Broadband Mapping and Network Design Using Realtime GIS

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Abstract

A major goal for the State of Michigan is to sustain efforts needed to strengthen the state's economic base. While a number of strategic policy initiatives and programs have been enacted to meet this goal, none is more important than improving access to high-speed telecommunication services and assuring that comprehensive information is available from carriers and other service providers regarding the type, quality and location of services. This paper presents the development of a "Realtime" online mapping application deployed during the data collection phase of the LinkMichigan Regional Telecommunications Planning Program. The integrated software application designed utilized ArcSDE, ArcIMS and Java to provide telecommunication providers a means to map their facilities, service areas and proposed broadband networks, online in Realtime. The relevance of employing these technologies for creating Realtime, online mapping applications is limited only by one's imagination.

Introduction

One of the major goals of the Michigan Economic Development Corporation (MEDC) is to sustain, on a long-term basis, efforts that are needed to strengthen our state's economic base. Improving access to high-speed telecommunication services is the most important state economic infrastructure issue for the new century; not roads, not sewers not water, but telecommunications infrastructure. Whether for business, government, healthcare, or educational purposes, higher speed "broadband" access is increasingly becoming a necessity—not a luxury.

Michigan is a recognized leader in competing for new business growth and attracting and retaining a world-class workforce, but unless greater telecommunications access becomes available to all parts of the state, Michigan stands to lose its prominence.

Recognizing the importance of telecommunications access to Michigan's business climate and quality of life, the Board of Directors of MEDC has established, as a key element of its 2001 operating plan, the development of the LinkMichigan Telecommunications Planning Program (LinkMichigan) to expedite an advanced telecommunications infrastructure to all parts of the state. Facilitating the development of the most advanced and robust telecommunications infrastructure in the country is the goal of the LinkMichigan initiative.

Telecommunication Issues
Efforts to bring government and educational resources to citizens, educators, and learners throughout the state will not be fully realized without greater broadband deployment. Given the fast-speed connections needed for many courses and programs, the reality is that many families and children do not and will not have access to resources that others in connected areas have unless action is taken. Based on complaints filed with the MEDC and the PSC, dissatisfaction with broadband or "bandwidth" availability in the state is clearly increasing. Similar to problems being experienced in other areas around the country, Michigan businesses have found it difficult to access the type of high-speed service needed to conduct complex electronic transactions. Problems may not appear until the need for broadband is discovered and access is unavailable—or not available in a timely manner.

Just like traditional roadways, as more and more roads or "on-ramps" are built onto the information highway, larger "backbone" roads are needed to carry such traffic in a quick and efficient manner. Many regions of the state currently lack adequate backbone infrastructure to carry fast-speed broadband traffic.

Information about what capabilities exist throughout the state is critical. Developers and others planning for their telecommunications needs must have access to information that lets them know what is available, where it is available, and specific information on timing expectations for service installation. Another concern stems from the large amount of unregulated infrastructure being installed across the state. Utilities, railroads, school districts and others have installed fiber and advanced switching capabilities across the state with little or no knowledge to government officials.

Figure 1, shows a map of the states where telecommunication infrastructure projects were underway when the LinkMichigan project was initiated in 1991.
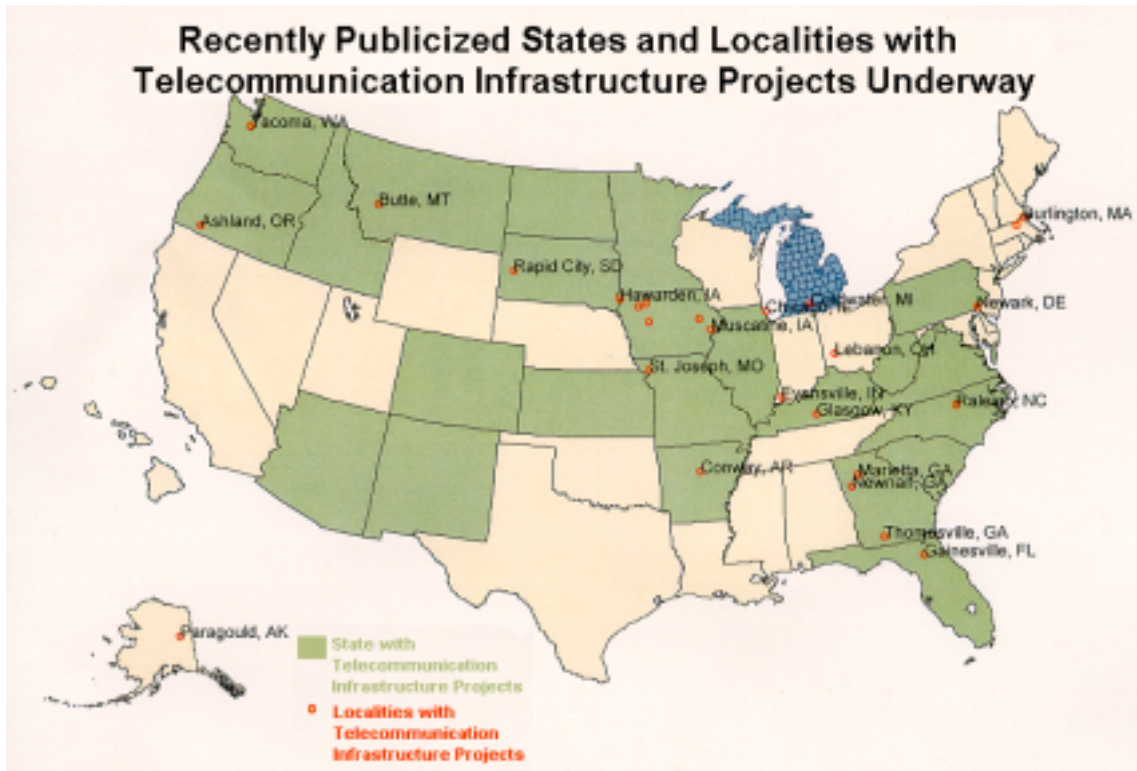
Figure 1 Michigan's Competition

To address the telecommunications issues described above, four primary initiatives were identified as goals for the LinkMichigan Telecommunications Planning Program. These were:

1) Right of Way Legislation
2) Broadband Development Authority Legislation to develop funding strategies
3) Statewide Aggregation
4) Regional Telecom Planning
        a) Current Infrastructure
        b) Anticipated demand for services
        c) Options for meeting the need
        d) Implementation plan including anticipated funding options

The focus of our project was initiative 4a, Infrastructure Inventorying. The challenge was how to design a mapping system for the Heart of Michigan Planning Group (HMPG) that could collect current infrastructure information from telecommunications providers in the format that MEDC specified, and also allow later infrastructure updates. Figure 2 shows the geographic extent of the HMPG region.
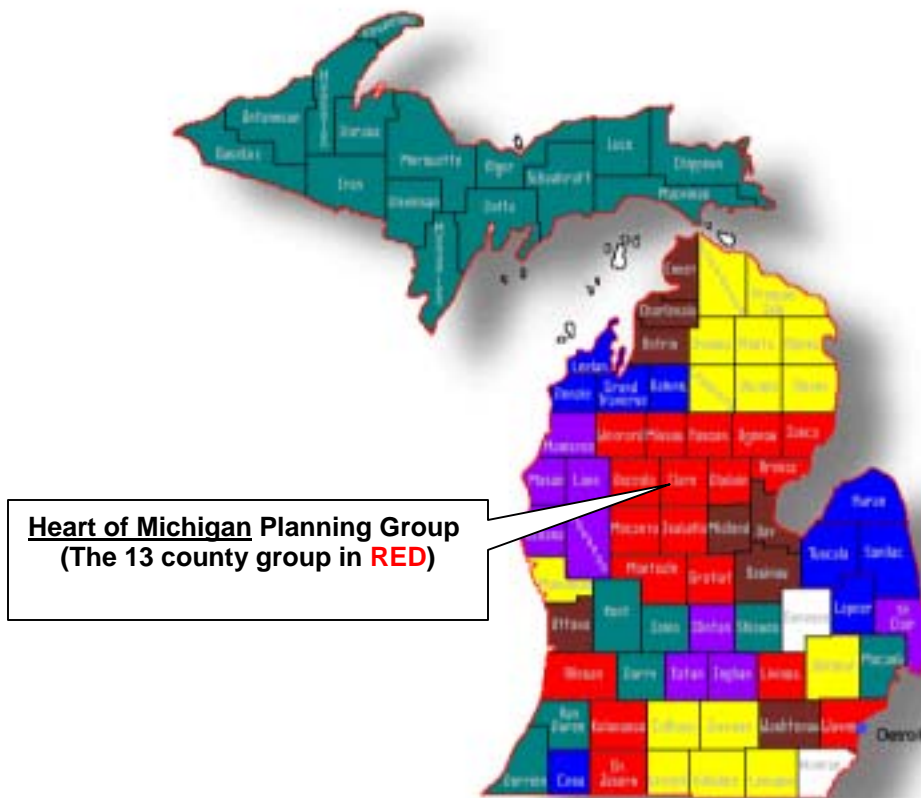
Telecom Planning Grants

Heart of Michigan Planning Group
(The 13 county group in RED)

Figure 2. Heart of Michigan Plan Group

Dynamic Telecommunications Infrastructure Planning System

The Dynamic Telecommunications Infrastructure Planning System (DTIPS) is a software application that was designed for the Heart of Michigan Planning Group (HMPG). HMPG was one of 24 planning groups in Michigan that applied to the MEDC for planning grants to collect telecommunications inventory data.

The primary purpose for the application was to provide a means by which telecommunication infrastructure and planning data obtained during the LinkMichigan Telecommunications Planning Program could be acquired and presented in a geographic context. It was recognized early in the planning for this project, by HMPG Officers and Staff, that the inventory data and method proposed for collection, would be much more valuable if the data collected was also mapped. The original plan by MEDC for the data collection phase of the project was to only capture the required information, via a questionnaire, and put those responses into an Access database designed by American Megacom Incorporated, a subcontractor to MEDC. Figure 3 presents the relational structure of the AMI database.
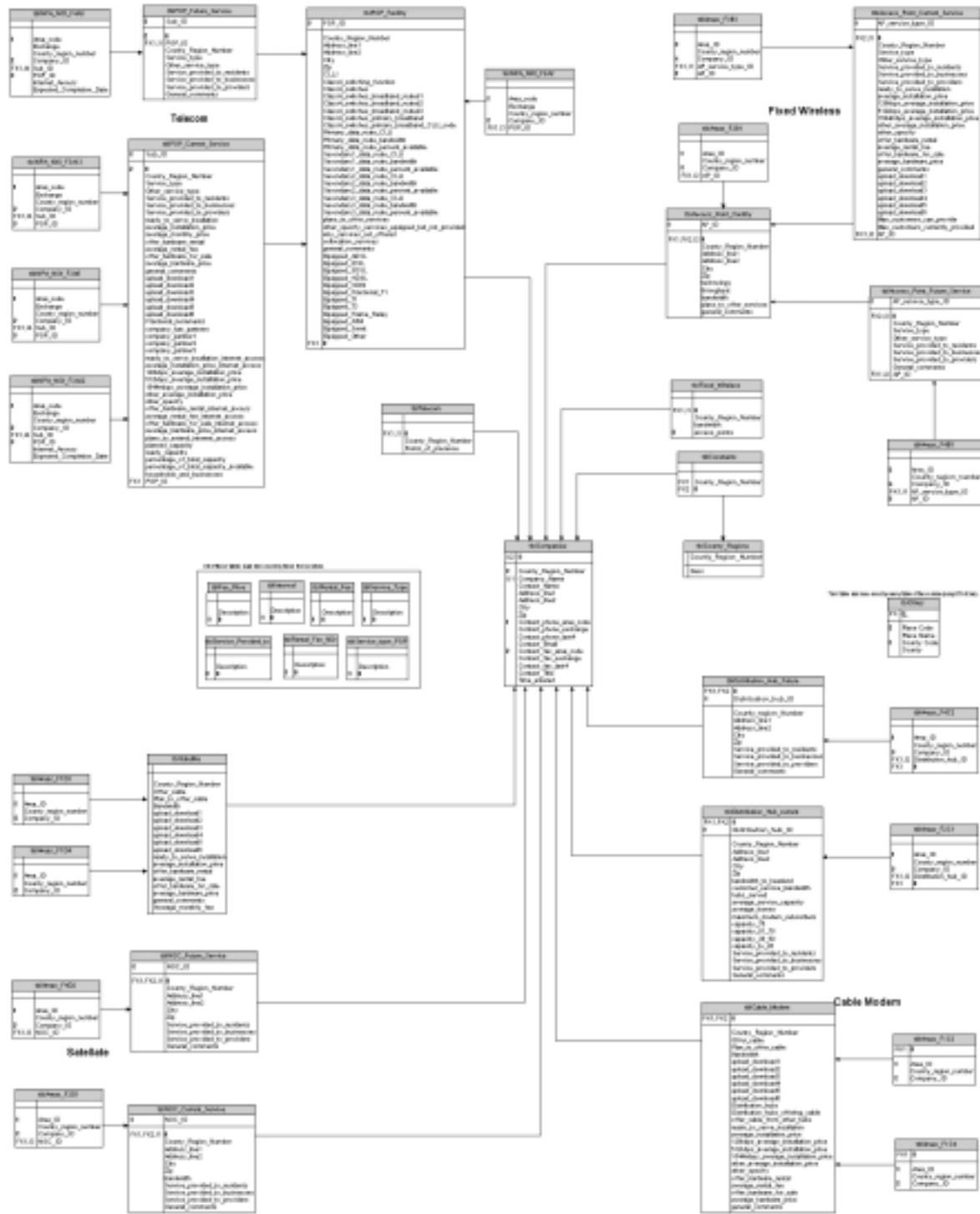
Figure 3. AMI Database structure

Secondly, it was recognized from the beginning of the project that the data being captured was dynamic. Therefore, HMPG wanted an application that had the capacity to make revisions to the data beyond the initial data acquisition period.

Thirdly, since the purpose of the LinkMichigan Program was to aid with economic development, the HMPG Steering Committee wanted the system to aid in future economic development decision-making processes.

Lastly, the final goal of DTIPS was to provide a mechanism by which users could provide input into the program during the grant period and suggest recommendations for changes to both the telecommunications data mapped by Merit Network and to the geographic basemap layers used as a spatial reference for placement of the telecom infrastructure.

To achieve these goals, all of the components were designed to take advantage of the ubiquitous-ness of the Internet and freely available Web browser technologies. We coded the AMI telecommunications questionnaires into ASP and integrated an ESRI ArcIMS map service with ArcSDE and custom designed JAVA tools to create a "real-time internet mapping application" that can capture telecommunications facility and service areas, over the Web.

An overview of DTIPS features is described below:

- Provide Telecommunications Providers with Internet access to Web-enabled questionnaires and to a mapping interface within the structure of the questionnaires that allows Providers to identify their facilities and service areas in order to create point and polygon shapes representing these features in real-time (DTIPS Provider Inventory Application);

- Assemble basemap geographic data layers acquired from the Center for Geographic Information, (CGI - State of Michigan) for each of the 13 counties which comprise HMPG, and established a Website which makes these data layers available to all users (DTIPS Map Viewer Application);

- Create Discussion Forum and Online Chat applications to foster data sharing and communication between HMPG residents and Governing Committee members (DTIPS Discussion Forum / Online Chat Application).

List of the DTIPS Component Functions

DTIPS has three main components. Each component performs specific functions and has its own website. These components are as follows:

1. DTIPS Provider Inventory Application
   http://maps.acad.emich.edu/online_form/
2. DTIPS Map Viewer Application http://maps.acad.emich.edu/hmpg/

3. DTIPS Discussion Forum /Online Chat Application
   http://maps.acad.emich.edu/hmpgdf/

Component I - DTIPS Provider Inventory Application

This component is the core component for the LinkMichigan Provider Inventory Application. This component provides Telecommunication Providers with a web-based questionnaire and interactive map interface, which can be used to link questionnaire data to facility location and service area geography. This component itself includes three parts: web-based questionnaire, real-time GIS mapping tool and the data security control tool (see figure 4).
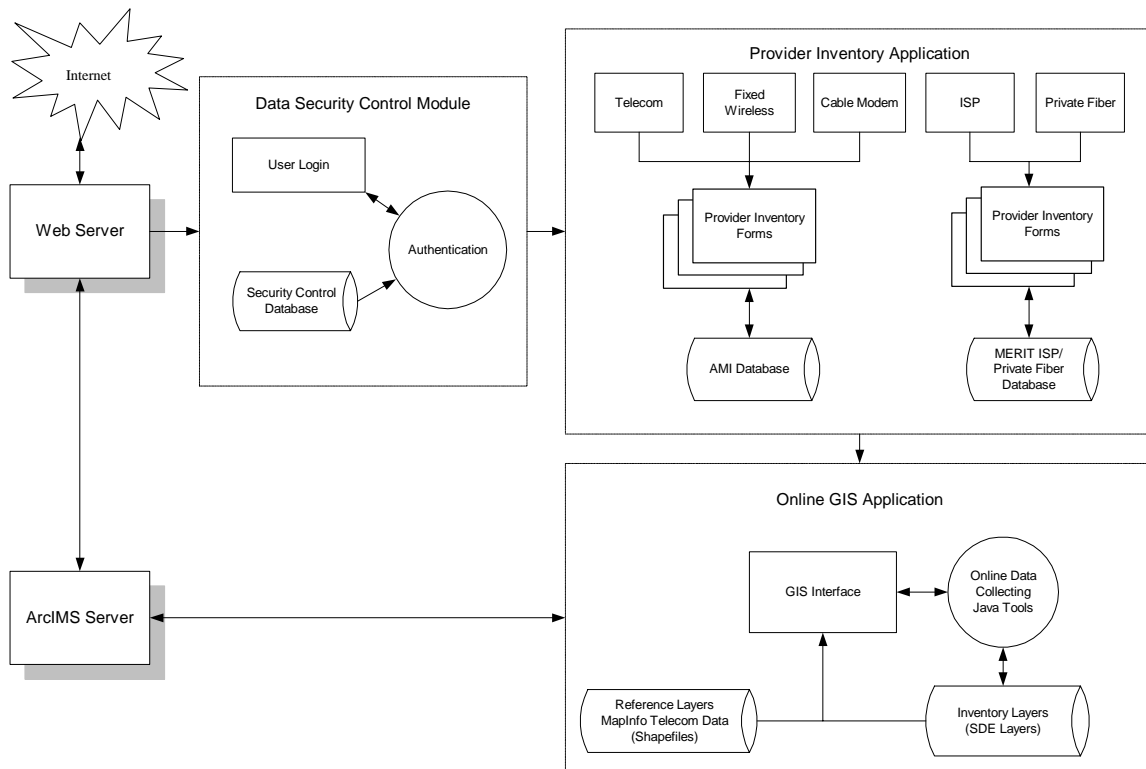
Figure 4. System architecture of the DTIPS Provider Inventory Application

The Web-based questionnaire portion is used to collect provider's information and save the information to the Microsoft Access database. It provides functions such as:

- o Collects/Edits Provider data
- o Collects/Edits/Deletes facility information
- o Provides the interface to the GIS mapping tool

There are five kinds of telecommunication services: Telecom, Fixed Wireless, Cable Modem, Internet Service Provider and Private Fiber Network. The providers can add, edit and delete their facility information and service data and add and edit defined attributes for the telecom layers.

The real-time GIS mapping tool provides many of the ArcIMS Toolbar functions, but also provides new real-time mapping functions developed in JAVA. These functions are:

- o Add Facility Points (allows creation of new facility points)
- o Draw Service Areas (allows creation a polygon shaped service area)
- o Create Service Areas using Buffer Tool Buffer (allows creation of a circular shaped service area)
- o Delete Facility Points and Service Areas.

These operations write data to a geodatabase in real-time and are presented to the Web user instantaneously (See Figure 5)
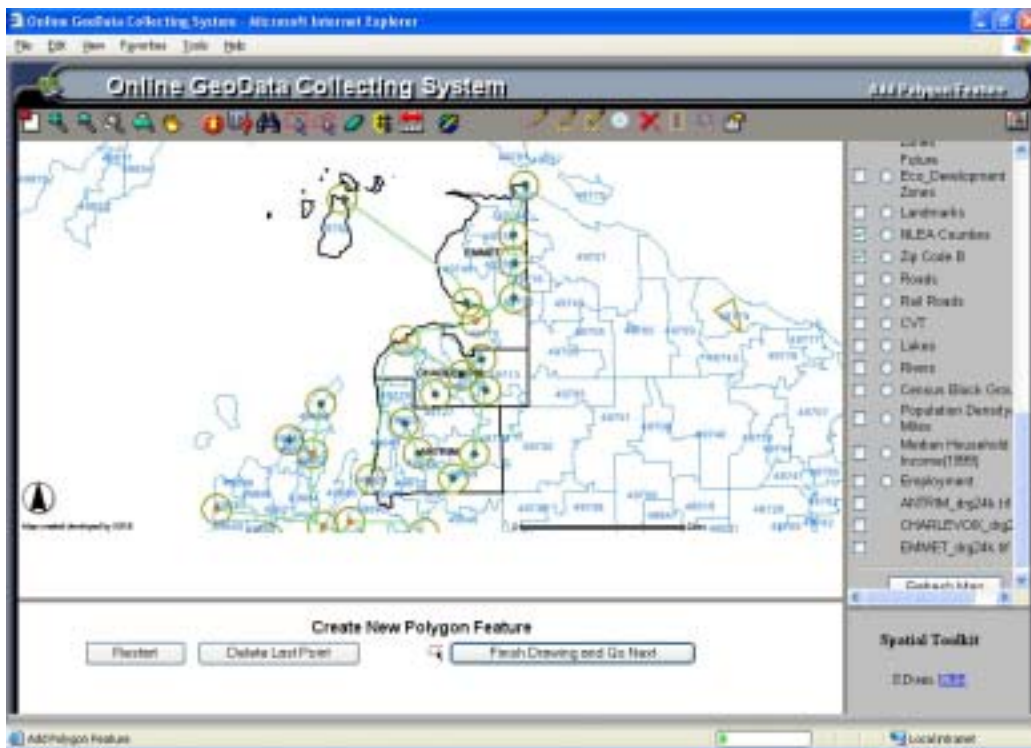
Figure 5. Interface of the Real-Time GIS mapping tool

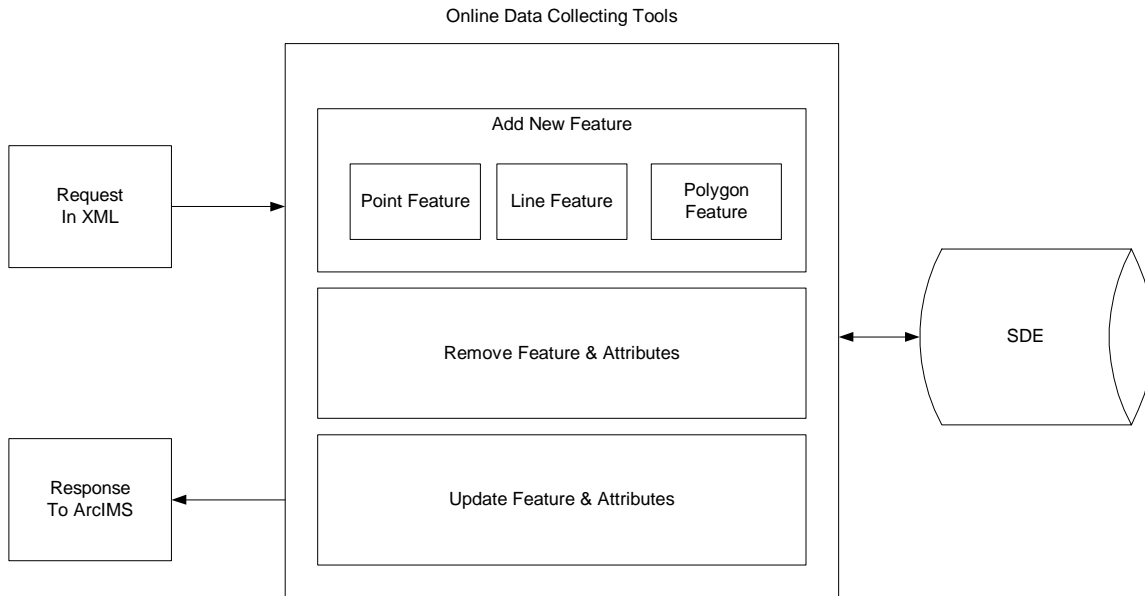Figure 6 presents the architecture for the JAVA tools, which create the features in real-time.

Figure 6. Structure of the online data collecting tools

The data security control module provides user management and authentication functions to the system. To gain data integration in the inventory database and the geo-database, each user only can modify his own inventory data.

Component II - DTIPS Map Viewer Application

This component provides the user the ability to view and interact with geographic data via a Web browser. Using the ESRI ArcIMS HTML Viewer and accompanying tools, the user can Zoom and Pan the Map Display Area, Identify and Find Features, Search for Features, Measure Distances and Set Display Units, Graphically Select Features, Buffer Features, Locate Addresses, and Print a Map. This Website also provides the shapefiles and corresponding metadata files to the user for downloading to a local machine for more in depth analysis, if they prefer.

Component III - DTIPS Discussion Forum / Online Chat Application

This component is to provide HMPG residents with a means to communicate their ideas to Steering Committee members managing the LinkMichigan Telecommunications Planning process. Using the Discussion Forum, users can post new topics for discussion into a selected forum, and then other users can respond to these topics. In addition to monitoring a discussion on a topic, the Discussion Forum allows users to add a file, or an attachment to their posting and in this way forums can be used as a means of sharing files and sharing work. Users can also browse discussion topics in all the other HMPG counties, not just their own county. The Online Chat application provides users who log into the discussion forum at the same time, a way to chat with each other online, in real-time.

Summary

The DTIPS development was unique in the state. The HMPG Steering Committee understood early on that the usefulness of this inventory data would come about only through the ability to map it. Through mapping, data becomes information that can support decisions. The DTIPS system is a powerful tool for the HMPG region.

The goal of the LinkMichigan Regional Telecommunications Planning Program was to provide telecommunications facility and broadband service area data to regional planning groups to aid in economic development projects. To complete the data gathering goals for the LinkMichigan Program, Merit Network (Merit) and the Institute for Geospatial Research & Education (IGRE) Web-enabled the Broadband Provider Inventory forms designed by American Megacom, Inc. Web-enabling these forms allows telecom service providers a convenient and simple way to complete the forms online rather than using paper forms. By completing the forms online, the data input is captured directly to an Access database without further word processing.

In addition to providing an online means to complete the provider inventory forms, Merit also recognized that the data collected using the inventory forms required additional information related to WHERE facilities and broadband service areas are located. Therefore, to capture these components, (e.g. to answer the WHERE questions), IGRE developed a process whereby specific form questions activate a real-time Internet mapping website, which can be used by providers to indicate where facilities such as Points of Presence, Access Points or Distribution Hubs are located, and can also be used to indicate where broadband service area boundaries are located.

The mapping tools provided on the Web site makes it easy for providers to map their central office locations and service areas and save them to a spatial database. Using this process, the facility data and service area boundaries identified are linked to the appropriate forms of the questionnaire and are also captured as a database record.

Using the online forms and map drawing tools together, gives the providers a powerful tool by which telecommunications maps can be easily created. These maps will be used later, by regional planning groups to make informed planning decisions with regard to telecommunications infrastructure needs in their jurisdictions. The maps will show things such as:

1) Where providers can "plug-in" their networks;

2) Where facilities are located and connected to fiber; and

3) Who the organizational contact is for a facility, including phone and email information for that person.

Knowing the location of the telecommunication service areas will provide valuable planning information on where additional facilities can be located, thereby increasing the utilization and efficiency of the existing network infrastructure components.

References
Michigan Economic Development Corporation report "LinkMichigan" May 14, 2001.
http://medc.michigan.org/cm/attach/94595AF5-BAE2-4BEE-856A-22DA8A130538/linkmichigan2.pdf

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