



| Digital Substation >

Connecting to the digital world with the future built in.

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Digital Substation

Overview



Benefits



Solutions



Products



Digitalization is Changing Everything

As the smart grid gains momentum, digital technologies are being steadily incorporated into utility operations.

A study by Ernst & Young Global Limited (EY) found that 92% of electrical utilities and power generation companies decided to invest in the digital grid in 2017. Over the next few years, that trend has only accelerated. EY predicts that investment in the digital grid will reach half a trillion dollars annually.

The digital grid has moved front and center in the power and utility sector. It is being driven by the growth in renewables, increasing cybersecurity risk and the demand for greater efficiency.

To realize the benefits of a digitized grid, however, the equipment must offer high performance and reliability. That requires a network infrastructure that can not only deal with current demands, but can cope with future innovation and a massive increase in data traffic volume.

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The key to achieving these benefits is the Digital Substation



Overview

Benefits

Solutions

Products



The Digital Substation

Digital substations replace point-to-point copper cables with fiber optic communication systems.

Traditional substations have always relied on copper cables connecting together primary equipment like circuit breakers, conventional current and voltage transformers and protection relays.

Digital technologies, communications and standards are driving the evolution of digital substations. The digital substation means replacing conventional measuring equipment such as current transformers (CTs) and voltage transformers (VTs) with non-conventional instrument transformers using digitalized sensor technology. This will reduce exposure to high voltage signals.

This new breed of high-performance digital sensors and merging units are much easier to install. They can pass digital outputs directly to the process bus, and preserve signal integrity.

Non-conventional Instrument transformers (NCITs): Provide primary values to the merging units based on new principles.

Merging Units (MU): Converts analog primary values of the NCITs in digital information.

IoT: Value-adding central applications, big data analytics IT/OT integration.

Sensors: Provide more information on current status of the electrical equipment.

Process Bus: Communicates field data to protection and control system based on IEC 61850-9-2.

Digital Control Room: More data acquisition, intelligent decentralized applications, cyber security, and digital protection and automation with station bus based on IEC 61850.

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Opportunities

- Reduction of Operational and Capital expenses
- Better measurement accuracy to monitor, control and protect valuable assets
- Higher system availability to prevent and reduce outages
- Higher flexibility, standardization and interoperability
- Integration with fewer devices
- Increased people safety



Overview

Benefits

Solutions

Products



6 key benefits of the Digital Substation

Digital Station Level >

Digital Process Level >

Cybersecurity >

Asset Management >

Grid Operation >

Integrated Engineering >



Overview

Benefits

Solutions

Products



Digital Station Level

Ensure optimal deployment of operating resources

Protection systems, substation automation, protect people and investments.

The most important components of digital substations are the protection devices systems and the substation automation system.

As the connecting link between the primary equipment – for instance the switchgear – and the grid instrumentation substation automation system and control center system, these components ensure optimum use of all systems involved.

Key benefits

- Reliable protection in case of critical grid conditions and faults due to environmental influences or faulty operating equipment.
- Highest levels of security for personnel and investments.
- Seamless connection between primary technology and grid control technology.
- Communicates via Ethernet for optimally coordinated system performance with zero time loss.
- Allows optimal deployment of operating resources.



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Overview

Benefits

Solutions

Products



Digital Process Level

Save money, space, ensure optimal data transmission

There are tremendous benefits to using innovative technologies in primary equipment and digitally transmitting primary data on current and voltage.

New technologies like NCITs (non-conventional instrument transformers), for example, are employed in conjunction with “merging units” and process bus communications technology, which allow the primary values to be digitalized at process level and be communicated within the substation via Ethernet. This represents another important step for greater cost-efficiency and reliability.

Key benefits

- Reliable protection in case of critical grid conditions and faults due to environmental influences or faulty operating equipment.
- Cost savings, especially on cabling/copper wiring and installation
- Interoperable design enables vendor-neutral solutions through application of IEC 61850
- Extended functionality: integration of multiple data sources, independent signal distribution
- Improves flexibility and scalability: simple add-on of intelligent field devices

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Overview

Benefits

Solutions

Products



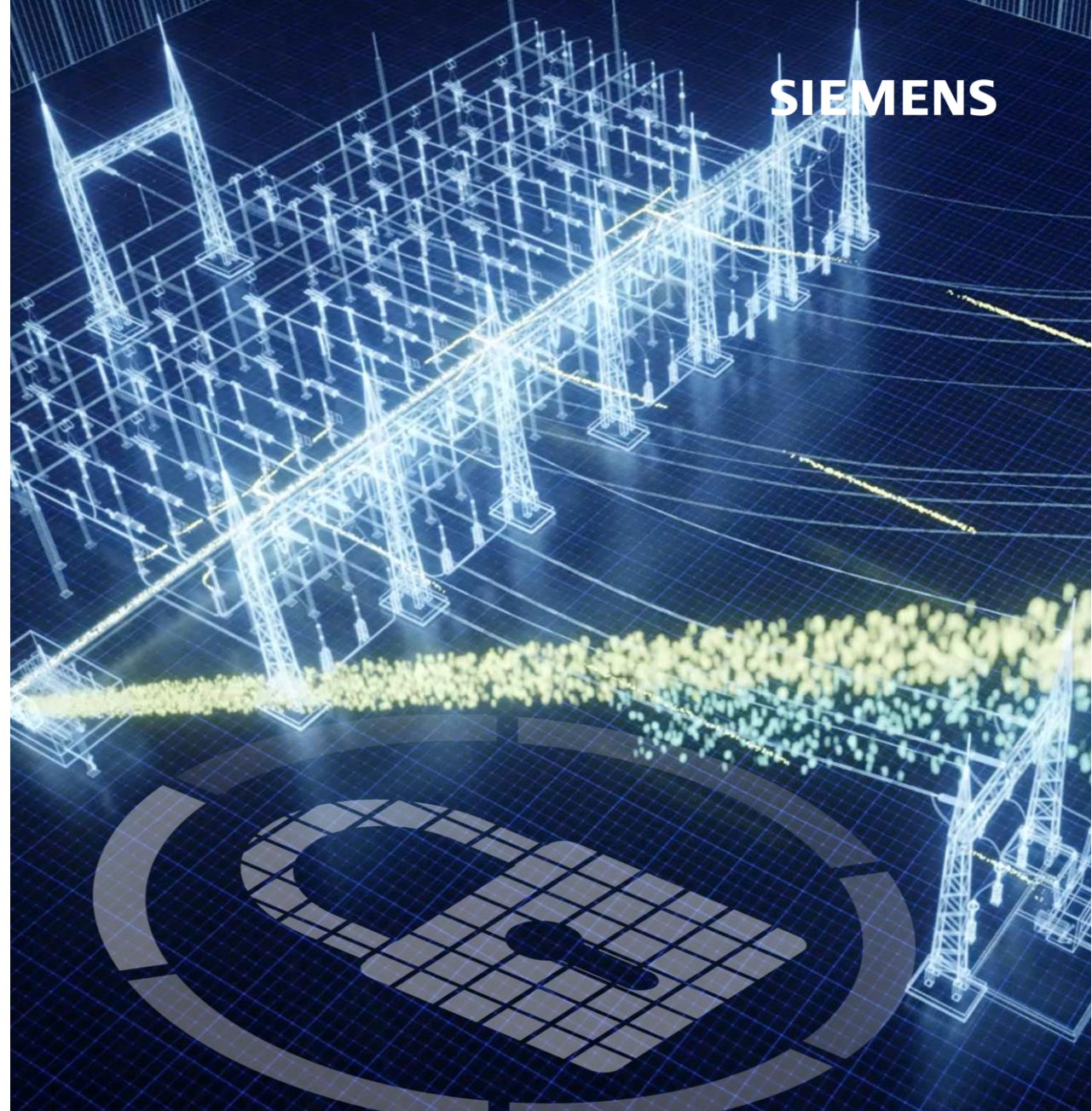
Cybersecurity

Ensure safe, secure, and efficient operation

Cybersecurity protects industrial infrastructure and processes from malware and targeted attacks.

- Creates a secure end-to-end architecture that maximizes visibility throughout the entire network environment, devices, and events.
- Assures the necessary protection of critical infrastructures and proactive compliance with the legal framework
- Prevents downtime, which increases system availability
- Prevents personal injury and damage to assets
- Preventing downtime, minimizing cyber risks
- Regulation compliance
- Retention of good reputation
- Comprehensive coverage of all security aspects from a single, trusted partner

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Overview

Benefits

Solutions

Products



Asset Management

Keep the value of investments as high as possible

Asset management based on data collected digitally lowers a substation's life cycle costs and enhances its availability, safety, and security.

- Guarantees that equipment, system software are state-of-the-art
- Ensures cybersecurity
- Optimally utilizes operating resources
- Increases availability of primary and secondary equipment
- Early warning system as support for planning preventive maintenance measures
- Optimizes strategies for investment, operation, and maintenance (CAPEX/OPEX)

Digital asset management

- Patch management
- Substation device monitoring
- Software solutions for asset management



Overview

Benefits

Solutions

Products



Grid Operation

Ensure availability of electricity anywhere, anytime

Unstable conditions in sections of the grid or the entire grid can lead to a complete blackout.

- Efficient condition monitoring of extensive power transmission grids
- Dynamic grid simulation for assessing grid stability
- Validates protection settings
- Validation of grid quality
- Prevents downtime, increases availability

Wide Area Monitoring System (WAMS)

- Real-time detection of instabilities, power swing, islanding, overload, blackout prevention
- Increased operational awareness – early reaction, better grid utilization

Fault Record Analysis

- Faster and accurate fault location analysis for better action planning (restoration)
- Recommendation for operation



Integrated Engineering

Simple, reliable and faster

From system engineering to automation; integrated data storage in combination with an electronic workflow

Integrated engineering is based on the digital data exchange between grid operators and suppliers but as well throughout the supplier process, from systems planning, engineering, and parameterizing right through to testing and commissioning.

Digitalization simplifies these processes because important data can be made available throughout the entire lifecycle of a Digital Substation.

These tasks may be simplified by a single master data set that is used by all tools and systems and for all of these work steps.

Key benefits

- Significantly reduced time to operation
- Reduced cost
- Fast availability and exchangeability of data
- Improved data quality through digitalized engineering process
- Interfacing to asset management
- Reduced documentation time in case of refurbishment



Benefits Summary

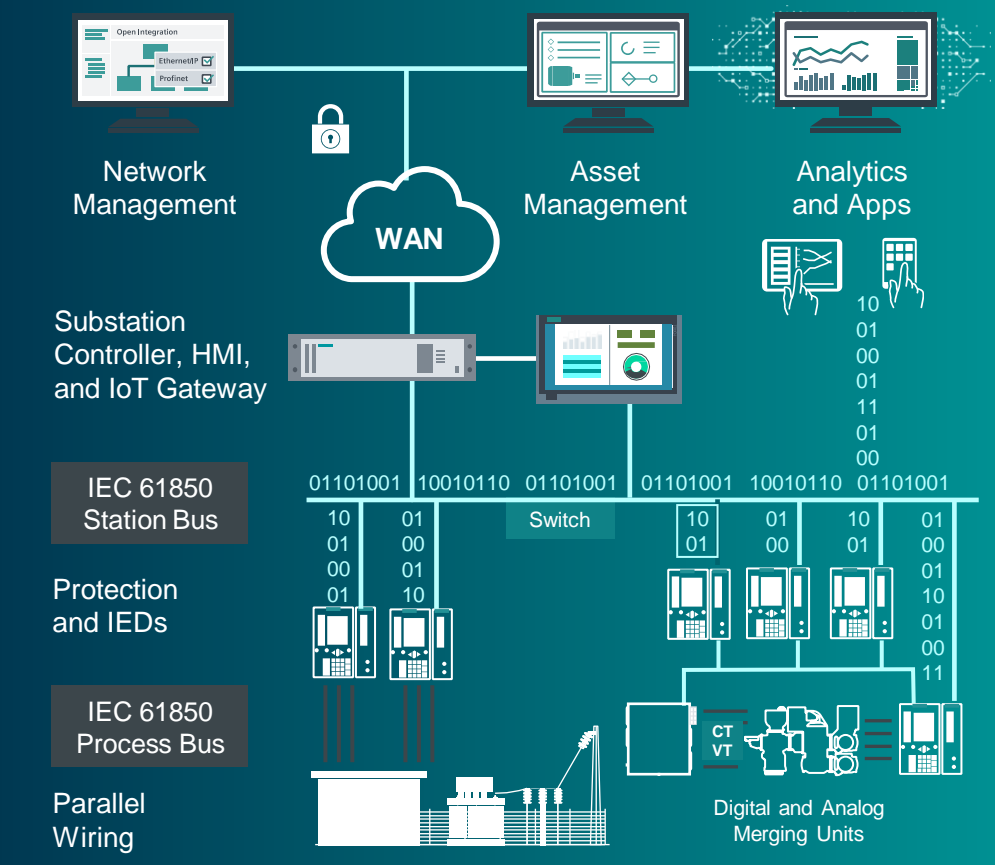
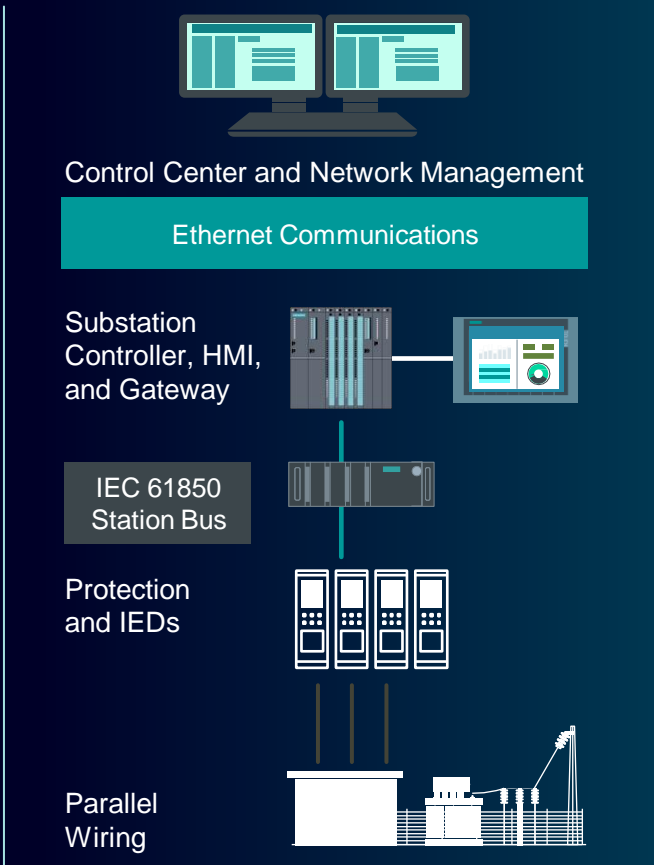
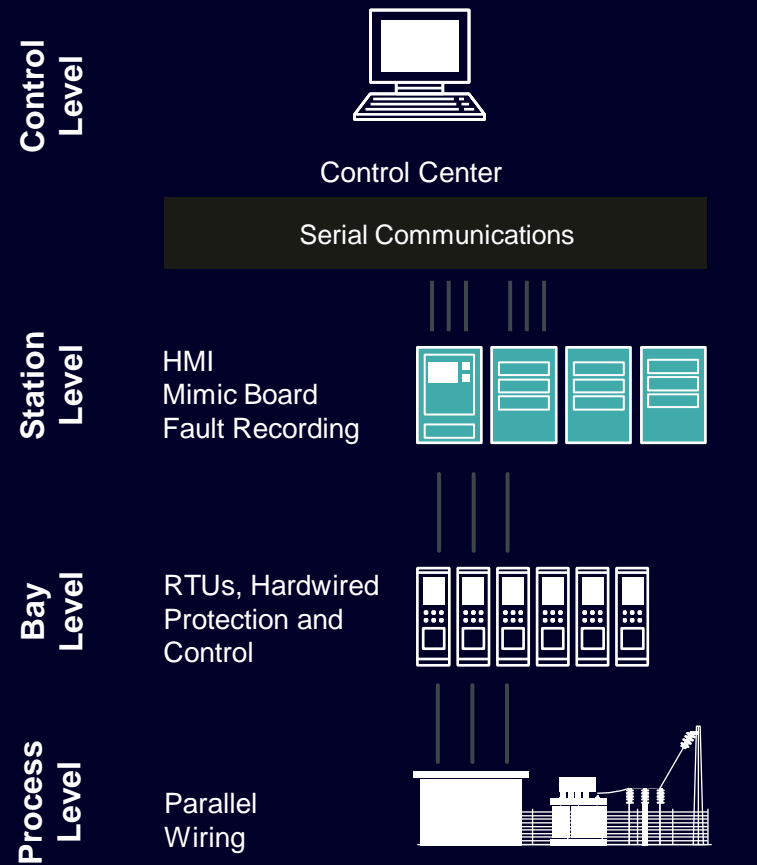
Siemens concept clearly addresses grid operators' challenges

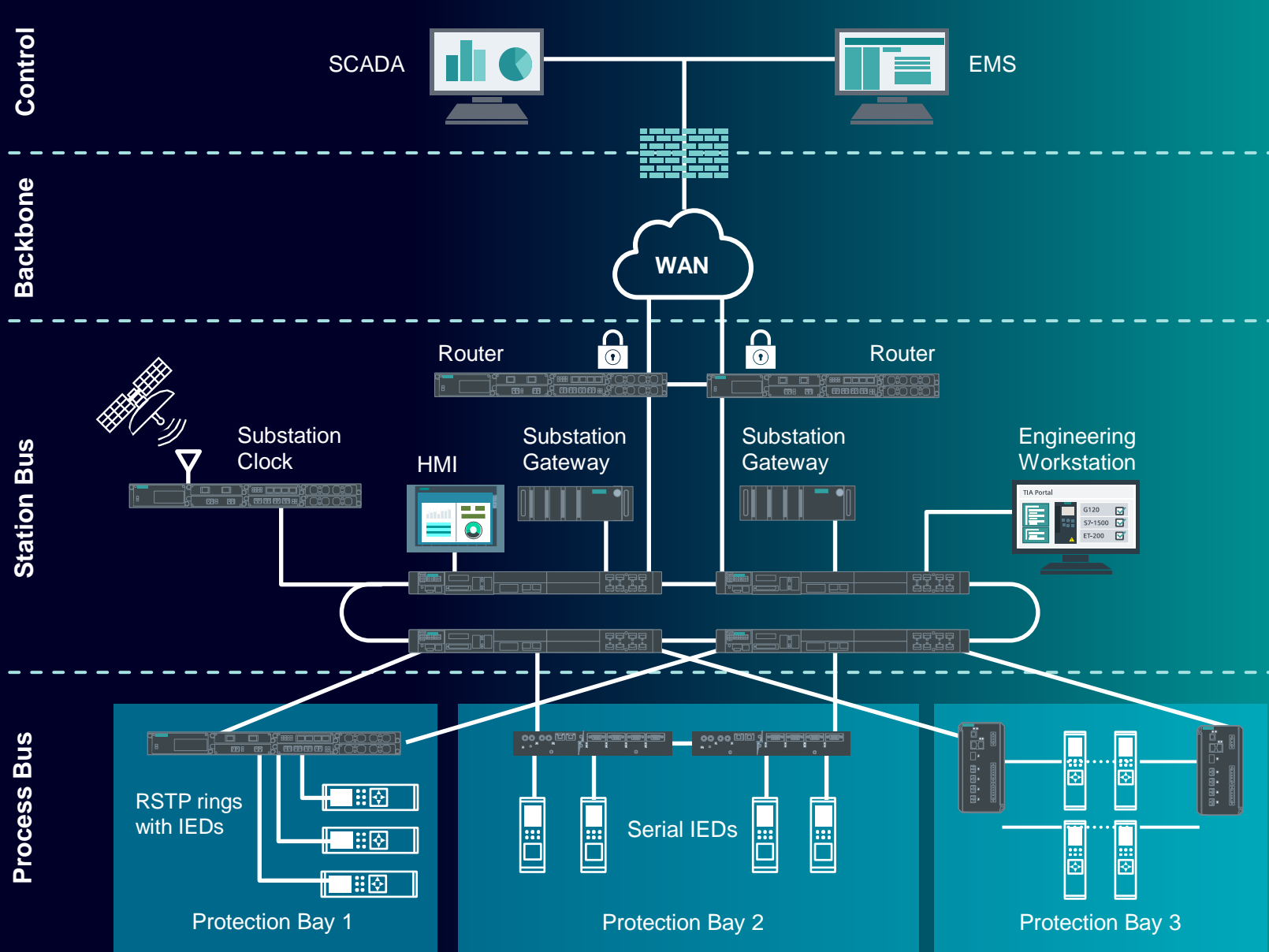
Digital Substation Benefits	Reduce CAPEX	Reduce OPEX	Reduce TCO	Investment Security	Asset productivity	Adopt new business models	Avoid outages	Reduce outage times	Avoid human errors	Quality assurance	Privacy and security of data	Time to operation	Regulatory compliance	Environmental impact	Standardization
Station Level	✓		✓	✓								✓		✓	✓
Process Level	✓		✓	✓								✓			✓
Cyber Security		✓		✓			✓				✓		✓		
Asset Management	✓	✓	✓		✓	✓	✓			✓		✓			
Grid Operation						✓	✓	✓	✓				✓		
Integrated Engineering			✓	✓		✓			✓	✓		✓			✓



Evolution of Substation Automation

From standard cabling to the digital substation





Digital Substation Solution

- **Zero Packet Loss**
Error-free communications for high EMI environments
- **Secure Remote IED Access**
Enable secured and reliable remote access to electric power operations
- **Cybersecurity**
Enabled by holistic security concept and security-integrated portfolio
- **Precise Time Synchronization**
Network equipment supporting sub-microsecond accuracy for Digital Substations
- **Redundant Network Architecture**
Continuous operation 24/7
- **Network Management**
Highest transparency for industrial networks and all connected devices



Overview

Benefits

Solutions

Products

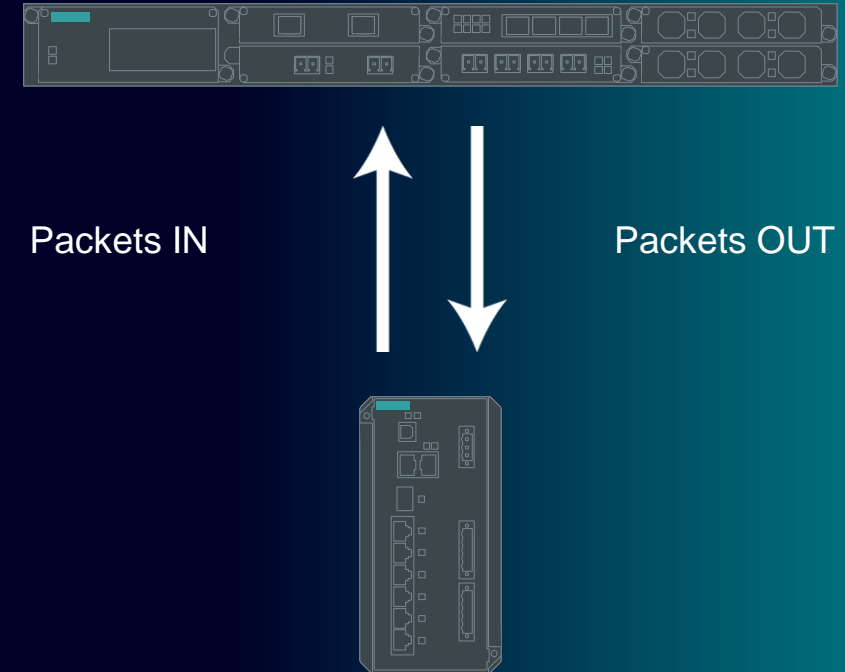


Zero Packet Loss

Error-free communications for high EMI environments

Zero-Packet-Loss™ technology is designed to provide the same level of EMI immunity performance and reliability as protective relaying devices.

- Immunity to EMI in utility environments:
IEC 61850-3, IEEE 1613
- 15 destructive type tests
- IEEE 1613 Class 2 performance
- Vital for Mission critical networks used for protection and control



Overview

Benefits

Solutions

Products

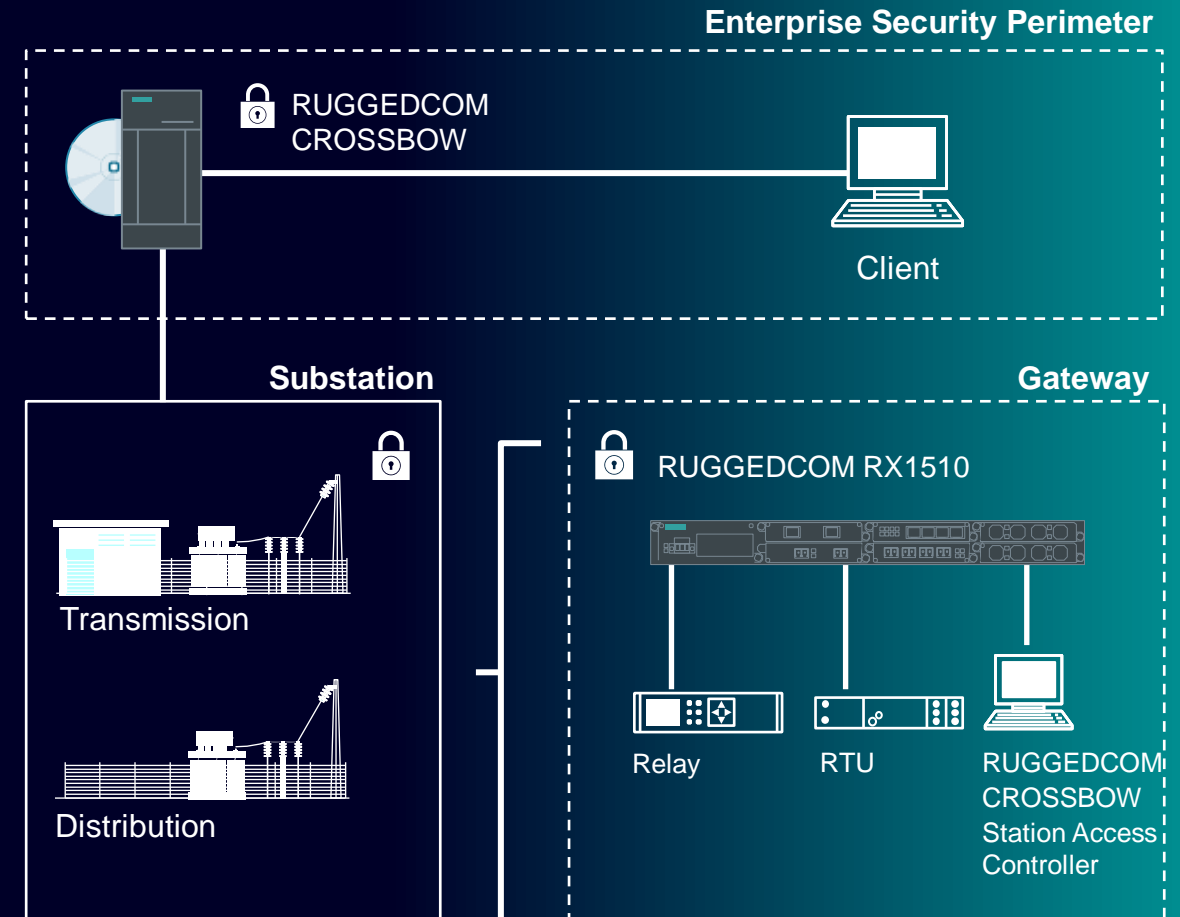


Secure Remote IED Access

Secure, reliable access to electric power operations

Solutions for network management, cybersecurity and secure remote IED access, data conversion, configuration and visualization.

- Secure remote IED and network connectivity
- RSA SecurID, Active Directory and Radius authentication
- NERC CIP compliant activity logging
- IED Password Management
- Seamless, redundant architecture
- Fault and Event Data Retrieval
- IED Configuration Management



Cybersecurity Solutions

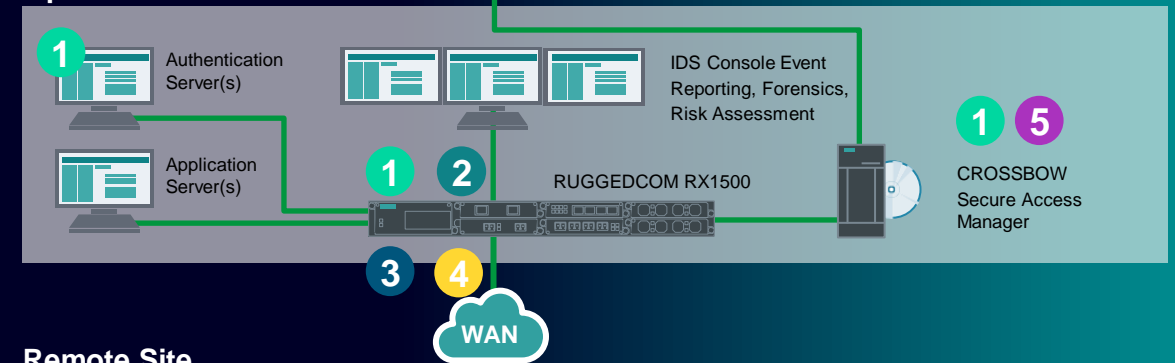
Solution	Description
1 Intrusion Detection System (IDS)*	<ul style="list-style-type: none"> Statistical & behavioral algorithms Non-intrusive, non-signature based
2 Deep Pack Inspection (DPI)*	<ul style="list-style-type: none"> DPI for protocol specific commands (e.g. S7, 61850, Modbus, ...)
3 Intrusion Prevention System (IPS)*	<ul style="list-style-type: none"> Monitors traffic Drops malicious packets Blocks traffic from the source address Resets connection
4 Next Generation Firewall (NGFW)*	<ul style="list-style-type: none"> Application level detection & protection (e.g. malware monitoring) Integrated IDS/DPI functionalities Scalable management for multiple security services and zones
5 Secure Access Control	<ul style="list-style-type: none"> Remote IED access, logging, and data privacy Secure connection to field devices without going to the field Strong two factor authentication through RSA SecurID, Active Directory and RADIUS

Addressing cybersecurity solutions through all OSI layers

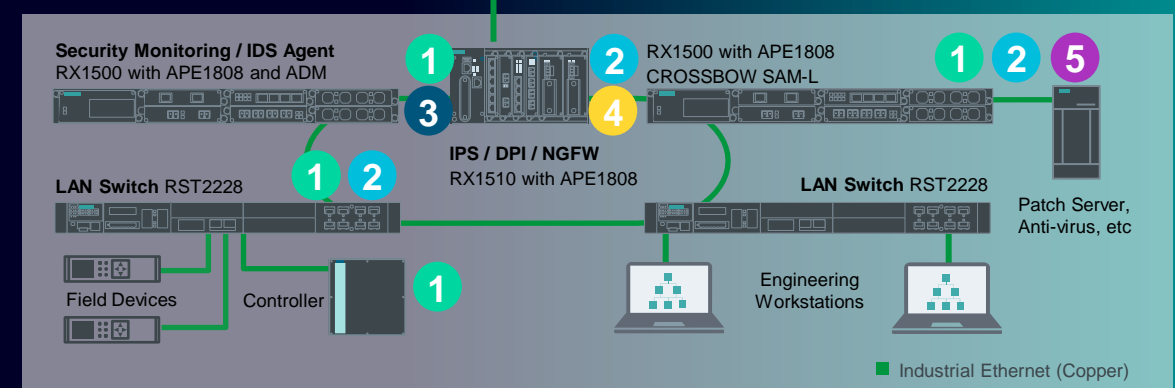
Corporate Network



Operations Center



Remote Site



*Bundled solutions on RUGGEDCOM Multi Services Platform with certified partner applications



Overview

Benefits

Solutions

Products

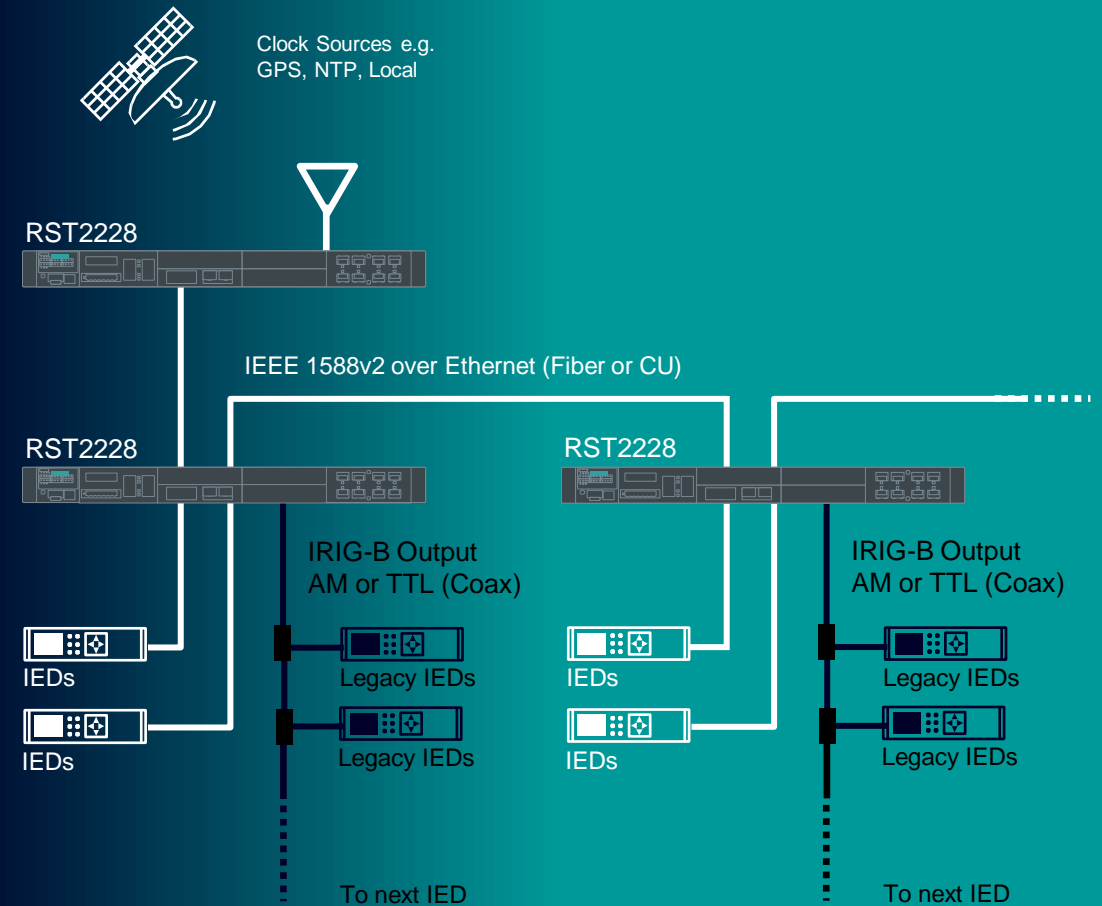


Precision Time Sync

Solutions to increase efficiency and uptime

Precision timing solutions improve an electric utility's monitoring and troubleshooting capability while also reducing capital expenses by converging timing and data networks.

- IEEE 1588 v2 precision timing protocol over Ethernet
- Synchronize substation IEDs to sub microsecond accuracy
- Accurate time stamping of system events and data

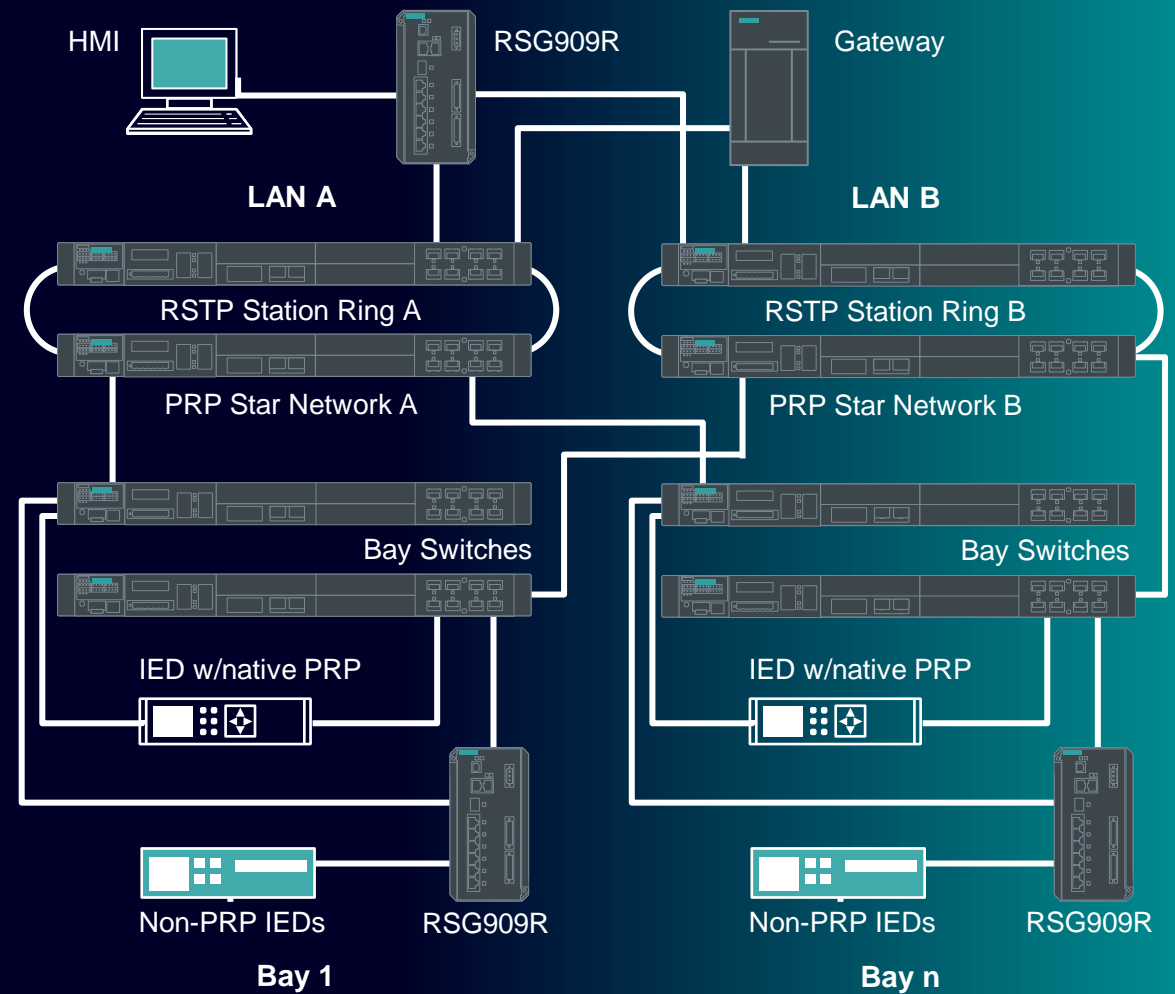


Redundant Network Architecture (RNA)

HSR/PRP for IEC 61850 for mission critical substation networks

Very high plant availability as a result of parallel data transfer via separate network structures with no frame delays during reconfiguration of one of the two network structures.

- Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy Protocol (HSR)
- Guaranteed Zero-Packet-Loss™ for any single point of failure
- Taking zero packet loss capabilities of a switch and deploying it across a bumpless network infrastructure

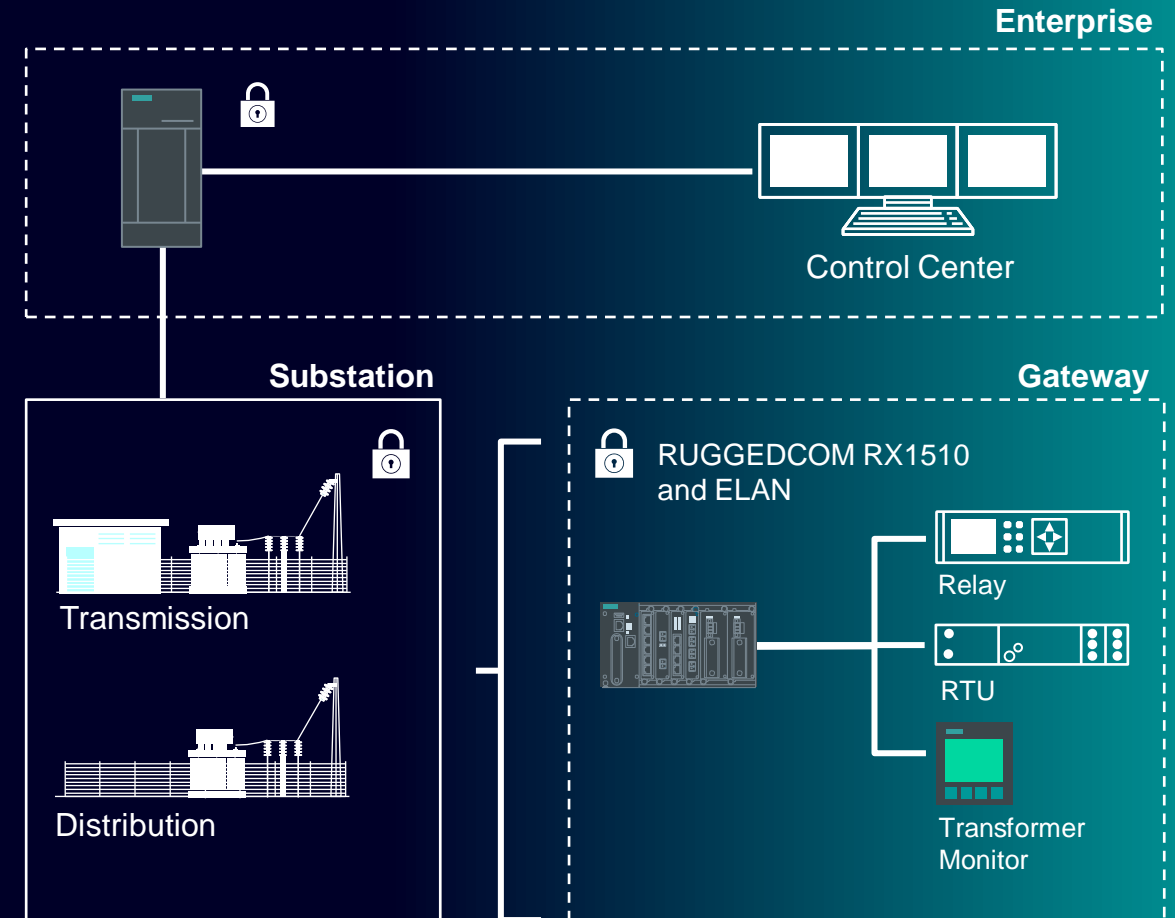


Network Management

Highest transparency for industrial networks and all connected devices

Improves operational efficiency, speeds up system provisioning, and preserves data validity, allowing focus on the key events in the network.

- Automated IED file management
- Protocol conversion
- Data concentration
- Integrated into RUGGEDCOM



RUGGEDCOM Digital Substation Products

- Precise time synchronization according to IEEE 1588.
- Flawless, maintenance-free operation in extreme conditions and temperatures.
- Hardware flexibility for various substation topologies.
- Cost savings through reduced civil engineering and labor, simplified installation and testing.
- Interoperability with support of both Ethernet and IEC 61850-3 standards.

[RX1500 Series](#)[APE 1808](#)[RST2228 Series](#)[RSG900 Series](#)

A cost effective, modular utility grade Layer 2/3 switch and router with selectable WAN, serial and Ethernet options.

Learn more about the RX1500 Series



A utility-grade computing platform that plugs directly into RUGGEDCOM RX1500 family and runs third party software applications.

Learn more about APE 1808



Multi-service platform for critical applications

Ethernet layer 2/3 rack switch RUGGEDCOM RX1500

The RX1500 series is a cost efficient utility grade Layer 2 and Layer 3 switch and router. The RX1500's modular and field replaceable platform allows customers to select amongst WAN, serial and Ethernet options.

Technical data

Gigabit LC, M12 (A, X-coded), RJ45, SFP

Fast Ethernet LC, RJ45, M12 (D, A, X-coded), SFP

APE RJ45, USB, DVI

10 FL ST – up to 2 km

T1/E1 T1 = RJ48 (channelized), E1 = RJ48, BNC

Serial RJ45 (RS232, RS422, RS485)

Cellular SMA (antennas), 2FF (mini-SIM), GSM, EDGE, HSPA, EVDO (network)



Edge Processing with
Software Ecosystem



Key benefits at a glance

- Rugged and modular, hot-swappable
- Layer 2 and Layer 3 switch and router
- Optional redundant power supply



Overview

Benefits

Solutions

Products



Edge application processing engine

RUGGEDCOM APE 1808



CPU	Intel x7-E3950 – 4 cores (x86_64)
CPU speed	1.6Ghz and higher
RAM	8GB DDR3 with ECC
Storage	64 GB pseudo-SLC
Front Network Ports	1x 10/100/1000mbps RJ45
Backplane Network Ports	1x 1000mbps
Graphics	Intel HD 500 (DisplayPort)
USB Ports	2x USB 3.0
MicroSD Reader	1x micro-SDHC
Audio	Intel HD Audio through DisplayPort
OS Support	Debian Linux and Windows 10 IoT Ent.

A utility-grade computing platform that plugs directly into RUGGEDCOM RX15xx family and runs third party software applications like an industrial PC*

Fresh take on the APE with enhanced features to support the newest industry trends

*Requires ROX 2.13.0 in RX15xx to identify APE 1808



Overview

Benefits

Solutions

Products



Power-over-Ethernet

Failsafe relay output

Rugged steel enclosure

Service panel with
USB-Console interface
and CLP slot

Redundant power supply:

- 12, 24 or 48 VDC
- HI Voltage VAC/VDC

4 uplink supporting
1/10 Gbit/s

6 (4-port) field modular,
front loading modules,
Fast Ethernet or Gigabit
(LC, RJ45, SFP, POE)

RST2228 Series

Learn more [➤](#)

The RUGGEDCOM RST2228 and RST2228P are 19" rack switches, with high density ports with 10 Gbit/s uplinks and optional Power-over-Ethernet to effectively handle the ever growing amount of data in a Digital Substation network.



Overview

Benefits

Solutions

Products



High bandwidth for high data throughput

Ethernet rack switch RUGGEDCOM RST2228

Electric power utilities face a growing need for flexible, future-proof and highly reliable communications providing higher bandwidth to manage ever increasing amounts of data from mission-critical applications, particularly at the substation level. In other words, the RUGGEDCOM RST2228 is a perfect fit.



Key benefits at a glance

- Increased bandwidth for reliably handling growing amounts of data
- High port density to connect more devices, thereby minimizing capital expenses
- Supports simple, cost-effective migration from copper to fiber-optic networks
- Reduced setup time in the field and fast, easy module exchange, if necessary



Technical data

19" Layer 2 Ethernet rack switch

4 x 1/10 GBit/s uplinks

24 x 10/100/1000 Mbit/s field-modular interfaces + PoE

4-port field-modular with RJ45, FastConnect and SFP interfaces

IEEE 1588 transparent clock support

RUGGEDCOM CLP support



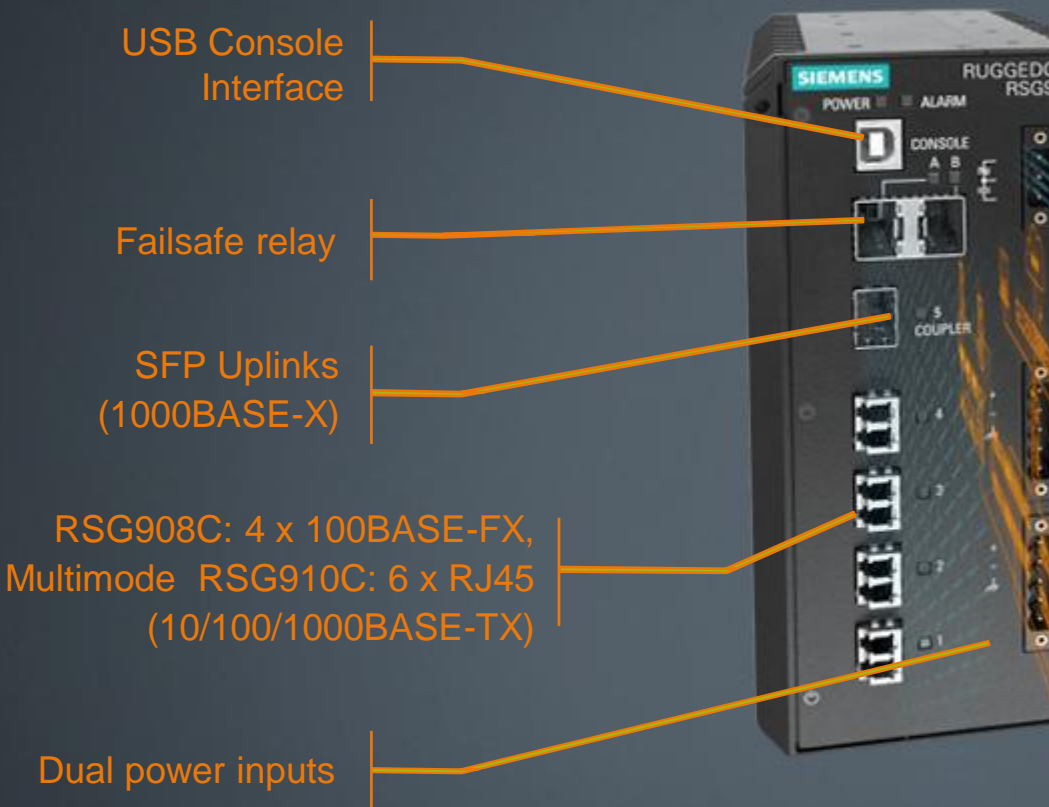
Overview

Benefits

Solutions

Products





USB Console Interface

Failsafe relay

SFP Uplinks (1000BASE-X)

RSG908C: 4 x 100BASE-FX, Multimode
RSG910C: 6 x RJ45 (10/100/1000BASE-TX)

Dual power inputs

RSG907R, RSG909R

[Learn more](#) >

Four award-winning full Gigabit rugged compact switches offer IEEE1588 Precision Time Synchronization, HSR and PRP functionality to mitigate the risk of communication disruptions and downtime and are ideal for Digital Substation networks that require high bandwidths and accommodate future expansions.



Overview

Benefits

Solutions

Products



Redundant communication in a compact design

Compact Ethernet switches RUGGEDCOM RSG909R and RUGGEDCOM RSG907R

Given the size and complexity of today's network architectures, switches that support redundancy protocols such as PRP and HSR have become indispensable for mitigating the risk of communication disruptions, downtimes and, consequently, revenue loss.

Key benefits at a glance

- Support of seamless redundancy protocols such as HSR and PRP to ensure network availability
- Reduction of maintenance costs by combining precision timing and network communications data on one network
- Providing safe, reliable operations to minimize the risk of data and revenue loss



RUGGEDCOM RSG907R

- 4 x 100 Mbit/s LC multimode fiber ports
- 3 x Gigabit SFP ports to support redundancy functions

RUGGEDCOM RSG909R

- 6 x 10/100/1000 Mbit/s RJ45 ports
- 3 x Gigabit SFP ports to support redundancy functions



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