Maximizing a Fixed Base Network Investment via Propagation Modeling

WP-300

White Paper

DEVELOPING A FRAMEWORK OF SYSTEM PERFORMANCE PRIOR TO PURCHASING AND DEPLOYING ASSETS

Implementing a fixed base network is a major decision that requires an investment of time, funding, human resources and customer support to ensure success. A best practice that is proven to maximize that investment is to complete a propagation study prior to deployment, to determine optimal network coverage. Propagation studies eliminate guess work because they rely on scientific methodology. They maximize the utility's investment in a fixed base system by defining specific information that projects the end signal strength of every meter in use. By incorporating propagation modeling as part of the analysis process, the utility can use the information to confidently employ the most efficient planning available to control costs and performance.

However, just as no two utility service areas are alike, approaches to performing propagation studies can vary dramatically as well. Off-the-shelf, "cookie cutter" methods will deliver basic data on how many collectors may be needed, but to uncover the true characteristics of a service area in the pursuit of cost-effective yet superior coverage, a more comprehensive study should be selected. Where traditional methods fall short, the Sensus propagation modeling system provides all the necessary information. It accounts for performance goals of the utility, growth expectations, and unique land use issues.

Comparing Propagation Study Methods

Identifying the appropriate number of collectors needed for an effective deployment has historically been determined by using the cookie-cutter method. In this model, all utilities – regardless of geography, population or existing or potential collector sites – are treated the same. Collectors are generically placed along a predetermined grid – typically as close as every half mile – based strictly on square miles and a mathematical equation with little or no regard for meter-to-collector connectivity calculations, normally referred to as the "link budget". This application maximizes system requirements and adds to the overall cost of installing and maintaining a fixed base system because collectors are often installed regardless of need. Furthermore, without using the physical location of meters (indoor/basement, etc.) in a design and placing collectors at random locations – the chance of missing higher priority readings increases dramatically.

As expected, problems can be numerous with this method. The approach does not guarantee the placement of collectors is possible, or if they will perform well. Nor does it have data to predict strength of the meter-to-collector signal. As a result, the utility often encounters unforeseen issues, such as inadequate facilities and property rights, and/or leasing troubles during the deployment stage, and the inevitable coverage lapses following deployment. Without proper system analysis, the utility is forced to adjust infrastructure requirements during implementation, resulting in increased capital costs and higher operational and maintenance needs.

With the use of collector-based AMI systems, "right-of-way" usage is harder to come by as years pass. There are two important reasons for this. First, most new developments have chosen to install utilities underground, which prohibits the use of pole space. Secondly, the cost of installing on overhead locations has increased, further escalating the finances of the total project. Also, the sheer number of sites stresses utility manpower for maintenance and repair, impacting the system's life-time costs and possibly making a system deployment economically unfeasible.

The Sensus Propagation Modeling system differs from this overly-structured approach. It centers on working with each utility as a unique organization with its own set of circumstances. The comprehensive study is built by pulling a myriad of assets and liabilities together to create a customized approach to system deployment.

The Sensus system is grounded on the belief that, in a data collection network, system performance is measured by the percentage of data received from meters. In order to reach an acceptable performance level, a good reception rate must be maintained from all transmitters. The number and locations of collector sites must be suitable to match the expected performance goals of the network. For this purpose, a propagation model of the radio link is built.

Sensus Propagation Modeling Parameters

In order for a fixed base system to provide accurate data, regularly, from meters, the accuracy and validity of the data must be ensured by the quality of the meter modules and the robustness of the error-free wireless communication protocol. A message transmitted by a meter is measured via message reception probability, or, the likelihood of that message being received and properly decoded by a receiver. This probability generally depends on terrain characteristics, and clutter, such as vegetation and buildings. Propagation modeling is used in order to predict this parameter.

Message availability is defined as the probability of a message being available, i.e. properly received, at least once over a specified period. This term is associated with message redundancy, which is the number of times messages are transmitted within that specified period. Message availability is calculated as: A = 1-(1-P)¬n, where A is the message availability, P is the reception probability (= message reliability) and n is the number of messages per (typically one day) period.

For example, with a message reliability of 70%, and redundancy of two messages per day, the daily message availability would be 1-(1-0.7)2= 0.91. In other words, if meter modules are initialized to transmit reads twice a day and each message has 70% reliability, at least one message would be received daily from 91% of the meter modules. Since this is a statistical phenomenon, there is no connection between the 91% received on day X and the 91% received on day Y. The measured system (or network) availability is calculated as the number of meter modules received (at least once) that day, divided by the total of meter modules deployed. Note that there is a tradeoff between message redundancy, which increases availability, and other system parameters, most notably meter module battery life in the case of water and gas meters.

The propagation modeling processes is as follows:

- Set message availability goal
- Define message redundancy (e.g. to ensure sufficient battery life)
- Calculate desired message reliability: P= 1-(1-A)1/n
- Determine required signal strength, using normal distribution curves and the fixed base receiver sensitivity
- Create a coverage map showing proposed site locations, predicted reception, and the number of collector's that would 'receive' each meter module location

For example, to obtain 98% availability at two messages per day, P=1-0.020.5= 0.86. To reach 86% reliability, the signal strength would need to be –113.4 dBm, 8.6 dB above the receiver sensitivity of –122 dBm. The propagation model will predict, for various collector location combinations, the coverage areas of the system. The produced map also indicates how many receivers cover each transmitter location.

The area to be covered is defined before the propagation prediction is made. The propagation prediction will typically predict signal strengths in an area to 90% accuracy. With specific availability and reliability goals defined, the result of the model is a recommendation for the amount and location of base stations.

Sensus advises its customer to consider several important factors when determining the number of collector sites needed for its new system. The first factor is a collector site's characteristics. To avoid the cost of constructing new sites, various tower and rooftop availability databases should be considered to determine the availability of suitable sites. Utility-owned towers and rooftops should be investigated first to reduce recurring costs. Site characteristics that are required by the propagation model are latitude and longitude coordinates, antenna height, the number of radials to be used in calculations, the distance from the site to be modeled, and ground elevation of the site.

Model characteristics are also reviewed, such as operating frequency, earth curvature, the percentage of time in which the signal strength exceeds the predicted value, the percentage of meter module locations in which the signal strength exceeds the predicted value, clutter properties from buildings or average height of obstacles, transmitter height, antenna polarization, and transmitter power. Transmitter power for each meter, whether it be water, gas, or electric, are constant. Rather, it is the physical location that creates attenuation values for the modeling. Elements of the receiver are also examined, such as the antenna gain, center line of the antenna, transmission line loss, connectors , and any other losses that may occur.

Preparing for a Propagation Study

Before Sensus begins its study for a utility, a report of infrastructure assets as well as its growth potential and goals are compiled by utility personnel. Sensus also discusses deployment expectations and system requirements with utility officials, to ensure that implementation requirements and system performance expectations are clearly understood. This up-front work is crucial to give Sensus enough information to complete the modeling process, but it is also beneficial to the utility, because it will then have a complete understanding of the process and how it will ultimately help in meeting the organization's performance goals today and in the future. Once this information is established and the necessary preliminary data is collected, the study begins.

Performing the Modeling

Once all the critical items have been identified, the next step is to transfer the information to propagation modeling software. Mapping is used to consider additional assets and liabilities that may affect network coverage. Four layers of mapping are constructed: Meter locations, prospective collector locations, the Digital Elevation Model, and Land Use/Land Clutter.

First, the planner plots the area on the mapping software in order to get a complete picture of the terrain. Terrain is an important factor of performance indicators, as it can fluctuate from location to location. Once the territory has been plotted and identified, the proposed collector sites are included as part of the model. These factors are then combined to identify the physical surroundings of the proposed system, known as land use clutter, which could mean trees, buildings, homes or anything that will further attenuate the signal from the meter to the collector. Plotting these items and identifying their connection to system performance provides flexibility in design and assists the process to define system requirements.

Additional factors are also entered into the mix to properly complete the evaluation. Information to be added includes:

- Meter locations (inside or outside the structure, and above or below ground, etc.) and their distance to proposed collector sites
- Population density
- Future growth plans
- Territory boundaries
- Read requirements (read delivery time for billing, special reads etc)

Examples of Sensus Propagation Modeling

In the propagation model, various collector sites are proposed and analyzed as part of the modeling process to determine system optimization. For example, municipality X may have five towers available in its service territory and these sites are suggested as possible locations for collector installation. After analysis of the sites and surrounding environment, propagation modeling shows that deploying a collector at three of the five towers will provide sufficient coverage for the entire service territory. Modeling also determines if FlexNet Network Portals (FNP) or FlexNet Receiver Portals (FRP) are necessary to hit remote territory pockets. These portal options are an extension of a collector footprint and are more cost-effective than using a full-blown collector for these hard-to-reach areas.

In an opposite scenario, utility B may propose using just two existing towers within their system as possible collector sites. After completion of the propagation study, it is determined that additional sites are required in order to provide efficient coverage. In this case, the utility will be asked to identify additional locations such as rooftops and other various towers to determine the availability of suitable sites. These sites will then be examined and a determination will be made as to the requirements for additional collectors or FNP/FRPs.

The Final Report

Once the evaluation is completed, a recommendation is presented with supporting documentation describing system infrastructure requirements. The completed propagation study provides the necessary information to strategically place collector's in order to achieve the most economical and effective solution. Often, the number of proposed sites exceeds the number of hosts needed. Typically, the model returns recommendations for fewer collector devices than utility officials anticipated, and is the first pleasant surprise and cost-saving measure in the process.

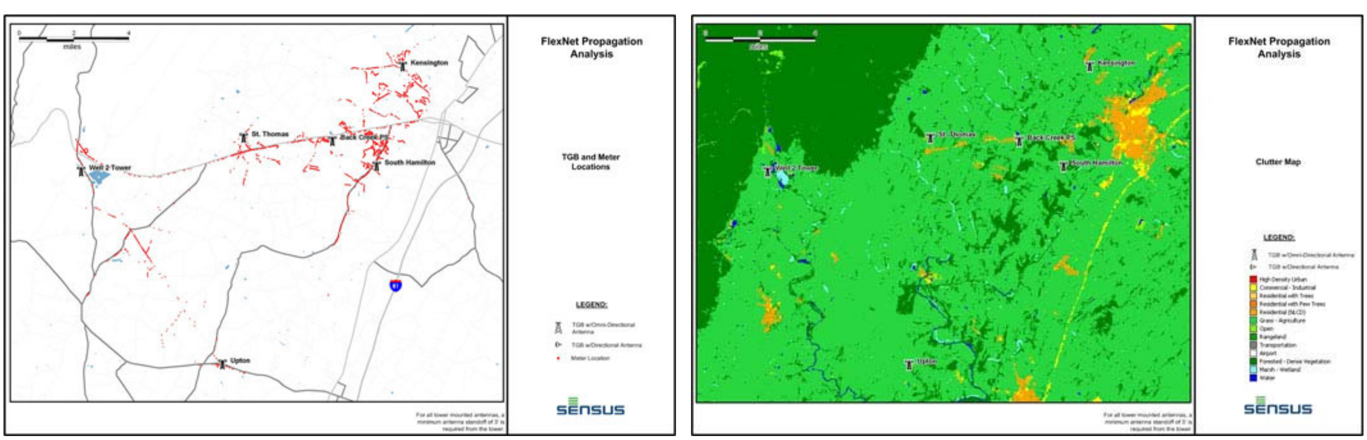

Figure 1. Examples of two of the four layered maps used when developing a Propagation Model. Left to right: collector / meter locations and defined clutter values.

Conclusion

Without the results of propagation modeling to design an implementation plan, deploying a fixed base system is subject to random deployment of equipment, which calculates to large infrastructure requirements and high operational and maintenance costs. The Sensus propagation modeling provides a thorough and accurate assessment through detailed analysis more so than the traditional design process used by others. The use of modeling software and considering unique terrain characteristics alone separate propagation modeling practices from the cookie-cutter grid-method, because all utilities have their own set of assets, liabilities, and terrain factors, which ultimately factor in to the final proposal.

Simply put, the Sensus propagation modeling eliminates guessing and maximizes the utility's investment. Proper up-front analysis provides as close to a plug-and-play environment as possible, whereas the cookie-cutter approach requires more actual field analysis after deployment, which can be time consuming and costly.

Any large capital investment should be thoroughly examined and executed in a manner that meets the expectation of the customer and provides a cost effective solution. The Sensus propagation modeling accomplishes this task by identifying and accounting for all factors that may affect system performance. This logical approach provides the end-user with supporting documentation of a thorough and accurate approach to deploying an efficient system with the least amount of infrastructure required.

Choosing a fixed base meter data collection system is a good business choice. However, it is important to ensure that the system is being used as efficiently as possible. Propagation modeling provides the foundation for a solid implementation strategy by identifying key elements – early in the process – that may affect initial deployment and long-term performance. Immediate benefits of propagation modeling are found in its ability to minimize infrastructure requirements while assuring sufficient coverage, and by reducing any need for third-party collaboration for host sites. In the long-term, propagation models give a utility detailed information upon which to base future strategies.

And, the objective, scientific methodology used to create the propagation model gives confidence to all segments of the supply chain that decisions made are best for the customer, the utility, and the local governing body. Propagation modeling supplies information to make sound recommendations in order for the utility to control costs and provide better service to its customers.

About Sensus

Sensus leads in innovative and evolving technology solutions that enable intelligent use and conservation of critical energy and water resources. Sensus has led the discovery, development, and implementation of technologies for the energy and water industries for more than a century. Water, gas, and electric utility customers around the world benefit from the company's open, flexible products and solutions to help them optimize their resources – today and tomorrow. Headquartered in Raleigh, N.C., USA, Sensus serves customers from locations throughout the Americas, Europe, Africa and Asia. For more information, visit www.sensus.com.

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