Get to the Point

Why a point-to-multipoint RF network is a necessary foundation to enable distribution automation applications of the future and for grid modernization to succeed.

Aclara | UTILITY DIVE

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

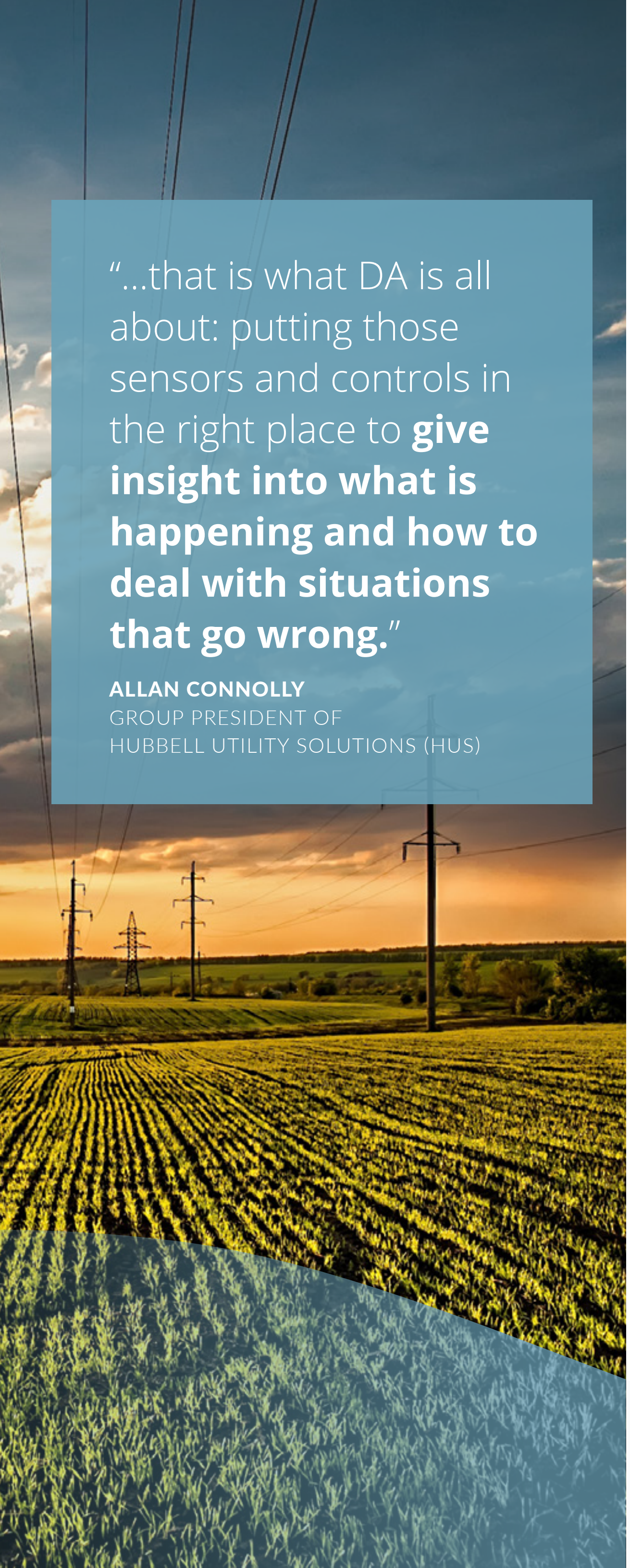
One straightforward way to quickly grasp just how much the distribution grid has changed over the past decade is to look at what has been added to it.

Though our century old distribution system aged remarkably well, the centralized, top-down power system with electricity flowing in one direction is now outdated. A 2015 Department of Energy (DOE) report noted that 70% of power transformers were 25 years of age or older, 60% of circuit breakers were 30 years or older, and 70% of transmission lines were 25 years or older.

In addition, the accelerating number of installations of distributed energy resources (DERs) have transformed the grid at an unprecedented level, creating new complexities for distribution operators that go well beyond the management of two-way power flow. The need to incorporate DERs into the planning and operation of the electricity grid has become vital to fully realize its value while at the same time ensuring power quality and reliability for all customers.

DER deployments connected to the grid are increasing rapidly and require integration into grid operations. This means the adoption of distributed resources necessitate better interconnection, communications technologies, integrated networks with advanced distribution, and reliability technologies to optimize the grid while providing safe, reliable, affordable electricity. The grid of the future needs to be managed in a more automated, integrated, and intelligent way.

According to the U.S. Energy Information Administration, **86.8 million smart meters had been installed by 2018 and projections are that their total number globally will double by 2024.**



"…that is what DA is all about: putting those sensors and controls in the right place to **give insight into what is happening and how to deal with situations that go wrong.**"

ALLAN CONNOLLY
GROUP PRESIDENT OF
HUBBELL UTILITY SOLUTIONS (HUS)

A new network approach for the distributed grid

Not surprisingly, utilities are exploring new approaches and tools to upgrade their existing network architectures and manage an increasingly distributed grid in ways that simultaneously extend the lifespan of equipment, lower operating costs, improve transparency across the network, and bolster customer satisfaction.

Distribution automation (DA) has emerged as one of the most effective ways to modernize the grid to handle and optimize the many impending and already realized tectonic changes that utilities are experiencing. In fact, in a 2018 Zpryme survey of 160 utilities, almost 90% agreed that DA was essential to grid modernization. Survey respondents were resoundingly clear: DA must play a critical role in the successful integration of distributed renewables, energy storage, electric vehicles (EVs) and microgrids.

The emphasis on DA makes sense. With complex, two-way power flows and an abundance of intelligent devices connecting to the grid, the importance of smart, real-time and automated control and management becomes indispensable.

"We see it repeatedly. Utilities want help with how to deal with the combination of perfect-storm factors coming together. That is why we have seen more and more requests for better sensing, software and insights into what is happening on the grid at all times and how to run it better with fewer people," said Allan Connolly, group president of Hubbell Utility Solutions (HUS). "The distribution-automation piece of that is crucial because that is what DA is all about: putting those sensors and controls in the right place to give insight into what is happening and how to deal with situations that go wrong."

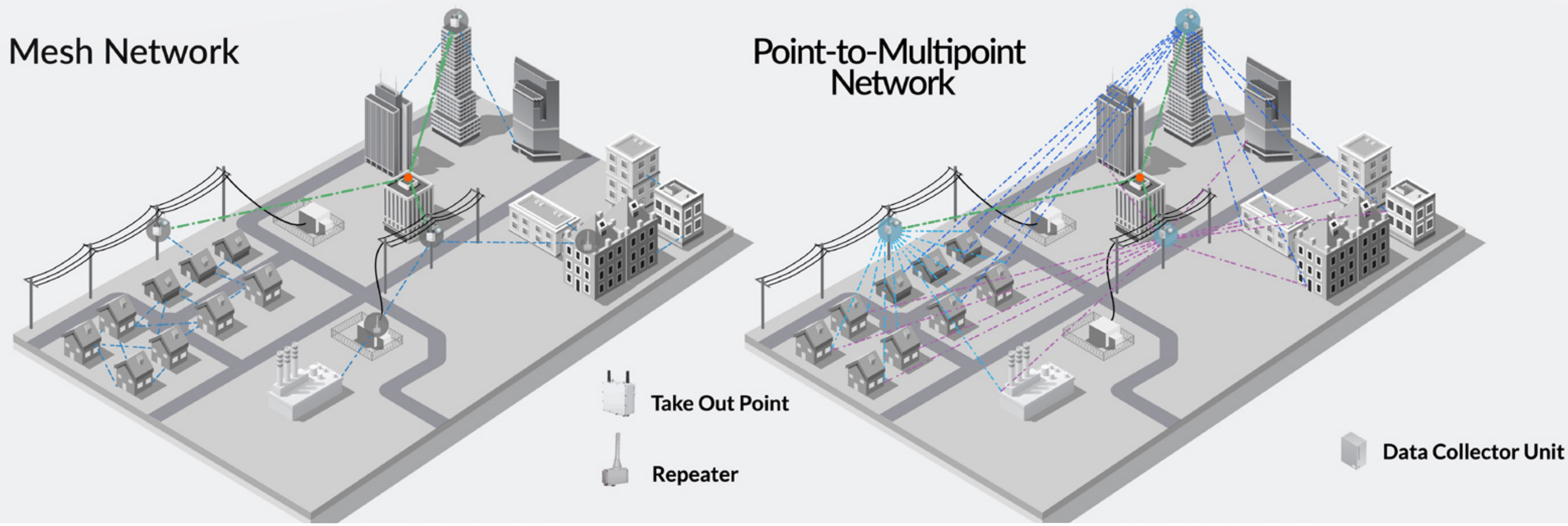
A communications backbone for grid modernization

While the promise of DA is widely accepted, there is also a recognition that some essential gaps to fully realizing its benefits remain. **Arguably the most pressing gap — or at least uncertainty — is utilities' existing legacy AMI communications networks. In fact, in the Zpryme survey, only 30% of utilities expressed confidence that their communications networks were well prepared for what comes next with DA.**

It's hard to overstate just how vital a robust and scalable communications network is to deliver on the promise of DA. Indeed, without sophisticated and reliable communications, it is impossible for utilities to achieve the sort of automation, real-time control, and visibility that distribution grid operators increasingly need. While those day-to-day operations are critical, distribution grid operators also need robust communications networks in order to support what is clearly going to be a large and ongoing integration of DERs, sensors, smart meters, and other technologies.

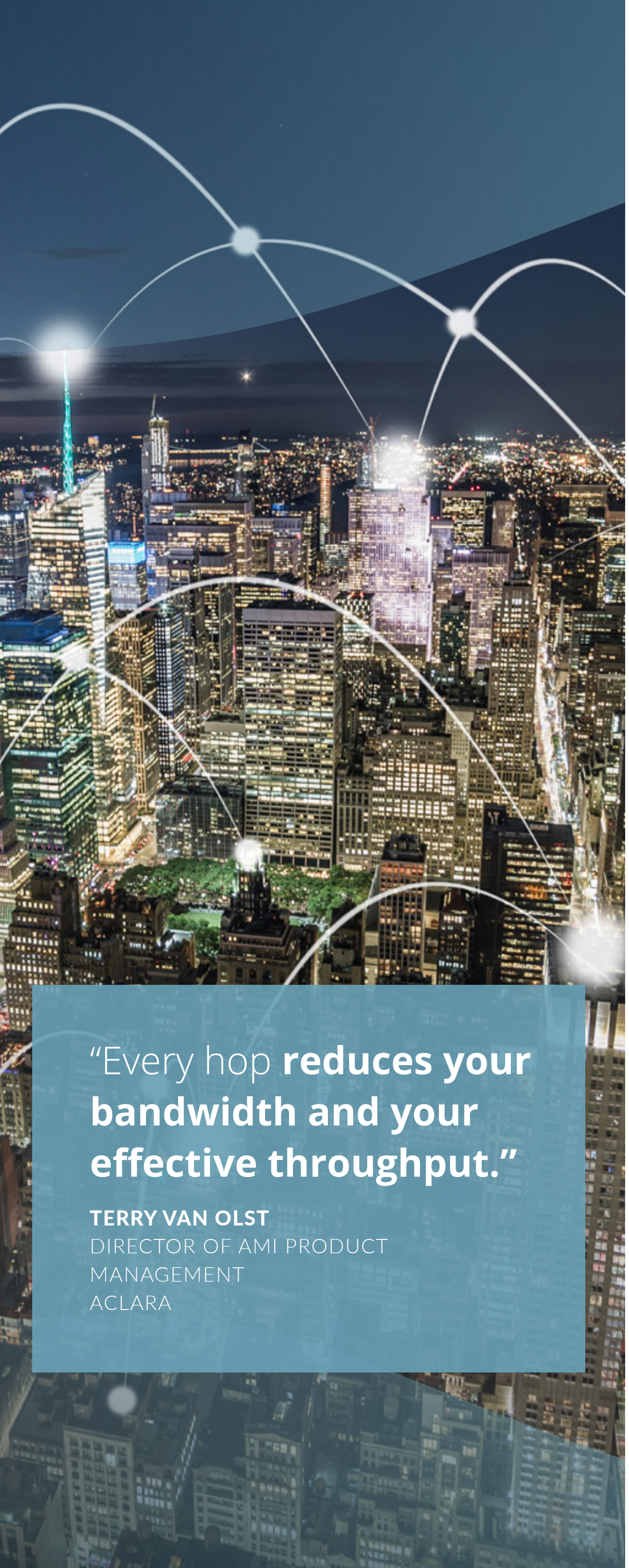
Yet, there is good reason for many utilities to be wary about their existing communication networks. Therefore, more and more utilities realize that an important decision in the journey toward improved DA is the choice of a robust and reliable radio frequency (RF) network. But the problem is that far too many utilities don't think they have a choice of RF networks and may not realize that we have come a long way in regard to RF technology.

The first RF networks on the market were cost-effective wireless solutions that utilities used to handle meter readings for dense areas — readings that, frankly, were not particularly time-sensitive.



Today, the ongoing transformation of the grid from one-way to two way power distribution and growing demands by customers for better information on consumption means that utility network requirements must change. These new challenges also demand networks to be more responsive, robust and offer visibility into a myriad of grid conditions. Having the proper network topology in place is crucial so utilities can provide the scalable communications needed to support system growth and critical applications that will help improve the efficiency, reliability, and security of power systems.

As such, a newer RF technology like point-to-multipoint is often better suited to handle the demands of distribution grids today because of their ability to evolve and meet future requirements. Point-to-multipoint RF networks often turn out to be a better option for utilities — especially large utilities that require advanced capabilities, such as rapid outage response — because of fundamental differences in the way they are architected compared to other topologies. These differences are most obvious in three areas: **latency, resilience and prioritization.**



> "Every hop **reduces your bandwidth and your effective throughput."**
>
> **TERRY VAN OLST**
> DIRECTOR OF AMI PRODUCT MANAGEMENT
> ACLARA

Comparing RF network architectures

A brief tutorial on the main differences between the various network architectures helps illustrate why the choice of an RF network goes a long way toward determining whether a utility can achieve its DA and grid-modernization objectives.

A good way to conceptualize the difference between networks is to remember the purpose of the architectures. Ultimately, the job of a communication network is to get data from endpoints, usually meters, to a collector or takeout point, and eventually to the utility's headend. How these networks are designed and configured can have a big impact on how quickly, reliably, and cost-effectively they can accomplish that increasingly critical task.

There are some inherent limitations that result from how a mesh network, for instance, is configured. For data to make its way from the meter to the headend, a traditional mesh only has one pathway: Signals travel (or hop) from one meter to another before finally reaching a takeout point. Often, multiple hops are required before reaching the takeout point. Each hop that is required to get data from a meter to the collector and ultimately to the headend has a negative impact. Hence, every hop reduces the bandwidth and throughput effectiveness.

Some may argue that the fact that signals hop between multiple meters on their way to a collector actually enhances the system's resilience because it provides redundancy. The argument is that if one meter goes down, the other meters find another path. This characteristic is called self-healing. However, critical time is lost as the network reconfigures. If multiple meters fail or lose power, the mesh network can take hours or days to reconstruct itself.

In addition, in some situations a group of meters is located too far from the utility's take out point for signals to reach it.

In these situations, installation of repeaters is required as an intermediate hop to get signals from the endpoints to the collector. Those repeaters then become a mesh system's single point of failure, which can undermine the redundancy of the system. The important point to remember here is that this topology provides a single pathway for a signal to follow.

Point-to-multipoint systems, on the other hand, are designed in a fundamentally different way, one that vastly improves the capacity of utilities to achieve their DA objectives. For example, point-to-multipoint network designs have redundancy built in to include more than one collector. Messages from meters are delivered to a multiplicity of collectors before being transmitted to the head end.

"If a collector goes down, the meter reading will go through a second collector," said Terry Van Olst, director of AMI product management for Aclara. If both collectors are working normally, it merely means that duplicate data is delivered to the head end. That duplicate data is then filtered, and the most recent is maintained.

A natural question is whether there is a negative impact on a utility's cost if it opts for a system with two or more redundant collectors. While it is true that a mesh configuration has fewer collectors, they often require the installation of several repeaters. Plus, in some cases, a mesh network is configured with multiple take-out points for meter groups, providing redundancy, but also adding expense to the system.

The long-term cost advantages of mesh become questionable when one considers all the expenses. Not only are there upfront costs required to make the mesh network resilient and able to operate more like a point-to-multipoint network, there are also ongoing maintenance expenses as well as the persistent threat of failure.

Point-to-multipoint systems are designed in a fundamentally different way, one that **vastly improves the capacity of utilities to achieve their DA objectives.**

There is a wide range of benefits of point-to-multipoint networks, particularly when it comes to DA. **Some of the most significant benefits include:**

LATENCY

Time matters when it comes to successfully implementing DA. Latency refers to the time lapse involved when the endpoints on a distribution grid communicate with the utility's headend. With mesh architecture, it is not always obvious how long it will take data to be received; it could be anywhere from 150 milliseconds to as long as two minutes. That time uncertainty is a direct result of mesh architecture. "A mesh network has several hops that the packets of information from the endpoints have to go through before it gets back to the headend," said David Boone, vice president of product management at Aclara. "You don't know what the latency is going to be, and from application to application that could vary and could adversely impact performance." By contrast, point-to-multipoint architecture has a deterministic near-real-time latency because data from endpoints always have just two hops: from the device to a takeout point, also known as a data collector unit (DCU), then to the headend and does not rely on multiple hops between field devices before reaching the takeout point which introduces higher than acceptable latency for DA applications.

RESILIENCE

The success of DA depends on the availability and reliability of data to then be able to control the various devices on the network. In mesh architecture, however, data is vulnerable because the infrastructure that transmits and stores them may have limited memory for backup. Put another way; if a storm damages the equipment on a mesh network, data can be lost forever.

By contrast, point-to-multipoint architecture has built-in resilience. That is because the information from meters and other critical devices is sent to multiple takeout points, which can store the data for up to 35 days or more. So, if one is damaged or malfunctions, the data remains secure. This is not just conjecture. The New York City Department of Environmental Protection, North America's largest public water utility, began deploying Aclara's point-to-multipoint architecture in 2009. The architecture was completed by the time Superstorm Sandy hit in 2012, and while the storm damaged 12 DCUs, no data was lost.

PRIORITIZATION

Especially today, there are times when operators of distribution grids need to prioritize the information they receive. Under normal conditions, mesh and point-to-multipoint networks do just fine reading meters. But when there's an outage that requires a fast response or a dramatic change in load or generation, grid operators need the ability to prioritize the information they see and the actions they take. When there is a power outage with a mesh architecture, meters all do a last gasp ping, and that flood of data often crashes the mesh network.

"When you want to do sophisticated things like control and monitoring, timing is crucial," Connolly said. "You want to be able to deal with the important information first and then information that is not as critical later. The way our architecture works is, we have meter reading as the lowest priority, sensing is in the middle. and alarms when something is going wrong are at the top."

While these are all significant differences between the various architectures generally, others are unique to Aclara's RF electric solution. For example, Aclara operates on a licensed 450-470 MHz radio. "The customer owns the license, which minimizes the risk that you are competing against other types of devices communicating in the non-licensed spectrum, like garage-door openers and baby monitors," Boone said.

Also unique to Aclara's RF is the ability to scale and integrate other third-party applications as a utility's operations become increasingly sophisticated. This is possible because Aclara's RF solution integrates with the AclaraONE® software platform, which allows utilities to customize networks and run applications that are uniquely important to their distribution grid. This is particularly important as utilities look to the future and select the partners and applications necessary to evolve and improve their networks. This will become increasingly important as distribution grids become increasingly complex, particularly as EVs become more commonplace.

Using point to multipoint to build for the future

Despite a long history of relying on mesh networks, the evidence is ample that electric utilities are increasingly turning to point-to-multipoint networks as they pursue DA and other initiatives. Indeed, recent deployments of Aclara's RF have taken place across the country and in utilities of all sizes, including the San Francisco Public Utilities Commission, Dothan Utility Services in Alabama, Guadalupe Valley Electric Cooperative, and PenTex Energy in Texas.

First organized in 1938, PenTex Energy is a 10,000-member nonprofit electric cooperative based in Muenster, Texas. Neil Hesse, PenTex's general manager, said the utility began looking at Aclara's RF network to provide network architecture for more urban areas of its service territory. The utility uses Aclara's TWACS® power line communication (PLC) system and will continue to use the system in more rural areas of Pentex's service territory. "I knew of Aclara's PLC system and the high quality the product delivered," Hesse said. "Knowing the track record of Aclara's PLC system, we were given an opportunity to beta-test the new Aclara RF electric solution."

After an initial pilot project of 750 meters, PenTex fully deployed Aclara's RF network, which Hesse said was an essential part of the utility's overall goal of improving its use of data to do everything from remotely read meters and collect payments online to respond to grid conditions quickly. "With the increased data available for our cooperative to increase efficiencies, PenTex Energy needed alternatives with higher bandwidth for the increased data flow," Hesse said. "We are able to see near real-time data with our new Aclara RF electric network. The network will allow us to be more proactive versus being reactive."

Why distribution automation is critical

The need for scalable and sophisticated tools is particularly pressing because utilities face a dilemma: more and more is being asked of increasingly complex distribution grids, yet there is now a long legacy of underinvestment in the U.S. power system as a whole. For example, in the American Society of Civil Engineers' most recent infrastructure report card, the country's energy system received a D+. The report noted a projected investment shortfall of $177 billion in the electricity system between 2016 and 2025.

Money isn't the only challenge. According to a 2017 U.S. Department of Energy report, 25% of electric and natural gas employees will be ready to retire by 2022, meaning that the unprecedented challenges of operating and modernizing the distribution grid will largely fall on the shoulders of new and inexperienced workers.

The obvious question for many utility executives is how to successfully navigate that much change while still delivering on the fundamental mission of utilities to provide safe, reliable and affordable electricity? At the same time, utilities understand that they need to choose partners, tools, and technologies able to help them with their most immediate operational challenges while also building a foundation that will allow them to scale and adapt with all the inevitable changes yet to come.

Importantly, Hesse also said that Aclara's RF provides a foundation to achieve future goals. "PenTex Energy was excited knowing of the future possibilities that the network would support. It was recently greatly enhanced when Hubbell purchased Aclara," he said. "Now the network has a vast array of distribution-automation equipment available to enhance our distribution system. This will allow us to monitor and operate distribution networks remotely."

Another utility that has benefited from its implementation of Aclara's RF is the Guadalupe Valley Electric Cooperative (GVEC). GVEC provides electricity, internet service, and a range of home solutions (including solar, HVAC, and fiber optic internet) to members in its 3,500 square mile territory east of San Antonio, Texas. Though the cooperative was established in 1938, it has a forward-looking perspective on the importance of technology and data. "Data has absolutely become more a part of who we are as a utility and who we are as a company," said Sean Alvarez, the chief operating officer of GVEC. "It helps us in so many ways to make intelligent business decisions."

Because GVEC has been delivering internet services to its members since 1998, it experimented with technology as a tool to operate its grid better through real-time load visibility and real-time communications to open and close capacitor banks. Those early experiences underscored the importance of a communications network in achieving GVEC's grid priorities, including improved automation and visibility. "In order to be intelligent with the grid you have to have visibility to the substations and the endpoints," said Alvarez.

In order to achieve that intelligence, GVEC opted to work with Aclara to deploy its point-to-multipoint system to over 80,000 meters. One big benefit GVEC saw in working with Aclara was that it could utilize Aclara's smart meters, but Alvarez also says it was key that Aclara's system operates on licensed frequencies. "We placed value on the license. Being in the internet business, we saw a lot of inefficiencies and interference with the unlicensed side," he said. "The licensed product gives us a spectrum that is clean, and if it becomes dirty there is a remedy for it."

Also important to GVEC was that the Aclara RF solution could scale and expand in the future. "If you use the same Aclara RF radio modules in their devices, like capacitor and regulator controls and voltage sensors on the network, I can piggyback on that and have a more intelligent and efficient grid," said Alvarez. "You can add a lot to this system to bring value down the road."

Aclara, a division of Hubbell Utility Solutions, is a world-class supplier of smart infrastructure solutions (SIS) and services to more than 1,000 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. Aclara was recently recognized for its vision and end-to-end solution strategy by Navigant Research, won a Global Smart Energy Networks Enabling Technology Leadership Award as well as a North American New Product Innovation Award from Frost & Sullivan, and was named a finalist in three categories of the Platts Global Energy Awards.

Visit us at Aclara.com, follow us on Twitter @AclaraSolutions or subscribe to our blog.

BRAND**STUDIO**

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