



ENABLE POWER SUBSTATION EFFICIENCY WITH 5G TECHNOLOGY

5G Wireless Networks Bring Improved Operations, Security, and Performance to Aging Electrical Power Substations

ENERGY SECTOR CHALLENGES

- To keep pace with the rapid evolution of communication and control technologies, decades-old electric power substations are overdue for a digital upgrade to boost resiliency and efficiency.

WIND RIVER SOLUTIONS

- **Wind River Linux:** Industry-leading open source operating system for connecting, securing, and running IIoT systems, networks, and devices in the A&D, energy, industrial, medical, and transportation segments
- **VxWorks:** The world's leading RTOS, enabling deterministic applications scaling from very small compute packages across A&D, industrial, medical, and more
- **Wind River Helix Virtualization Platform:** A real-time, embedded Type 1 hypervisor that can manage unmodified guest operating systems running in virtual machines, consolidating workloads for industrial and energy system control automation
- **Wind River Simics:** An environment that allows developers to simulate anything, chip to system, and get the access, automation, and collaboration tools required for agile development practices

THE CHALLENGE

For years, electric power systems around the world have relied on a hub-and-spoke model with large-scale generators at the center, distributing to millions of end users. At the edge of the grid, many existing power substations are operating with equipment that is more than 40 years old on average, and in some cases may have been designed and installed before World War II.

These large, complex systems have improved tremendously thanks to advances in protection and control system technology, but the evolution toward renewable energy sources calls for a more adaptable, resilient model that can contend with dramatic fluctuations in electricity supply and demand in real time. How can utility engineers modernize communication and control technologies at the substation level while simultaneously improving efficiency and resiliency?

THE APPROACH

The industry is increasingly recognizing the benefits of digital substations, particularly when linked with 5G communication networks. A slate of rapidly evolving digital technologies is transforming the energy sector, and telecommunications service providers that offer 5G cellular communications networks are supporting this shift. These advances unlock opportunities for efficient energy distribution, new business services, actionable data analytics, and the ultra-low latency response times that are essential to real-time operations across regional power distribution systems.

Traditional copper-run electric substations are saddled with obsolete control equipment that boosts maintenance expenses and makes it difficult to assess the health and safety status of the equipment. Grid operators are often tasked with physically visiting the substations to detect issues and identify problems.

Digital technologies and high-speed communications using 5G can improve the reliability of the grid, enhance worker safety, and minimize interruptions in power. Replacing copper signal wires with fiber-optic and 5G connectivity enables automated and on-demand operations through Internet of Things (IoT), virtualization,

and AI technologies. Data quality and quantity is enhanced compared to traditional substations, and decision-making is made more quickly in day-to-day operations as well as in emergency situations.

Given the increasing role of renewable energy sources integrated into electrical distribution systems, digital substations have become an essential tool for contending with intermittent sources and smart grid implementations.

The key functions of modern digital substations include:

- Interconnecting power lines with components of the system, isolated from the control house
- Monitoring and controlling system operations
- Protecting the power system equipment from damage or failure

5G capabilities—including high-speed throughput, low latency operations, expanded spectrum coverage, integrated security features, and 99.999% availability—offer many ways to improve the operation and protection of substations.

Modernizing the Grid with 5G Wireless Technology

Ongoing collaboration between technology leaders, standards organizations, and energy providers is solving the challenges of incorporating 5G networks into energy infrastructures. One key challenge involves establishing 5G connection links between base stations and the core network (backhaul). This requires defining the interoperability between a mix of fiber and wireless technologies. Fiber services need to be implemented while also integrating high-capacity wireless backhaul solutions into the infrastructure, including 5G installations. Regulatory work needs to be accomplished at both a national and an international level to define a workable ecosystem—one that doesn't interfere with existing systems—within which 5G services can be deployed at a favorable economy of scale and high degree of interoperability. Spectrum considerations and radio technology standards that apply to 5G equipment must be coordinated on a global scale.

One of the primary benefits of 5G communication and the modern digital substation is the ease of asset management. By applying supporting technologies, including IoT, predictive analytics, and automated control systems, energy operators will be able to reduce maintenance costs, plan resource use more efficiently, and detect pending failures before problems escalate to a point where a power shutdown is necessary.

The modern asset management of a digital substation could encompass automation monitoring of critical substation components to provide data and analytics to optimize maintenance

activities according to their importance to grid operations. This could help lower maintenance costs of strategic components, implementing more accurate predictive maintenance notifications to reduce device failures and reduce the quantity of unplanned outages and the outage time.

A growing trend in the U.S. that is enabled by smart meters and digital substations is demand response programs. Customers can use apps to track their household energy use and schedule energy-intensive operations, such as charging an electric vehicle or using the clothes dryer, at times of low demand, thus saving money (in areas where time of use rates apply) and helping utilities plan to cost-effectively meet regional energy requirements.

Wind River products support these moves to modernize energy infrastructures.

Wind River Linux

[Wind River Linux](#) is a commercially supported version of Linux for embedded applications, cost-effective security, and access to pre-built containers (with Docker and Kubernetes support). It plays a key role in cloud-native 5G environments, helping maximize server use by creating self-contained packages of applications that can be installed and run while sharing a common operating system kernel.

VxWorks

The powerful RTOS capabilities of [VxWorks®](#), the industry-proven, real-time operating system from Wind River, supports modern development methods for building solutions that are secure, safe, reliable, and certifiable. VxWorks accelerates data-processing tasks in industrial environments and within 5G networks to ensure responsive operations in mission-critical deployments.

Wind River Helix Virtualization Platform

[Helix™ Platform](#) reflects 30 years of Wind River experience in meeting the stringent requirements of energy operators and utilities, consolidating workloads across multiple virtual machines, supporting container technology, and enabling operators to fully virtualize their industrial control systems. A real-time, embedded Type 1 hypervisor supports a diverse range of operating systems, delivering safety, performance, and flexibility in energy system infrastructures. Helix Platform strengthens low-latency operations within an on-premise cloud infrastructure using a 5G network.

Wind River Simics

[Simics](#)[®] helps create highly secure substation installations through elaborate simulations that can detect system vulnerabilities and streamline DevOps development projects. Simics provides a simulation environment to test systems and cybersecurity protections via secure virtual hardware in a safe and controlled environment and includes collaboration tools to improve development processes.

THE RESULT

The antiquated electricity grid that exists in the U.S. is rapidly evolving, and this transformation is driven by a variety of factors. Since the early 1990s, mandatory renewable electricity standards have been implemented by 29 states, and several states have set goals for establishing 100% renewable energy systems by 2050. Digital technologies make these targets achievable by enabling the grid to accommodate more renewable energy sources. Digital substations provide energy companies with the tools and architecture to incorporate a mix of energy resource options into their services and decarbonize their business models.

Real-time information on energy use through smart meters, IoT, and 5G can both enable substation operators to efficiently orchestrate the distribution of energy and keep consumers informed to better manage their personal energy use. By harnessing the benefits of 5G technology, Wind River is playing an important role in building and supporting modernized electricity grids and creating efficient energy systems for the future.

To learn more about Wind River Linux, VxWorks, Helix Platform, or Simics, visit www.windriver.com or contact [Sales Inquiry Desk](#).

