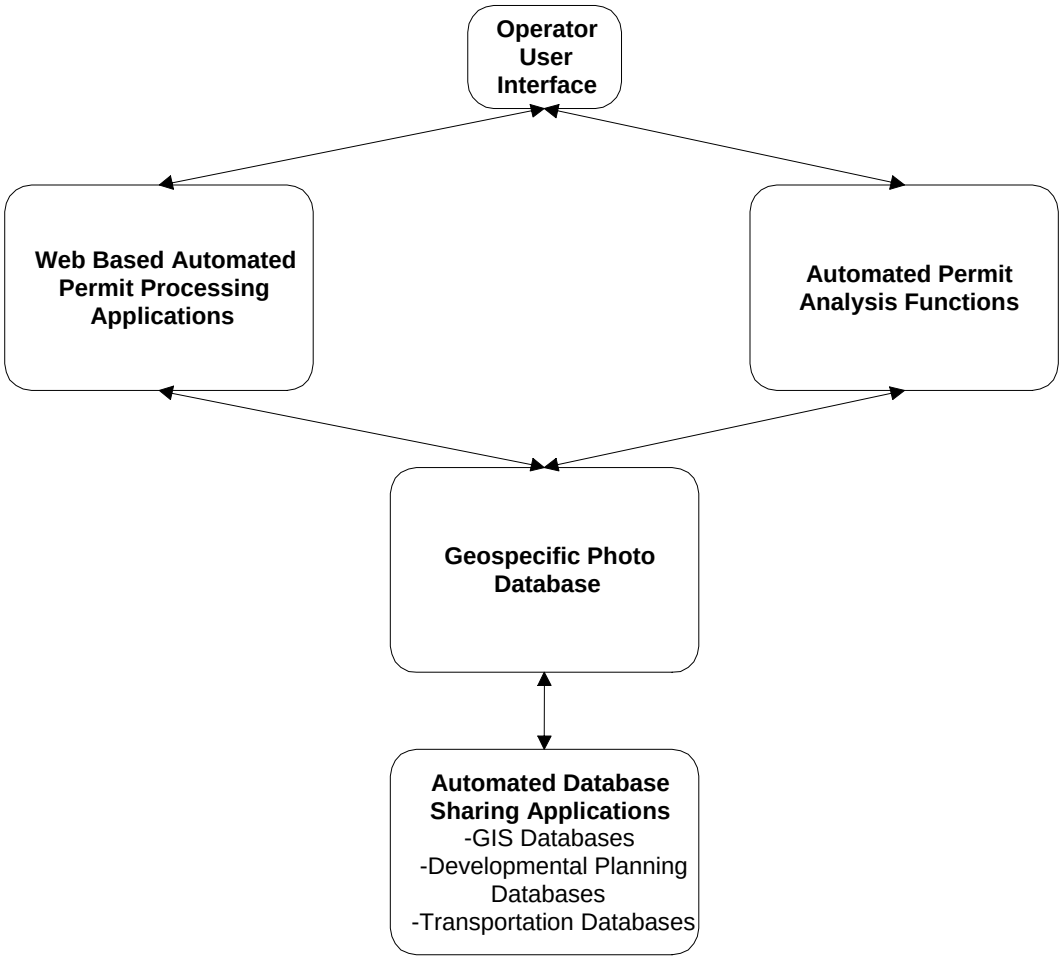

Figure 1- System Software Components

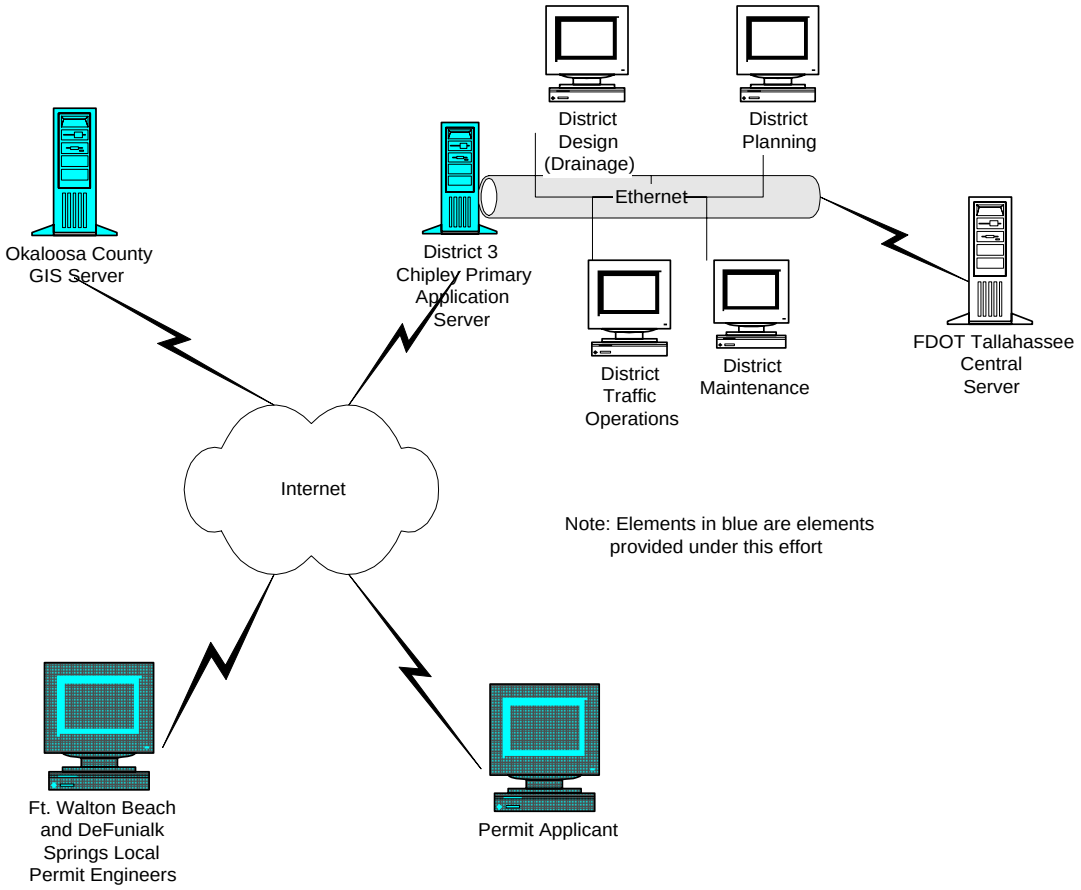

Figure 2 System Concept Diagram

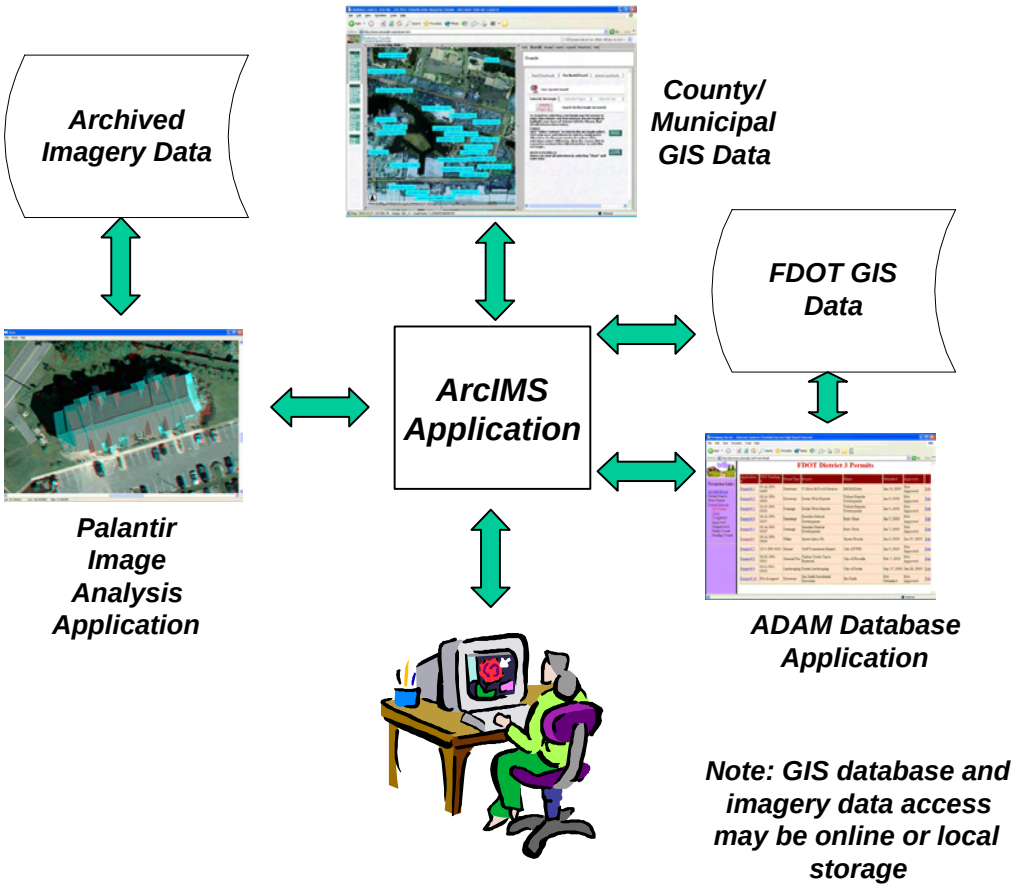

Figure 3- Notional System concept Using ArcIMS

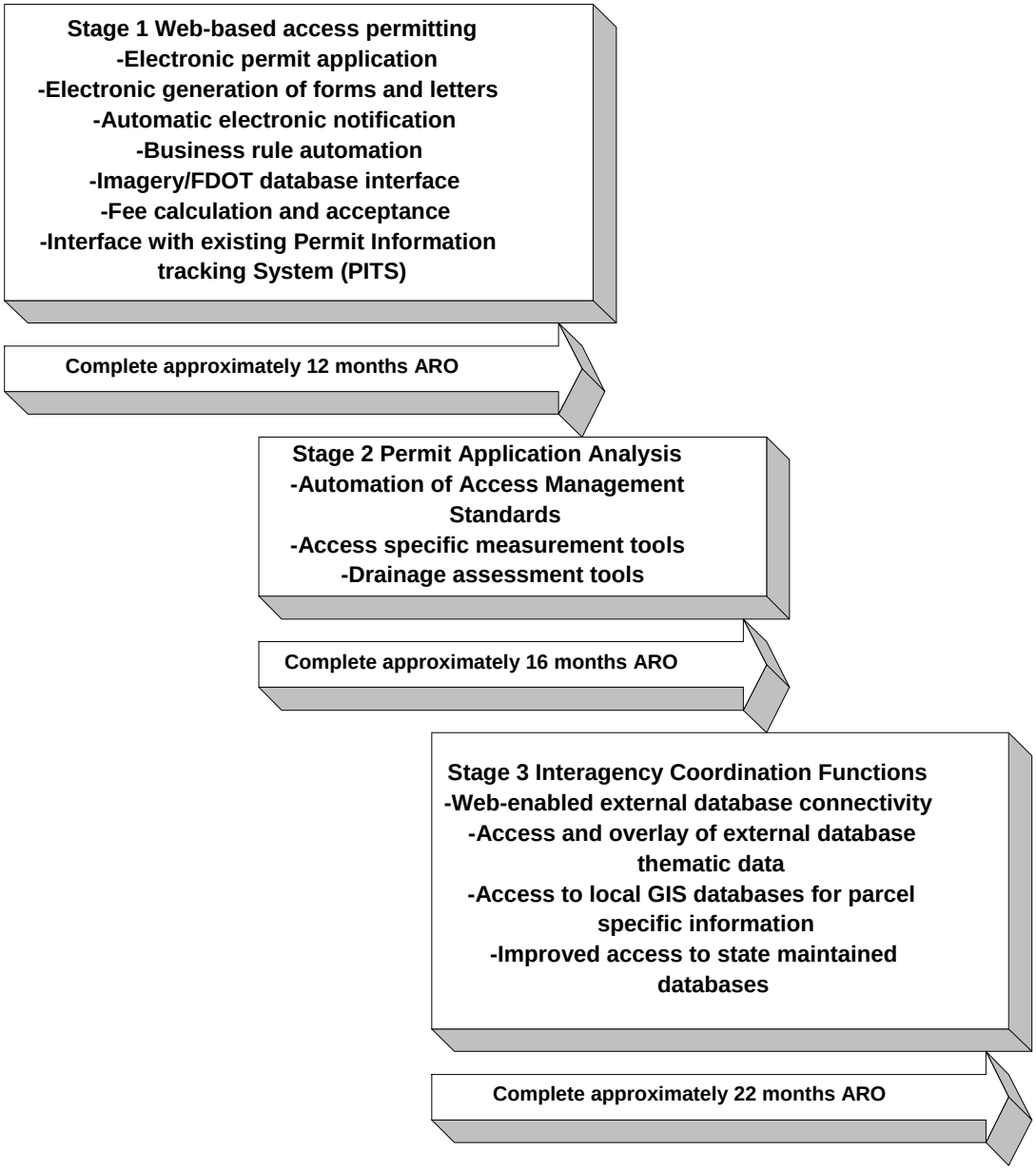

Figure 4 Staged Functional Delivery

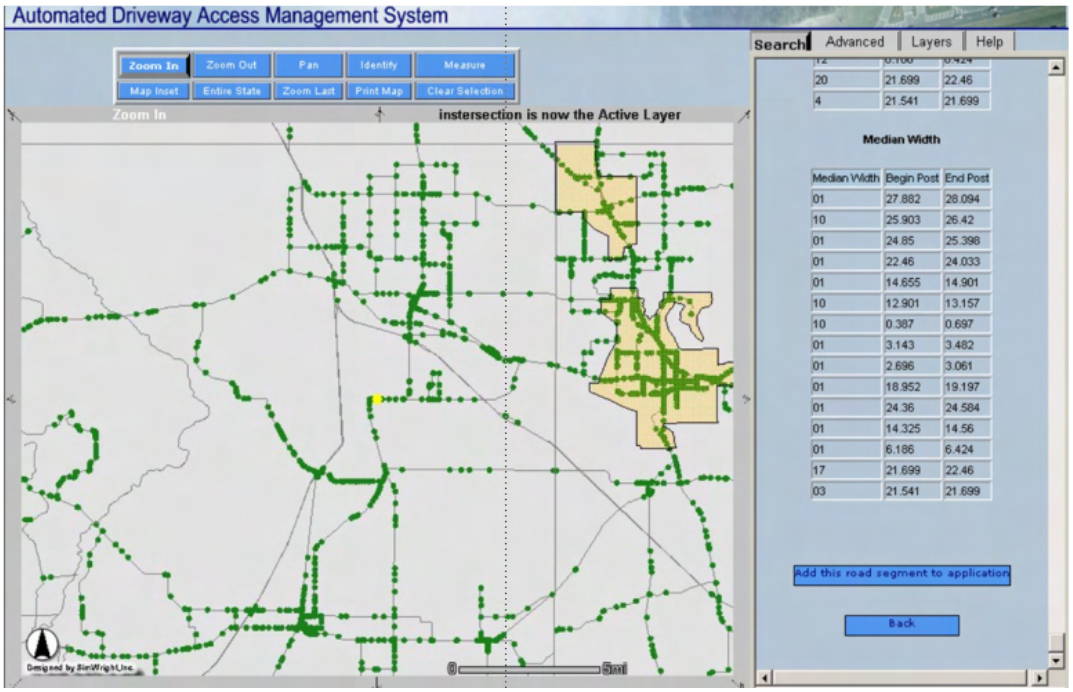

Figure 5 Adding RCI Data to Permit Application

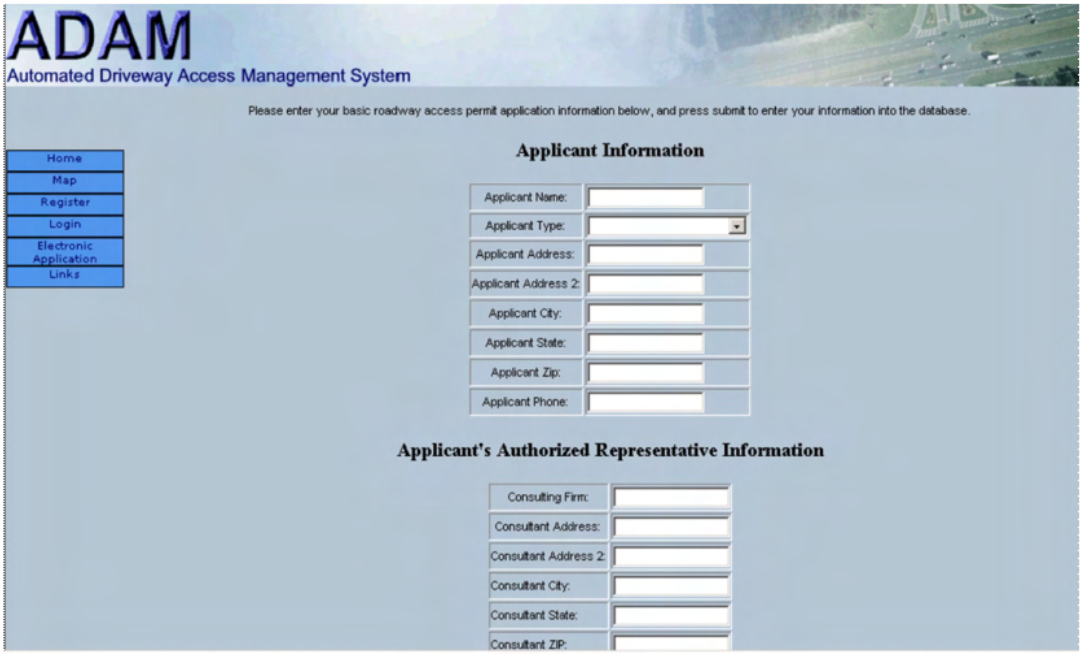

Figure 6 User Permit Application Via Map Interface

Figure 7 Stereo Anaglyph Palantir Image