

# Smart Substation for the French Power Grid

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# Key Drivers for Utilities

- Improved operational performance
- Improving the safety of installations
- Increased reliability / availability
- Reduced engineering and maintenance costs
- Optimizing asset management

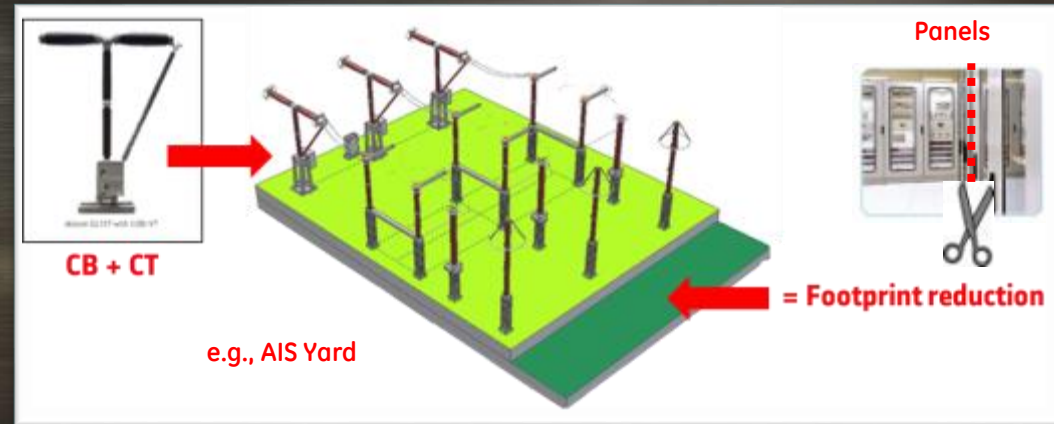


# Responding to the Drivers:

## Digital Substations

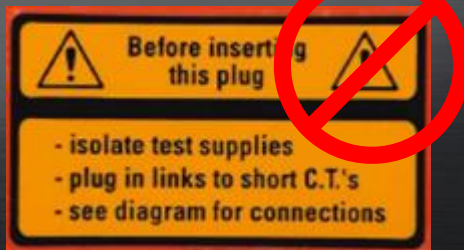
### 1. Footprint Reduction

- **Primary equipment, AIS:** Sharing of steelwork and foundations
- **Primary equipment, GIS:** CT chamber size reduction with Digital Instrument Transformers, VT integration in bus-duct
- **Secondary equipment:** Panel size reduction: compact IEDs
- **Copper hardwiring replaced by fiber**



### 2. Safety

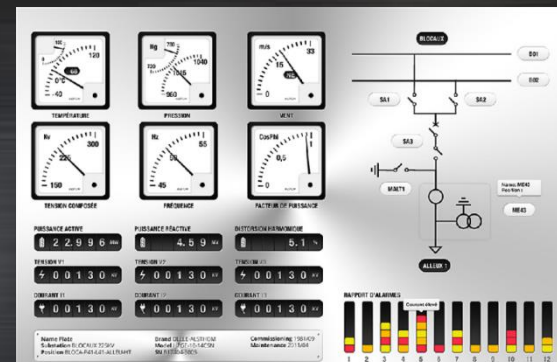
- **Primary equipment:** Oil-free instrument transformers
- **Secondary equipment:** Removal of CT secondary circuit, removal of need to change ratio taps



Care for  
employees  
and the  
public:  
No fatality  
risk

### 3. Situational Awareness Applications

- Integrated condition monitoring, asset management and wide area control



Clear alerts  
and  
dashboards

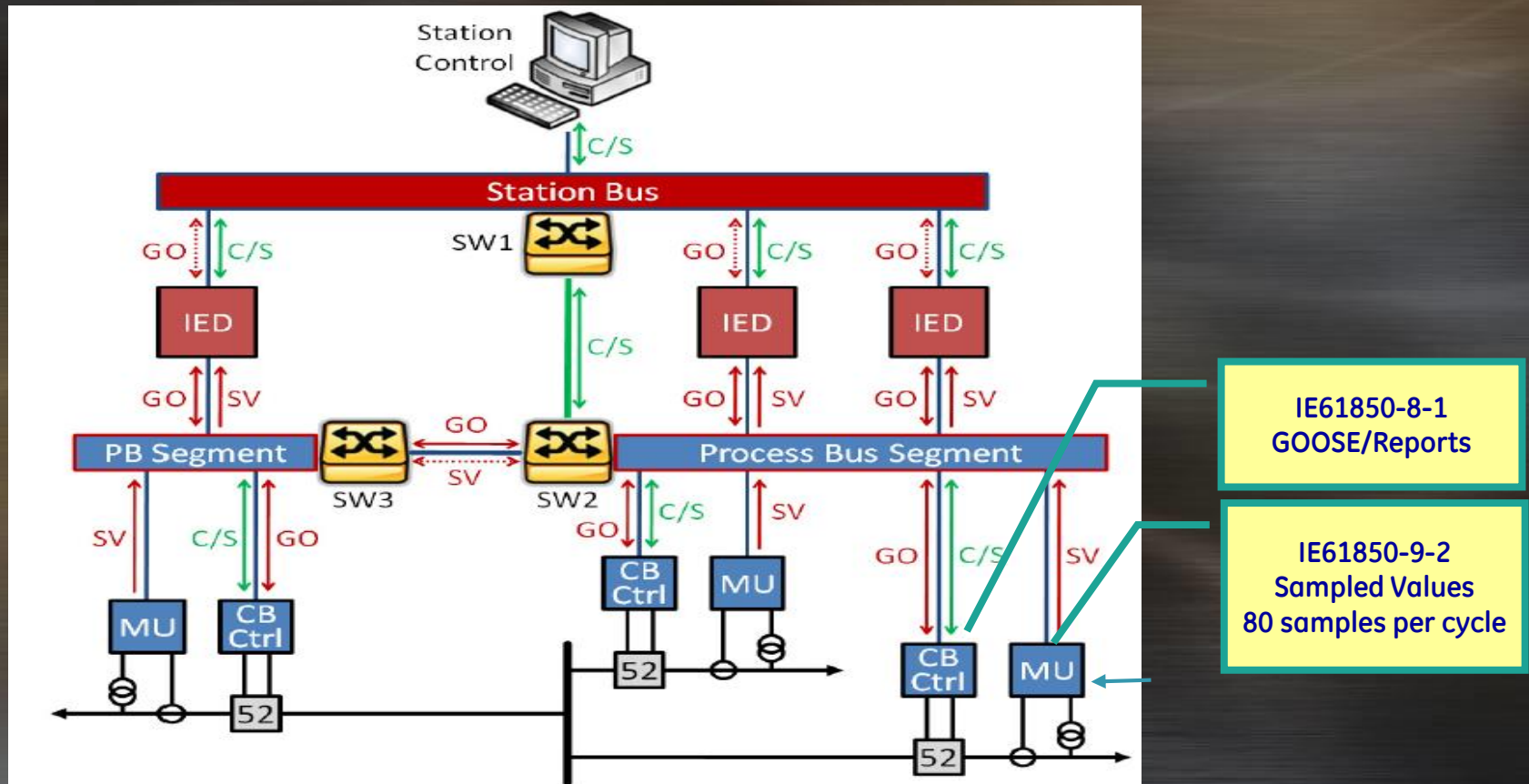


# Wiring, Wiring, Wiring...



- **Safety issues** – equipment isolation, touch and step potentials, EMC
- **Copper** – raw material cost has increased 400% in 10 years
- **Material cost** – cubicle wiring and test costs, labor cost per wire end termination
- **Schematic design** - verification cost, excessive on-site work content
- **Civil work costs** – trays, troughing, cable access/egress, etc.
- **Maintainability cost**

# Leveraging IEC 61850



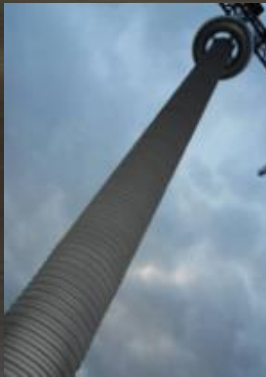
## Process Bus Definition in IEC61850 standard

- The process bus connects within a bay the primary equipment to the IEDs
- The process bus can span several bays in particular applications



# Digital Instrument Transformer Solutions

## *Advanced Metering and Protection & Control*

Application	AIS/GIS	AIS	GIS	GIS
Technology	Optical (Faraday)	Capacitive	Rogowski	Capacitive
	Current Measurement	Voltage Measurement	Current Measurement	Voltage Measurement
				



# Engineering Optimization

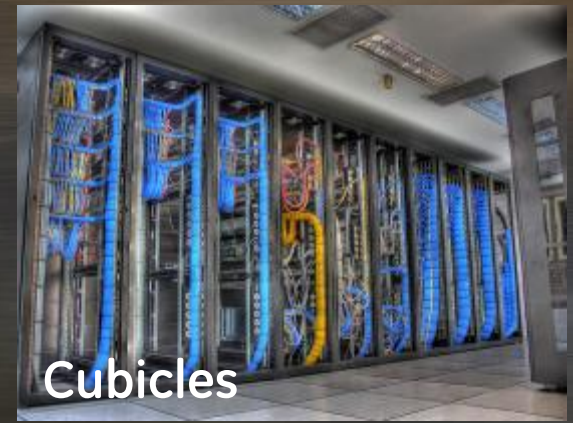


**Steelwork  
Foundations**

DIT weigh 5 - 10% of conventional:  
tons become kg



**Building  
Foundations**



**Cubicles**

Half size relays and BCU – half the  
number of panels



**Cables**

Reduction of 200km of copper hardwiring  
in a transmission substation



**Ducts**



# Poste Intelligent Introduction



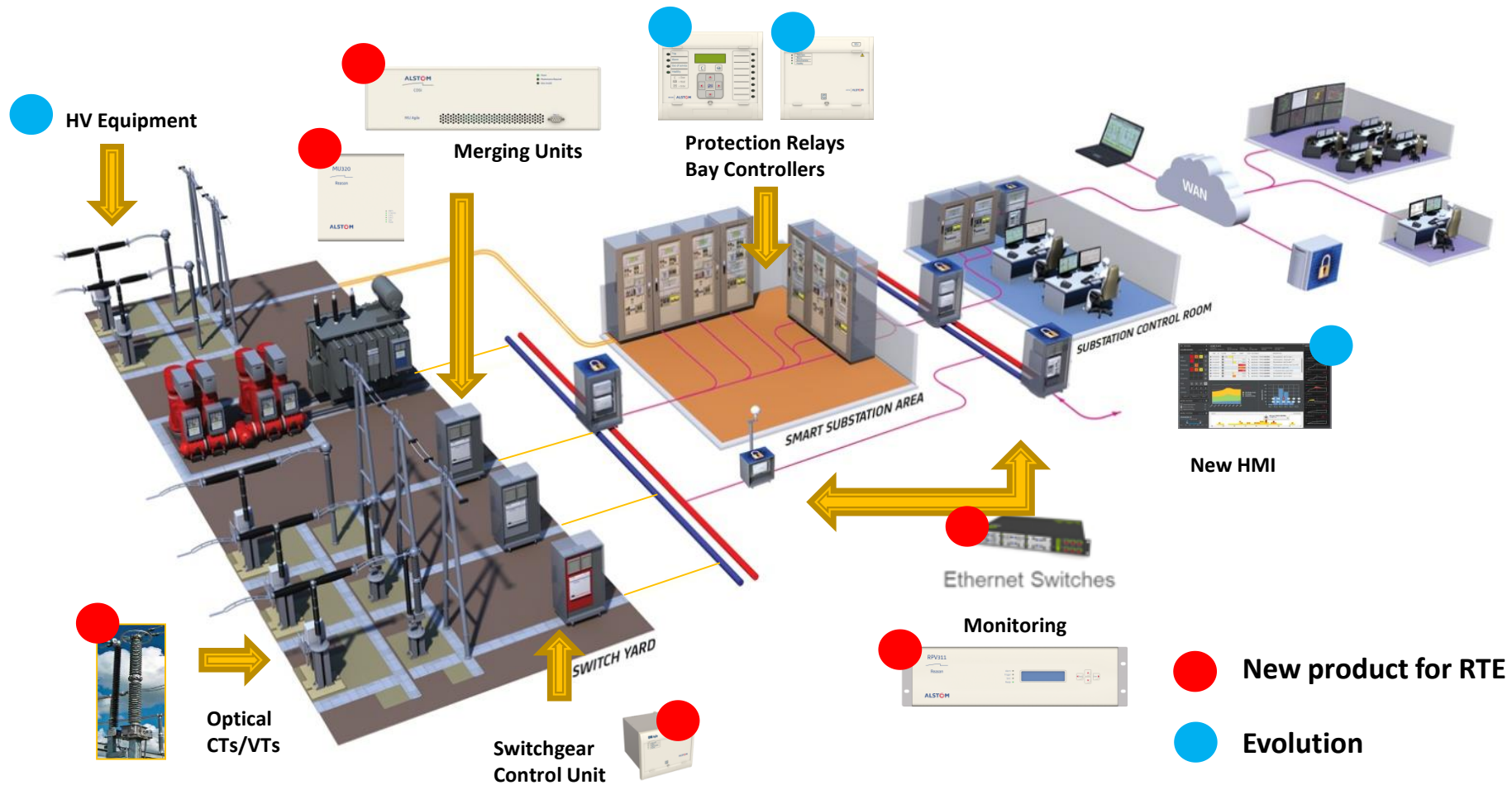
- ✓ Part of French program "Grid for the Future"
- ✓ Real size demonstrator on two substations (225kV and 90kV)
- ✓ Smart grid project focusing on transmission substation

- ✓ Six French industrial partners
- ✓ RTE and GE are the main contributors
- ✓ Provide the next generation of smart grid substations





# RTE Poste Intelligent



# Poste Intelligent:

## Blocaux 225 kV / 90 kV AIS

### Challenge

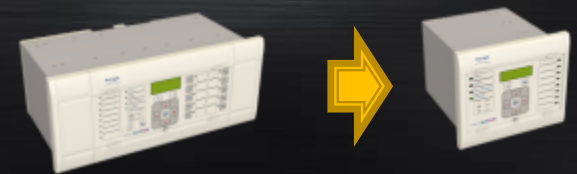
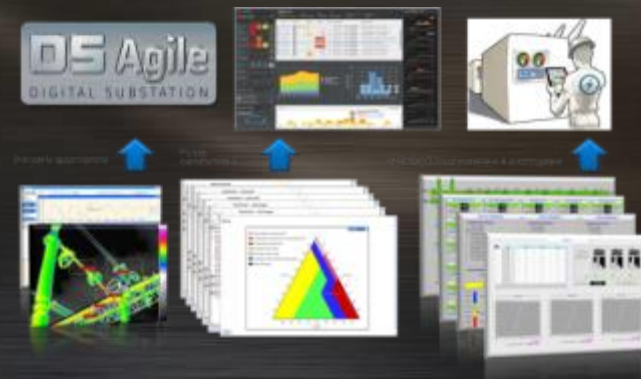
- Refurbishment of existing protection & control system for two large substations (10 Bays 225 kV, 12 Bays 90 kV)
- **Innovative solutions bringing new functionality**, complete substation digitizing (electrical, mechanical, environmental data)
- Manage redundancy, **move away from hardwiring**
- Manage **inter-substation automation**

### Solution

- Full DCS and protection system, process bus **1Gb/s**
- **Condition monitoring, real time situational awareness**
- **Wide Area Control Scheme**, security system
- **Digital-CT + LPIT-VT**

### Key benefits

- **Minimized outage** time, improved equipment availability
- Increased **safety**, prevent cyber-security attacks
- Improved inter-changeability, enhanced flexibility and grid **operability**
- Increased **reliability** with inherent **system redundancy**
- **Optimized maintenance, remote substation monitoring**
- Reduced relay footprint – full 19" rack -> half 19" rack for **smaller panels**



# What's New at Blocaux?

- **Optical CT** technology, **compact CT and VT footprints**
- **No more copper hardwiring** for command and control
- Flexibility in **physical separation** of instrument transformers and IEDs
- New approach for **redundancy and reliability** issues – self-healing
- **Harmonized protection scheme** for 225 and 90 kV
- External kiosks/cabinets for digitizing only in the yard, intelligence is centralized
- **Multifunction IEDs** subscribing to multiple SV streams
- New distribution of the LN in the LD for **fewer devices and failure tolerance**
- Permanent SV generator for **remote commissioning and testing**
- **Permanent spare parts for automatic reconfiguration** in case of failure
- **Containerised substation** methodology – System A, System B



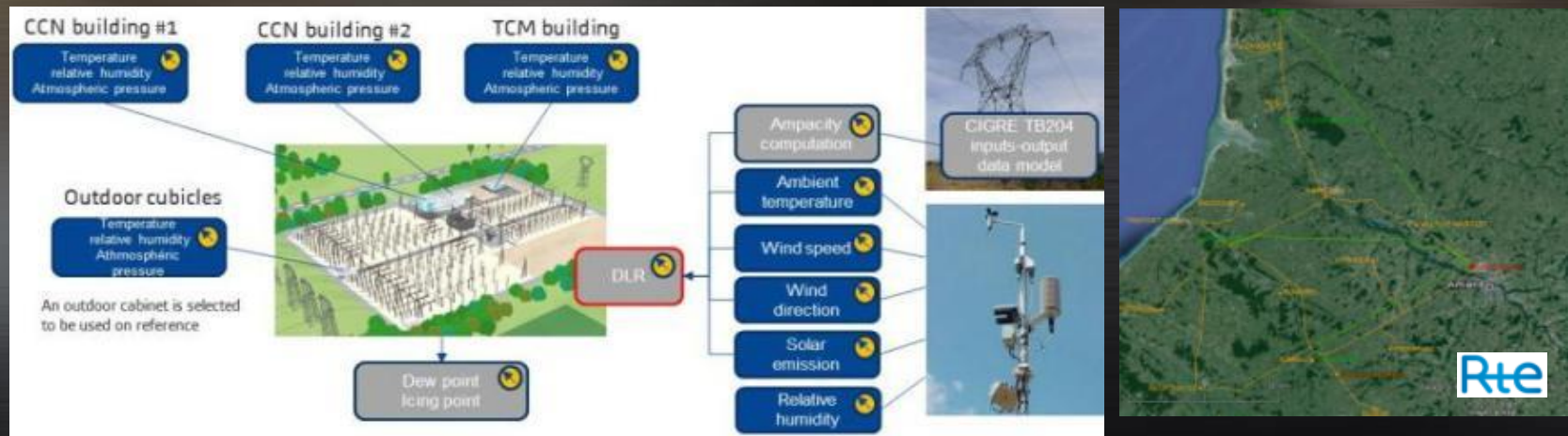


# Operational Benefits

- Local state estimator
- Redundancy controller
- Weather-based dynamic rating for transformers and overhead line
- Data historian for long term analysis (asset management)
- Digital Paralleling Voltage Regulation
- Wide Area Control Units (WACU) and IEC 61850 WAN for extended benefits across neighbor substations

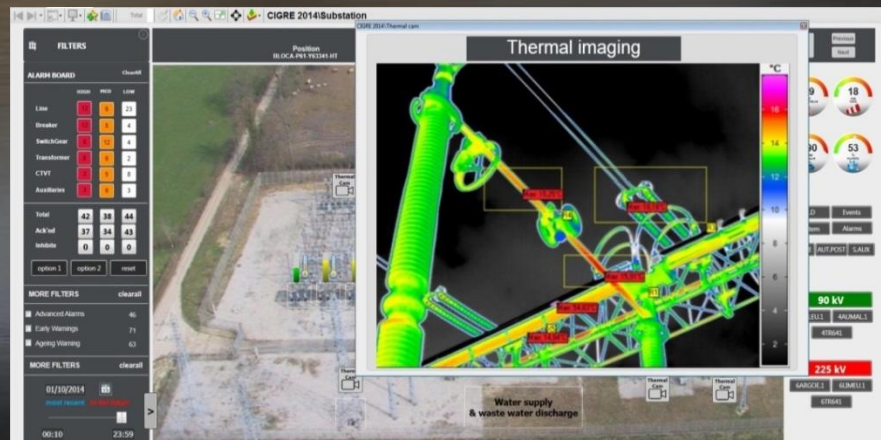
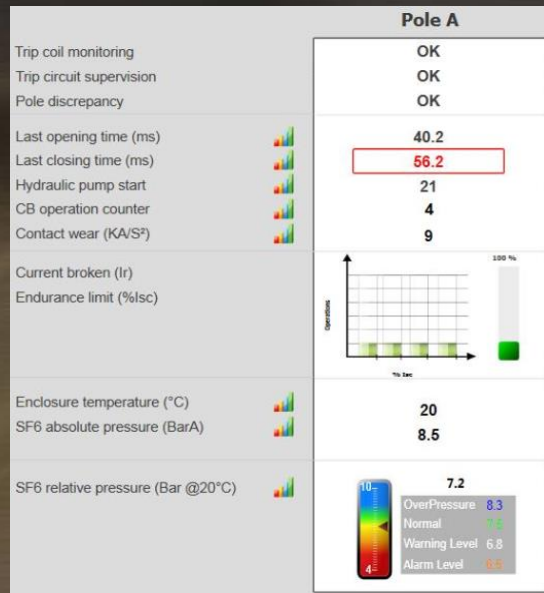
## Automatic fault analysis and location

- Fault analysis - location converted to geographical data (GPS) with tower identification
- Correlation with lightning activity
- Relay tripping time and autoreclosure delay compared to technical specifications
- Healthy overhead line identification
- Help for rapid restoration plan and relay failure identification



# Situational Awareness

- A single HMI integrates all the substation functions
- Remote access is complete and secure



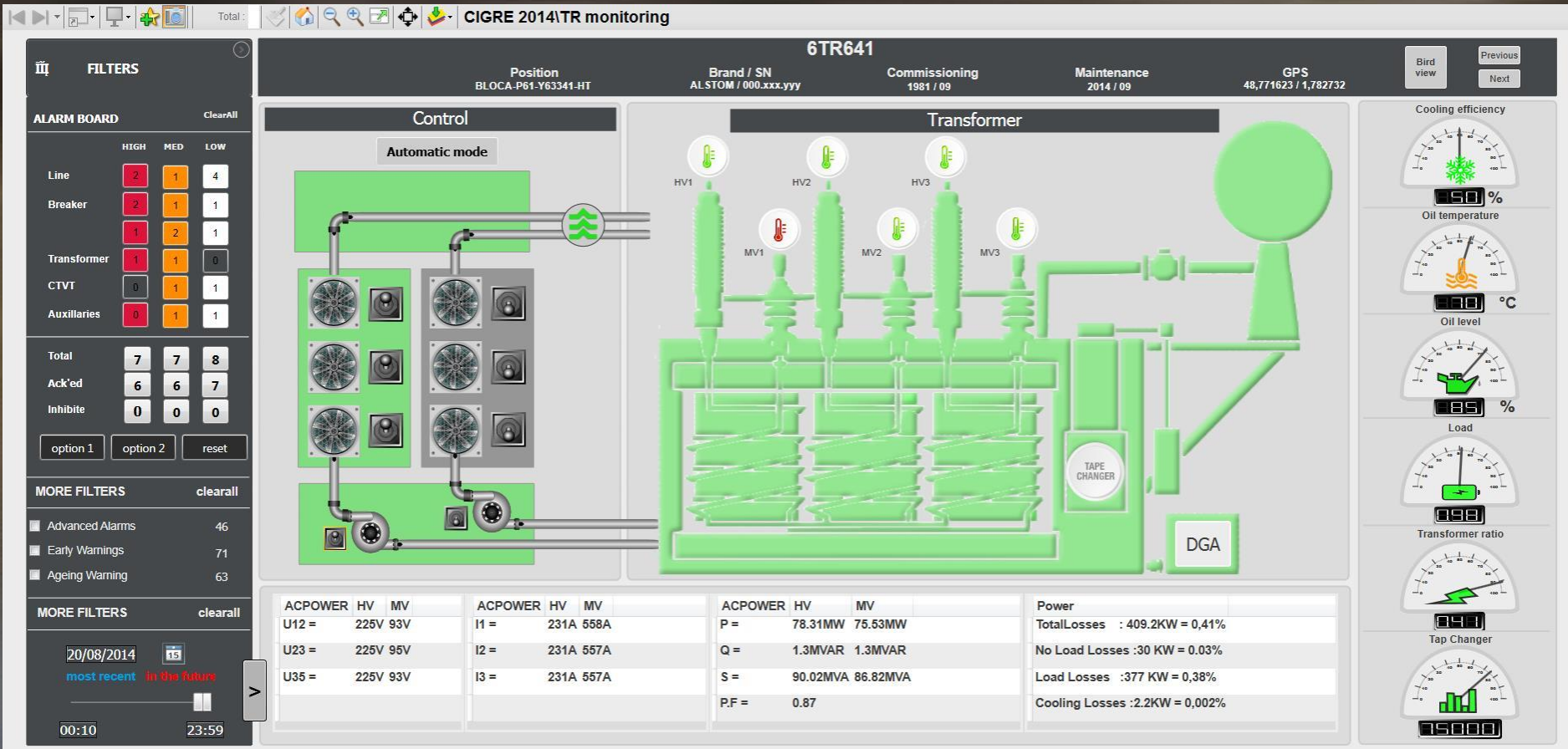


# Circuit Breaker Condition Monitoring



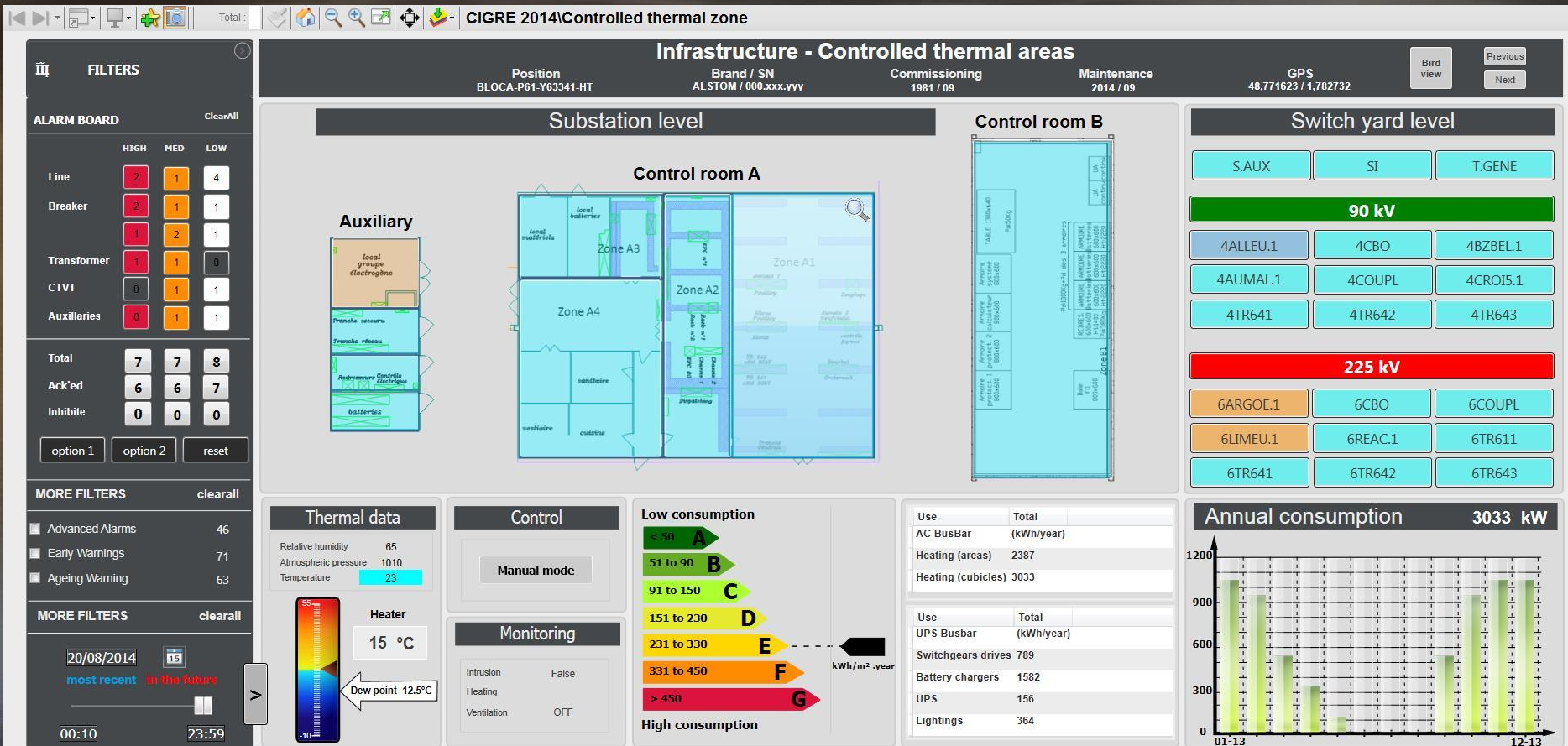


# Power Transformer Monitoring



# Infrastructure Monitoring:

## Energy Efficiency



# Poste Intelligent Will Deliver

- **Reliable and more accurate data for grid operation** : Providing substation state estimation
- **Facilitate distributed energy resource integration**: Wide area voltage regulation, Dynamic line Rating, Wide area automation.  
-> Based on wide area data exchanges
- **Implement latest technologies for primary devices** : COSI-CT optical sensor, COSI-VT low power voltage transformer, digital circuit breaker and disconnectors. Power transformer data digitizing.
- **Secondary system control, monitoring and maintenance** : Provide an innovative way of secondary device redundancy, as well as system self-healing capability. Reducing secondary device urgent maintenance and optimizing the maintenance tasks.
- **Full and secure data access and remote maintenance capability** : Secure Web-based substation access offering remote testing and reducing the physical substation presence needed for maintenance.



SCADA/EMS/ DMS



Protection  
& Control



Asset Health  
Management

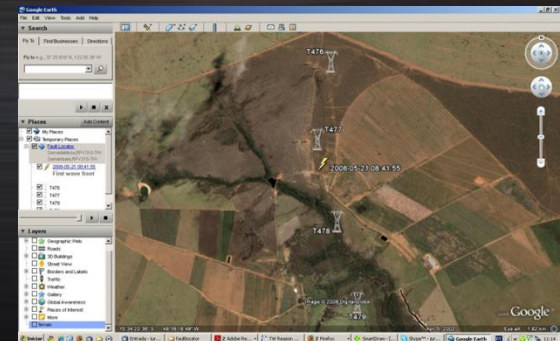
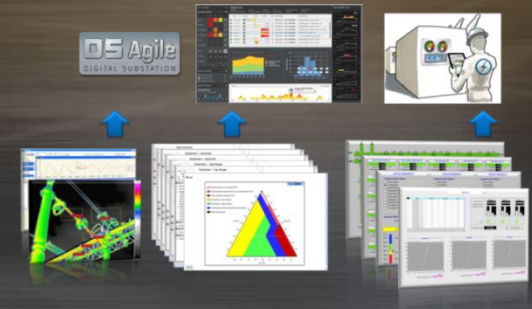


IT



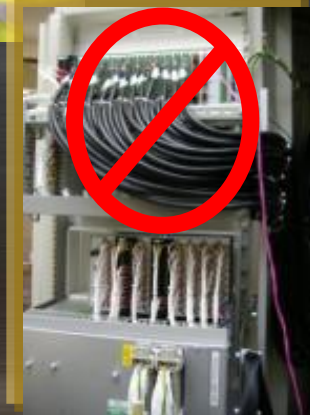
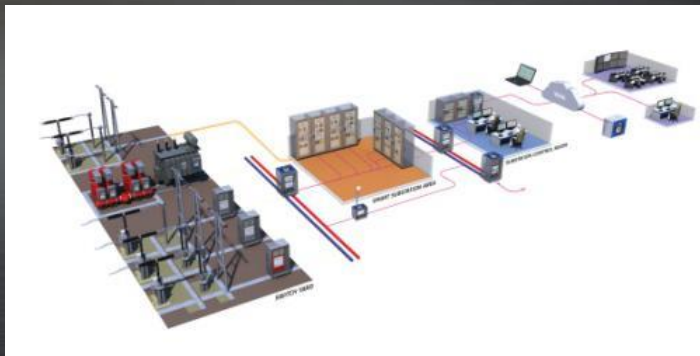
# Poste Intelligent Will Deliver

- **Situational awareness:** Real-time knowledge of primary device status, infrastructure monitoring, substation environment monitoring => moving from periodic maintenance to predictive maintenance
- **Reduced-site activities and infrastructure:** Use of digital technology for primary devices and on-field data acquisition reducing time needed for installation, commissioning and outage. Benefits for substation civil works and wiring.
- **Interoperability:** Substations fully based on IEC 61850 standard
- **Human Machine Interface:** Concentrating all substations data electrical and non-electrical on one single environment
- **Protection against intrusion:** Cyber-security and site protection, video surveillance
- **Recovery time improvement :** Fault locator optimization based on multiple-end fault algorithm



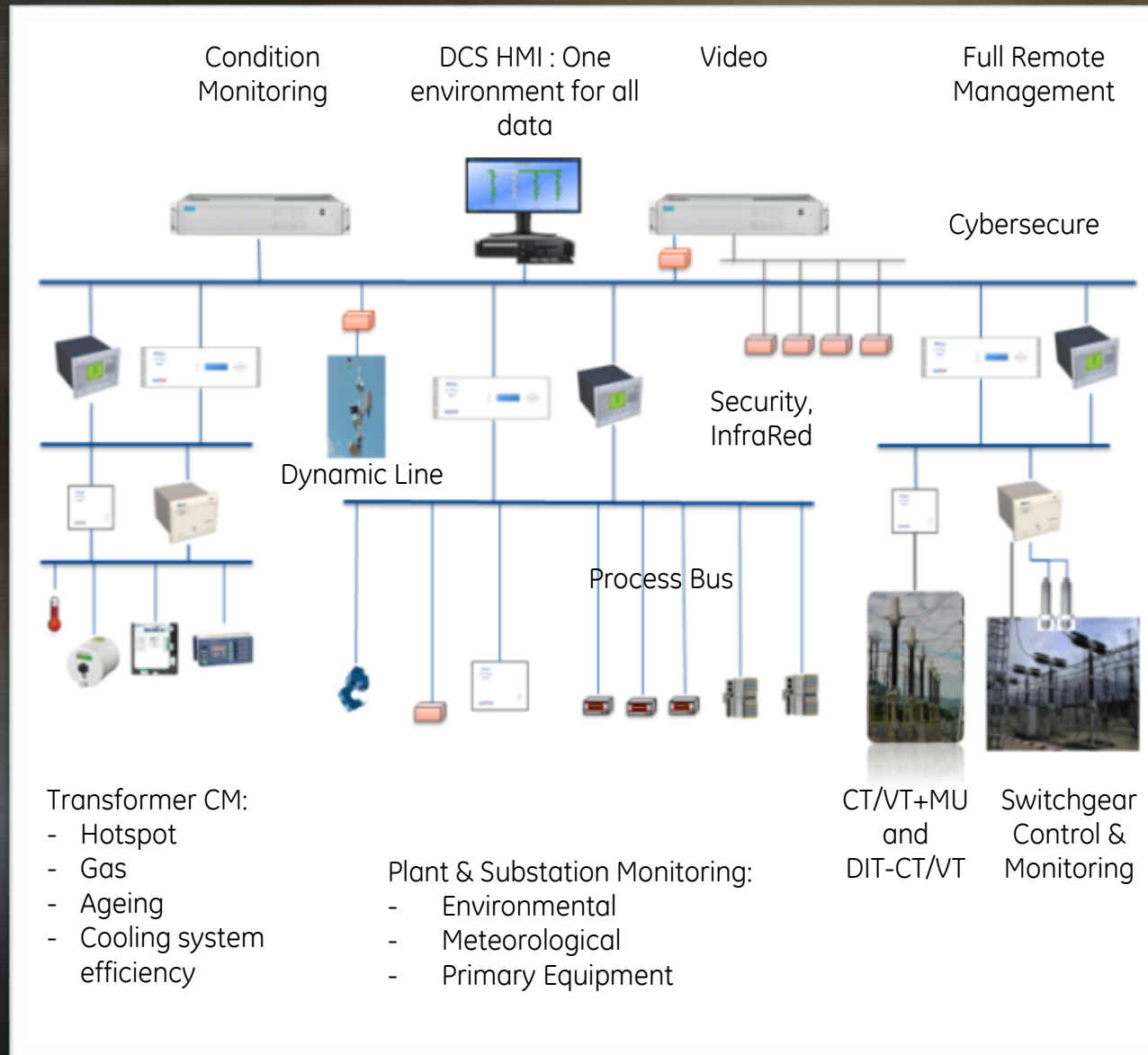
# Main Changes - Digital vs Conventional

- **Digital instrument transformers** vs. wound CT/VT
- Few **Ethernet** cables vs. multitude of hardwires in trenches
- **Digital acquisition** of data vs. analogue wiring
- **Integrated architecture** vs. discrete solutions
- **Single, overall DCS** vs. separate control & monitoring
- Data-rich **situational awareness** vs. simple alarms
- **Optimised substation footprint** vs. discrete equipment
- **Functionality defined in software** vs. wired bay schematics
- **Standard bay solutions** vs. custom engineering



# Conclusions

- First full digital substation in France
- Smart extends from the SCADA to the substation in a distributed way
- First step toward an optimisation of IEDs
- Powerful real time response to DER integration challenges
- Total remote control
- Concept for the secondary equipment: maintenance free





Thank You

Questions?