

The Challenge of Disruption

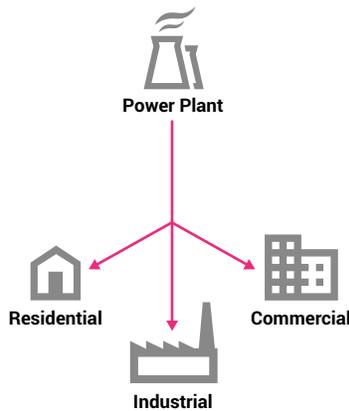
Distributed Network Intelligence in the Age of Distributed Energy
Resources (DER)



Introduction

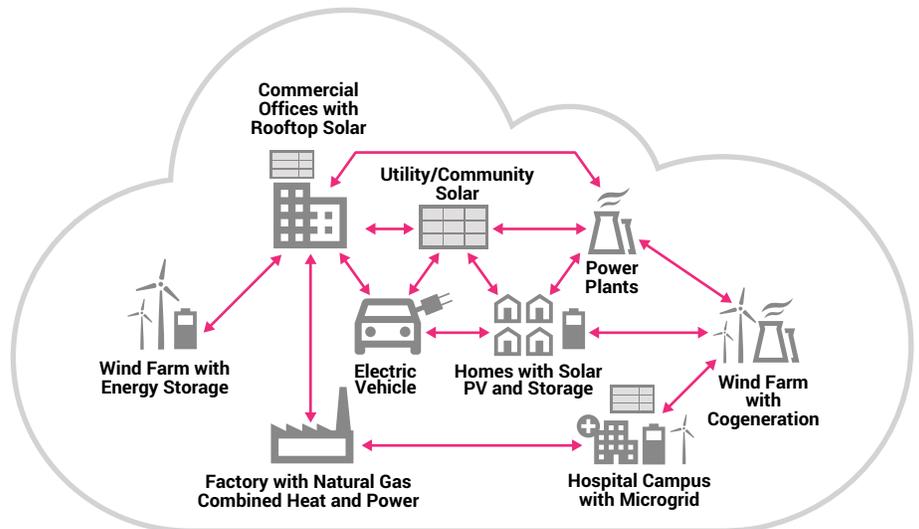
Power utilities are experiencing significant disruption, primarily driven by Distributed Energy Resources (DERs). These resources are transforming the industry from a traditional unidirectional power flow model to a more dynamic, decentralized grid. In this new paradigm, power generation is no longer limited to large central plants. Instead, it is distributed across numerous small-scale generators and renewable energy sources, such as solar, wind, hydro, and gas, located in diverse environments including rural, metropolitan, and residential areas. This shift necessitates a comprehensive evolution of the platforms controlling transmission and distribution (T&D) grids, which need to be extended to the very edge of the energy network.

TODAY One-Way Power System



- Large, central located generation
- One-way energy flow
- No flexibility
- Simple market structure

EMERGING The Energy Cloud



- DER-Distributed Energy Resources
- Multiple input and users
- Digital smart grid and AMI
- Complex market structure

Several key trends are in this modernization include:

- Electrical vehicle (EV) charging requires advanced monitoring and control systems to manage the redistribution of energy resources across a vast number of charging stations.
- Energy storage systems for households, businesses, and industries.
- Growth in micro-grids capable of meeting their own energy needs and even sharing energy with utility companies.
- Compliance with stringent environmental, security, and safety regulations.
- New payment models where utility companies remunerate small and individual energy producers.

The Components of Transformation

Emerging technologies and trends are driving the development of the 'Energy Cloud,' characterized by interconnected, automated systems and the widespread use of Industrial IoT devices.



Smart Grid Systems – The evolution from a one-way electro-mechanical grid to pockets of connectivity and automation is paving the way for widespread connectivity with modern Industrial IoT devices. Eventually, this will become the 'Neural Grid,' featuring cloud-based AI, ubiquitous connectivity, edge computing, and automation.



The Digital Substation - This transformation is marked by the shift from first-generation SCADA, and telemetry systems to digital, connected platforms based on standards like IEC 61850. Legacy remote terminal units (RTUs) and programmable logic controllers (PLCs) are being replaced by new-generation intelligent electrical devices (IEDs) that communicate through advanced, secure protocols using Ethernet-based, resilient substation systems.



Communications Network – With SDH/SONET transport networks reaching end-of-life, power utilities must evolve to a modern unified packet transport network capable of supporting all IT and OT services. This network must provide the deterministic packet transport required for legacy SCADA, teleprotection, and telemetry systems, as well as IP/MPLS to support large-scale packet-based services.



Smart Meters - Advanced metering instruments (AMIs) provide real-time, bi-directional data and are integrated into the power grid communications network via fiber, wireless, or copper.



Big Data - Managing and securing vast volumes of OT and IT data quickly from all points of the distributed grid is crucial. Standardization aims to establish an architecture which facilitates data and information exchange within the energy cloud.



Asset and Grid Management Platforms- These platforms control and monitor every element of the grid from a central operations control center. This enables real-time response, precise billing, and enhanced customer satisfaction and retention.



Cyber Security - The proliferation of access points in an energy cloud introduces more avenues for potential cyber-attacks. Power utilities must adopt proactive cyber security policies that go beyond traditional compliance measures to safeguard both hard and soft assets across the grid.

Challenges and Solutions

Power utilities vary significantly, and their motivations for embracing change and modernization are influenced by local and regional laws and regulations. Energy generators, transmission system operators (TSOs), and distribution system operators (DSOs) each have unique reasons for pursuing modernization. These reasons include cost savings, improved energy quality, enhanced efficiency and sustainability, and reductions in environmental impact and greenhouse gas (GHG) emissions. Additionally, modernization efforts aim to improve reliability and resilience, increase customer satisfaction and retention, and boost sales and profits

Power utilities must navigate various challenges to achieve a cost-effective transformation:

Workforce

The skills required for managing a traditional unidirectional grid are insufficient for the age of DER. Workforce skills must evolve to handle new technologies and platforms.

Maintenance and Management

Managing a greater number of assets over a complete lifecycle while maintaining mission-critical status poses a significant challenge. Analytics will play a key role in helping operators manage the DERs and predict failures and degradations.

IT/OT Convergence

IT/OT convergence is required to support cross-domain services and applications such as demand-response systems, real-time customer relationship management and office-to-field systems for improved grid reliability and resilience. An additional benefit of a converged IT/OT network is that cyber security threats can be addressed more holistically.

Network Complexity

The energy cloud requires a massively increased volume of data generated by vastly increased number of devices distributed across the network. Managing this data will require advanced tools such as DER management systems, asset management platforms, and cloud/ edge computing capabilities

Communications Network

An intelligent communications network connecting different elements of the smart grid is essential. This network must support applications such as:

- Applications (eg. billing services, call center, analytics, cloud services, data storage and management).
- End-user services (eg. smart meters, smartphones/tablets, smart appliances, EV charging stations, smart sensors).
- Infrastructure (eg. transmission and distribution grid, solar, wind, gas stations, micro-grids, utility-scale storage).

The Challenge of Disruption

Improving Safety and Security

Critical infrastructure, as a strategic asset, is highly regulated to ensure security and resilience. Standards like NERC CIP address the reliability, availability, and security of power utilities.

FAN-to-T&D Connectivity

Deploying countless smart meters and smart sensors in the distribution network (Field Area Network) and connecting them to transmission and generation control centers presents several challenges. Various solutions have been developed to address these challenges, including:

- Satellite: Used in remote, rural areas.
- Private RF Mesh Networks: Such as IoT backhaul solutions like LORA and Spring Networks.
- Public Wireless: Including 2G/3G and 4G networks.
- Point-to-Point and Point-to-Multipoint Microwave Systems.
- Private Fiber (FTTx), Leased Lines, and PLC (Powerline Communications): Using medium/low voltage lines for data communications

There is no 'one-size-fits-all' solution, as each scenario requires different interfaces and capacities from the transmission communications network. The network must provide high bandwidth, predictable low latency, be highly secure, and agile enough to support multiple current, legacy, and future services. 5G standalone has been architected to provide Enhanced Mobile Broadband eMBB, Massive IoT (mIoT), Ultra-Reliable Low Latency Communications (URLCC) needed for utilities to evolve into smart utilities. This ubiquitous 5G delivery platform will provide:

1 ms End-to-end roundtrip delay (latency)

Up To 10 Year battery life for low-power, M2M devices (such as IoT)

99% Reduction in energy consumption

100% Coverage

1000 Times the bandwidth per unit area

1-10 GBPS Connections to endpoints GBPS in the field

10-100 Times number of connected devices

99.999% Availability

Secure Network 

Creating a ubiquitous field area network (FAN) using 5G technology, and with under 1ms latency across very large geographies, may not be possible for a few years yet. It will require specific sets of features and capabilities from the transmission communications network to serve as a backhaul for such services.

The Long and Winding Road to Modernization

FUTURE The Energy Superhighway

- Broadband
- Low-latency
- Multi-technology
- Multi-purpose
- Large, central located generation
- Owned or leased network



The Challenge of Disruption

Modernization requires comprehensive changes to traditional methodologies, including developing new business models, increasing network security, and enhancing resilience and grid reliability, all while supporting a complete digital transformation.

As organizations embark on the long and winding road to modernization, they need a communications network vendor partner that understands their specific challenges. Such a vendor should provide:



Optimized Hardware: A complete packet and optical portfolio is needed to optimize the interfaces, cost, and size of the solution. The solution must support legacy TDM/PCM services with circuit emulation in conjunction with deterministic packet transport (MPLS-TP). The solution must also support IP/MPLS for IT services and future evolution and offer Optical Transport for bulk data transport. In-service scalability is crucial to allow the solution to grow, and for distributed energy resources, DIN-Rail mountable form factors are necessary.



Risk-Free Migration and Network Modernization: Proven, field-tested transition processes and partners are required, from project definition and development through implementation and onto long-term operation and evolution.



Advanced Operations Software: Operations should be simplified to increase network availability and reduce total cost of ownership (TCO). This can be achieved by providing intuitive network management for the entire network, including mission-critical service assurance and advanced fault management features. The software must ensure the network operates at maximum availability, usage, and efficiency. It should also provide optimized security for power systems, including SCADA anomaly detection, encryption at all levels, and next-generation firewalls.

Paths To Modernization

There are three primary strategies for modernizing communication networks for generators, TSOs, and DSOs:

- **Full Migration (PTN Migration)** involves building a packet transport network (PTN) alongside the existing SDH/SONET network. New packet-based services/applications are supported on the PTN, and legacy services/applications are migrated onto the PTN using circuit emulation. Once all legacy services/applications have been migrated the SDH/SONET network can be retired
- **Phased IP Approach (IP Overlay)**, involves building a packet transport network (PTN) alongside the existing SDH/SONET network to support new packet-based services/applications. The SDH/SONET network can only be retired when all legacy services/applications have been phased out or a full migration process run.
- **Phased Optical Approach (OTN Overlay)**, involves building a DWDM OTN network as an overlay to the existing SDH/SONET network. High-order SDH/SONET tunnels/trails are migrated onto the new OTN, and packet aggregation elements are added to support new packet-based services/applications. Once all high-order tunnels/trails are migrated, the high-order SDH/SONET network can be retired. The low-order SDH/SONET network remains in place until legacy services are phased out or a full migration process is run.

Any IT/OT and Utelco strategy will influence the speed at which a fully functional PTN is required and hence the migration strategy selected.

Conclusion

To meet standards and deliver mission-critical services and applications, it is essential to have future-proof building blocks in place. Partnering with an experienced communications network vendor who understands the transformation and modernization processes is key to successful implementation.

For more information about Ribbon's Intelligent IP Optical Middle Mile for Mission Critical Networks, visit rbbn.com

Contact Us Contact us to learn more about Ribbon solutions.

About Ribbon

Ribbon Communications (Nasdaq: RBBN) delivers communications software, IP and optical networking solutions to service providers, enterprises and critical infrastructure sectors globally. We engage deeply with our customers, helping them modernize their networks for improved competitive positioning and business outcomes in today's smart, always-on and data-hungry world. Our innovative, end-to-end solutions portfolio delivers unparalleled scale, performance, and agility, including core to edge software-centric solutions, cloud-native offers, leading-edge security and analytics tools, along with IP and optical networking solutions for 5G. We maintain a keen focus on our commitments to Environmental, Social and Governance (ESG) matters, offering an annual Sustainability Report to our stakeholders. To learn more about Ribbon visit [rbbn.com](https://www.ribbon.com).