White Paper

Factors that Make Power-line Communication the Best AMI Choice

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Executive Summary

Metering is only part of the technology that makes up advanced metering infrastructure (AMI). Communication systems – the infrastructure part of the network – are equally important in achieving the strategic objectives of a utility. For power providers serving rural areas or municipalities with medium to low-density meter populations or mountainous landscapes, power-line communication technology is an ideal choice.

In short, power-line communication networks:

- Bridge gaps in disbursed geographies by working over existing power-line infrastructure.
- Deliver smart grid capabilities and a meter-read rate better than 99 percent.
- Improve the reliability of the distribution network through recording of outage events.
- Offer improved latency through bi-directional communication.
- Provide the foundational technologies for the smart grid.

When looking at power-line communication technologies, it is important to consider differences between systems that employ carrier methods versus those that use signal modulation. The type of power-line technology chosen can affect the performance of a system, making it more vulnerable to harmonics or requiring extra equipment like repeaters to improve the signal.

In addition, how easily a system accommodates new functionality and whether it can be combined with other technologies such as radio frequency (RF) solutions are factors that must also be considered.

This white paper looks at the advantages power-line communication delivers and the system features utilities should look for to maximize its performance and return on an AMI investment.

Bridging the Gaps in Disbursed Geographies

The most-established and proven form of fixed network metering technology is power line communication. Utilities have been using bidirectional signals sent over power lines to read meters for decades, particularly in areas where meters-per-line-mile density has long made the business case for this method of reading meters relatively easy to justify.

Power line communication technology is an ideal solution for utilities that have a geographically disbursed network because the infrastructure exists within the electric distribution grid itself and leverages a utility's own distribution wires. In meter reading, two-way communication predominates.

Because power-line communication systems utilize a utility's wires, they reduce infrastructure costs associated with data collectors, repeaters and antenna towers associated with wireless technology. Some power-line systems such as those from Aclara, only require substation equipment for data collection, versus the numerous line-of-site data collection units and repeaters required by an RF system.

In cases where meter density is medium to low, power-line communication can dramatically lower the cost of ownership of AMI, versus an RF solution. These systems also avoid signal propagation issues that RF solutions may encounter in areas with mountains, canyons, and dense vegetation.

Delivering Smart-Grid, Must-Have Capabilities

In 2013, researchers at the Electric Power Research Institute (EPRI) interviewed managers at utilities with a collective 50+ million smart meters installed and concluded that, "AMI meets the definition of a disruptive technology that improves a product or service in ways that the market does not expect." That's because AMI is a backbone for smart grid applications, not just meter reading. The research team identified 86 AMI applications and narrowed down the most common ones in a top-10 list. Their report is publicly available here.

As EPRI's researchers pointed out, most utilities with AMI already use it for metering, billing and system management. The handful of other applications being piloted by most EPRI survey respondents included power quality monitoring, phase validation, and support for conservation voltage reduction.

EPRI's researchers maintained that their top-10 list of applications represented "what almost every utility will strive to achieve" with AMI. In other words, such applications are table stakes. Power-line communication systems are well suited to achieving every item on the list.

EPRI's Top 10 Uses for AMI

Metering

- Meter reading
- Bidirectional metering
- Net metering
- Nontechnical losses

Utility operations

- Restoration verification
- Outage notification
- Distribution asset load monitoring
- Power quality monitoring
- Conservation voltage reduction support

Other

- Distribution of firmware

Survey of Advanced Metering Infrastructure Applications, Electric Power Research Institute, 2013

Going back to an AMI system's nominal goal – meter reading – these systems can deliver a read rate better than 99%. More important, few, if any, utilities exceed 50% network utilization. Most organizations are meeting their daily read requirements in three or four hours of system use, leaving plenty of capacity for utility managers to take advantage of the system for applications beyond meter reading.

Improving the Reliability of the Distribution Network

As steadfast monitors of all activity on a distribution system, power-line communication systems are relentless recorders of outage events, momentary outages (or blinks), outage duration, and other quality indices. This capability, combined with head-end analytics, can help utilities determine the general location where crews should check the system for tree limbs, hot clamps, and other distribution network problems.

Power-line systems also provide phase identification, which is becoming increasingly important in areas where proliferation of rooftop solar results in phase imbalance caused by residential PV systems being connected to only one phase.

On the outage restoration side, power-line systems support outage detection. On-demand reads, or meter "pinging," combined with advanced algorithms, helps utility engineers proactively locate faults, verify restoration, and avoid discovering single "nested" outages long after restoration crews have left the area. The Aclara system has an efficient one-byte fast ping to support outage detection and localization.

Some power-line communication systems also allow for meter-device grouping, which helps electric system engineers quickly understand feeder status. In the Aclara system, group reads can quickly interrogate 256 meters on an outbound command, which substantially improves throughput and performance.

Solving Latency Issues

In the past, some power-line communication systems sometimes earned a reputation for latency issues. However, such problems aren't inherent in the technology overall; rather, they are the result of how communication is performed over power lines.

What does this mean to the utility? Utilities now can use the additional capacity to handle smart grid applications above and beyond meter reading. That's because the time to retrieve a full complement of meter data from a 5000-meter bus, including intervals, voltages, kilowatt hours, tamper indicators, error flags and demand could be reduced from 60 to 20 minutes.

Building the Smart-Grid Foundation

The AMI top-10 must-do list compiled by EPRI five years ago would likely look very different in the light of the increased adoption of distributed energy resources (DER) seen today. Increasingly, utilities must push intelligence and control to the grid edge. Power-line communication systems allow them to do so.

Load-control, for instance, was an early application for power-line systems and an increasingly important part of the smart grid. This is particularly true in areas where distribution energy resources are proliferating and utilities must balance an increasingly complex mix of supply and demand.

One electric utility in the Southeastern United States, for instance, has been using Aclara's power-line communication as the foundation of its load-shedding program for more than 30 years. The system has proven to be a fast way to curtail demand and maintain system reliability.

Load control is a proven technology that can assist a utility deliver reliable energy at the lowest cost. Though Today, the utility also uses the system for economic dispatch to ensure the most cost-effective procurement and delivery of electricity. The utility has some 830,000 of its 4.9 million customers enrolled in a program that communicates with more than one million load controllers connected to customer devices.

The concept of economic dispatch refers to reducing generation costs by activating the least expensive resources to produce energy first. Applied to distribution automation, the concept refers to reducing load – energy use – for short periods during times of peak demand to reduce the need to buy energy at expensive peak prices. By managing customer loads, high peak prices can be avoided.

For a system-wide event, FPL can create an overall load reduction of two gigawatts (2051 megawatts) in fewer than 15 seconds. The load curtailed has enabled the utility to defer construction of three medium-sized power plants since the program's inception.

Along with load shedding, power-line communication systems are fully equipped to deliver the type of sensor data that gives utilities greater situational awareness of distribution-system health. Combined with smart meters, the systems allow for transport of voltage, frequency, and power quality data. In addition, they allow for distribution system automation such as remote control of capacitors, bank-line switches and reclosers, voltage regulators, and load-tap changers.

Gaining More from Power-Line Communication

Not all AMI systems that leverage power lines are equal. Among the things to consider, you'll find these factors:

Carrier or modulation?

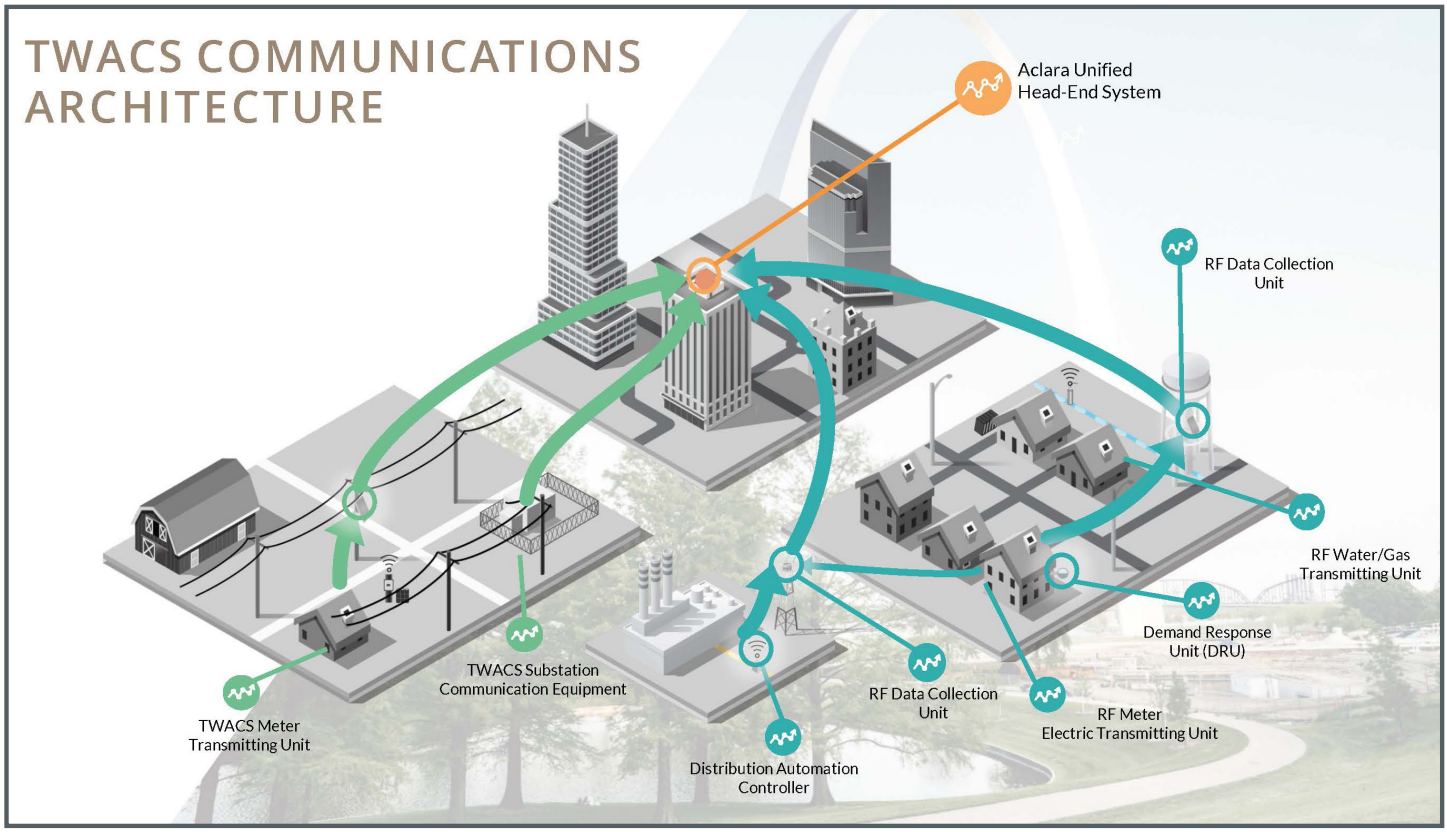
Some power-line systems overlay a carrier signal over the electric signal. This often requires additional devices on the network, such as repeaters, line condition equipment, and signal boosters. It also leaves the signal vulnerable to distortion due to harmonics and other power quality issues.

Other power-line systems, like those from Aclara, use signal modulation. There's no carrier superimposed over the electric signal itself, which eliminates the need for additional devices on the line. It also protects the metering communication signal from harmonic distortion. For example, the Aclara system modulates at the zero cross of the 50 or 60 hertz electricity sine wave. On the outbound signal, the system modulates at the zero cross on the voltage and, on the inbound signal, it modulates on current. Consequently, harmonics and other line distortion is not imposed on the system.

Hybrid-ready systems

Even when a utility needs power-line communication for the bulk of its territory, there may be times when it's appropriate to add RF communication to the network, or vice-versa. Sometimes the need is to support higher throughput and data rates, or read non-mains connected devices such as water and gas meters. Sometimes a mix of rural and suburban territory makes hybridization attractive.

Power-line systems usually cannot work seamlessly with RF solutions., making it difficult for utilities to optimize the business case for AMI. Aclara, however, offers both technologies and a single software headend solution that simplifies using the two communication technologies in a hybrid scenario.



The TWACS power line communication system offers bi-directional and concurrent transmission of data, capturing more that 99% of device readings.

Application extensibility

In system design, extensibility refers to the ease with which a system can accommodate new functionality. Given the rapid change taking place today within the electric industry, extensibility becomes increasingly vital.

Some extensibility is tied to how data from a metering system gets used. For instance, fault location and outage management improve dramatically when meter data is fed into outage management systems.

This capability expands further with algorithmic analysis of the data before it is handled by the outage management system. Here's an example: Suppose a multiple-user outage has occurred. If one meter in the affected area were to be interrogated and fails to respond, that doesn't necessarily mean that this one meter – let alone the entire subdivision – is experiencing an outage. Signal processing and other communication errors could be the reason the meter isn't responding.

If a second meter is interrogated and it also fails to respond, the probability that both meters are experiencing an outage rises. As each meter in the subdivision is interrogated, the probability of outage can be computed with increasing certainty. The aggregate of all the data collected within the subdivision makes for a more reliable conclusion about the outage state of the neighborhood.

Since data can be statistically correlated with the outage state of the surrounding points as well as all points between it and the power source, this analysis allows utilities to more accurately triangulate the likely source of the outage. Aclara's fault detection and localization algorithm performs just this type of analysis from within the AMI system.

Summary

While the use of meter data for fault detection can help utilities keep the lights on, analytics allow them to continue to become more precise. Utilities also are using AMI networks for much more than meter-reading, and are reading sensors and other devices using the same communication networks that handle meter reading. Could the system you're implementing someday be used for smart city applications, like street lighting control? Could it govern electric vehicle charging stations or help customers with building energy management?

The list of applications and uses for AMI systems continues to grow. What's vital is that you select a communication technology that can adapt as our grid evolves. Modern power line communication systems from Aclara are certainly able to handle the bulk of these applications and those to come.

About Aclara

Aclara, now part of the Hubbell Power Systems family of brands, is a world-class supplier of smart infrastructure solutions (SIS) to more than 800 water, gas, and electric utilities globally. Aclara SIS offerings include smart meters and other field devices, advanced metering infrastructure and software and services that enable utilities to predict and respond to conditions, leverage their distribution networks effectively and engage with their customers. In 2016 Aclara won a Frost & Sullivan Global Smart Energy Networks Enabling Technology Leadership Award and was named a finalist in three categories of the Platts Global Energy Awards.

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