EnergyPulse

Satellite Reinforces the Smart Grid

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Many utilities don't realize that the smart grid's promise of ubiquitous, real-time information isn't feasible without satellite broadband in the networking technologies mix.

The ideal smart grid communications network requires multiple transport technologies and standards, undoubtedly including terrestrial fixed and wireless broadband, and all coalescing around an IP backbone. However, a terrestrial-only architecture is vulnerable to disasters on the ground, whether natural or man-made, and cannot alone ensure fail-safe operation. To achieve that means employing a true alternate communications path, which only satellite provides. The resulting hybrid terrestrial and satellite network can realize the high reliability and availability demanded across the entire smart grid, including the necessary combination of reach, capacity and bandwidth scalability.

It's an important issue for utilities to deal with now, because the industry has begun a huge spike in smart grid infrastructure investment. More than $10.75 billion was poured into smart grid IT improvements in 2009, according to IDC. And the American Recovery and Reinvestment Act awarded $3.5 billion in grants to 100 utilities for the advancement of their smart grid plans. In the rush to build out the smart grid, it's easy to make mistakes in how to best invest those funds.

High Availability that's Affordable

According to Marzio Pozzuoli, founder and CEO of Woodbridge-based RuggedCom Inc., currently about 10 percent of electricity consumption requires "six 9s" of reliability (99.9999). That number is expected to increase to 60 percent by 2020. And by 2020, 10 percent of energy consumption will require "nine 9s" of reliability, or an average downtime of just 32 milliseconds a year.[1]

With so much of this uptime riding on the data side of the smart grid, utilities need to implement the highest availability data communications architecture possible within reasonable cost. And this requires redundant connections at critical sites as a minimum, where a single point of failure could bring down the network and jeopardize the grid. But as noted earlier, a terrestrial-only redundant approach is folly, because severe disruptions on the ground can disable or destroy both fixed and wireless infrastructure alike, no matter the redundancy. What's needed is to reinforce terrestrial connections with a true alternate path.

Enter satellite. Today, satellite technology is used to deliver high quality broadband services to millions of customers globally spanning all market sectors, from major enterprises and governments, to small businesses and consumers, at speeds, reliability and availability that are comparable to or better than terrestrial technologies. Indeed, many of today's highest availability networks -- such as for lotteries and emergency preparedness -- employ satellite due to its fundamental advantages -- ubiquitous, continent-wide coverage, and cost of connectivity independent of location, distance, or density of subscribers.

The ideal smart grid architecture will therefore seamlessly blend redundant wire-line, wireless and satellite communications channels to yield the highest possible reliability and availability. Keeping it also affordable means deploying the most cost-effective technology at each site and backing up those that are operationally critical as a minimum, with the overall constraint of having no single points-of-failure. Here are just a few examples illustrating the feasibility of such a network.

Substation Connectivity

Satellite connectivity has been used for years in Supervisory Control and Data Acquisition (SCADA) applications for remote locations in oil-and-gas and other energy exploration areas. Traditional private satellite networks work well for these low-data rate, hard-to-reach applications, delivering secure and ubiquitous coverage inexpensively.

The same promise holds true for electric substation applications. But to achieve 100 percent uptime, a single technology solution falls short. For example, a typical commercial satellite connection delivers 99.7 to 99.9 percent link availability, which means that for 0.1 to 0.3 percent of the time, a connection will be lost. That downtime typically occurs in rain and snow storms. And unfortunately that's when substation connectivity is most critical to prevent electricity outages.

To solve the problem, utilities can employ a backup connection which ensures nearly 100 percent availability. Combining a Ku- or Ka-band satellite service as the primary network, with an L-band based satellite service as backup will prevent the substation connectivity from degradation during precipitation. L-band satellite communications is not susceptible to rain fade because of its low frequency, ~1.5GHz, compared to Ku (~14GHz) or Ka (~28GHz) bands. In a hot-standby configuration, when the primary link fades the backup L-band connection continues to deliver traffic. It's also cost-effective; a commensurate terrestrial backup solution might cost three times or more for the same level of availability.

This satellite approach offers another major advantage as well: 100 percent nationwide coverage. No matter how remote a substation's location, there are no "dark" spots with satellite connectivity. And to keep an eye on substations or enable field technicians to call into headquarters, satellite broadband supports applications like video surveillance and Voice over IP (VoIP).

Distribution Automation

Many utility companies rely on phone complaints from customers to discover outages and problems. Scott MacDonald, a partner with Emerald Technology Ventures, a Montreal-based venture capital firm that specializes in energy technologies, says that compared to the telecom industry, "[The utility industry] is in the dark ages." However, combining network technologies can address that issue. Communication points along the grid can continually monitor the grid and automatically react to real-time issues as they occur. These communication points -- which could be a substation or a single utility pole -- will have the ability to manage multiple communications paths, from wire-line, to MPLS, to 3G cellular, to satellite.

Smart grid connectivity requirements for distribution automation are similar to substation requirements. However, a dual path, high-availability solution may not be cost effective for distribution automation. A single, high-availability connection at an access point that is fed by distribution devices may be a better solution for monitoring and control.

Utilities have another option they may not be aware of. An L-band satellite network offers a very small form factor, is environmentally hardened, can be mounted anywhere, and is easy to install. Most importantly, it can be deployed virtually anywhere, including rural and remote locations where other solutions are not available. More densely populated areas may be more affordable using a 3G cellular solution.

Whichever technology is deployed, improved responsiveness to failures results in dramatically reduced outage times and maintenance costs, and makes for greater customer satisfaction. Better predictability and quicker issue response means a more efficient, reliable and cost-effective operation.

AMI

Home area networks will allow appliances and other energy-consuming devices to communicate to the utilities through Advanced Metering Infrastructure (AMI) networks. Customers will be able to understand energy consumption in fine detail and work with utilities to reduce energy consumption.

AMI requires communication between a smart meter, whether residential or commercial, and the data center. To achieve this end-to-end connectivity, various technologies are required. Typically, both licensed and unlicensed wireless solutions are deployed between the home and a collection point further upstream. The collection point then needs a communications link to the data center. It's common today to use cellular networks from the collection

point onward in a wireless mesh network for AMI. But cellular networks are susceptible to the congestion patterns of consumer voice users. Another issue is that during disasters, either cellular coverage is knocked out or cellular use dramatically increases, thereby eliminating or diminishing bandwidth for data applications over the network. And cellular data coverage is limited typically to more populated areas and often not available in rural or remote areas.

Satellite technology can also serve a key role in implementing the WAN. Enterprise satellite systems deliver custom network solutions that are secure, don't traverse the Internet, and provide ubiquitous coverage. Further, small terminal designs enable easier installations, including pole mounts. Privacy, scalability, bandwidth, ease-of-deployment, and reach are all significant benefits satellite can provide, either in the dark spots of a cellular network or in place of the cellular network itself to provide a complete end-to-end AMI solution.

Mobile Workforce

Gone are the days where a company's workforce is not connected at all times. Cellular coverage is extensive and affordable, but may require multiple providers to cover larger geographic areas. And while cellular data delivers a few hundred kilobits-per-second performance, coverage may be spotty and fluctuate in quality. Range is another issue. When personnel work in locations that drift outside of range, they typically have to drive back to some location to find connectivity when they want to communicate back to the home office. It's not an ideal solution, especially when personnel are working to restore interrupted service.

Satellite solves the "dark spots" problem. Even the smallest of vehicles can be equipped with fixed mobile or on-the-move satellite technology. The vehicle is equipped with a router which first tries to connect via cellular service or private wireless, and then via satellite. The router automatically finds the service that is available, so field personnel are constantly connected. This kind of solution supports all data needs -- work orders, dispatch, and repair support. And data throughputs are high enough to support virtually all kinds of information transfers, from emails, to data files, to videos.

Conclusion

Satellite networking technology has developed rapidly and now delivers the combination of high performance, availability, and security that can greatly aid smart grid efforts for the utility industry. Substation connectivity, distribution automation, AMI, and smart trucks are four key areas in which a satellite solution can provide the most cost-effective communications solution. Indeed, satellite solutions are an essential part of the multi-technology 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.

References

1. The Star, "Transforming Dumb Network Into Smart Grid," January 1, 2009

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Mr. Nelson has been in the satellite and data networking industry for over 16 years. Currently he is director of service development for the Utilities, Energy and Transportation market sectors within the Business Solutions Group in the North American division of Hughes. As such, he is responsible for the development of services pertinent to those industries. His various positions at Hughes have included international and domestic product and service development utilizing the latest technologies developed and manufactured by Hughes.

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