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Looking to the Sky for SMART Grid Intelligence

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Critical to the level of intelligence that can be achieved in making the grid smarter is its backbone—the network and communications infrastructure. The requirements of the communications network are demanding, encompassing issues such as scalable bandwidths, robust security, high network reliability and availability, and cost-effectiveness. Many in the industry have concluded that the most cost-effective approach to meet these requirements is to leverage the range of transport technologies available, while relying on common open standards, such as IP, to integrate into a single overall network. This article presents the value that advanced, satellite-based networks can deliver as part of the smart grid communications infrastructure, across areas ranging from substation automation (SA) and distribution automation (DA) to AMI collectors.

NOT YOUR FATHER'S SATELLITE

Unknown to some, satellite networks have evolved at a similar or faster pace than other networking technologies, making huge strides in improving performance, reliability and cost. Some of the highest availability networks in the enterprise market, such as for lotteries and emergency preparedness and recovery, are based on satellite and its fundamental advantage: ubiquitous coverage. And now, when combined with high-performance IP and other standards-based capabilities, satellite networks deliver high-quality, private broadband connectivity.

Very high network availability, in excess of 99.99 percent, can be achieved through innovative dual frequency, dual access solutions by using Ku-/Ka-band satellite service in conjunction with L-band satellite

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service as backup. Smart grid network elements such as remote substations and distribution elements can be connected using satellite without compromising on the expected benefits driving the smart grid.

In addition, new satellite technology can cost-effectively deliver benefits such as on-the-move vehicle connectivity, allowing those out in the field to connect directly with headquarters and eliminate costly trips to the office to get information. Satellite holds the potential to facilitate distribution automation, meaning utility companies can proactively monitor their distribution elements for outages and service demands. Utility managers and technology decision-makers should take into account the benefits satellite technology can deliver for these applications and the benefits they can deliver to smart grid efforts.

SUBSTATION CONNECTIVITY

Satellite connectivity has been used for years to provide supervisory control and data acquisition (SCADA) applications for remote locations in the oil and gas industries and other energy exploration areas. The data requirements are generally low in volume but regular in frequency or periodicity. Private satellite networks have served this need well by delivering secure, custom network bandwidth profiles and ubiquitous coverage. The solution has worked well technically and economically for hard-to-reach SCADA and SCADA-like requirements in these industries.

This still holds true. Satellite is a great fit for these types of applications and is in use to support SCADA and other applications at substations. The performance of the applications is consistent and effective. With the increasing goal of achieving near 100 percent uptime, however, conventional Ku- and Ka-band satellite solutions fall short. A typical commercial satellite connection is generally engineered to deliver 99.7 to 99.9 percent link availability, which means that on average, 0.1 to 0.3 percent of the time, a satellite connection will be lost. That percentage coincides with a certain intensity of precipitation. When it rains or snows to a certain degree of intensity, the satellite connection will drop for the period of that critical intensity. Substation connectivity is most critical during storms where electricity outages increase, thus making a conventional satellite solution not optimal to achieve near 100 percent availability, until now.

With any type of connectivity solution, it is difficult to achieve 99.99 or 99.999 percent availability with a single-thread connection. To address this problem, many utility companies employ a backup connection that can increase the availability of any connectivity to nearly 100 percent. So how can this availability be achieved with a satellite-only solution? The answer is with an L-band-based service that backs up the primary Ku- or Ka-band satellite connection. L-band is in the 1-2 GHz range and is not susceptible to degradation during precipitation. When the primary Ku- or Ka-band satellite service fades during rain, the backup path, L-band, will be available to pass traffic. The L-band service is usage-based and can be expensive with heavy usage. Because it will be used as the exception and not the primary connection, however, it only will be used a small percentage of the time to pass low-volume traffic, and, therefore, costs will be kept to a minimum. A commensurate terrestrial solution might cost three times or more for the same level of availability.

By combining L-band with Ku- or Ka-band satellite technology as a high-availability solution, a satellite solution can deliver the performance that has always been delivered for SCADA-like applications, but with near 100 percent availability that is required for substation connectivity. In addition, satellite still provides its inherent advantage—100 percent nationwide coverage. There are no dark spots. Furthermore, satellite supports broadband applications such as Voice over Internet Protocol (VoIP) and video surveillance. Network bandwidth can be tailored to specific requirements, and the solution is completely private, meaning no traffic crosses the public Internet. L-band and Ku-band satellite technology has been available for some time but until now has not been combined in this manner to provide a single solution. A certain set of requirements exists such that the traffic profile, the remote locations and the need for very high

availability make this an ideal solution for the utility industry.

DISTRIBUTION AUTOMATION

Similar data requirements, as those in substation connectivity, exist to support monitoring elements along distribution lines. The attributes of private satellite connectivity to enable distribution automation are similar to those for substation connectivity. A dual path, high-availability solution, however, may not be cost justified. A single, high-availability connection at an access point fed by distribution devices might be a better solution for monitoring and control.

There are a couple of options. One is to use the L-band solution. It has a small form factor, is hardened, can be mounted anywhere, and is easy to install. Again, the downside is usage costs. Depending on the volume of traffic, it might be cost prohibitive to use the L-band solution at all locations. Locations in more densely populated areas likely are better served with an alternative licensed or unlicensed wireless solution. In rural, less dense areas, however, the same wireless technologies might be more costly and in these areas, the slight premium that might be incurred by using an L-band solution might be justified.

The second alternative is to use advanced antenna technology for fixed Ku- or Ka-band satellite service. Emerging advanced antenna designs offer a small form factor, are easily installed and pointed, and have fixed operating costs. In most cases, availability can be designed to approximately 99.9 percent.

AMI BACKHAUL

Advanced metering infrastructure (AMI) requires communication between a smart meter at a customer's location and the data center. To achieve this end-to-end connectivity, various technologies can be considered, including deployment of licensed and unlicensed wireless solutions between the home and a collection point further upstream, with subsequent communication to a data center. Common practice in deployments and pilots is to use carrier cellular solutions from the collection point onward to serve the wide area network (WAN) needs in the AMI end-to-end solution. Utilities must consider challenges and considerations with the cellular service, however, such as congestion, loss of coverage during disaster and limited range.

Satellite technology presents a high-quality, low-cost alternative. Enterprise satellite solutions provide ubiquitous, continentwide coverage and because they are private networks, they are not susceptible to public usage because they do not traverse the Internet or other public network. Furthermore, advanced antenna designs allow for easier installation to accommodate mounting on pole tops. Privacy, scalability, flexible bandwidth, ease of deployment and reach are all significant benefits satellite provides as a comprehensive end-to-end AMI solution or at the least as a fill-in for the dark spots of a cellular network solution. In the U.S. it is estimated that 2 percent or more of coverage areas have this dark spot problem, for which last-mile satellite connectivity is a viable, cost-effective alternative to a local wireless solution.

In the midst of all the new and exciting options available to utility providers, communications infrastructure remains one of the most important decisions companies must make when implementing smart grid initiatives. To that end, satellite networking technology has developed rapidly and delivers the combination of high performance, availability and security that can aid smart grid efforts for the utility industry. Substation connectivity, distribution automation and AMI are key areas in which a satellite solution can provide the most cost-effective communications solution. Satellite solutions are an essential part of the multitechnology approach required by the utility industry to achieve an end-to-end, smart grid communications infrastructure—one that is reliable, fast, secure and cost-efficient.

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