XI JORNADA TECNICA, SANTIAGO, 30 / 31 JULY 2019

Digital Hybrid Switchgear

Leading the way for a smarter grid

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Agenda

- Digital Substations - Introduction
- Digital Hybrid Switchgear
- References
- Predictive Service 4.0

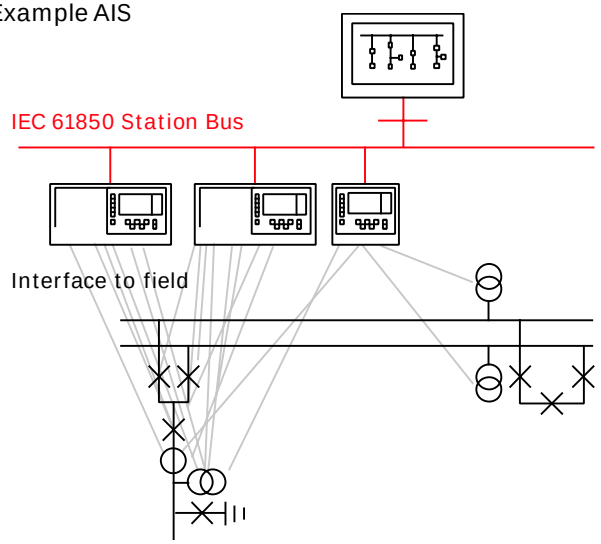
Digital substations

Introduction

Digital Substation
Features

Conventional Substation

Example AIS

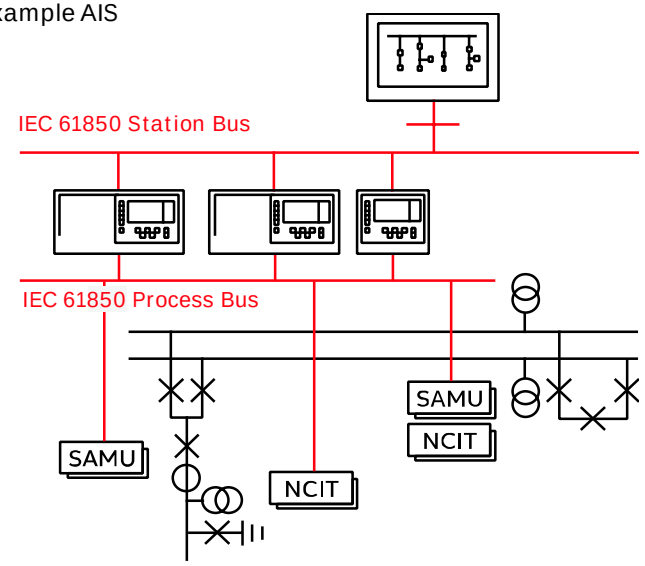


Primary components stand alone

- Lower OpEx for operators
- Less and smaller control cubicles
- Linear NCIT / no saturation
- Less cabling
- Less material
- Shorter cycle times
- Smaller footprint
- Future proof due to IEC 61850

Digital Substation

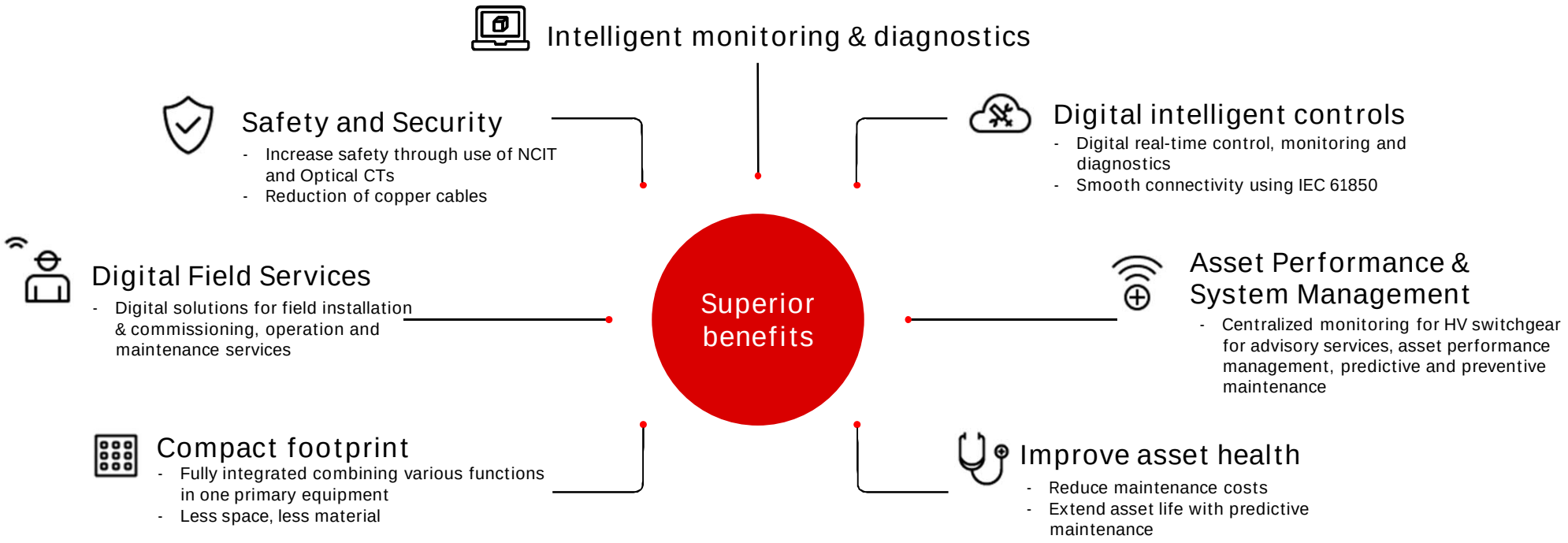
Example AIS



Integration of components – small footprint

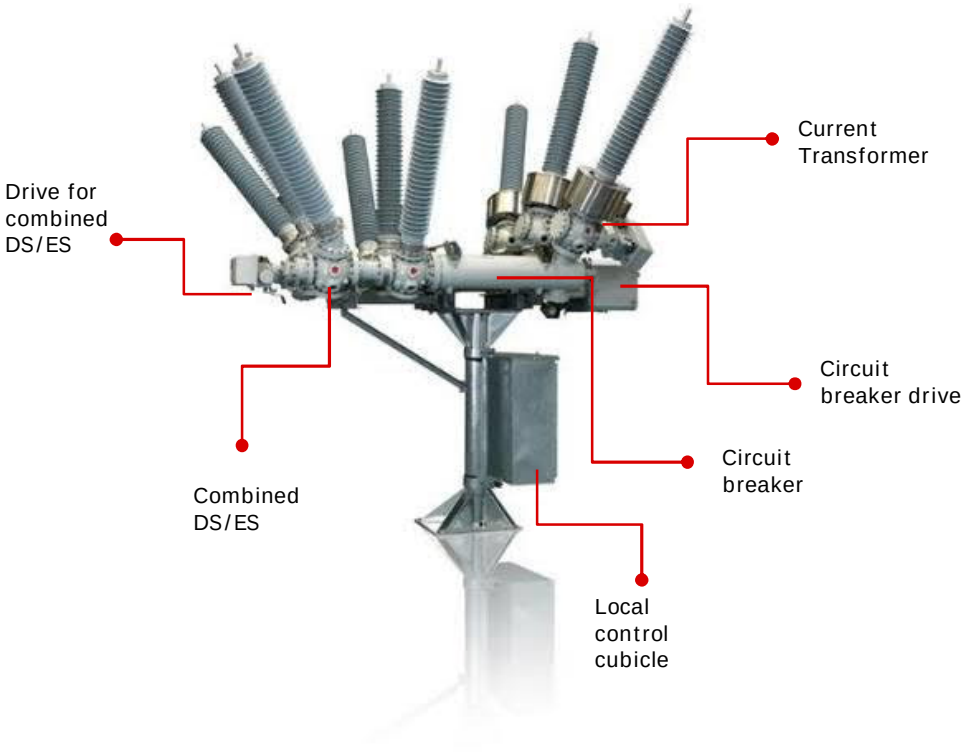
Digital substation

Benefits of digital switchgear



Digital Hybrid Switchgear

Digital Hybrid Switchgear
Introduction



Main facts

- Complete range: voltage level from 72.5kV / 31.5kA to 420kV / 63kA.
- High flexibility and modularity: all the functions of a HV bay in one single product.
- Ready to use: transportable fully assembled and pre-tested.
- Space reduction: more than 50% space reduction compared to traditional AIS equipment.
- Fast erection and commissioning time: E&C time reduced to max. 2 / 3 days for each module based on specific configuration.
- Reduced maintenance and increased reliability: use of gas reduces maintenance requirements and increases reliability of the substation.
- Market leader: more than 8.000 bays installed.

Digital Hybrid Switchgear

Three Types:

- Periodical Inspections
- Preventitive Maintenance
- Revision

Periodical Inspection

- 1 / Year

Preventative Maintenance

- After 5000 mechanical operations
- After 20 years of service.
- When the number of short-circuits is approaches a determined value

Revision

- After 10000 mechanical operations
- 40 years of service

Digital Hybrid Switchgear

Preventative Maintenance

- After 5000 mechanical operations
- After 20 years of service.
- When the number of short-circuits is approaches a determined value

PASS 72.5 kV 31.5 kA								
Number of Operations	3.000	1.200	160	40	20	10	8	5
Short Circuit Current (kA)	1	2	5	10	15	20	25	32
PASS 145 kV 40 kA								
Number of Operations	5.000	800	200	89	50	32	20	13	9
Short Circuit Current (kA)	2	5	10	15	20	25	30	35	40
PASS 420 kV 63 kA								
Number of Operations	10.000	1.000	650	300	150	25	50	20	12
Short Circuit Current (kA)	5	7	10	14	20	80	35	50	63

Most are visual checks or other checks such as:

- Check alarms, pressure gauge condition
- Check moisture level (connect hygrometer to PASS filling device)
- Check lubrification
- Retighten screws and bolts

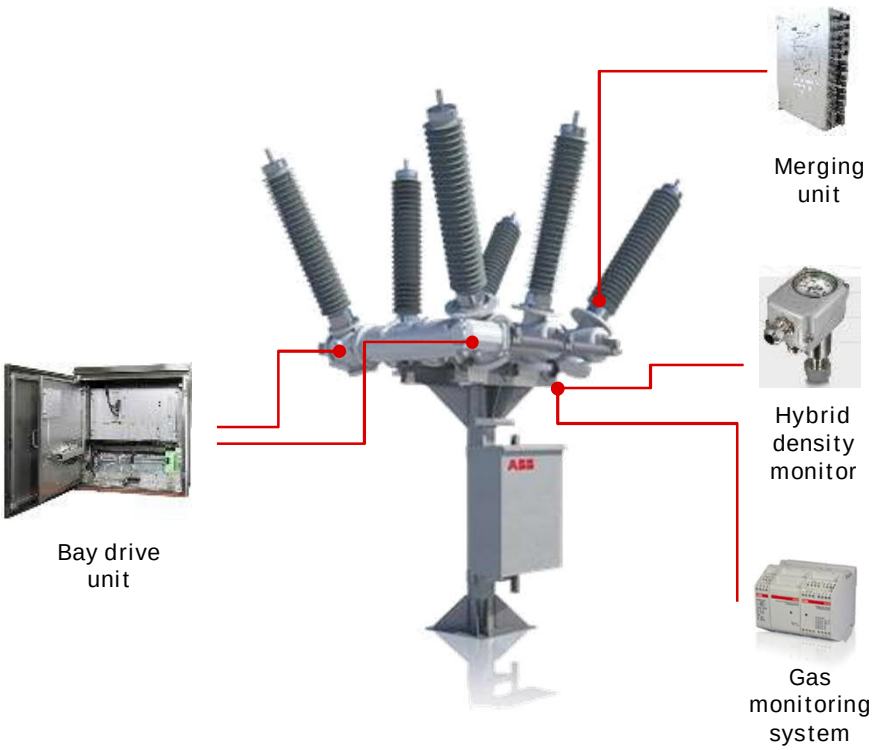
More demanding operations:

- Repetition of commissioning mechanical tests
- Visual inspection of contacts and CB chamber condition
- Check contact resistance of main circuit

- Outage required
- Spares
- Requires different training levels

Digital Hybrid Switchgear

Bay drive and gas monitoring system



Hardware components

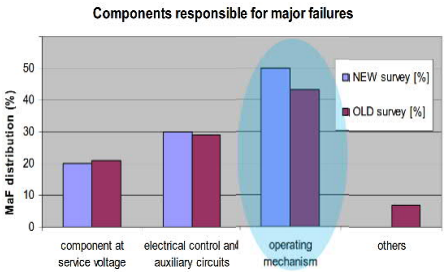
- Bay drive unit: control and monitor the switching devices (e.g. CB and DS/ES) of the HV bay while simplifying connection and configuration of P&C system;
- Hybrid density monitor: provide real time information of gas pressure;
- Gas monitoring system: enable identification of potential gas leakages;
- Merging unit: digitalize analog signals from CTs and VTs.

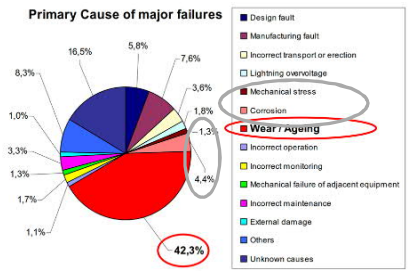
Digital Hybrid Switchgear

Why innovative drives?

CIGRE WG A3.06 “Reliability of High Voltage Equipment, Final Result – Circuit Breaker” stated that:

- ~70% of major and minor failures occur during normal service of the CB, and when an operation is demanded
- ~50% of major failures of High Voltage Circuit Breaker are due to issues on operating mechanism
- ~50% of these failures are due to mechanical issues (for stress, ageing, corrosion)





MD1.4: the solution for operating mechanism issues

Embedded failure detection:

- Continuous self-diagnostic and automatic error notification
- Periodical verification of capability to operate the CB
- Redundancy of critical components (power supply and logic)
- Remote monitoring and live maintenance service operations

Higher reliability:

- Less moving components
- Adjustable travel curve profile: reduction of contact wearing
- Exceed M2 requirements as per IEC 62271-100: tested for 30.000 operations
- Type test for extreme environmental conditions (-60°C up to +70°C, humidity), EMC and shock/vibrations as per IEC 62271-1

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Comparison with spring drives

CB operation

The circuit breaker is operated by means of:

- the release of energy stored in a spring

VS

- a servomotor energized by capacitors

Both are available for Single Pole Operations and Three Poles Operations

Interlocking logic and mimic

Interlocking logic and mimic are based on:

- electromechanical components (e.g. relays, buttons, lamps)

VS

- electronic boards and a display

I/Os connections

Connections can be performed with:

- Terminals connected to fixed I/Os

VS

- Terminals or IEC 61850 compliant connection connected to configurable I/Os

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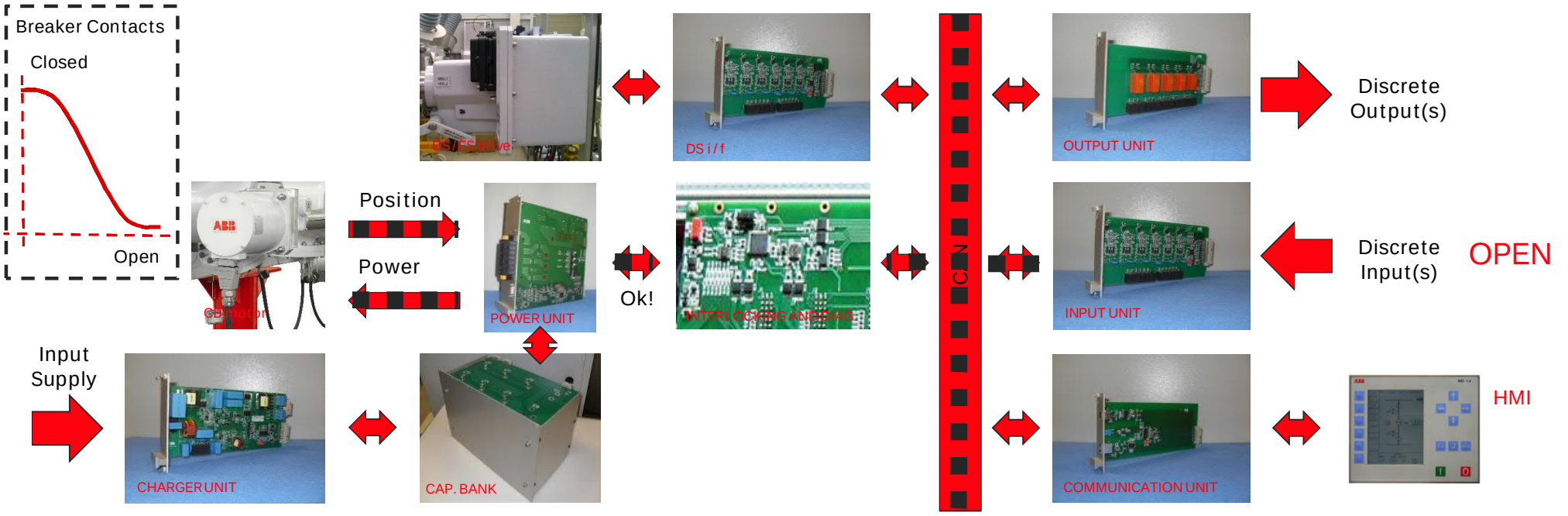
Principle of operation

How it works?



Digital Hybrid Switchgear

Capabilities

Nome funzione	Release attuale del MD	Prox release del MD
Corsa dei contatti	Si, solo off-line, i dati vanno scaricati localmente dal sistema	Si, live con visualizzazione sia da locale che da remoto
Velocità dei contatti	Si, solo off-line, i dati vanno scaricati localmente dal sistema	Si, live con visualizzazione sia da locale che da remoto
Tempo di reazione	Si, solo off-line, i dati vanno scaricati localmente dal sistema	Si, live con visualizzazione sia da locale che da remoto
Tempo di energizzazione della bobina	Si, solo off-line, i dati vanno scaricati localmente dal sistema*	Si, live con visualizzazione sia da locale che da remoto*
Usura dei contatti	No	Si, live con visualizzazione sia da locale che da remoto
Usura degli ugelli	No	No, forniamo indicazione unica dell'usura dei contatti
Contatore operazione	Si, live con visualizzazione locale	Si, live con visualizzazione sia da locale che da remoto
Corrente RMS	No	Si, live con visualizzazione sia da locale che da remoto
Temperatura del gas	No, usare MSM	No, usare MSM
Temperatura del cabinet	Si, live con visualizzazione locale	Si, live con visualizzazione sia da locale che da remoto
Tasso di perdita	No, usare MSM	No, usare MSM

Nome funzione	Release attuale del MD	Prox release del MD
Usura dei contatti - Corrente di fase	No	Si, live con visualizzazione sia da locale che da remoto
Usura dei contatti – Tempo d'arco	No	Non misurato, si usa valore tabulato
Usura dei contatti – Spostamento del contatto	No	Non forniamo misura puntuale ma indicazione sull'usura
Sistema gas – pressione del gas	No, usare MSM	No, usare MSM, forniamo indicazione letta da MSM sul display
Sistema gas – temperatura del gas	No, usare MSM	No, usare MSM
Sistema gas – densità del gas	No, usare MSM	No, usare MSM
Sistema meccanico – posizione nel tempo	Si, solo off-line, i dati vanno scaricati localmente dal sistema	Si, live con visualizzazione sia da locale che da remoto
Sistema meccanico – tempo di manovra	Si, solo off-line, i dati vanno scaricati localmente dal sistema	Si, live con visualizzazione sia da locale che da remoto
Sistema meccanico – tensione del motore	No	Si, live con visualizzazione sia da locale che da remoto
Sistema meccanico – energizzazione della bobina	Si, solo off-line, i dati vanno scaricati localmente dal sistema	Si, live con visualizzazione sia da locale che da remoto
Sistema meccanico – posizione dei contatti ausiliari	Si	Si, live con visualizzazione sia da locale che da remoto
Bobina di apertura/chiusura - impedenza	Si, live con visualizzazione locale*	Si, live con visualizzazione sia da locale che da remoto*
Bobina di apertura/chiusura - continuità	Si, live con visualizzazione locale*	Si, live con visualizzazione sia da locale che da remoto*
Meccanismo di caricamento – tensione del motore	No	Si, live con visualizzazione sia da locale che da remoto**
Meccanismo di caricamento – numero di operazioni	N/A	N/A**
Meccanismo di caricamento – tempo di carica	No	Si, live con visualizzazione sia da locale che da remoto**

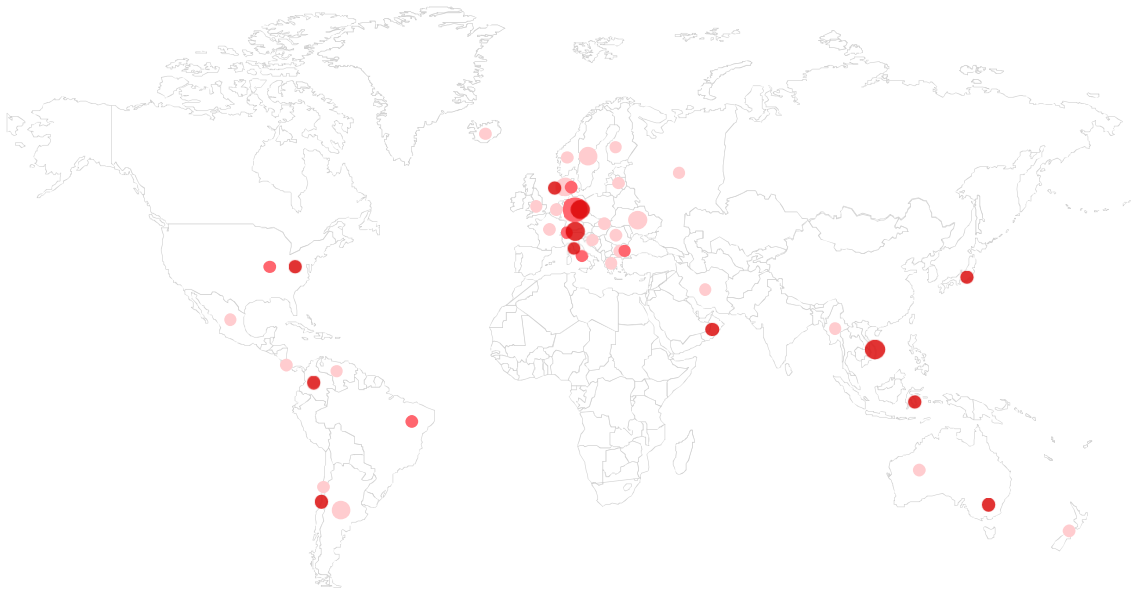
References

Digital Hybrid Switchgear

References

More than 15 years of installations

- 450 LTB with MD 1.3
- 257 PASS with MD 1.3
- 107+42 PASS/COMPASS with MD 1.4



Digital Hybrid Switchgear

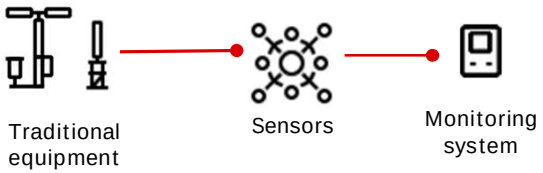
Predictive Service 4.0

Predictive Service 4.0

Technology comparison

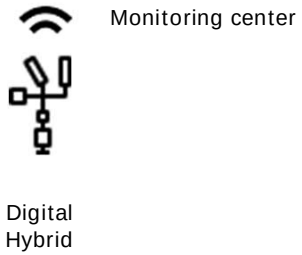
Traditional Equipment

- Traditional equipment does not provide information on their status (i.e. a spring mechanism is «silent» about his status).
- In order to verify the status of the main components it's necessary to perform inspection activities on site.
- Traditional equipment can be digitalized by using sensors / transducers;
- The digitalized information can feed a monitoring system;



PASS equipped with Digital MD1.4 Drive

- PASS equipped with MD1.4 Drive (Digital Hybrid) is the hub to monitor the complete HV bay including drives, SF6 gas, electronics etc...
- It includes monitoring system and communication module for transferring information to monitoring center;
- Self-diagnostic is performed at component level;
- The quantity and quality of information allow preventive maintenance and proactive digital services.



Predictive Service 4.0

Products Digitalization

Service 4.0: Remote monitoring of PASS/CBs with BLK Drive

We are going to complete the development of a Digital kit to digitalize the existing switchgears. The scope is to ensure a constant monitoring of: n. operations, spring charge operating time, contact wear from current, aux switches times.

It's a modular structure to add-on to the system. It's independent from existing protection and control system with some different communication systems alternative.

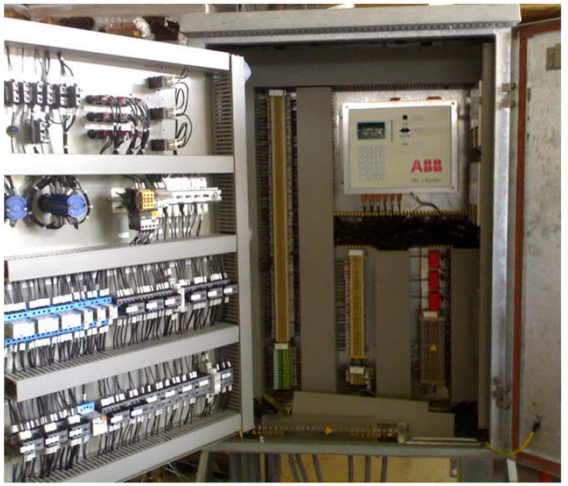
Encoder (CB and DS)

Hybrid Density Monitor

Merging unit (CT and VT)

MSM

MOT



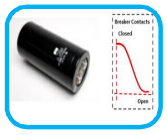
Predictive Service 4.0

Products Digitalization

Service 4.0: Remote monitoring of PASS with MD 1.4 Drive

MD1.4 : on-line and advanced monitoring feature for CB and DS/ES (e.g. trend analysis, CB operating time, speed and curves, DS/ES status).

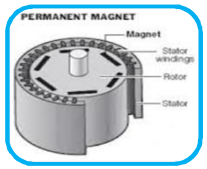
Compact servomotor drive
Mechanical endurance >30.000 CO



Digitally controlled - Highest precision
Energy to enable the operations stored in capacitors

The (I\O) & interlocking of the CB managed by electronic boards (easily configured at any time)
Cu reduction cables in S/S (≈80%)

Data can be downloaded and analyzed for diagnostic and monitoring.



Reduction in moving parts
Stator / Rotor
less contact wearing

Digitally controlled - Highest precision
Energy to enable the operations stored in capacitors

Friendly and configurable HMI Interface

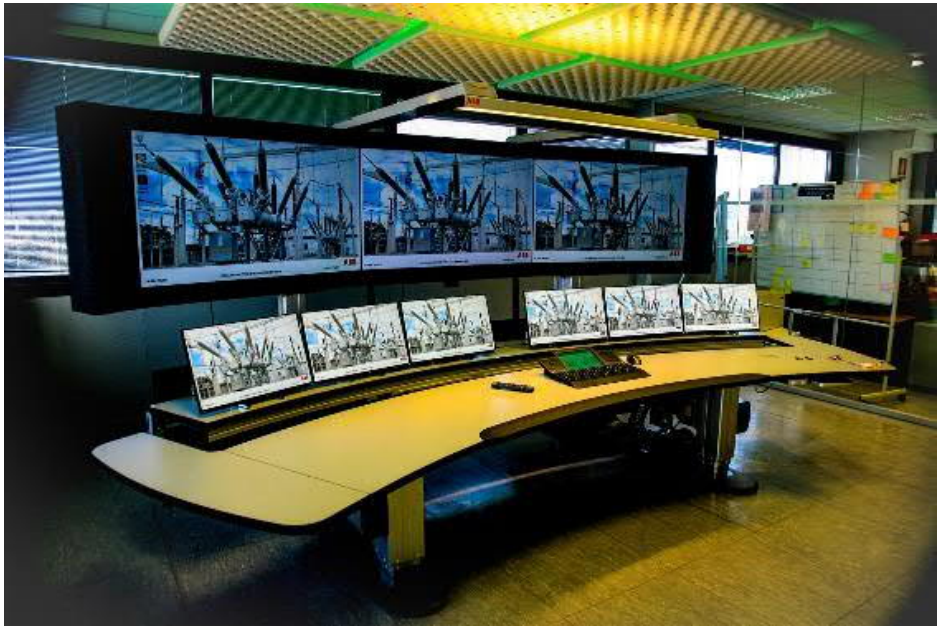
IEC 61850 and cyber security certified
Power loss proof

Predictive Service 4.0

Collaborative Center (CoCe) @ ABB

Remote monitoring center

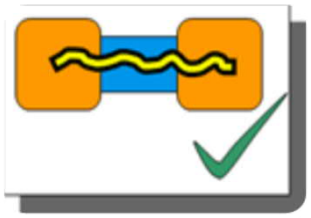
- Information collected by the HV bays can be transferred to the ABB Collaborative Center (CoCe);
- CoCe would provide continuous remote monitoring of the equipment and predictive maintenance based on data from site;
- In case of alarms, expertise is available to remotely support on site activities for rapid assessment of the issue;
- Different service packages are available for different levels of support.



Predictive Service 4.0

CoCe: MONITORING PARAMETERS

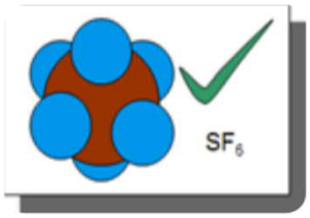
Wear



Interrupter Wear

Number of operations

Dielectric

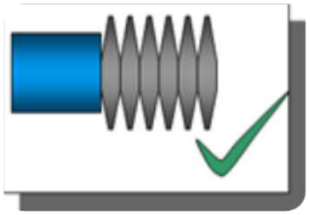


SF6 Density

Temperature Compensated Pressure

GIS: Partial Discharge; Arc Detection

Mechanical



Transducer Travel

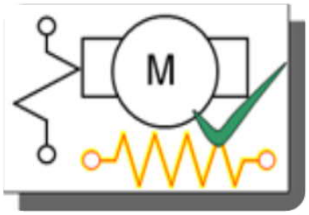
Simulated Travel (Patented)

Number Operations

Mechanism Time

Damper Travel

Accessories



Temperature / Heater operation

Motors, Coil Continuity Monitors

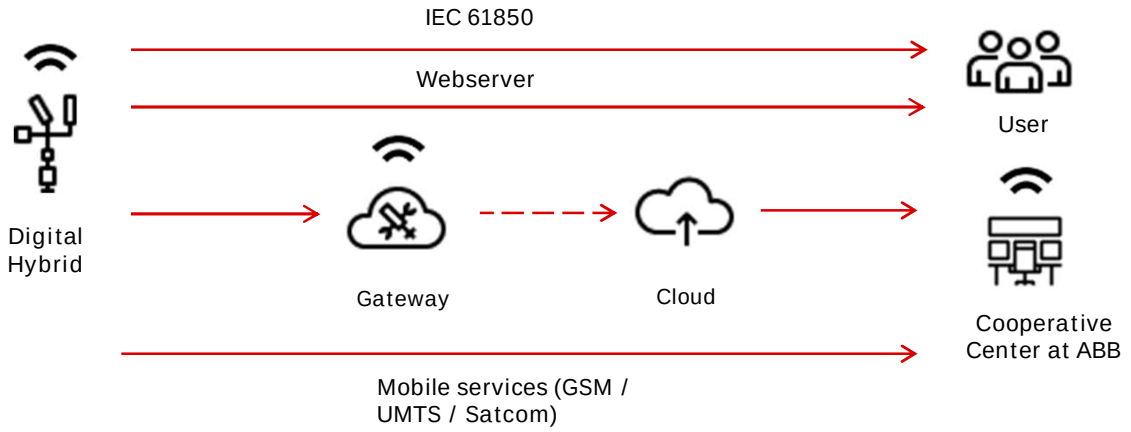
Predictive Service 4.0

Communication system

Possible alternatives

Digital Hybrid will provide information on its status using cyber-secure monodirectional connections via:

- IEC 61850 protocol (for end-customer use);
- Webserver (for end-customer use);
- Webserver and connection to Collaborative Center via gateway and cloud services;
- Mobile connection (GSM, UMTS, satcom).



Predictive Service 4.0

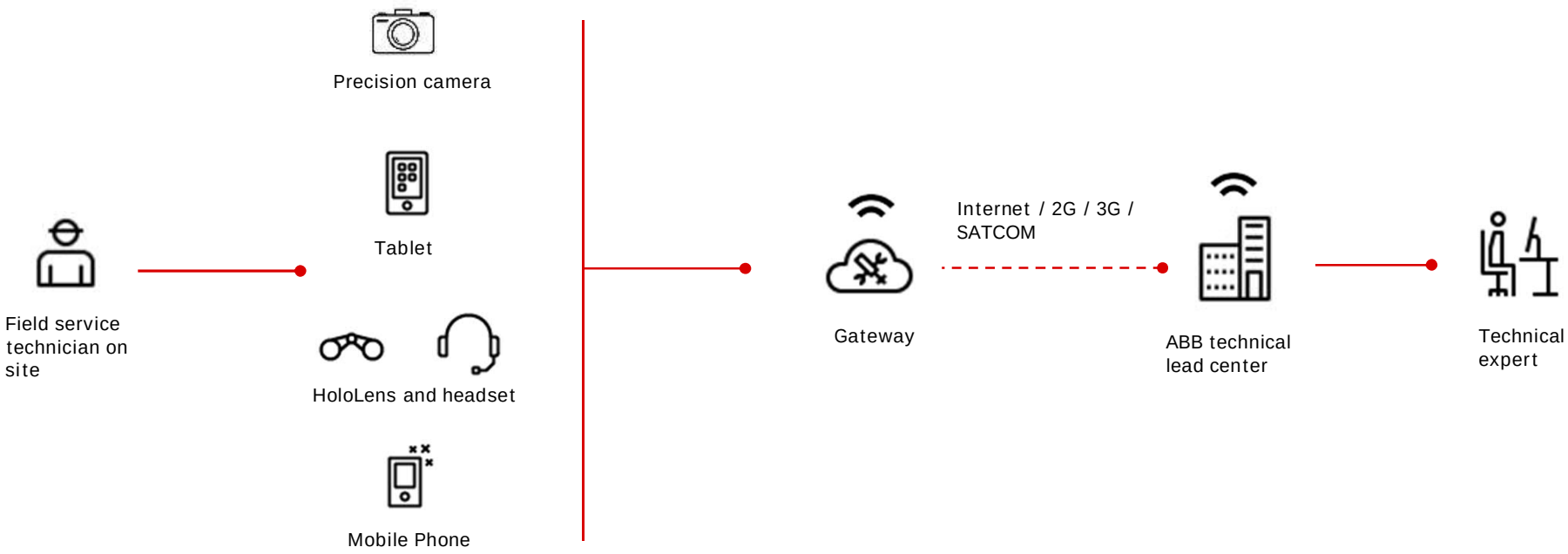
Remote assistance kit

Main advantages

- Fast remote support provided by experts in ABB's technical lead center;
- Live connection with video and audio sharing between site and technical support;
- Possibility to share info received by endoscope and precision camera;
- Instructions and documents sent by the technical lead center appear on field technician's monitor and HoloLens.
- Connection between site and ABB technical lead center via mobile network (2G, 3G etc...) and satellite communication in remote areas;
- Reduced response time and fast intervention;
- Reduced risks of mis-operations at site.

Predictive Service 4.0

Remote assistance kit



Live connection from site to the technical lead center

Predictive Service 4.0

Customers Events at new ABB CoCe in Lodi

Customers Events already organized:
- ENEL Green Power
- TEKFOR
- INDUSTRIES (Power Quality Event)
- AXPO

Customers Events already planned in June:
- A2A
- ENEL Distribuzione

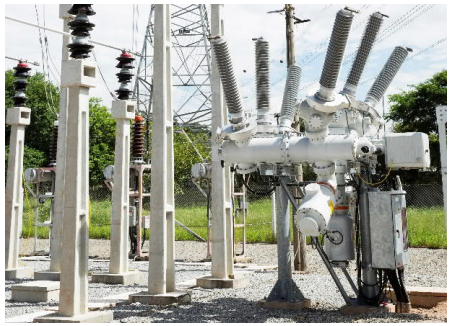
Predictive Service 4.0

Predictive Service 4.0

Complete digital package

Digitalized Switchgear

– Digital Hybrid switchgear as the digital hub to control and monitor the complete HV bay.



Communication system

– Communication system to transfer information from HV switchgear to monitoring center.

Remote monitoring

– Collaborative center at ABB office for remote monitoring of HV switchgears.

Remote Assistance

– Digital kit to provide remote assistance to technicians at site.