OCTOBER 26, 2017

Smart devices & IOT change the way data centers operate

Data center webinar series
Dave Sterlace, Don Elliott
The future of data centers is being influenced by industrial trends, such as hyperscale, modularity, wireless, security, and digital. In each session of this series you will learn innovative design and operations strategies driven by these trends to improve availability, scalability and efficiency.

Data center webinar series
Technology and design strategies for the data centers of tomorrow

The future takes ability: Control for the industrialized data center
August 24, 2017
11:00 a.m. EST

Benefits of modularity in a data center
September 21, 2017
11:00 a.m. EST

Smart devices and IOT change the way data centers operate
October 26, 2017
11:00 a.m. EST

Transformer design and maintenance strategies for reliability, safety and efficiencies
November 7, 2017
11:00 a.m. EST
Speakers

Dave Sterlance  
Global Head, Data Center Technology, ABB

Don Elliott  
Product Management, Medium Voltage ABB
IOT overview and trends
# Drivers behind today’s data center

Smarter, larger, and more secure

<table>
<thead>
<tr>
<th>Unprecedented scale</th>
<th>Wireless</th>
<th>Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>20B connected devices by 2025 per Gartner 50B per Cisco</td>
<td>3000 cell sites in NYC today vs 100k in 2025</td>
<td>will drive edge</td>
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</tbody>
</table>

### Security

Target’s breach went in through HVAC “back door” in ‘12

### Flexibility

...infrastructure must scale like IT loads

### Visibility

infrastructure needs to follow “fail small” paradigm
IT consumerisation is driving huge demand
IoE, M2M will only further accelerate growth

Data center trends

- Hyper-growth requirements
- Hyper-scale infrastructure
- Era of 5G
- Era of Cloud Computing
- Era of new Digital world
- Era of everything connected and automated
- Era of multi tiered datacentre facility
Data center industrialisation is inevitable
everyone wants “GOOGLE-like” functionality

- Highly available infrastructure
  - rapid modular design-and-build

- Super efficient industrial operations
  - lights out, remote-hands, central NOCs

- Automated workload management
  - just-in-time capacity provisioning
Data center challenges are universal pains

risk, efficiency & capacity are (traditionally) hard to achieve

Availability & performance management are tough

over-design & over-spend are standard strategies

Troubleshooting & root cause analysis are complex

over-provisioning and over-staffing are common

Capacity planning and management are error-prone

manual processes and ‘gut feel’ are acceptable
Learning from other industries is an opportunity
innovation without the risk

Islands of automation are history in other industries
ABB already has 15,000+ mission-critical installations
2016 US Department of Energy Report:
Data Center Electrical Energy Consumption dropped to 1.8%

- Average PUEs have dropped dramatically
- Virtualization and IT energy efficiency gains
- More improvements possible: Hyperscale, DCIM, Cloud/CoLo, Storage Technologies, ...
- The exact future is unpredictable

**ABB’s solutions**

**Our value propositions**

- **Intelligent grid connection**
- **Electrification solutions**
- **Industrial automation & DCIM**
- **Construction components**
- **Safety & security**
- **ABB Ability™**

- Improve safety and security
- Cost effective: cost savings in electrical infrastructure
- Factory tested and easy to install
- Space savings with selected products
- Modularity, flexibility and scalable solutions
- Enhance TCO and asset intensity as the key to profitability and growth
- Connectivity and digital
- Local service centers
The ABB Difference

Intelligent grid connection

Deep component visibility
Flexible infrastructure

Intelligent data needs intelligent power
The ABB difference for data centers

Industrial design provides an edge

Product and system reliability
- Robust ABB equipment for the most challenging conditions.
- Integration expertise in designing for what could go wrong.
- Smart devices with intelligent interfaces and control.

Greener, more efficient data centers
- Expertise in renewables and energy integration

Safety in design and operation

Critical power for critical business
- Modularity in our solutions.
- Dynamic capacity management.
- Digital operations
Unlocking the ABB potential in digital

ABB Ability connects customers to the power of the Industrial Internet of Things turning data insights into direct action through our services and expertise

- Know more, do better
- Expertise at each life cycle stage
- Technology leadership
- Deep sector knowledge
- Decades of experience in digital
- End to end and closed loop solutions
- World’s largest installed base of connected industrial devices
Datacenter customers

Innovation in action: Reliable power distribution for data centers
ABB’s MNS and Unigear keep Norway’s leading data center provider running flawlessly

ABB is keeping the power on at Safe Host’s data center in Switzerland
Reliable power supply with ABB’s air-Insulated UniSec switchgear, equipped with vacuum circuit breakers, current and voltage combi-sensors, and Relion® protection relays

Gerard Sikias
CEO, Safe Host

ABB delivers 100% uptime for datacenter operator Systemec
In Venlo, the Netherlands, data center operator Systemec runs a state-of-the-art TIER 3+ data center facility

Jos Derkx
CEO, Systemec
Datacenter customers

132 KV Substation London
A UK co-location customer wanted to have more control over their critical grid connection and selected ABB to supply, install and commission a state-of-the-art 132 kV substation.

LV/MV Financial customer Mexico
A leading Latin American bank located in Mexico selected ABB to provide an end to end integrated low and medium voltage power trains solution.

LV/MV mega data center Singapore
A leading technology brand selected ABB to provide all of the critical low and medium voltage infrastructure for their first mega-center in south Asia.

LV/MV mega data center Ireland
A global internet service company selected ABB’s UPS technology to protect their critical load in a multi megawatt data center.

Automation platform Finland
An internet services company selected ABB to provide an industrial control platform to provide vSegmentbility and control of all of their site’s critical infrastructure.

MV distribution – colocation operator USA
A major colocation operator in the United States selected ABB’s MV switchgear as part of a multi-vendor approach to ensure maximum uptime in their power train.
Digital switchgear IOT integration
Agenda

Why digital switchgear?
What is digital switchgear?
Key digital switchgear components:
  - Current and voltage sensors
  - Protection & control relays with LEA inputs
Innovative bus protection with digital switchgear
Major benefits with examples
ANSI medium voltage switchgear

What do customers want?

Be simple!
Be “smart”!
Be flexible!
Be on time!
Be environmentally friendly!
Be future proof!
Be efficient!
Be safe!
Be easy!
ANSI medium voltage digital switchgear

New concept for switchgear

Digital switchgear

Digital Switchgear is not only new products, it is also a new concept in protection, control, and automation.

SAFETY & SIMPLICITY are the most significant benefits, but there are many more.
## ANSI medium voltage switchgear

### Levels of digitalization

<table>
<thead>
<tr>
<th>Digital switchgear</th>
<th>Description</th>
<th>Main switchgear value</th>
</tr>
</thead>
</table>
| **Level 1**        | Simply replace CTs & PTs with Current & Voltage Sensors | 1. Reduced weight  
2. Space saving (primarily due to elimination of PT compartment)  
3. Eliminates problems of saturation and Ferroresonance  
4. Safety- no possibility of open CT circuits |
| **Level 2**        | Above + IEC61850-8-1 & GOOSE messaging Ethernet cabling between Protective Relays. | Above +  
5. Significant reduction in wiring between frames  
6. Late customization |
| **Level 3**        | Above+ Process bus (61850-9-2LE) Requires use of Merging Units (MUs), time synchronization devices & Ethernet switches. Fiber optic connection from bay (switchgear) to substation. | Above +  
7. Improved flexibility – changes in protection only require IED level changes. |
ANSI medium voltage switchgear

Form factor permits switchgear space savings

Current sensors

Voltage sensors

<table>
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<th>MV sensors</th>
<th>Standards</th>
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<tbody>
<tr>
<td><strong>Current sensors</strong></td>
<td>• IEC 60044-8 (2002)</td>
</tr>
<tr>
<td></td>
<td>• IEC 61869-10 (NEW)</td>
</tr>
<tr>
<td></td>
<td>• IEEE PSIM Working Group</td>
</tr>
<tr>
<td></td>
<td>• CSA Available</td>
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<td></td>
<td>Electronic current transformers</td>
</tr>
<tr>
<td><strong>Voltage sensors</strong></td>
<td>• IEC 60044-7 (1999)</td>
</tr>
<tr>
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<td>• IEC 61869-11 (NEW)</td>
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Sensors – ideal for critical applications

Concerns better addressed by sensors

- Increased safety
- Reduced footprint
- More linear response
- Simplified installations – less wiring, smaller footprint, lighter weight
- Digital implementation (on board A/D), with present and future advantages
- Reduced energy use, esp. in tight compartments

- 20+ yr old technology in switchgear
- Use solid state components and little or no ferromagnetic material in circuit
- Lack of magnetic core → very low energy output – cannot typically transfer power to secondary
- Numerous form factors for indoor and outdoor application (voltage only, current only, combination)
- Wide variety of outputs – from ~100 mV / mA to 120 V / 1 Amp
Current sensors

Current sensors are safer than conventional CTs

Digital switchgear

Rogowski coil sensor
– Us=150 mV for 50 Hz --- 80 A Primary
– Us=180 mV for 60 Hz --- 80 A Primary
Proven technology which brings many benefits in various applications > 5 years
Output voltage is proportional to the derivative of primary current
Output voltage is integrated by protective relay
Accuracy up to class 0.5
Complies with IEC 60044-8

No saturation (air core)

Open CT hazard eliminated

\[ u_s(t) = M \frac{di_p(t)}{dt} \]
Current sensors
Increased performance in differential protection

Rogowski Coil
Improved sensitivity for “in zone” faults
Speed of response
High security for “out of zone” faults
Multiple slopes not required (transformer)
Current sensors
Combined accuracy class 0.5/5P630
**Voltage sensors**

Voltage sensors are safer than conventional PTs

**Voltage sensors**

- Resistive voltage divider sensor
- 10,000:1 transformation ratio
- Accuracy up to class 0.5
- Passive element
- No fuses required
- Complies with IEC 60044-7

Gas Insulated Switchgear (GIS) uses Capacitive Voltage Divider (CVD) sensors.

\[ U_S = \frac{R_2}{R_1 + R_2} U_P \]

No ferroresonance (non-inductive)
Voltage sensors

Combined accuracy class 0.5/3P
Current and voltage sensor connections to IED

Point-to-point wiring eliminated with RJ-45 cables

Almost no analog wiring in the switchgear – increases reliability
Digital test switch

Testing operation

- FT Switch Digital per 3 Phase
- FT-14 Switch Digital
- FT-14 Test Plug
- PROTECTION RELAY
- SENSORS
- L1
- Test set
Relays for digital switchgear
Future proof solution based on IEC 61850

Based on worldwide accepted IEC 61850 standard ensuring long-term sustainability

Ready to be connected to remote control (SCADA) systems

GOOSE messaging configured with software setting

Available IEC 61850 Edition 2 features:

– Vertical communication

– Horizontal GOOSE communication

– Process bus

LEA (low energy analog) inputs
IEC 61850-9-2LE process bus & GOOSE messaging

One line diagram
IEC 61850-9-2LE process bus & GOOSE messaging in digital switchgear

Replacing copper with Ethernet

Digital substation reduces wiring complexity and resulting risks for operations & maintenance personnel

Before

No cable tray

After

Single conduit to carry fibers
IEC 61850-9-2LE process bus & GOOSE messaging

Footprint, copper wires, safety, reliability and cost
Utilization of directional overcurrent elements of feeder protection relays. Dedicated bus protection relay is not required (reduces footprint)

Reliable: operates only upon a fault on the protected bus
- All contributing breakers are tripped and block-closed
- Acceptable operating speed

Secure: able to distinguish external (through) faults
- Allows the individual breaker to trip first to maximize system reliability
Bus protection

Unique features

**Bus protection**

Flexible to multiple incoming/contributing sources

The bus protection is accomplished by each breaker’s associated protection relay, which is already existing.

A master relay is assigned to perform the bus protection scheme with a backup relay automatically assuming the master relays operation during relay failure.

All contributing relays communicate to the master and backup relays via Ethernet based IEC61850 GOOSE communication.
**Bus protection**

**Scheme development**

IEC61850 compliant and capable of GOOSE communication

- If the constant integrity/quality check of the GOOSE communication is bad, the scheme shall be disabled and an alarm is issued immediately

Two phase and ground directional overcurrent elements:

- 67P/N-1 as reverse direction (REV) for detecting fault current flow into the bus
- 67P/N-2 as forward direction (FWD) for both detecting and tripping fault current flow out of the bus (through) fault
Bus protection

Principle of operation (internal bus fault)

**Bus protection**

Bus fault occurs
At least one reverse direction (REV) element is detected
Not any forward direction (FWD) element is pending
The “master” relay trips and block-closes all contributing breaker via GOOSE
Bus protection
Principle of operation (external through fault)

An external/through fault occurs, i.e., on Feeder #2
Feeder #2 relay FWD detected
The rest of relays either see REV or not FWD
Feeder #2 breaker trips
Bus protection

Communication redundancy
Bus protection

Benefits versus conventional schemes

- Safer to handle relays on energized switchgear due to digitized CTs and PTs
- Can be applied to either AIS or GIS switchgear
- Adaptable towards increases in system fault levels without the need to upgrade system components
- Flexible to bus expansion without labor intensive scheme changes versus conventional schemes.
- Reduction of wiring versus conventional schemes that removes the requirements for dedicated bus CTs
- Improved scheme security by being immune to the effects of CT saturation
- Low or no cost of bus protection scheme
- Communication redundancy
- Simpler
ANSI medium voltage digital switchgear
Quick delivery time from order to operation

Digital switchgear
Eliminates the trouble of defining details like CT/PT data ...
– For all applications/relays?
  • No, but nearly all of them. Reduced engineering and easier configuration selection. Reduces project administration and engineering costs

Supports minimized time to receive project documentation
– CT/PT data not required
– Flexible towards last-minute changes
– Most changes are simply realizable within the IED’s logic, only minor changes in wiring and schematics (if any)
Digital switchgear benefits

Reference project: ANSI switchgear at a US polymer chemicals complex
Digital switchgear benefits

Reference project: ANSI switchgear at a US polymer chemicals complex

Footprint: -25%, costs: -8.9%
ANSI medium voltage digital switchgear
ReliaGear® ND Digital, Advance™ Digital, SafeGear® Digital

Safety
- Low energy analog output eliminates hazard associated with open CT secondary
- Fewer wires to install makes switchgear easier to maintain
- Solution is continuously self-supervising with maximized error detection

Savings
- Form factor of voltage sensors = switchgear space savings
- Size of current & voltage sensors = weight savings
- Broad application range of the sensors = inventory savings
- Significant energy savings during operation
- Savings on total cost of ownership

Speed
- Concept allows for compression of time from order to delivery
- Late customization possible

Simplicity
- Fewer wires to install, commission & maintain
- Fewer parts to fail leads to increased reliability

Sustainability
- Universal standards (IEC61850) enable future system expansion
- Handle future load changes without mechanical reconfiguration of system
- Lower lifetime environmental impact
ANSI medium voltage digital switchgear

Designed to meet the needs of the future (and today)

- Be "smart"!
- Be flexible!
- Be on time!
- Possibility of late customization
- Be future proof!
- Be efficient!
- Be safe!
- Be simple!
- Be reliable!
- Be environmentally friendly!
- Be easy!
- Minimal variation > Low inventory needed
- Measurement devices with high accuracy over an extended range. Can deal with varying load flows.
- Significant energy savings
- Simplified wiring
- Space & weight saving

Significant energy savings: Possibility of late customization

Be on time: Measurement devices with high accuracy over an extended range. Can deal with varying load flows.
Questions