System Assessment and Validation for Emergency Responders (SAVER)

Propagation Modeling Software Application Note

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System Assessment and Validation for Emergency Responders

Prepared by the Justice and Safety Center at Eastern Kentucky University

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FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems, and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL). The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency responder equipment
- Providing information that enables decision-makers and responders to better select, procure, use, and maintain emergency responder equipment.

Information provided by the SAVER Program will be shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: “What equipment is available?” and “How does it perform?”

As a SAVER Technical Agent, the Eastern Kentucky University (EKU) Justice and Safety Center (JSC) has been tasked to provide expertise and analysis on key subject areas, including communications and incident decision support software with a focus on the needs of responders from small and rural communities. In support of this tasking, EKU developed this *Propagation Modeling Software Application Note* to provide emergency responders with information about the capabilities, functionality, and use of propagation modeling software that support effective communications. Propagation modeling software falls under the following AEL equipment categories:

- 04AP-03-GISS, System, Geospatial Information (GIS): Includes application software as well as integrated hardware for implementation. GIS systems support the acquisition, integration, and dissemination of geospatial data and imagery. GIS systems provide or support multiple response functions, including: geospatial analysis, modeling, and mapping.
- 04AP-05-CDSS, Software, ICS: Incident Command System software including command/plans and decision support tools.

Visit the SAVER section of the Responder Knowledge Base (RKB) Web site at https://www.rkb.us/saver for more information on the SAVER Program or to view additional reports on propagation modeling software and other technologies.

POINTS OF CONTACT

SAVER Program
Science and Technology Directorate
U.S. Department of Homeland Security
TSD Stop 0215
245 Murray Lane
Washington, DC 20528-0215

E-mail: saver@dhs.gov
Web site: https://www.rkb.us/saver

Justice and Safety Center
Eastern Kentucky University
50 Stratton Building
521 Lancaster Avenues
Richmond, KY 40475

E-mail: saver@eku.edu

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1. INTRODUCTION AND SOFTWARE OVERVIEW

According to the National Incident Management System (NIMS), "[e]ffective emergency management and incident response activities rely on flexible communications and information systems that provide a common operating picture to emergency management/response personnel and their affiliated organizations" (U.S. Department of Homeland Security [DHS], 2008a). To help them address communications needs at the scene of an incident, or within a supporting operations center, emergency response agencies are increasingly turning to software tools. One communications tool response agencies are currently utilizing is propagation modeling software.

Propagation modeling software is used to identify, in visual formats, coverage maps for wireless communications. The results of the analyses, conducted through use of specific propagation models, can help discover deficiencies in current communications systems and provide analysis for the expansion of existing systems. Outcomes may also assist in the deployment of temporary systems. Communications analysis can be performed for traditional Land Mobile Radio (LMR) systems as well as cellular systems, Worldwide Interoperability for Microwave Access (WiMAX) systems, and 802.11/Wireless Fidelity (Wi-Fi™) data systems. There are various commercial applications that can be utilized to support emergency response agencies in establishing communications by providing terrain analysis and visualization of communications coverage.

The purpose of this *Propagation Modeling Software Application Note* is to provide emergency responders with information about the capabilities, features, and use of propagation modeling software. Propagation modeling software is applicable to any emergency response discipline that has a responsibility for establishing wireless communications within communities and at incident scenes.

Unless otherwise cited, the authors collected information for this application note during the market survey of propagation modeling software, the first phase in the System Assessment and Validation for Emergency Responders (SAVER) Program process, as well as through Internet research and manufacturer interviews.

1.1 Software Overview

The use of wireless communications has become a fundamental requirement for emergency responders to effectively respond to and recover from natural and man-made disasters. For common incidents, the existing wireless communications infrastructure in a community may provide an appropriate level of communications coverage and reliability. Many emergency responders, however, operate in rural or vast wilderness areas where wireless communications coverage is weak thereby resulting in the need to deploy a temporary communications network. Likewise, responders deployed through mutual aid agreements may need to establish wireless communications networks in areas with unfamiliar terrain and infrastructure. Urban areas also present unique challenges to communications officials due to their complex array of structures with interior spaces and a landscape that continually evolves due to development. Even in stable geographic environments, responders find themselves regularly upgrading, expanding, and altering their wireless communications equipment and facilities with new radios, antennas, repeaters, and even communications types.

One way to overcome the obstacles listed above is through the employment of propagation modeling software, which is one of the many modeling and simulation tools that are currently available to emergency responders. Propagation modeling software is a computer-based tool used to predict the wireless communications coverage area of a given fixed, mobile, or ad hoc communications infrastructure in various terrains and/or environments. This ability enables emergency responders to replicate real-life wireless communications systems and situations to determine communications coverage as well as to identify elements that can affect communications coverage (e.g., loss of a repeater during a natural disaster). In addition, emergency responders can use propagation modeling software to evaluate their current communications infrastructure to identify deficiencies, target areas where the infrastructure needs to be enhanced, identify procurement requirements for the system, or to possibly modify existing protocols to adjust to certain scenarios. See Section 2 for a discussion of propagation modeling software applications.

Whether for operational or planning purposes, propagation modeling software offers emergency responders with the tools to support the evaluation and development of wireless communications networks. Depending on the capabilities of the specific product, propagation modeling software can support communications modeling in natural, man-made, indoor, subterranean, marine, and other environments. Software packages can also support ad hoc modeling at specific static incidents (e.g., events with large crowds) or for incidents in which the operations are constantly changing (e.g., wildland firefighting operations). See Figure 1-1 for an image of a notional incident scene with coverage areas identified by propagation modeling software, which allow responders to identify potential sites for repeaters to enable communications between Command Post Alpha and Bravo.

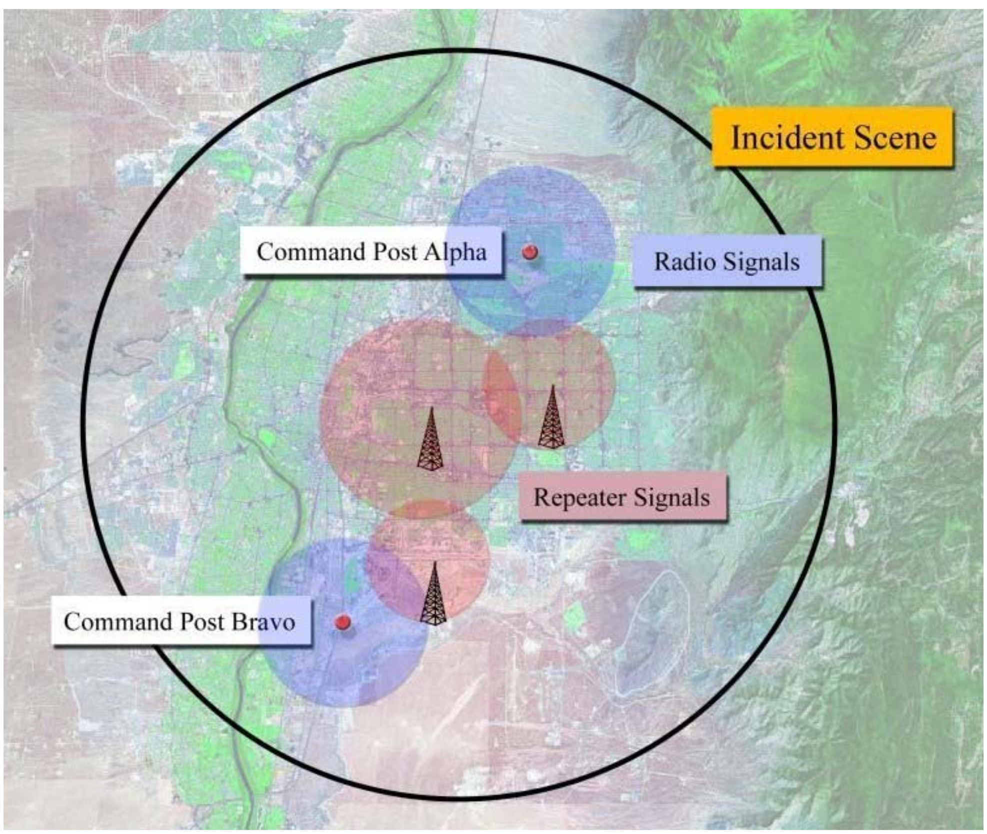

Figure 1-1. Coverage Areas for Notional Incident Scene

Propagation modeling software ranges from freeware[1] systems to commercial systems and those designed for use by the United States military that are being adapted for civilian use. With a pricing range from $0 (freeware) to $40,000, there are various elements of propagation modeling software that directly affect its pricing. Propagation modeling software pricing is commonly dependant on the number and type of features provided, such as:

- Number of propagation models used in analysis;
- Modeling additional operational environments beyond outdoor natural and man-made environments (e.g., indoor, subterranean, marine);
- Modeling additional communications types (e.g., satellite);
- Displaying additional Geospatial Information System (GIS) data layers beyond contour lines/topography maps and transportation systems (e.g., aerial photography, civil boundaries/political maps);
- User access controlled through the use of usernames and passwords;
- Saving and backup of operational files via automatic features; and
- Expanding software to fit agency needs through an Application Programming Interface (API).

Depending upon the specific product, the propagation modeling software may also require monthly or annual fees for server access or system use. Due to the complex nature of the software and propagation modeling, manufacturer technical support is routinely included with the purchase; however, the base price for many products may not include training, which can range from $500 to more than $5,000.

While complex in nature, propagation modeling software only requires a personal computer, whether it be a desktop or laptop computer. Most propagation modeling software can be effectively used on a Windows®-based computer with, at a minimum, Windows 2000™, 1 Gigahertz (GHz) processor, 1 Gigabyte (GB) of Random Access Memory (RAM), and 1 GB of free disk space. This enables the software to be utilized not only in an office setting for evaluation and planning purposes, but it also allows the software to be used in the field via a laptop within a mobile command system for ad hoc communications modeling at an incident scene.

The following sections provide a brief summary of common propagation modeling software capabilities and features. Note that these sections do not aim to provide an all inclusive list of purchasing considerations or software requirements; response agencies may have special needs that are not addressed in the following sections.

1.2 Common Features

Propagation modeling software offers an array of analytical tools to enhance the evaluation and planning of communications infrastructure. These tools work in conjunction with other compatible mapping software to provide a means of planning incident response communications.

[1] Freeware describes a product that is open to the public on the manufacturer's Web site that can be downloaded and used free of charge.

1.2.1 Communications Modeling and Analysis

To support the analyses and estimations of communications coverage, propagation modeling software utilizes one or more propagation models, many of which have specific applications. For example, the Longley-Rice propagation model (also known as the Irregular Terrain Model [ITM]) is able to take terrain features into consideration by utilizing readily available data from the National Geospatial-Intelligence Agency (NGA) and the U.S. Geological Survey (USGS).

Due to the numerous propagation models that are available, it is particularly important to choose the most appropriate propagation model for the operational environment. For example, the Longley-Rice model may be an appropriate propagation model for application in rural, remote, wilderness, or other sparsely-populated areas. Other models, such as the Okumura Model, are designed for urban environments with large buildings and are more applicable in densely populated areas.

Within propagation modeling software, the models are mathematical processes in which the results are simulated on a map illustrating the predicted communications coverage area. The analyses performed by propagation modeling software provide the end user various data points through which communications can be evaluated. Additionally, propagation models offer the ability to manipulate the communications infrastructure (e.g., addition of repeaters and/or antennas; damage to communications infrastructure due to natural disaster) and observe the resulting effect on communications coverage. For example, propagation modeling software can help emergency responders answer critical questions, such as what is needed to extend necessary communications coverage or whether communications can still be achieved in the event of the loss of a radio tower during a disaster.

1.2.2 Required Inputs and Resulting Outputs

There are commonly required inputs from end users that produce the resulting outputs of propagation modeling software. While not intended to be a comprehensive list, Table 1-1 presents the common propagation modeling software inputs and outputs. The inputs listed in Table 1-1 are required from the end user to effectively perform a propagation modeling study. In addition to the inputs listed, certain geographic features or GIS data is also required to produce a propagation study. While most propagation modeling software is preloaded with the required GIS data, some products provide GIS data at an additional cost or require the end user to provide the data. Once all data is successfully entered, the primary output from the propagation modeling software is the predicted distributions and concentrations of communications coverage within a given geographical area. Please note that depending on the analysis requested, some inputs may become outputs and vice versa (e.g., transmission line loss, antenna height and placement).

Table 1-1. Common Inputs and Outputs

<u>Inputs</u>	• Propagation model selection (e.g., Longley-Rice Model for wilderness areas; Okumura Model for urban areas)
	• Study type selection:
	  o **<u>Contour studies</u>** compute a single closed polygon based on a user-specified signal strength.
	  o **<u>Radial studies</u>** compute signal strength on uniformly-spaced circles radiating from a fixed facility/point out to a user-defined distance.
	  o **<u>Tile studies</u>** compute signal strength at points on a rectangular grid.
	  o **<u>Target studies</u>** compute signal strength at user-specified points.
	• Communication type and frequency or frequency range (see Section 1.2.3 for more information)
	• Transmitter location (latitude and longitude)
	• Antenna type, height, and gain/signal power amplification (expressed in decibels)
	• Antenna height above average terrain (calculation of the altitude of the antenna site minus the average altitude of the surrounding terrain)
	• Antenna mounting location
	• Transmission line loss over the length of transmission line (expressed in decibels)
	• Attenuation factors that modify the output of the propagation model to account for unique land characteristics (e.g., forested areas, urban space) that may cause signal loss

<u>Outputs</u>	• Transmission line loss calculations • Antenna height calculations • Maps of current communications coverage • Maps and recommendations for placement of repeaters for assured communications • Communications coverage maps that account for the weather, environment, and other obstructions

1.2.3 Communications Types

The ability to model various communications types is dependent on the specific models utilized by the software. Most propagation modeling software provides models for common communications types, which are described below. The exceptions are satellite and cellular communications, which are capabilities that are typically part of propagation modeling software at the higher end of the price scale. The following communications types are organized from most- to least-commonly addressed by propagation modeling software.

- Traditional LMR systems rely on use of radio frequencies in the 30 Kilohertz (KHz) to 300 GHz range, including the Very High Frequency (VHF; 30 Megahertz [MHz] to 300 MHz) and the Ultra High Frequency (UHF; 300 MHz to 3 GHz) bands as well as amateur radio signals.
- The 802.11 a/b/g/n standard set (also known as Wi-Fi) was developed by the Institute of Electrical and Electronics Engineers (IEEE) for the purpose of enabling wireless computer communications in the 2.4, 3.6, and 5 GHz frequency bands.
- WiMAX, also known as 802.16, combines the benefits of broadband and wireless. WiMAX is designed to provide high-speed wireless Internet over very long distances and provide Internet access to large areas, such as cities.
- A cellular network, often called a "cell," is a communications network that is served by fixed-location base stations. When joined together via base stations, these cells provide communications coverage that enables a large number of portable (e.g., mobile phones, pagers, etc.) and fixed (e.g., land-based telephones) receivers to communicate with each other. The most common example of a cell is found in a mobile phone network.
- Satellite provides telephony and data services to users worldwide via special surface-based terminals (e.g., satellite phone, Broadband Global Area Network [BGAN] terminals), which communicate to ground stations through a constellation of telecommunications satellites.

1.2.4 Mapping and Display Options

Available propagation modeling software is linked with a GIS to visualize the predicted communications coverage in a defined geographic area. In this case, the stored geographic map and propagation data are used to generate information, such as identification of areas that have weak or nonexistent communications coverage. To achieve this, propagation modeling software is compatible with popular mapping and imagery software and tools, such as:

- Earth Resource Data Analysis System, Inc. (ERDAS) Imagine®
- Environmental Systems Research Institute (ESRI) ArcGIS™ and ArcView™
- Google Earth™
- MapInfo®
- Maptitude®
- Other software that utilize the Cartesian Coordinate System (XYZ), the American Standard Code for Information Interchange (ASCII) Output for ESRI, or latitude and longitude shapefiles

The mapping and imagery capabilities of propagation modeling software also include the ability to display various GIS data layers in addition to text overlays. The common data layers that propagation modeling software is capable of displaying include the following:

- Aerial Photography
- Civil Boundaries/Political Maps
- Contour Lines/Topographic Maps
- Population
- Transportation Systems (e.g., streets, highways, railroads)

These capabilities allow for the display of the output data in multiple formats for the various output types. These may include path analysis, terrain analysis, and path reliability. Coverage predictions and path analyses can be displayed in either two dimensional (2D) images or three dimensional (3D) modeling. Additionally, most propagation modeling software allows emergency responders to customize the outputs by providing them with the capability to turn on or off various overlays and through the use of colors to represent various levels in the output. See Figure 1-2 for an example propagation modeling software display that utilizes 2D images, 3D modeling, and colors.

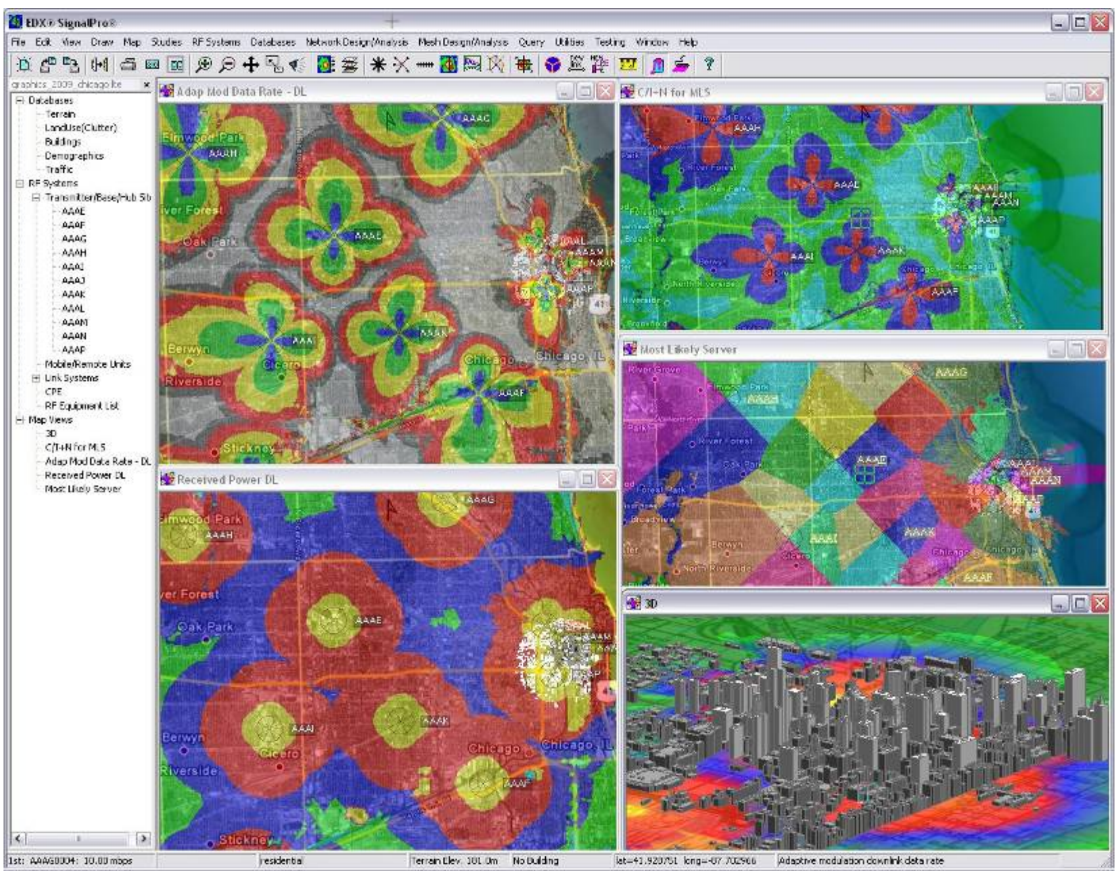

Figure 1-2. Example Propagation Modeling Display

1.2.5 Information Security

According to NIMS, "[p]rocedures and protocols must be established to ensure information security" (DHS, 2008a). Emergency responders should determine if the security features offered with the propagation modeling software supports their agency's information security policies and protocols.

Except for those products at the higher end of the price scale, most propagation modeling software does not provide user access controlled by username and password. Further, only certain propagation modeling software includes mechanisms that automatically back up operational files if some type of failure occurs and subsequently provides a mechanism to retrieve the saved data. Therefore, emergency responders should also consider archiving databases and files regularly on a separate computer system for records management and operational redundancy purposes.

1.3 Standards and Regulations

Like other software applications, propagation modeling software has features that may be standardized for interoperability or compatibility purposes. Most notably, some propagation modeling software comes with mapping and/or imagery tools that may be applicable to the DHS Geospatial Data Model (GDM) and other products and standards endorsed by the Federal Geographic Data Committee (FGDC). Also, the following standard establishes a common set of symbols for use by mapmakers in support of emergency responders: *American National Standards Institute (ANSI) InterNational Committee for Information Technology Standards (INCITS) 415: Homeland Security Mapping Standard – Point Symbology for Emergency Management*.

The following organizations provide additional standards, terms, and common practices relating to propagation modeling software:

- Alliance for Telecommunication Industry Solutions (ATIS)
- Federal Communications Commission (FCC)
- Institute of Electrical and Electronics Engineers (IEEE)
- Institute for Telecommunications Sciences (ITS)
- Telecommunications Industry Association (TIA)

For example, the *ATIS Telecom Glossary 2007* provides uniform and up-to-date definitions for the general terminology used in telecommunications. See Appendix A for a list of Web sites for these organizations.

1.4 Other Considerations

There are other considerations that emergency responders should be cognizant of when evaluating the purchase of propagation modeling software. The following provides a sample list of these considerations.

- **No Single Solution or Model:** Emergency responders must be mindful that no single propagation model is suitable for all situations, and every model has limitations and uncertainties.

- **Estimations:** Propagation modeling results are estimations and predictions only. Although the purpose of modeling is to account for as many important factors as possible, nuances always exist within the predicted area that may affect communications, such as interference from other networks, weather, environmental factors, man-made structures, and measurement errors (Neuland and Kurner, 2007; Zvanover, Pechac, and Klepal, 2003). As a result, emergency responders should expect deviations between the results of the analyses and the actual communications coverage. Therefore, the accuracy of communications coverage predictions should be tested once networks are established.
- **Managing New Releases:** Software technology tends to evolve very quickly as compared to hardware; new versions of software with new capabilities are generally released more often than their hardware counterparts. An additional burden for emergency responders that regularly train on and use propagation modeling software is the need to manage new releases and updates from infrastructure configuration, training, and operational perspectives.
- **Level of Expertise:** Use of propagation modeling software will require some level of specialized knowledge about radio propagation theory. For example, emergency responders with a radio communications and a technical or engineering background will have the appropriate knowledge and expertise needed to apply the software with minimal support from the manufacturer. The ideal users may be credentialed Communications Unit Leaders (COMLs) or Communications Technicians (COMTs).
- **Map Dependencies:** The visual coverage maps assist emergency responders in evaluating current systems and in making decisions about the placement of communications equipment. Regardless of the propagation model used to generate the outputs and the extent of inputs, the quality and version (date) of the maps may affect emergency responders' abilities to make these decisions. Therefore, emergency responders should not overlook the value of the mapping and imagery tools and ensure they meet their operational and planning needs.
- **Security and Redundancy:** Inherent with any information management system is the security of the data, which presents new risks and costs to emergency responders. These risks include the accidental or criminal release of sensitive information, and the loss of operational data due to a system failure or loss of power.
- **Service Fees and Licenses:** Some propagation modeling software manufacturers charge monthly or annual service fees for accessing and using applications. Also, it is not uncommon for manufacturers to charge agencies for individual user licenses and accounts.

2. APPLICATIONS

Although propagation modeling software can be used at incident scenes to perform ad hoc propagation modeling, the products may also be used in preparedness and planning activities. These activities can range from the evaluation and design of permanent communications systems (e.g., LMR, cellular, Wi-Fi) to the deployment of temporary or ad hoc communications systems for specific incidents (e.g., wildland fire and search and rescue operations) or events (e.g., large gatherings such as sporting events or concerts). Specifically, propagation modeling software has been used to plan and deploy communications systems in response to terrorist attacks, natural disasters (e.g., hurricanes), and other large-scale incidents. The following sections provide examples of how propagation modeling software may best apply to the various elements of emergency response communications.

2.1 Response Agencies and Positions

Common users of propagation modeling software include the traditional public safety disciplines at the local and state levels of government (e.g., fire services, law enforcement, emergency medical services). Any emergency responder supporting the communications function may also benefit from the use of propagation modeling software. In addition to agencies at the local and state levels of governments, many federal agencies use propagation modeling software, such as the U.S. Department of Defense, DHS (specifically, the Federal Emergency Management Agency, U.S. Coast Guard, U.S. Customs and Border Protection, and U.S. Secret Service), U.S. Federal Aviation Administration, and U.S. Forest Service. Further, private companies also utilize propagation modeling software to develop and maintain their communications systems. Examples of these users include utility companies (e.g., electric, water, gas), manufacturing companies, and transportation companies (e.g., railroads).

Regardless of what agency is utilizing the product, propagation modeling software has the most direct applicability for those individuals responsible for the establishment and the maintenance of operable communications during an incident. An example of this applicability is the Communications Unit within the Logistics Section of the Incident Command System (ICS). According to NIMS, the Communications Unit is responsible for "effective communications planning as well as acquiring, setting up, maintaining, and accounting for communications equipment" (DHS, 2008a).

Within the Communications Unit of the ICS, or an equivalent organizational element within an agency, the position typically responsible for assuring incident communications is the COML. According to the SAFECOM Program Web site, COMLs have the "knowledge of local communications systems and local, regional, and state communications plans and are responsible for developing plans for the effective use of incident communications equipment and facilities, managing the distribution of communications equipment to incident personnel, and coordinating the installation and testing of communications equipment." Specifically, the *ICS Communications Unit Leader (COML) All-Hazards Training Task Book* identifies the following COML tasks that may be supported through use of propagation modeling software:

- Designing of communications systems to meet incident operational needs by:
    - Coordinating, through the chain of command, the locations for equipment to be installed (e.g., repeaters, satellite telephones, telephone lines, etc);
    - Creating diagrams of current communication system(s); and

  - o Determining optimal locations for any future expansion of communications equipment using topographical maps to evaluate elevation and separation needs.
- Maintaining accurate records of all communications equipment by:
  - o Documenting geographic locations of equipment and transferring this information to local maps; and
  - o Keeping records for local and national resources to ensure return to proper location. (DHS, 2008c)

Further, many local and state Emergency Operations Centers (EOCs) are configured based on an Emergency Support Function (ESF) structure as described in the *National Response Framework* (DHS, 2008b). At these levels, the emergency responder(s) responsible for ESF #2 – Communications may need to maintain awareness of communications coverage at the incident scene(s) and support tactical operations. Using inputs from emergency responders in the field, they may be able to conduct analyses using propagation modeling software or benefit from compiling and presenting outputs from units in the field.

2.3 Permanent Systems and Planning

Figure 2-1. Rooftop Repeater Array

Propagation modeling software can be employed by agencies to assist in the design and development of new permanent communications systems or in the evaluation and expansion of current systems. For example, urban areas present communications challenges due to their complex array of structures with interior spaces and a landscape that continually evolves due to development. Propagation modeling software can also aid the numerous communities that are in the process of planning their compliance with the FCC order to narrow band their current systems, which will have a direct impact in the coverage of their systems (FCC, 2004). Propagation modeling software can help these agencies to identify additional antenna and repeater sites that will be necessary to achieve their desired communications coverage and reliability. Further, propagation modeling software may be an important planning tool when communications systems are being upgraded from analog to a Project 25 digital system, which is becoming more prevalent (see DHS SAFECOM Program). It could also assist in the integration of new and emerging technologies such as WiMAX, 802.11 data systems, and Third Generation Mobile Communications Technology (3G).

In addition to the planning, development, and evaluation of permanent systems, propagation modeling software also offers several preparedness benefits to emergency responders. For example, the use of propagation modeling software can help improve local and/or regional cooperation and planning. This can be achieved through the process of evaluating, updating, and centralizing information on radio communications infrastructure (by the COML or COMT), which can help increase collaboration between local and/or regional agencies for mutual aid purposes. Additionally, propagation modeling software can assist in structuring emergency response exercises, which can provide a better understanding of possible communications impacts on field personnel during incidents.

2.4 Temporary Systems

Propagation modeling software can be deployed at incident scenes in order to quickly determine antenna and repeater sites to support incident communications. This capability is extremely important in rural and remote locations where communications may be limited or nonexistent. An example is communications for wildland fire response, which commonly traverse vast wilderness areas. In fact, there were 5,921,786 acres burned in 2009 as a result of wildland fires in the United States according to the National Interagency Coordination Center (NICC). More than 25 individual fires exceeded 40,000 acres, which are significant areas of land for single incidents (NICC, 2009). In order to expand communications coverage in these areas, COMLs often use propagation modeling software to identify potential repeater sites and to visualize the predicted coverage in order to optimize their limited communications assets.

Figure 2-2. Wildland Fire Operations

Additionally, emergency responders deployed through mutual aid agreements may also need to establish communications networks in disaster-affected areas or locations with unfamiliar terrain and infrastructure. Recent events and literature suggest that a collapse of terrestrial telecommunications infrastructure is a common result of disaster (Patricelli et al., 2009). A recent case in point was the 2005 hurricane season, which devastated portions of Alabama, Mississippi, and Louisiana and caused significant damage to communications infrastructure, including 9-1-1 centers, cell towers, telephone switching centers, and 800 MHz radio systems (The White House, 2006).

Propagation modeling software may also be used to support the establishment of communications for special events, which may require additional fixed resources to create interoperability between the various public safety and security agencies working the event. The special event could also require an increased level of service if the event is located at the fringe of existing service area. Propagation modeling software can assist in the design of temporary infrastructure to ensure that interference is minimized and that the required level of service is provided.

3. CONCLUSION

In summary, propagation modeling software, if used appropriately, helps emergency responders in establishing operable wireless communications for either permanent day-to-day systems or ad hoc systems at incident scenes. Propagation modeling software, however, is highly specialized and is best used by personnel who have a good understanding of communications systems (e.g., COMLs) as there are a number of user defined parameters that are dependent on the type and location of the system. In order to maximize the value of the software, it is recommended that the emergency responder utilize the software on a regular basis in order to be operationally efficient.

Please note that software technology tends to evolve very quickly as compared to hardware; new versions of software with new capabilities are generally released more often than their hardware counterparts. Emergency responders need to manage these changes and account for the other considerations identified in Section 1.4 when purchasing and using propagation modeling software.

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APPENDIX B – ACRONYMS/ABBREVIATIONS

The following acronyms/abbreviations are commonly used in this document.

Acronym/ Abbreviation	Definition
AEL	Authorized Equipment List
ATIS	Alliance for Telecommunication Industry Solutions
COML	Communications Unit Leader
COMT	Communications Technician
DHS	U.S. Department of Homeland Security
EKU	Eastern Kentucky University
ESF	Emergency Support Function
FCC	Federal Communications Commission
GB	Gigabyte
GHz	Gigahertz
GIS	Geospatial Information System
ICS	Incident Command System
IEEE	Institute of Electrical and Electronics Engineers
LMR	Land Mobile Radio
MHz	Megahertz
NICC	National Interagency Coordination Center
NIMS	National Incident Management System
RKB	Responder Knowledge Base
SAVER	System Assessment and Validation for Emergency Responders
S&T	Science and Technology Directorate
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access