Digital substations
Introduction, benefits, offerings
Outline

What is a digital substation?

Benefits of digital substations

ABB offering for digital substations
Substation evolution

Network Level
- Network Management
- Serial Communications
- MPLS-TP

Station Level
- IEC 61850
- Copper Cables
- Protection and control IEDs

Bay Level
- Hand-wired Protection & Control
- Copper Cables

Process Level
- Conventional monitoring cabinet
- Conventional busbar
- IEDs with FOCIS

Conventional | Modern | Digital
Evolution of current and voltage transformer

From conventional CTs and VTs to NCITs*

New applications like combined current and voltage NCITs for metering and protection

Standardized integration of protection, control and metering with IEC 61850

Present

Evolution of conventional VTs and CTs

Sensors for current and voltage

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*NCITs = non-conventional instrument transformers
What is a digital substation

Comparison of conventional and digital

Conventional substation

Digital substation

Digital substations reduce cabling, need less space and increase safety.
Digital Substation and IEC 61850

Conventional

Conventional substations

IEC 61850 Station Bus
Replace wiring and legacy protocols between bays by digital communication

Interface to field
Hardwired point to point connections between primary and all secondary equipment

Thousands of hardwired point-point connections
Digital Substation and IEC 61850

Digital

Digital substations with process bus

- All signals digital on station and process level
- All information available on communication network analog measurements, switchgear status, monitoring data
- Control and protection commands on highly available fiber optics
- Information is acquired ones and distributed on the bus

The process bus reduces cabling and efficiently distributes information
ABB Digital Substation

- Cyber security on substation borders, system level and in the electronic devices
- Utility communication on MPLS/TP and existing SDH networks with FOX615
- Relay room with process bus based protection
- Process bus
- GIS w. NCIT for U&I Smart local control cubicle with redundant control and MSM switchgear supervision
- SAM600 to digitize bushing CT measurements CoreTec transformer monitoring with CoreSense
- UniGear Digital MV switchgear with NCITs
- Extended operator workplace
- Intelligent substation HMI
- FOXMAN NMS
- Building mgmt. system
- MicroGrid HMI
- Asset Health Center
- MicroGrid with Photovoltaic panels
- Trojan Energy Storage
- Utility communication on MPLS/TP and existing SDH networks with FOX615
- Mobile workforce management
- Enterprise asset management
- Extended operator workplace
- Intelligent substation HMI
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Outline

What is a digital substation?

Benefits of digital substations

ABB offering for digital substations
Benefits of digital substations

Overview

Main benefits

- Safety
- Reduced substation footprint
- Interoperability
- Reduces copper cabling
- Ease of configuration
- Maximum reliability and availability
- Real-time performance
- Smart Grid communications capabilities
- Reduces cost of ownership

Digital substations are safer to operate, future proof and require less space
Benefits of digital substations

Increased safety

Reduced risk of electrical shock

- Handling of current transformer circuits and signaling voltage poses a threat to life and equipment
- Process bus eliminates the galvanic connection between protection and control panels and the switchyard.
- Eliminates CT and VT circuits in the protection & control panels
- Replaces conventional 110/220VDC indications with fiber optics

Eliminates the electrical connection between primary and secondary
Benefits of digital substations

Less transport

**Less material means less transport and CO₂ emissions**

- More than 30 tons less material to be transported to site for an average sized transmission level substation
- The weight of the fiber optic cabling is around 90% less than the copper cables it replaces
- If CTs are replaced by optical ones, almost 80% weight reduction on CTs is achieved

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<thead>
<tr>
<th>Conventional substation</th>
<th>Digital substation</th>
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Around 30t
Less material

Less transport, less CO₂, less heavy lifting equipment required
Benefits of digital substations

Less space

**Space requirement reduced by half**

Up to 60% and more reduced space for protection and control panels

- The IEDs require less space due to absence of conventional IOs
- Absence of terminals enable integration of more IEDs per panel
- Integration of protection in GIS LCC enables further space reduction

Reduction of switchyard footprint by up to 50%

- By using circuit breakers with integrated disconnecting functionality and optical current transformers

High function integration in relay room and switchyard enable space reduction

Conventional substation

Digital substation

Up to 60% less space in relay room

Up to 50% reduction space in the switchyard
### Benefits of digital substations

**Less installation and outage time**

**Shorter time for secondary system installation and refurbishment**

- 40% reduction of installation time for new protection and control systems.
  - Fewer panels to install
  - Fewer cables to be pulled, connected, tested
- Reduction of feeder outage time by 40 to 50% during secondary system upgrades
  - Full system test from process IO to protection, control and scada system off-site
  - Installation of new FO based system while station is in service
  - Flexible placement of new protection panels, without depending on SS cabling

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**Shorter outage times increase system availability and utility revenues**

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**Benefits of digital substations**

**Operational cost reduction**

**Savings in maintenance and future retrofits**

Efficient maintenance
- Supervision of all exchanged data, reduces the need for periodic maintenance testing
- Permanent supervision enables fast and precise actions in case of failures

Fast and save testing
- IEC 61850 testing and simulation features enable fast and save isolation and testing of protection functions

Standard compliance enables efficient future retrofits of secondary system

**Lower operational costs thanks to supervision and standards**

**Conventional substation**

**Digital substation**

Operational cost reduction
Outline

What is a digital substation?

Benefits of digital substations

**ABB offering for digital substations**
Digital Substation portfolio & architecture
The ABB offering for digital substations
SDM600 System data manager

See the unseen from a new perspective

The comprehensive software solution for automatic management of service and cyber security relevant data across your substations
- Disturbance recorder handling
- Cyber security management
- Maintenance and service data management

SDM600 sets new marks in ease of configuration and visualization of data
Digitally Managed Assets & Workforce Mobility

Cyber security on substation borders, system level and in the electronic devices

Utility communication on MPLS/TP and existing SDH networks with FOX615

Relay room with process bus based protection

Process bus

GIS w. NCIT for U&I
Smart local control cubicle with redundant control and MSM switchgear supervision

High Voltage

SAM600 to digitize bushing CT measurements
CoreTec transformer monitoring with CoreSense

Medium Voltage

UniGear Digital MV switchgear with NCITs

Low Voltage

Building management system with RTU500 for integration of sensors and actuators

Extended operator workplace

FOXMAN NMS

Building mgmt. system

MicroGrid HMI

Asset Health Center

MicroGrid with Photovoltaic panels
MicroGrid controller
Battery Energy Storage

EV Charging

Enterprise asset management
Mobile workforce management

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Digitally Managed Assets & Workforce Mobility

Connected Asset Lifecycle Management

Asset Performance Management

Extend asset life with predictive maintenance

Enterprise Asset Management

Maximise asset availability with industry best practices

Workforce Management

Optimise worker productivity with a mobile workforce

ABB Ability™ Connected Asset Lifecycle Management™

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Integration with substation automation

ABB Ability™ Connected Asset Lifecycle Management™

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Continuous optimization and improvement

All data sources:
• Sensors
• Historian
• Databases
• EAM

Expert models (ABB, third party)
Statistical models (Azure Machine Learning)

Connect / collect
Analyze / predict
Inform

Track
Act

Enterprise asset and work management

Advanced operational business intelligence
Digitally Managed Assets & Workforce Mobility

EAM – Ellipse Select

Ellipse Select Maintenance

**Ellipse** is the #1 Enterprise Asset and Work Management system for asset-intensive industries¹

**Ellipse Select** is the pre-configured version of Ellipse enabling:
- Immediate business outcomes
- Built-in best practices
- Fast implementation

ABB has been delivering EAM software for over 35 years

¹ARC Advisory, EAM for Electric Power Generation, Electric Power T&D, and Mining, 2016
Digitally Managed Assets & Workforce Mobility

Ellipse SaaS Apps

**Ellipse SaaS Apps**

**Approvals app** – Review and provide financial approval on requisitions, invoices, contracts and other financial documents

**RequestWork app** – Capture image and text information, and raise a work request for processing in Ellipse

**ExecuteWork app** – Workers complete assigned work orders, report labor and maintain the work log

Purpose-built for the task; intended to be simple, intuitive and require less up-front training
Digitally Managed Assets & Workforce Mobility

Case Study – Potential Annual Savings

- **8% O&M**: Optimized maintenance strategy
- **+3 years**: Increased life of assets
- **2%**: Overtime costs

- **4% O&M**: Optimized labor
- **Risk**: Safety, Environmental, Regulatory
- **millions**: Capital replacement & deferred depreciation

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## Digitally Managed Assets & Workforce Mobility

**Case Study – Additional Potential Savings**

<table>
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<tr>
<th>Top Benefits</th>
<th>How ABB Helps</th>
<th>Sample Business Outcomes</th>
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<tbody>
<tr>
<td>Reduce downtime and improve safety</td>
<td>Assessing criticality focuses priority work</td>
<td>26% improvement in asset availability from 71% to 90% in five years</td>
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<tr>
<td>Improve effectiveness of asset management across the lifecycle</td>
<td>Enhancements to streamline processes across asset acquisition, build, repair and disposal</td>
<td>36% Increased jobs completed per technician by 15%-36%</td>
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<tr>
<td>Improve proactive maintenance by consistently deploying maintenance strategy</td>
<td>Utilising templates effectively ensures consistent maintenance strategy</td>
<td>10% Reduce asset running costs by 10%</td>
</tr>
<tr>
<td>Get a comprehensive view of Return on Assets</td>
<td>Complete visibility into assets cost with the productive unit hierarchy</td>
<td></td>
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