

Utility Communications

FOX615 universal multiplexer for utility networks

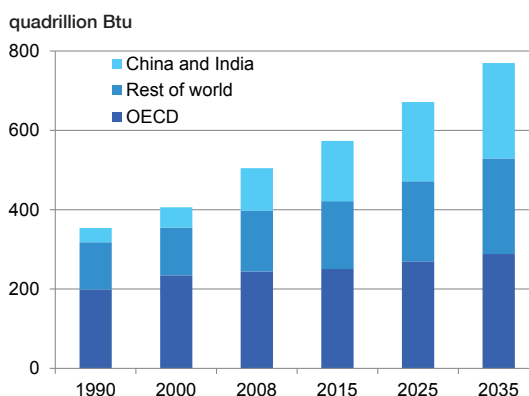
Today's challenges

Utilities today face a variety of challenges. Steep increases in power consumption, with no corresponding expansion of transmission and generation capacity, have led to severe pressure on power systems around the world. Cost efficiency adds to this pressure as more utilities are privatized and strive to minimize CAPEX and OPEX. With the introduction of distributed renewable power generation and the evolution of smarter grids, communication is becoming ever more important in the world of utilities.

To maintain stability and security of supply, power networks need accurate real-time data

To maintain network stability under heavy loads, which leave little margin to accommodate unexpected events, power systems must react quickly to anomalies. This requires constant access to real-time data.

Global Energy Consumption



Source: U.S. Energy Information Administration, International Energy Outlook 2011 (IEO2011)

Smarter grids – the future has started

To meet today's challenges, power systems must satisfy four key requirements: those of capacity, reliability, efficiency and sustainability. Achieving these aims, which place conflicting demands on the system, will result in a partial migration of grid infrastructure from wholly centralized generation to an increasingly distributed system that includes a significant portion of renewable generation.

This, in turn, will lead to multidirectional power flows, which require reliable, real-time communications to maintain grid stability. Grids can be improved by the installation of sensors to gather data on grid conditions. But the improvements can be realised only with the installation of communications systems that are capable of transmitting those data, in real-time, to the control systems and operators responsible for keeping the grid in order.



Operational excellence – a must for any utility

Market deregulation in the power sector has led to increased pressure to reduce cost. Multiservice communication networks, properly designed and installed, can cover all requirements for the operation of the grid with minimal cost, without compromising performance.

Multiservice communication networks reduce OPEX

The individual elements of a multiservice communications network provide flexibility in terms of scale and future technology migration. That means CAPEX can be optimized and investments protected. OPEX too can be optimized by highly integrated functionality and remote management facilities. Less equipment in the system means lower operational and maintenance costs.

Managing technology migration to protect your investments

Guaranteed performance

A particularly challenging aspect of network ownership is the anticipated migration to new technologies for utility communications. Most of the operational networks that currently provide real-time data services are based on TDM (SDH) technology. The deterministic behavior of this technology is fully compliant with the hard real-time requirements of power utility applications. TDM enables multiservice networks to transmit data from multiple applications, including teleprotection, operational telephony, SCADA and high-speed Ethernet for administrative purposes. It guarantees the performance values required by each individual application, and also offers high bandwidth (up to 10 Gbit/s, STM-64) and WDM to accommodate future growth.

Public telecommunications systems, on the other hand, accommodate steadily increasing demand for bandwidth, driven by triple-play applications (Internet, telephony and television) using Ethernet/IP. This has led to increasing deployment of packet-switched networks.



Quality of service in these applications is limited by the fact that PSNs do not maintain persistent connections. This loss of quality is, however, not critical since, unlike utility-specific applications, public telecom applications have no hard real-time performance value requirements.

A lack of real-time capability in the communication system can lead to power outages



In contrast to packet-switched technology, TDM provides inherently fast and deterministic communications. A failure to provide such communications could lead to grid outages and damage to primary equipment (e.g., breakers and transformers), leading ultimately to significant financial losses and damage to the utility's reputation.

Another important aspect for network operators to consider is cyber security. As the systems controlling our power networks and industrial control systems become ever-more interconnected and reliant on the Ethernet/IP-based technology, the increased risk of security breaches needs to be addressed.

So, deciding which technology to implement is not an easy task. On the one hand, it needs to be future-proof, and on the other, it needs to meet all real-time application requirements, thereby proving its suitability for power utilities. FOX615 satisfies both of these criteria. It is the only universal multiplexer platform that meets utility-specific requirements for operational communication networks in such a highly integrated way, and it significantly reduces both CAPEX and OPEX for utilities.

Utility communication – more than a telecom niche market

Communication networks are a utility's nervous system. While public telecom companies focus on providing communication services to millions of end-customers, utilities use communication networks to ensure the reliability of their grids. Unlike the world of public telecoms, electrical networks are generally composed of long-established infrastructure, where the demands on the communications channels are relatively static, comprising high availability (eg, 99.999%) coupled with a variety of application-specific requirements. Although there are some similarities between communications used by public service providers and those used by utilities, the demands on utility communications are considerably more stringent.

Integration of existing infrastructure

Investment cycles in utilities are much longer than those in the public telecom sector. Protection and control equipment in electrical substations, which is ultimately connected to utility communication equipment, is particularly long-lived.

The ultimate goal of an all-Ethernet/IP network is still far away, particularly for power grids, which link hundreds or even thousands of established substations. A basic requirement of such a system would be longevity and full, long-term support for legacy interfaces. In place of full network refurbishments, often seen in public telecommunications networks, utility networks evolve slowly, increasing in size and migrating to new technology step by step. This evolution means that high interoperability between old and new installations is an absolute must.

Utility communication – intuitive configuration is key

Operational communications networks play an essential role in the grid, but are not considered a core functionality.

Operational excellence is ensured by user-friendly interfaces and intuitive tools

The networks tend to be operated by relatively small teams of generalists, responsible for large numbers of products and specialized functionalities. Operational excellence can be ensured by user-friendly interfaces and intuitive tools, combined with a powerful, centralized network management system.

Long investment cycles means access to legacy interfaces must be maintained



Application requirements – challenging communication networks

Teleprotection functionality – safeguarding the electrical grid

When short circuits occur on power lines, it is absolutely essential that the fault is cleared within tens of milliseconds. That means that the maximum communications delay, from end-to-end of the system, must be less than 10 milliseconds. Additional requirements include symmetrical communications delay times, redundant channel routing, with bidirectional switching and restricted signal jitter. If the application fails to operate correctly (too slowly or not at all), the negative impact, in terms of outages and financial losses, could be enormous. This is why protection applications are among the most important in the grid and require communication systems, with real-time performance and the highest levels of availability.



Hard real-time communication is required for teleprotection



SCADA applications – the brain of the utility

The core business of a utility is the reliable and effective operation of its electrical power grid. The performance of the grid depends on the operator's ability to access accurate, real-time data on the status of the network. As more distributed power generation sources come on line, and smart grid applications are implemented, high-availability communications networks, capable of real-time performance, have become a mandatory requirement.

Network availability is key for reliable operations and sophisticated redundancy schemes are needed at various levels, using different redundancy protocols. Since power grids are large installations, built up over a number of years, communication demands will differ significantly from substation to substation, depending on the devices used at the time of construction.

SCADA applications require sophisticated redundancy schemes and topologies

Utility environment – a challenge in itself

Utility communication equipment used for operational networks is generally installed in substations and is exposed to severe environmental conditions. In addition to extremes of temperature, communications equipment is also exposed to magnetic and electrical fields, which are particularly severe during short-circuit events. In order to maintain the high levels of availability required, especially in emergency situations, utility communications equipment must be extremely robust and reliable. In dusty and remote environments, where regular maintenance cannot be guaranteed, fan-less designs are preferable.

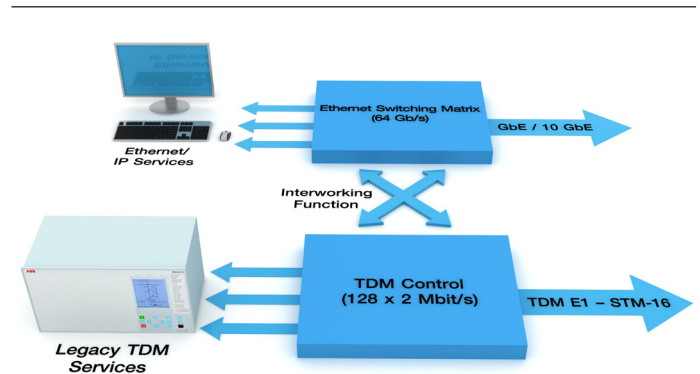
FOX615 – bridging technologies

FOX615, the universal solution for power utilities

FOX615 provides the perfect combination of traditional TDM (PDH/ SDH) technology and sophisticated Ethernet/IP features to meet all requirements mentioned here. It allows easy integration into existing infrastructure and extension projects, enabling step-wise migration, while protecting investments.

TDM and Ethernet/ IP Services in one platform

These two technologies are combined to address the performance criteria of utilities, demanding both real-time applications and packet-switched requirements of new Ethernet/IP based applications. This allows easy integration and extension of existing infrastructure and high protection of investments.



FOX 615 – universal multiplexer

FOX615: the perfect combination of real-time communications capability and Ethernet/ IP functionality



ABB's fundamental aim when designing the FOX615 was to produce a multiplexer that would fulfil the needs of real-time utility applications, while avoiding all technology-imposed performance constraints.

This is what led to the decision to support both TDM and packet-switched technologies in a single device. This combination allows the user to setup an SDH network, fulfilling all performance requirements, and migrate to packet-switched solutions at a later stage, when functionality has been proven, without needing to replace the communications equipment.

FOX615 provides a powerful switching engine for packet-based communications, as well as a two-stage cross-connect for traditional TDM (PDH/SDH) signals.

Utility-focused equipment design

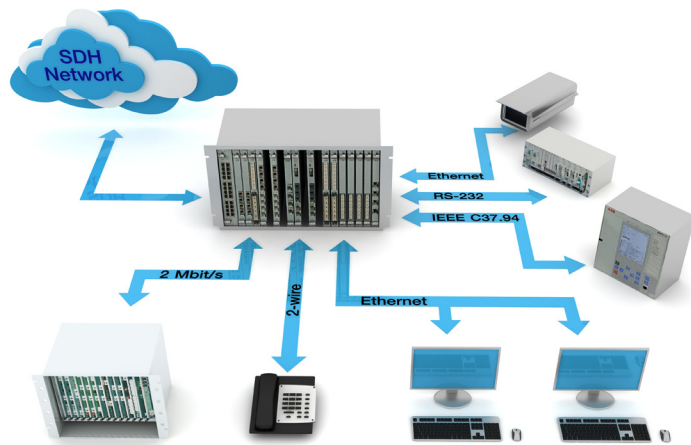
By integrating access and transport functionality in a single device, the FOX615 is a perfect solution for power utilities. It includes a range of user interfaces, including those required for utility-specific protection applications and special functionality eg, for SCADA 101/104 systems.

On the transport side, FOX615 offers up to STM-16 capacity, enabling the construction of wide-area communication networks. The integrated access and transport multiplexer functionalities significantly lower OPEX and space requirements, since only a single platform needs to be installed and maintained, and no wiring is needed between individual boxes. An additional benefit is that only one network management tool is needed for configuration purposes.

Integrated access and transport functionality help to reduce the OPEX

The FOX615 is configured via an intuitive, user-friendly graphical user interface, which also facilitates easy maintenance of the device. Equipment views, configuration tabs and drop-down menus help the user to configure individual network elements, intuitively, and without specialist expertise. A strong network management system ensures that all elements are properly supervised, and allows easy channel programming, from 64 kBit/s to complete SDH links, using the networking package.

FOX615's modular platform provides scalability in terms of both capacity and technology to protect the long-term value of your investment.



FOX615 release 1 – Multiservice SDH backbone network

Utility-specific interfaces and functionality

FOX615 has integrated interface modules for both distance and differential protection applications.

Integrated interfaces for protection applications provide optimized solutions

The teleprotection interface, TEPI1, provides four high-voltage interfaces, which can be used to connect directly to the distance protection relay, and complies fully with IEC60834-1. The protection interface, OPIC1, provides four interface ports, in compliance with IEEE C37.94.

Together, OPIC1 and TEPI1, provide an optimized solution for power utilities' mission-critical applications for differential and distance protection applications. This delivers a number of benefits, including:

- Fewer interfaces and fewer hardware elements which bring higher system availability, leading to a higher overall MTBF of the protection system
- Reduction of wiring between individual boxes, enabled by the higher functional integration of FOX615
- One configuration tool for all services, reducing maintenance costs
- Full integration of FOX615 into the network management system, bringing faster reaction times.

Utility-hardened equipment

The FOX615 multiplexer is a utility-grade communication product, capable of operating in electromagnetically polluted environments and across broad temperature ranges (-25°C up to +60°C) commonly found in electrical substations. Very high MTBF figures and exhaustive redundancy options ensure the availability of the system. For dusty environments, where moving parts should be avoided, a fan-less version of the FOX615 is also available.

Extended temperature range and high EMC/EMI values are essential

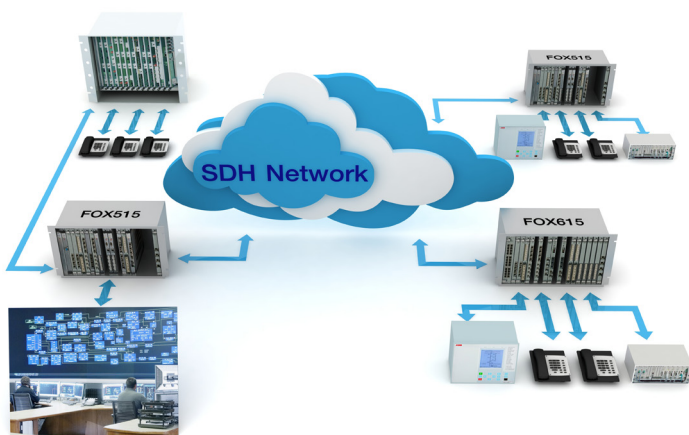
Full interoperability with FOX515 and easy migration to future technologies provides long-term protection of investments

FOX615 – the perfect extension to FOX515

FOX615 is fully interoperable with the FOX515 platform. It is based on the same configuration philosophy and the equipment has the same format and appearance. This means that existing FOX515 networks can easily be expanded using FOX615 devices to provide full interoperability on individual communication channels, enabling the two FOX devices to communicate on the level of each single data channel. This, in turn, enables applications such as substation RTUs to be connected to the FOX515 access interface on one side, and terminated on the corresponding access interface of the FOX615 in the control center. The same is of course true for other applications such as teleprotection or voice.

Interoperability between FOX615, FOX515 and legacy FOX-U protects investments

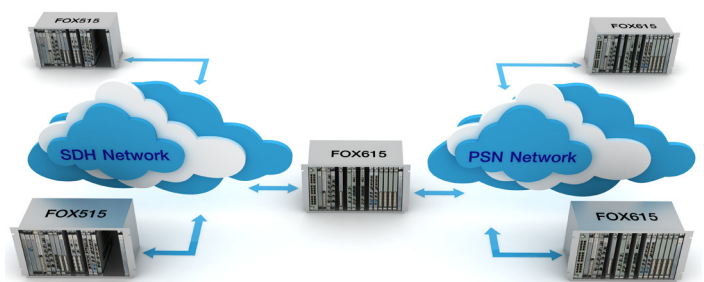
In addition to full interoperability between individual data channels, FOX615 also guarantees full interoperability of the management communications channel, the network management system, and enhanced protection features available on the access or aggregate interfaces.



FOX615 is fully interoperable with FOX515

FOX615 – technology migration

For customers planning to migrate SDH communications systems to packet-switched technology, FOX615 provides the optimal solution. Using this device, it is possible to set up multi-technology networks, comprising traditional SDH technology (FOX515 or FOX615) and next-generation packet-switched technology. All necessary interworking functionalities are integrated into FOX615.



FOX615 migration

This means that systems can be migrated to new technologies link-by-link, as soon as a substation is Ethernet/IP ready, while the remaining parts of the network continue to operate on TDM technology.

FOX615 offers the possibility for link-by-link migration to new technologies

FOX family

FOX615 is part of ABB's range of higher capacity FOX multiplexers used in operational multiservice communication networks for the transmission of real-time data, protection signals and other traffic such as the utility's own IT data.

It is also part of ABB's extended FOX family of equipment, which provides transmission capacities up to STM-64 (10 Gbit/s) and Gigabit-Ethernet (1 and 10 Gbit/s).

Integrated network management system solutions

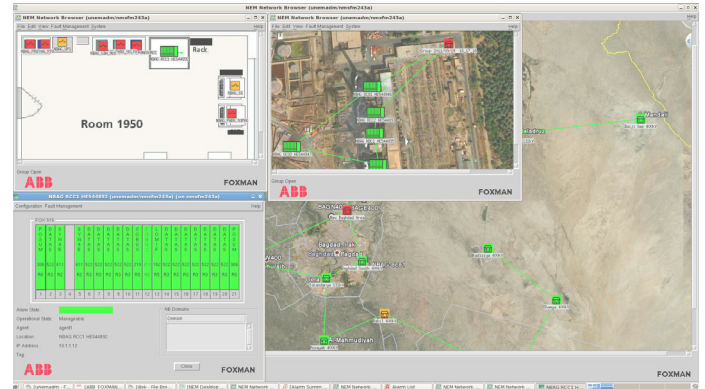
FOXMAN-UN network management system

FOXMAN-UN is a powerful network management system, which can be used in combination with various ABB communication devices. FOX615 is fully integrated into FOXMAN-UN, and that includes FOX615's utility-specific interfaces for distance and differential protection. FOXMAN-UN provides sophisticated supervision features, such as graphical representation of the communication network, a view of the synchronization status of FOX615 network elements and performance monitoring of inks. In addition, FOXMAN-UN allows certain tasks, such as firmware distribution and activation, to be automated and scheduled.

Minimizing maintenance

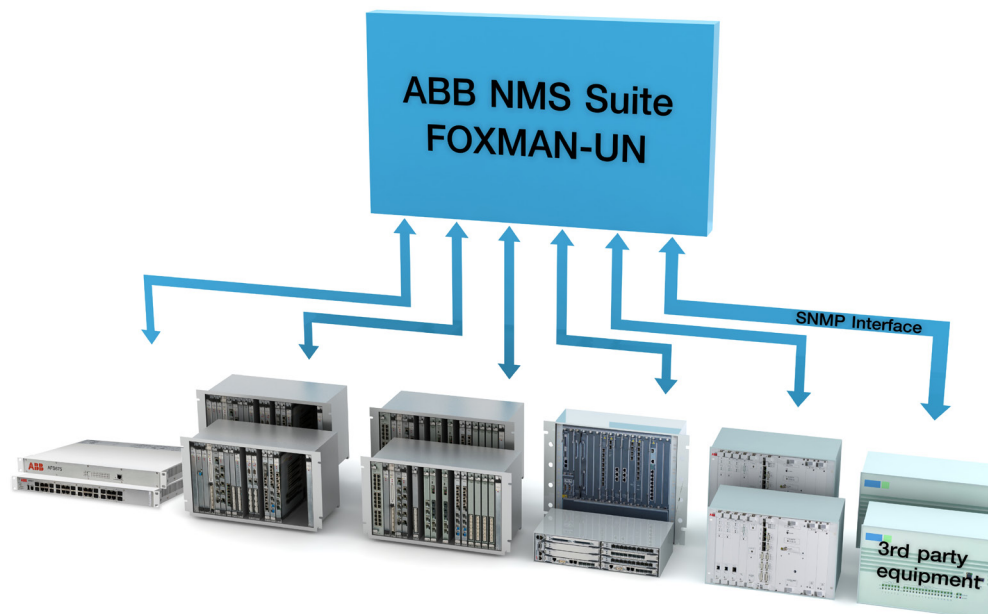
FOX615 is configured using the FOXCST graphical configuration software. Intuitive user dialogues, equipment views and the ability to configure offline help users to reduce down time of network elements and speed troubleshooting. The full integration of FOX615 into FOXMAN-UN ensures easy configuration of multiple network elements.

FOXMAN-UN's unique ability to integrate a range of ABB utility communication devices helps operators to enhance the overall performance of utilities' operational networks.



Uniting all events in a single system significantly improves the availability of communication infrastructure and reduces OPEX by providing a centralized view of the whole system.

System-wide network management solutions help to increase availability and reduce OPEX



FOXMAN-UN, integration of various ABB utility communication equipment

Features and benefits

Features	Benefits
Universal platform supporting TDM and packet-switched technology <ul style="list-style-type: none"> Can be upgraded to packet-switched technology, with 1 GbE and 10 GbE uplink ports 	Future proof solution providing investment protection Provides future migration scenario from TDM (SDH) networks to packet-switched (data) networks Provides the freedom to migrate to new technology as soon as application requirements are met
Combined access and transport multiplexer from subrate 64 kBit/s up to SDH STM-16	Reduces OPEX through: <ul style="list-style-type: none"> Lower maintenance efforts Operators need to be trained in the use of only one system Less wiring needed Less space required
Full support of legacy data, voice and utility-specific interfaces <ul style="list-style-type: none"> Voice: 2/4 wire E&M, FXS, FXO, including conferencing functionality Data: V.24/V.28, V.35, V.11, RS-485, X.21, G.703 64kBit/s, E1 Teleprotection compliant with IEC 60834-1 IEEE C37.94 for direct connection of differential protection relays 	Higher availability of communication network Flexibility to integrate all necessary services Scalability to accommodate future needs Reduced OPEX
Utility-specific functionality <ul style="list-style-type: none"> Point-to-multipoint configurations for legacy SCADA protocols Logical bridging instances for real separation of critical user data traffic Bidirectional switching for redundant channel routing of protection signals 	Optimized solutions for utility applications Highest availability for mission critical applications Integrated solution
Full support of enhanced Ethernet/IP interfaces <ul style="list-style-type: none"> Optical interfaces (SFP based) up to 12 cages Electrical interfaces from 4 – 24 ports 10/100/1000 BaseT L2 switching and L3 routing functionality Specific functionality for SCADA applications 	Flexibility to integrate all necessary services Scalability of system Powerful Ethernet switch, high port density Functionality adapted to application requirements
Modular platform ready for future expansion	Long life time of platform Lifetime in line with utilities' investment cycles Can be upgraded to accommodate future requirements Scalability of system
Very high availability figures <ul style="list-style-type: none"> Redundant CPU Redundant power feeding Very high MTBF Fan-less option available 	Neither power transmission nor distribution will be affected by problems in the communications system Reduced maintenance efforts Long life cycle and high MTBF ensure long-term investment protection
Designed for the utility substation environment	No communications outages or equipment breakdown will be caused by operating conditions Reduced maintenance efforts
Full interoperability with FOX515 and FOXMAN-UN	Protection of investments of existing networks
User-friendly network management system	Faster reaction times Reduced OPEX due to easy maintenance and operation

Why ABB utility communications?

FOX615 – a future proof solution

FOX615 modular structure and can be extended with additional functionality at any time. This includes upgrades to packet-switched functionality, since the FOX615 chassis is equipped with fully redundant GbE and 10 GbE Ethernet star connections.

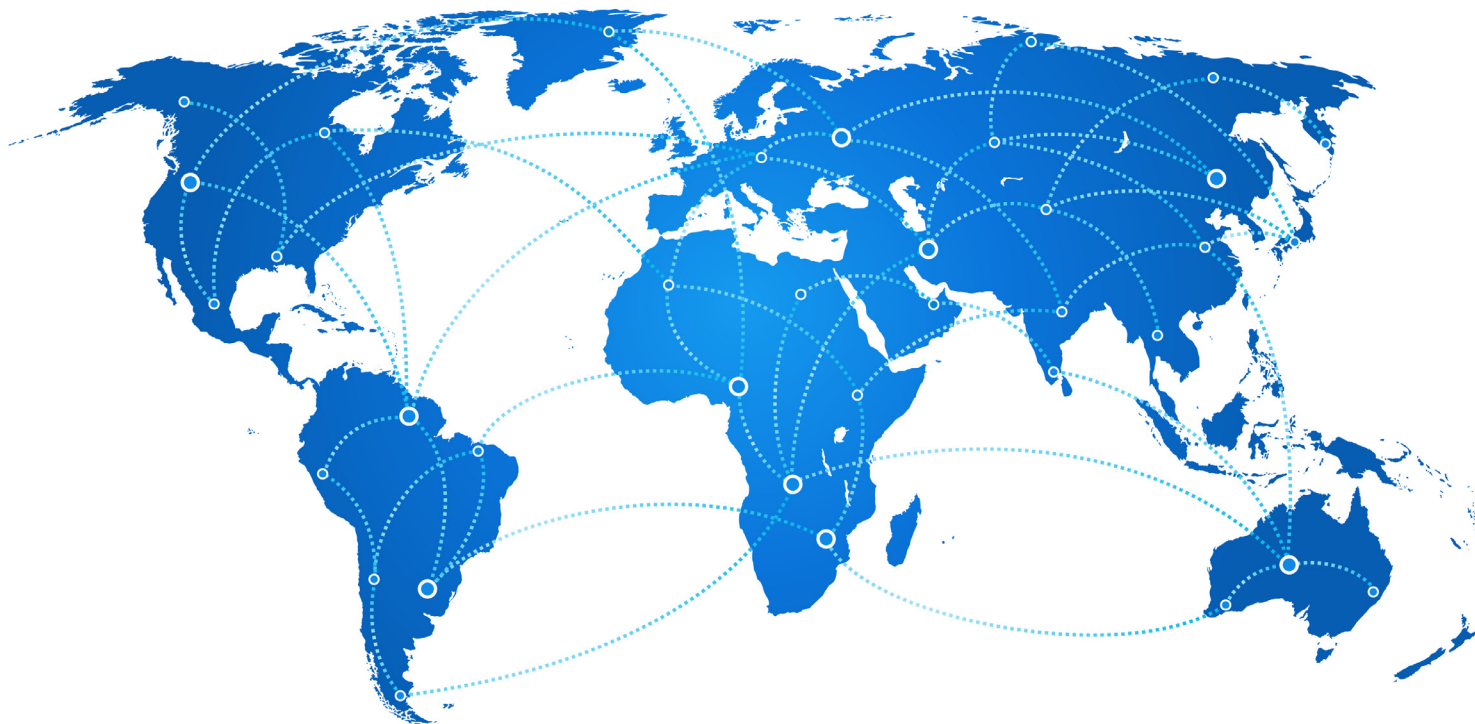
ABB utility communications

ABB is a long-standing and experienced supplier of solutions for power utilities. These include network supervision, protection systems and communication solutions for operational networks. ABB also actively participates in organizations like CIGRE, IEC and IEEE, contributing recommendations and standards for future developments in the electric power industry. As one of only a few companies that provides both communications and protection and control solutions for the operation of power grids, ABB can deliver outstanding and solutions for the demanding applications of power utilities optimized.

ABB provides optimized communications solutions, built on extensive knowledge and experience in the power utility environment

ABB utility communication has a huge installed base of communication devices for operational networks worldwide, including teleprotection devices, Power Line Carrier equipment and fiber optic communication.

The new FOX615 provides an outstanding combination of state of the art TDM technology, future packet switched technology and utility specific features in an unseen way. This makes it the most appropriate, cost effective solution for power utilities.



List of abbreviations

CAPEX	Capital expenditure
EMC	Electro magnetic compatibility
EMI	Electro magnetic immunity
GbE	Gigabit Ethernet
IP	Internet protocol
IT	Information technology
MTBF	Mean time between failures
OPEX	Operational expenditure
PSN	Packet switched network
PSTN	Public switched telephone network
RTU	Remote terminal unit
SCADA	Supervisory control and data acquisition
SDH	Synchronous digital hierarchy
TDM	Time division multiplexing
VoIP	Voice over IP
WDM	Wavelength division multiplexing

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