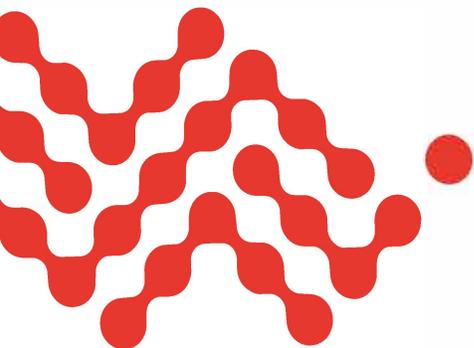



SIERRA
WIRELESS®

Considering cellular for DTT on your distributed energy grid? With LTE, you get safe, effective operation – plus a foundation for modernization.

The Sierra Wireless Perspective on Distributed Energy Grids

Ongoing retirement of copper lease lines is forcing operators of distributed electricity grids to find new ways to deploy Direct Transfer Trip (DTT), an essential technique for clearing faults. LTE cellular delivers the performance and security DTT needs, at a cost dramatically lower than that of fiber-optic cabling. What's more, LTE cellular is supported by management systems that create a solid foundation for complete grid modernization.



Managing Change

Today's electricity grids are in transition. The flow of power is undergoing a fundamental shift, moving away from the traditional top-down structure to a more decentralized, distributed structure that makes widespread use of small-scale power generators, including renewables like solar and wind. The amount of distributed generation has already doubled in the last decade, and is expected to continue growing rapidly. In the United States, for example, the analyst Wood Mackenzie predicts that cumulative Distributed Energy Resource (DER) capacity will reach 397 gigawatts in 2025, up from 59 gigawatts in 2019.

At the same time that grids are becoming increasingly decentralized, they're also having to deal with more frequent disruptions. Changes in weather patterns are giving rise to more extreme, frequent, and costly weather events. The System Average Interrupt Duration Index (SAIDI), which is a measure of how long the average customer typically has to do without power each year, went up dramatically. In 2013, the average customer experienced just over 200 minutes of outage per year, but by 2018, the most recent year with data available, that number had risen to above 350 minutes.

The challenge, then, is to work more efficiently with distributed energy resources, while making the grid itself more resilient. Automation is an important part of meeting this two-fold challenge, since interconnected systems that can communicate and coordinate with one another, without human intervention, can react more quickly and efficiently when faults occur.

Total US DER capacity will grow to 397 GW by 2025

Source: Wood Mackenzie, 2020

DTT as an Entry Point for Automation

One of the most widely used communication schemes for this type of system-to-system interaction is Direct Transfer Trip (DTT), a system of protection that sends a trip command to remote circuit breakers when a fault is detected. DTT provides a means of synchronizing to protect equipment and ensure power quality before closing the connection between a substation and a DER. DTT is an effective way to get the system up and running again because it isolates the impacted segments of the distribution network, to avoid damage to grid equipment, and protects utility workers while they service the fault.

Because DTT is an essential safety mechanism, it's a mission-critical part of grid operation and needs to be extremely reliable. In the ideal deployment, the DTT system runs on a dedicated communication link that offers low latency, protection-grade security, and redundancy, in case the primary method of communication is lost.



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The Need for Alternative DTT Formats

For a long time, DTT systems were typically deployed on leased copper telephone lines. The Plain Old Telephone System (POTS) format was readily available and provided the necessary latency and reliability to support DTT operation. Over the last several decades, though, as telecom providers have moved away from copper lease lines to more advanced services, electricity grids have felt the effect. Copper lines aren't being maintained the way they once were, and this lack of upkeep can lead to unwanted disconnections that can trigger false DTTs. Also, with local telephone companies investing less in copper landlines, electricity grids have fewer options for deploying new DTT services as they expand to include new DERs.

There are a number of alternatives to using copper lease lines, but the options don't always meet the need. Communications that use overhead lines, such as Power Line Carrier Communication (PLCC), may not offer the necessary bandwidth or reliability and can be difficult to manage. Similarly, microwave transmission requires line of sight between substations, which may not be possible with rugged terrain, and weather conditions can distort signals.

Using a dedicated fiber-optic channel offers an ideal combination of low latency, good bandwidth, and low signal attenuation, but using fiber is prohibitively expensive in most applications, especially if new cabling needs to be installed. According to a 2019 report published by the U.S. Department of Transportation, the per-mile deployment cost of new fiber-optic cabling is about USD 27,000 per mile but, depending on the terrain, can be as high as USD 267,000 per mile. In rural areas, where DERs are often installed on rugged terrain, running fiber-optic cable from the DER to the substation can run millions of dollars, even over relatively short distances.

When compared to the alternatives, cellular communication that supports Long Term Evolution (LTE) data offers several advantages. LTE cellular is widely deployed and readily accessible just about everywhere, doesn't need line of sight for connectivity, can withstand harsh weather conditions, and is cost-effective to deploy and maintain.

The average electricity customer experiences at least 350 minutes of outages per year

Source: SAIDI 2018



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Fiber-optic cabling can cost as much as USD 267,000 per mile to install

Source: US DOT, 2019

What We're Seeing

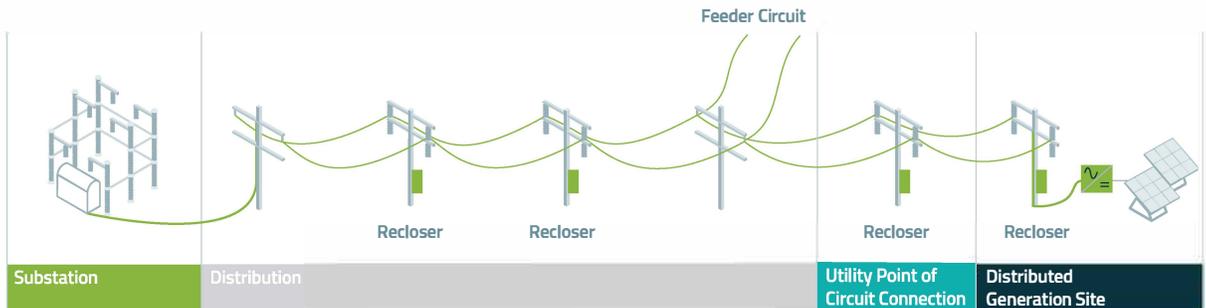
At Sierra Wireless, we work closely with utilities to deploy cellular solutions that increase efficiency and add automation. Four of the five top 20 power utilities use Sierra Wireless solutions to connect critical infrastructure and vehicle fleets. To support DTT, we deploy an optimized combination of ruggedized routers, VPN servers, and management software. The result is a secure, reliable implementation that gives operators a cost-effective way to meet regulatory requirements while adding automation.

A good example of our approach to cellular for DTT is our collaboration with Eversource Energy, a Fortune 500 energy company based in New England. The Eversource Energy DTT installation, located in Western Massachusetts, provides secure LTE cellular coverage between the substation and local wind and solar resources. DTT systems are installed on the grid reclosers, which detect and interrupt momentary faults, at each distributed generation site.



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Eversource Energy is a publicly traded Fortune 500 energy company headquartered in Berlin, Connecticut and Boston, Massachusetts. The company provides retail electricity, natural gas service, and water service to approximately 4 million customers in Connecticut, Massachusetts, and New Hampshire.

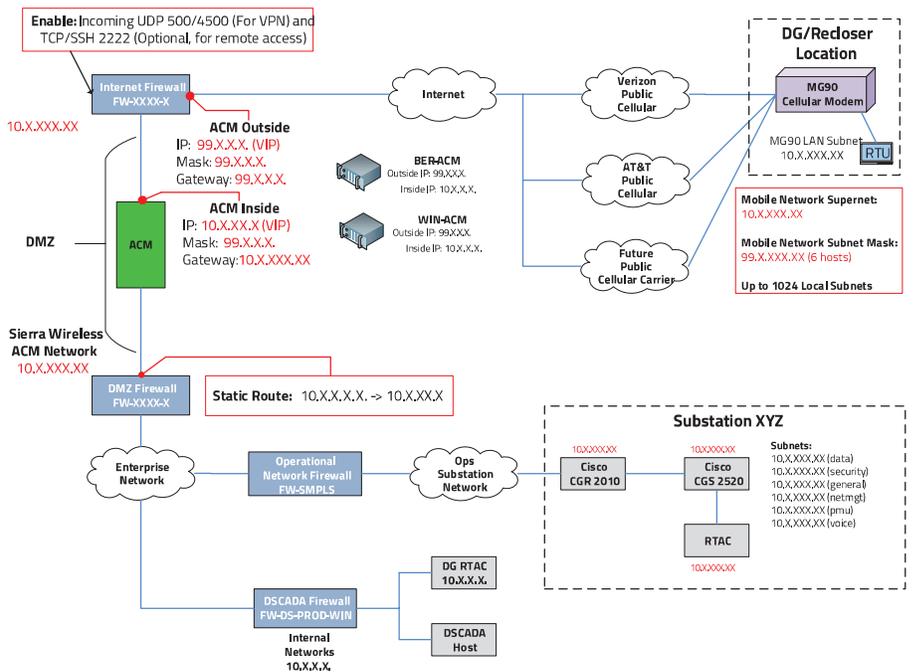


DTT systems (green boxes) are mounted on grid reclosers at the distributed generation site.



Each recloser-mounted DTT system includes SEL Real-Time Automation Controller (RTAC) and enclosure, for Cooper Form 6 recloser control, as well as a Sierra Wireless MG90 AirLink router, a ruggedized LTE-Advanced networking platform, designed for use in secure, always-on connectivity for mission-critical applications.

To maintain security and protect data communications, each AirLink MG90 router in the distributed generation site uses a secure VPN connection on a public network provider to communicate with a Sierra Wireless MG90 AirLink Connection Manager (ACM), an optimized VPN server that securely connects the distributed generation site to the backend network. For added protection, the MG90 ACM is installed in Eversource Energy’s DMZ network, which is isolated from other networks and limits access to the internal enterprise subnet.



DTT setup, showing Sierra Wireless MG90 AirLink routers and ACMs



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LTE Cellular Does DTT Right

The Eversource Energy deployment serves to verify that a commercial cellular carrier communications medium can provide the availability, latency, reliability, and security required for a DTT application.

- **Availability**

The MG90 AirLink router is designed to support two cellular providers at once and can automatically select between a primary and secondary connection to maintain optimum availability. The best available network is automatically chosen based on user-customized scoring sessions as part of an intelligent, policy-defined link management function. The MG90 AirLink router constantly monitors all available networks to determine if a connection can be made and if data can be successfully transmitted, and effortlessly switches between WAN connections to provide uninterrupted communications and prevent downtime, performance issues, and dead zones. The router supports public and private carriers, including Citizens Broadband Radio Service (CBRS) and FirstNet.

- **Latency**

Time is of the essence with DTT, since fast responses help protect equipment and workers. The protocols used for DTT communications stipulate strict limits on message timing, so the system can be highly responsive when action is required, and DTT systems need to meet these requirements in order to conform to regulatory requirements. In particular, there are two standards that govern the speed of DTT system operation. First, there is IEEE 1547-2018, which defines the DTT response, requiring distributed generation sites to cease energization in two seconds or less. Second, there is IEC 61850, which defines messaging formats for peer-to-peer communications between field devices in the grid, including Generic Object-Oriented Substation Events (GOOSE) messages that transfer instructions such as START, STOP, TRIP, and CLOSE. GOOSE messages have a strict delivery timing requirement of 3 ms. Fast performance is one of the reasons why Eversource Energy selected the MG90 AirLink router, with its optimized LTE-A connectivity, for its deployment. The Eversource Energy installation operates well within the latency and timing requirements of both IEEE 1547-2018 DTT operation and IEC 61850 GOOSE messaging.



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READY FOR DTT

- MG90 AirLink Router Performance
- Multi-network capability
- Licensed and unlicensed LTE bands
- Low latency, high bandwidth
- Dual SIMs, dual LTE radios
- Gigabit Wi-Fi, WAN & Ethernet
- 5V operation
- Built-in security, including 128-bit AES encryption

BUILT TO LAST:

- Ruggedized MG90 AirLink Router
- Aluminum chassis
- Water and dust resistant
- -30 to +70 °C
- MIL-spec to withstand shock, vibration, and humidity
- LED diagnostics on front of router
- Ports: Ethernet, RS-232, five configurable digital I/O

- **Reliability**

Multi-network operation means the MG90 AirLink router can switch between networks to maintain availability and reduce risk. The dual-radio setup creates redundancy because two LTE carriers are always on. The two radios are continuously connected to two different carriers. Millisecond switching between the two means that a simple interruption in the DTT system is not enough to disconnect a distributed generation site from the grid. This reduces the number of false DTT signals and increases network resilience. Also, the router itself is purpose-built for use with utilities. It is housed in a ruggedized chassis, designed according to military-grade specifications and SCADA standards, so it keeps the unit operational under even the harshest weather conditions.

- **Security**

As with any mission-critical function, security is a vital part of DTT systems. The Eversource Energy installation uses Sierra Wireless security mechanisms to safeguard operation at every point. The MG90 AirLink router is assigned a unique identifier, which is used with authentication commands to confirm the MG90's identity when accessing the IPsec VPN tunnel. For DTT applications, using IPsec adds an extra layer of security over existing L2TPV3 tunnels, using 256-bit AES security algorithms to encrypt any data communicated over the cellular network. The MG90 AirLink router can be configured to connect with the ACM using a LAN-2-LAN IPsec or a Host-2-LAN VPN tunnel. To defend against unauthorized access, the system verifies pre-shared keys (a unique key can be assigned to each link), before sending or receiving any data.

The Added Advantage of a Management Application

From a hardware standpoint, the Eversource Energy deployment delivers all the necessary elements for successful DTT operation. By partnering with Sierra Wireless, though, the deployment gets the added benefit of the AirLink Mobility Manager (AMM), a powerful, browser-based software application that enables users to configure, monitor, and analyze Sierra Wireless routers and their associated applications.

The AMM supports real-time mass configuration, control, and troubleshooting of routers and the connected infrastructure, so there are fewer reasons to roll service trucks and send workers into the field. The AMM delivers a continuous stream of rich, real-time network data, allowing operators to observe, track, and examine the behavior of hundreds of devices throughout the grid. The MG90 AirLink routers in Eversource Energy's deployment have constant communication with the AMM, so they can transmit data to the AMM in near real-time and commands can be sent from the AMM to the field immediately.



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WHY THE AIRLINK APPROACH DELIVERS END-TO-END SECURITY

- **SECURE PRODUCT DEVELOPMENT** – Design, implementation, verification, validation, defect management, documentation and training, incident response
- **SECURE DEPLOYMENT MANAGEMENT** – Identification and access control, system integrity, data confidentiality, resource availability, intrusion detection

By delivering situational awareness, LTE cellular is, in many ways, a logical starting point for grid modernization.

The AMM's security mechanisms, which include data encryption over the air and the network, let the system detect intrusion and, at the same time, make it safe to perform firmware updates and other patches over the air. The AMM can be installed behind a firewall, to protect access, and access privileges can be set to read only or read/write capabilities, depending on the need. The AMM also offers configurable reports for advanced analytics.

Taking LTE beyond DTT

In our experience, once DTT systems are in place, grid operators begin considering cellular connectivity for other applications, too. In some cases, cellular is used mostly as a backup to copper and fiber-optic lines, but in other cases, cellular is bringing new levels of automation and efficiency to the Systems Operation Center (SOC). Situational awareness, made possible by secure, real-time communication from substations down to the generator, makes it easier to troubleshoot and address issues.

Cellular connectivity can be a starting point for grid modernization, offering a solid foundation on which to build. Grid operators can consider a wide range of options, including Distribution Management System (DMS), Dynamic Volt VAR optimization, monitor and control (DSCADA) for distributed generation customers, electric vehicles, modeling and forecasting, and streamlined interconnection of distributed generation interconnects.



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4 out of 5 of the top 20 power utilities use Sierra Wireless solutions to connect critical infrastructure and vehicle fleets.

Start with Sierra

From an industry perspective, the utility market is one of the strongest areas for Sierra Wireless. Our development teams focus on ways to enhance development and simplify deployment, by focusing on security and automation. We're actively connecting grid equipment, and helping utility companies make the most of mobility, too. We connect service vehicles of all kinds, including bucket trucks, so fleet managers can take advantage of telemetry data. Also, by using our ruggedized, vehicle-mounted gateways, P&C engineers and service workers can create vehicle area networks while in the field. Using their preferred portable devices, field personnel can send and receive data while onsite, for added efficiency and effectiveness.

Take the Next Step

To learn more about how Sierra Wireless uses LTE cellular to deploy DTT and enable grid modernization, visit us at www.sierrawireless.com.

About Sierra Wireless

Sierra Wireless is the leading IoT solutions provider that combines devices, network and software to unlock value in the connected economy. Companies globally are adopting IoT to improve operational efficiency, create better customer experiences, improve their business models and create new revenue streams. Whether it's a solution to help a business securely connect edge devices to the cloud, or a software/API solution to help manage processes associated with billions of connected assets, or a platform to extract real-time data to make the best business decisions, Sierra Wireless will work with you to create the right industry-specific solution for your next IoT endeavor. Sierra Wireless has more than 1,300 employees globally and operates R&D centers in North America, Europe and Asia.

For more information, visit www.sierrawireless.com.

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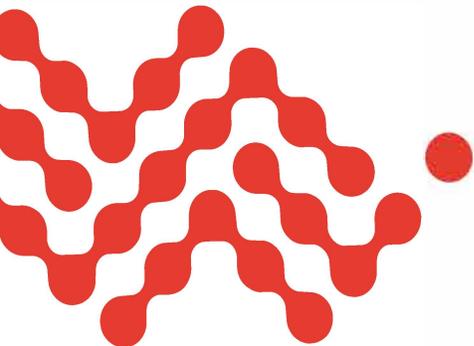
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How Utilities Can Improve Customer Experience and Reduce Operating Costs by Connecting Their Mobile Workforce

The Benefits of Implementing a Vehicle Area Network

To improve customer experience and reduce operating costs, a number of utility companies are looking to streamline their field operations using a vehicle-based cellular networking strategy. Consolidating connectivity over a vehicle area network (VAN) reduces costs while increasing field productivity. This white paper outlines key strategies for streamlining operations, finding efficiencies and lowering costs with the right technology solutions.





Utility companies today face challenges on many fronts—meeting consumer expectations, adhering to regulatory requirements, addressing aging infrastructure and maximizing profits. To maintain market agility, utilities must adapt more quickly to change, get closer to customers, increase their focus on value-added services and collaborate with a wide range of partners.

When it comes to technology and infrastructure investments, those in leadership seek investments that provide maximum payback by reducing operational expenses, increasing profits and improving customer service levels. Connecting the mobile workforce and vehicles to the enterprise can be one of those high-impact investments.

Many utility organizations have turned to cellular technology to connect their mobile workforce. Cellular networks continue to rapidly evolve with Long-Term Evolution (LTE) technology. In addition, mobile workforce management tools are becoming more powerful and sophisticated. Implementing the right strategy for connecting your mobile workforce to the enterprise creates an opportunity for significant return on investment.



Challenges: Cost and Complexity

Traditionally, utilities have relied on equipping workers with laptops that use embedded or internal cellular modems for enterprise connectivity. In some cases, these laptops are assigned to a worker or attached to a vehicle. While cellular-connected laptops have served mobile workforces for many years, as the desire to add new applications and systems to the vehicle grows, this approach comes with added cost and complexity.

COST: Each new application, device or system, such as a rugged tablet, GPS tracking or on-board driver video, comes with additional installation and recurring costs. Connecting hundreds, if not thousands, of mobile devices, each with their own subscriber identity module (SIM) data plan results in a high monthly expense.

COMPLEXITY: Adding new devices, applications or systems, such as location-based services requiring vehicle GPS, increases overhead and complexity over time. When it comes time to upgrade connectivity (for example, a new network operator or modem), the configuration of other systems may be impacted. Many utilities do not have a centralized, extensible platform that supports all of their current needs and whatever new technologies they might opt for in the future.



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WHY FIRSTNET?

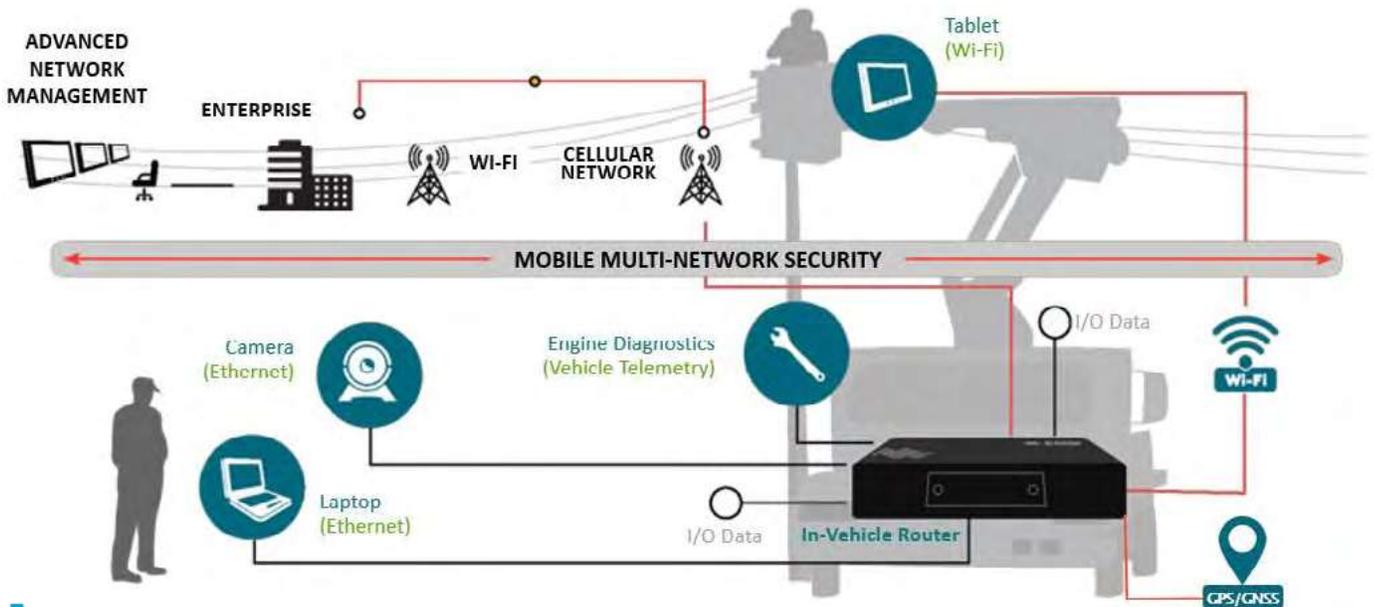
Mobility for the Modern Utility: Vehicle Area Networking (VAN)

Utilities can modernize their fleets with technology and solutions, including cellular connectivity and mobile networking devices. These solutions provide better coverage, improve operational efficiency, help meet increasing customer demands and reduce high operating costs.

Deploying a VAN approach helps consolidate and secure communications for utility in-vehicle systems. A VAN solution can also incorporate GPS location services and vehicle telematics and sensors to enable advanced fleet management and efficient use of resources through real-time location tracking and vehicle data.

A Comprehensive Approach to Utility Cost Reduction

At the heart of a VAN approach is a vehicle-based cellular router that establishes a continuous, reliable and secure internet connection for field personnel, giving workers access to corporate applications and enabling two-way communication. Devices, such as laptops or tablets, can connect to the network via the router. Applications, like vehicle telemetry, in-vehicle cameras and remote system access, can all share network resources and more readily interact with the line-of-business applications field personnel use every day to perform their work.



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OpEx Savings

By combining the latest cellular networking and vehicle telematics technologies, a VAN approach can help utilities save on operating expenses in multiple ways:

LOWER SUBSCRIPTION COSTS

Devices and applications connected to the VAN over Wi-Fi or wired connection can share a single cellular data plan rather than requiring cellular subscriptions for each device.

REDUCE DOWNTIME FOR EQUIPMENT AND WORKERS

Engine and vehicle health data collected from the vehicle's diagnostic port can be collected and sent to fleet management teams to warn of vehicle problems in real-time, avoiding costly repairs and service downtime.

SAVE ON CELLULAR CONNECTIVITY EXPENSES

Automatically switch communications links from a cellular connection to your local network (depot Wi-Fi) in the yard for data-intensive operations, such as uploading large, bandwidth-intensive files.

INCREASE FIELD WORKER PRODUCTIVITY

Easily add mobile applications that increase field service productivity by putting more information into workers' hands with real-time access to customer and product data, asset location and parts inventory.



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IT Operational Savings

A VAN approach can help your company reduce IT-related operational costs by delivering:

SECURE CONNECTIVITY

Consolidate security for all devices connected to the router, providing a safer and more manageable alternative to using client-based virtual private networks (VPN) on each individual device through a router-based VPN. This helps reduce the risk of security breaches that may result in reputational and financial crisis.

REMOTE MANAGEMENT

Troubleshoot and manage connected systems remotely—reducing the need for your IT team to resolve connectivity issues, perform upgrades or add new equipment.

FUTURE-PROOF PLATFORMS

Adapt to changing business needs by making it easier to add cameras, voice over IP (VoIP), bucket weight monitoring and other Internet of Things (IoT) technologies with a VAN-centralized configuration on a single platform.

Asset Utilization Savings

Smarter communications systems mean you will be able to manage your fleet more efficiently in crucial ways that deliver:

IMPROVED LOGISTICS

Track vehicle and worker locations, even if devices are turned off and/or workers are away from the vehicle, with a VAN solution that has integrated GPS capability.

ENHANCED VISIBILITY INTO UTILIZATION IN REAL-TIME

Control your fleet and enable smarter decision-making about vehicles, workers and asset usage with an “always-on” GPS connection.

BETTER EMERGENCY PREPAREDNESS

Respond quickly and help restore service in case of an emergency or natural disaster. VAN solutions that support dedicated cellular public safety networks, such as FirstNet, make it easier to coordinate mutual aid between utilities and public safety first responders.



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Fleet Management and Safety

In addition to fixed operational costs, a utility company can streamline operations and improve productivity in important ways, including:

- Remote application and data access.
- Reliable, continuous, real-time access to remote applications, such as mobile workforce management and work-order and outage management tools help ensure efficient use of service vehicles.
- **VEHICLE INSIGHTS**
Make more informed and pro-active decisions about vehicle usage and health. Vehicle sensors provide data that can warn of vehicle trouble, extending vehicle life and lowering repair costs.
- **COMPLIANCE AND REGULATORY STANDARDS**
Document compliance with safety ratings and regulatory standards such as using odometer and GPS data to compute state-based highway taxes owed. Monitor vehicle-specific information such as fuel consumption using telematic applications.
- **WORKER SAFETY AND ACCOUNTABILITY**
Always know where your workers and equipment are, including hazardous locations. Some VAN routers can dynamically operate across more than one network to provide redundancy and better coverage. This provides workers with reliable access to enterprise applications and crew communications, keeping them and their equipment safe.



The Bottom Line

Building a compelling business case for investing in a new vehicle communications approach ultimately rests on a holistic and comprehensive assessment of IT, operations and fleet management needs—both current and long-term. Since many of the applications and tools they require rely on secure, reliable connectivity, many utility organizations are taking the opportunity to re-examine their approach and the technologies they use to connect their mobile workforce with the enterprise. Many utilities are determining that a VAN is one of their best investments.



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Customer Stories

The following are real-life examples of how utilities have leveraged vehicle area networks.

PIERCE PEPIN COOPERATIVE SERVICES

Pierce Pepin is a western Wisconsin electric distribution cooperative serving more than 7,665 members and 1,332 miles of active lines. They wanted to modernize their vehicle communications capabilities in ways that increased worker safety and made it easier and faster for dispatch and other office personnel to track field vehicles, especially during emergency restoration.

Pierce Pepin implemented a network of 4G LTE Wi-Fi mobile gateways, each with built-in GPS, in all 15 of its heavy-duty vehicles. This enabled them to implement a computer-aided dispatch and automated vehicle location (CAD/AVL) platform that improves communications and lets dispatch know the position and status of all vehicles at all times.

Average first-year savings per co-op across the 20 co-ops that participated was \$40,210, and the average annual recurring cost savings per co-op was \$3,100.

[Read the full case study here.](#)



NASHVILLE ELECTRIC SERVICE

Nashville Electric Service (NES) is one of the largest publicly owned electric utilities in the US, serving more than 360,000 residential and business customers across seven counties in north-central Tennessee. NES wanted to automate their manual vehicle location systems in addition to gaining increased bandwidth for new applications and on-board systems. They also wanted the ability to track location of critical assets in real-time, reduce outage response times and increase employee safety.

NES installed wireless routers in their bucket trucks and supervisory vehicles, which provided wireless connectivity to laptops and other devices in and around the vehicle. The router forwarded GPS information allowing NES dispatchers to track all vehicles on a single screen and dispatch the closest truck to an outage or service call. This provided reduced response times and fuel use, while improving efficiency and customer service.

NES was able to reduce operating costs, manage customer interactions in real-time, improve routing and scheduling, and increase worker productivity and safety.

[Read the full case study here.](#)



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80% of the Top 20 US Electrical Utilities use Sierra Wireless solutions to connect critical infrastructure and vehicle fleets.

Sierra Wireless Utility Solutions and Services

Utilities confidently turn to Sierra Wireless to securely connect their critical infrastructure and vehicle fleets. Sierra Wireless has a portfolio of routers that are purpose-built for mission-critical applications and challenging environmental conditions.

For more information visit: <https://www.sierrawireless.com/products-and-solutions/routers-gateways/industrial-networking/>

Sierra Wireless AirLink Complete makes it easy to remotely deploy, monitor and maintain multiple routers. A single dashboard displays up-to-date information about all of your devices. Easily manage your equipment, identify problems, reduce downtime and lower your cost of ownership.

For more information visit: <https://www.sierrawireless.com/products-and-solutions/routers-gateways/airlink-complete/>

To learn more about Sierra Wireless and its solution partners, contact your sales representative or call us at: 1-877-687-7795.

About Sierra Wireless

Sierra Wireless is the leading IoT solutions provider that combines devices, network and software to unlock value in the connected economy. Companies globally are adopting IoT to improve operational efficiency, create better customer experiences, improve their business models and create new revenue streams. Whether it's a solution to help a business securely connect edge devices to the cloud, or a software/API solution to help manage processes associated with billions of connected assets, or a platform to extract real-time data to make the best business decisions, Sierra Wireless will work with you to create the right industry-specific solution for your next IoT endeavor. Sierra Wireless has more than 1,300 employees globally and operates R&D centers in North America, Europe and Asia.

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