We are bridging the gap. ABB Digital Substation

ABB’s Digital Substation is a core enabler to increase safety, productivity and reliability for grid operators and to reduce the overall substation cost.
“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 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
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ABB’s Digital Substation is a core enabler to increase safety, productivity and reliability for grid operators and to reduce the overall substation cost.

Digital substations remove the last electrical connection between the high voltage equipment and the protection and control panels, creating a safer work environment, while 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 offer improved data quality and a shorter decision time in the event of an emergency.
Leading substation development for over 100 years.

Dependable substation performance is a key factor for grid reliability. ABB has been designing and building substations since the 1900s.

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 first major technological step was in 1965, with the introduction of gas-insulated switchgear (GIS) that reduced substation footprints. Alongside the development of GIS technologies, ABB has significantly improved the performance of conventional air-insulated switchgear (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 substation footprint 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.
ABB Ability™

2017
ABB Ability™ launched
Enabling end to end digitalization from the process level to the control room and beyond.

2011
New applications
First installation of FOCS optical CT integrated in 400kV disconnecting circuit breaker.

1998
Sensors
Commissioning of the first digital substation with sensors for current and voltage.

1900s
Conventional
Instrument transformers.
ABB Digital Substation
A significant breakthrough 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 1990s, 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, bulky current and voltage sensors with small, 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 amounts 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.

The ABB Digital Substation 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).
ABB Digital Substation benefits.

Bridging the gap between analogue and digital. Enabling a safer work environment, reduced maintenance costs and end-to-end digitalization from the process level to the control room and beyond.

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.

Safety is improved because 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 prevent disruptive and catastrophic damages caused by 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 AIS 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.
— Based on a typical conventional 400kV double busbar AIS substation compared to a modern variant using SAM600 process bus I/O system and FOCS integrated in disconnecting circuit breakers.
— ** Of new secondary systems.
— *** During secondary system retrofits.

**Up to 80% copper cable reduction***

**40% shorter installation phase**

**Up to 60% less space in the relay house***

**Operational cost reduction**

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**Future-proof**
Digital substations enable faster implementation of future technologies.

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

**Software-based testing**
Safe testing with software based simulation and verification.