



Achieving greater reliability  
and sustainability in the grid

Ameren builds a private IP/MPLS fiber  
network across its electrical grid

NOKIA

“Our customers are asking: How can we leave this planet better than we found it?” says Brian Hartman, Senior Manager of Network Engineering, Ameren. “More and more people are in tune with the environment, and they’re demanding more information from us on their energy use.”

Ameren serves 2.4 million electric and 946,000 natural gas customers across Illinois and Missouri. These states have a mixture of densely populated areas, smaller industrial cities, and extensive farmland. “It’s difficult to handle both the urban and rural environments, and the energy requirements from both states are slightly different, too,” says Hartman. “Our biggest challenge is that our customers are demanding more reliability, and more information.”

For managing substations, Ameren was dependent on leased lines based on copper cable, in some cases dating back to the 1950s. Communications reliability had become a serious problem. “In the past, the phone company could get

the line back up in three hours at the most,” says Hartman. “That has changed. We are seeing downtime of days. If we lost communications to a substation, we lost visibility to part of the electric grid. We couldn’t see how the energy was flowing out of those substations. If we needed to open and shut switches remotely, we couldn’t do that.”

If there was a prolonged outage, Ameren would need to switch to manual processes, including sending crews to manage the disconnected locations. It was time consuming and expensive.

Leased lines didn’t offer the bandwidth required for managing modern utilities infrastructure, either. For example, video monitoring is an effective means

for substation physical security. “The infrastructure the phone company has is 9600 baud,” says Hartman. “You can’t do anything with cameras over that bandwidth.”

Across the US, service providers are phasing out leased lines. They’ve been superseded by internet protocol (IP) services, and leased lines are expensive to maintain for the few remaining customers. Ameren has negotiated with its provider to keep the leased lines going until June 2022. After that, the service provider can cancel them with a 60 days’ notice period.

Ameren needed to replace the leased lines, to ensure it could access timely information from the grid and deliver the reliable energy that Ameren’s customers demand.



## Moving to fiber

Ameren is connecting fiber to approximately 420 substations and other locations in the transmission grid to build a private network. Roll-out began in 2017 and Ameren is now about half-way through the project. The fiber runs along the transmission lines. Ameren runs IP/MPLS communications over the fiber.

“We have our own right of way, and we’ve also been able to leverage a lot of other activity in the transmission space,” says Dave Bruemmer, senior network engineer, Ameren. “If we need to rebuild a transmission line or reconductor a line, there is only a small marginal cost to add fiber while the crew is there.”

“We’ve wanted to move to fiber for some time,” he adds. “We could see the industry moving to packet-based communications. We wanted to do packet communications that met the needs of our legacy communications, allowed us to segregate traffic, and allowed us to control quality of service. IP/MPLS looked like the best fit for us.”

The fiber provides a 100 Gigabit backbone, easily enough to carry video in substations. Cameras in substations are used for access control and security monitoring, with more than a dozen cameras in bigger substations. The network architecture is a mesh, so there is redundancy and communications can go anywhere in the network. The primary and back-up control centers use the fiber network for mirroring data, to ensure redundancy.

Parts of Missouri and Illinois can be hard to reach with fiber and some areas are already served by microwave links. In those cases, Ameren has typically reused the existing 150 Mbps microwave connections and adapted them to run IP/MPLS.

The fiber roll-out began with the 100 Gigabit ring, built through a large section of Ameren’s territory across both Illinois and Missouri. Ameren is now pushing the fiber out further into its grid. “We’re moving closer and closer to every substation,” says Bruemmer. “If we have issues with cutting over some sites, before the telephone companies eliminate service, we want to be sure we have fiber near enough, to easily extend wireless coverage to that site.”

## Running applications over MPLS

Ameren launched the teleprotection application early in the project, to ensure that substations can communicate with each other and take action to trip within 10ms when a fault occurs on the line. MPLS gives Ameren the deterministic quality of service required for this latency sensitive application to work correctly, every time.

“Depending on the relay scheme, we also wanted to make sure we were not reliant on fiber that goes directly between two substations,” says Bruemmer. “MPLS gives us ways to ensure we have a primary route and the option of another route, with the ability to switch very quickly. That’s our most critical need, and sometimes teleprotection alone drives the need for a fiber path.”



## A flexible router

To provide the connectivity in the substations, Ameren chose the Nokia Service Router product portfolio for IP/MPLS-based communications between substations and control centers. The router was introduced as Ameren migrated to fiber and adopted MPLS. It supports a wide range of transport media including fiber, microwave, copper, and wireless, providing a rich set of interfaces for connecting new and legacy equipment. These include E&M and RS-232 found on SCADA remote terminal units (RTUs), and C37.94 and Ethernet on differential relays.

“The Nokia IP/MPLS router had better legacy interfaces support than others we evaluated,” says Bruemmer. “Very few other vendors do anything with legacy interfaces. Those that do seem to be lagging behind Nokia. We are trying to get away from those legacy interfaces, but the reality is that we can’t get away fast and we knew that compatibility would be important.”

The Nokia IP/MPLS router has become the standard platform for handling Ameren’s substation communication needs. Bruemmer says: “We like to

minimize the number of platforms we use. There is so much technology for our support people to learn and remember. To be able to minimize that really helps them to maintain the communications network.” In addition, Nokia’s network services platform is also used in the Digital Command Center to monitor, maintain, and troubleshoot the communications network.

Cybersecurity is a top concern these days, particularly for critical applications. Using Network Group Encryption (NGE), Ameren can apply encryption across an entire application domain, e.g. SCADA, centrally from the network services platform. Compared to using many point-to-point encrypted tunnels, NGE simplifies security management.

The Nokia photonic transport solutions are used for the optical core, providing amplification across links of over 80km in the fiber network. “The Nokia photonic service switch has good features for amplification and for controlling bandwidth,” says Bruemmer. “It’s using a fraction of our bandwidth, giving us room to grow.”

## Extending the network

“We now have a high-speed, reliable network,” says Hartman. “We don’t have the issues we had with the phone company. We are driving down our operational expenses associated with communications, which helps us to make our rates affordable to our customers.”

At one point, there appeared to be an error in the teleprotection services across the MPLS system, and at first Ameren thought the new network equipment was at fault. It transpired that the Nokia technology and fiber network were revealing problems that weren’t visible with the older network. “It took us a while before we realized the problem was on our side,” says Bruemmer. “Nokia worked with us, even after they knew it was not a problem with the Nokia product, and helped us to fix it. More than anyone else, Nokia understands our industry.”

Ameren continues to roll out fiber throughout its transmission network but also has an eye on new applications that the network can enable.





Chief among them is a wireless field area network (FAN) using private LTE for the distribution grid. Applications that could be enabled on private LTE include SCADA for the distribution grid and the gas infrastructure, capacitor bank control, Advanced Metering Infrastructure (AMI), S&C IntelliRupter intelligent reclosers, Faulted Current Indicators (FCI), pole sensors, street light controllers, and push-to-talk (PTT) radio for crews. The MPLS network can be extended over the Field Area Network while leveraging the existing fiber network for backhaul.

Ameren has already completed a successful pilot project, with support from Nokia. “During the pilot, we had a Nokia resident field engineer who was stationed with us,” says Hartman. “The resident engineer was fundamental to helping us achieve a successful trial.”

## A close partnership

“The best thing about working with Nokia is the partnership,” says Bruemmer. “Nokia has been standing side by side with us, working through any issues. We have a Nokia field engineer embedded in our digital command center, helping to teach our employees how to maintain the MPLS network. We’re running a network now that the phone companies were doing for us externally previously, so Nokia’s support has been instrumental in our success.”

## Improving quality and sustainability

Hartman concludes: “As we move towards a more converged network and eliminate individual proprietary networks, we will be asking what it enables us to do at each of those substations that was not possible before. How can we improve power quality and sustainability? What additional monitoring can we do? This network will give us the capability in the future to use data analytics to predict failures before they occur, so we can help reduce unplanned outages for our customers.”



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## Challenges

- Ameren's customers were demanding greater reliability and more information from the electrical grid.
  - Leased lines connecting substations to the command center were becoming unreliable, with downtime sometimes measured in days.
  - Ameren had until June 2022 to find a replacement for the leased lines, after which the service provider might discontinue providing those services.
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## Solution

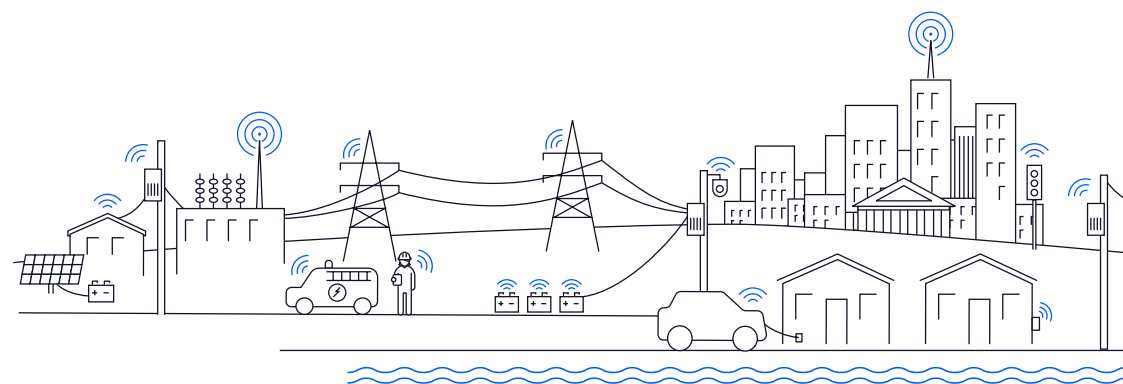
- Ameren built its own IP/MPLS fiber network along its transmission lines, connecting its substations.
  - The Nokia Service Router product portfolio provides connectivity between substations and control centers, with full compatibility for legacy and new equipment.
  - The Nokia photonic transport solutions are used for the optical core, and enable 100 Gigabit links of over 80km.
  - Nokia engineers trained Ameren's team on managing the new network, and helped Ameren with troubleshooting problems.
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## Benefits

- Ameren has improved the quality of its teleprotection, ensuring that fiber-connected substations can quickly act if there is a fault on the line.
- Ameren has been able to introduce video surveillance at the substations to improve security.
- The IP/MPLS fiber network provides a foundation for extending communications into the distribution grid, with plans for a private LTE network to enable distribution automation, manage crew communications, monitor gas facilities, and support advanced metering. It also supports emerging applications such as asset performance monitoring to improve asset reliability and efficiency.

“Our biggest challenge is that our customers are demanding more reliability, and more information.”

Brian Hartman, Senior Manager of Network Engineering, Ameren



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