# Empowering Intelligence at the **Grid Edge**

SENSUS
a **xylem** brand | UTILITY **DIVE**

Custom content for Sensus by **Utility Dive's Brand Studio**

# Introduction

**The boom in advanced technologies behind the meter,** as well as the burgeoning variety of distributed energy resources (DERs) connected around the grid, is driving the need for grid-edge intelligence.

Even though utilities need more intelligence at the grid edge, the process of selecting the right combination of tools to do this job can be hindered by misconceptions about grid-edge intelligence. (See page 3) However, it is possible to dispel these myths and develop solutions that are precisely tailored to a utility's unique circumstances and resources by thinking holistically and creatively about the capabilities of the entire advanced metering infrastructure (AMI), not only about smart meters.

# 4 Myths of Grid-Edge Intelligence

| Myth | Truth |
|---|---|
| Grid-edge devices must run apps. | Running apps at the grid edge isn't always necessary. Sometimes processing is best handled at the system head-end. |
| Grid-edge devices must have, and use, peer-to-peer (P2P) communication. | P2P communication can be helpful, but isn't always necessary, and there are some tradeoffs. |
| Mesh networks are required to support grid-edge intelligence. | Both centralized and mesh networks can support grid intelligence. |
| A grid-edge device must possess the capabilities of a Linux computer in order to be "intelligent." | Intelligent grid-edge devices encompass a range of built-in processing power. Also, just because many advanced capabilities may be included in a device doesn't mean they all need to be used. They merely represent options, and their adoption should be decided case-by-case. |

sensus
a **xylem** brand

> ## "We're discovering that behind-the-meter assets can have a larger grid impact than the traditional view of load"
>
> Jared Gregory, product manager for Sensus

"Traditionally, utilities only cared about what happened on the grid up to the meter. The customer's home or business was simply a load, undifferentiated consumption," said Jared Gregory, product manager for Sensus. "But now we're discovering that behind-the-meter assets like batteries, electric vehicle chargers, inverters for rooftop solar, and smart appliances and thermostats can be treated as resources. They can have a larger grid impact than the traditional view of load, so utilities need connectivity to these resources."

What makes a grid "smart" is not only the devices deployed around the grid edge; it is the combination of those devices and the communication network that connects them to each other and the head-end system. Robust grid-edge intelligence can be achieved via a variety of strategies for distributing processing power between smart meters and the AMI system head-end.

Just because a smart meter is able to run apps (the way a Linux computer can) or communicate with nearby meters does not mean that it need always do these things to support intelligent functions at the grid edge. Certain grid-edge capabilities (such as temperature auto open, high-current analytics, load-side sensing and open/neutral) are best served by devices at the grid edge.

We're not scientists.

sensus
a **xylem** brand

These functions require lower processing power, and they must be executed as quickly as possible, independent of the network. It is up to each utility to assess which specific types of grid-edge intelligence capabilities, at which points in its AMI network, would best align with its current and future needs and resources.

Through this inquiry, utilities can determine the best architecture to support the advanced services that customers increasingly demand — as well as to enhance the reliability and efficiency of the power system, reduce outages, and control long-term costs for maintenance and upgrades. Such an assessment often reveals that a utility is more ready to deploy intelligent grid-edge functions than previously believed.

# 1 Centralized vs. Decentralized AMI Architectures

Utilities have two primary options for AMI network architecture:

- **Centralized.** Meters exchange messages and data with the system head-end primarily through towers or other collection points across the network.
- **Decentralized.** Meters mostly communicate directly with each other over a mesh network. This generally entails several "hops" to communicate with the system head-end.

For grid-edge communication and control, both AMI architectures have advantages and disadvantages. However, centralized AMI networks offer some significant compensating advantages that utilities sometimes overlook.

For instance, in a centralized network, there is less need for meters to run on-board apps in order to obtain sophisticated and flexible functionality at the grid edge (via fast, reliable communication with the head-end). Overall, centralized AMI networks tend to require less infrastructure, not more – thus yielding long-term efficiencies in maintenance and repair of field assets. This approach also provides a much easier and faster path towards deploying an AMI network.

In fact, both centralized and mesh networks can execute intelligent functions at the grid edge, including:

- Collecting meter data, at intervals as short as one minute
- Improving outage protection, management and recovery
- Sophisticated network-enabled analytics
- Distribution automation
- Phase identification
- Theft identification
- More robust demand response

- Conservation voltage reduction
- Volt/VAR optimization and control
- Smart street lighting

Centralized AMI also tends to withstand the test of time, extending the value of capital investments. For instance, in 2008, PECO (an Exelon utility serving the greater Philadelphia area) deployed a large AMI network with centralized communication to serve 1.7 million electric and 500,000 gas customers. An earlier, centralized automatic meter reading (AMR) deployment had shown PECO that this architecture offered advantages for supporting future grid-edge intelligence capabilities. It has proven especially valuable for outage management.

"Our fixed network allows us to maximize operations during storms and major system events," said Glenn Pritchard, manager of advanced grid operations and technology for PECO. "Unlike a mesh system that relies on meters as communication nodes, the point-to-multipoint architecture guarantees delivery of crucial outage and restoration messages from meters, such as last gasp outage messages."

PECO's Sensus AMI network includes 175 towers or other data collection points, deployed over 2,100 square miles – from the dense urban environment of Philadelphia out to dispersed rural areas. Most meters can communicate with at least two base stations. This redundancy is crucial during severe weather or other major system events.

"During Hurricane Sandy in 2012, we lost service to nearly one-third of our towers, but we still maintained communication to over 98% of our meters," said Pritchard. "That redundancy supported very accurate situational awareness, so we could dispatch the right crew to the right location the first time, and restore power faster. During that one storm, we saved $15 to $20 million in truck roll costs."

On an everyday basis, the capabilities of PECO's centralized AMI network improves customer satisfaction, helps the utility spot grid issues as they emerge, and increases maintenance and repair operational efficiency.

# 2 Data Processing: Where Does it Really Need to Happen?

Centralized architecture gives utilities the opportunity to access more data, providing options for where analytics are performed. This enables utilities to leverage smart meters and other endpoints to make decisions and measurements which do not require running on-board apps. As long as the communication network provides reliable data quickly enough, analytics can occur either at the head-end or at the meter – whichever makes sense for that use case.

A meter need not be the equivalent of a Linux computer to behave in smart ways. For instance, it might be able to immediately shut itself down when overheating without waiting for instructions to arrive from the system head-end. Meanwhile, less time-sensitive decisions could be executed at the head-end.

Processing for phase identification is another function that could be handled at the system head-end as data from meters arrives via a centralized network. Phase identification involves retrieving one timing value from each meter, and then matching the relationships between these values. This task has numerous grid benefits, but usually is not mission-critical. This is a good example of an application that can be performed easily at a centralized location.

By contrast, phase identification over a mesh network requires each meter to communicate with every other nearby meter, to collectively compare a particular value and determine whether nearby meters are on a similar phase. This type of distributed application is relatively more complex to implement and maintain. It can yield the same result as centralized phase identification – but with higher
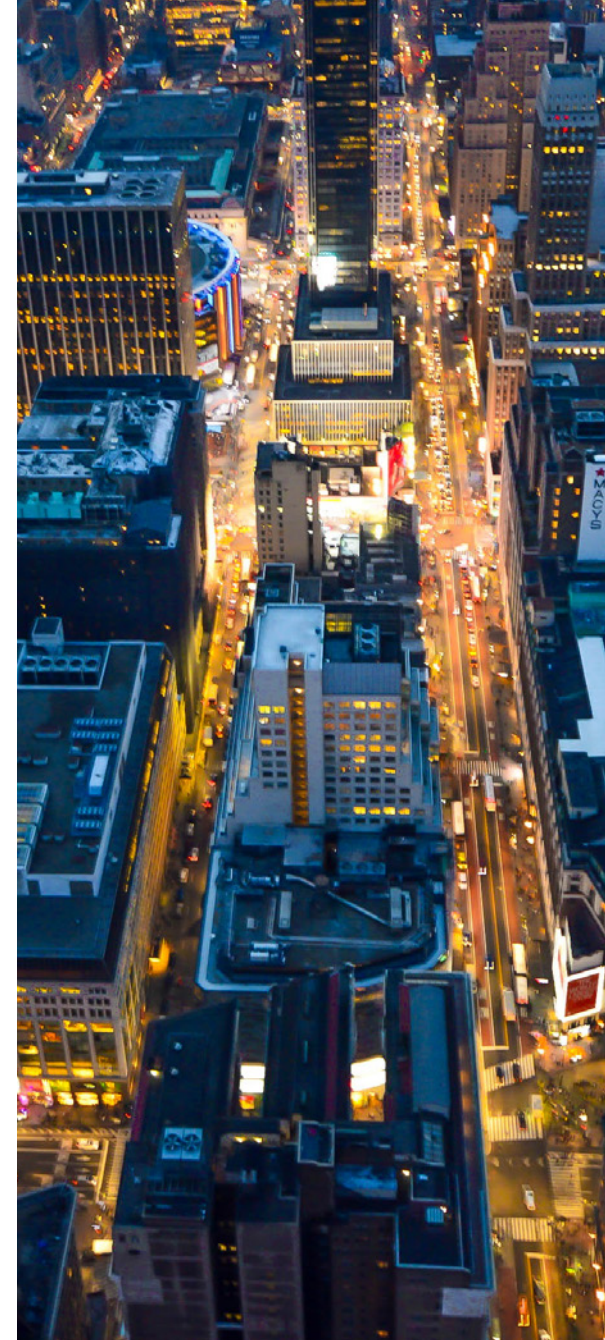
costs for equipment and engineering. Furthermore, when phase irregularities are identified within a mesh AMI architecture, it's more difficult to investigate the root cause. The utility can only refer to the output file indicating phase, not actual data from meters.

A centralized AMI architecture can also perform phase identification, since nearby meters are able to communicate with each other, as well as with base stations. Each endpoint includes components to both transmit and receive. Thus, in cases where performing calculations at the head-end would be too slow, or perhaps not feasible, a centralized architecture can still provide edge-to-edge communications and decision making. The utility can specify how and when meters are able to directly interact with one another, and then communicate this to affected meters. This option can simplify maintenance, troubleshooting and engineering efforts.

# 3 Advanced Applications of Centralized AMI

While decentralized AMI architecture is deployed by some utilities, others are reaping substantial grid-edge intelligence benefits from centralized AMI networks. For instance, Alabama Power is leveraging its centralized Sensus AMI network to perform automated, continuous phase identification.

"We use our meters to reality-check our network model," said Derl Rhoades, manager of AMI for Alabama Power. "It's critical to know which phase our customers are on for load balancing and voltage control/balancing across our grid. We couldn't do that over a mesh network."

Historically, Alabama Power performed phase identification manually. Field crews equipped with phase detectors would periodically visit all parts of the grid, taking one-time measurements. This data would be brought back to the utility, where staff would analyze and compare it to the network model – a time-consuming process that only provided a snapshot of the network.

"The catch with that method was that we get a lot of thunderstorms around here," said Rhoades. "Tree limbs go down all the time, taking down powerlines, so our model keeps changing. Once we would get it updated, it would only be reliable for a short time. Now we continuously keep our model correct."

Channelizing messages allows a utility to prioritize different types of data, explained Gregory. "For example, Mrs. Jones' meter read is probably not as important as a distribution automation command. With channelization, these messages don't compete with each other."
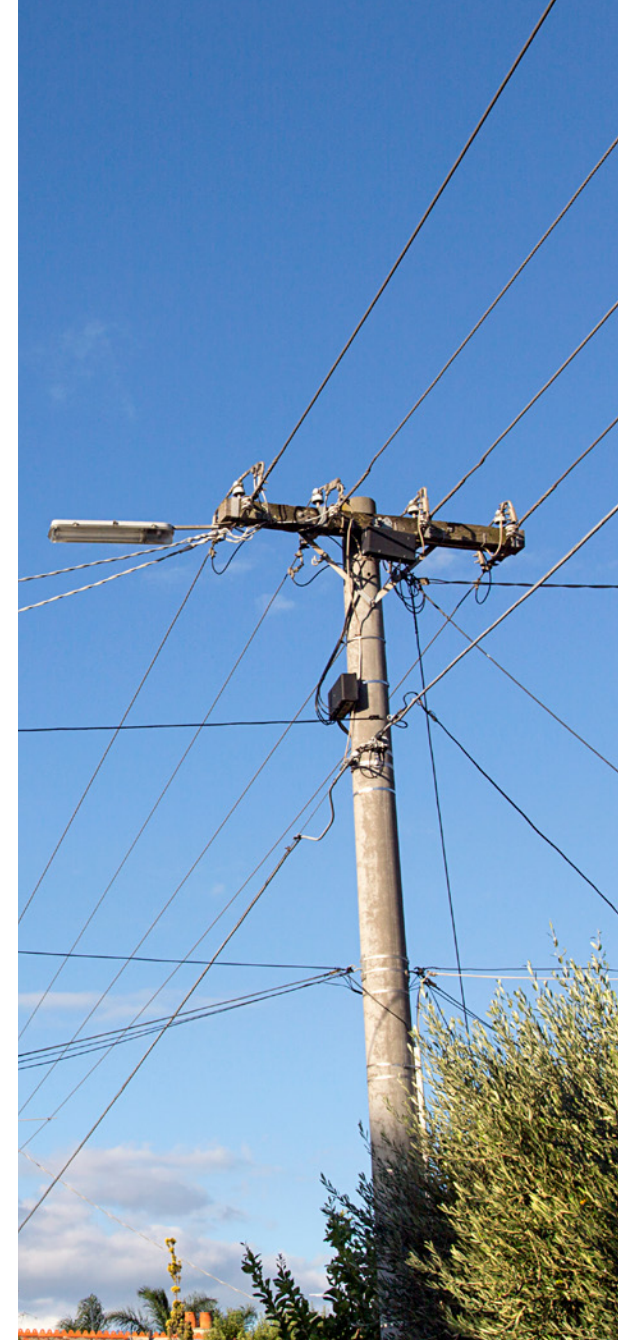
Another problem that utilities can combat with greater grid-edge intelligence is meter theft. When a meter is stolen, the utility might not detect this quickly or easily. Typically a homeowner calls to report a power outage. Then, the utility spends time checking whether adjacent homes are also out of power, as well as checking for local grid problems. After this investigation, the utility will dispatch a truck – one of the most costly aspects of utility repair and maintenance operations.

All of this trouble and expense can be avoided. "A particular level of force is required to remove a meter from its socket," said Gregory. "Upon removal, an outage alarm will be sent to the AMI system head-end, plus a tampering alarm based on the force recorded by sensors on the meter. The utility will immediately see these concurrent alarms."

Centralized communication also helps locate and recover the stolen meter. Most smart meters do not include GPS – but even when they do, this does not guarantee a location lock. When the stolen meter is powered up at a new address, it resumes utility communication along a new network path. On a centralized network, analytics can identify which base station that meter contacts most often.

"Our takeaway is: don't design your AMI network for today, design it for tomorrow... in the long run you'll save more money by getting a head start."

Derl Rhoades, manager of AMI for Alabama Power

By correlating base station data with stored data about which nearby meters are authorized to rebroadcast a message, utilities can accurately pinpoint the stolen meter's location.

Looking ahead, Rhoades said that Alabama Power might explore opportunities to use its existing smart meters as gateways to connect to Internet of Things (IoT) devices, electric vehicle charging stations and other emerging use cases. Exchanging data with the system head-end could support more granular real-time decisions. Also, centralized AMI could support non-wires expansion of grid capacity, increasing the utility's ability to integrate renewables.

"Our takeaway is: don't design your AMI network for today, design it for tomorrow," said Rhoades. "There will always be new data demands and use cases that you haven't even imagined yet. There will be an incremental cost today to build your network to support unknown future data demands, but in the long run you'll save more money by getting a head start."

# Conclusion

Utilities must think long-term when weighing AMI options. Consider these questions when selecting the right tool for this mission-critical infrastructure:

- Which kinds of speed, data, resilience and processing power would be required to support future needs, expectations and opportunities?
- Which kinds of reliability and services might customers come to expect, especially regarding access to their data or interaction with their devices or DERs?
- As the frequency and severity of storms, wildfires and other grid disturbances increases, what kind of system architecture will maximize overall resilience and situational awareness?
- Where would it make the most sense to perform most of the calculations and other data processing for each important type of intelligent functionality you'll need at the grid edge?

By answering these questions, you can clarify which AMI system architecture would most efficiently and effectively provide the long-term capabilities and flexibility that your utility will require.

# sensus
## a **xylem** brand
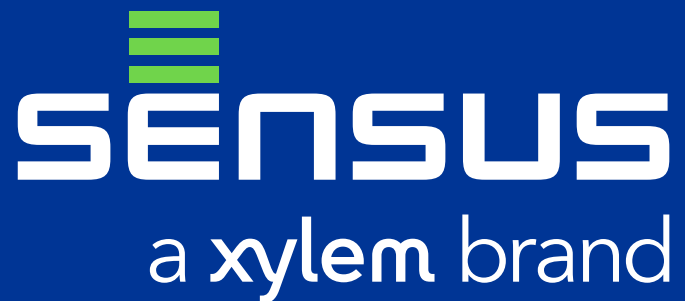
Sensus, a Xylem brand, helps public service providers, including utilities, cities, industrial complexes and campuses, do more with their infrastructure to improve quality of life in their communities. We enable our customers to reach farther by responding to evolving business needs with innovation in sensing and communications technologies, data analytics and services.

**LEARN MORE**

# INDUSTRY **DIVE**

**Custom Content. Targeted Results.**

Industry Dive's Brand Studio collaborates with clients to create impactful and insightful custom content. Our clients benefit from aligning with the highly-regarded editorial voice of our industry expert writers coupled with the credibility our editorial brands deliver. When we connect your brand to our sophisticated and engaged audience while associating them with the leading trends and respected editorial experts, **we get results.**

**LEARN MORE**