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In Energy and Infrastructure, Location Intelligence

GIS plays critical role in US telecommunications planning & security

By Kristen Davis

The U.S. faces thousands of national security threats each year; in case of emergency, it's imperative that our wireless telecommunication systems are active and defensible. For that reason, the Institute for Telecommunication Sciences, the research and engineering laboratory of the National Telecommunications and Information Administration, an agency of the U.S. Department of Commerce, provides propagation models essential to wireless communications planning to a number of government agencies.

ITS has been providing radio wave propagation predictions since before World War II, but times have changed. Since accurate geographic information is critical for developing accurate propagation models, ITS more recently developed propagation modeling website tools that use commercial geographic information systems to both acquire geographic data and display geographic coverage areas.

Previous propagation modeling programs required government users to have a concrete understanding of radio propagation and prediction concepts, but many of these models were ported to new programs that operate in a Windows® environment and integrate with the proprietary Esri™Geographic Information System program most commonly used by its sponsor agencies. This implementation only requires users to install licensed commercial software and have some expertise in the use of that software.

But times have changed again. The federal government has created a digital strategy, establishing, among others, the goals of making existing high value data and content available through web APIs, and using a shared platform approach to develop and deliver digital services in order to lower costs and reduce duplication. So, seven years ago, with assistance from Department of Defense sponsors, ITS began developing a new generation of web-based GIS solutions for propagation prediction. NowITS disseminates software applications that reduce dependency on licensed software applications, allowing end users to access the models through a web interface, the Propagation Modeling Website. The PMW uses commercial GIS to both acquire geographic data and display geographic coverage areas. It covers radio frequencies from 1 MHz to 20 GHz.

The PMW login screen is shown in Figure 1. Users can log into a central server to perform propagation analysis, storage and retrieval. PMW includes the capacity to perform propagation analysis using any of the following propagation models: TIREM 3.15; Longley-Rice 1.22; COST 231 Extended Okumura-Hata; Undisturbed Field/Mobile-to-Mobile; and ICEPAC. Propagation analyses, using all five models, can be performed in either single or batch transmitter mode using a separate thread for each analysis.

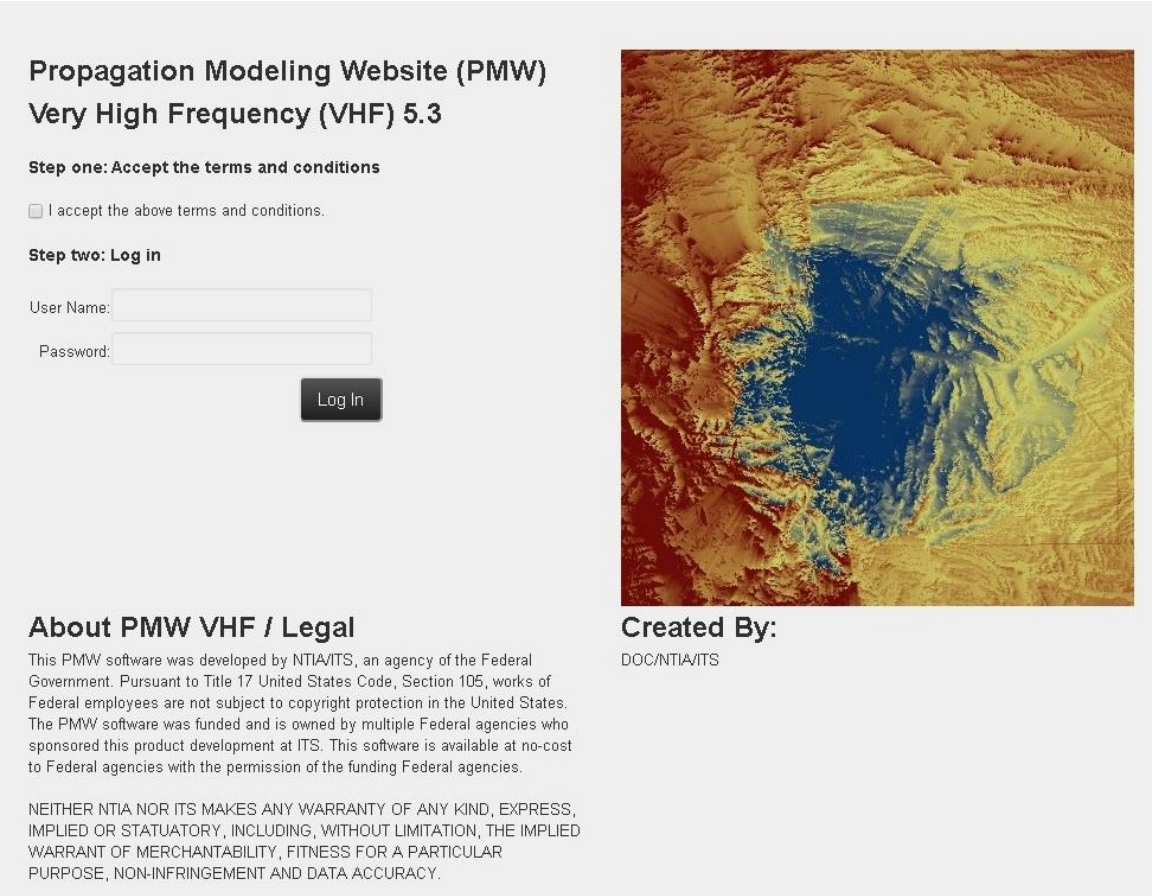

Figure 1. Users log into a central server via this PMW log in screen.

Users can export propagation analyses in .kmz format as well as GIS shape or Esri layer files, for use with Google Earth or another GIS such as Esri's ArcGIS for Desktop application. Figure 2 shows an example of field strength studies from four of the five models, exported from PMW and imported into Google Earth.

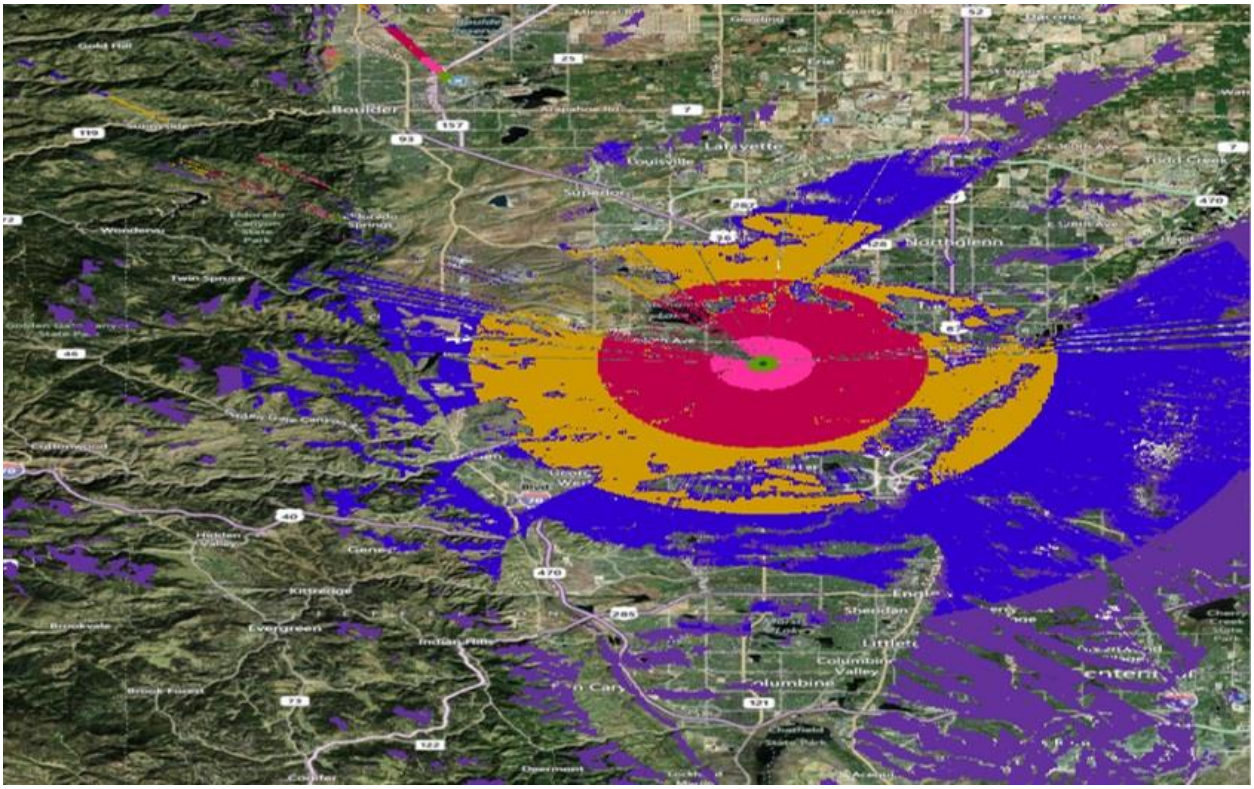

Figure 2. This field strength study uses the Longley-Rice model for a transmitter located southwest of Boulder, Colorado. The analysis was run in PMW, then imported into GoogleEarth.

In single analysis mode, users can geographically select a transmitter from an embedded interactive map display. In batch mode, users can load an Excel transmitter file and plot the desired transmitters on the map prior to running the analysis. This functionality was developed using open source products OpenStreetMap and OpenLayers.

The PMW is delivered with five zoom levels for the map, which translates roughly to a scale of 4,888 meters per pixel. The PMW is shipped with additional zoom levels up to 12, or a scale of 76 meters per pixel. OpenStreetMap provides 20 zoom levels to achieve a scale of 0.298 meters, but rendering each tile for 20 zoom levels would result in a storage requirement of 54 terabytes. Figure 3 shows the web map zoomed to level 12. The reason for packaging and shipping the geographic data with the software is that many PMW users operate in a secure environment and cannot connect to the internet to dynamically update the data.

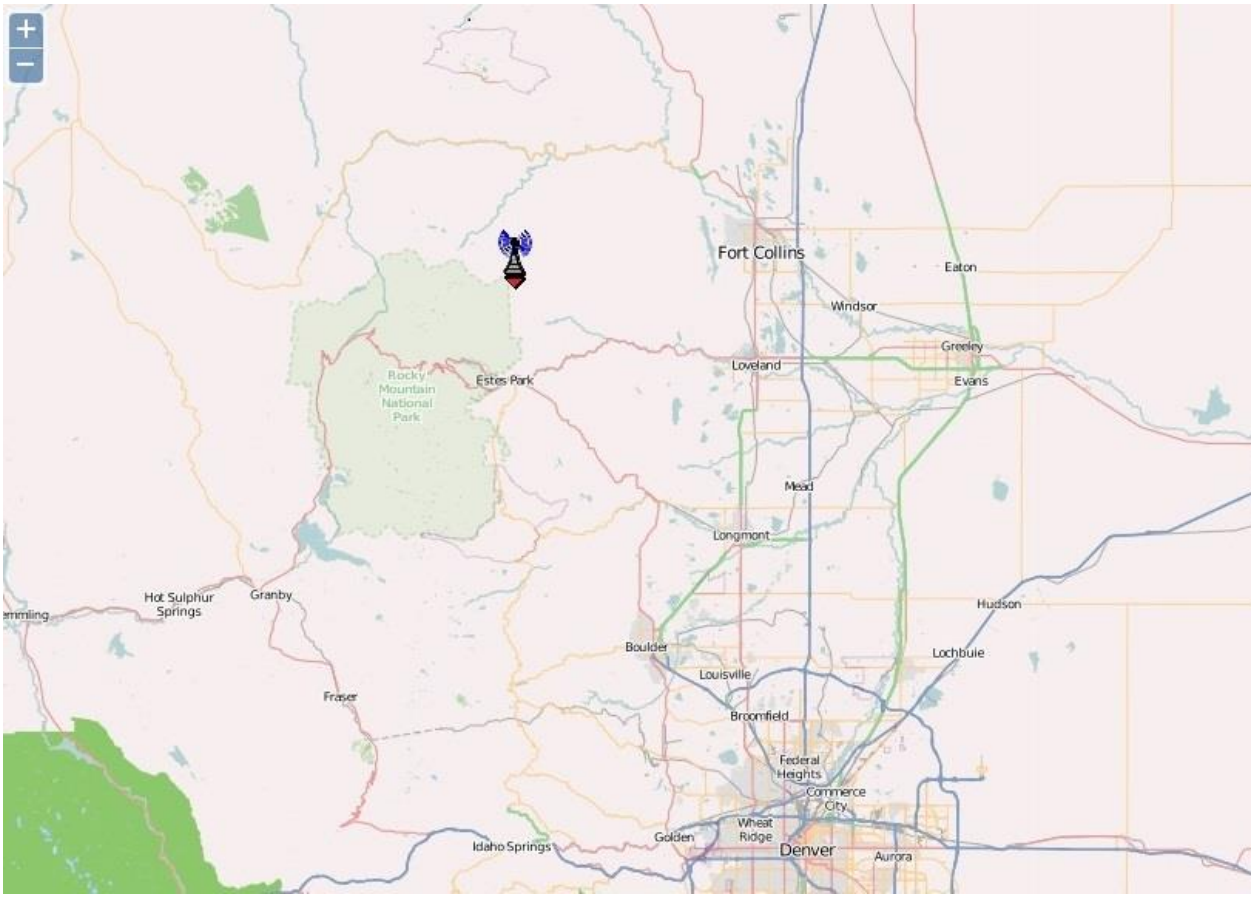

Figure 3. The embedded web map shows the geographic location of proposed transmitters.

The PMW is currently customized to fit the needs of ITS' sponsors, which include several DoD agencies and the National Weather Service, and is available only to U.S. government agencies. To meet the different security needs of defense and civilian agencies, the solution can be implemented either on an agency's own secure intranet or on an ITS-hosted secure website. Because the PMW is extremely modular in design, as new sponsors join the project the PMW can grow to fit additional needs and requirements. For example, NWS uses the tools to map radio coverage to U.S. population, to ensure that its All-Hazards Emergency Messages will reach at least 95% of the population. DoD agencies might use the tool for tasks like planning the location and density of transmitters and repeaters for new or ad hocsecure communications networks.

The PMW solution integrates commercial, off-the-shelf GIS, database and web-development products in a fully customizable analysis environment that can be tailored to meet individual customer needs. The solution was designed to be cost efficient, modular and scalable. It operates in a Windows environment, using widely available tools and utilities. Users can access the models from virtually any desktop or laptop through a browser interface. Hardware used in the development of the PMW included a dual quad-core web development machinewith 32 GB of RAM. The software included: Windows Server 2008 R2, Esri ArcMap 10.1, Visual Studio 2010, SQL Server 2008, .NET 4.0 and IIS 7.5.

Due to the large selection of GIS databases available, customer agencies can choose to include terrain, satellite and aircraft imagery, ground transportation infrastructure, building data and/or population distribution. By developing PMW, ITS has provided system tools to help government agencies efficiently manage their telecommunications infrastructure through sound system planning and interference detection for national security and public safety.

The Institute for Telecommunication Sciences supports its parent agencies by performing the research and engineering that enables the U.S. government, national and international standards organizations, and many aspects of private industry to manage the radio spectrum and ensure the advancement of innovative, new technologies. ITS also serves as a principal federal resource for solving telecommunication issues for other federal agencies, and state and local government. Certain commercial products are identified in this article to adequately specify the technical aspects of the reported modeling solution. In no case does such identification imply recommendation or endorsement by the National Telecommunications and Information Administration, nor does it imply that the products identified are the best available for this purpose.

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