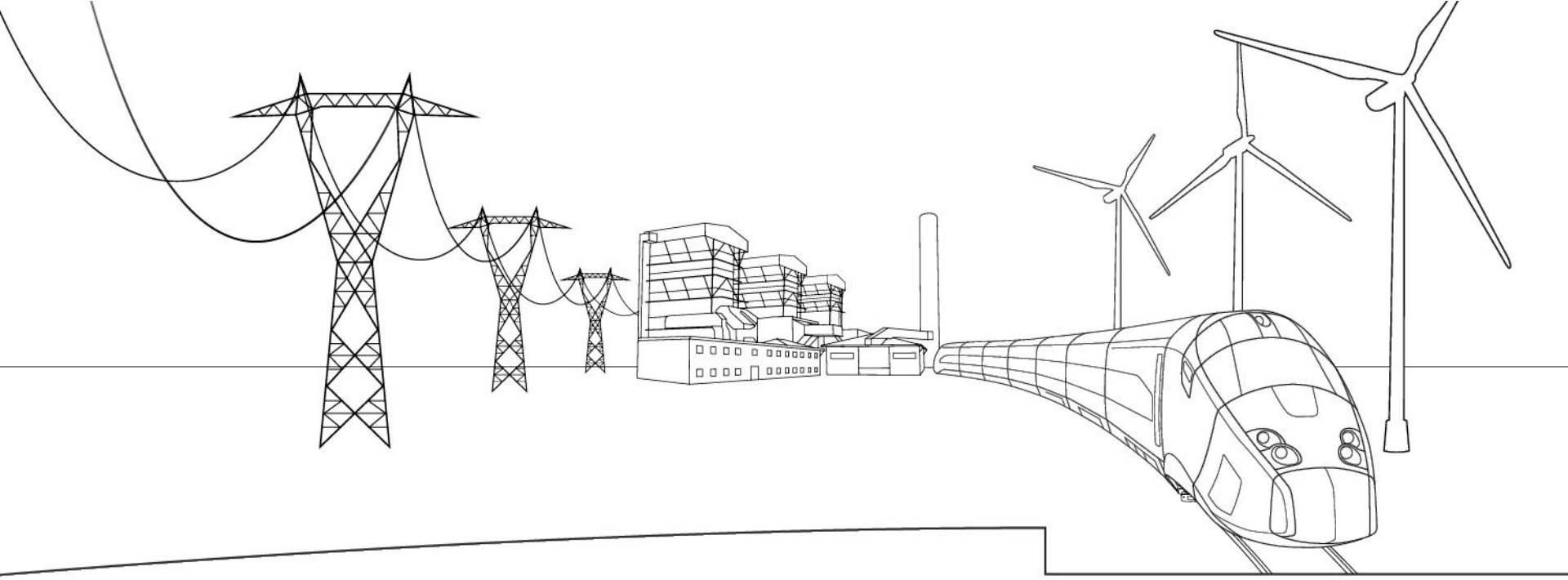


Movement to the full Digital Substation

Ravindranauth Ramlachan

CIGRE

10/22/2013

ALSTOM

Shaping the future

Why Digital - 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, labour cost per wire end termination
- Schematic design - verification cost, excessive on-site work content
- Civil work costs – trays, troughing, cable access/egress…
- Maintainability cost

ALSTOM

What is a Digital Substation?

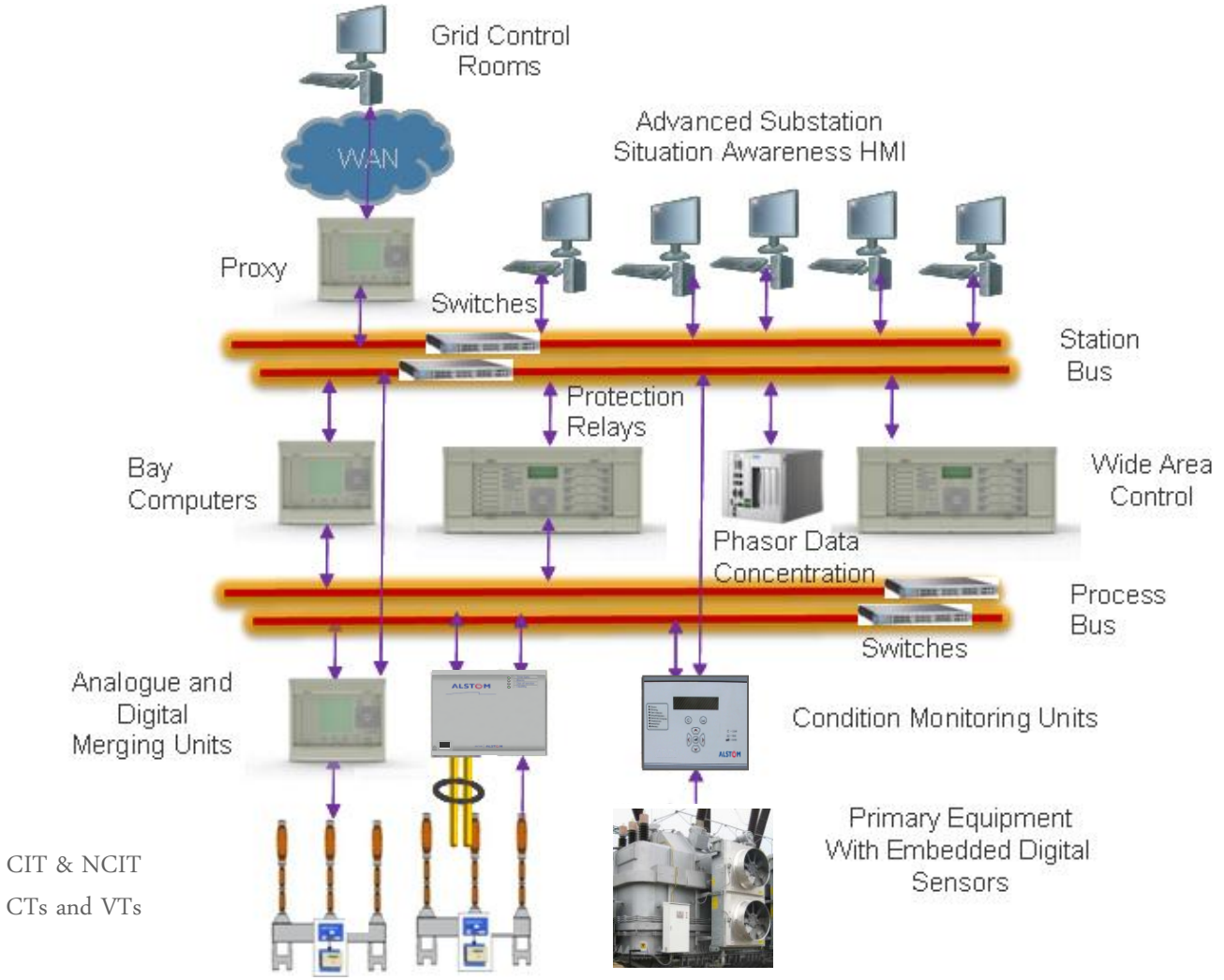
Digital substations are those which have embedded processing intelligence in order to implement part of their operational duties, and as such typically exceed the capability of their analogue predecessors. The intelligence adds:

- Ease of use
- Asset management
- Modularity
- Vendor interoperability
- Real time awareness

Realized by digitizing the data related to the primary process at the point where it is measured

ALSTOM

The Digital Substation – Architect Levels



Station Control

Protection and Control

Primary Equipment Process

ALSTOM

Key Drivers

Improved Safety

-Eliminate open circuit CTs

Asset Optimisation

-Intelligent monitoring of equipment

Reduced Maintenance Cost

-Condition-based maintenance

Optimisation of New Investments

Increased Reliability and Availability

extensive self-diagnosis capability, **redundancy**

Why install a digital substation?

"Not only does it optimise overall lifecycle costs, it is easier to use. Asset managers now have a vital tool that, with less wiring and fewer commissioning tests, accommodates preventive maintenance and can extend transformer and switchgear lifetime. Digital substations are modular, so they can be tailored to system needs and open to third-party devices. It is easy to retrofit protection and control schemes with minimal outage constraints. Ultimately, operators manage a smarter grid, with better, more complete real-time situational awareness, making the system more available and secure."

ALSTOM

Key Drivers

Standardisation and Interoperability

-Multi Vendor

Ease of Refurbishment

-Refurbish with minimum primary outage

Improved communication capability

-Data available to all levels

Environmental Responsibility

-Wiring is reduced by typically 80%.

Why install a digital substation?

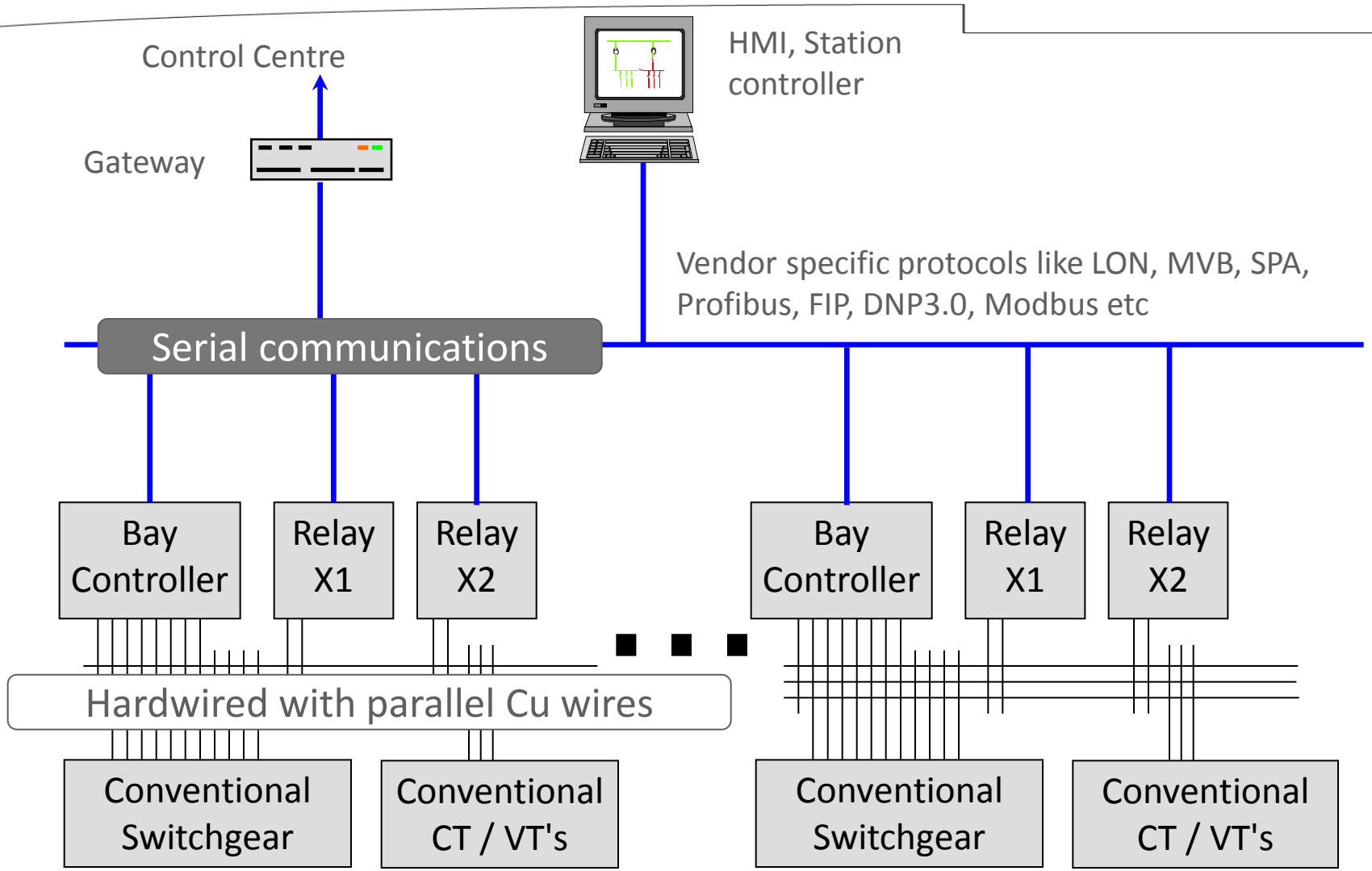
"Not only does it optimise overall lifecycle costs, it is easier to use. Asset managers now have a vital tool that, with less wiring and fewer commissioning tests, accommodates preventive maintenance and can extend transformer and switchgear lifetime. Digital substations are modular, so they can be tailored to system needs and open to third-party devices. It is easy to retrofit protection and control schemes with minimal outage constraints. Ultimately, operators manage a smarter grid, with better, more complete real-time situational awareness, making the system more available and secure."

ALSTOM

Technology Enablers and Standards

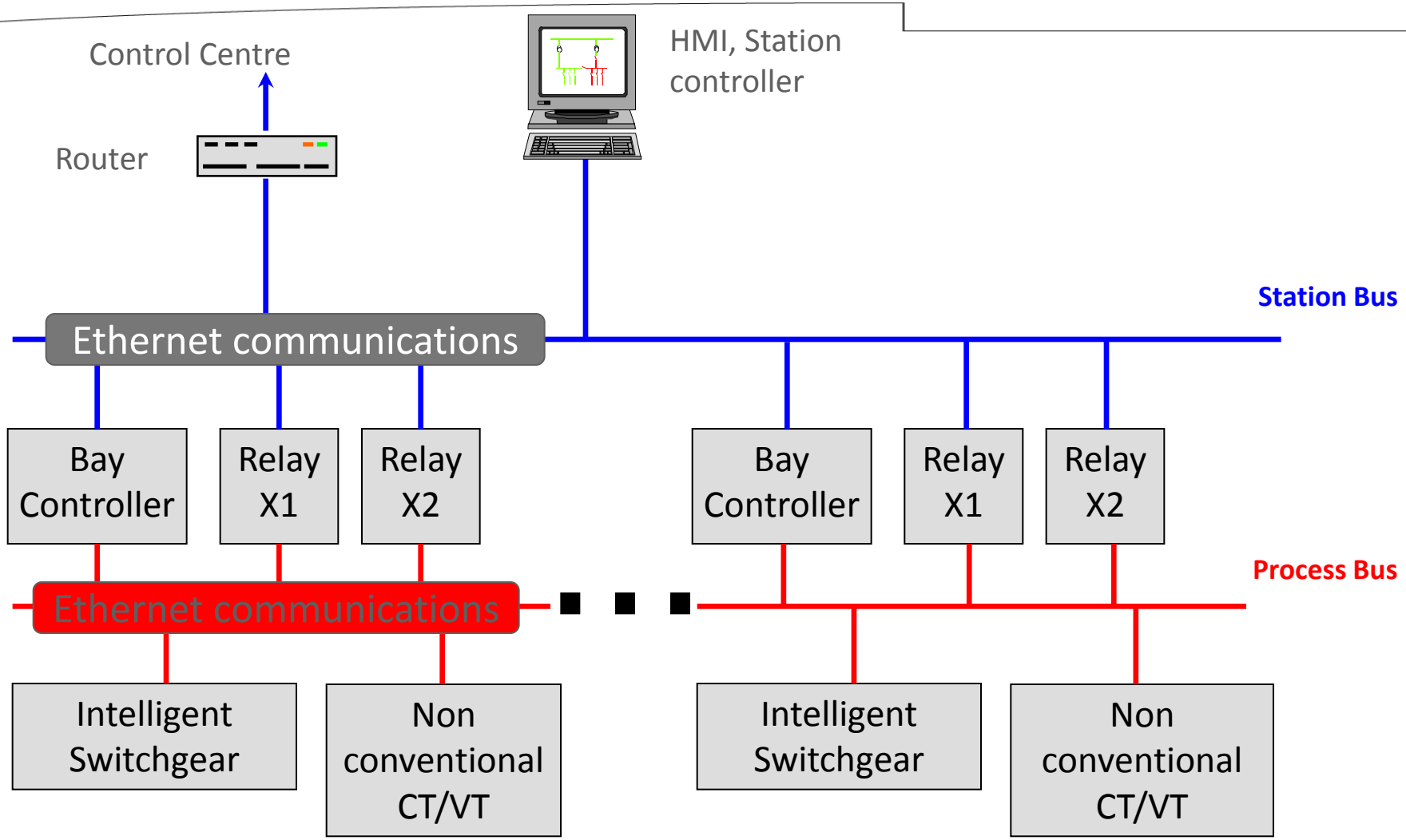
- Ethernet (typically 100Mbit/s, moving towards 1Gb)
- IEC 61850
  - IEC 61850-8-1 and GOOSE Service
  - IEC 61850-9-2LE for Sample Values
- IEC 62439-3
  - PRP for redundant star architecture
  - HSR for redundant ring architecture
- IEEE C37.118 – phasor measurement
- Precision time synchronising (µs)
  - GPS (1pps)
  - IEEE 1588
- **Non Conventional CTs (NCIT) & Merging Units (MU)**
- Cyber security

What does IEC 61850 solve?



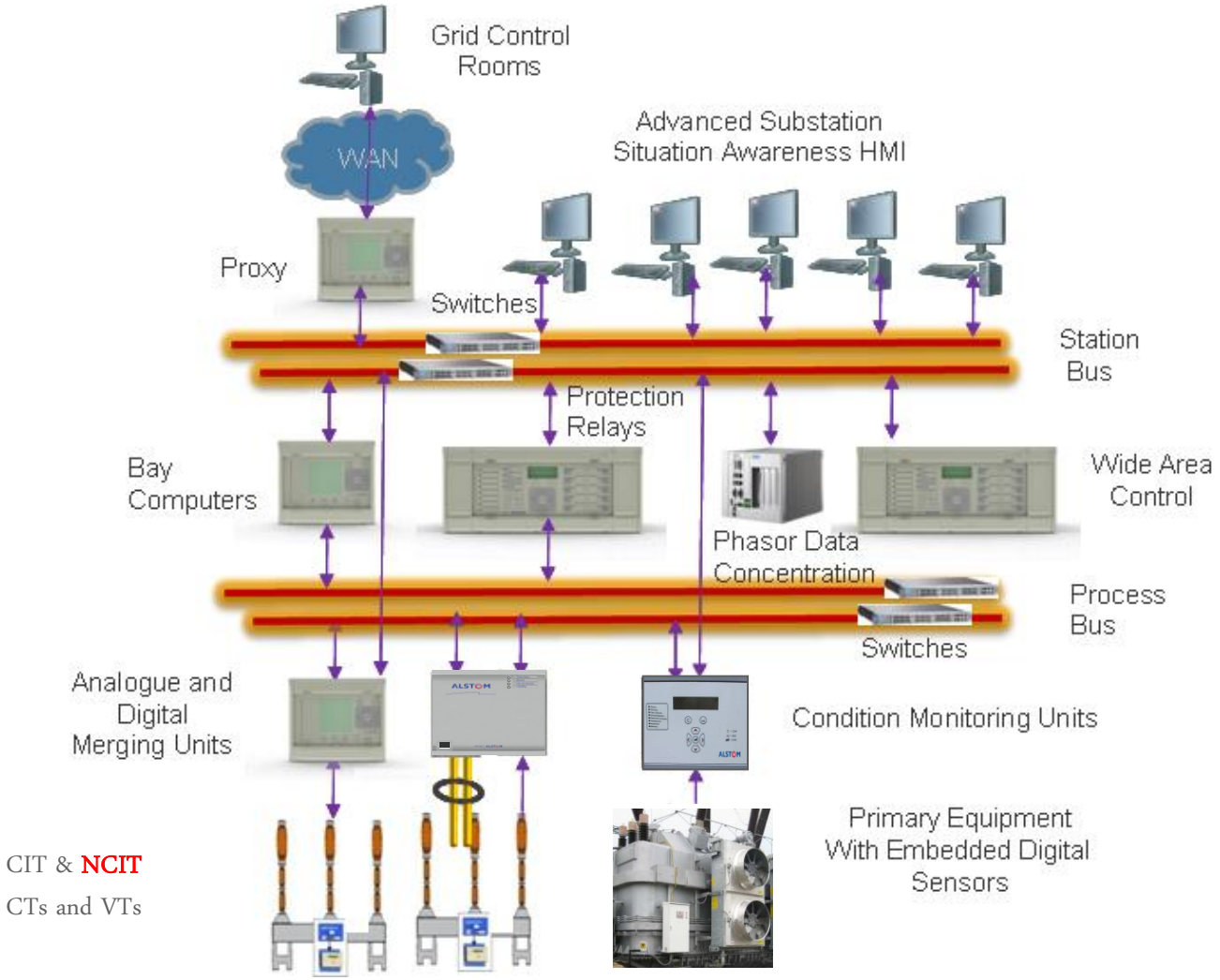
ALSTOM

What does IEC 61850 solve?



ALSTOM

The Digital Substation



Enablers

-Ethernet
-Redundancy

-61850
-Station Bus
-Process Bus

-Precision Timing

-NCIT/MU

-Cyber Security

ALSTOM

NCIT Advantages

- Cost Savings *(particularly at voltages above 200kV)*
  - Compact and lightweight primary current and voltage transformers
  - Space-efficient, easily transportable
- Digital Standard IEC 61850-9.2 - Interoperability
  - Interoperability between conventional CT/VTs, other vendors supporting IEC 61850-9.2, and test equipment
  - Ease of integration in the Total Digital Substation.
- Safety - Reliability - Availability
  - No explosion risk
  - No wired cross-site CT connection
- Measurement Improvement
  - No saturation, no ferroresonance, accurate transient response
  - High bandwidth: Wide dynamic range for Protection short circuits, whilst retaining accuracy for low-current Measurement
- Exploitation Ease
  - Ethernet distribution of sampled analogue values to multiple devices
  - Ease of extension or modification without affecting physical wiring
  - Measurement class accuracy and Protection dynamic range

ALSTOM

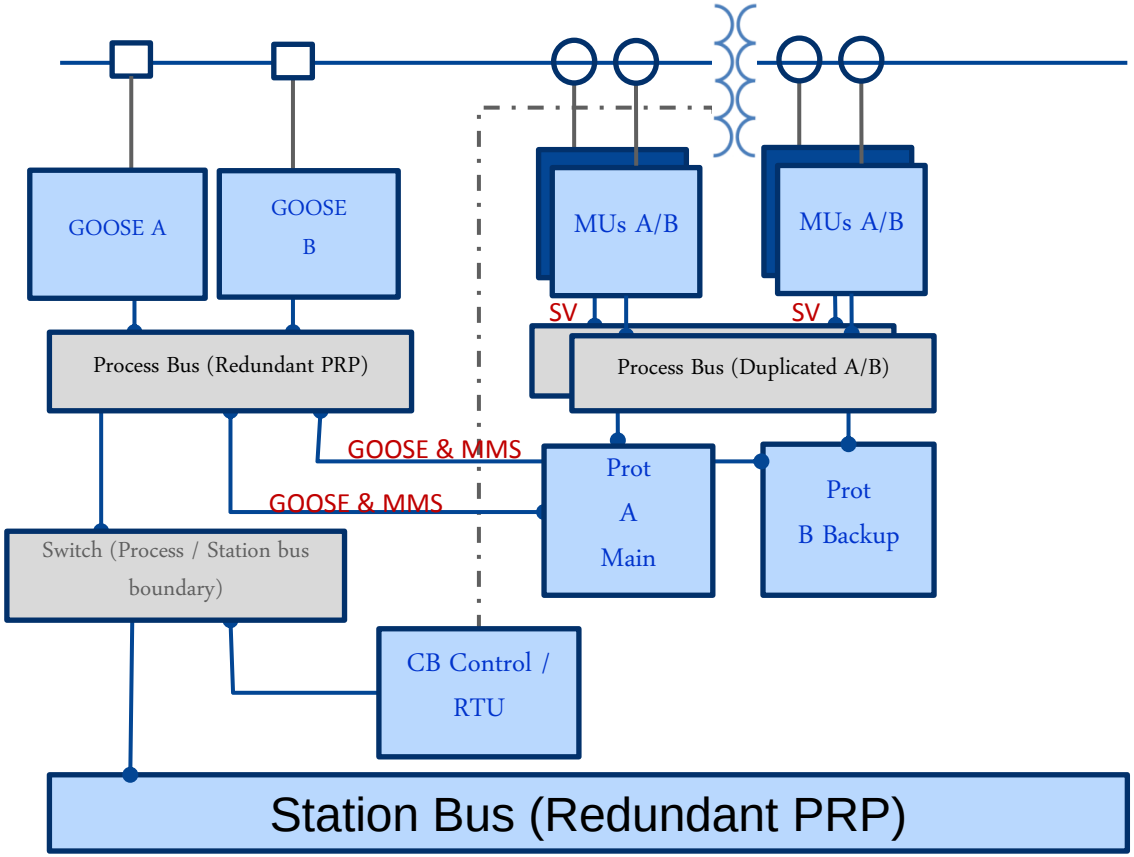
Digital Substation Challenges

- Redundancy
  - Extends to communication network
  - Same considerations as with “traditional” substation
- Testing
  - How to isolate and test
- Precision Timing
  - Common time source needed

ALSTOM

Architecture Redundancy Considerations

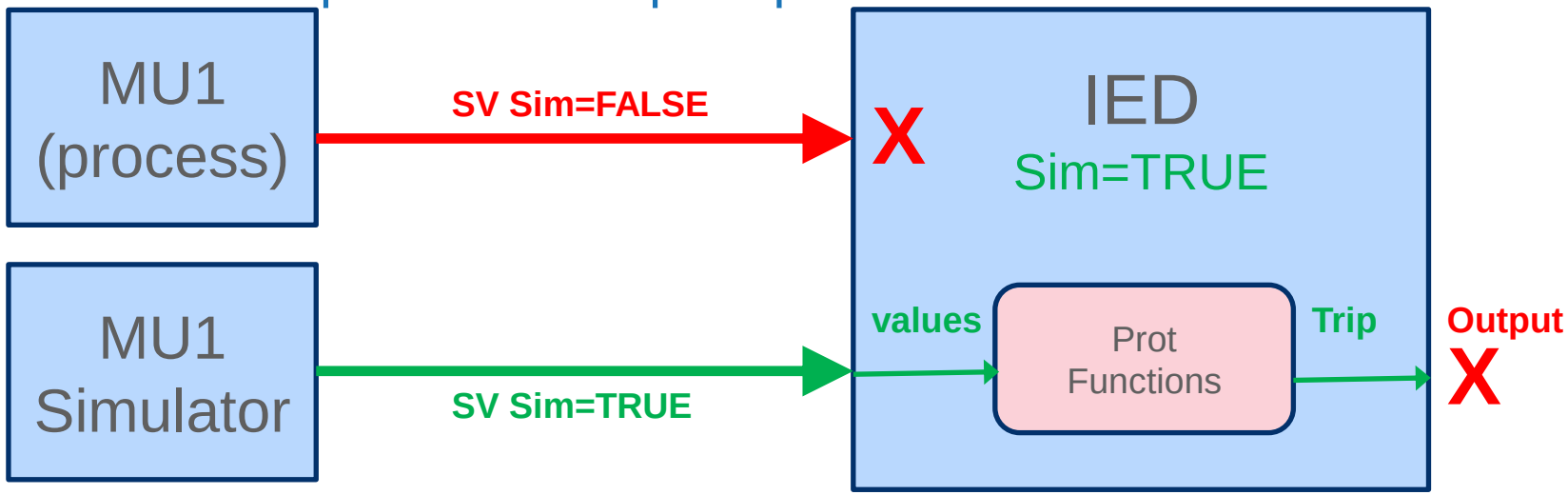
- There are numerous ways to increase the reliability and availability of a digital substation through redundancy
  - Redundant sensors
  - Redundant IEDs
  - Redundant networks



SV considerations – isolation and testing

- Set IED into ‘Simulation’ mode

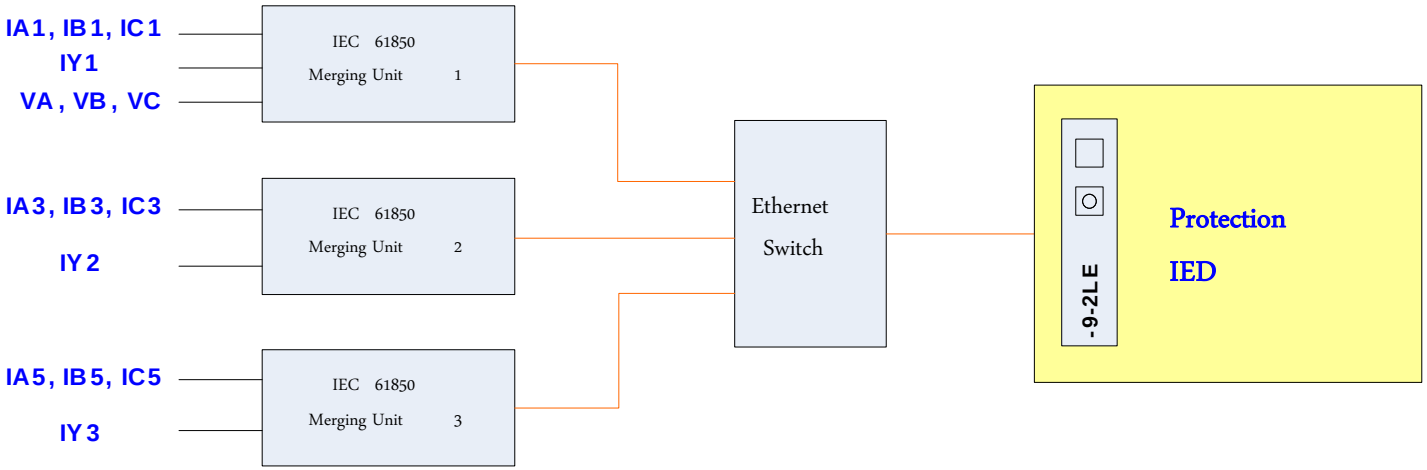
- IED processes SV frames with Test/Simulation indication set
  - Does not operate IED trip outputs



ALSTOM

Merging Unit considerations – SV delays

- Different delay in samples from different MUs
  - could be from different vendors

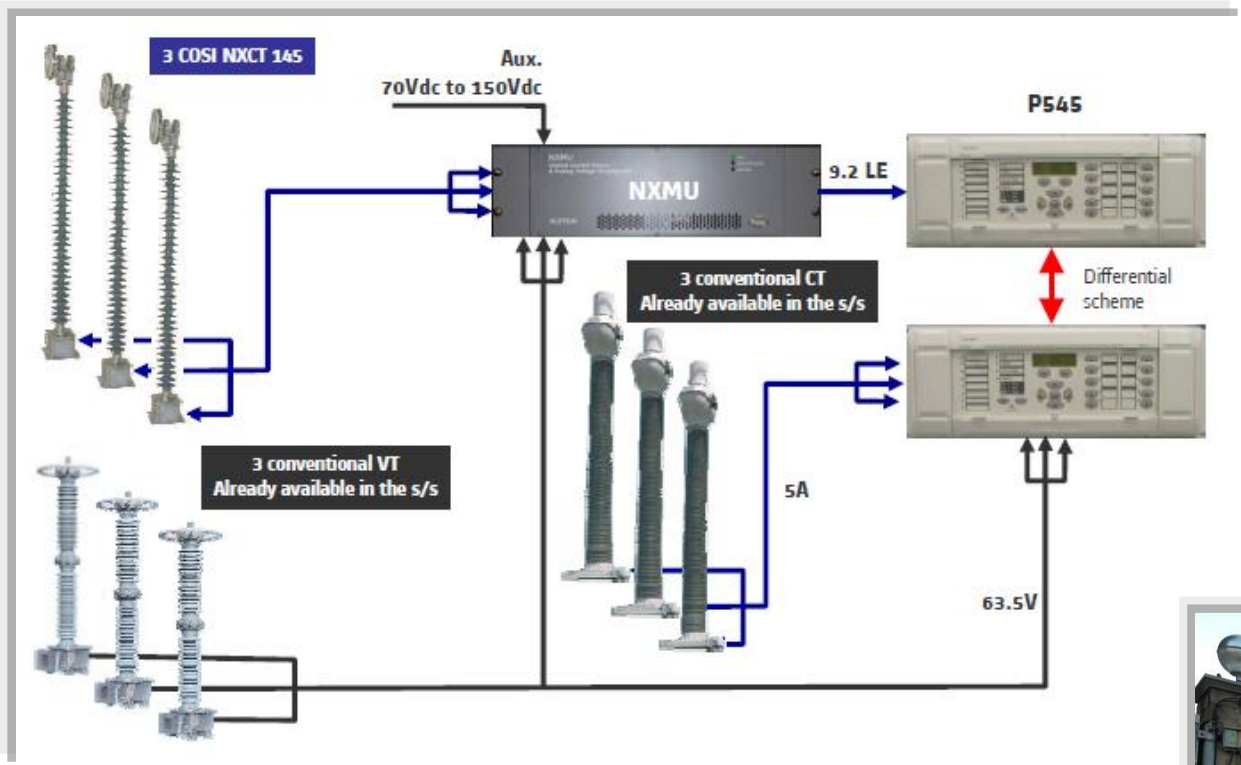


Merging Unit considerations – SV delays

- Need each MU to be accurately synchronized
  - 1 PPS, IEEE 1588 PTP
- IED processes global/local synchronization indication for SV received
  - Adapts protection functions – e.g. inhibits current differential
  - Alarms on loss of synchronization
- IED should align SV according to maximum time delay between subscribed Merging Units

ALSTOM

Pilot Projects



ENDESA substation:

SE Llobregat

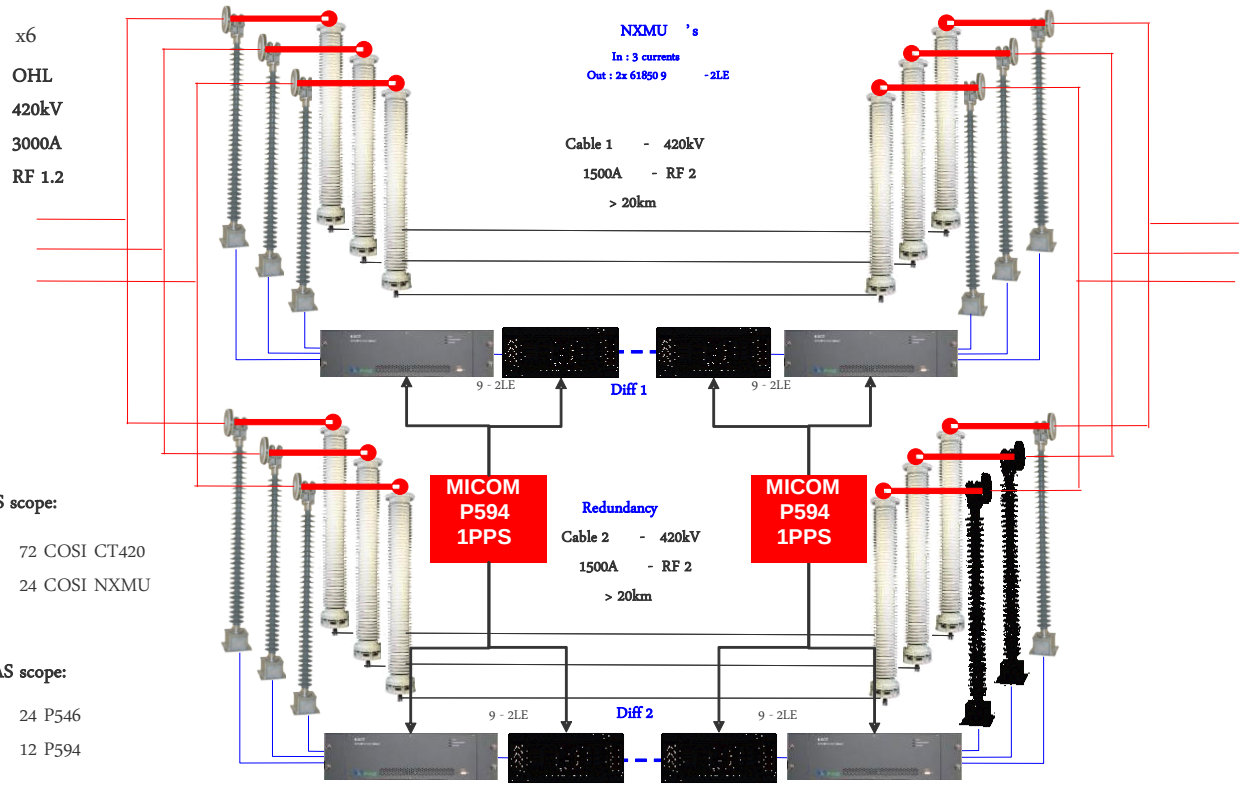
145kV

Presentation title - 24/10/2013 – P 17

Pilot Project – ENERGIENET, Denmark

ENERGINET: Denmark – Full digital solution

6 Underground 420 kV Cables differential monitoring



AIS scope:

- 72 COSI CT420
- 24 COSI NXMU

SAS scope:

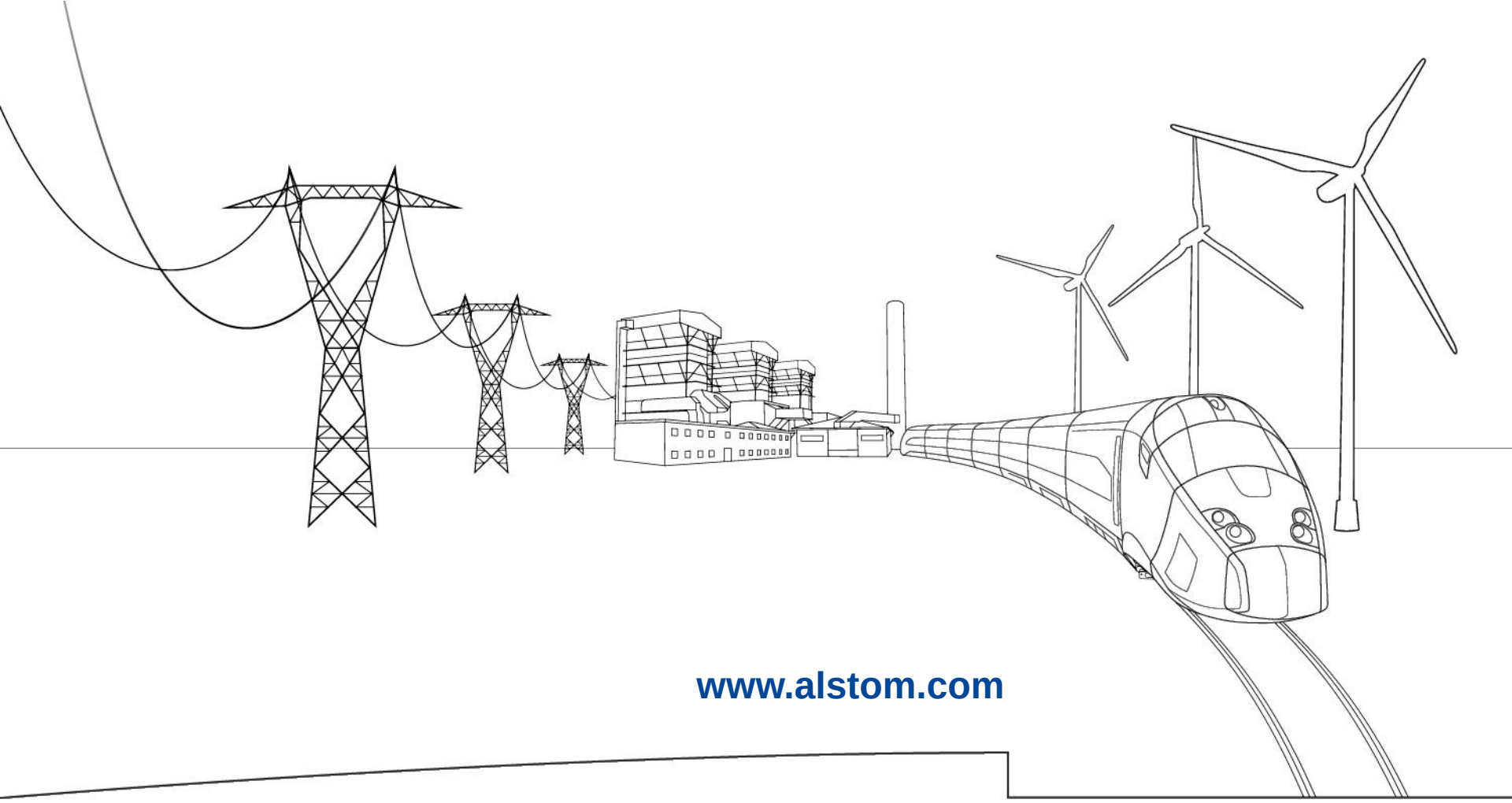
- 24 P546
- 12 P594

ALSTOM

The Digital Substation: Conclusion

- **The Digital Substation requires:**
  - A common, coherent solution integrated using modern communication architectures
  - An optimized solution for customers, with reduced costs of ownership and higher performance
- **This is supported by the application of IEC 61850 within the substation :**
  - Digitization of data at source
  - Implementation of “real-time” communications
  - Integration of all control, measurement, protection and monitoring functions
  - Test features

ALSTOM



www.alstom.com

With Alstom, preserve the environment.
Is printing this presentation really necessary?

ALSTOM
Shaping the future