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- Overview of Substation Automation
- Case Studies from Around the World
- Product Selection Guide

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Overview of Substation Automation

Case Studies from Around the World

Product Guide

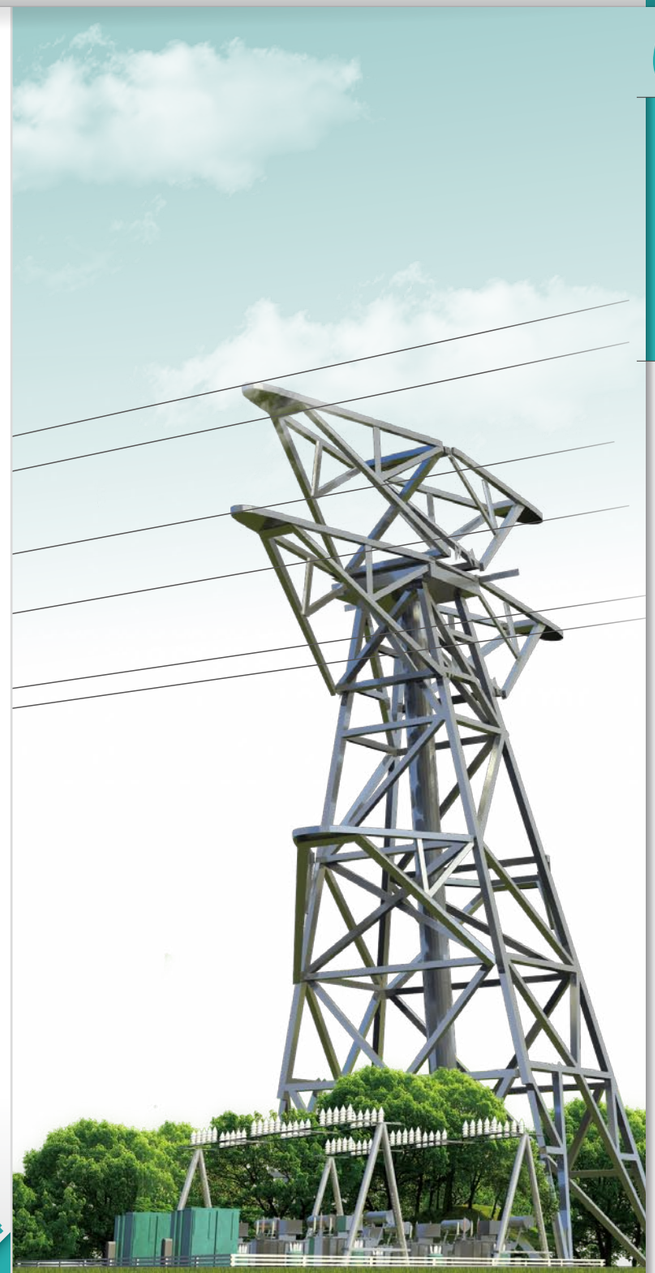
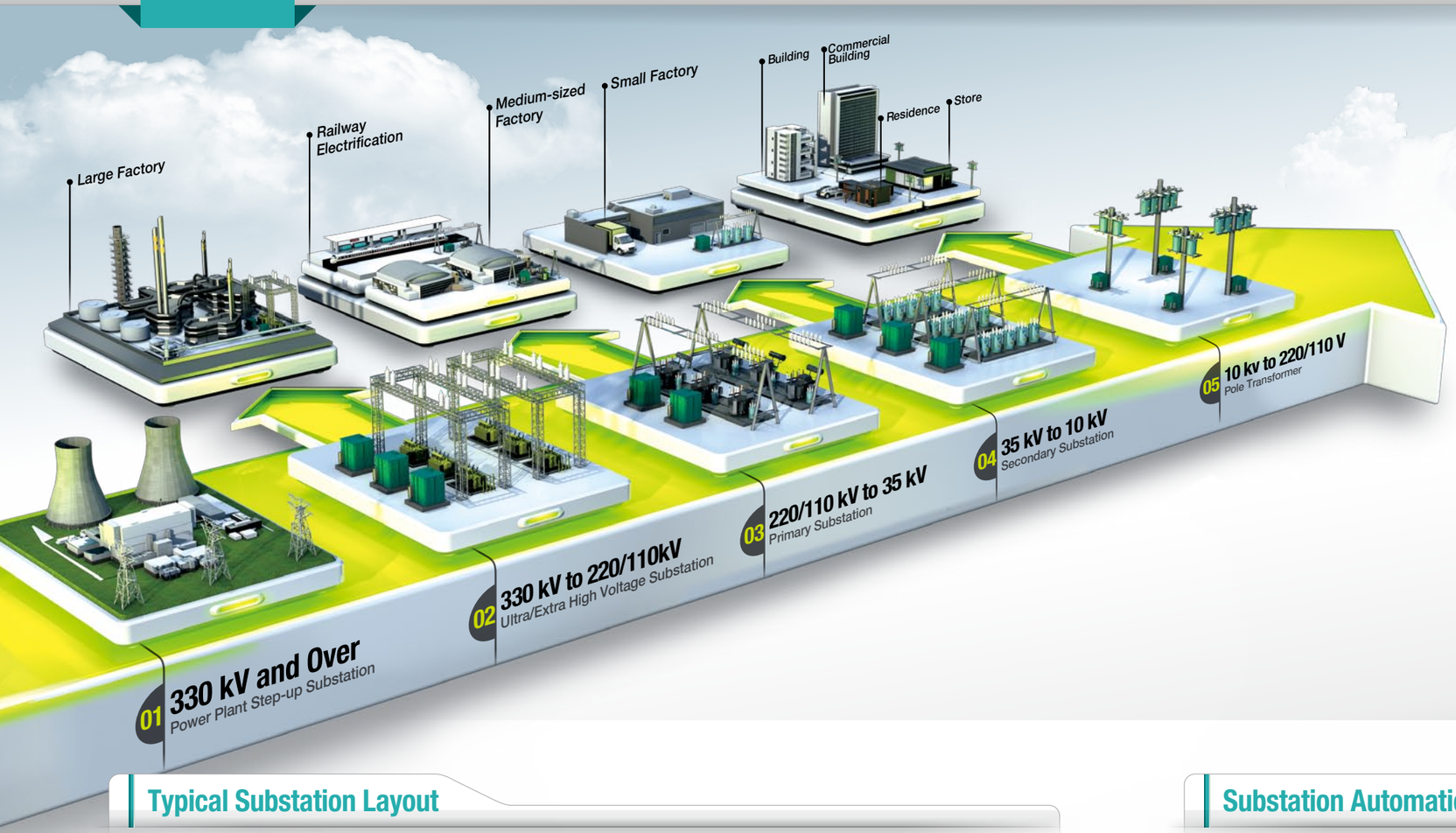


Table of Contents



Overview of Substation Automation

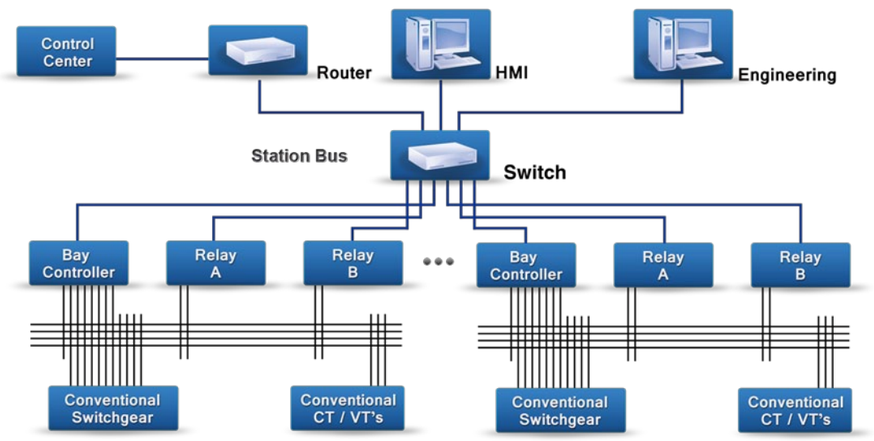
Power System Flow

Yes, electrical substations are already a critical part of the electrical distribution grid. Yet that role is destined to become even more significant in the coming years, as the green revolution pushes “smart grid” technology to move substations beyond their current role of metering and switching to include net metering and grid-tie systems, effectively expanding the substation from a "distributor" to a "generator", or at least to an "electrical aggregator".

In the past, electrical power suppliers have pushed electricity from high voltage generating plants to consumers who typically require much lower voltages. Substations have handled the energy transformations that are required to manage this delivery, whether it is for transmitting power to residential transformers or to industrial field sites like factories, commercial buildings, or railways.

Typical Substation Layout

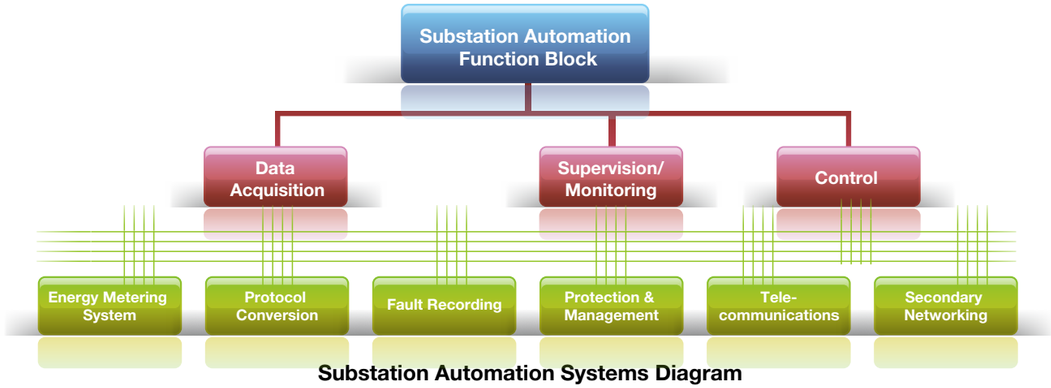
The integration of digital communications technology with intelligent electrical devices and automated metering began some years ago. Today, system architectures similar to what is shown below are commonly adapted into automated IEC 61850 substation systems.



Traditional System Architecture

Substation Automation System Functionality

“Substation automation” is a very large technological arena, encompassing data acquisition, system monitoring, and centrally managed control of transformers, step-down and step-up substations, generators, distribution points, and bulk or industrial facilities. Solutions range from single function units to fully integrated, comprehensive, high-performance automation systems.



Substation Automation Systems Diagram

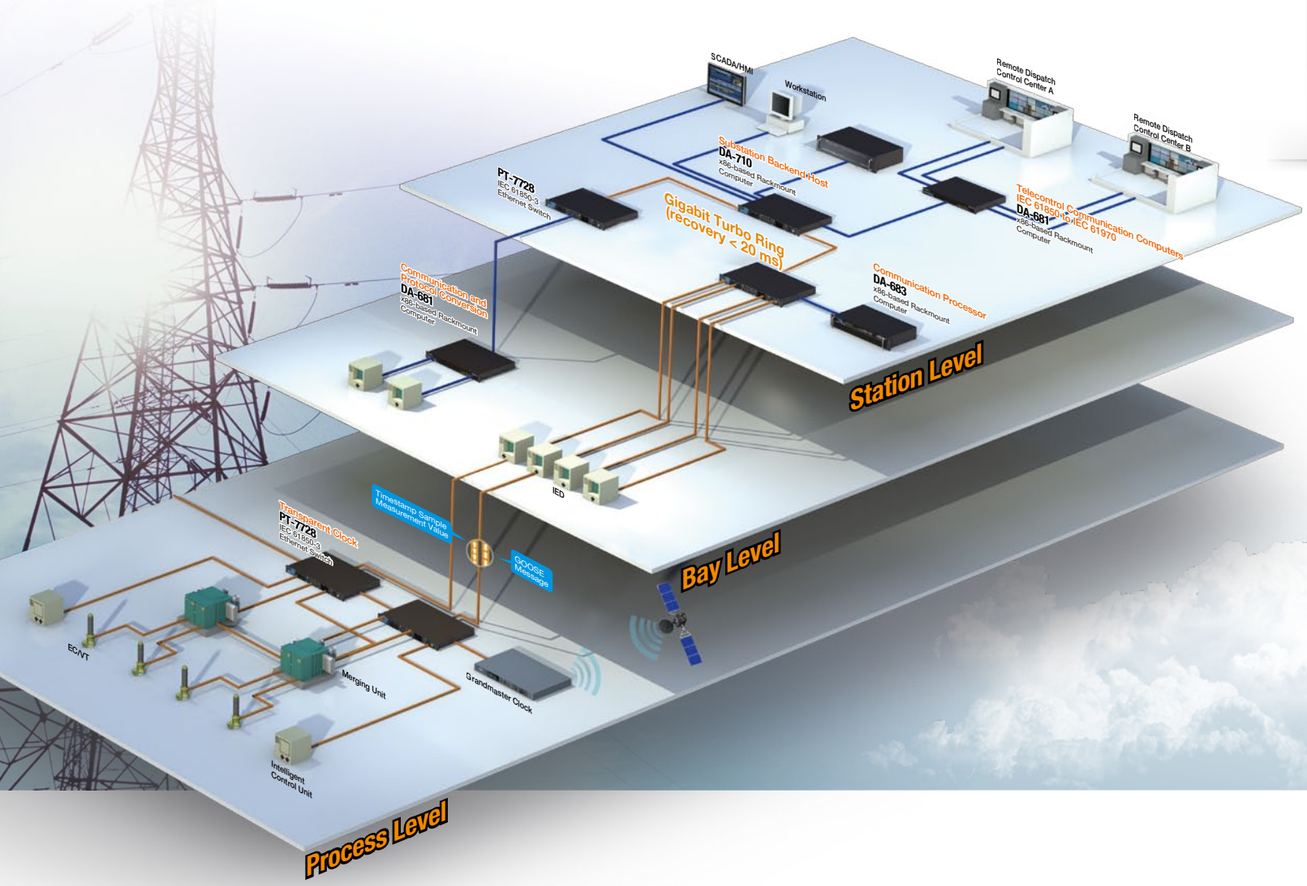
Power automation processes rely on data acquisition, but supervision and delivery controls must manage that data seamlessly, preferably without human intervention. Fully automated management is the goal, with operator commands reserved only for the most questionable and immediate alerts.

IEC 61850-3 and IEEE 1588 Substation Automation

Substation automation integrates existing substation devices into a new networked infrastructure, linking primary and secondary devices for data acquisition, device control, and event recording into an automated network requiring little-to-no human interaction. IEC 61850-3 and IEEE 1588v2 compliant substations are founded on networks divided into three logical layers called the station level, bay level and process level.

- The station level administers macro-tasks like full substation system control, fault analysis, event logging, system diagnostics, and alarms.
- The bay level administers subsystem controls, voltage/current protections along the transformer, bus/bar monitoring, measurement and metering, breaker alerts, event/fault recording, and lower-level alarms.
- The process level's main task is communication between protection units/meters and the forwarding of sampled values and binary status signals from IEDs.

Moxa provides a suite of networking and computing solutions for constructing smart substations. The figure below illustrates a smart substation that implements IEC 61850 for common communication models and IEEE 1588 for precise time synchronization among smart devices.



Over 300 Successful Substation Deployments

Many Moxa products are specifically designed for use in substation automation systems. Our solutions include technologies so advanced they are fueling the smart grid revolution, meeting both IEEE 1613 and IEC 61850-3 certifications for substations, while also supporting the IEEE 1588v2 standard (PTPv2) for precision time synchronization. These features are key to Moxa efficiency, and set the stage for servicing large-scale power networks at the next level of reliability and efficiency.

Create rock-solid and future-proof substation networks by partnering with Moxa. With 25 years of expertise in substation networking, we have delivered digital solutions to over 300 substation networking and computing markets, all around the world.

Trusted Partner

300+ Satisfied Substation Customers

- China State Grid
- China Southern Power
- Korea Southern Power
- TaiPower
- ABB
- Alstom Grid
- Schneider
- Siemens

Utility-grade Design

- IEC 61850/IEEE 1613 compliance (KEMA tested)
- Zero-packet-loss Ethernet switches -40 to 85°C operating temp. (no fans)
- 20 ms network redundancy
- Cyber security

Future-proof Solutions

The Latest Technology

- IEEE 1588v2
- Turbo Ring™ & Turbo Chain™
- World's first IEC 61850 compliant industrial computer

In the following 6 sections of this reference book we share success stories from all over the world, and show you how Moxa overcomes critical automation issues in the electrical power industry. Then in the final section we take you through the products Moxa recommends for building a smarter substation, and show you how useful you will find these fruits of our achievement.

Substation Technical Guidebook

This guidebook contains the following information:

- A summary of current substation environments, and how smart substations make a substation smarter.
- An overview of the IEC 61850 and IEEE 1588v2 standards for smart substations.
- Moxa's breakthrough solutions for the IEC 61850-3 and IEEE 1588v2 standards, which apply to network redundancy, secondary system networking, and embedded computing systems.
- Global case studies categorized by the voltage used.
- Details of what Moxa has to offer:
  - ❶ how we exceed substation standards
  - ❷ our value-added software and service
  - ❸ our comprehensive solutions.

At a Glance

Xijing City Power

Launched in 2011

Region:
Xijing City, Wuxi County, Jiangsu Province, China

Substation Voltage: 220 kV/110 kV

Type of Substation:
As a featured demonstration of the Chinese National Power Network's new 220 kV/100 kV smart substations, the Xijing substation's sensor network is entirely fiber optic, with current sensors comprising digitized measurement, simulation, and benchmarking systems. This is the first substation in the world to combine both GOOSE and sampled measurement values (SMVs) with the Precision Time Protocol, version 2 (IEEE 1588v2 standard).

Distributor: SAC

Jiangsu | China

Precision Time Protocol (IEEE 1588v2) Enhancements in a 220 kV Substation

Moxa's IEC 61850-3-compliant PowerTrans industrial Ethernet switches feature PTPv2 (IEEE 1588v2), delivering synchronized sampled measurement values (SMV) across the process level with nanosecond precision. With these latest advancements in timing, PowerTrans switches have broadly improved efficiency in a major Chinese power utility.

Project Introduction

China's new generation of smart substations rely on synchronized GPS-based time stamping, high data-sampling rates, and keen, nanosecond accuracy for increased efficiency and reliability. For a 220 kV substation in Xijing, a city in Jiangsu Province, China's state utility provider used IEEE 1588v2 (PTPv2) technology to synchronize its processes to nanosecond granularity, making monitoring, control, and protection applications more efficient. Thanks to the use of PTPv2 in these new smart substations, China's electrical grid now utilizes highly accurate, finely-grained sampled measurement values (SMVs) of voltage and current, empowering system operators with valuable data that improves their ability to maintain and analyze the process bus environment.

Jiangsu province's rapid economic growth over the past few decades has made it one of China's most energy-hungry provinces; consequently, of all the provinces in China it is also the most advanced in smart grid development. By deploying IEEE 1588v2 technology now, Jiangsu is putting its network well ahead of current substation technology.

Application Requirements

Protection Trips

Substation protections will trip when abnormal values are returned at any level. To obtain more accurate SMVs at the critical process level, this smart substation uses IEEE 1588v2 technology to achieve extremely precise synchronization, giving intelligent overload relays (IEDs) more accuracy for closer analysis and evaluation of switching priorities.

System Requirements

- Synchronization of SMV streams to nanosecond accuracy
- Dual layout for relay protection units, with full redundancy of related process levels
- Rugged IEC 61850-3-compliant Ethernet switches that withstand harsh substation environments
- Transparent Clock (TC) mode for increased synchronization accuracy
- Zero-packet-loss Ethernet switches for mission-critical GOOSE transmissions
- The SMV network, GOOSE network (both at the process level), and the MMS network (at the station level) must be completely independent
- Up to 4 switched Ethernet links between any two IEDs

Moxa's Solution

Moxa IEC 61850-3 Ethernet Switches

Process Level: The PT-7728-PTP Ethernet switches connect secondary equipment like merging units and IEDs (network analyzers, protection measurement units, and fault recorders) to the process bus. The PT-7728-PTP Ethernet switches receive SMVs from the merging units, and upon receiving abnormal SMVs will transmit GOOSE messages to the IEDs to protect switchgear by adjusting circuit breaker intervals. In addition, the PT-7728-PTP Ethernet switches work as a transparent clock, forwarding recalibrated PTP signals from the master clock.

Station Level: At the station level, PT-7728-PTP Ethernet switches connect the Power SCADA system, telecommunication units, the network communication recording system, and the fault recording substation.

System Description

In the Xijing 220 kV substation, electronic current/voltage transformer (CT/VT) merging units convert analog signals into the IEC 61850-9-2 digital format. To deliver highly accurate synchronization of sampled measurement values (SMVs) across the 110 kV process bus, Moxa's IEC 61850-3-compliant PT-7728-PTP Ethernet switches were installed in a dual-tree topology, creating a redundant fiber network backbone along which electronic CT/VT merging units were installed in pairs, substantially increasing network reliability.

On the process level, Moxa PT-7728-PTP Ethernet switches are designed with IEEE 1588v2 transparent clock functionality to synchronize SMV streams to nanosecond accuracy; this eliminates the extra cabling requirements needed for 1PPS or IRIG-B propagation of timing signals. For high-priority information, these rugged Ethernet switches further provide zero-packet-loss guarantees for GOOSE messaging.

On the station level, the PT-7728-PTP Ethernet switches connect the Power SCADA system to the telecommunication units that control the switchgear.

VLAN Setting

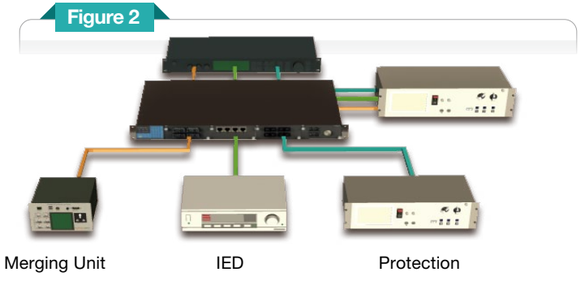
Moxa PT-7728-PTP Ethernet switches come with VLAN setting functionality that provides an easy and convenient management environment for system maintenance and administration. A single switch can separate networks into three VLANs, each with its respective IEDs, meters, and controllers. See Figure 1 below.

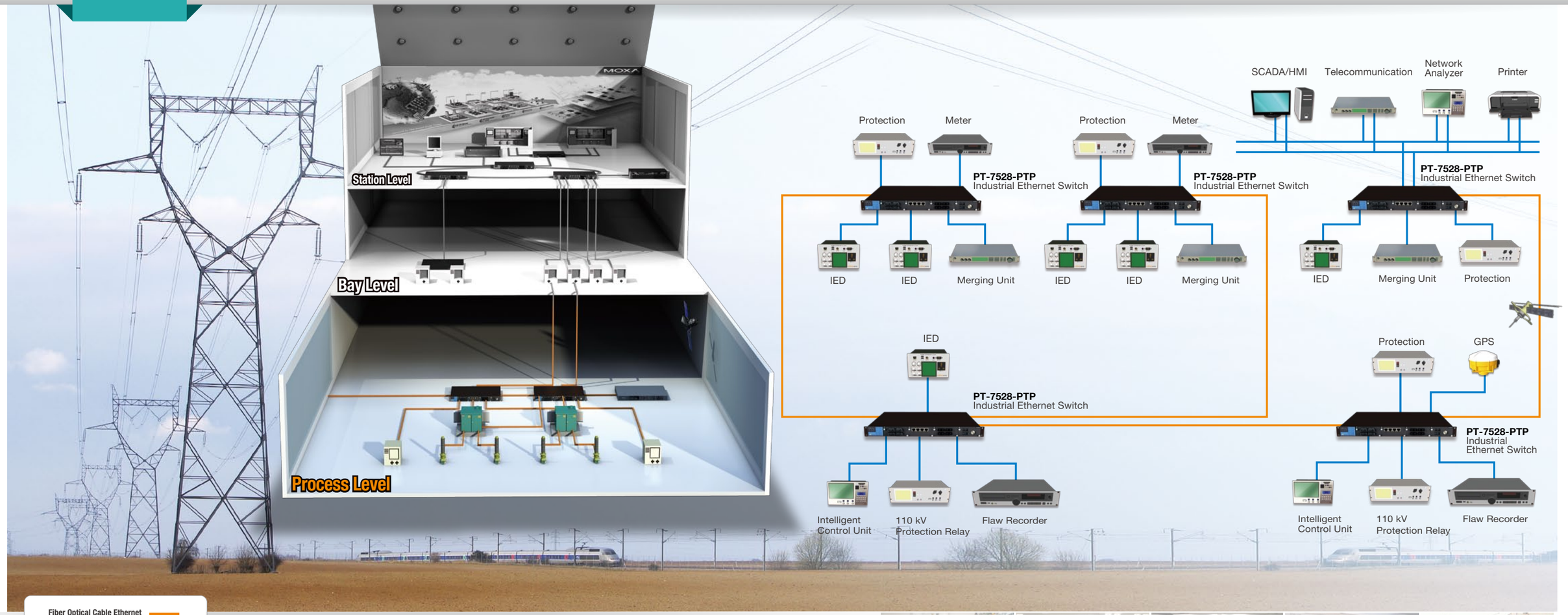
Multi-Port Mirroring

The PT-7728-PTP's Multi-port Mirroring allows users to record every single packet that passes through the switch. In this way, the PT-7728-PTP switch provides improved network security and system monitoring at all times, whether before, during, or after an alarm is triggered. See Figure 2 below.

Figure 1

Figure 2





Moxa's Value and Differentiation

- IEC 61850-3 and IEEE 1613 certification
- Turbo Ring / Turbo Chain network redundancy achieves 20 ms or faster recovery times across networks of up to 250 switches
- Industrial-grade, 19-inch rackmount design operates in temperatures from -40 to 85°C
- Redundant power inputs at 24/48 VDC or 110/220 VDC/VAC
- Flexible, modular configuration with up to 28 fiber optic ports (24+4G ports) for long-haul transmissions and scalable gigabit bandwidth
- Layer 3 Ethernet switches supporting IP routing protocols for complex automation

Products

- IEEE 1588v2 engineered at the hardware level, for precise synchronization of networks
- Electrically isolated redundant power inputs with universal 24/48 VDC or 110/220 VDC/VAC power supply range
- Zero packet loss under harsh EMI conditions (KEMA tested)
- Fanless design with operating temperatures from -40 to 85°C
- PT-7728-PTPs on the process bus connect and receive SMVs, upload them to protective control IEDs at the Bay Level, and then transmit GOOSE messages to switchgear IEDs at the process level

IEC 61850-3
IEEE 1613

- The PT-7728-PTP works as a transparent clock (TC), calculating clock latency to increment correction fields used by the boundary clock (BC)
- **Multi-port Mirroring** duplicates all data across multiple ports, delivering a complete record to an independent computer for easy troubleshooting
- **VLAN/Multicast** data communication eases network management and improves security
- **Broadcast Storm Suppression** provides automatic filtering of unsafe packets

At a Glance

Taiwan Semiconductor

(Manufacturing Company, launched in 2011)

Region:
Hsinchu, Taiwan

Substation Voltage: 10 kV/35 kV

Type of Substation:
The manufacturing substation uses ABB's MicroSCADA for data acquisition and analysis, fault recording, protection parameter configuration, event alarms, and event lists.

System Integrator: ABB

Hsinchu | Taiwan

Moxa's DA-710 Computers: MicroSCADA Management in a Power Substation

Moxa's DA-710 computers come with a powerful Intel processor, well-engineered for industrial tasks like data computing, data acquisition, and graphics control. These computers also offer a selection of network interfaces that include serial, LAN, and digital input/output channels. In addition to all of this, the software platform facilitates various protocol conversions amongst a wide variety of current and legacy devices, like DNP 3.0, Modbus, serial, TCP/IP, LON, IEC 870-5-105, ANSI x3.28, and more. For remote locations, the DA-710 makes use of Moxa's NPort 5600 device servers and MGate 3480 Modbus gateways to connect with remote I/O devices that communicate via the Modbus protocol.

Application Requirements

Power SCADA Communication Server

This solution is implemented at the bay level, where the MicroSCADA requires a powerful computer to work as the communication server between station levels. The bay level computer must come with multiple communication interfaces to connect various devices that include IEDs, meters, and UPS units. These devices perform a variety of tasks, including data acquisition, data analysis, protocol conversion, fault recording, protection parameter configuration, event alarms, and event lists.

System Requirements

- High performance x86-based computers for front-end data acquisition and data analysis
- Redundant power cabling
- No hard drive: 32 GB CompactFlash card for RAM storage
- Fanless, rugged design
- Multiple communication interfaces: serial ports, Ethernet ports, PCI slots, and DI/DO channels
- Capable of multiple protocol conversions: DNP 3.0, Modbus, various serial protocols, TCP/IP, LON, IEC 870-5-105, ANSI x3.28, and more
- Reliable and powerful controller for data acquisition, data computing, and graphics control

Moxa's Solution

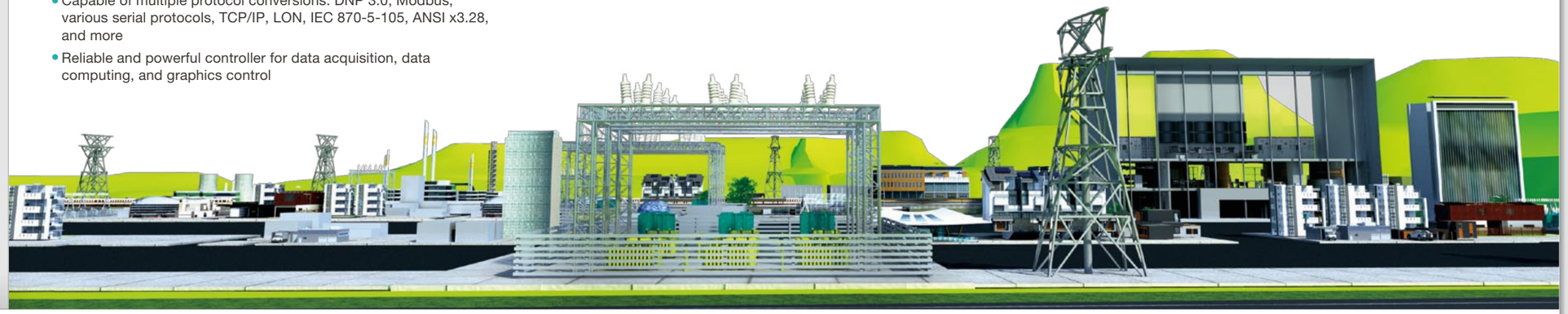
Moxa's DA-710 computers connect IEDs, meters, UPS units and other devices to the bay level. Working as front-end controllers for the MicroSCADA, the DA-710 computers collect data at the field site for analysis and transmission to the graphics control center at the station level, where the information is further processed. Station level data is used for various jobs, such as producing management reports, data recording, protection parameter configuration, event alarms, and event lists.

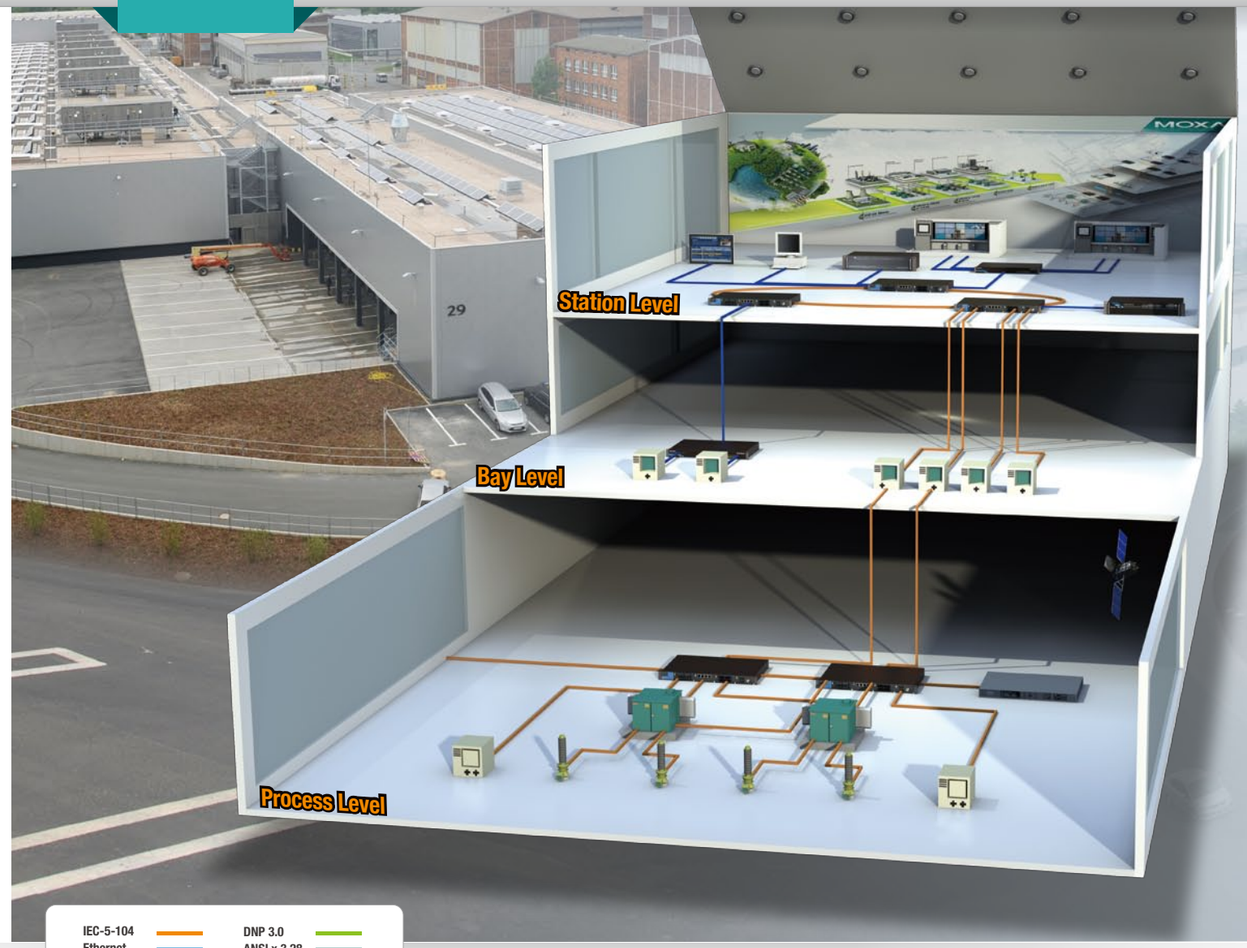
Because traditional serial protocols were not engineered to travel long distances, when using TCP/IP to connect remote Modbus devices to the DA-710, RTUs and their associated IEDs are first connected to an MGate 3480 Modbus gateway and/or an NPort 5600 device server before the network path to the DA-710 can be completed. This arrangement offers an optimal solution for Modbus devices that are located at distant field sites.

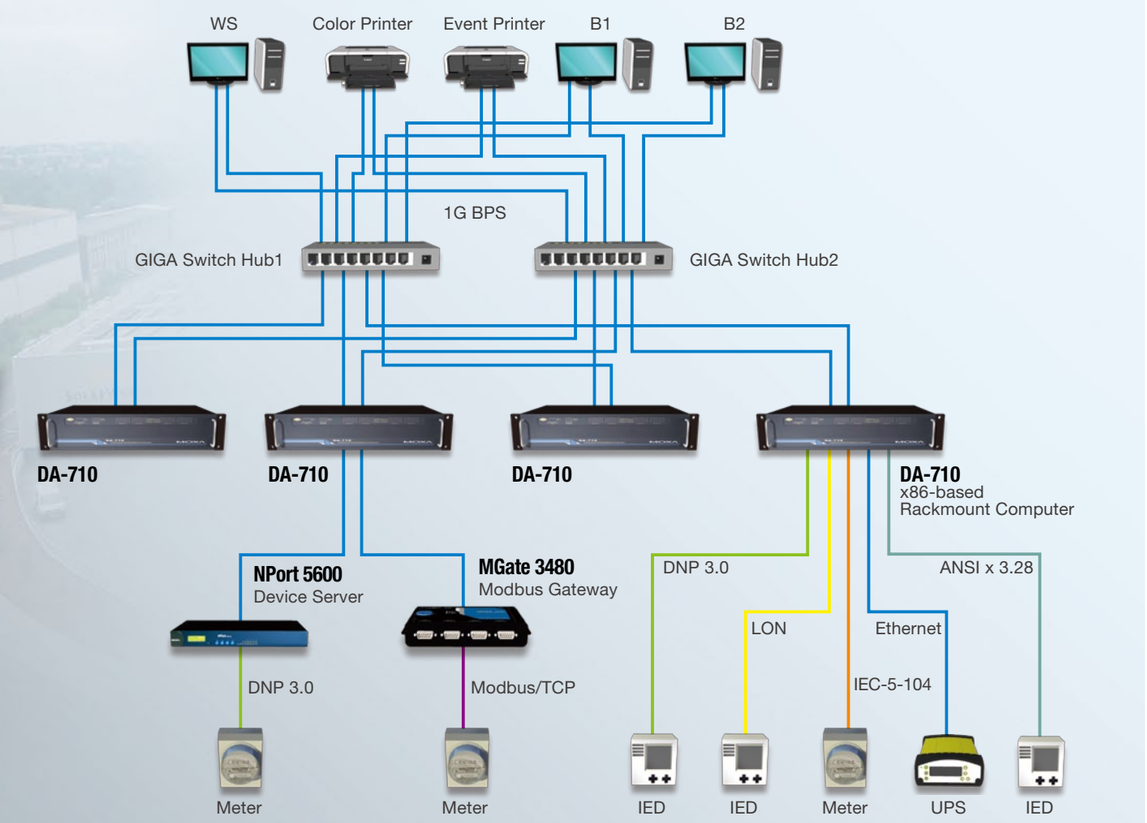
Locally, the DA-710 computers may directly connect various devices running incompatible protocols, fulfilling the DA-710's role as the main communications server. The ability to perform these protocol conversions is another key feature of the DA-710. Acceptable protocols include all the standard protocols (Modbus, TCP/IP, RS-232, RS-485) plus DNP 3.0, LON, and ANSI x3.28, among others.

System Description

A Taiwanese semiconductor company has its own private power substation, and needs high-performance front-end controllers with MicroSCADA support to manage data acquisition, data analysis, protocol conversion, and graphics control. The controllers must be extremely reliable and stable in order to reduce front-end workload. Each substation requires four to five computers to perform these tasks. The MicroSCADA controllers are located at the station level.







What Moxa's Solution Provides

- The guarantee of the leading name in China's substation automation market
- A comprehensive, fully integrated automation system
- Widely recognized knowledge and experience with substation systems
- The added convenience of direct sales, for faster time-to-market
- Value-added software libraries and APIs, with ready-to-hand consultant services

Products

- x86-based performance DA-710 computers that can rapidly perform fine-grained data acquisition and data analysis, reducing front-end workload
- Dual power inputs for reliable system operation
- 32 GB CompactFlash cards as the main storage medium, guaranteeing system reliability by avoiding the risks associated with hard drive failures
- Multiple interfaces for Ethernet, serial, and PCI
- Efficient communication across different protocols, including DNP 3.0, LON, TCP/IP, IEC 870-5-103, and ANSI x3.28
- NPort 5600 device servers connect remote devices and perform various protocol conversions
- MGate 3480 Modbus gateways translate Modbus protocols from serial RTU and ASCII protocols into TCP/IP
- Fanless, rugged design

DA-710
x86-based Rackmount Computer

MGate 3480
Modbus Gateway

NPort 5600
Device Server

At a Glance

Kemerovo Oblast | Russia

Berezovsky Electric Networks, LLC

Region:
Town of Berezovsky, Kemerovo Oblast, Russia

Substation Voltage: 110 kV

Substation Name:
Berezovskie Elektricheskiye Seti, LLC

Type of Substation:
Government utility distribution and transmission substations widely scattered within the harsh East Siberian taiga.

The use of Moxa equipment for automation of district electrical networks

Moxa's PT-7728 industrial Ethernet switches help monitor, control, and manage electrical substations in the mining town of Berezovsky, in the Kemerovo administrative region (Oblast) of Russia. These switches improve the reliability of the electrical network's automated dispatch control system, which has been designed to collect safety and security information about the power system.

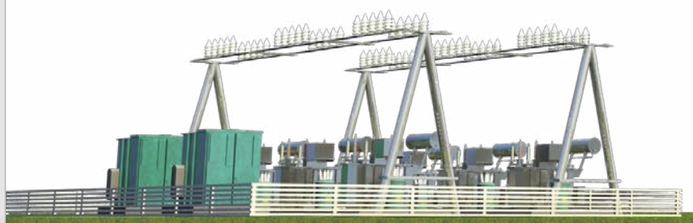
СИБИРСКАЯ ЭЛЕКТРОТЕХНИКА CJSC (Siberian Electrical Engineering CJSC, or SIBEL) was established in Novosibirsk in the 2004 breakup of the Russian headquarters of Kemont JSC (Ust-Kamenogorsk, Kazakhstan), a government-owned company with more than 50 years of experience producing medium and high voltage electrical equipment. At present, SIBEL represents a group of companies focused on the manufacture and delivery of complex electrical power solutions, from custom designs to "turnkey" objects like high/low voltage equipment, system protection, and automated control systems.

Project Introduction

The system was deployed at Berezovsky Electrical Network, LLC, in the town of Berezovsky, Kemerovo Oblast. The company is the town's power supplier, and one of the leading residential electrical providers in all of Russia. Berezovsky has a population of almost 50 thousand, and is divided into three districts that cover a total area of over 70 square kilometers. The town is situated in a forested area, 80% of which is in the taiga zone.

Berezovsky's municipal electrical facilities consist of 100 km of underground cable, 610 km of overhead lines, and 173 transformer substations with 10 high voltage points. In addition, the company administers almost two thousand street-lamps and about 40 kilometers of street lighting cables.

Because the town facilities are so spread out, the primary concern of system developers was how to manage control systems over such a large geographical distance. In addition, like everywhere in Siberia, the equipment needed to stay operable even in extreme temperatures that could range from -40 to 60°C. It was also necessary to pay close attention to electromagnetic compatibility (EMC) requirements.



Application Requirements

This substation system required industrial Ethernet switches to connect electricity meters, alarms, and other IEDs to the substation's switchgear automation system. In addition, industrial Ethernet switches and device servers were also needed on the site's front-end for the collection and transmission of data back to the control center, along with a device server for the time synchronization system's GPS receiver.

System Requirements

- PT-7728 switches: IEC 61850-3 compliant, managed multi-port switches with Gigabit Ethernet ports that operate in temperatures from -40 to 85°C
- EDS-316 and EDS-308: compact, industrial DIN rail Ethernet switches
- NPort IA5150I interface converters, for transferring data from RS-232/422/485 serial interfaces via Ethernet networks

System Description

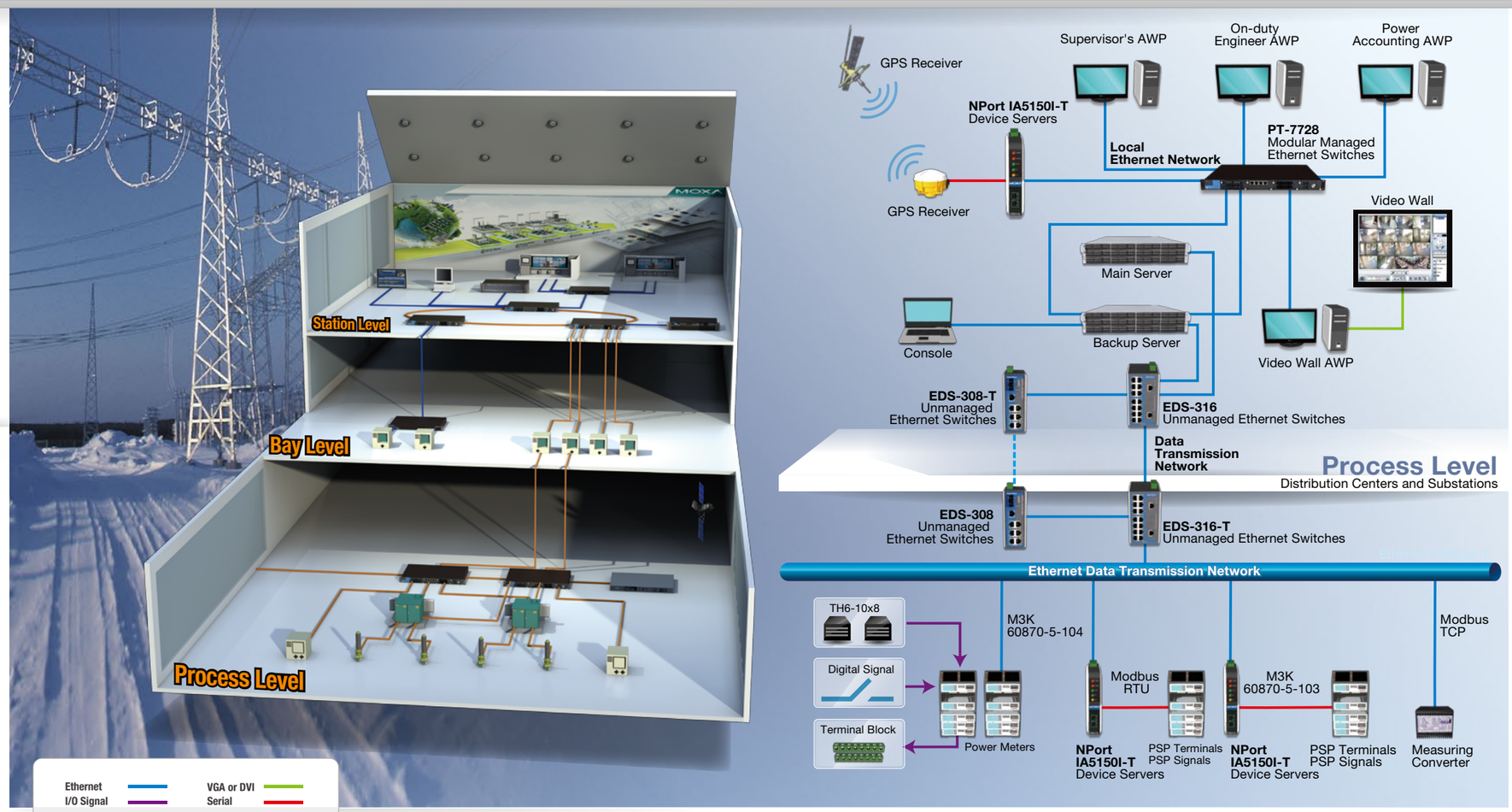
To improve electrical network reliability and oversight at the Berezovsky substation, an automated dispatch control system with monitoring, control, and management subsystems was deployed. The system is designed to collect power system protection (PSP) information, to monitor and control electrical networks, and to manage switchgear from the electrical network supervisor's workstation.

The monitoring system consists of KIPP-2M electricity meters with input and output modules for measuring electrical parameters and fixing and controlling switchgear positions; SATEC PM130P digital power meters; MiCOM P12x series PSP terminals; and other sensor devices (like alarms). The company's distribution points (DP) and transformer substations (TS) are located dozens of kilometers away from the supervisory control center; thus, the enterprise deployed an Ethernet network for speedy data collection and transmission, with optical fiber backbone links and twisted-pair cables connecting DSL modems. Moxa communication equipment connects the monitoring, control, and supervisory systems.

Information collection and processing is carried out on two servers, with one running in hot standby. The industrial servers are installed in a 19" cabinet with UPS, and run MS Windows 2003 Server. System visualization is provided by three workstations (called "AWPs") built on Veriton PCs running MS Windows 2007, each with an additional video card that connects to 30 cm displays. The telemetry database (and its processing software) in the supervisory center's SCADA system is a very basic software suite based on MS-DOS called the Operational Information Complex (OIC). The OIC collects information via Modbus and IEC 60870-5-xxx industrial protocols for basic information processing that is displayed on the supervisory workstation; from there, remote commands can be initiated. The entire control system is serviced by a single engineer.

This electrical substation's monitoring, control, and management system is extensible both in terms of macro-level information processing and power facilities, as well as at the micro-level of importing additional task data into MS Excel to customize connection schemes, track work crews, register switch forms, and perform technical accounting.

The system is easily adapted to monitor and manage electric networks and substations with different types of low-level hardware, whether microprocessor-based controllers (IEDs), microprocessor-based terminal protection, or electric power meters. At the same time there is no need to set a standard remote control station or RTU at the energy facility.



Moxa's Value and Differentiation

- Moxa equipment provides Ethernet access to devices from various manufacturers across multiple data transfer protocols, even in harsh climatic conditions
- Moxa switches allow the construction of LAN networks both at the level of objects of control (substations and DS), as well as at the level of district power networks
- Moxa NPort converters have two Ethernet ports, for convenient daisy-chaining
- Moxa equipment can be configured with bundled software over the Internet, via a simple web server
- Moxa devices were easily integrated with local security policies

System Description

PT-7728 modular managed Ethernet switches

- Electrically isolated redundant power inputs with universal 24/48 VDC or 110/220 VDC/VAC power supply range
- Zero packet loss, even under harsh EMI conditions (KEMA tested)
- Fanless design stays operable in temperatures from -40 to 85°C
- On the process bus, the PT-7728 switch connects and receive SMVs, uploads them to protective control IEDs at the bay level, and then transmits GOOSE messages to switchgear IEDs at the process level
- **Multi-port Mirroring** duplicates all data across multiple ports, delivering a complete record to an independent computer so troubleshooting and system analysis are made easy
- VLAN/Multicast data communication eases network management and improves security
- The PT-7728 switch provides **broadcast storm suppression** through network filters

EDS-308/316 unmanaged Ethernet switches

- Compact form with DIN rail mounts, for easy installation
- Tolerance of temperatures from -40 to 75°C ensures reliable operations in harsh environments
- Transparent transmission of tagged VLAN packets
- Broadcast storm protection for system security

NPort IA5150I-T device servers

- Responsible for serial-(RS-232/422/485)-to-Ethernet protocol conversions
- Compact form with DIN rail mounts, for easy installation
- Redundant DC power inputs for system reliability

At a Glance

Jinan Steel Works

Region: China

Company:
Jinan Stainless Steel Works

Substation Voltage:
35 kV/10 kV

Substation Type:
Enterprise Substation

Customer Needs:
Powerful, rugged industrial computers to serve as the core control and processing units for data acquisition and protocol conversion

Jinan | China

Substation Automation for a Chinese Steel Factory

Moxa's automation and networking hardware form an integral layer in the data acquisition and protocol conversion back-end of a steel foundry's local electrical substation control system.

Project Introduction

One of the largest stainless steel works in China decided to upgrade its electrical substation automation system with data processing and protocol conversion additions to its remote communication control units. Communication control computers would replace IPCs to form a distributed back-end system with a centralized front-end control center.

The power substation was divided into several subsystems, each serving independent stations of varying roles within the steelworks. Each subsystem utilized smart meters to optimize resources, centralize management, and enhance efficiency. In addition, all the remote devices are centrally monitored and managed by a customized master SCADA called the "CCMS3000 central management system," administered from the main offices' control center. Each 35KV/10KV substation communicates with the master SCADA via an optical-fiber Ethernet backbone. The purpose of the upgrade was to reduce costs and other overhead by further optimizing electrical supply management and maintenance, enhancing distribution quality and efficiency, and providing real-time discovery, analysis, recording, and response to problems in power delivery.

The central CCMS3000 management system is expected to reliably provide real-time monitoring of the distributed substation's operational status, giving direct access and reports on all substation devices. It should automatically perform data management tasks like load analysis, consumption metering, and load balancing, while also enhancing overall system or individual device efficiency.

Application Requirements

Communication Control Unit

- The industrial/bulk electrical substation at the Jinan steel works is a multi-site, distributed installation with several remote sites combined under a single master SCADA system.
- Each station within the substation utilizes intelligent metering to centralize the custom management system. The back-end addition must easily integrate with these existing resources and enhance overall efficiency.
- The master SCADA system is a custom software package named CCMS3000; this SCADA system links the main substation with each of its remote units over an optical fiber LAN. CCMS3000 centralizes and streamlines management and monitoring to optimize operation and maintenance costs and enhance the overall quality of delivery. Its ultimate goal is to discover, record, and handle event faults, preferably before they affect the power supply.

System Requirements

- Four remote stations will require communication control computers for core data collection and processing of I/O from meters, Ethernet-to-fiber converters, and other process peripherals
- High-performance rackmount computers form the basis of the local SCADA subsystem
- All devices must be compliant with IEC 61850 while supporting protocols that include Modbus, IEC-60870-5-104, DLT645, and TPC/IP

Moxa's Solution

01 The substation's various independent units have been connected by a network that is conceptually divided into three parts: the back-end monitoring level (i.e., bay level), management level (i.e., station level), and field device level (i.e., process level). Each of the steelworks' power units participates in each of the three levels via a communications control station that includes a Moxa DA-662-16-LX computer as the communications controller. These DA-662 computers:

- communicate downwards with meters and various intelligent devices via Modubs, DLT645, and other protocols;
- communicate upwards with the LAN and step-down station via IEC 104 (i.e., T104, or serial communication via TCP/IP); and
- are responsible for collecting and controlling all data from the hot-rolled and cold-rolled factories.

02 Each cold- and hot-rolling station has been equipped with communications control units built around a DA-662 controller, an NPort 5430 device server, an Ethernet-to-fiber converter, and other peripheral devices.

The NPort 5430 serial device servers:

- collect data from the cold/hot-rolling stands for communications;
- come with a small LCD monitor to display short messages and
- can connect up to 31 serial devices via an RS-485 interface.

System Description

Smelter 1

Main Station (Mill Stand A & B): A communication processing unit that includes a DA-662 computer for communications control, a switch, 2 optical converters, and other process peripherals.

Mill Stand C: A communication processing unit that includes an NPort 5430 serial device server, an optical converter, and other process peripherals.

Mill Stand D: A communication cabinet that includes a serial device server (NPort 5430), an optical converter, and other process peripherals.
The DA-662 communications controllers are responsible for the collection, back-end analysis, and communications control of all data originating from Smelter 1's mill stands (stations A, B, C, D, and E) or its cooling station.

Smelter 2

Main Station: A communication processing unit that includes a DA-662 computer as a communication controller and various process peripherals (IEDs). This DA-662 is responsible for collecting and controlling all IED data from Smelter 2's mill stands (stations G and K) and its cooling station.

Hot Rolling Station

Main Hot Rolling Station: A communication processing unit that includes a DA-662 computer as a communication controller, a switch, an optical converter, and other process peripherals (IEDs).

Cooling Station: A communication processing unit built around an NPort 5430 serial device server, an optical converter, and other process peripherals. This DA-662 is responsible for collecting and controlling all IED data from the hot-rolling station and its attached cooling station.

Cold Rolling Station

Main Cold Rolling Station:

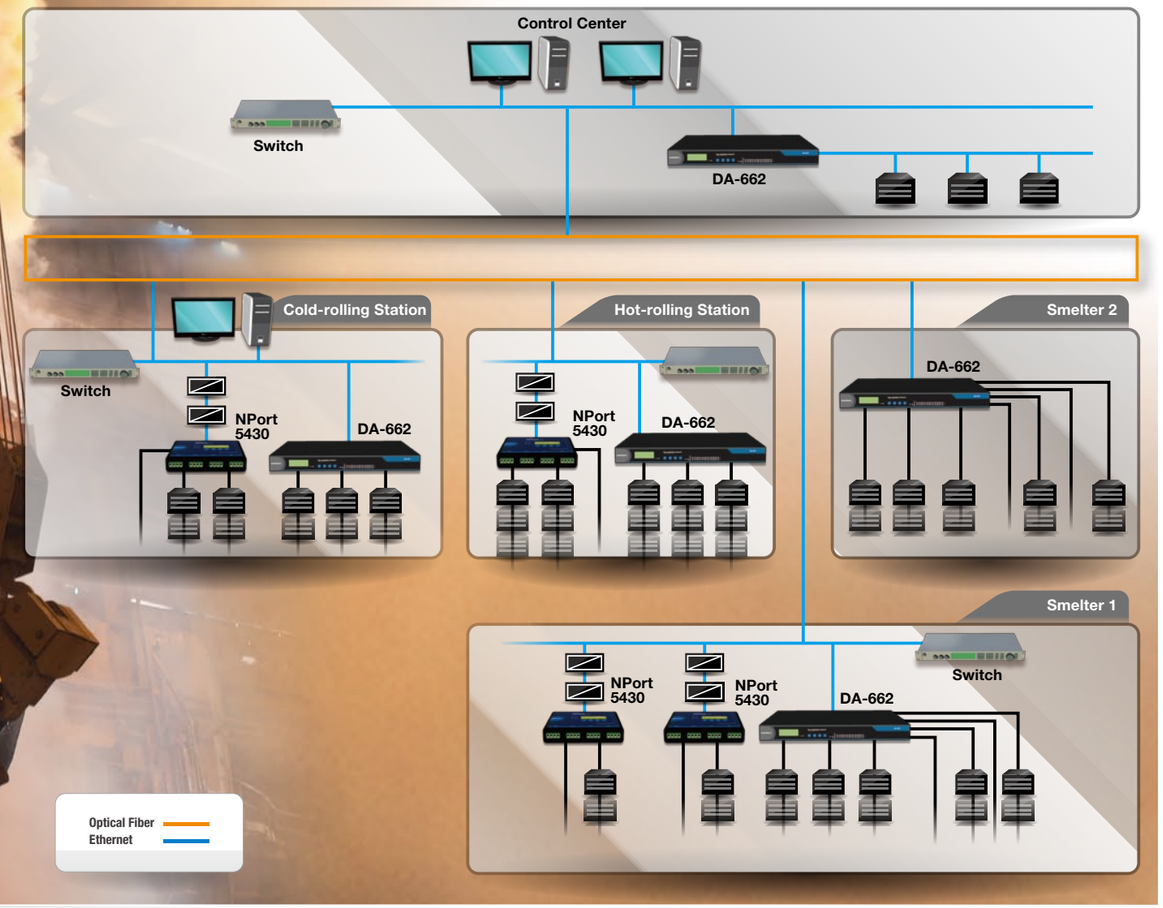
A communication processing unit that includes a DA-662 computer as a communication controller, a switch, an optical converter, and other process peripherals (IEDs).

Cooling Station:

A communication processing unit built around an NPort 5430 serial device server, an optical converter, and other process peripherals.

This DA-662 is responsible for collecting and controlling all IED data from the cold rolling station and its attached cooling station.

Communications between the DA-662 and the master SCADA system (CCMS3000) is via the TCP/IP IEC 104 protocol.



System Requirements

- A centralized and stable management platform for a distributed electrical substation
- Back-end data processing for remote devices
- Protocol conversion among Modbus, DLT645, and TCP/IP IEC 104
- Redundant network architecture for continuous system operation
- Easy integration with other communication systems
- Long MTBF to guarantee system reliability

Moxa's Value and Differentiation

- Fanless and cable-less, these computers feature a solid-state hard drive and low power consumption for a highly reliable solution suitable for substation environments
- A ready-to-run RISC-based FOSS platform gives users greater flexibility of deployment with unparalleled OS stability, guaranteeing easy integration with third-party devices
- Multiple Ethernet ports provide network redundancy for continuous operations
- Software protocol conversions facilitate communication between a variety of legacy devices and protocols
- Pre-installed real-time FOSS (Linux/GNU) operating system for high customizability, quicker system response times, and easy integration
- Fast and efficient customization services meet any customer requirement
- On-board remote device server for quick, cost-effective networking

DA-662-16-LX

RISC-based rackmount computer

- Intel XScale IXP-425 533 MHz processor
- 16 software-selectable RS-232/422/485 serial ports
- Quad 10/100 Mbps Ethernet for network redundancy
- 15 KV ESD surge protection for all serial signals
- PCMCIA 802.11b/g CardBus
- Wide range of power input voltages from 100 to 240 V AC/DC

NPort 5430

4-port RS-422/485 serial device servers

- LCD panel for easy IP address configuration
- 10/100M auto-sensing Ethernet

At a Glance

Nanyang | China

Nanyang City Power

Region: Nanyang City, Henan Province, China

Substation Voltage:
A 500kV/220kV/35kV step-down substation

Type of Substation:

The substation is divided into six transformer vaults, one of which serves as a main room: there are two 500kV vaults, two 220kV vaults, a smaller 35kV vault, and a main room where another 35kV transformer is housed alongside the control and communications equipment.

Within each room there is a single communications cabinet, except for the main room where there is one cabinet for the transformer and another that communicates wtih the main control room.

Distributor:
Zhongyuanhua Electricity

Nanyang Substation: Data Acquisition and Fault Recording

Nanyang City Power in China's Henan Province has put Moxa's DA-681 industrial computers to work as communications cabinets in a step-down stations' six transformer vaults. These cabinets coordinate communications from numerical protective relays and fault recorders, collating, storing, and transmitting data to the central control system while also serving in the substation control centers as the main data processing and HMI display units.

Application Requirements

Communications Cabinets and HMI Data Processing

The Henan substation required communication cabinets to monitor and consolidate its protection systems at the process level across five transformer vaults and in a sixth, where an additional DA-681 also serves as the substation's main communications relay with its control room. These communications cabinets connect numerical protective relays and fault recorders for data collection, local analysis and processing, storage, and transmission to the substation's remote control center. Thanks to these automated subsystems, everyday substation safety, management efficiency, and emergency response times are all improved, while upper-level decision making at the central grid control is more fully informed of grid faults, load spikes and surges, and overall grid performance. These improvements in automation efficiency provide substantial overall enhancements in the quality of local grid services.

The communication cabinets are responsible for collecting and storing the following information:

- Protective relay output: switchgear alerts, alarms, current signals
- Protective relay and fault recorder data
- Protective relay fault measurements of distances, phase currents, and phase voltages
- Fault recorder data and setting management

System Requirements

- Industrial-grade rackmount computers for collecting data from the edge units and transmitting it to the local remote dispatch and provincial power dispatch centers
- High-performance, open platform computers for stable operations to perform various tasks, such as data acquisition, data management, and data transmissions
- Multiple RS-232/485 serial ports, and multiple LAN ports to fulfill the demanding requirements for substation automation, voltage protection, and data recording

Moxa's Solution

Moxa DA-681 rackmount industrial computers as primary protection control units

- Moxa DA-681 rackmount industrial computers work as the central computers in communications cabinets serving a distributed substation protection system. These cabinets collate data from data acquisition units, numerical protective relays, and fault recorders via the Ethernet network in compliance with the IEC 60870-5-103 standard. Each cabinet collects data and transmits it to another DA-681 computer which serves as the main protection control communications unit.
- The protection control units collect all protection and fault data and transmit it to the upstream control center, performing tasks like HMI and display processing and data analysis locally.

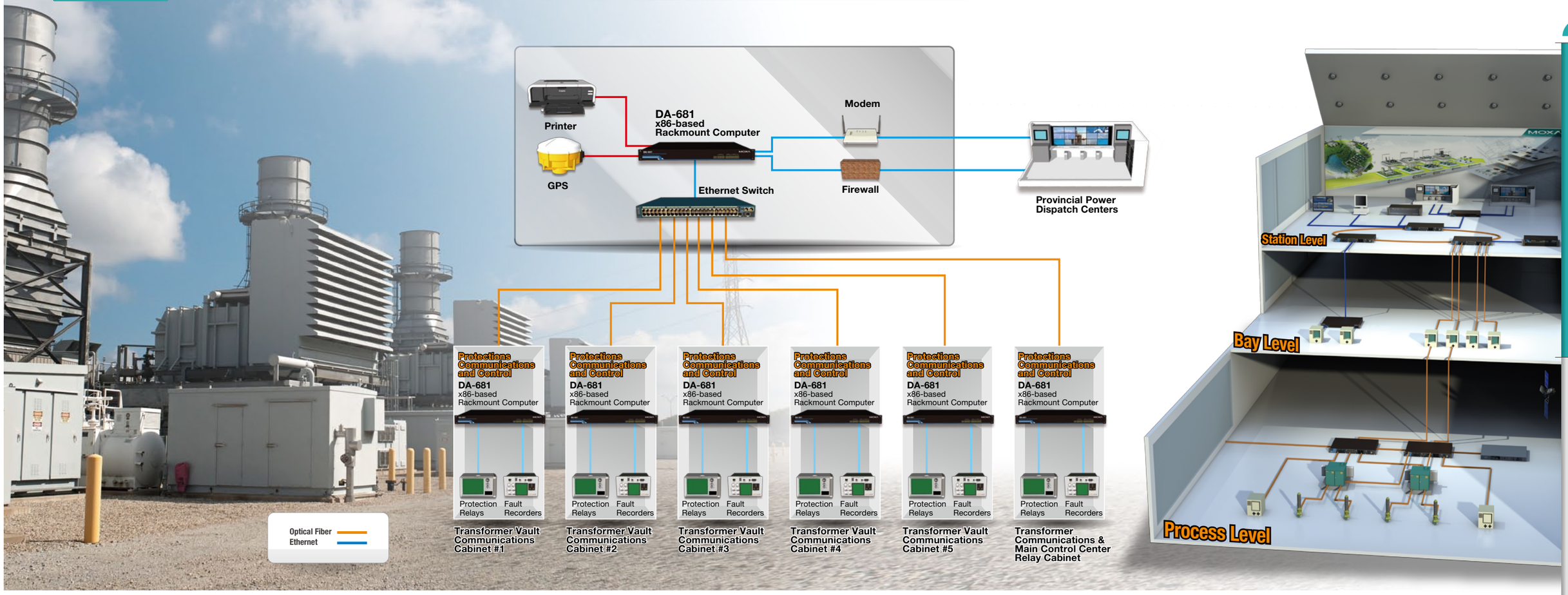
System Description

This application consists of a main control center/transformer vault that links 5 remote transformer vaults. These all require computers for the local protection system's communications cabinets, for which Moxa's DA-681 industrial computers were chosen.

In each transformer vault the DA-681 computers are used to connect protective relays and fault recorders. The main functions for the DA-681 are to collect the data from these units, perform basic analysis, and to transmit this data to the control center.

In the main control center, a DA-681 computer has also been used as a central communications server that collects data from the local systems situated in the same room as well as all data from the other transformer vaults. This data is analyzed, processed, and then transmitted to the remote control dispatch to be used as the main reference for substation operations. The DA-681 computers thus help improve safety, emergency response, and grid management decisions, enhancing the overall efficiency of substation operations and grid services.

As data collection, data analysis, and data transmission are the most critical tasks for this application, it requires powerful and industrial-grade computers to work as the main management unit. Moxa's DA-681 computers work well as the management units at both remote field sites and the control center, and guarantee stable and reliable network communications for data acquisition, analysis, and transmission.



Moxa's Value and Differentiation

- High-performance industrial computers for reliable and stable operations
- Flexible and ready-to-run x86-based platform for easy hardware integration with third party devices and quick time-to-market
- Fanless, low power platform with dual 100/240 VDC/VAC redundant power for a reliable substation solution
- 6 Ethernet ports for multiple network communication and 12 serial ports for ample device connectivity
- Quick and sincere after-sale service

Product

DA-681

x86-based rackmount computer

- DA-681-I-DPP-T x86-based industrial computer with IEC 61850-3 certification
- Dual power redundancy (dual-power and power-protected models only)
- Powerful performance with Intel Celeron M 1GHz processor with 400MHz FSB
- Six 10/100 Mbps Ethernet ports
- 1 CompactFlash socket, 1 IDE ATA-150 connector for storage expansion
- 4 isolated RS-232 and 8 isolated RS-485 ports
- Embedded Linux or WinXPe
- 1U/19 inch rackmount model
- Dual 100/240 VAC/VDC power input
- Fanless design

At a Glance

Sonelgaz Substations

Region: Algeria

Company: Efacec/Sonelgaz

Substation Voltage: 400 kV

Customer Needs:
Construct a highly reliable and rugged communication backbone
for IEC 61850-3 modernization.

Key Benefits:
- High network availability
- Sustainable network bandwidth
- Ease of maintenance and administration

4 Substations | Algeria

A Highly Reliable Communication Backbone for Substation Modernization

Moxa products anchor a highly reliable communications backbone to reap the benefits of full IEC 61850-3 conformity while providing product flexibility that eases installations and network maintenance.

Project Introduction

Efacec, the largest power solutions provider in Portugal, is a multinational corporation that employs around 4000 people and annually processes over 1000 million Euros of orders. Efacec exports around half of its production, and has presence in over 50 countries.

Sonelgaz is Algeria's state-owned electricity generation, transmission, and distribution company. Sonelgaz approached Efacec for help in building four new automation systems for substations all across Algeria: two for transmission substations, and two for distribution substations. Each required communications systems to connect the station and bay levels with the digital protection relays at the process level. To guarantee that all data would be securely transmitted with zero packet loss even when under extreme EMI, Sonelgaz stipulated that the final system must be fully IEC 61850-3 compliant. To this end, Efacec chose Moxa's PowerTrans PT-7728 series IEC 61850-3 compliant Ethernet switches to form the basic communications backbone.

Application Requirements

To prevent accidents, whenever abnormal sampled values are reported the substation needs to immediately (within 4 milliseconds) activate the switchgear. In this application, PT-7728 IEC 61850-3 Ethernet switches are deployed as the main communications bridge between IEDs and protection relays. Verified by KEMA, the PT-7728 meets the IEC-61850-3 and IEEE 1613 standards; this guarantees no packet loss even when operating under extreme EMI. These specifications certify that the PT-7728 will reliably and accurately transmit GOOSE messages to the protection relays, especially in extreme situations that require immediate, automated reactions.

System Requirements

- IEC 61850-3 products are certified for reliable operations under extreme substation EMI
- A comprehensive, self-healing ring topology that prevents failure and outages, providing uninterrupted connections by ensuring fast network recovery times
- Redundant, ring-topology SCADA uplinks along the backbone
- A meshed network connecting the SCADA system to the monitoring units, for rapid responses and ease of maintenance and control

Moxa Solution

At the process level the PT-7728 Ethernet switches connect secondary equipment (CT/VT merging units and IEDs) and protection relays to fill a mission-critical networking role. Upon receiving abnormal values from secondary devices, a PT-7728 will then forward GOOSE messages from the IEDs to protection relays managing switchgear controls.

In addition, PT-7728s are also deployed at the station level, transmitting process and bay data to the local HMI for monitoring and management while simultaneously forwarding all data to the local grid's centralized remote control station for comprehensive grid management.

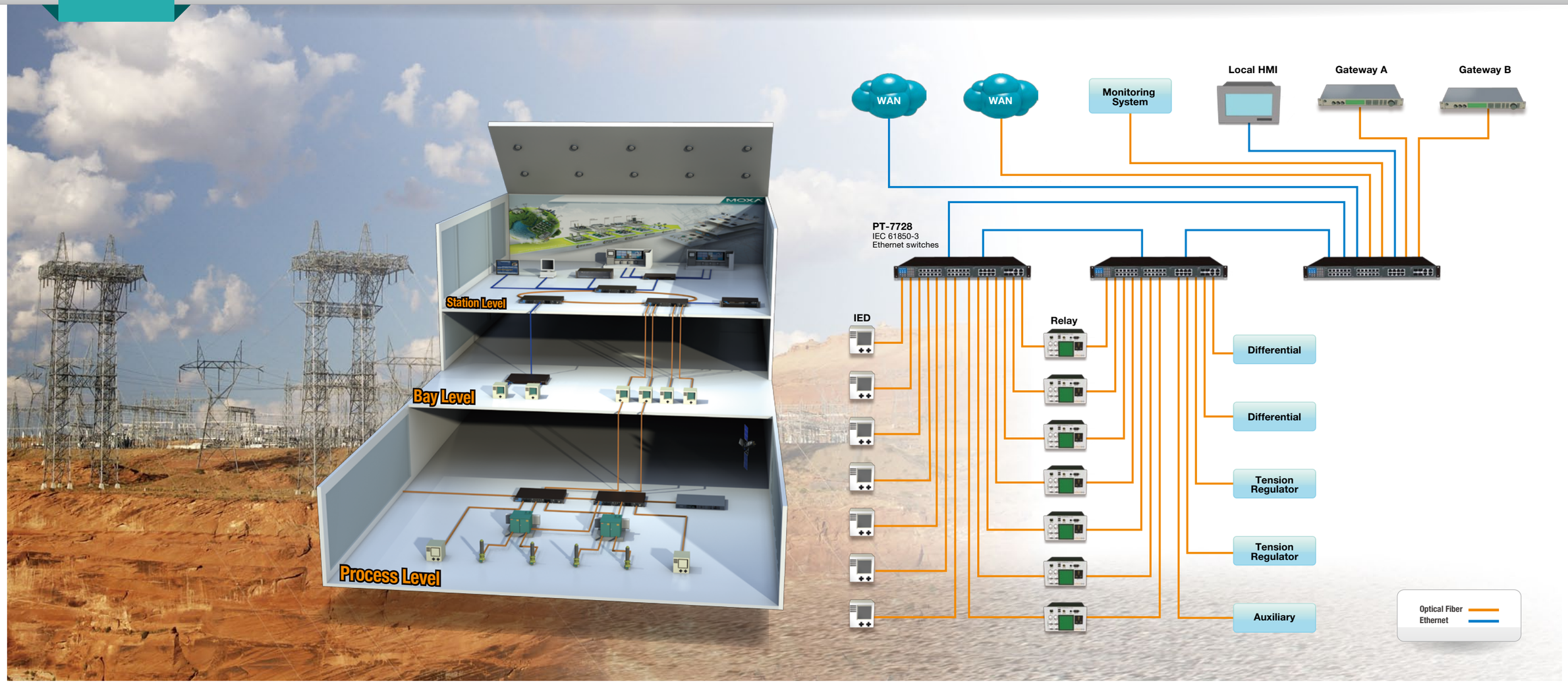
System Description

To be certified as IEC 61850-3 compliant a network's underlying communications backbone must operate reliably in harsh substation environments. This is why IEC 61850 specifies environmental EMI/EMC criteria. Efacec chose Moxa's switches for this substation's network backbone because Moxa's PowerTrans products are specifically designed for rugged substation operations and are certified as fully IEC 61850-3 and IEEE 1613 compliant by KEMA, a well-respected independent consulting and testing laboratory that serves the energy and utility industry.

Moxa's PT-7728 IEC 61850-3 compliant Ethernet switches are deployed in a 400 kV transmission substation to connect automated protection relays and other intelligent electronic devices (IEDs) into a Gigabit Ethernet ring network. In addition to ring redundancy, RSTP technology further guarantees fast network recovery should any particular link fail.

The PT-7728 comes with four Gigabit Ethernet ports, providing the capacity needed to maintain gigabit throughput on a redundant network. Four high capacity ports allow ring topologies to be easily deployed, while extra ports are available for connections to the core switches and the off-site grid control center. Additional PT-7728 switches are connected to the local SCADA server and redundant central units to link system operators to sensors and IEDs at the field sites. Finally, the modular rackmount design with rear cabling and front display is easy to install and convenient to administer.

Through this highly reliable, future-proof communications network designed specifically for substation environments, Sonelgaz was able to achieve the project goals of its substation modernization program by reaping the full benefits of IEC 61850.



Moxa's Value and Differentiation

- The PowerTrans PT-7728 series is fully compliant with the IEC-61850 directive
- Non-stop operation is the key criterion for mission-critical applications: the PowerTrans features dual, isolated, redundant power supplies with 88 to 300 VDC power inputs
- Modular, rackmount chassis with rear panel cabling and an easy to read front panel display were crucial considerations for this project

PT-7728 Series

IEC 61850-3 24+4G-port modular managed Ethernet switches

- IEC 61850-3, GOOSE, and IEEE 1613 Class 2 compliant (KEMA certified)
- Turbo Ring redundancy for fast network recovery (< 20 ms)
- Isolated, redundant power inputs with universal 24/48 VDC or 110/220 VDC/VAC power supply range
- Fanless design with wide temperature tolerance ranging from -40 to 85°C

Power Substation Computers

	DA-685	DA-710-XPE DA-710-LX	DA-681-I-SP-XPE DA-681-I-SP-LX	DA-681-I-DP-XPE DA-681-I-DP-LX	DA-681-I-DPP-T-XPE DA-681-I-DPP-T-LX	DA-682-XPE DA-682-LX	DA-683-SP-XPE DA-683-SP-LX	DA-683-DPP-T-XPE DA-683-DPP-T-LX
Computer								
CPU Speed	1.66 GHz	2 GHz	1 GHz	1 GHz	1 GHz	1 GHz	1.66 GHz	1.66 GHz
OS (pre-installed)	–	WinXP Emb. or Linux	WinXP Emb. or Linux	WinXP Emb. or Linux	WinXP Emb. or Linux	WinXP Emb. or Linux	WinXP Emb. or Linux	WinXP Emb. or Linux
DRAM	–	–	–	–	–	–	–	–
FSB	667 MHz	533 MHz	400 MHz	400 MHz	400 MHz	400 MHz	667 MHz	667 MHz
Flash	–	–	–	–	–	–	–	–
System Memory	1 GB (2 GB max.)	1 GB (2 GB max.)	512 MB (1 GB max.)	512 MB (1 GB max.)	512 MB (1 GB max.)	512 MB (1 GB max.)	1 GB (2 GB max.)	1 GB (2 GB max.)
PCMCIA	–	–	–	–	–	–	–	–
Expansion Bus	–	4 slots	–	–	–	2 slots	2 slots	2 slots
USB Ports	2 (USB 2.0)	4 (USB 2.0)	2 (USB 2.0)	2 (USB 2.0)	2 (USB 2.0)	4 (USB 2.0)	4 (USB 2.0)	4 (USB 2.0)
Digital I/O	4 DIs, 4 DOs	4 DIs, 4 DOs	–	–	–	–	4 DIs, 4 DOs	4 DIs, 4 DOs
Storage								
Built-in	2 GB (DOM)	2 GB	2 GB	2 GB	2 GB	1 GB	2 GB (DOM)	2 GB (DOM)
CompactFlash Socket	✓	✓	✓	✓	✓	✓	✓	✓
HDD Support	✓	✓	✓	✓	✓	✓	✓	✓
Other Peripherals								
KB/MS	✓	✓	✓	✓	✓	✓	✓	✓
Display								
Graphics Controller	✓	✓	✓	✓	✓	✓	✓	✓
LAN Interface								
10/100 Mbps Ethernet Ports	–	–	6	6	6	–	–	–
10/100/1000 Mbps Ethernet Ports	6	4	–	–	–	4	6	6
Magnetic Isolation Protection	1.5 KV	1.5 KV	1.5 KV	1.5 KV	1.5 KV	1.5 KV	1.5 KV	1.5 KV
Serial Interface								
RS-232 Ports	2	2 (DB9-M)	4 (DB9-M)	4 (DB9-M)	4 (DB9-M)	–	2	2
RS-485 Ports	6	–	8 (TB)	8 (TB)	8 (TB)	–	–	–
RS-232/422/485 Ports	–	–	–	–	–	–	–	–
ESD Protection	–	4 KV	15 KV	15 KV	15 KV	–	–	–
Digital Isolation	–	–	2 KV	2 KV	2 KV	–	–	–
Console Port	–	–	–	–	–	–	–	–
Serial Communication Parameters	Data Bits: 5, 6, 7, 8; Stop Bits: 1, 1.5, 2; Parity: None, Even, Odd, Space, Mark							
Flow Control	RTS/CTS, XON/XOFF	RTS/CTS, XON/XOFF	RTS/CTS, XON/XOFF	RTS/CTS, XON/XOFF	RTS/CTS, XON/XOFF	–	RTS/CTS, XON/XOFF	RTS/CTS, XON/XOFF
Baudrate	50 bps to 115.2 Kbps	50 bps to 115.2 Kbps	50 bps to 115.2 Kbps	50 bps to 115.2 Kbps	50 bps to 115.2 Kbps	–	50 bps to 115.2 Kbps	50 bps to 115.2 Kbps
LEDs								
System	Power, Storage, Power Failure	Power, Storage, Power Failure	Power, Storage, Power Failure	Power, Storage, Power Failure	Power, Storage, Power Failure	–	Power, Storage, Power Failure	Power, Storage, Power Failure
LAN	100M, 1000M	100M, 1000M	10M, 100M	10M, 100M	10M, 100M	100M, 1000M	100M, 1000M	100M, 1000M
Serial	TX, RX	TX, RX (for 4 modules), Programmable	TX, RX	TX, RX	TX, RX	TX, RX	TX, RX	Tx, Rx
Physical Characteristics								
Housing	SECC sheet metal (1 mm)						SECC sheet metal (1 mm)	SECC sheet metal (1 mm)
Weight	4 kg	14 kg	4.5 kg	4.5 kg	4.5 kg	7 kg	4 kg	4 kg
Dimensions	315 x 440 x 90 mm	400 x 480 x 180 mm	440 x 315 x 45 mm			440 x 315 x 90 mm	440 x 315 x 90 mm	
Mounting	Standard 19-in rackmount	Standard 19-in rackmount	Standard 19-in rackmount	Standard 19-in rackmount	Standard 19-in rackmount	Standard 19-in rackmount	Standard 19-in rackmount	Standard 19-in rackmount
Environmental Limits								
Operating Temperature	-10 to 60°C	-10 to 50°C	0 to 60°C	0 to 60°C	-40 to 75°C	-10 to 60°C	-10 to 60°C	-40 to 75°C
Storage Temperature	-20 to 80°C	-20 to 80°C	-20 to 75°C	-20 to 75°C	-40 to 85°C	-20 to 80°C	-20 to 80°C	-40 to 85°C
Ambient Relative Humidity	5 to 95% RH	5 to 95% RH	5 to 95% RH	5 to 95% RH	5 to 95% RH	5 to 95% RH	5 to 95% RH	5 to 95% RH
Regulatory Approvals								
EMC	FCC, CE (Class A)	EN 55022 Class A, EN 61000-3-2, EN 61000-3-3, EN 55024, FCC Part 15 Subpart B Class A	EN 55022, EN 61000-3-2, EN 61000-3-3, EN 55024, FCC Part 15 Subpart B Class A, IEC 61850-3 (DPP-T models only)			EN 61000-6-4, EN 61000-3-2, EN 61000-3-3, EN 55024, FCC Part 15 Subpart B Class A	CE (EN 55022, EN 61000-3-2, EN 61000-3-3, EN 55024), FCC (Part 15 Subpart B, CISPR 22 Class), CCC (GB9254, GB 17625.1), IEC 61850-3 (DPP-T models only)	
Safety	LVD, UL, cUL, CCC	UL 60950-1, CSA C22.2 No. 60950-1-07, CCC (GB4943, GB9254, GB17625.1)	UL 60950-1, CSA C22.2 No. 60950-1-03, EN 60950-1, CCC (GB4943, GB9254, GB17625.1)			UL 60950-1, CSA C22.2 No. 60950-1-03, EN 60950-1, CCC (GB4943, GB9254, GB17625.1)	UL/cUL (UL 60950-1, CSA C22.2 No. 60950-1-03), LVD (EN 60950-1), CCC (GB4943)	
Green Product	RoHS, CRoHS, WEEE	RoHS, CRoHS, WEEE	RoHS, CRoHS, WEEE	RoHS, CRoHS, WEEE	RoHS, CRoHS, WEEE	RoHS, CRoHS, WEEE	RoHS, CRoHS, WEEE	RoHS, CRoHS, WEEE
Reliability								
Buzzer, RTC, WDT	✓	✓	✓	✓	✓	✓	✓	✓
Warranty	3 years (see www.moxa.com/warranty)							

	DA-660-8-CE DA-660-8-LX	DA-660-16-CE DA-660-16-LX	DA-661-16-CE DA-661-16-LX	DA-662-16-CE DA-662-16-LX	DA-662-I-16-CE DA-662-I-16-LX
Computer					
CPU Speed	266 MHz	266 MHz	533 MHz	533 MHz	533 MHz
OS (pre-installed)	WinCE 5.0 or Linux				
DRAM	128 MB	128 MB	128 MB	128 MB	128 MB
FSB	–	–	–	–	–
Flash	32 MB	32 MB	32 MB	32 MB	32 MB
System Memory	–	–	–	–	–
PCMCIA	–	–	✓	✓	✓
Expansion Bus	–	–	–	–	–
USB Ports	–	–	2	2	2
Storage					
Built-in	–	–	–	–	–
CompactFlash Socket	–	–	✓	✓	✓
HDD Support	–	–	–	–	–
Other Peripherals					
KB/MS	–	–	–	–	–
Display					
Graphics Controller	–	–	–	–	–
Mini Screen with Push Buttons	✓	✓	✓	✓	✓
LAN Interface					
10/100 Mbps Ethernet Ports	2	2	2	4	4
Magnetic Isolation Protection	1.5 KV	1.5 KV	1.5 KV	1.5 KV	1.5 KV
Digital Isolation Protection	–	–	–	–	2 KV
Serial Interface					
RS-232/422/485 Ports	8 (RJ45)	16 (RJ45)	16 (RJ45)	16 (RJ45)	16 (RJ45)
ESD Protection	15 KV	15 KV	15 KV	15 KV	15 KV
Digital Isolation	–	–	–	–	2 KV
Console Port	✓	✓	✓	✓	✓
Serial Communication Parameters	Data Bits: 5, 6, 7, 8; Stop Bits: 1, 1.5, 2; Parity: None, Even, Odd, Space, Mark				
Flow Control	RTS/CTS, XON/XOFF, ADDC®				
Baudrate	50 bps to 921.6 Kbps (non-standard baudrates supported; see user's manual for details)				
LEDs					
System	OS Ready	OS Ready	OS Ready	OS Ready	OS Ready
LAN	10M, 100M	10M, 100M	10M, 100M	10M, 100M	10M, 100M
Serial	TxD, RxD	TxD, RxD	TxD, RxD	TxD, RxD	TxD, RxD
Physical Characteristics					
Housing	SECC sheet metal (1 mm)				
Weight	2.6 kg	2.6 kg	2.6 kg	2.6 kg	2.94 kg
Dimensions	440 x 45 x 198 mm				440 x 45 x 228 mm
Mounting	Standard 19-inch rackmount				
Environmental Limits					
Operating Temperature	-10 to 60°C	-10 to 60°C	-10 to 60°C	-10 to 60°C	-10 to 60°C
Storage Temperature	-20 to 80°C	-20 to 80°C	-20 to 80°C	-20 to 80°C	-20 to 80°C
Ambient Relative Humidity	5 to 95% RH	5 to 95% RH	5 to 95% RH	5 to 95% RH	5 to 95% RH
Regulatory Approvals					
EMC	CE (EN55022 Class A, EN61000-3-2 Class A, EN61000-3-3, EN55024), FCC (Part 15 Subpart B, CISPR 22 Class A)				
Safety	UL/cUL (UL60950-1, CSA C22.2 No. 60950-1-03), TÜV (EN60950-1)				
Green Product	RoHS, CRoHS, WEEE				
Reliability					
Buzzer, RTC, WDT	✓	✓	✓	✓	✓
Warranty	5 years (see www.moxa.com/warranty)				

IEC 61850-3 Ethernet Switches

	PT-7728-PTP	PT-7528-PTP	PT-7828	PT-7728	PT-7528	PT-7710	PT-G7509	PT-508/510
Number of Ports								
Max. Number of Ports	28	28	28	28	28	10	9	8/10
Max. Number of Hardware PTP Ports	14	28	–	–	–	–	–	–
Gigabit Ethernet, 10/100/1000 Mbps	Up to 4	Up to 4	Up to 4	Up to 4	–	Up to 2	9	–
Fast Ethernet, 10/100 Mbps	Up to 28	Up to 24	Up to 28	Up to 28	Up to 28	Up to 10	9	8/10
Power Supply								
24 VDC, isolated	✓	✓	✓	✓	✓	–	✓	✓
48 VDC, isolated	✓	✓	✓	✓	✓	–	✓	✓
12/24/48 VDC	–	–	–	–	–	✓	–	–
88-300 VDC or 85-264 VAC, isolated	✓	✓	✓	✓	✓	✓	✓	✓
Installation Options								
Rack Mounting	✓	✓	✓	✓	✓	✓	✓	–
Panel Mounting	–	–	–	–	–	✓	–	w/ optional kit
DIN-Rail Mounting	–	–	–	–	–	–	–	✓
Operating Temperature								
-40 to 85°C	✓	✓	✓	✓	✓	✓	✓	✓
Redundancy and Backup Options								
Turbo Ring (Recovery Time < 20 ms)	✓	✓	✓	✓	✓	✓	✓	✓
Turbo Chain (Recovery Time < 20 ms)	✓	✓	✓	✓	✓	✓	✓	✓
STP/RSTP	✓	✓	✓	✓	✓	✓	✓	✓
Automatic Backup Configurator (ABC-01)	✓	✓	✓	✓	✓	✓	✓	✓
Network Management and Control								
Layer 3 Switching	–	–	✓	–	–	–	–	–
IPv6	✓	✓	–	✓	✓	✓	✓	✓
DHCP Option 66/67/82	✓	✓	✓	✓	✓	✓	✓	✓
Hardware-based IEEE 1588 PTP V2	✓	✓	–	–	–	–	–	–
LLDP	✓	✓	✓	✓	✓	✓	✓	✓
Modbus/TCP	✓	✓	✓	✓	✓	✓	✓	✓
IGMP/GMRP	✓	✓	✓	✓	✓	✓	✓	✓
Port Trunking	✓	✓	✓	✓	✓	✓	✓	✓
IEEE 802.1X	✓	✓	✓	✓	✓	✓	✓	✓
Port Lock	✓	✓	✓	✓	✓	✓	✓	✓
SNMP/RMON	✓	✓	✓	✓	✓	✓	✓	✓
VLAN	✓	✓	✓	✓	✓	✓	✓	✓
QoS	✓	✓	✓	✓	✓	✓	✓	✓
Relay Warning	✓	✓	✓	✓	✓	✓	✓	✓
Standards and Certifications								
CE/FCC	✓	✓	✓	✓	✓	✓	✓	✓
UL/cUL 60950-1	Pending	✓	✓	✓	✓	✓	✓	–
UL 508	–	–	–	–	–	–	–	Pending
IEC 61850-3 (Power Substation)	✓	✓	✓	✓	✓	✓	✓	✓
IEEE 1613 (Power Substation)	✓	✓	✓	✓	✓	✓	✓	✓
EN 50155/50121-4 (Railway Applications)	–	–	✓	✓	–	✓	–	–
NEMA TS2 (Traffic Control System)	–	–	✓	✓	–	✓	–	–

DA-683
x86-based IEC 61850-3 &
IEEE 1588 v2 Rackmount Computer

PT-7728-PTP
IEC 61850-3 & IEEE 1588 v2
Ethernet Switch

PT-510
IEC 61850-3 & IEEE 1588 v2
Ethernet Switch

CN2600
Industrial Terminal Server

Smart Substations

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