Improving capacity and performance for smart grid operations with converged, critical WANs

Use case

The ongoing migration to smart grid technologies will enable power utilities worldwide to operate bulk electric systems more efficiently while supporting decarbonization. Substation automation, distribution automation and a variety of new applications will revolutionize the way utilities manage and deliver electricity to customers. To truly enable the full potential of smart grids, a smarter communications infrastructure is needed to route the increasing amounts of monitoring, control and status information effectively, efficiently and on time. A converged, mission-critical wide area network (WAN) built on IP/Multiprotocol Label Switching (IP/MPLS), packet microwave, and packet optical networking technologies provides the flexibility, security, and scalability to support smart grid communication, as well as application-aware traffic management to ensure high quality of service (QoS) for critical grid applications.

Challenges

The IP-based devices and applications that enable smart grid architectures provide utilities with a continuous stream of information they can use to operate electric systems more efficiently and automate key functions. With more information, utilities can enhance safety, reduce operating costs, increase power quality, and improve outage response. It will also address grid control and protection challenges as generation in both the transmission and distribution grids evolve with renewables integration.

But to be effective, smart grid devices and applications require equally smart WANs. Each smart grid application increases the number of devices that must be monitored and controlled, the amount of data that is generated, and the data rates that must be supported. Legacy communications infrastructures that currently support power grid operational information were not designed for these new requirements. They don't provide the capacity, performance and QoS needed to support the massive amount of IP-based communication required for efficient smart grid operations.

In the past, utility operators built independent communications networks for specific functions. Typically, these networks were created to carry information for a specific grid operation such as teleprotection or supervisory control and data acquisition (SCADA), enterprise applications or support staff communications. They were engineered based on time division multiplexing (TDM) technologies, such as Synchronous Digital Hierarchy (SDH), and Synchronous Optical Network (SONET), and configured with pre-defined bandwidth and QoS parameters.

As a result, many utilities now have multiple networks that were not designed to interoperate. These legacy operational networks are not equipped to efficiently support the information traffic generated by new IP-based systems, such as SCADA, intelligent electronic devices (IEDs), synchrophasor, and video surveillance. In addition, they are not able to effectively discriminate between high-priority mission critical traffic and lower priority traffic across the network.

Complicating the situation is the fact that most of the deployed TDM-based legacy equipment is reaching the end of its useful life cycle and must be replaced. At the same time, carrier-based TDM and frame relay services that enable these grid systems today are being discontinued and more advanced replacement services that offer more bandwidth are at a significantly higher price.

Given the current situation and future requirements, utilities need a solution that can support existing systems and extend the reach of private WAN communications networks to more sites. The ideal solution should also pave the way for more advanced applications and devices that will enable the Internet of Things (IoT) in the smart grid of the future.

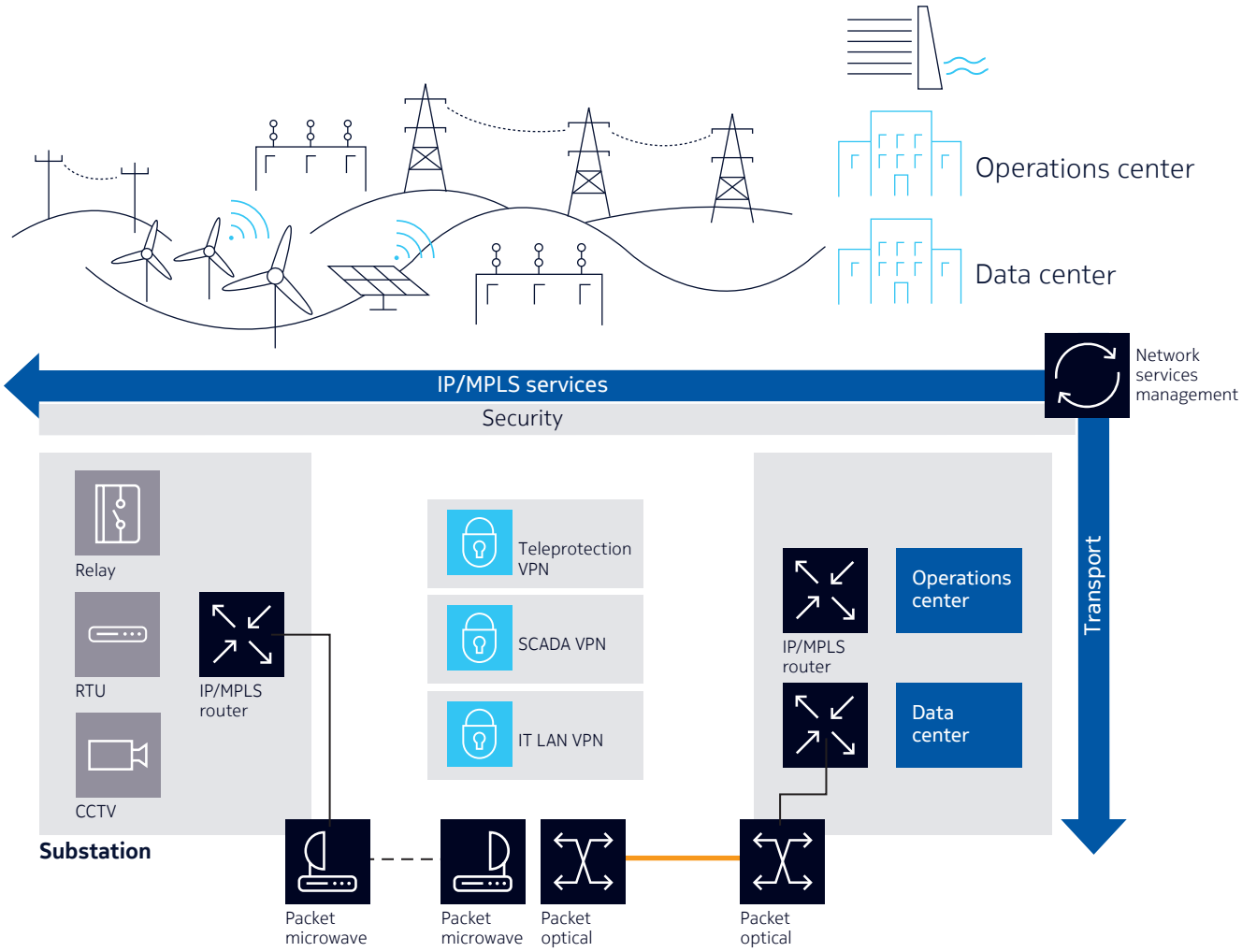
Solution: Converged, critical WAN

A converged, mission-critical WAN built on IP/MPLS, packet microwave, and packet optical networking technologies provides a highly available, flexible, secure, and scalable IP network that can address all smart grid communication requirements. With its rich features, the network can support legacy and emerging applications, and continue to evolve far into the future.

With its virtual private network (VPN) capability, IP/MPLS enables utilities to build versatile, service-aware networks for individual applications with service-level privacy, security, and reliability. These virtual networks are supported on a single converged infrastructure that provides the assured QoS needed to carry the volume and variety of information generated by smart grids. In addition, IP/MPLS can work over packet microwave and wavelength division multiplexing (WDM) optical transport technologies.

With reliable, high bandwidth connectivity, optical transport can efficiently support both operational and enterprise communications traffic. This makes it easier to connect remote systems, data centers, and corporate offices on one network. In addition, optical networking provides data protection through cyber security capabilities, including optical intrusion detection and low latency encryption. Sensitive data is protected through embedded layer 1 encryption, which complements the higher layer Network Group Encryption supported across the entire IP/MPLS network. This is part of a complete security management solution that spans multi-vendor and multi-technology IT and OT environments, and provides a single pane of glass perspective on the network.

Figure 1. Nokia's converged architecture for critical WANs



- Your smart grid communications network partner
- Nokia offers a complete approach to deploying converged, critical WANs built on:
- A strong product portfolio, which includes IP/MPLS routing, packet optical and packet microwave transport, and software-defined networking (SDN) technologies to effectively address a broad range of applications
- Asymmetrical Delay Control (ADC) for teleprotection support on IP/MPLS routers with encryption for enhanced security
- Flexible SCADA migration onto IP/MPLS network (with integrated multi-drop bridge and raw socket support)
- Advanced security features across multiple network layers as part of holistic security management that spans multi-vendor and multi-technology IT and OT environments and provides a single pane of glass perspective
- Proven engineering, integration and management services based on experience modernizing communications networks for more than 120 utilities
- Comprehensive common network and service management for IP/MPLS, optical, and packet microwave radio, which simplifies and reduces operational expenses

Nokia provides critical WAN solutions that leverage the IP/MPLS, packet microwave, and optical networking technologies needed to create flexible, secure, scalable communications networks for critical connections enabling smart grid applications. Combined with a broad and deep experience in the utility industry, these solutions have already helped utilities worldwide introduce smart grid applications that can improve operations, reduce capital and operating expenditures, improve security, and enhance grid reliability.

A Nokia converged, critical WAN allows power utilities to deploy a service-aware network that provides service scalability and quality, and enables per-service operations, administration and maintenance (OAM) and performance management. Equipped with industry-leading capabilities, including high availability non-stop routing and non-stop service, as well as asymmetrical delay control, a Nokia mission-critical WAN can meet the stringent reliability and performance requirements of smart grid applications.

From feasibility studies, conception and design to engineering, procurement, supply, implementation, operation and maintenance, Nokia provides an a comprehensive solution approach structured to enable effective and efficient smart grid operation. Our solutions are proven to work with products from a full ecosystem of partners, including smart grid solution vendors, system manufacturers and sensors.

Benefits

A high-capacity, high-performance critical WAN built on IP/MPLS, packet microwave, and packet optical networking technologies is a key enabler for the transformation of a power utility's transmission and distribution grids to more efficient smart grid operations. It provides a secure, flexible, and resilient platform upon which to build smart grid automation, control, and management functions for a decarbonized future. It enables the deployment of new devices and applications that can improve operations and grid responsiveness. It allows consolidation of enterprise and operational communications on a single network, which enables IT/OT convergence and provides the added value of combined data for outage and asset management, and new services. And it enables an efficient evolution to the Internet of Things (IoT) in the smart grid of the future.

- Optimizing smart grid operations with converged, critical WANs
- Nokia's converged, critical WAN enables a smarter communications network that supports:
- IP-based SCADA systems, which require flexible IP VPN services and interoperability with new IP-based remote terminal units and legacy RTUs
- Teleprotection systems, which require support for both legacy interfaces and new IEC 61850 GOOSE-based communications
- Substation automation systems and IP-based video surveillance systems, which take advantage of the increase in bandwidth that modern networking technologies offer
- Synchrophasor systems, which leverage IP-multicast capabilities for effective phasor measurement unit communications
- Distribution automation systems that can reach multiple endpoints across the grid and into the field area network (FAN)

With a converged, critical WAN, power utilities have the flexible, secure broadband connectivity needed for critical connections to support smart grid technologies that enable them to manage their grids more efficiently, deliver better power quality, defer the need for additional generation capacity, and reduce carbon emissions.

Some utilities have already quantified the benefits offered by a move to a converged, higher-capacity WAN infrastructure.

For example, a utility serving three million customers had all its transmission substations and many of its distribution substations connected with fiber infrastructure. It used this infrastructure solely for teleprotection traffic passing between transmission substations. The utility relied on legacy networking services from carriers to support almost all its data traffic, including operations and enterprise data traffic.

By moving to a converged WAN, the utility was able to migrate all operations and enterprise

traffic to a new private network running on the existing fiber infrastructure. With a migration of the transmission substations and operations center occurring over a three-year period, the utility projects significant savings compared to deploying new carrier replacement services. The seven-year total cost of ownership will be reduced by 10 percent with network operations supported internally and by 40 percent with outsourced operations on a private network.

Nokia's communication solutions provide power utilities with the critical connections to enable grids to operate more efficiently, reliably and safely. It will help ensure business continuity during incidents such as pandemics that cause considerable stress on grid operations and staff. To learn more about Nokia's solutions for power utilities, visit https://networks.nokia.com/power-utilities/mission-critical-wan.

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