We are bridging the gap.
Enabling Digital Substations.
ABB’s Digital Substation provides customers in the utility sector with unmatched control and efficiency. The digital substation reduces maintenance requirements and the need for miles of conventional cabling. ABB Ability takes these advances several steps further by combining the latest electrical gear with digital sensors and cloud computing. The result is that grid operators can make decisions based on comprehensive, up-to-the-moment information, while predictive algorithms can improve maintenance practices and asset management.

Claudio Facchin  
President, Power Grids division
ABB’s Digital Substation is a core enabler to increase safety, productivity and reliability for grid operators and to reduce the overall substation cost.

Enabling a safer work environment while reducing construction and operational costs. Digital Substations remove the last electrical connection between the high voltage equipment and the protection and control panels, creating a safer work environment, whilst reducing the costs for building, land, engineering, commissioning, operation and maintenance of the system. As a key component towards smarter grids, where utilities continue to integrate increasing amounts of intermittent renewable energy sources, Digital Substations will also help improve safety thanks to improved data quality and a shorter decision time in case of an emergency.
Since then, we have supplied tens of thousands of air-insulated, gas-insulated and hybrid substations with voltage levels up to 1,200kV to a range of very different sites: from the most densely populated locations to the harshest environments on earth.

Our major technological step was in 1965 by introducing gas-insulated switchgear (GIS) that reduced the footprint of substations. Alongside the development of GIS technologies, ABB has significantly improved the performance of conventional AIS substations. The latest innovation, the “combined” disconnector circuit breaker (DCB), integrates the disconnecting function into the circuit breaker. This eliminates the need for two separate free-standing disconnectors and reduces the footprint of the substation by more than 50 percent. ABB is the first company to develop this technology for voltage levels up to 500kV.

In the late 1980s, our innovations in substation automation replaced conventional protection and control systems with numerical ones. ABB is also dedicated to the development of industry standards, including those used in substation automation. We have been a driving force in the development and verification of the IEC 61850 substation communications standard since 1995. Since implementing the world’s very first IEC 61850 multi-vendor substation automation system in 2004, ABB has supplied thousands of products and systems for new and retrofit projects. ABB is the world’s leading supplier of air-insulated, gas-insulated and hybrid switchgear and substations, utility communication networks as well as IEC 61850 substation automation, protection and control solutions and systems.
2011

New Applications.
First installation of FOCS optical CT integrated in 400kV Disconnecting Circuit Breaker.

1998

Sensors
Commissining of the first Digital Substation with sensors for current and voltage.

1900s

Conventional
Instrument transformers.
ABB’s Digital Substation is a significant breakthrough. Innovation in substation technology.

Based on the seamless integration of state-of-the-art IEC 61850-based control and protection IEDs, with all relevant primary components and sensors of a modern substation. The primary components include high and medium-voltage switchgear, as well as substation transformers.

The defining feature of a Digital Substation is the implementation of a process bus. The IEC 61850 process bus enables the substitution of point-to-point copper connections between IEDs, other devices (e.g. instruments transformers, gas monitoring, MotorDrive™, etc.) and switchgear by means of a safe, standardized optical communication bus. Thanks to the process bus, real-time measurement signals and status information can be broadcast throughout a substation without complex wiring schemes.

In the late nineties, ABB commissioned the world’s first Digital Substation in Australia for Powerlink, a transmission service provider in Queensland. Even though the concept has evolved since then, the basic principles remain the same; substituting heavy and bulky current and voltage sensors with small and integrated sensors and substitute signaling copper wires with fiber optic communication buses. From 2008 onwards, ABB introduced the IEC61850-9-2 process bus between non-conventional instrument transformers and protection and control equipment. Digital Substations enable electric power utilities to increase productivity, reduce footprint, increase functionality, improve the reliability of assets and, crucially, improve safety for service personnel. Digital Substations exploit the benefits of digital protection, control and communication technologies, mirroring the trend towards digitalization seen in many other industries.

This trend towards digitalization also applies to other areas of the substation. Within medium-voltage switchgear panels, the horizontal exchange of IEC 61850-8-1 GOOSE and sampled analog values reduces wiring and accelerates the testing and commissioning. Digitalized technology can now continuously monitor mission-critical functions of high and medium voltage switchgear as well as substation transformers, while performing real-time simulation and diagnostics, ensuring that the pro-active management of the assets lifecycle is now possible.

The availability of increasing amount of data in the substation calls for better solutions to turn this data into actionable information, and to
ensure that data is properly and securely managed. The latest Substation Data Management and Asset Health management solutions offer means for a power utility to exploit the latest advances in this area.

ABB’s Digital Substation concept has also paved the way for well-known innovative switchgear solutions such as PASS (Plug and Switch System) and most recently the Disconnecting Circuit Breakers with integrated Fiber Optic Current Sensors (DCB with FOCS).
Digital Substation Benefits.

Bridging the gap between analogue and digital, enabling a safer work environment and reduced maintenance costs.

Thousands of engineering intensive and costly point-to-point copper signaling wires can be replaced by few fiber optic communication buses. The IEC 61850 standard safeguards the investment of the substation owners and enables interoperability between vendors of substation equipment.

Personnel safety is improved since less signal connections or inadvertently opened CT circuits can harm personnel during commissioning and service activities. Ultra-fast earthing switches installed in medium voltage cubicles to prevent disruptive and catastrophic damages caused by an arcing faults.

Digital Substations enable the reduction of the footprint of a substation because less space is required for protection and control panels and functions previously executed by physically separate equipment can now be integrated in one device.

For example, in Air Insulated Switchgear (AIS) substations a Current Measurement transformer can be replaced by an optical sensor (Fiber Optic Current Sensor) and fully integrated inside a Live Tank Breaker together with disconnecting and earthing functions. In the case of an Air Insulated Switchgear substation, the footprint can be reduced by 50% compared to a conventional solution*. Higher productivity can be achieved by means of new asset management systems with monitoring and diagnostics data from substation equipment. This feature substantially improves the efficiency of service activities. Monitoring and diagnostics is a strategic feature for utilities further reducing outage time and increasing reliability.

Transient stresses can be mitigated by means of point-on-wave switching which needs data from various sensors, meaning in many cases expensive closing resistors become obsolete.

To meet the increased need for the flexibility of the transmission and distribution grids, Digital Substations provide data and information that is required for the control of grid stability and for a quick response to changing grid conditions due to the integration of intermittent resources.

Digital Substations bring unseen opportunities for modern utilities.

Cyber Security
Protecting systems from cyber abuse or vandalism from the outside world.

Increased Safety
Digital substations reduces the risk of electrical shock by substituting copper wires with fiber optic cables.

Improved Asset Management
Gain control of the substation hardware with second-by-second analysis and control.

Backwards Compatibility
Deep integration with legacy products, supporting utility communication from the past and into the future.
**Future Proof**
Digital Substation enables faster implementation of future technologies.

**Software Based Testing**
Safe testing with software based simulation and verification.

**Lower CT Requirements**
Digitizing data right in the field, reduces burden and lowers CT requirements.

**Improved Asset Management**
Gain control of the substation hardware with second by second analysis and control.

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* Future Proof
Digital Substation enables faster implementation of future technologies.

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**Based on a typical conventional 400kV double busbar AIS substation compared to a modern variant using SAM600 process bus I/O system and FOCIS integrated in disconnecting circuit breakers.

** Of new secondary systems.

*** During secondary system retrofits.
Key Digital Substation Technologies.

Digitalization affects all components and aspects of a substation.

To deploy their full benefits for the owner and operator, the Digital Substation features have to be planned and designed during the specification phase. This ensures that in the medium term, substantial productivity gains are achievable in operation thanks to better asset utilization and thanks to synergies between various departments such as station control, automation and protection.

1. High Voltage Primary Equipment
Primary High Voltage switchgear in Air Insulated technology (AIS), Gas-Insulated technology or Hybrid Technology (PASS) Non-Conventional Instrument Transformers enable smaller substation footprint and easier engineering. Alternatively, existing CTs & VTs can be connected to Stand Alone Merging Units, which connect the analogue measurement signals to the process bus.

2. Protection, Supervision and Control
The substation automation, protection and control system solutions ensure reliable power transmission and distribution.

To ensure interoperable and future-proof solutions, the substation automation, protection and control system has to be designed to implement the core values of the IEC 61850 standard.

3. Medium Voltage Switchgear
Air and gas insulated switchgear solutions for primary and secondary distribution that suits various applications like railway power supply and wind farm integration.

4. Communication Networks
The Communication Network inside the substation and from the substation to remote network control centers. These solutions fulfill the highest demands with respect to safety, reliability, and real time response.

Extending the Digital Grid.

Monitoring & Diagnostics
Through remote access, the asset owner can evaluate the status of the equipment without dispatching an engineer to the site, saving both valuable time and resources. Since monitoring detects condition changes in real-time – versus periodically with traditional diagnostic methods – the asset owner has time to plan and act before faults occur.

Historian and System Data Management
Historian effortlessly collects, archives and enables you to visualize and analyze the primary process data. System Data Management software provides a solution for the automatic management of service and cyber security relevant data across your substations.

Digital Operations
An unparalleled range of solutions for asset performance management, operations and workforce management, and network control to help customers reach new levels of efficiency, reliability, safety and sustainability. With the capabilities to integrate information technologies (IT) and operational technologies (OT) to provide complete solutions to our customers’ business challenges.
The Substation Evolution.

Transition from conventional schemes to the Digital Substation.

Traditional substations have always relied on copper cables connecting together primary equipment like circuit breakers, conventional current and voltage transformers and protection relays. But digital technologies, communications and standards are driving the evolution of something new – Digital Substations.

![Diagram showing the evolution from conventional to modern and digital substations.](image-url)