ABB LITHUANIA 25YEARS CELEBRATION 2017

ABB’s Digital Substations for reliable next generation Transmission Networks

"Let's write the future. Together"

Hugo E. Meier, Business Unit Product Manager Grid Automation

ABB's Digital Substations for reliable next generation Transmission Networks

- Look and feel..
- The challenges …
- The evolution…
- Key enablers..
- Bringing it all together ..
- Experiences and References
- Benefits
- "the digital summary"

Substation

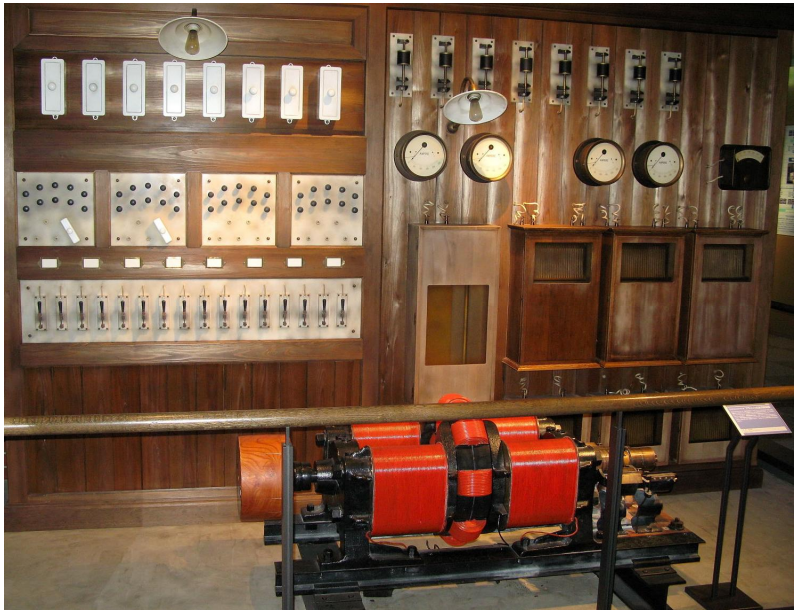
How does a substation look like?

Large Air Insulated Substation (AIS)

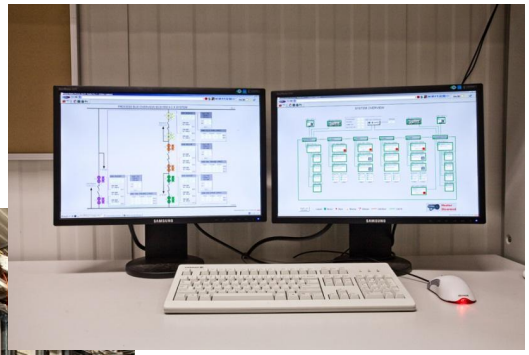
Large Gas Insulated Substation (GIS)

Substation Automation

100 years ago



today



The challenges for utilities and suppliers

Challenges in the market place

- Increasing demand on refurbishment of substations
- Project execution under increasing cost and time pressure
- Better utilization of existing assets
- Increased expectations on transmission system availability
- Safeguard investment over the entire life cycle
- Sustainability in the qualification of operators and suppliers

Digital substations respond to today's utility challenges

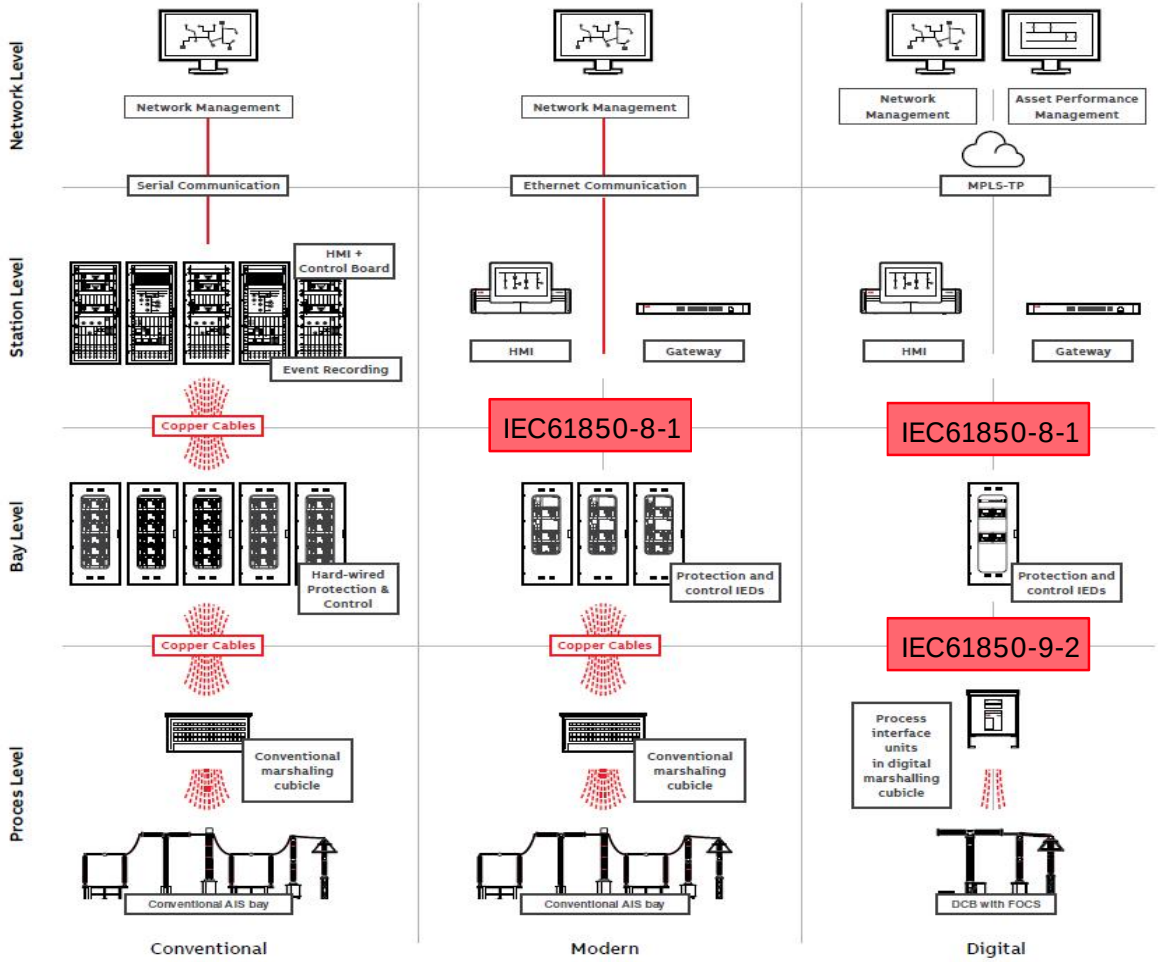
The Substation Evolution

Transition from conventional to the Digital Substation

Key enablers

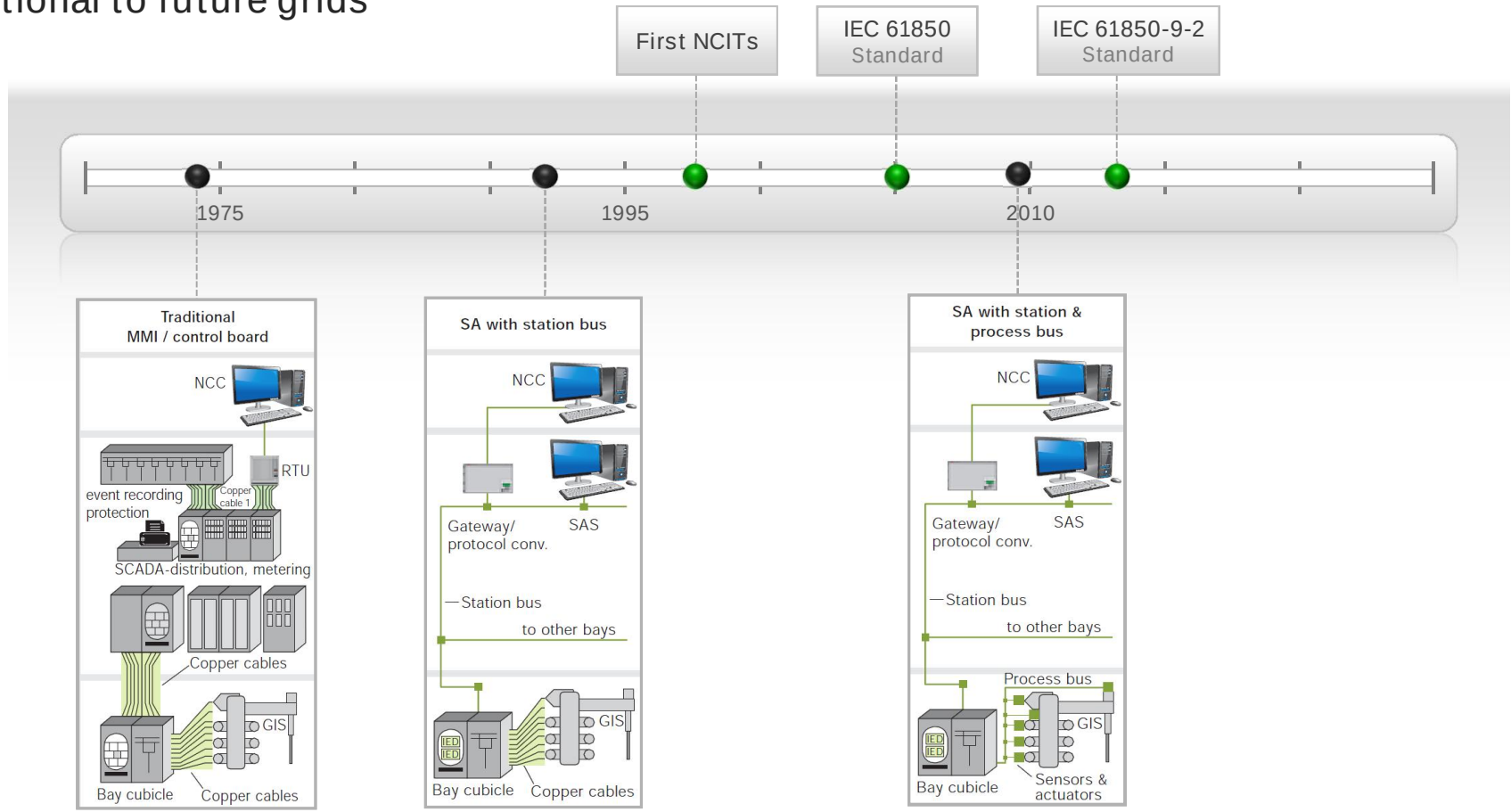
Traditional substations have always relied on copper cables connecting together primary equipment like circuit breakers, conventional current and voltage transformers and protection relays. But digital technologies, communications and standards are driving the evolution of something new – Digital Substations.

- IEC61850
- IEC61950-8-1 Station bus
- IEC61850-9-2 Process bus
- NCIT nonconventional transformers
- SAM Standalone-merging units
- Sensors and actuators



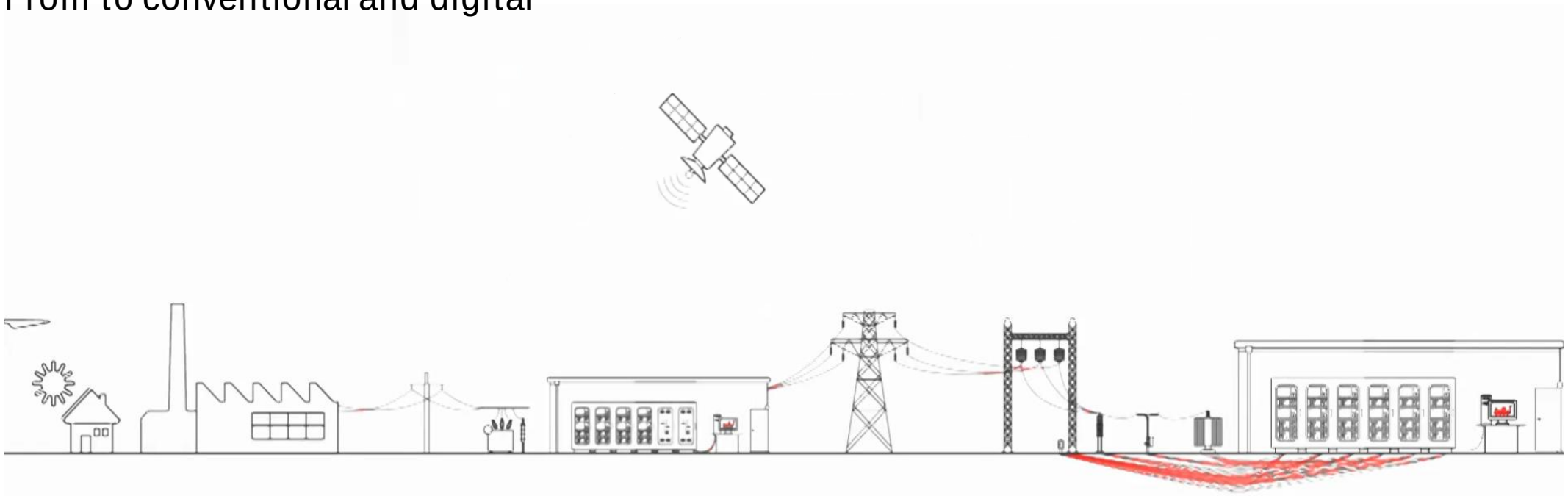
Trends and technologies of control systems

From traditional to future grids



What is a digital substation

From to conventional and digital



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

What is Digitalization ?

Digitization is the conversion of analog information in any form (text, photos, voice, etc.) to digital form with suitable electronic devices (smartphone, laptop, sensor, etc.) so that the information can be processed, stored, and transmitted digitally

Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities - it is the process of moving to a digital business

“By 2020, 50% of the Global 2000 will see the majority of their business depend on their ability to create digitally-enhanced products, services, and experiences. For industry leaders, the fastest revenue growth will come from information-based products and services. To facilitate the development of these products and services, worldwide investment in (digitalization) initiatives will reach $2.2 trillion in 2019, almost 60% more than in 2016.”

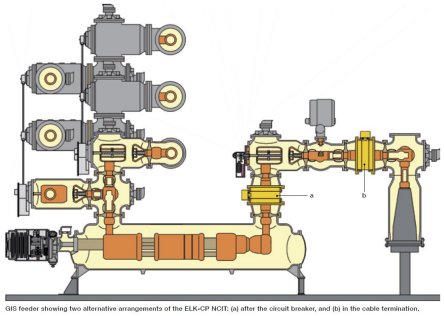
Source: IDC, 2016

Examples:

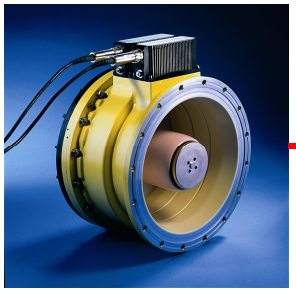
- Starwood's SPG Keyless Lets Guests Access Their Room With a Smartphone
- Babolat “Play” Connected Tennis Racquet Lets Players Analyze Their Game
- British Gas Provides a Smart Home Heating Controller Called Hive Active Heating

Digital Substation

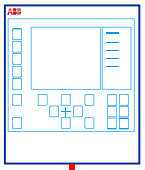
NCIT (sensors) solutions for GIS and AIS



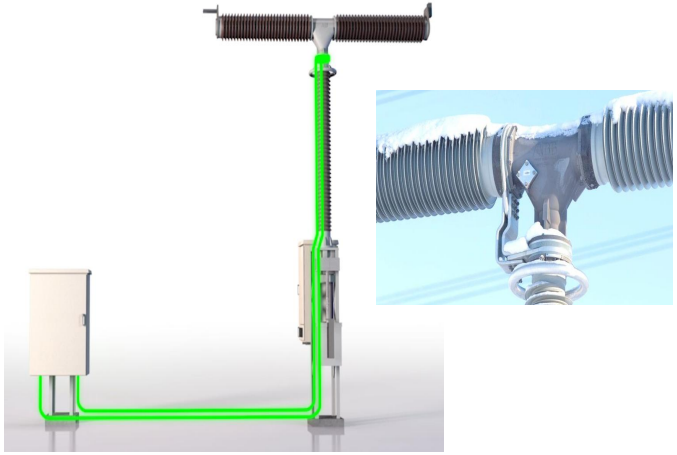
GIS feeder showing two alternative arrangements of the ELK-CP NCIT: (a) after the circuit breaker, and (b) in the cable termination.



Combined Current & Voltage sensor for GIS



Control and Protection



FOCS sensor head and electronics for AIS

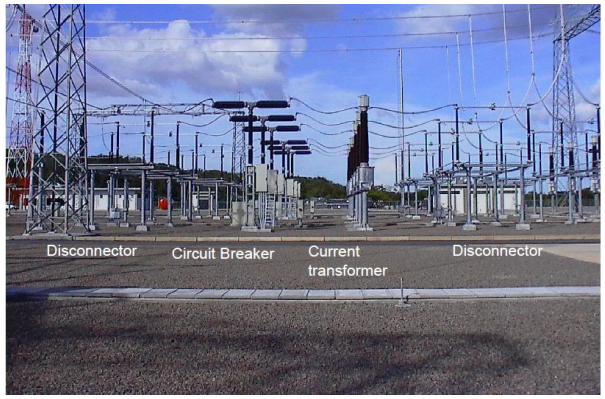
IEC 61850-9-2 LE

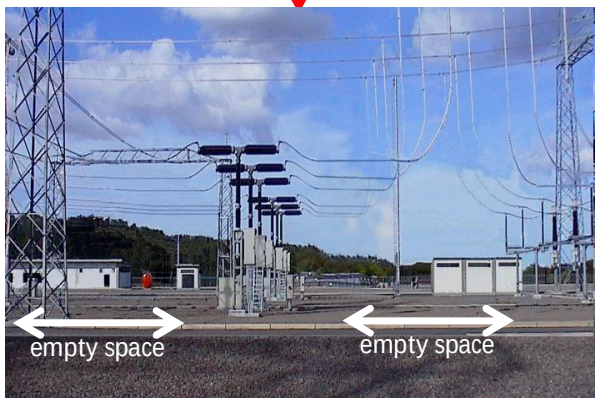
Digital Substation

Innovative solutions for a smaller foot-print

Values of smaller foot-prints

- Put SS at optimal location
- Reduce demand of land
- Less foundation costs
- Lower cost of civil work
- Less transportation
- Less material
- Prefab., pretested solutions
- Lower transportation costs
- Faster erection and commissioning





Digital Substations

Example: Space reduction in AIS

Space requirement reduced by half

Reduction of AIS switchyard footprint by up to 50%

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

Reduction of GIS footprint by up to 30%

– By using NCITs for current and voltage

– By integrating LCCs to GIS switchgear

High function integration in relay room and switchyard enable space reduction

conventional

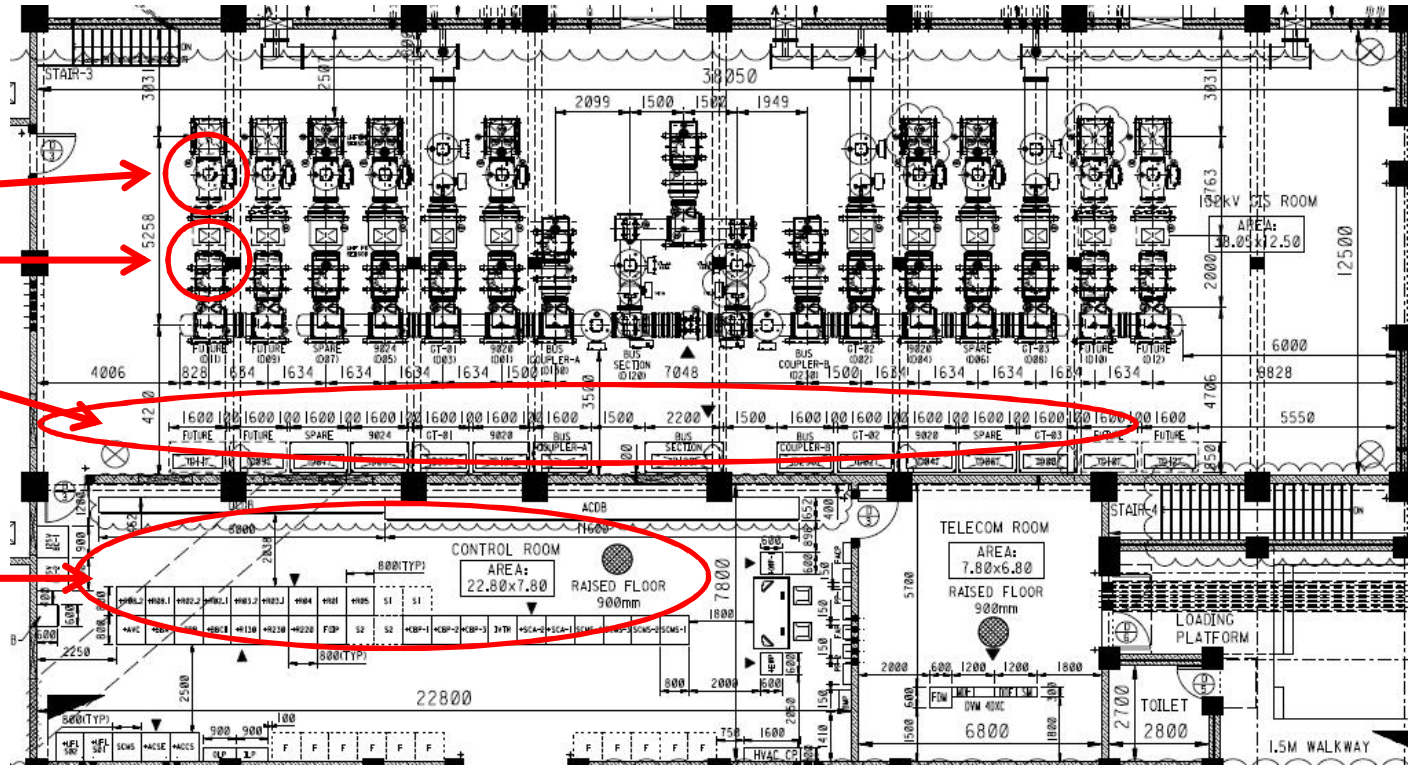
Digital

Up to
50%
reduction
space in the
switchyard

Digital Substation

Example: Opportunities to reduce the foot-print for a 145 kV GIS

- VTs
- CTs
- LCC
- Control room with protection cubicles



Digital Substation

NCIT for GIS hybrid in operation in Switzerland

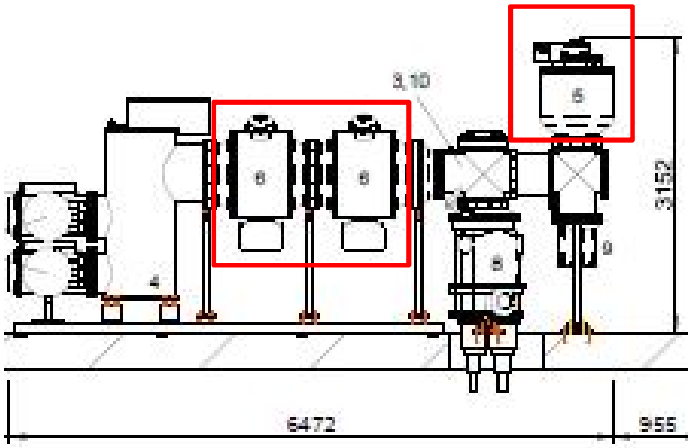
Since 6+ years in continuous operation

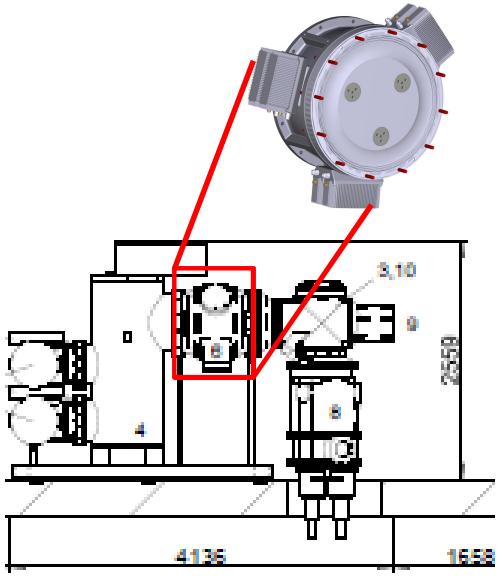
NCIT and IEC 61850-9-2 pilot installation

- ELK-CP3 NCIT for current and voltage
- REL670 line, REB500 busbar protection
- E880 revenue meters from L+G
- Simple commissioning thanks to in-built supervision features of used products
- System in permanent and stable operation since 2009
- Protection performance is same as conventional system
- Measuring accuracy meets expected class 0.2s

Digital Substation

Example: NCIT replace conventional CT and VT in 145 kV GIS



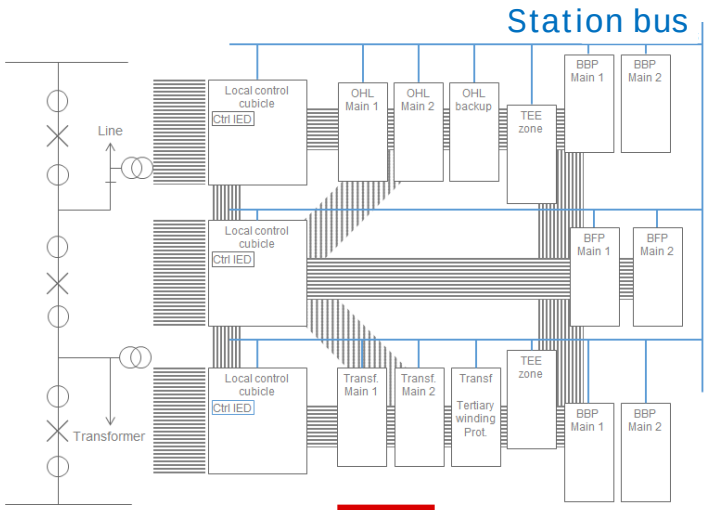


Footprint reduction of up to 30% for HV GIS with NCIT

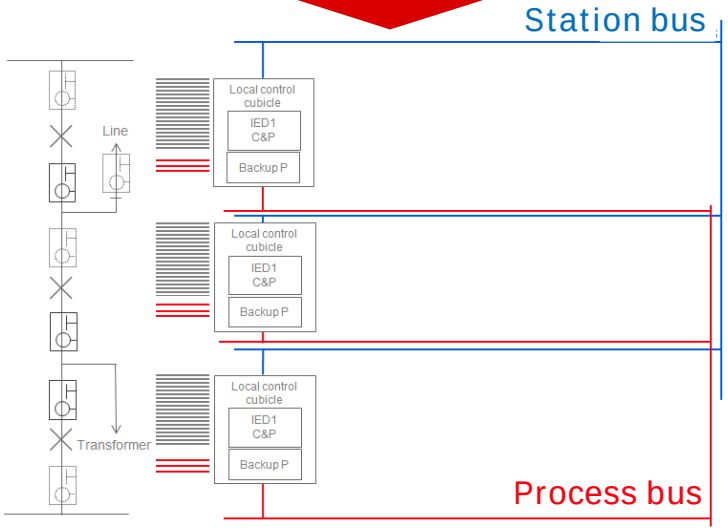
Digital Substation

Simplification of wiring and C&P panels in GIS

conventional



Digital



Full integration

Thanks to the reduction of wires, IOS and IED's the bay control and protection function can be integrated into one GIS bay. Some limitations may be given by the ratings of the primary equipment and by C&P specifications

Digital Substation

Main components with integrated monitoring and diagnostics functions

Features

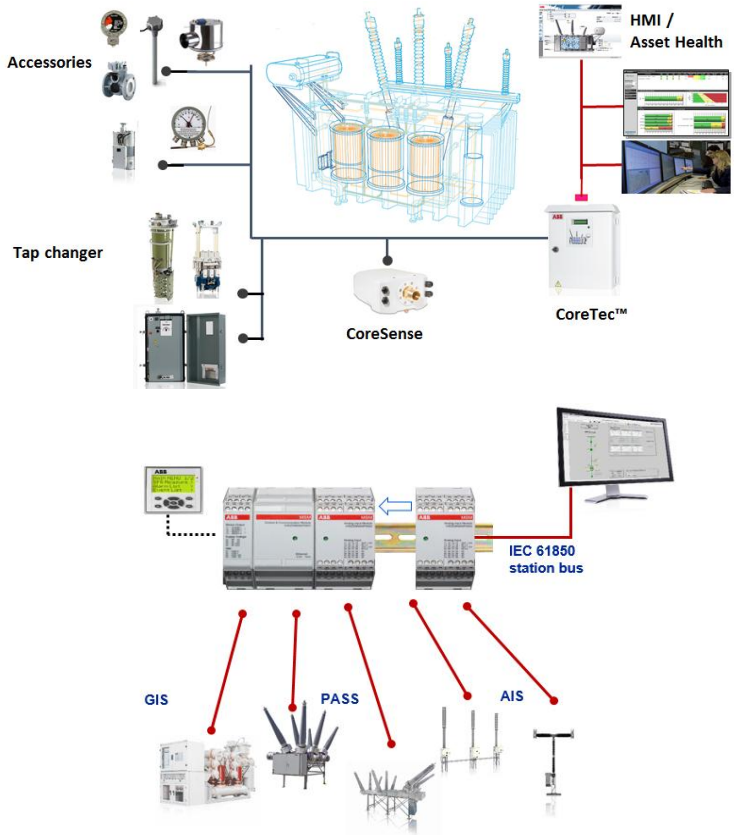
- Monitoring & Diagnostics for switchgear, transformers and IEDs
- Communication via IEC 61850 and other standards
- Connected to station monitoring and network level systems

Benefits

- Allows to shift from fixed time-based to condition or risk-based maintenance schemes
- Future: Dynamic loading (overloading in emergency)

Transformers

Switchgear



The ABB offering for digital substations

SAM600 process bus IO system

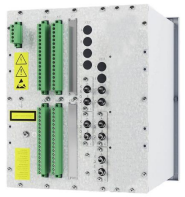
Modular IO system for conventional CTs and VTs

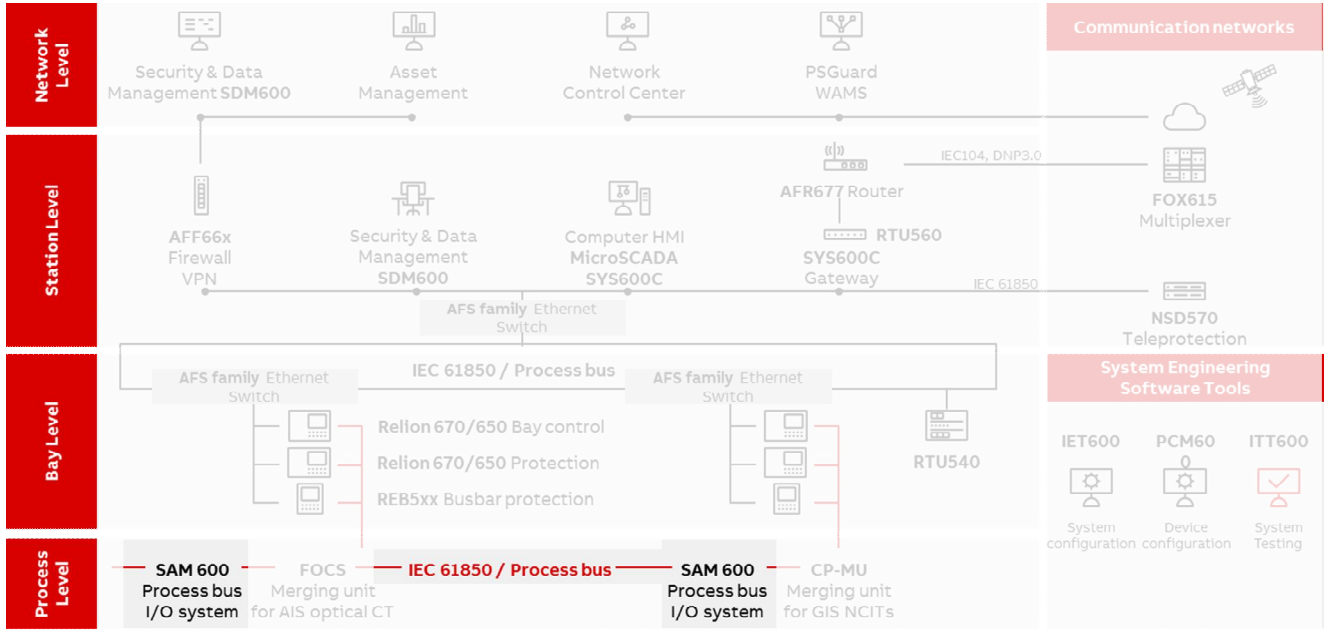
- SAM600-CT for conventional current and SAM600-VT for voltage transformers
- SAM600-TS for time synchronization

Compact modules are chained into a system to optimally adapt to different applications

IO module for binary signals

- Scalable SAM600-IO device for integration of conventional breakers, disconnectors, power transformers… into IEC 61850 process bus

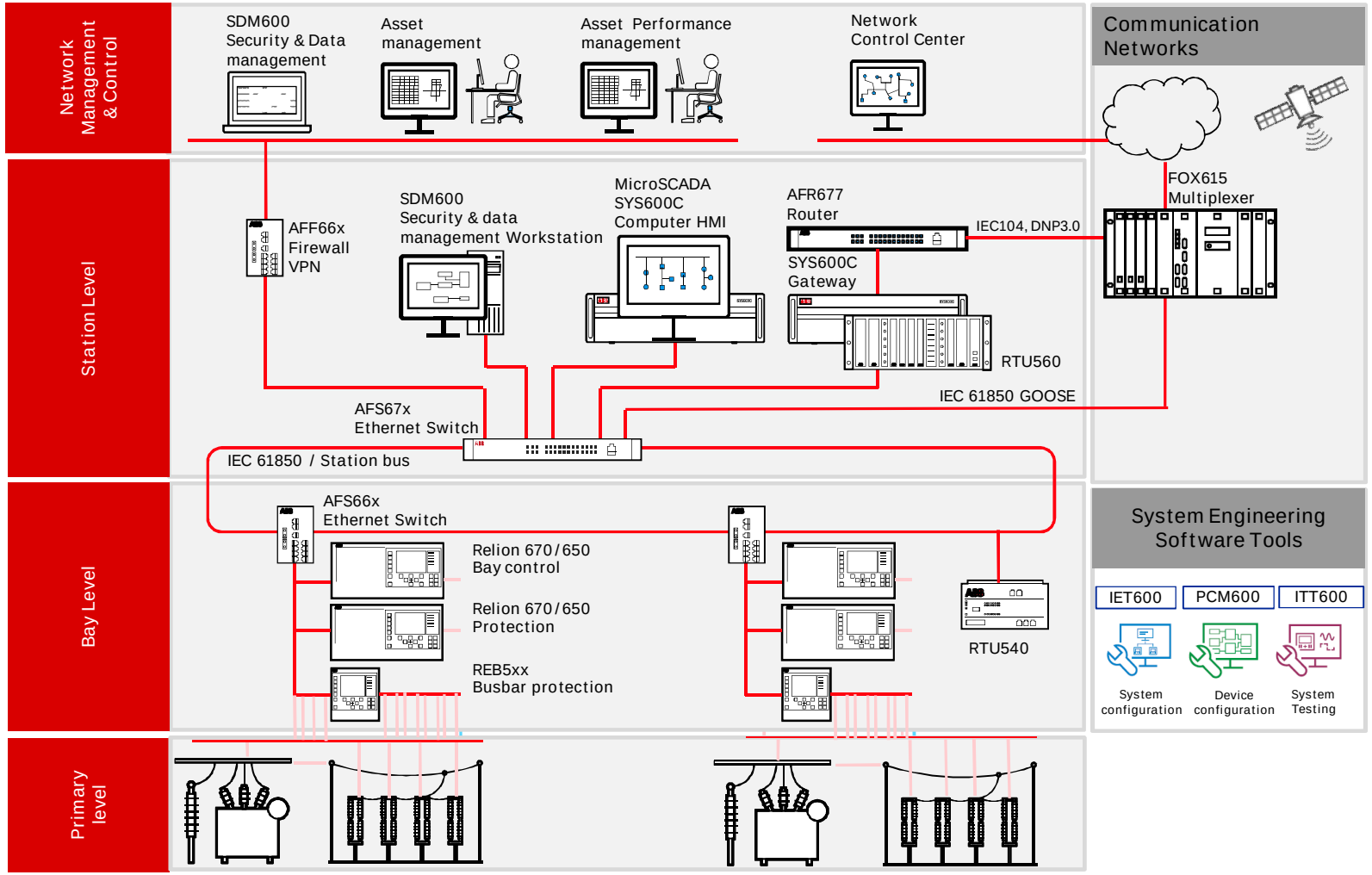




Transmission Automation

Portfolio and architecture

- Digitization of the signals at the process level
- Communication via IEC 61850
- Control, monitoring, supervision and visualization of the substation at station level
- System-wide engineering via integrated software
- Utility Communication via MLPS-TP
- Connectivity to Enterprise level for connected asset life cycle management

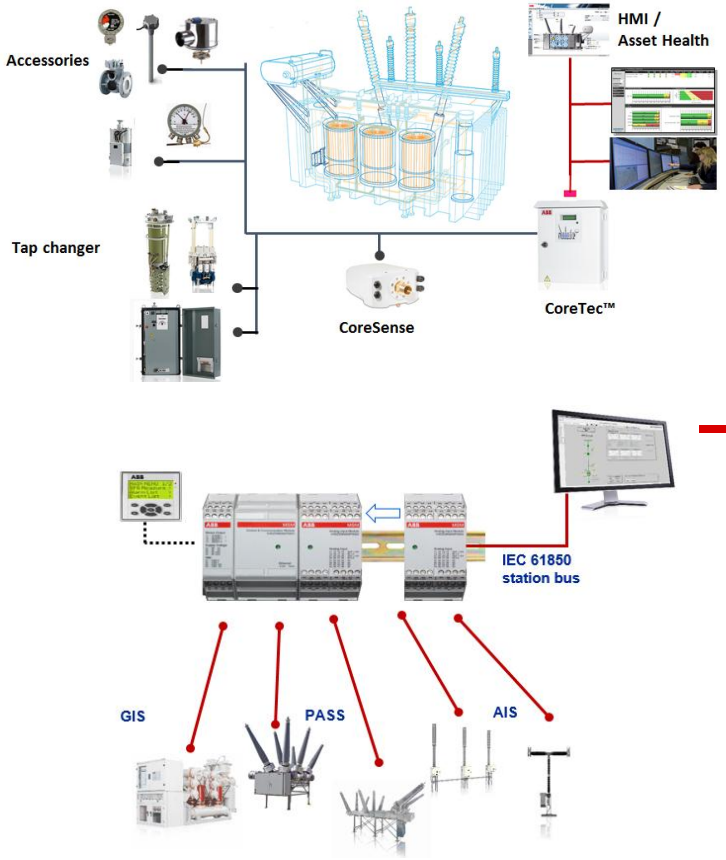


Bringing it all together

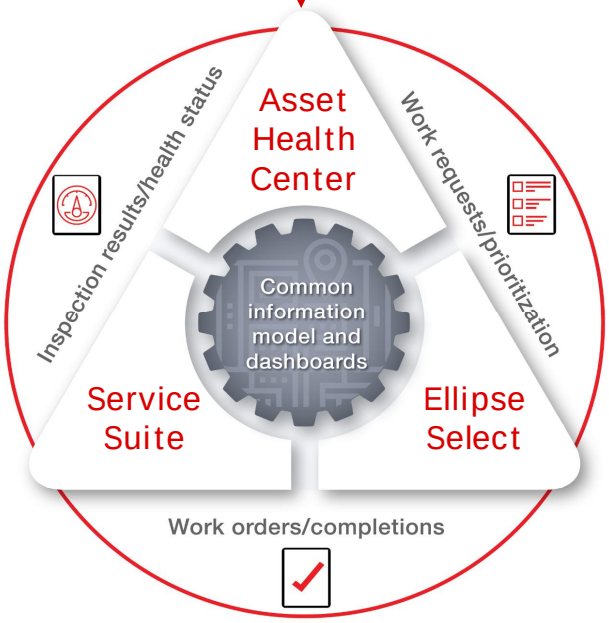
ABB Ability™ Connected Asset Lifecycle Management™

Transformers

Switchgear



- Unifies in a single solution asset management, maintenance and monitoring
- Combines disparate data sources to create a single source of truth
- Proactively predicts, prescribes and prioritizes maintenance
- Enables planning based on risk of failure and operational criticality
- Utilizes expert data modeling for continual improvement
- Leverages real-time operations data for improved efficiencies
- Delivers the right people to the right work at the right time



Connected Asset Lifecycle Management ™

Solution Scope

Asset Performance Management — Optimize asset performance while reducing costs, improving availability, and managing risks

Enterprise Asset Management — Manage physical assets, including asset register, work order management, inventory, and procurement functions

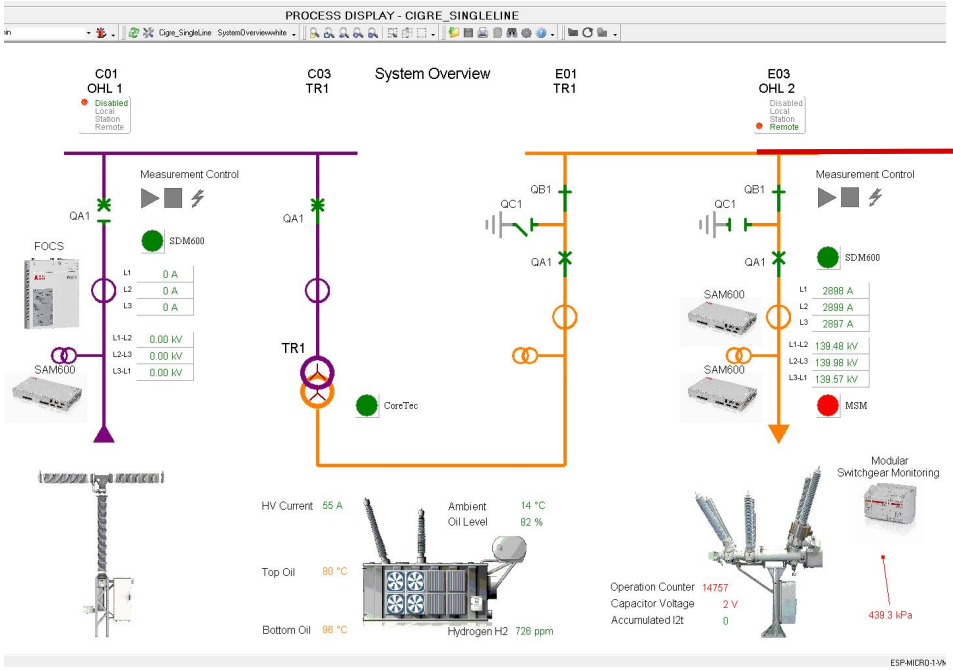
Workforce Management — Maximize productivity of the organization and the individual

Connection to Real Time Systems — Connection to real time systems ensures immediate and reliable data integration

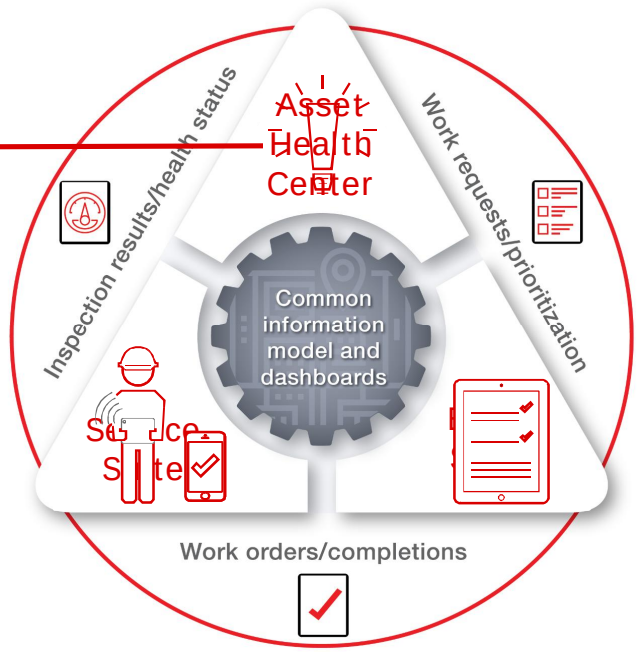
Asset Lifecycle Management is the process of optimizing the business benefit from assets throughout their lifecycle

Bringing it all together

ABB Ability™ Connected Asset Lifecycle Management™



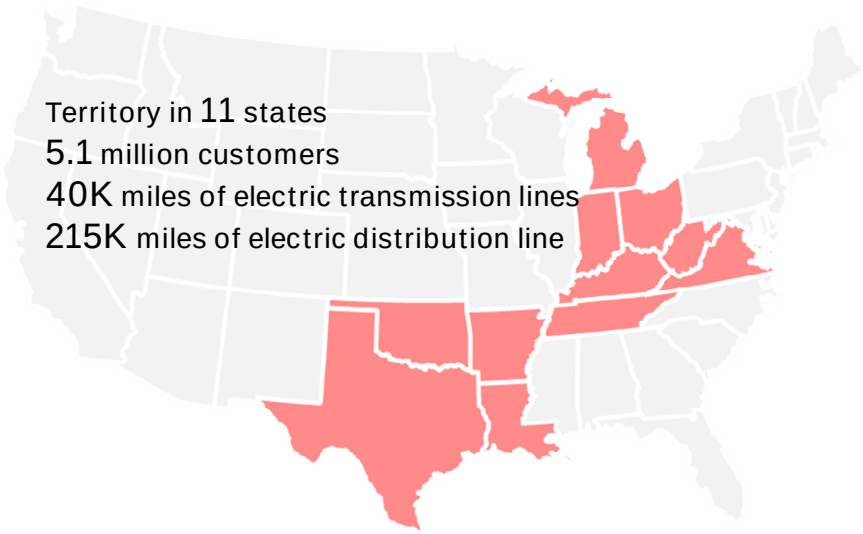
Historian



Integration with Substation Automation System drives work via condition monitoring

Case study

AEP American Electric Power



2 Years from Idea to 30,000 asset constantly managed

Prevented Multiple $5m Transformer Failures

Significant Reduction in O&M Costs

Now expanding to Cables, Capacitors & Other Asset Types

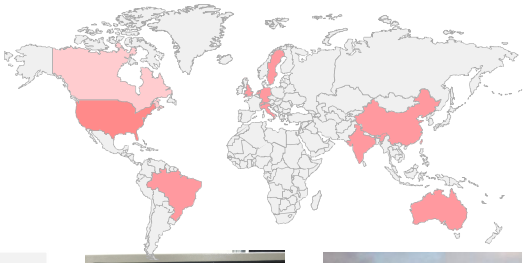
20,572 breakers

8,846 transformers

3,384 batteries

ABB's IEC 61850 digital substation experience

Project highlights



Pilot installation
NL
GIS NCIT
L+G revenue meter

Pilot installation
Braemar, AU
GIS NCIT,
670series

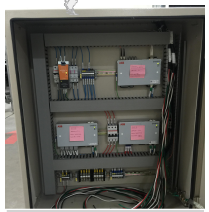
Pilot installation
SvK, SE
DCB with FOCS,
670series

Pilot installation
Nehden, DE
3rd party NCIT,
REB500

Real installation
Millmerran, AU
GIS NCIT,
670series, REB500

Pilot installation
Vattenfall, SE
AIS 3rd party NCIT,
670, 630, 615series

Pilot installation
TPC, TW
SAM600
670series, 3rd party



Pilot installation
TPC, TW
SAM600
670series, 3rd party

Real installation
UK
SAM600, FOCS
670series, 3rd party

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017

Pilot installation
Laufenburg, CH
GIS NCIT,
670series, REB500

Real installation
Loganlea, AU
GIS NCIT,
670series, REB500

Pilot installation
CH
GIS NCIT,
670series, 3rd party

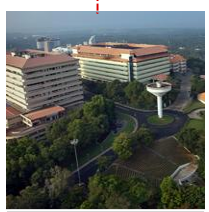
Real installation
Bulli Creek, AU*
GIS NCIT,
670series, REB500

Pilot
installation UK
GIS NCIT,
670 series

Pilot installation
CN (several)
DCB with FOCS
3rd party

Pilot installation
US
DTB with FOCS,
SAM600, 670 series

Pilot installation
BR
SAM600
670series



Real installation
IN
SAM600
670, 615 series

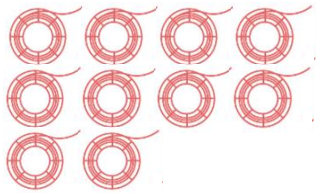
* 3 more projects under commissioning by utility
Pilot projects are installations to verify technology and compare to traditional systems
Real projects are installations without traditional backup

Benefits of digital substations

Less copper

Reduction in copper cables by up to 80%*

Conventional substation



Digital substation

Up to
80%
copper cable reduction

Point to point copper connections get replaced with fiber optics

30 tons less material

Conventional substation

Digital substation

Around
30t
Less material

Less transport, less CO2, less heavy lifting equipment required

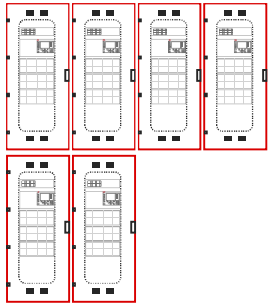
* in transmission level AIS substations

Benefits of digital substations

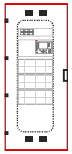
Less space in relay room

Space requirement reduced by half

Conventional substation



Digital substation

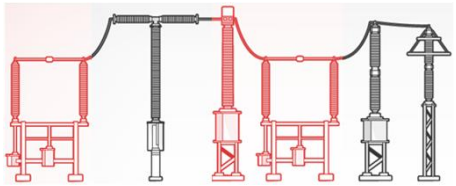


Up to
60%
less space in relay room

High function integration, smaller IEDs and fewer conventional components enables space reduction

Space requirement reduced by half

Conventional substation

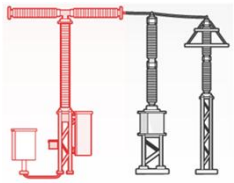


Disconnector

CT

Disconnector

Digital substation



Circuit breaker with integrated optical CT and disconnecting function

Up to
50%
reduction space in the switchyard

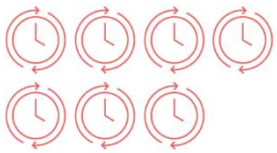
High function integration and NCITs enable space reduction in the switchyard

Benefits of digital substations

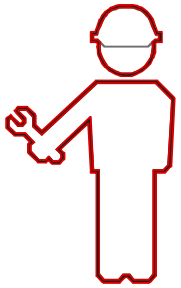
Shorter installation time

Shorter time for secondary system installation

Conventional substation



Digital substation

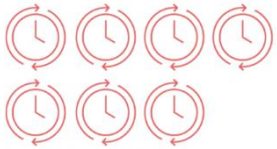


40% shorter installation time of P&C system

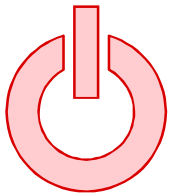
Shorter installation time decreases project runtime

Shorter time for secondary system refurbishment

Conventional substation



Digital substation



40% outage time reduction during P&C retrofit

Shorter outage times increase system availability and utility revenues

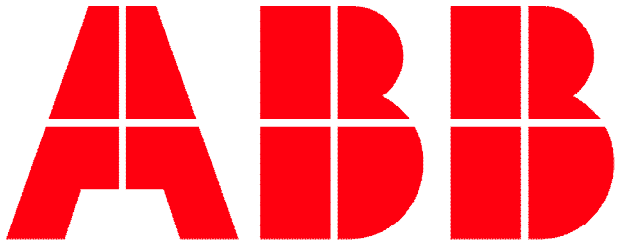
Benefits of digital substations

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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