

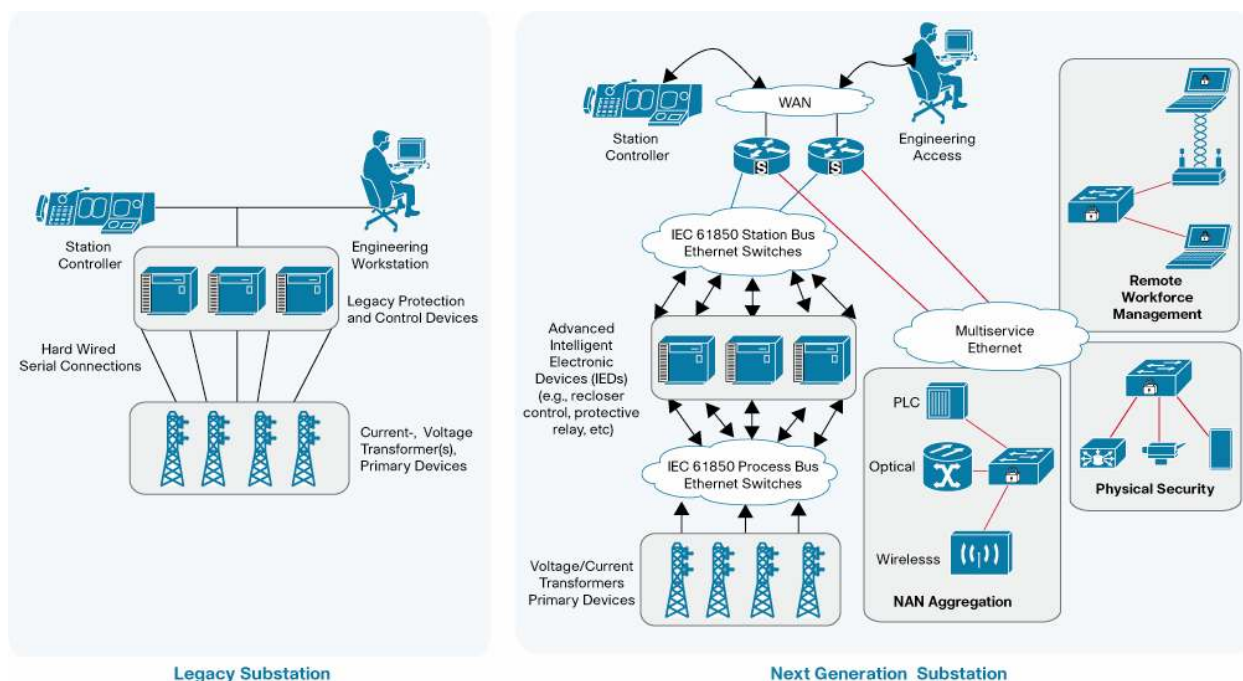
Substation Automation for the Smart Grid

The smart grid promises a more efficient way of supplying and consuming energy. In essence, the smart grid is a data communications network integrated with the power grid that enables power grid operators to collect and analyze data about power generation, transmission, distribution, and consumption—all in near real time. Smart grid communication technology provides predictive information and recommendations to utilities, their suppliers, and their customers on how best to manage power.

To achieve this vision of ubiquitous near-real time information, a transformation of the power grid communications infrastructure is needed, particularly in transmission and distribution substations. While modern data communication has evolved from telephony modems to IP networks, many power utilities are still deploying modem access and serial bus technology to communicate with their substations. The existing supervisory control and data acquisition (SCADA) remote terminal unit (RTU) systems located inside the substation cannot scale and evolve to support next-generation intelligence. Since flexible IEC 61850-compliant intelligent electronic devices (IEDs) and utility-grade rugged IP routers and Ethernet switches have become more widely available, many utilities are now ready to transform their communications networks from serial to IP-based communications.

Figure 1 shows the transition from a legacy substation to a next generation substation.

Figure 1. Substation Migration in Process



The migration toward this future transmission and distribution substation is taking place because of the desire to bring more automation and intelligence to the power grid network to address a myriad of utility concerns such as how to reduce operational expenses to ways to meet new regulatory requirements, such as NERC-CIP (**North American Electric Reliability Corporation—Critical Infrastructure Protection**). This paper describes Cisco's vision and activities in the area of substation automation to help ensure a secure smart grid and a reliable, sustainable energy supply.

Substation Automation Business Factors and Benefits

The transition from a legacy to future substation is taking place because of various substation automation factors:

- **Reduce operations expense:** The future substation reduces operational expenses by converging multiple control and monitoring systems onto a single IP network while helping ensure higher priority for grid operational and management traffic. This network convergence enables utility companies to reduce power outages and service interruptions as well as decrease response times by quickly identifying, isolating, diagnosing, and repairing faults. These improvements are achieved through automation and flexible access to operational control systems and, in the future, through better data correlation across multiple monitoring systems.

In addition, many utilities are facing an aging workforce, which will be retiring in the next 5 to 10 years. Utilities need to fill their pipeline of talent with a younger workforce that is capable of operating today's electric grid, but who can also help build the smart grid of the future. Utilities can benefit from substation automation by more efficiently using their existing workforce and reducing the amount of service calls through programs such as condition-based maintenance.

Further, substation automation allows utilities to extract further value from their corporate networks by providing a remote workforce secure access to applications and data that are located in the operations center.

- **Reduce capital expense:** As demand for energy continues to grow, utilities must find ways to generate power to meet peak loads. As a regulated industry, utilities must provide power regardless of the amount of power consumed. The cost of providing spinning reserves for peak load hours of the year is extremely high for society. Utilities are challenged to find new ways to shave peak load to help reduce costs and manage supply and demand of energy more efficiently.

Substation automation can be the enabling technology for mass-scale peak load shaving and demand response, which will reduce the need to build as many power plants to meet peak demand.

Additionally, substation automation can reduce the expense and complexity of dedicated control wiring between devices found in many transmission and distribution substations today by converging to an Ethernet-based network. Logical network segmentation and reconfiguration of IED connectivity are much simpler to achieve. Point-to-point wiring not only is expensive, but also increases the difficulty of fault isolation detection.

- **Enable distributed intelligence:** As network intelligence expands beyond the control center out into the substations, new applications can be developed that enable distributed protection, control, and automation functions. A distributed intelligent network also introduces opportunities for new service creation, such as business and home energy management.
- **Meet regulatory compliance:** For many governments, utilities are considered critical infrastructure and have economic and national security concerns. Because of this, various regulatory mandates exist or are emerging that require utilities to secure, monitor, and manage their critical data networks in accordance with regulatory requirements, such as NERC-CIP.

- **Improve grid security:** Grid security is not just about securing the electronic security perimeter (ESP) in the substation; it is also about creating a secure end-to-end architecture that maximizes visibility into the entire network environment, devices, and events.

Substation automation enables an important part of the end-to-end security architecture and allows network operators to control network users, device, and traffic. Physical security can be layered on top of this network security to create security zones of access control, IP cameras for surveillance monitoring, and video analytics to protect and alert network administrators of intruders.

A secure IP network for transmission of grid communications, physical security, and remote workforce management applications can be achieved through substation automation.

Cisco's Substation Automation Vision

Cisco's vision for smart grid automation is based on principles learned from years as the world leader in building secure data networks:

- Use cost-effective, well-known protocols (Ethernet/IP) that are easily integrated into other parts of the network and the associated operations environment.
- Take a solutions based approach instead of simply providing single point products to provide a secure, end-to-end architecture.

Cisco applies these principles to the unique environment and demands of the smart grid to create a converged, modular security platform that provides fast response to threats and helps ensure regulatory security policy compliance while reducing operating and management expenses. The Cisco® smart grid substation automation solutions approach helps to ensure a secure, reliable communications network.

Open Standards

When they migrate away from closed, proprietary protocols, utilities are no longer constrained by a single-vendor, proprietary solution. An open IP-based network enables networking of IEDs from multiple vendors, thereby increasing competition and pushing down costs. Peer-to-peer communication between IEDs is achieved through the use of VLAN and multicast capabilities, which are inherent to Ethernet.

This open standards approach supports multiple network topologies and redundancy schemes for protection against link and node failures within the substation. In addition, comprehensive upgrades of existing infrastructure are not needed since IP/Ethernet allows for the transport of legacy substation protocols such as Modbus and DNP3, thereby providing a smooth transition from the legacy to future substations.

Solutions Approach

Cisco's solutions-based approach to substation automation begins with understanding different use cases and benefits around substation automation and ends with designing complete solutions to address these use cases. Some use cases that were evaluated include:

- Next-generation substation automation with and without GOOSE (Generic Object Oriented Substation Events) messaging
- Substation automation with phasor measurement units (PMUs)
- Substation physical security
- Substation remote workforce management
- Substation remote engineering access
- Substation precise timing distribution
- Network and security management

- Condition-based maintenance
- Distributed analytics
- IP telephony

The preceding list is not exhaustive, but shows the variety of substation automation applications that can enable utilities to realize the benefits of a smarter grid.

Cisco's solutions fall into four main areas: networking solutions, security solutions, network management solutions, and advanced technology solutions. Within each area, Cisco offers a breadth and depth of products that, combined with a solutions approach, help utilities meet the challenges and needs of substation automation.

- **Networking solutions:** Building on Cisco's tradition of networking excellence, Cisco offers advanced rugged networking equipment and scalable architectures to enable reliable and secure two-way communication between substation SCADA equipment and the Energy Management System (EMS). These products are designed with substation in utilities environments in mind and offer zero-touch configuration methods.
- **Security solutions:** Defense in depth, as opposed to point solutions, is crucial for securing substation communications. Cisco offers security solutions on the host, on the routers, and on the switching platforms and specialized security solutions such as firewall, VPN, authentication, and IPS solutions. Cisco security solutions on the host, routers, switches, and appliances provide an end-to-end infrastructure that enables and protects critical communication networks.
- **Network management solutions:** Simple and common management software for managing thousands of substation devices provides easy policy enforcement across substations. Cisco also offers management and alarm reporting system software that can collect alarms from all the networking devices (including switches and routers), security devices (ASA and IPS modules on the ASA), and integration with third-party devices.
- **Advanced technology solutions:** Cisco offers the following advanced technology solutions for substations:
 - Physical security access solutions, which assist in NERC-CIP physical security compliance requirements
 - Video surveillance solutions, including cameras, video storage solutions, and analytical solutions
 - Voice solutions, which include ruggedized IP phones and Cisco CallManager solutions

Conclusion

Cisco is in a unique position to help energy organizations make the transformation to smarter grid, starting with a foundation of converged IP networks and proven security principles for substation automation. From a technology standpoint, the Cisco portfolio includes industry-leading networking equipment and software with integrated security capabilities that empower energy organizations to use Cisco's experience to build end-to-end, secure IP networks.

The maturity, reliability, and success of these products and services can shorten the learning curve for power grid



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