CASE STUDY

West Kentucky Rural Electric Cooperative Corporation

PROJECT

Private LTE Network Trial

TVA TENNESSEE VALLEY AUTHORITY

ABOUT

COMMUNITY-OWNED

Electric Cooperative

TOTAL EMPLOYEES

97

TOTAL MEMBERS

31,000+

PROJECT COST

TOTAL COST

$1.7M*

PER SQUARE MILE

$1,338

SERVICE TERRITORY

1,270

SQUARE MILES

Background

West Kentucky Rural Electric Cooperative Corporation, Inc. (WKRECC) provides electricity to more than 31,000 members in western Kentucky. As a Cooperative, members are the owners with oversight provided by a board of directors, elected by the membership and comprised of a representative from each of the Cooperative's four districts.

WKRECC conducted a pilot project to explore the feasibility of deploying a private Long Term Evolution (LTE) network to support their evolving operational needs as a modern electric utility.

West Kentucky Rural Electric was built by, belongs to and is led by the people in the communities they serve.

**This figure does not include costs associated with installation and hosting of a core server, as these costs were covered by a third-party service provider (NRTC) for this project.*

The Need for Private LTE

INTENDED TO ADDRESS:

Redundancy in Communication Networks

WKRECC had several communication networks in place, including fiber, point-to-point radio systems, Verizon carrier backhaul radio, cellular networks and Sensus networks. This fractured array of communications networks, many of which had been created for a single purpose, created significant redundancy costs for WKRECC — prompting the search for a more cohesive and efficient solution.

Bandwidth Constraints

Some of WKRECC's existing communication channels had limited bandwidth (e.g., 50 kHz), which was insufficient for a modern utility's needs. For example, WKRECC's current AMI, at the 50 kHz frequency, could only communicate with a handful of meters before getting overwhelmed by the data traffic. Private LTE offered a significant bandwidth upgrade to as much as 3 MHz, which is a 60 times wider spectrum.

BANDWIDTH UPGRADE

3 MHz | **60X** wider spectrum

Handicapped Smart Grid Advancements

The National Rural Telecommunications Cooperative (NRTC) is a member-driven cooperative that helps rural utilities deploy technologies that improve their operations and benefit the communities they serve. In 2019, before WKRECC's private LTE network trial, NRTC developed a technology roadmap for WKRECC, showing the potential economic impact of smart grid initiatives, including cybersecure mobile workforce, voltage reduction and SCADA deployments. A fiber-optic network was costly, and could not be justifiably supported, but a digital communications network was necessary to pursue these initiatives.

VARIOUS NETWORKS

- **Fiber**
- **Point-to-point radio systems**
- **Verizon carrier backhaul radio**
- **Cellular networks**
- **Sensus network**

LTE

WHAT IS PRIVATE LTE?

Private LTE is a dedicated, high-performance wireless communication network that operates independently of public cellular networks. It is designed to meet the specific needs of organizations and can support a wide range of applications ranging from smart grid technologies (e.g., AMI) to agriculture and emergency response.

Goals

WKRECC's primary goal for this pilot was to test the feasibility of deploying a private LTE network within their service territory. This private communications network was intended to enable several key functions for the utility, including SCADA, monitoring and control of devices behind the meter (e.g., solar panels, batteries and appliances) and enhanced workforce capabilities for laptop users and truck drivers.

WHAT WKRECC DID:

Conducted technology roadmapping exercise

with NRTC to identify WKRECC's communication network gap.

Evaluated various options including fiber and cellular networks — but found them cost-prohibitive due to WKRECC's large, spread-out service area. In fact, it would have cost WKRECC over $107M to deploy fiber throughout their system.

Engaged industry experts

and selected Ericsson as the preferred vendor based on their radio technologies.

Conducted a high-level computer model analysis

to design the 4G private LTE network.

Installed tower equipment

and repaired towers damaged by the December 2021 tornadoes in Kentucky.

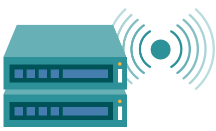
Rolled out components

including endpoint devices, wiring and modems and tested various use cases.

PRIVATE LTE NETWORK COMPONENTS

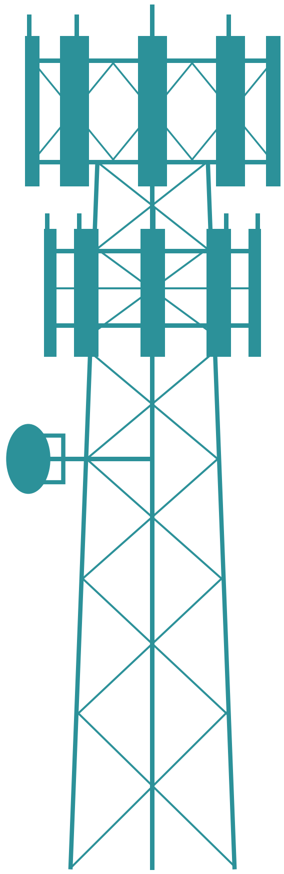
Endpoint Devices

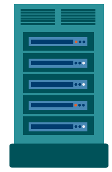
These include modems for households, truck radios, SCADA devices and other devices required for network functionality.



Radio Access Networks (RAN)

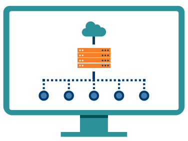
Essential hardware located on towers responsible for transmitting signals. Two cell sites were established as part of a single RAN during WKRECC's private LTE trial to assess network feasibility and performance.





Core Server

The central component that processes data received from towers and manages data traffic for hundreds of thousands of devices.



Local Packet Gateway

Acts as a gatekeeper for segmenting the network into user groups and organizations, allowing different entities to have their own networks.

Supporting a flexible, resilient and integrated grid.

Establishing a private LTE network enables WKRECC to **integrate and optimize smart grid initiatives and enable new capabilities**, such as real-time monitoring and control, self-healing networks and dynamic pricing. These initiatives and capabilities support TVA's Regional Grid Transformation (RGT) objective of advancing our electric system to meet evolving member expectations and changing world conditions.

Additionally, a high-speed communications network is among the core capabilities that the RGT team has identified as a foundational enabler of a modern and efficient grid, and necessary for capitalizing on more advanced technologies.

Project Results

6

use cases successfully tested

INCLUDING

- handsets
- truck radios
- fixed wireless
- SCADA
- retail internet service
- distribution automation

55-75* **Mbps download speeds**

10-12 **Mbps upload speeds**

*WKRECC expects its download and upload speeds to improve even further to as fast as 140 mbps for download / 20 mbps for upload in the near future, once it has finished removing unlicensed incumbent users from its network.

3

MHz bandwidth when assessing WKRECC's SCADA application

ACHIEVED SPEEDS:

13 **Mbps download**

5 **Mbps upload**

SCADA plays a vital role in WKRECC's transmission and distribution network, encompassing tasks such as managing voltage regulators, capacitor banks and recloser systems.

It also includes applications like fault localization, isolation and service restoration (FLISR), along with direct transfer trip (DTT) functions.

KEY LEARNINGS

Handshake Challenge

A "handshake issue" arose when connecting the Motorola AI-backed camera system to WKRECC's network, resulting in the cameras not being recognized by the system's network video recorder (NVR). This highlighted a need for network design improvements to ensure smoother communication between devices.

Standardizing of Equipment

Using a standardized set of equipment, especially for modems, proved superior to piecemeal solutions. WKRECC discovered that off-the-shelf, all-in-one devices were not only more cost-effective but also more reliable as they streamlined the utility's infrastructure and operations.

Interference Issue

During the trial, WKRECC encountered interference issues that were caused by non-licensed users operating on the same radio frequencies in their area. This disrupted WKRECC's network performance, and the utility is still in the process of removing these unlicensed users.

Aligned Skill Sets

Personnel with the right skill set, specifically network administrators and network engineers, were crucial for helping WKRECC manage its network capabilities.

Benefits for WKRECC

Better System Monitoring

WKRECC's private LTE network allows them to gather a more extensive range of data points from its SCADA applications, resulting in better operational visibility into its distribution system.

Improved Load Distribution

By fully utilizing AMI, WKRECC can better identify regions with electric versus gas heating and EV charging locations, enabling WKRECC to prepare for electrification in Western Kentucky and better manage load distribution across the grid.

Data Applications

Private LTE networks offer an array of valuable data applications tailored for utilities, which significantly enhances operational efficiency and customer service, decreases wholesale costs and creates new revenue opportunities.

Enhanced Cybersecurity

LTE networks, with their SIM cards and local packet gateway architecture, are significantly more cybersecure than traditional networks. SIM cards, for example, provide authentication for physical devices, which adds an extra layer of security.

Faster Response and Restoration

Data and insights made possible by its private LTE network have enabled WKRECC to more quickly identify, respond and recover to outages and other issues on their system.

Supporting DER

LTE networks, and other types of advanced telecommunications networks, can accommodate the growth in EVs as well as new solar and energy storage resources.

Recommendations for other LPCs

1

Use existing networks

Assess your existing communication networks and consider the benefits of a unified architecture, whether it's all-fiber, all-wireless or a hybrid approach.

2

Explore cost-effective alternatives

For example, private LTE can reduce redundancy and operational costs as well as cybersecurity risks.

3

Talk about the risks of not upgrading.

If you are proposing this type of project, emphasize the costs of not upgrading — for example, how much could a ransomware attack cost your organization?

4

Engage industry experts and vendors

A structured interview process can ensure you have the information you need to select the right technology partner.

5

Develop a infrastructure plan

A comprehensive infrastructure plan can encompass core servers, local packet gateways and RANs.

6

Establish a dedicated network administrator

A dedicated network administrator, whether in-house or outsourced, is essential to efficiently manage an organization's network.

7

Consistently track device performance and data usage

Tracking during proof-of-concept testing can improve cost estimation and carrier evaluation.

8

Prioritize cybersecurity

Harnessing advanced features like SIM cards and local packet gateways can safeguard your network against threats.

9

Secure appropriate licenses

Collaborate with regulatory authorities to secure the necessary licenses for your service area and to proactively mitigate any potential interference issues.

LEARN MORE

The Regional Grid Transformation (RGT) initiative is a collaboration between local power companies and TVA to transform the power grid into a more resilient, flexible and integrated system to meet customer expectations and changing world conditions.

Visit tva.com for details.

TVA TENNESSEE VALLEY AUTHORITY