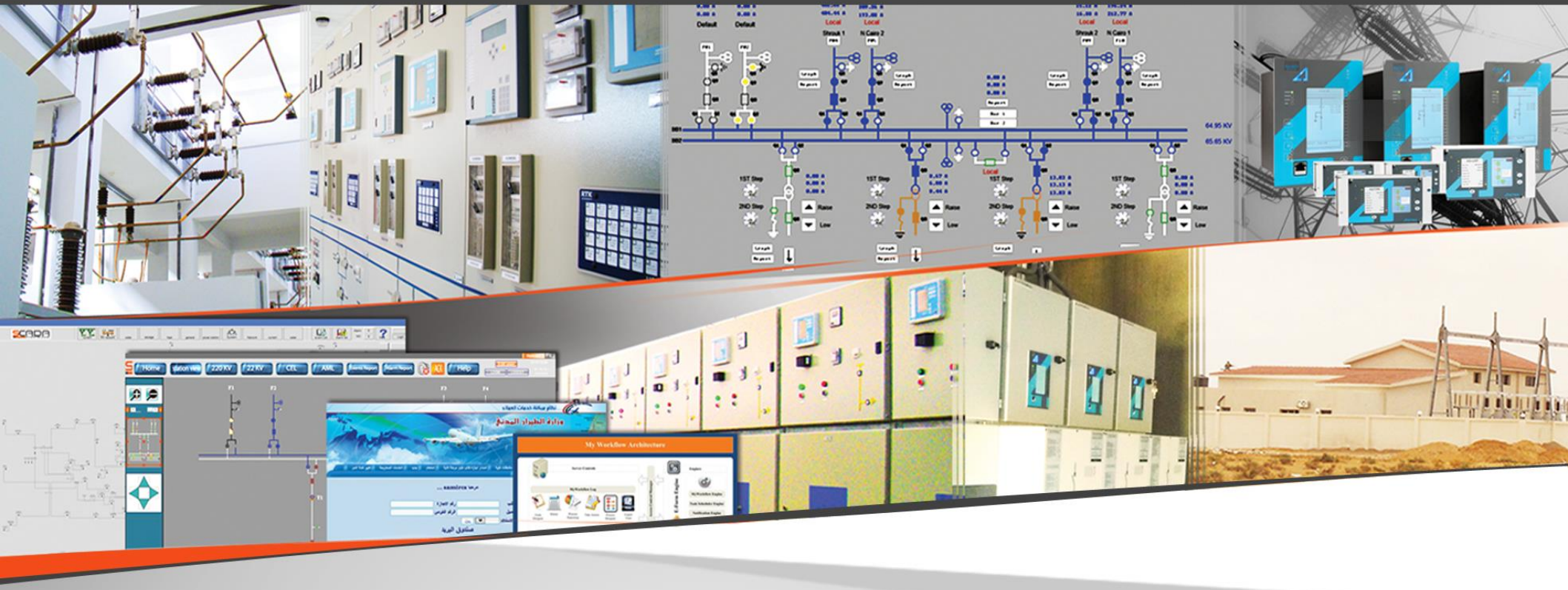

SCADA innovations

Substation Automation System
&
IEC61850

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Today Agenda

Part I

- How substation works
- Intro to Digital Substation
- Evolution of Substation Automation System
- New architecture according to IEC61850

Part II

- Benefits of IEC61850

Part III

- Bay Level
- Station Level

Part IV

- Comparison between conventional and SAS substation

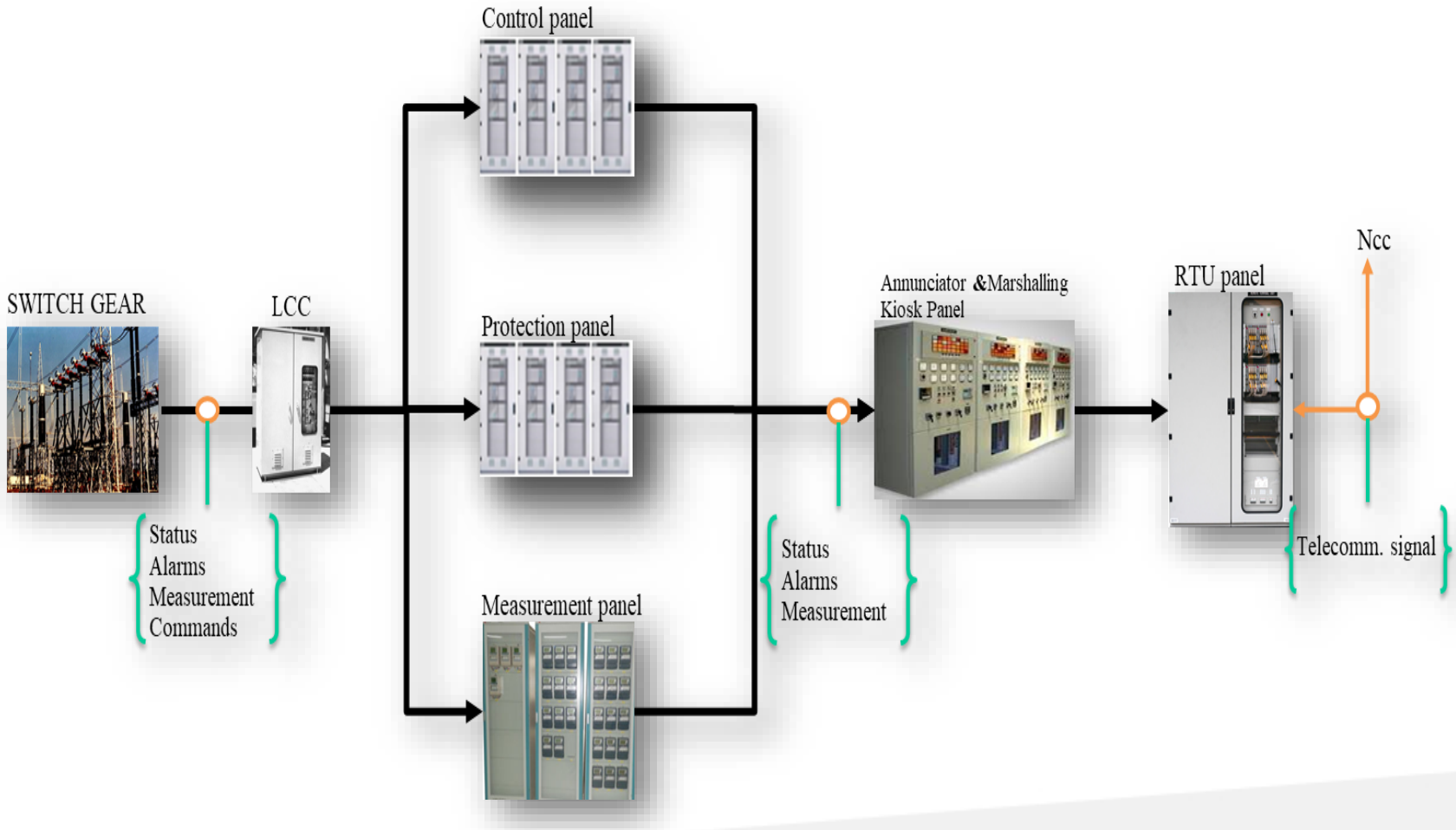
Substation automation system

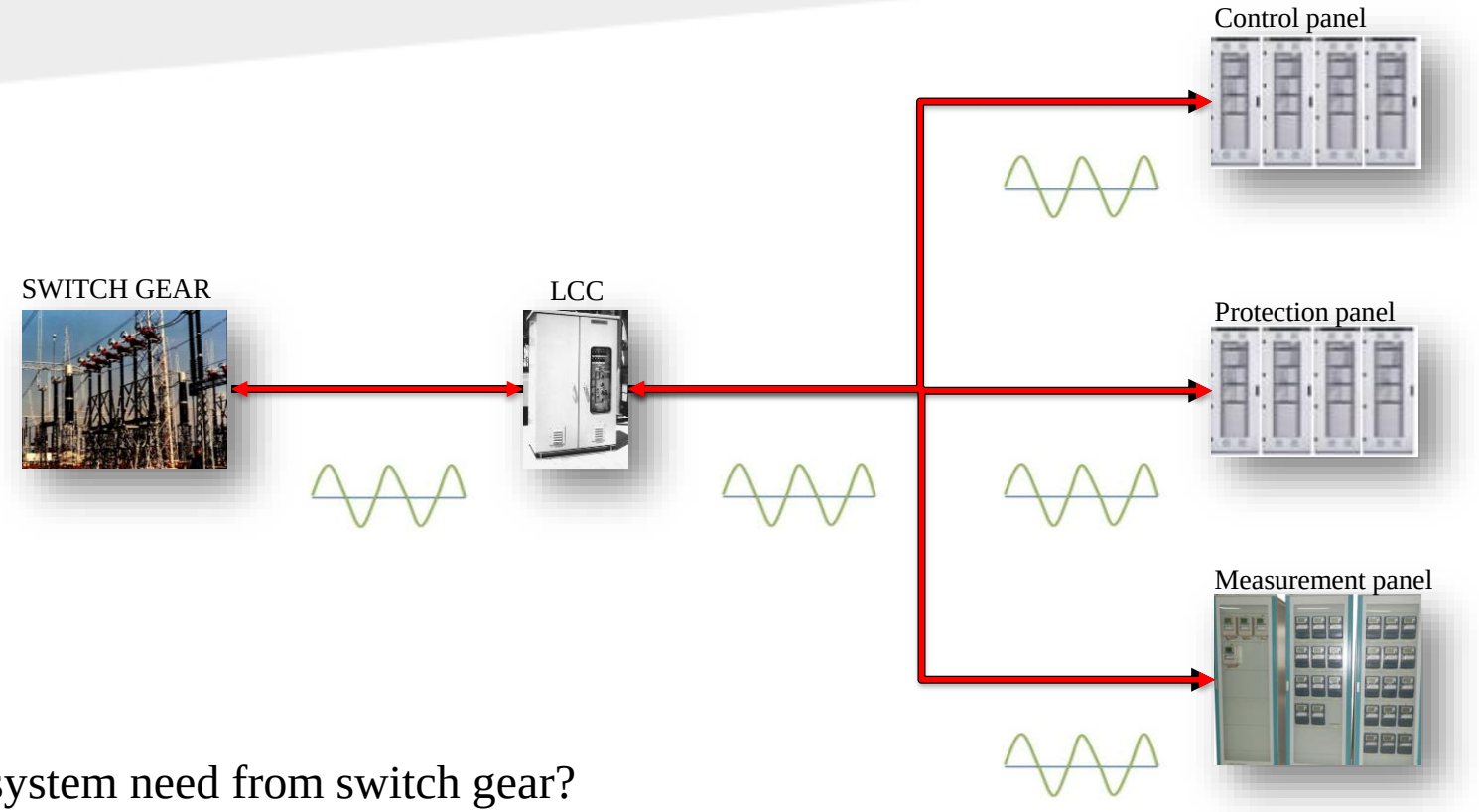
According to IEC61850

How substation works

Conventional Substation

- How signal generated and transmit through system



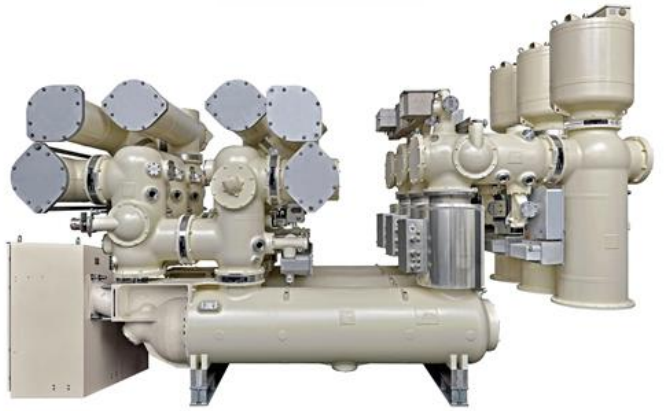


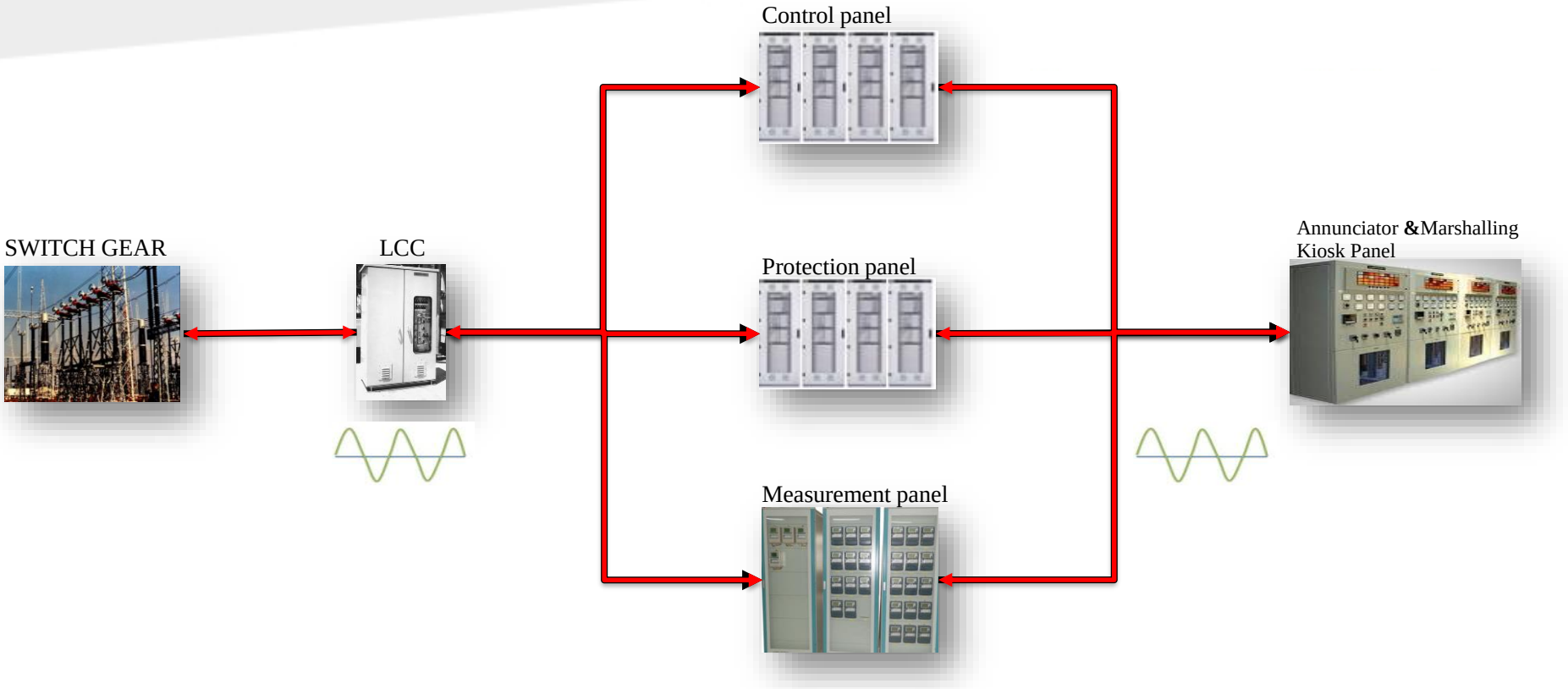
What system need from switch gear?

1- current signal from CTs
2- voltage signal from VTs
3- status from parts of switch gear

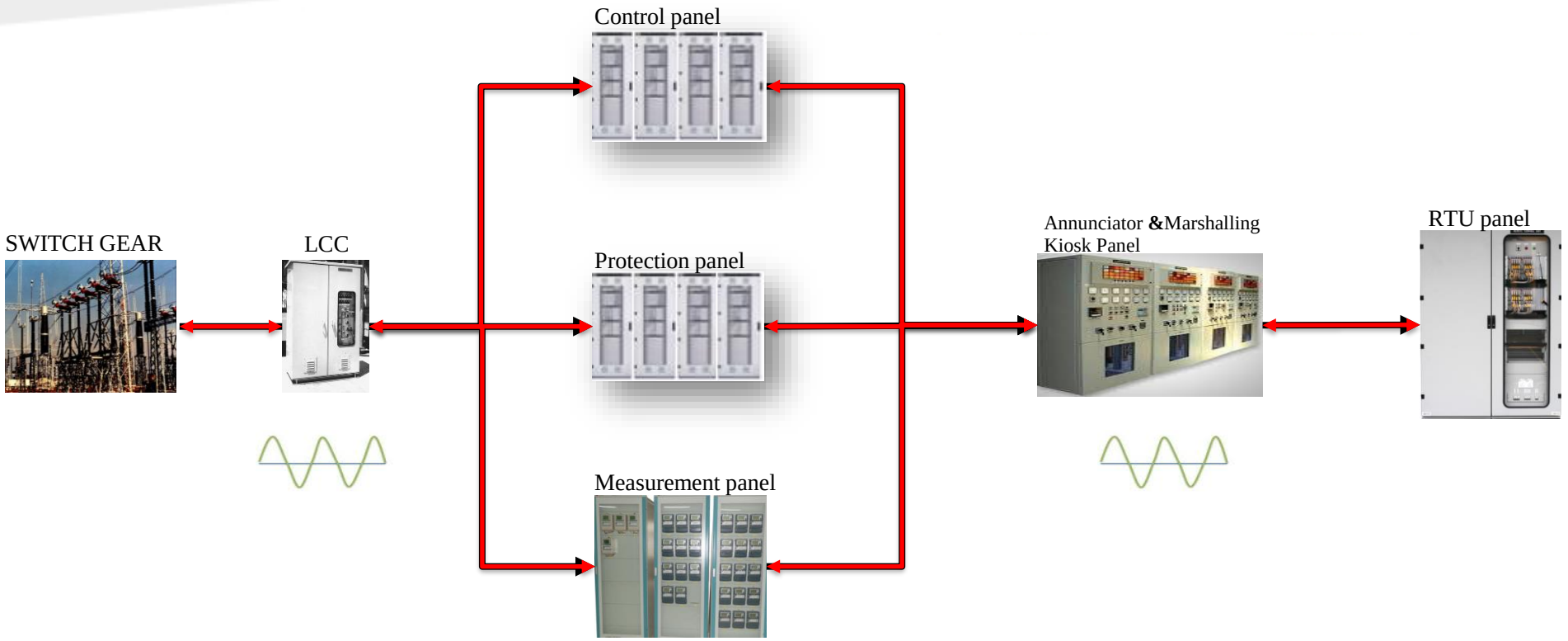
What switch gear need from system?

1- command signal to operate parts of switch gear
2- all alarms



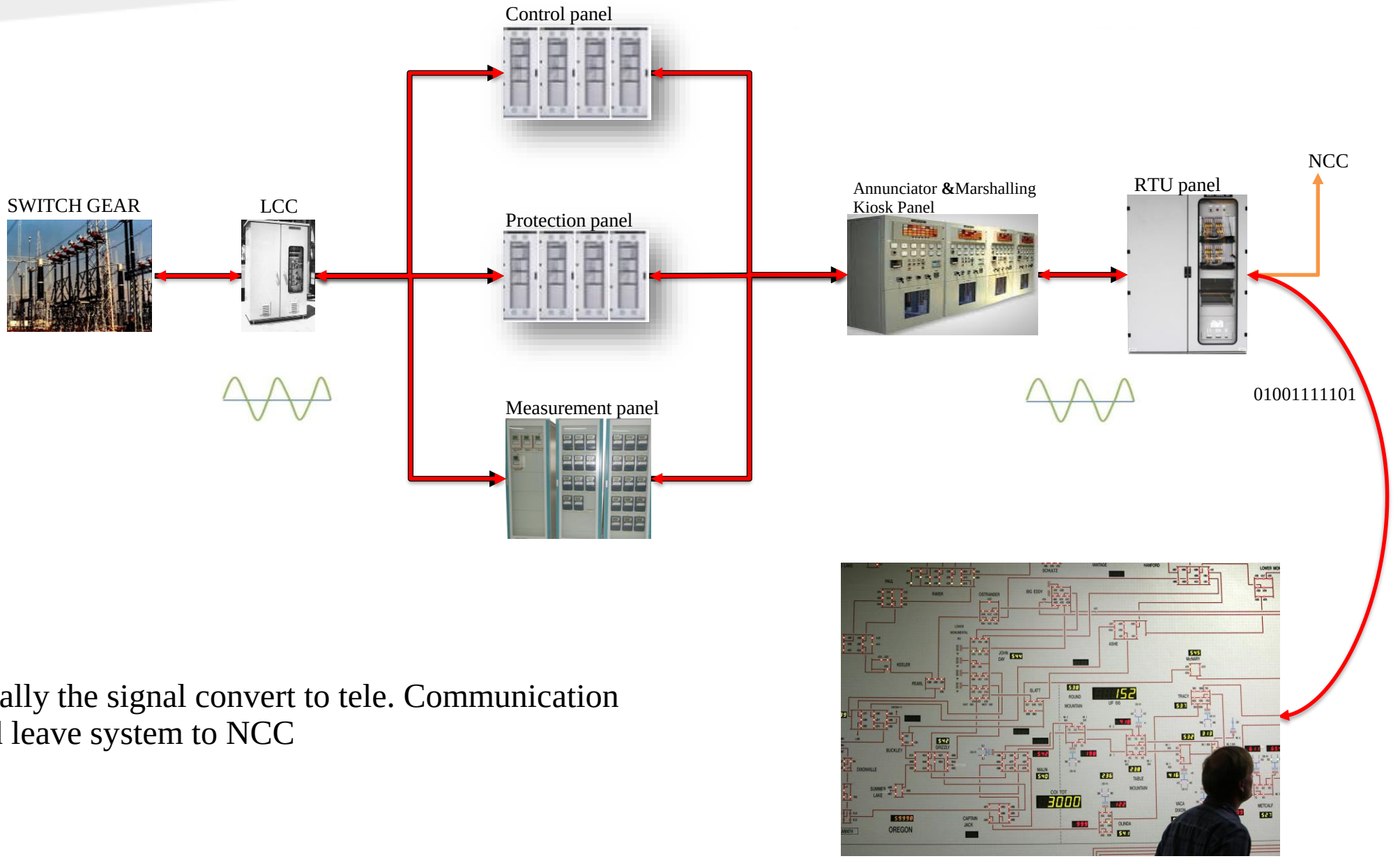


Signal distributed to all panels in parallel
1- Control panel
2- Protection panel
3- Measurement panel



At this stage system need to simplify this complicated circuit and display system status

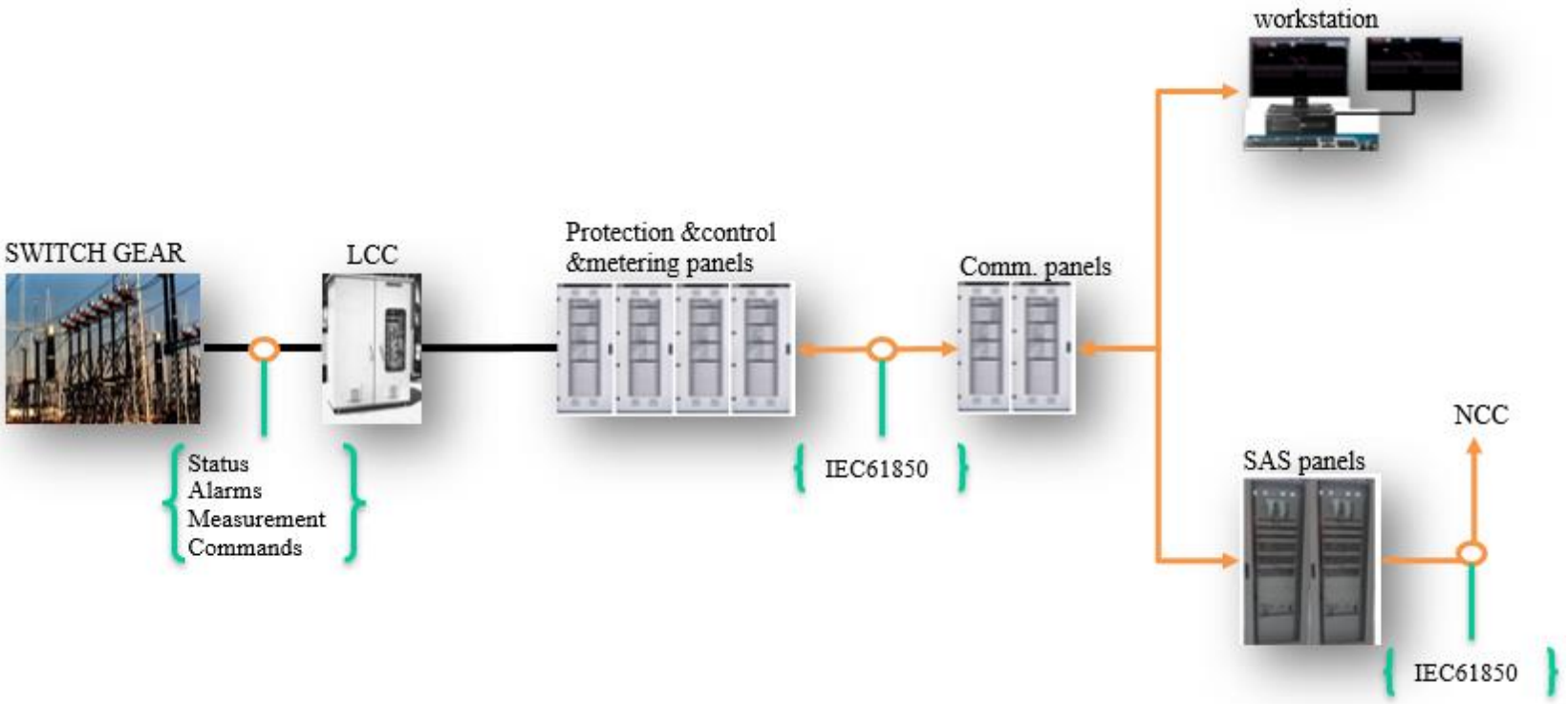
1- annunciator panel
2- marshalling panel
3- event record panel

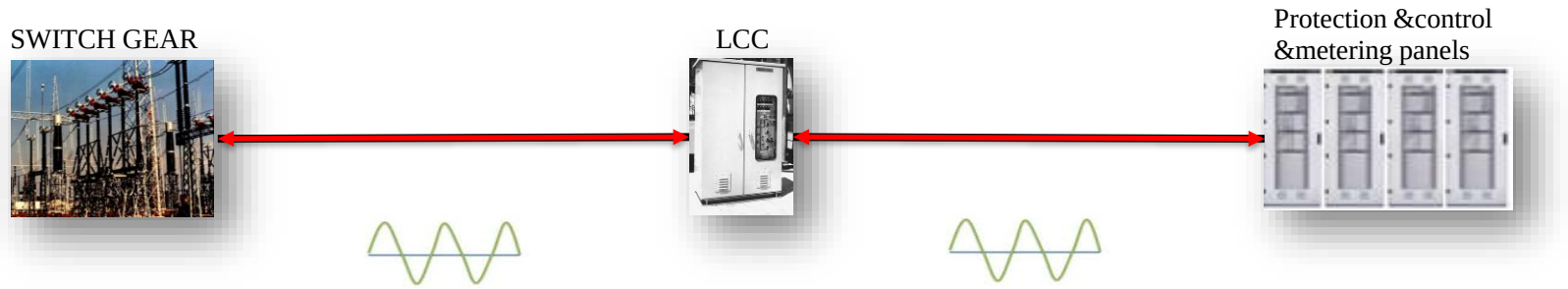


Finally the signal convert to tele. Communication and leave system to NCC

Substation Automation System (SAS)

- How signal generated and transmit through system





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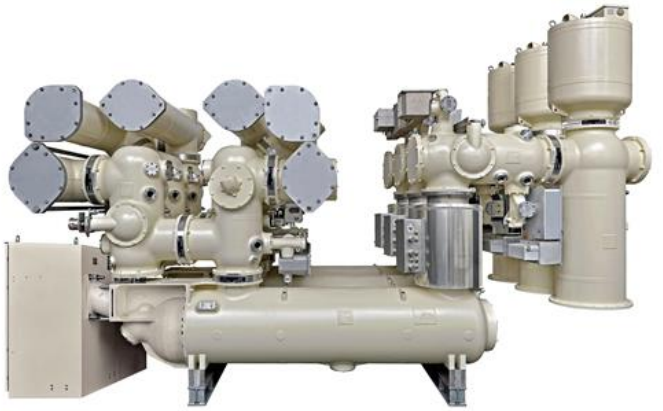

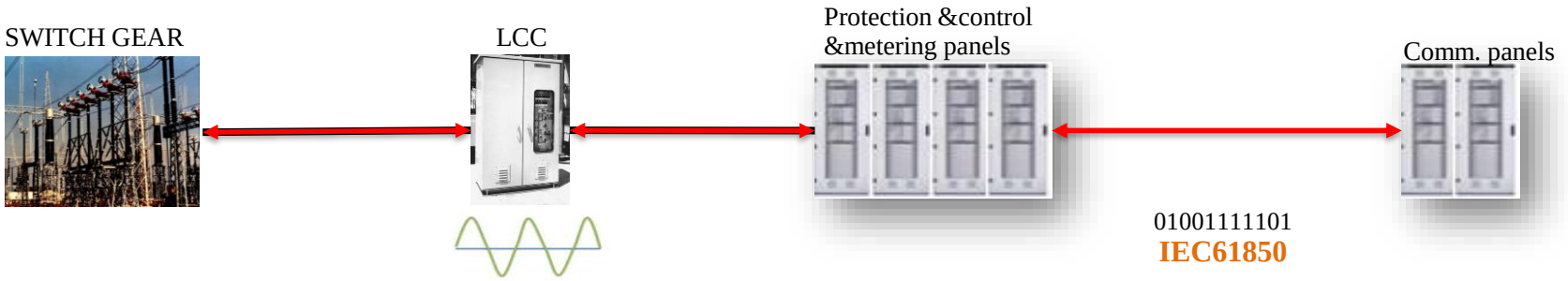

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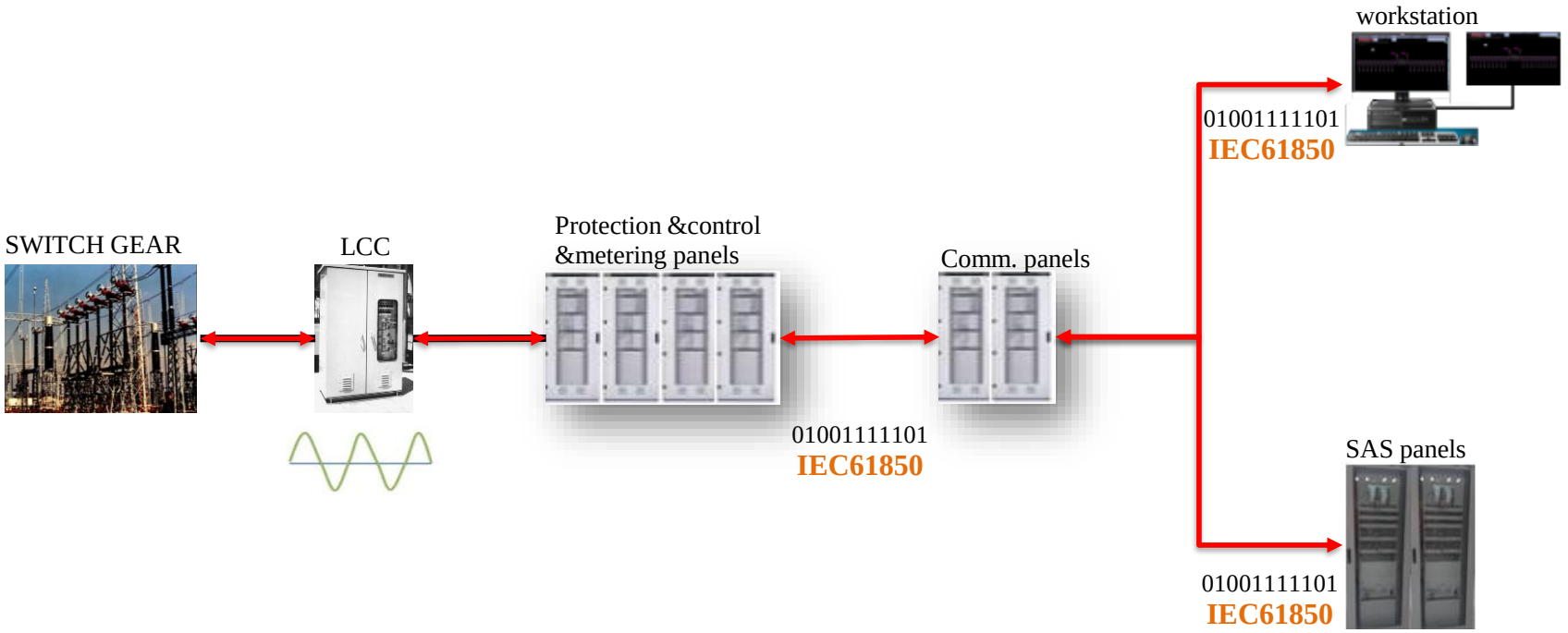
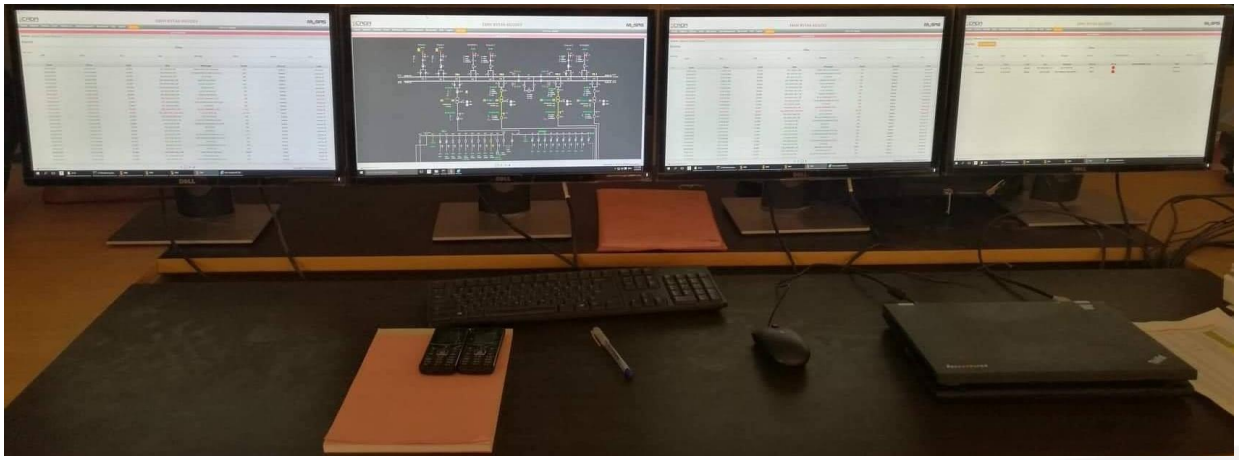
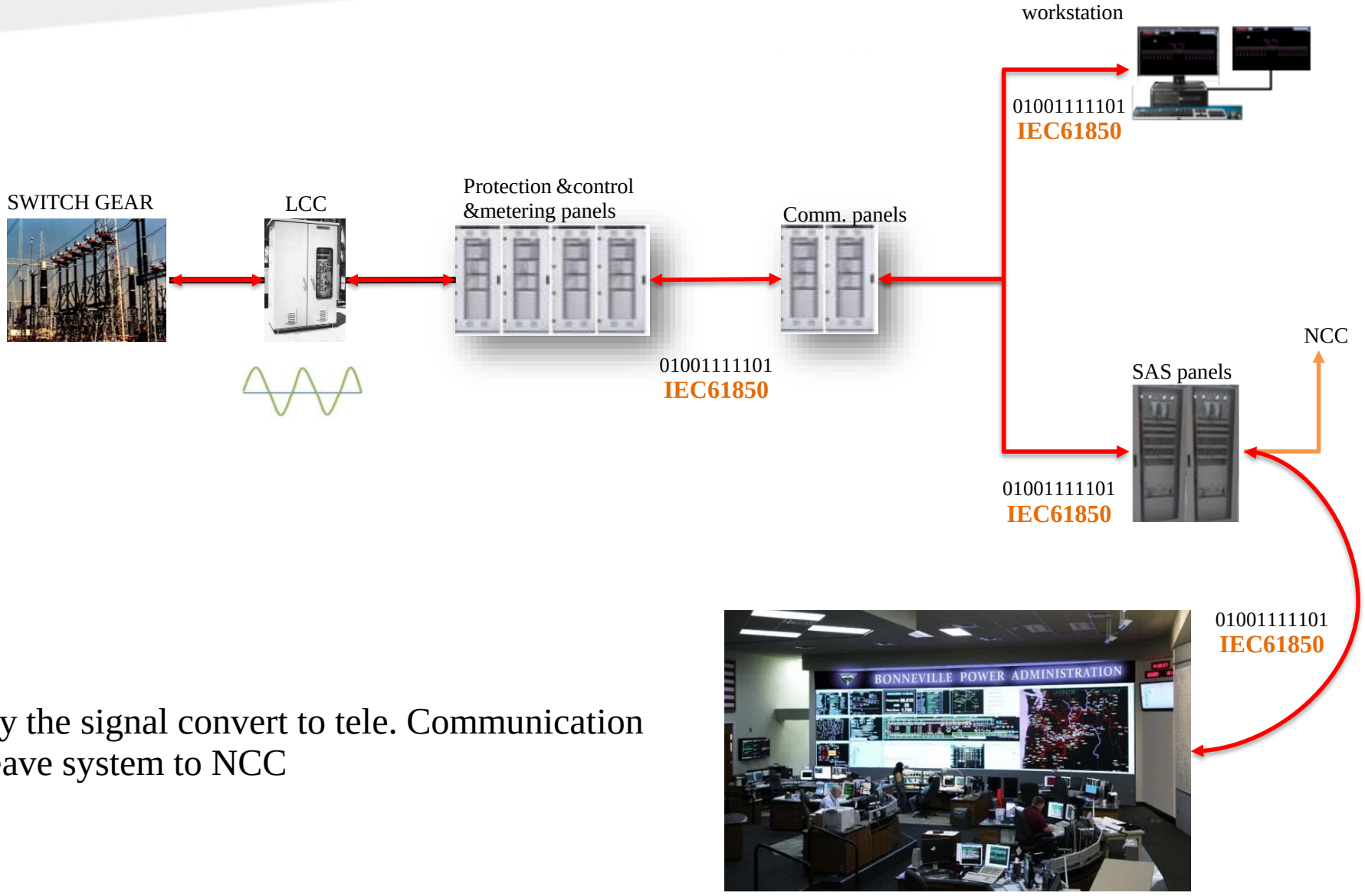


At this stage system need to display all status that transmit by station bus





Finally the signal convert to tele. Communication and leave system to NCC

Substation automation system

Substation automation is the integration of existing substation devices and a network infrastructure. By **integrating primary devices with networked secondary devices**, the substation can **perform automatic** industrial **tasks** such as **data acquisition**, **device control**, and **event recording**.

SAS enable utilities to manage the flow of electricity in transmission and distribution grids. SAS systems are important tools for the utilities since they protect and control substations and ensure grid stability.

How does a traditional substation become a digital substation?

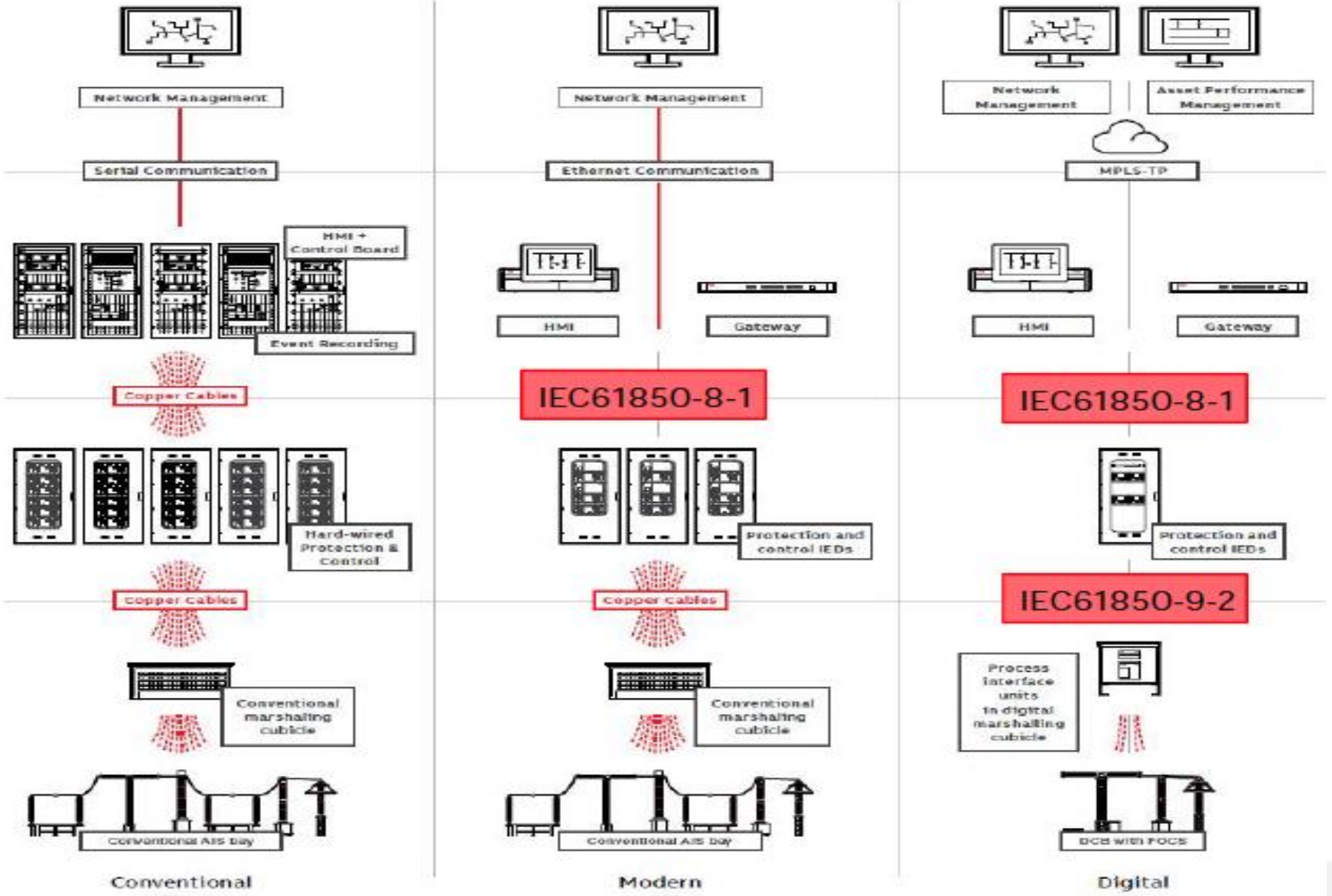
OR

when can you call a substation ‘digital’?

What is Digitalization ?

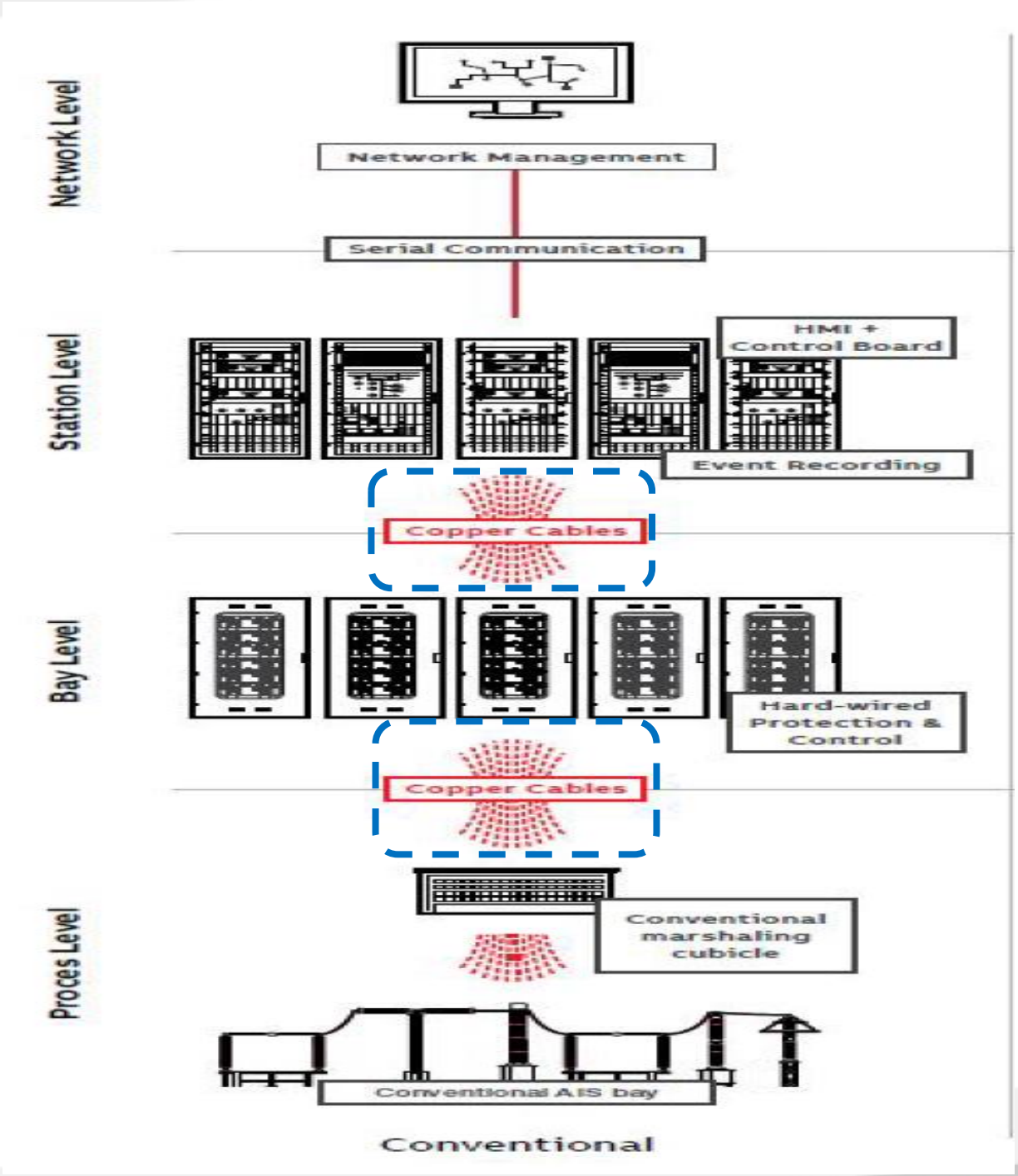
- Digitization is the conversion of analog information in any form (text, photos, voice, etc.) to digital form so that the information can be processed, stored, and transmitted digitally

The Evolution of Substation Automation

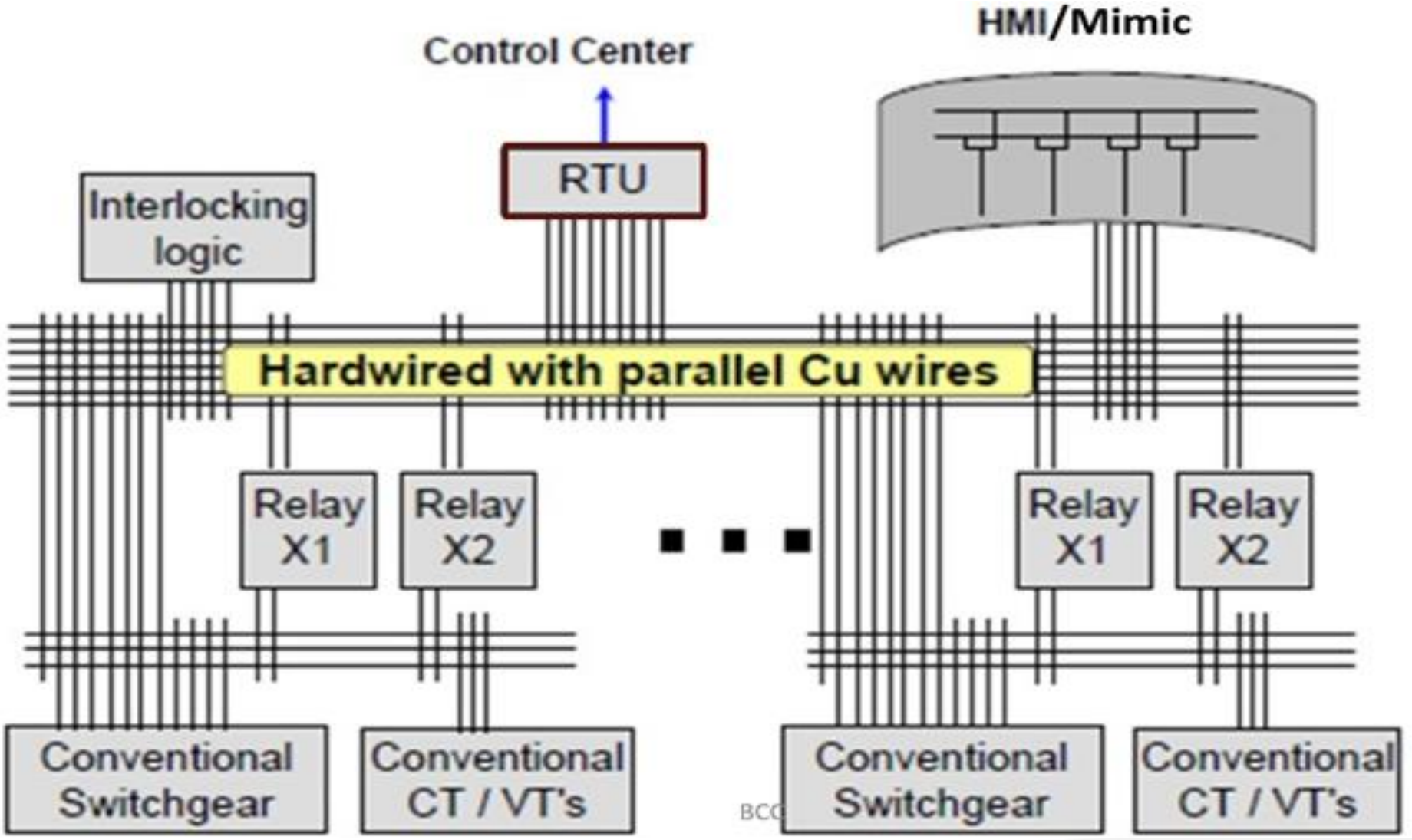


CONVENTIONAL SUBSTATION

Traditional substations have always relied on copper cables connecting together primary equipment like circuit breakers, conventional current and voltage transformers and protection relays.

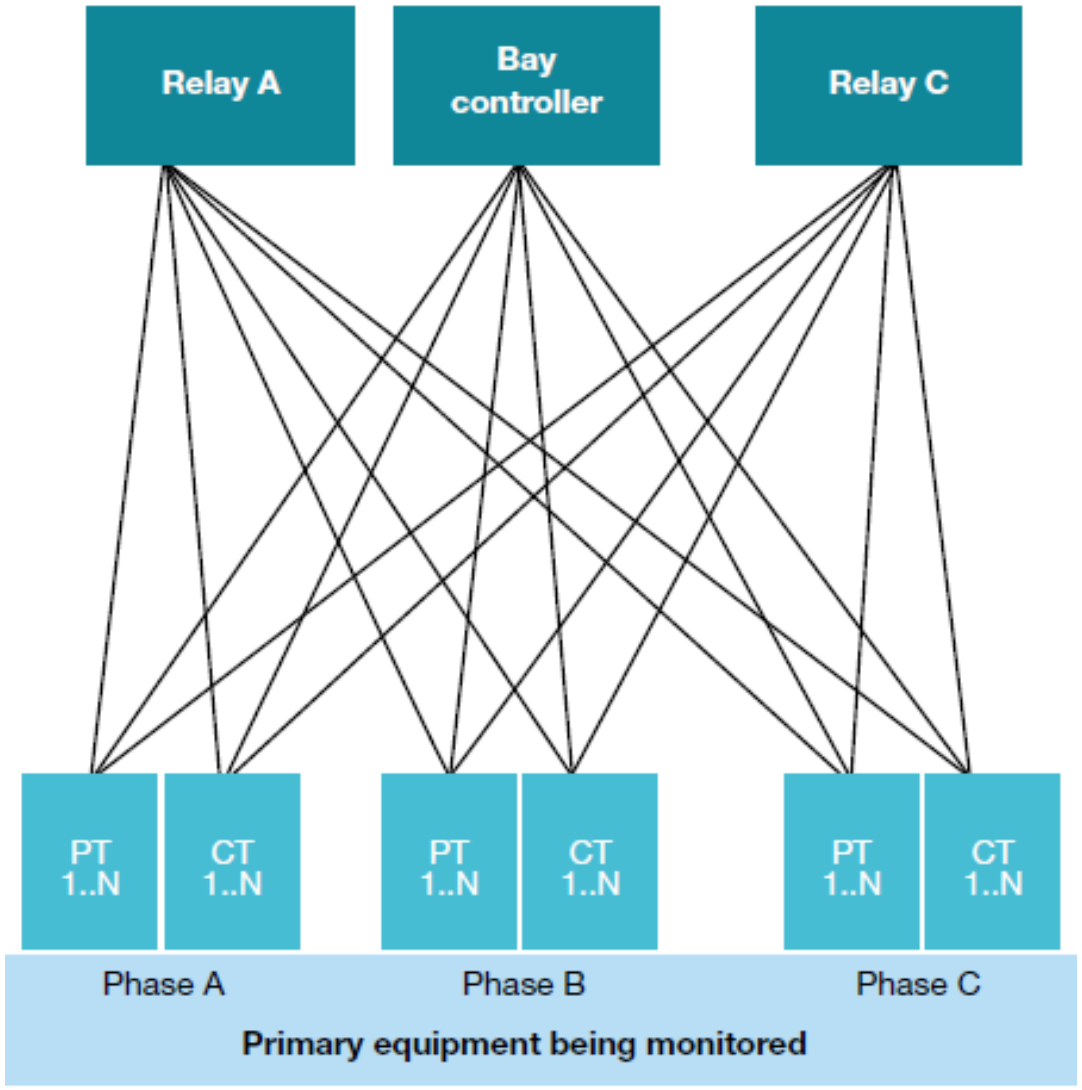


Conventional Substation



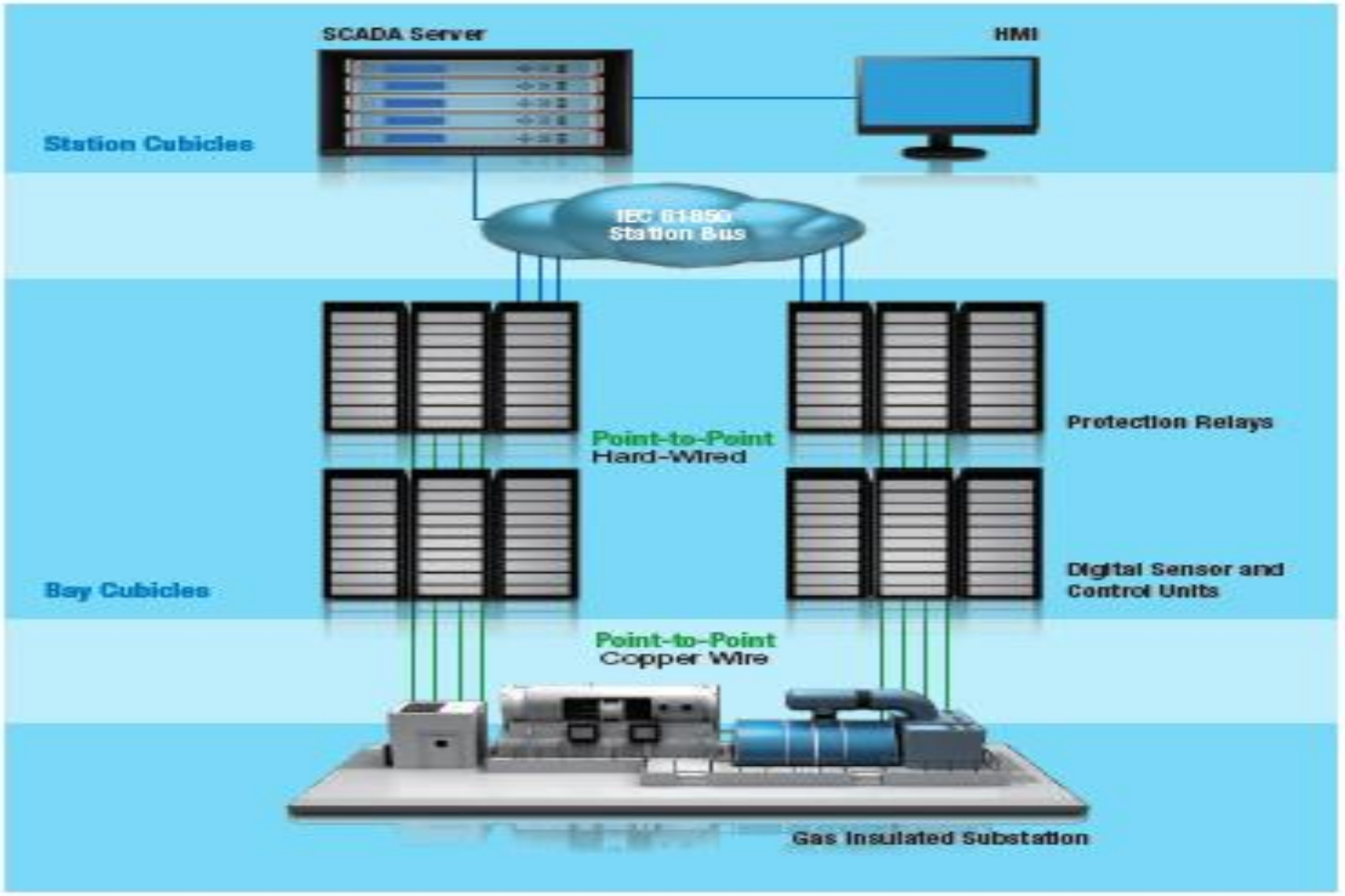
Measuring electrical parameters in a conventional substation

Conventional instrument transformers like potential transformers (PTs) and current transformers (CTs) measure the high voltages and currents passing through primary equipment. Copper wires connect the analog output from the transformers to secondary equipment, and the number of copper wires increases depending on the application.

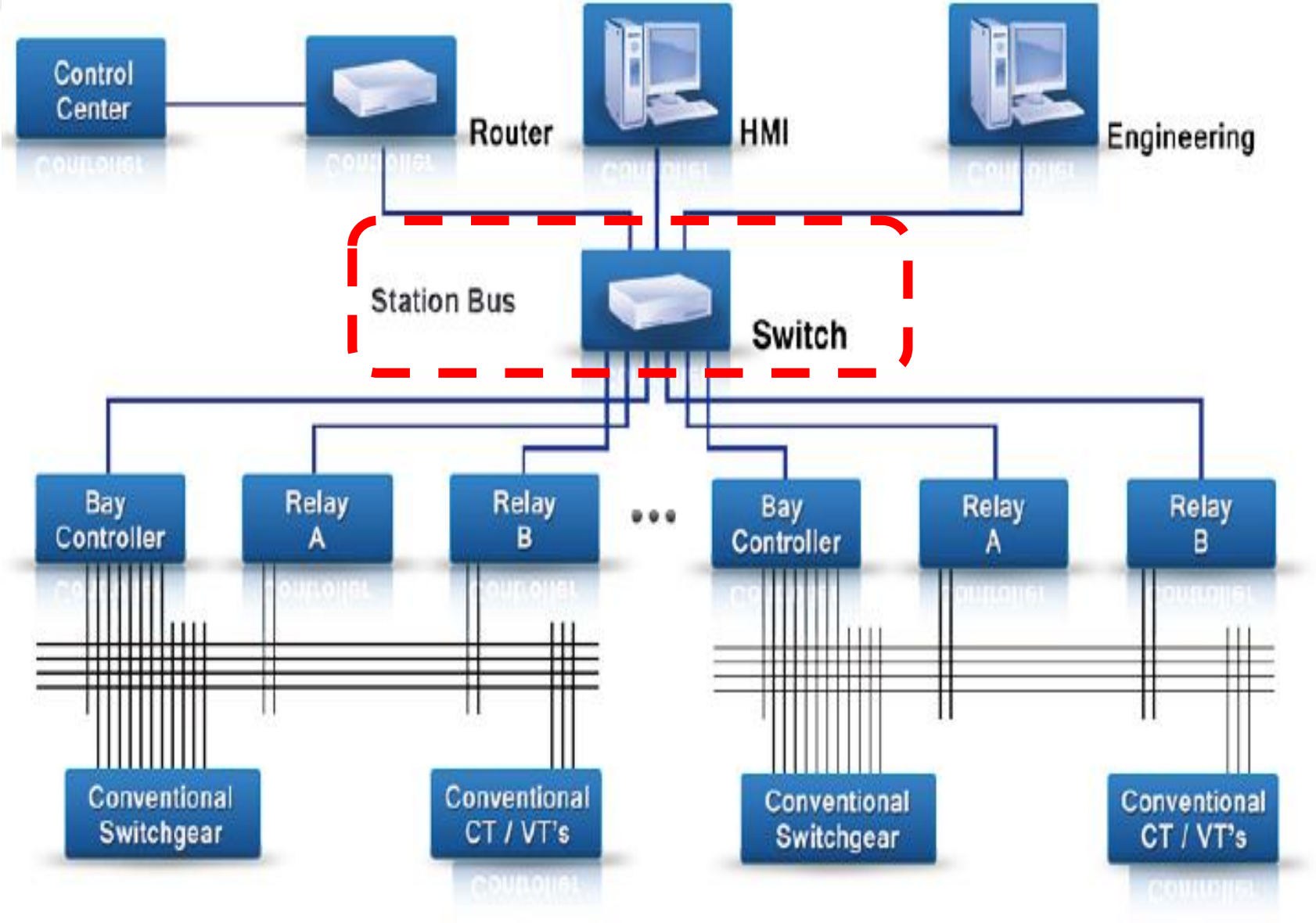


Digital Substation 1.0

Substation Automation with IEC 61850 Station Bus

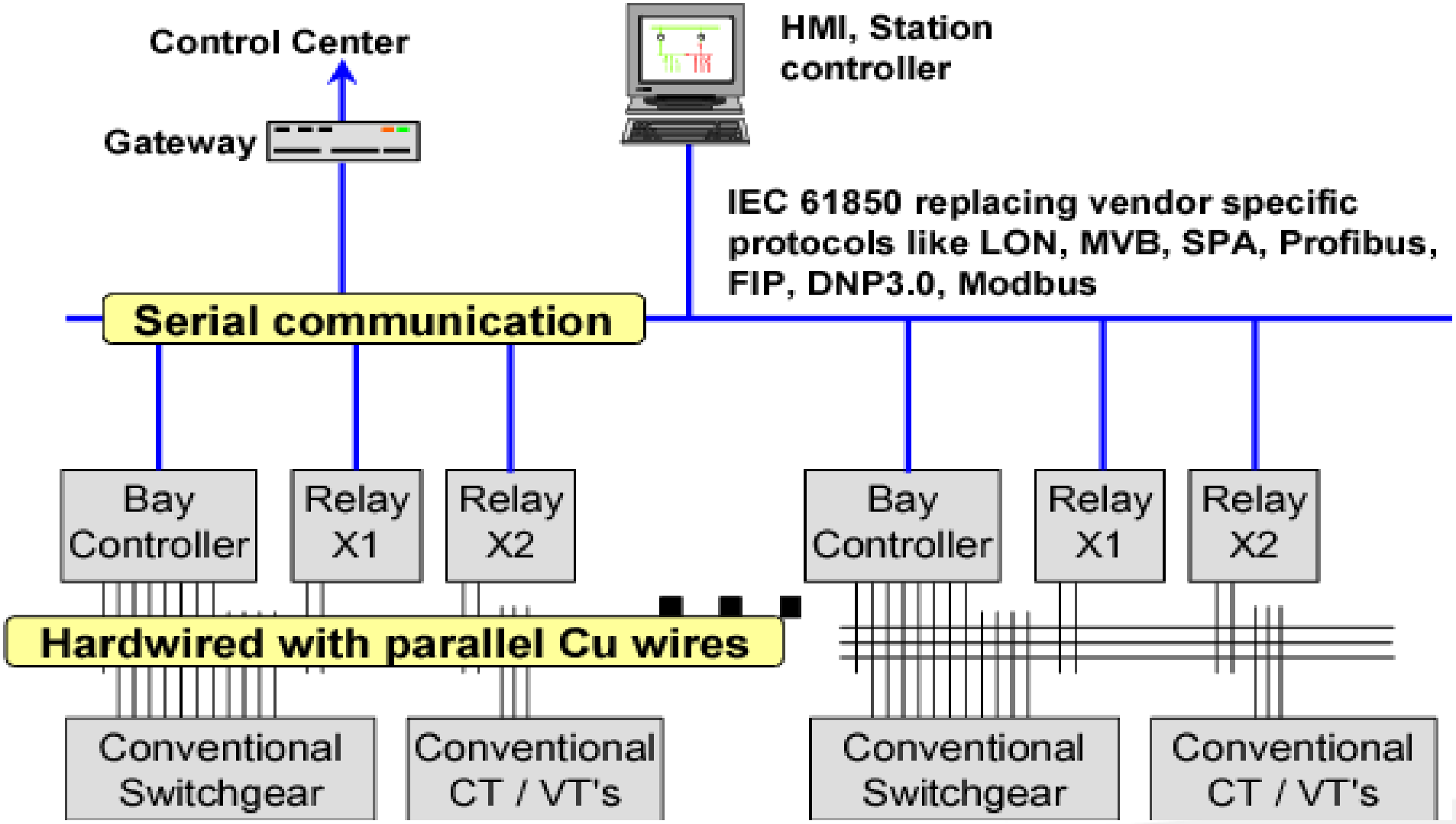


The release of the IEC 61850 Station Bus protocol in the 1980's was a big first step forward on the way to implementing a substation-wide all-purpose network.



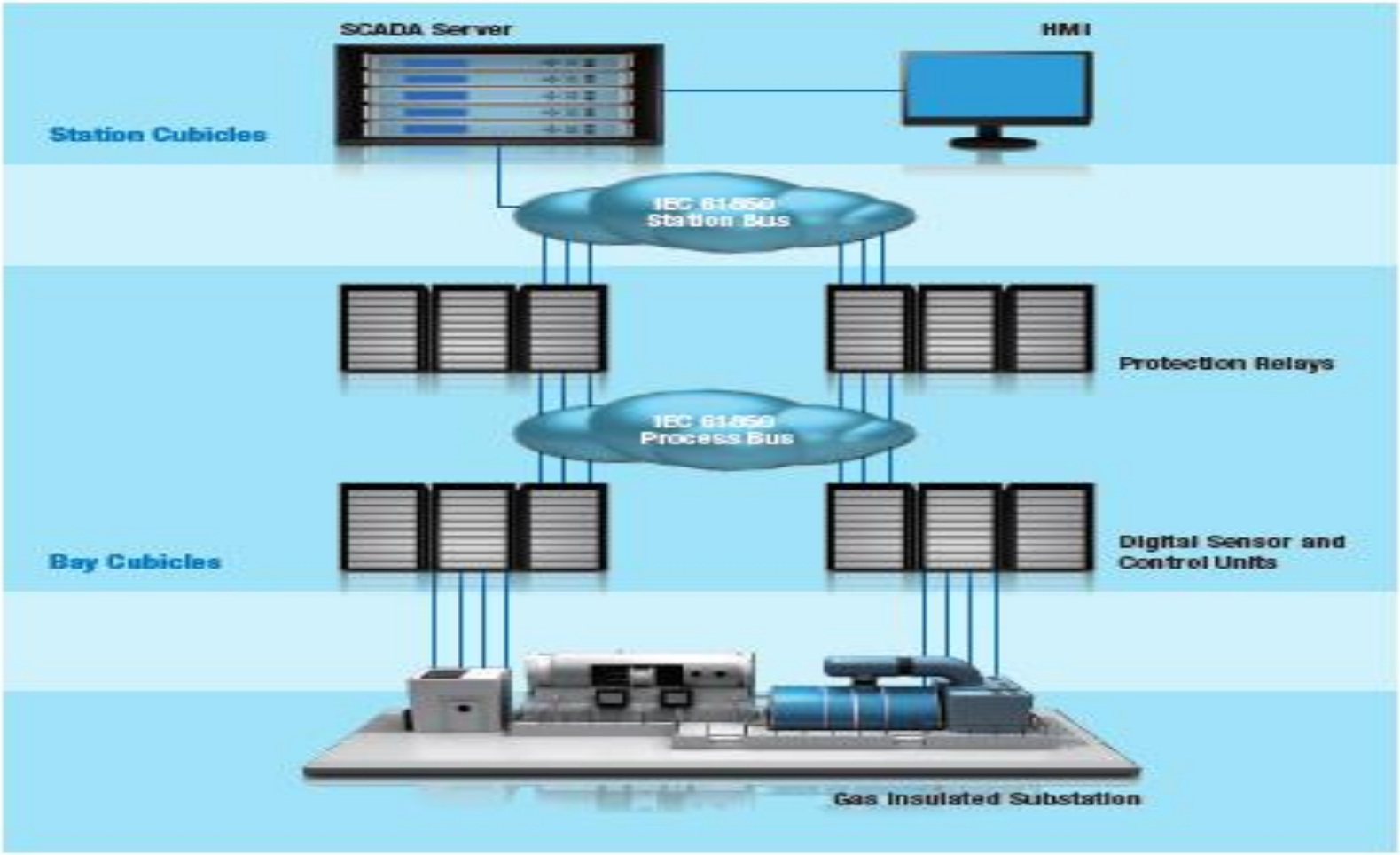
Traditional System Architecture

Substation Automation System

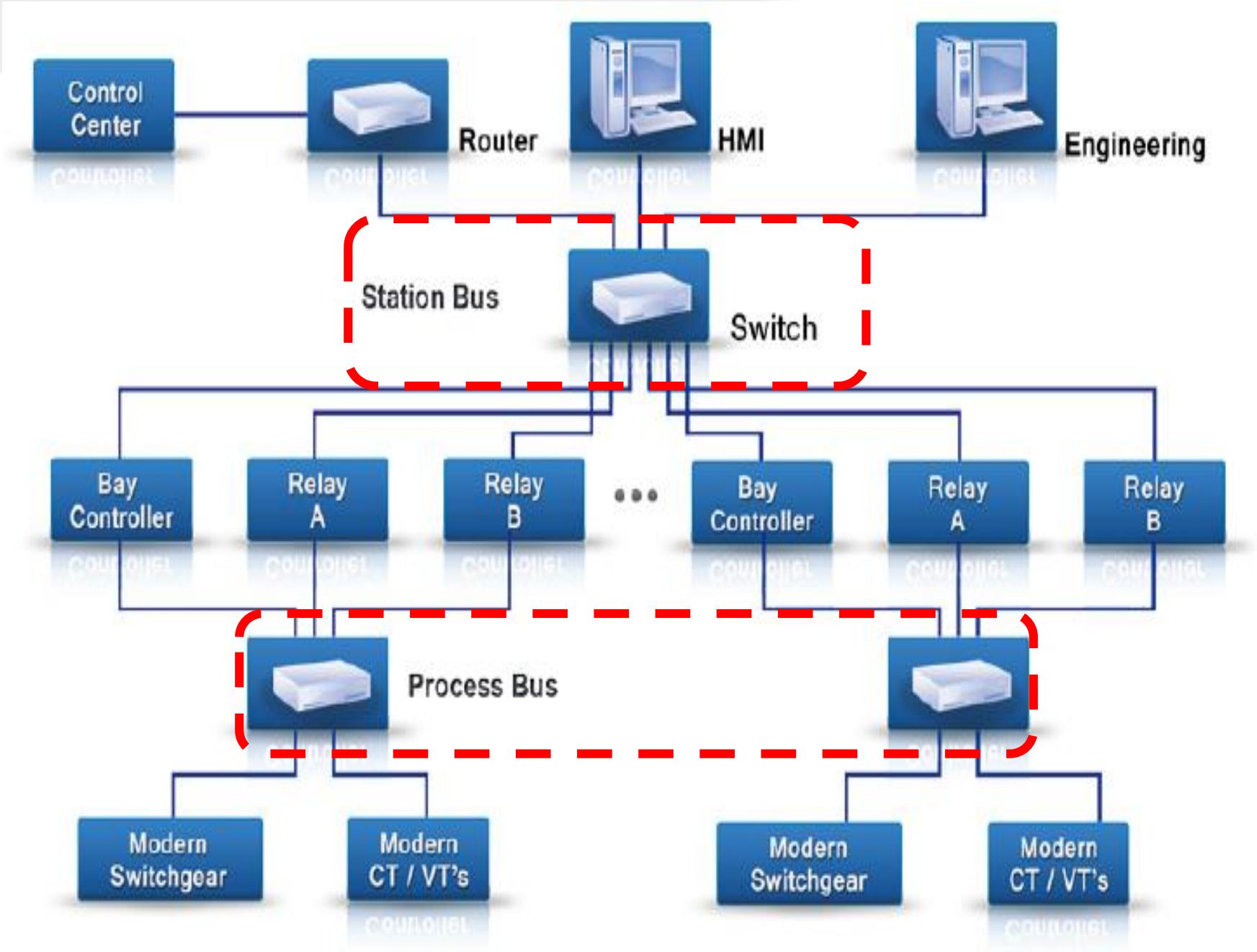


Digital Substation 2.0

Substation Automation with IEC 61850 Station and Process Bus

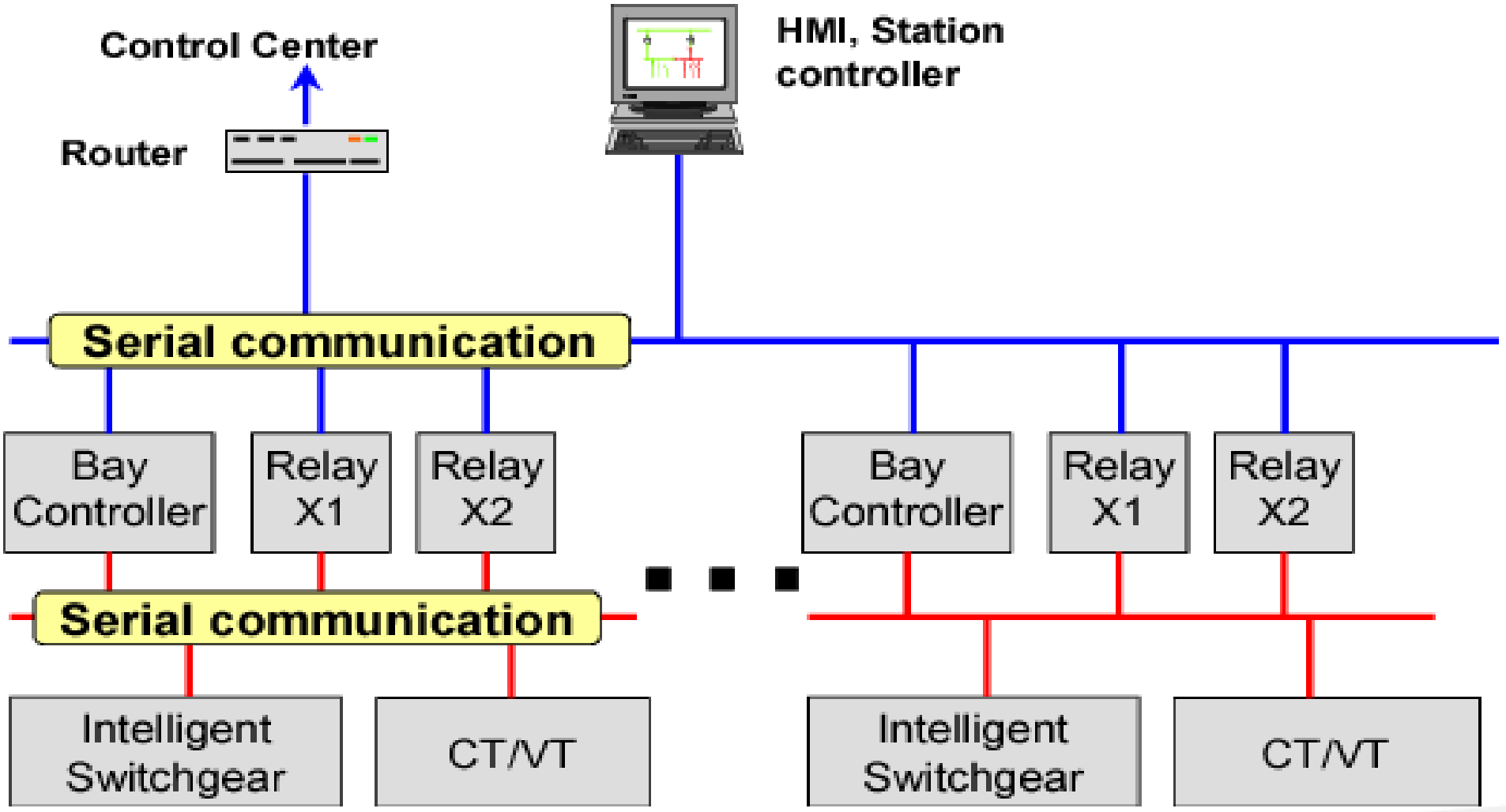


In 2005, the IEC 61850 standard was greatly improved by defining a Process Bus to connect the Process Level with the Bay Level.



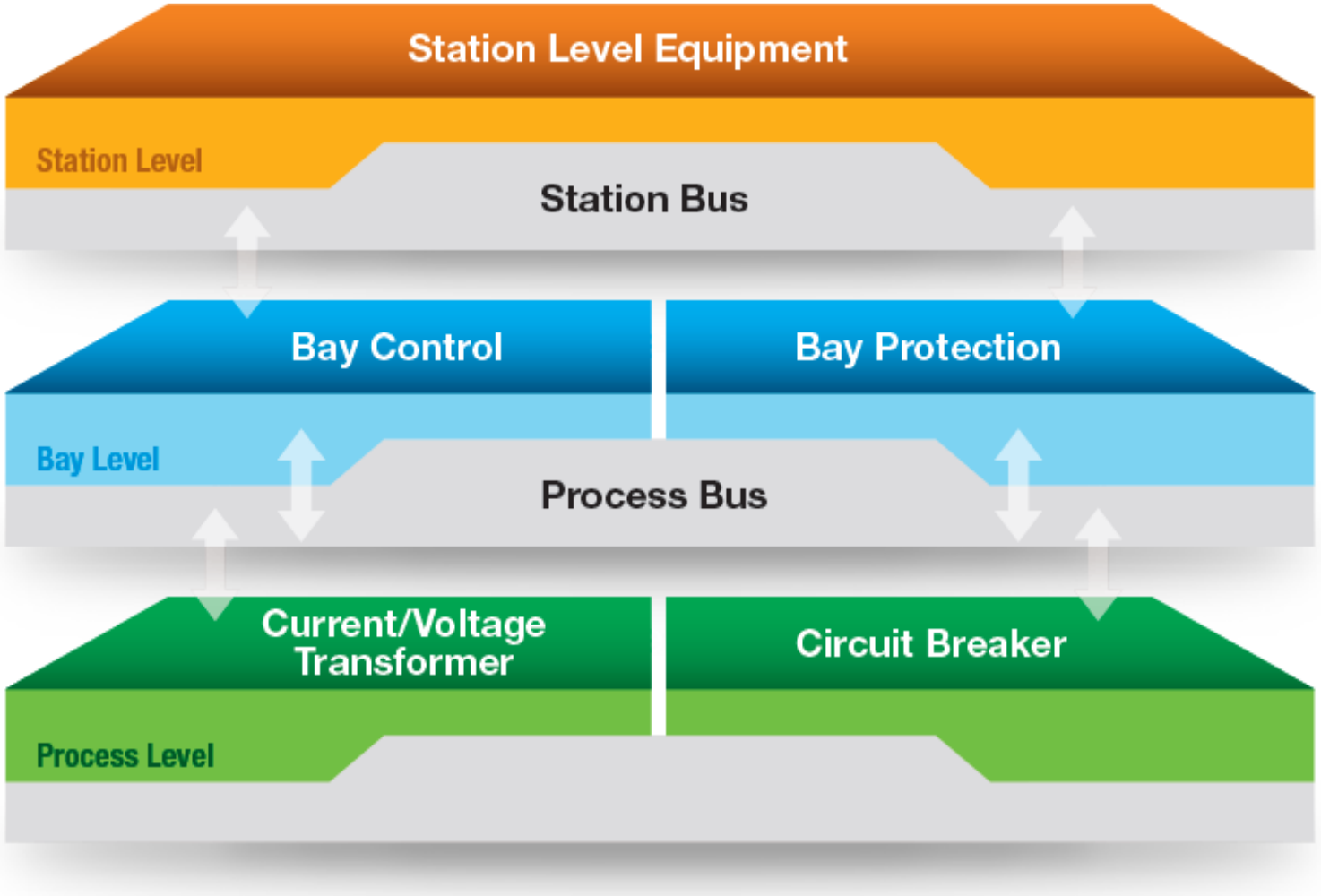
System Architecture Using IEC 61850-9-2

Digital Substation



The Architecture of Digital Substation acc. to IEC 61850

- Process Level
- Process Bus
- Bay Level
- Station Bus
- Station Level



IEC61850

IEC 61850 is a flexible, open standard that defines the communication between devices in substation automation systems. To enable seamless data communications and information exchange between the overall networks.

IEC 61850 is the most recent standard for communication networks and systems in substations.

Benefits of IEC61850

IEC 61850 Substation Overview

The advantages of implementing the IEC 61850 standard:

- Simplified Architecture
- Greater Reliability
- Future-Proof Design
- Vendor-Independence

Key Benefits of IEC 61850

- **Increases flexibility**

  by connecting protection, control, measurement and monitoring devices to common Ethernet network within substation

- **Reduces copper wiring**

  Through GOOSE messaging that enables fast and reliable applications like interlocking, distributed bay tripping, breaker failure, etc.

- **Reduces total installation cost**

  By enabling Process Bus with electronic CT/VTs and intelligent switchgear and by replacing conventional copper wiring by Ethernet digital communications

- **Eases system engineering and integration process**

  Through graphical configuration tools based on SCL language – XML

  common file format designed for exchange of configuration information

Key Benefits of IEC 61850

Improves application performance and security

Through fast Ethernet communications and redundancy (IEC 61850 Edition II)

Minimizes costs of technological obsolescence

Due to standardized naming conventions

Provides easy way of implementing typical applications

Because of object-oriented structure and high-level services that enable self-description of devices and automatic data discovery.

Saves time and money in setup & commissioning

Because of a global acceptance and adoption and future-proof concept of abstract services as well as independence of mapping to protocols

COMPARISON

Conventional Substation	Substation Automation System (SAS)
Operational Cost Reduction	
Up to 60% Less space in the Relay houses	
40% Shorter Installation Phase	
Up to 80% Cupper Wire Reduction	

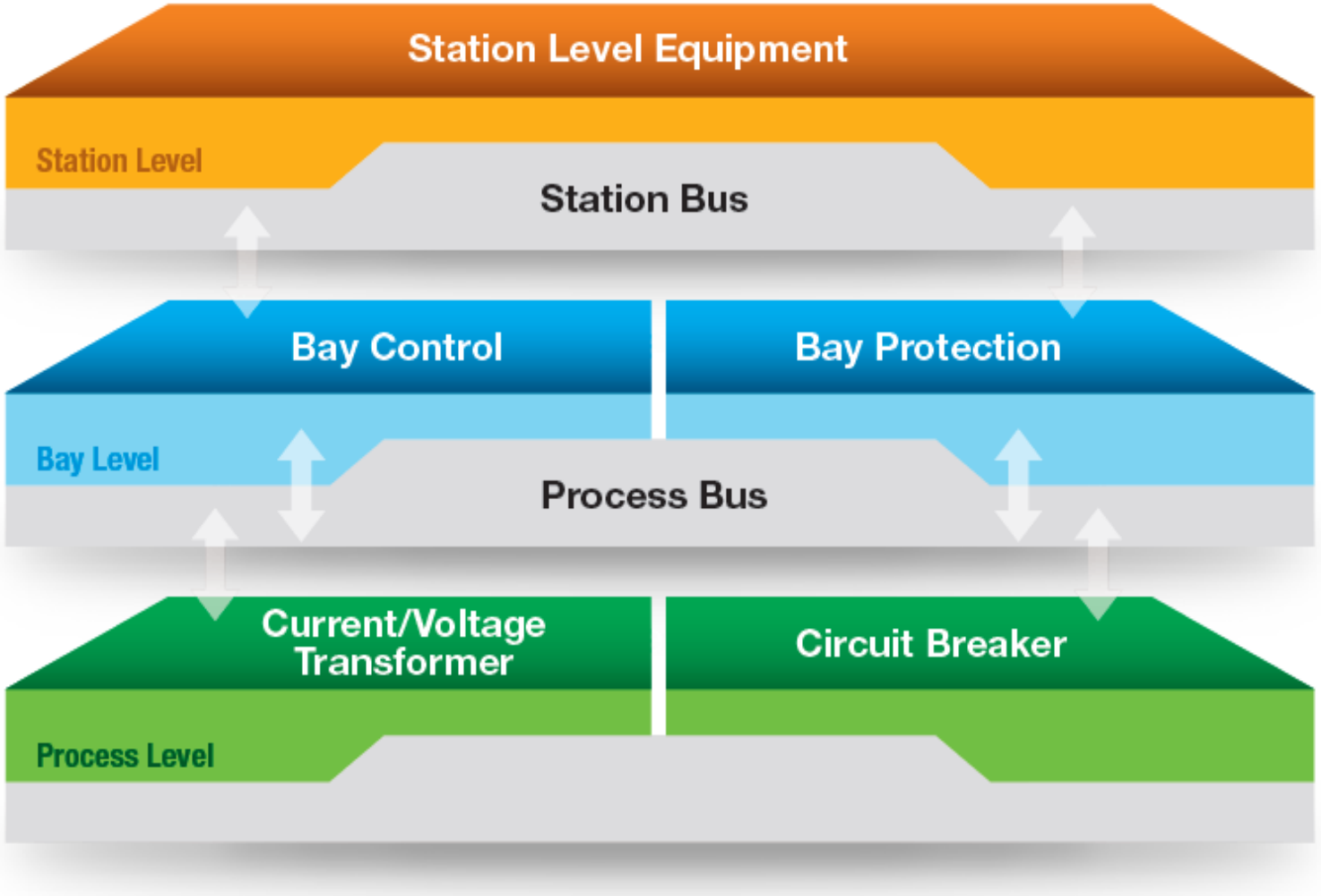
Digital Substation

As most substations today are switching and routing AC power at high/extra high voltage, **it is not the primary flow which is digital.** A digital substation refers to **its secondary systems**, including all the protection, control, measurement, condition monitoring, recording and supervisory systems associated with that primary “process”.

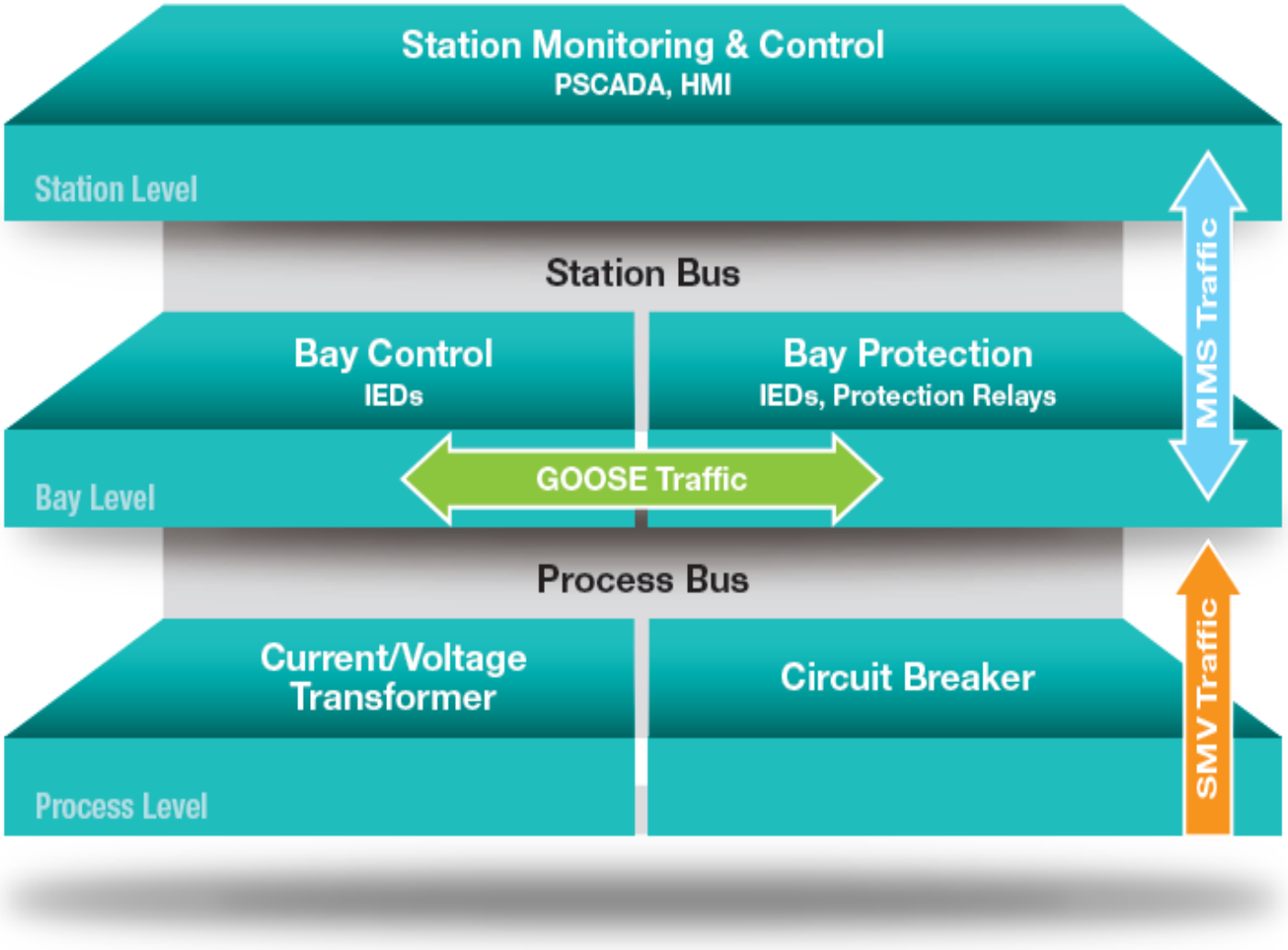
In general terms, in full digital substation **the data related to the primary process is digitized immediately, at the point where it is measured.**

The Architecture of Digital Substation acc. to IEC 61850

- Process Level
- Process Bus
- Bay Level
- Station Bus
- Station Level



IEC61850 Substation Communication Architecture



MMS Traffic — For monitoring substation status

GOOSE Traffic — For status updates and sending command requests

SMV Traffic — For transmitting power line current and voltage values

Process Bus

The defining feature of a Digital Substation is the implementation of a process bus.

The IEC 61850 process bus enables the substitution of point-to point copper connections between IEDs, other devises and switchgear by means of a safe, standardized optical communication bus.

Thanks to the process bus, real-time measurement signals and status information can be broadcast throughout a substation without complex wiring schemes.

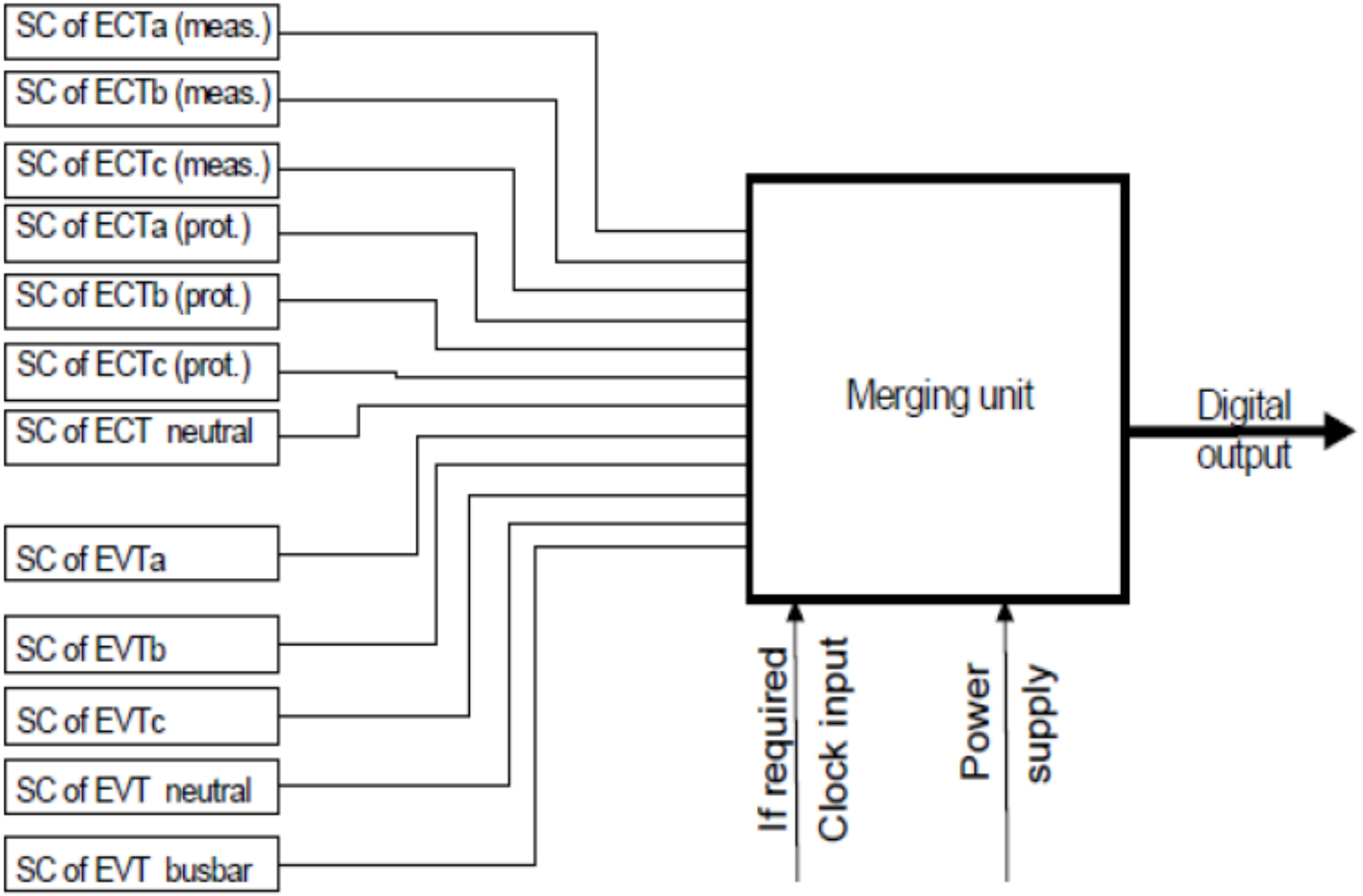
Process level equipment

Breaker IED

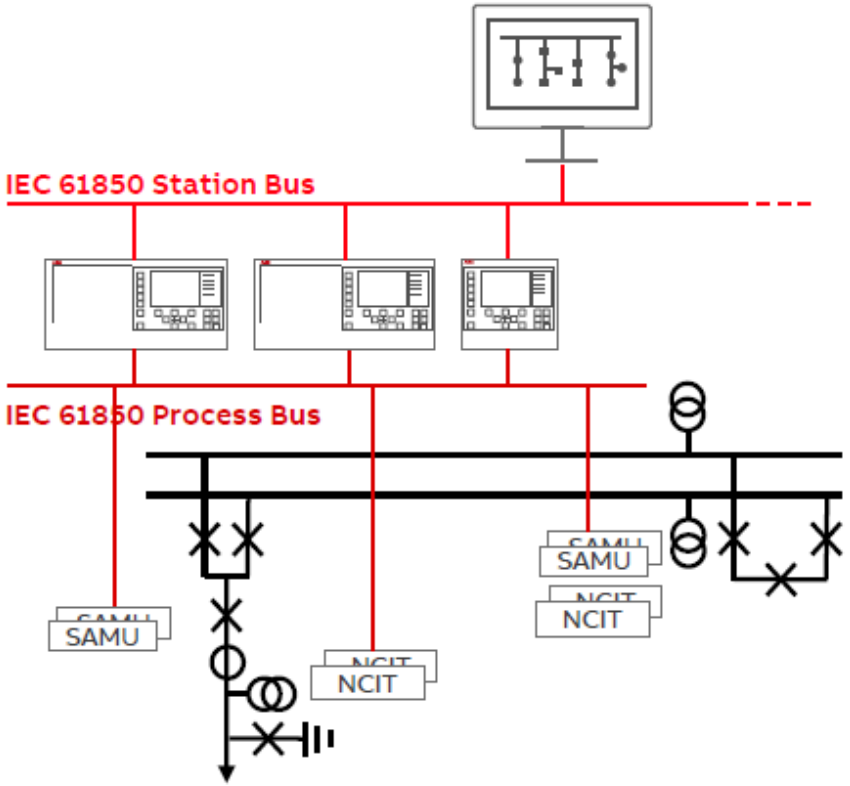
Non conventional IT

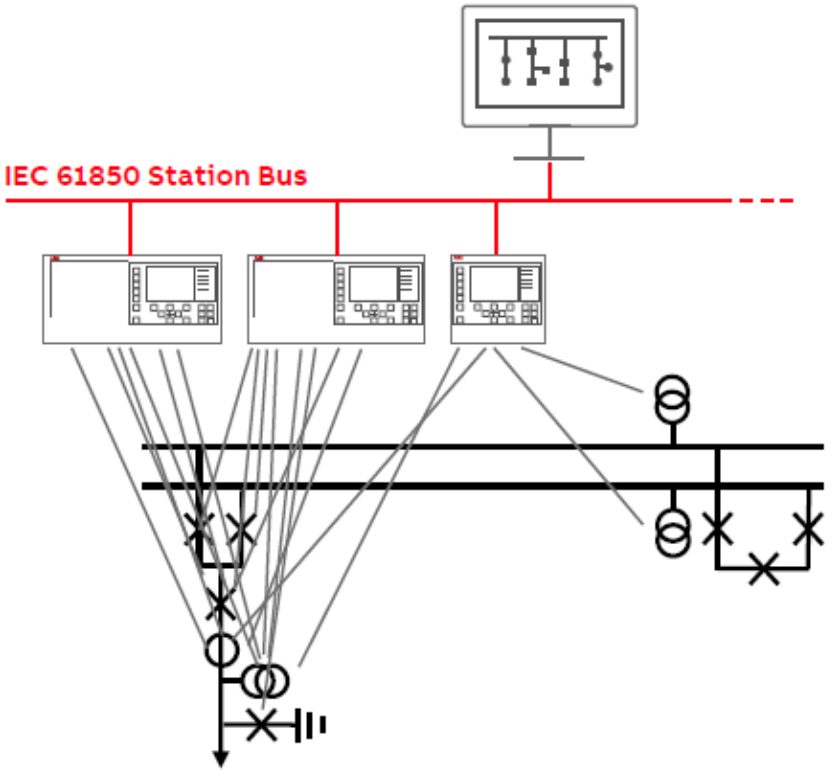
Merging unit

Merging units overview



Reduces copper cabling

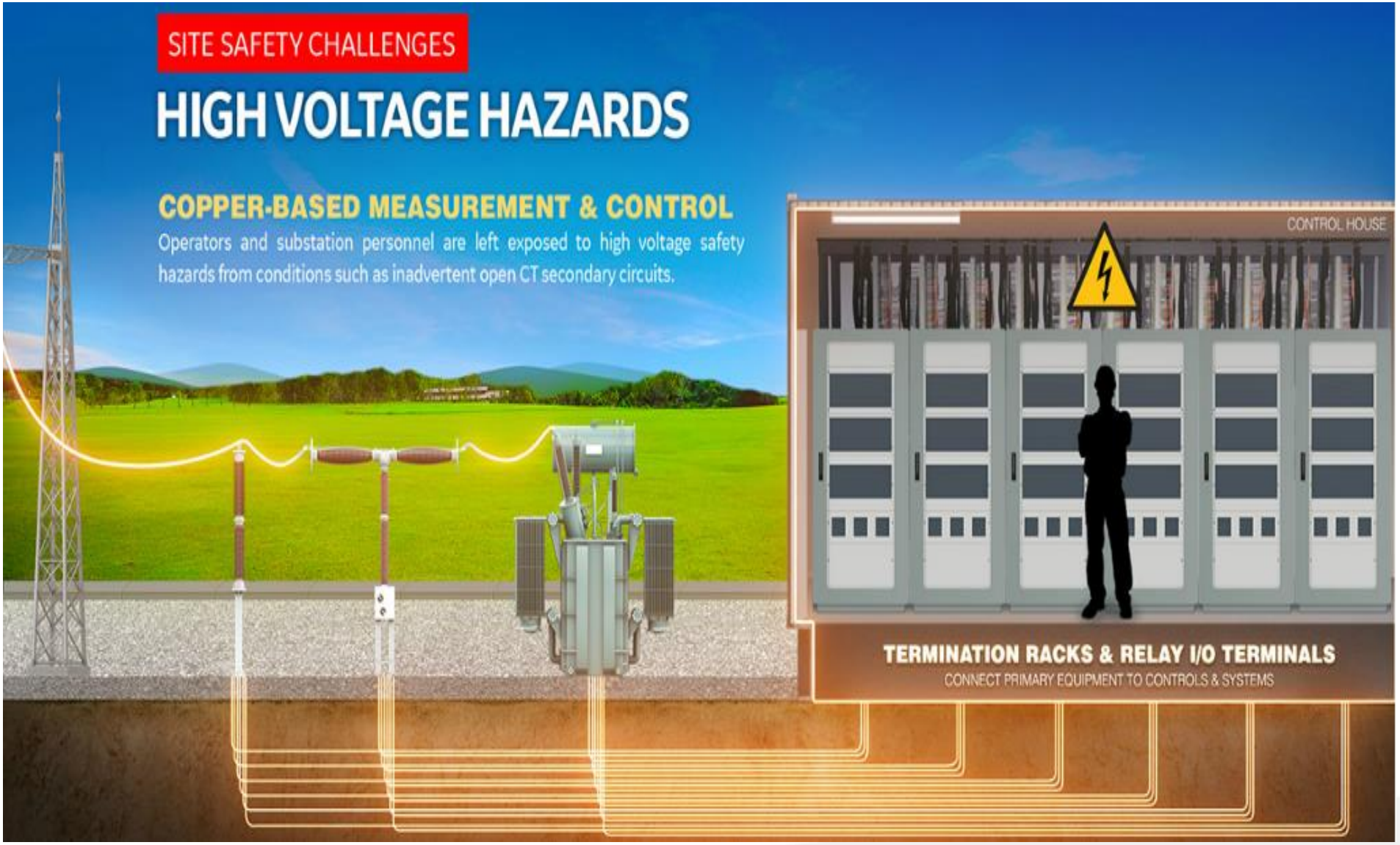




NCIT Non-conventional instrument transformers

SAMU Stand-alone merging units

Increased safety



Increased safety

Reduced risk of electrical shock

Bay Level

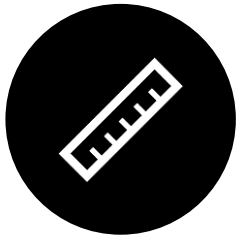
Introduction To Bay Level

•According to IEC 61850 standards, is an intermediate control place between switchgear boards (process level) and the main control house of the substation (station level).

Bay Level Function

PROTECTION

CONTROL



MEASUREMENT

LOCAL MONITORING

IEDs
Intelligent
electronic
devices

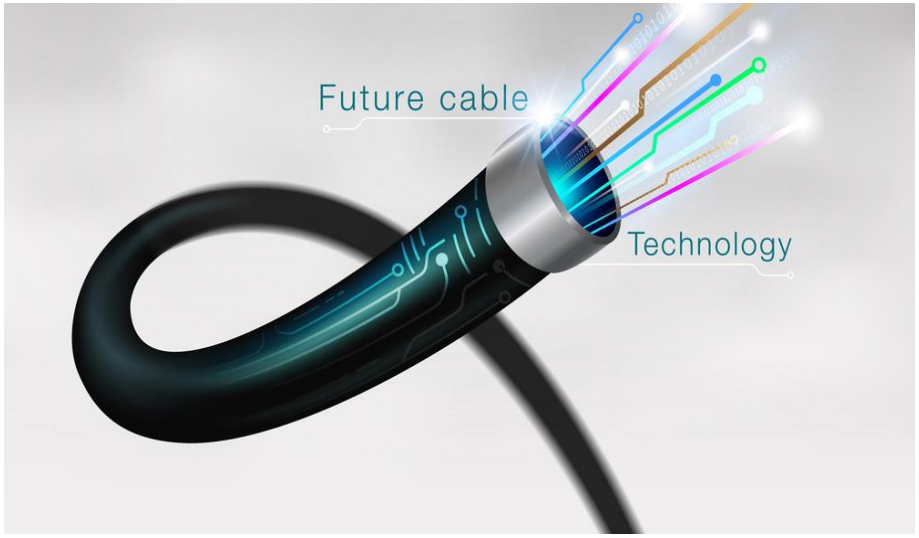
Protection
Relay

BCU

Communication
RTU
Gateway
Industrial Ethernet switch

measurement

Comparison between fiber optic cable and copper wire

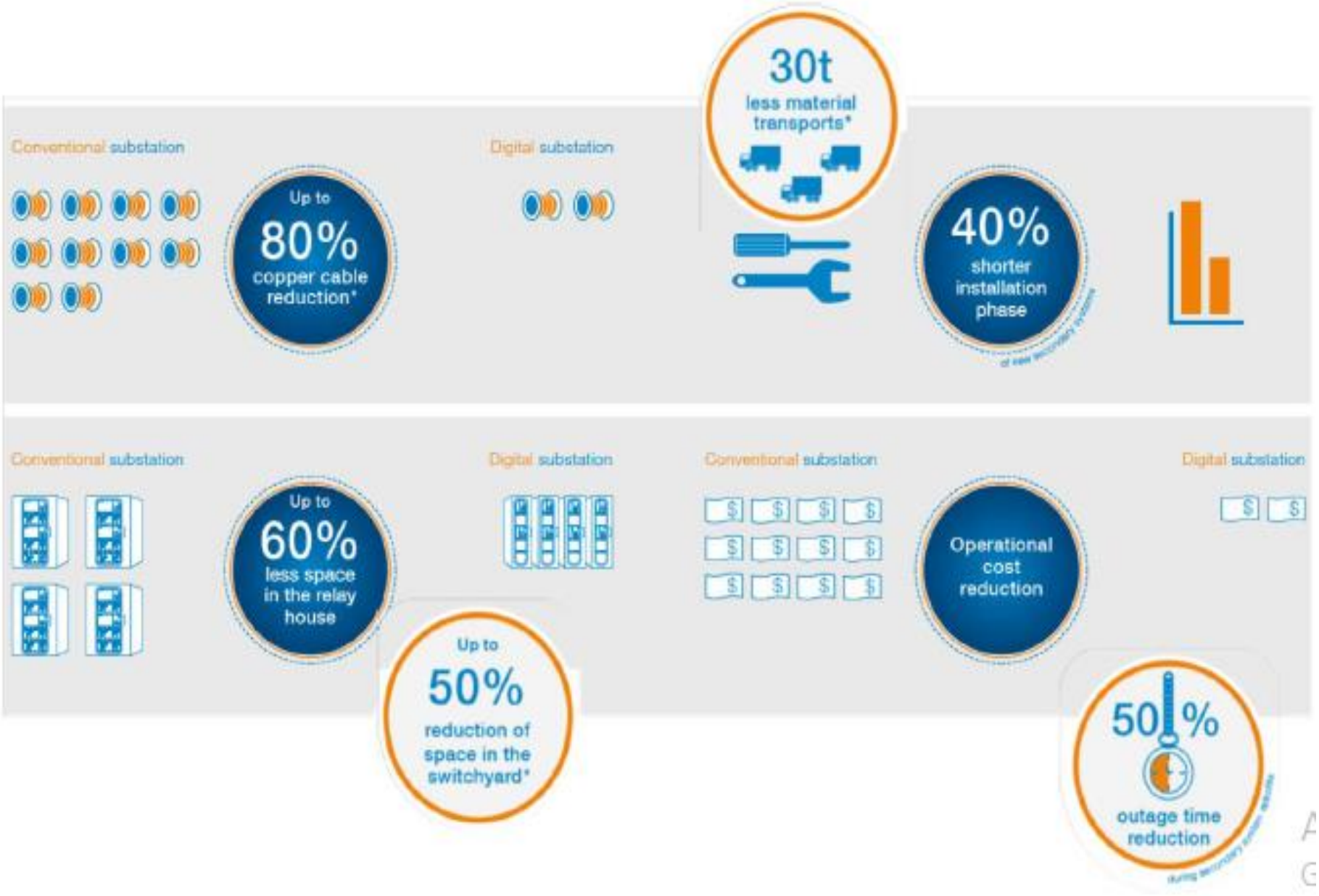


Fiber optic cable

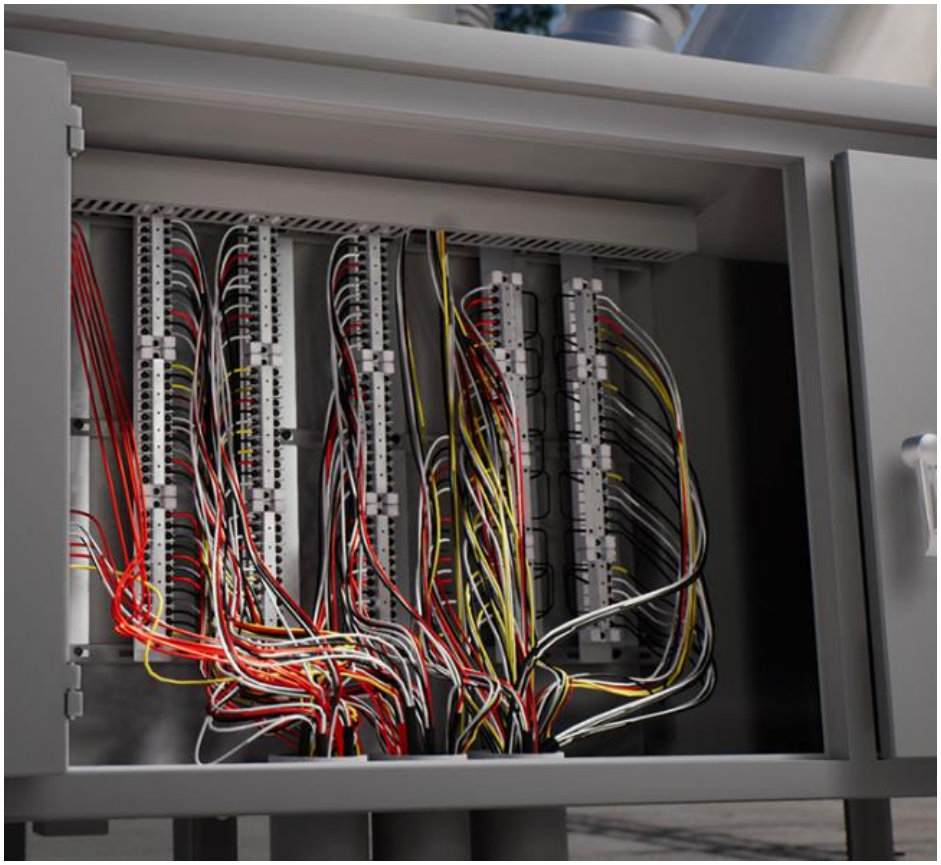
- transmit data at much higher speed
- not affected by electromagnetic interferences and power fluctuations
- very less affected by the corrosive chemicals
- Fiber cables are thin and lightweight
- average cost per meter 4 $

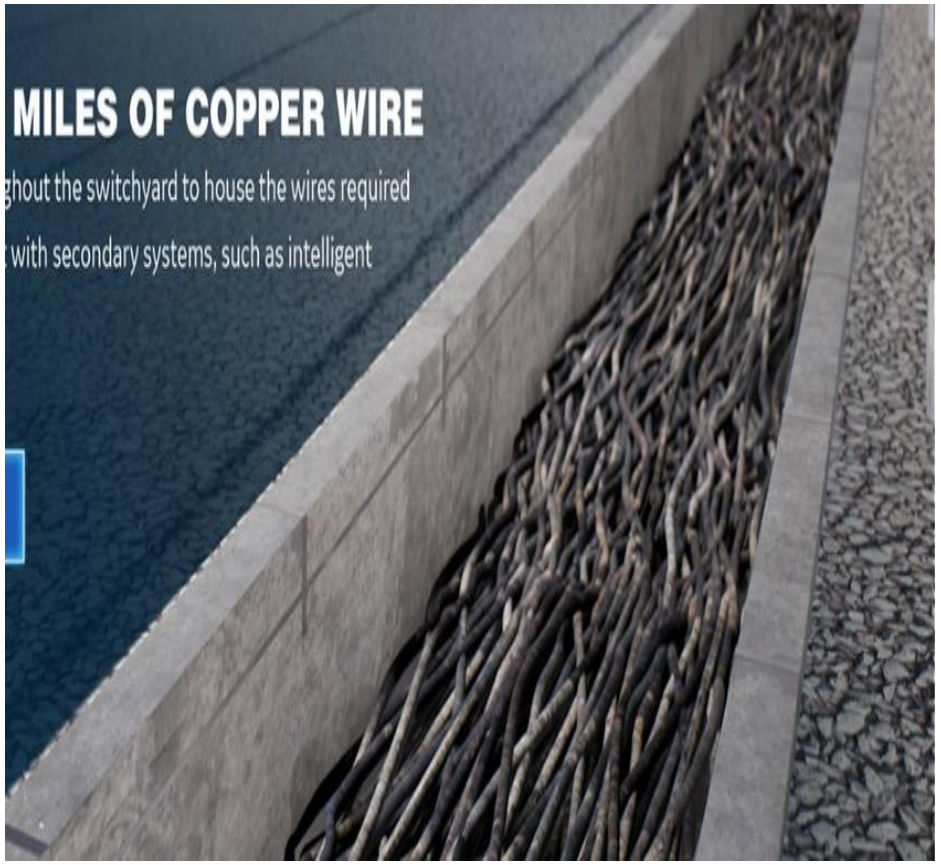
Copper wire

- transmit data at less speed than fiber optic cable
- affected by electromagnetic interferences and power fluctuations
- affected by the corrosive chemicals
- Average cost per meter 0.5 $


Conventional substation
Digital substation
Up to
80%
copper cable reduction*
30t
less material transports*
40%
shorter installation phase
Conventional substation
Digital substation
Up to
60%
less space in the relay house
Up to
50%
reduction of space in the switchyard*
Conventional substation
Digital substation
Operational cost reduction
50%
outage time reduction

Reduces copper cabling

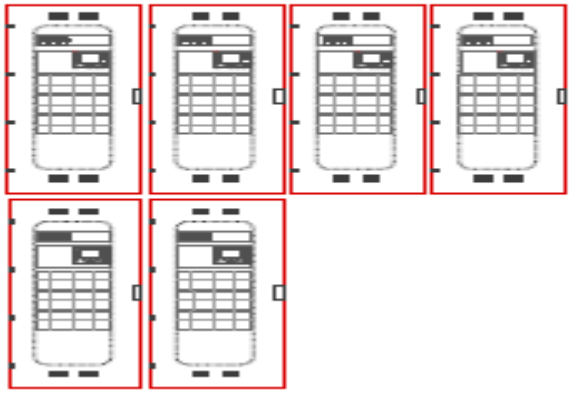




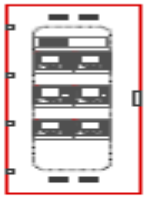
Reduces copper cabling

Less space

Conventional substation



Digital substation

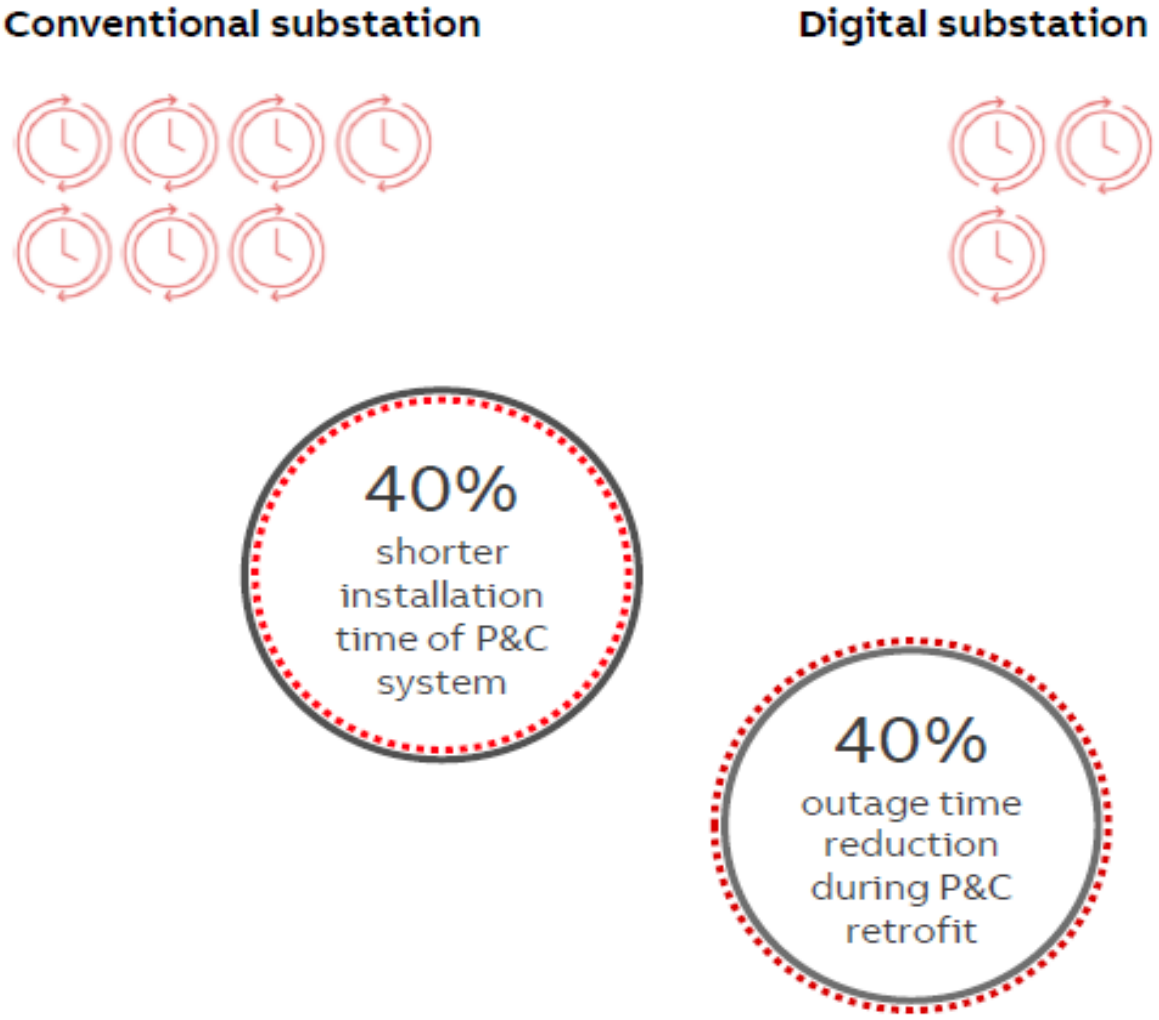


Up to
60%
less space in
relay room

Up to
50%
reduction
space in the
switchyard

Less installation and outage time

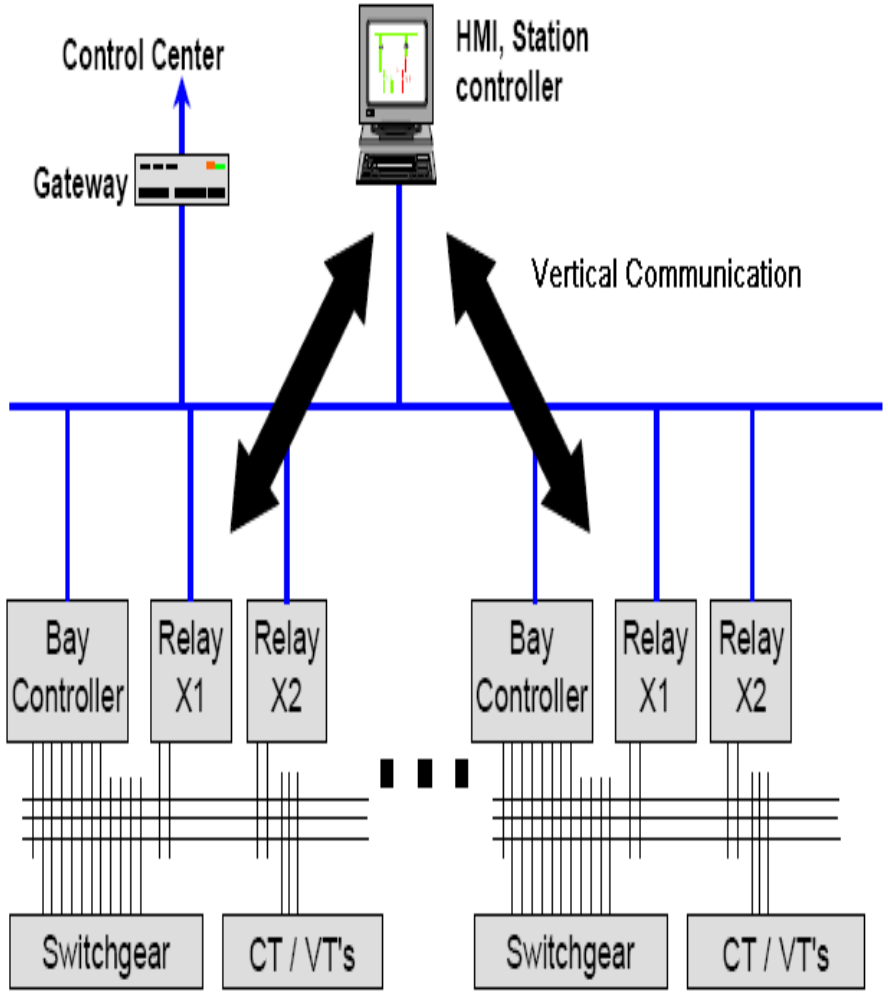
40% reduction of installation time for new protection and control systems.
– Fewer panels to install
– Fewer cables to be pulled, connected, tested



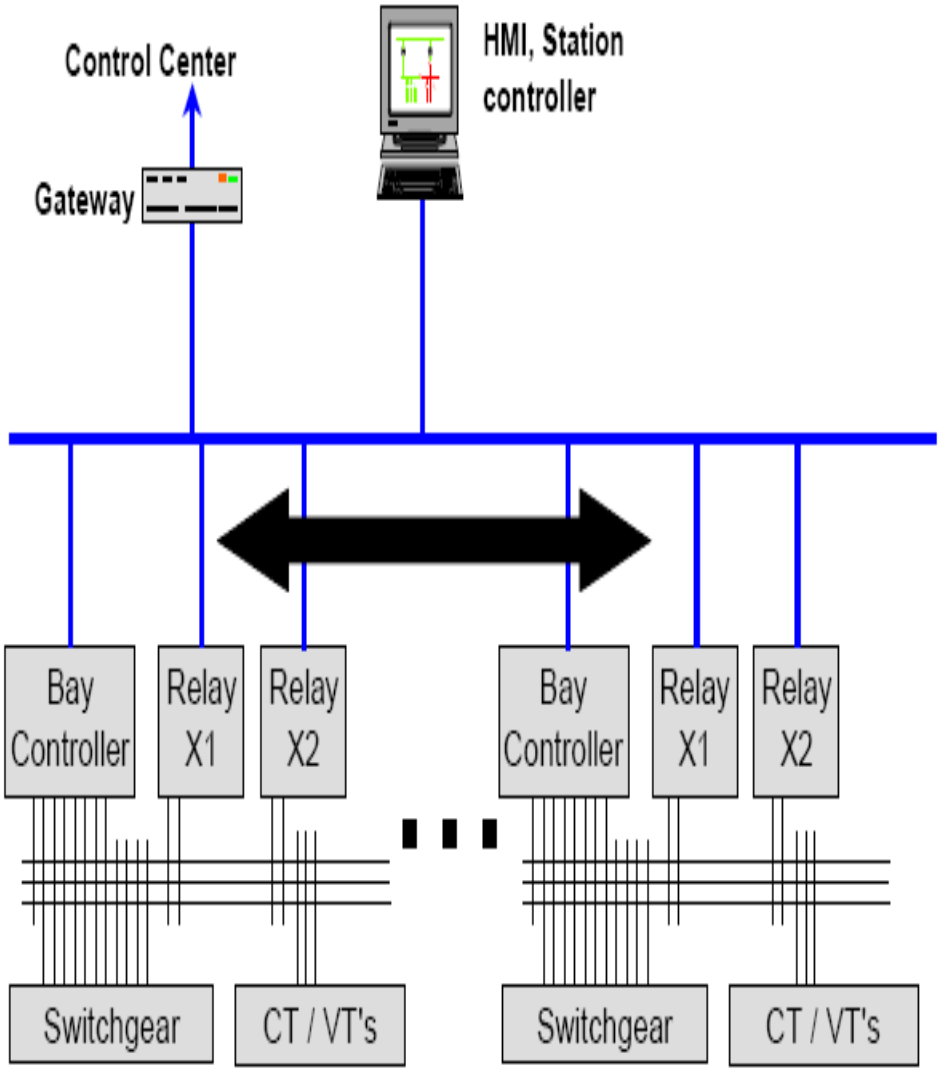
Station Bus

The physical structure of this bus consists of a fiber-optical arrangement to which the various upper parts of SAS devices are coupled.

Horizontal communication



Vertical communication



Station Level

Substation Automation System

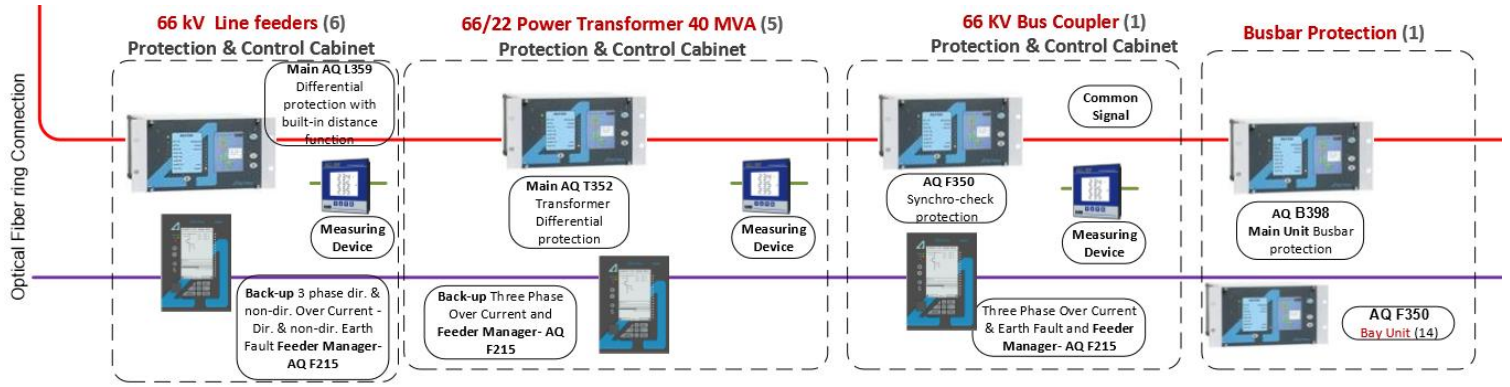
Station Level

- Station level refers to the place from where the substation is controlled and monitored as a whole.

- A dedicated master clock for the synchronization of the entire system shall be provided.

BAY LEVEL

Configuration of BAY LEVEL



Component of BAY LEVEL

1- Protection relay

2- Bay Control Unit (BCU)

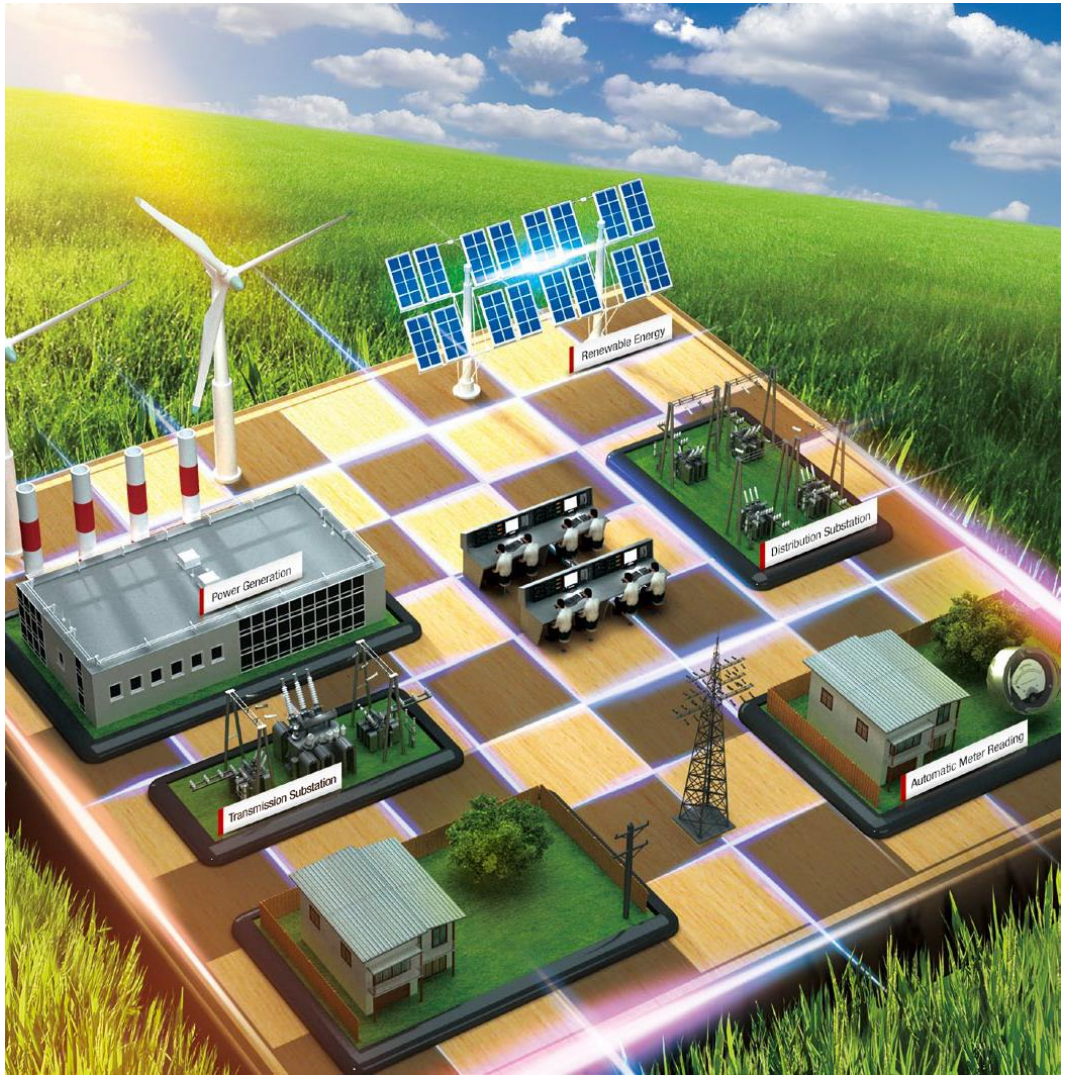
3- measuring device

Station level contains

- The central substation controller (Station Controller)
- The means for communicate with remote upstream control level (NCC)
- The local operating facilities (HMI)

Connection with NCC

NCC facilitates monitoring of the whole grid at the same time. It may work on organizing operations between different sectors of the grid by a pre-set operation plan at certain situations.



The main functions of the station controller

1- Communication with bay controllers through the station bus.

2- Communication with HMI through the station LAN.

3- Communication of all abnormal substation conditions to the NCC.

4- Recording of events with an adequate time resolution (e.g., less than 1 ms).

5- Providing a time synchronization signal to the bay controllers.

6- Compilation printing of alarm and event lists.

Human Machine Interface

HMI

- HMI is like the “face” of the SAS.
- It gives the substation operator access to control means as well as alarms and events displayed on the monitor screen.
- HMI consists of a set of pieces of hardware plus a package of applications software.

Levels of Visualization and Control

Remote HMI (NCC)

Local Substation HMI

Local Zone HMI

HMI Hardware

Color monitors

for display screens showing substation power circuits as well as control and monitoring resources.

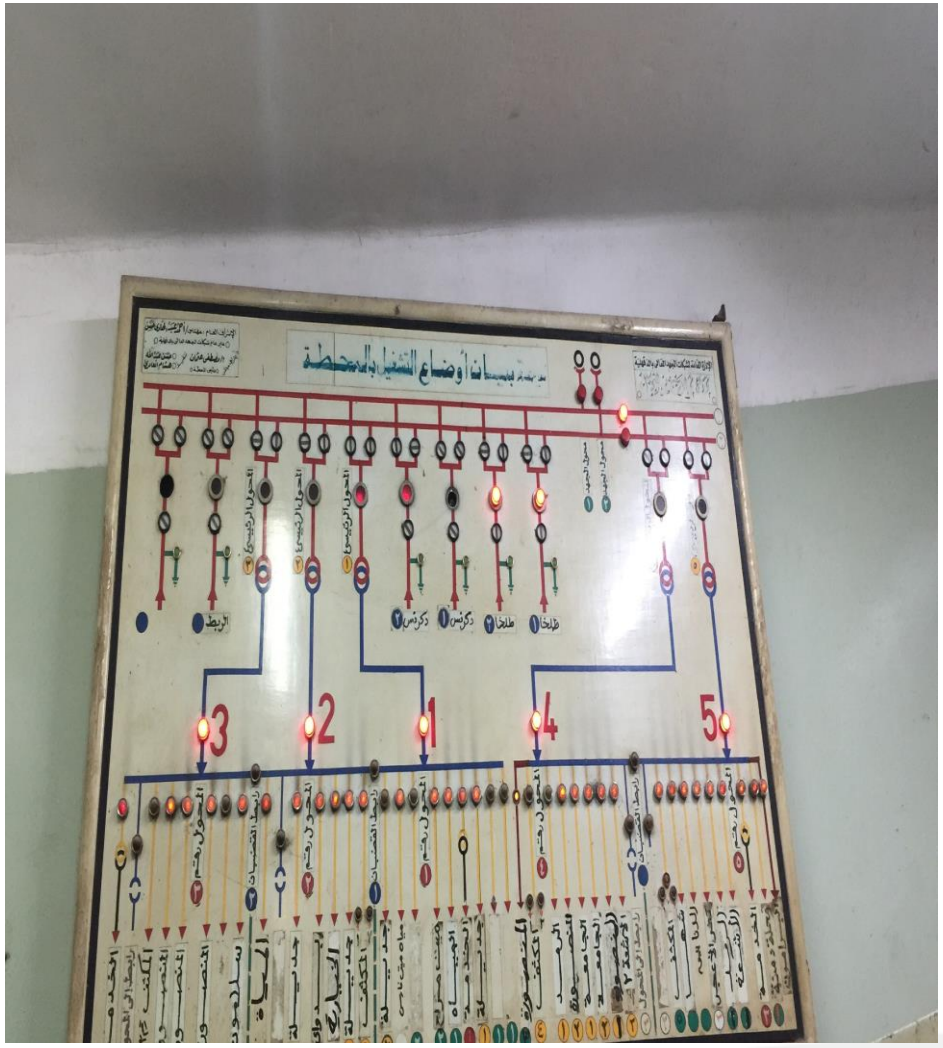
Alphanumeric keyboard

or function keys for interaction with displayed screens, and a mouse.

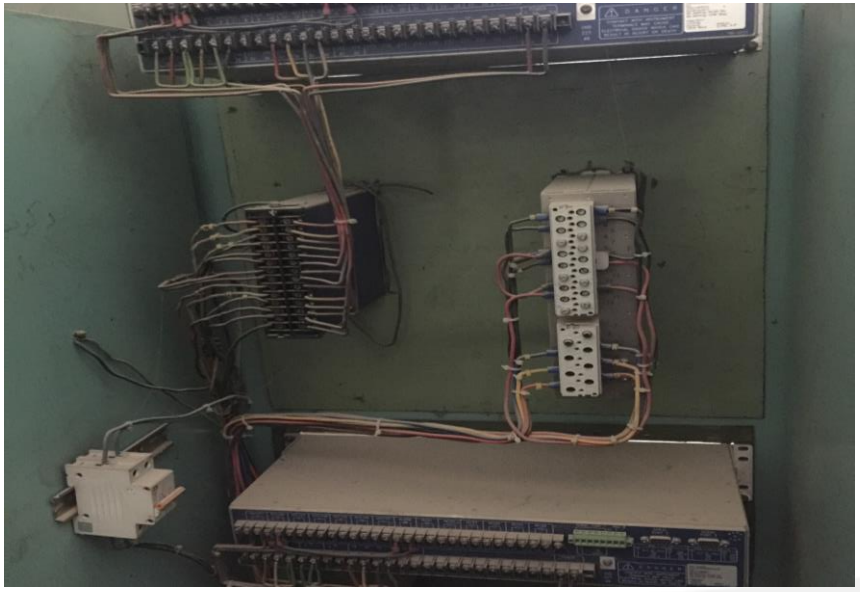
Printer

to produce hardcopies on demand and data logger for continuous printing of event texts in chronological order.

Conventional substations
From colangeel66/11

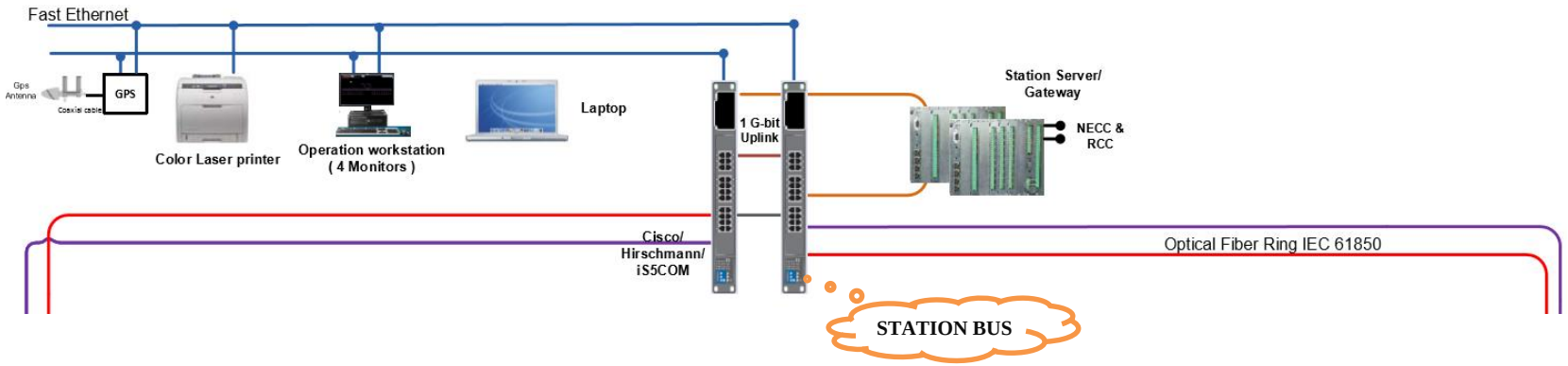


Massacre at the age of light speed



STATION LEVEL

Configuration of BAY LEVEL



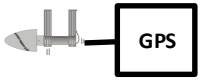
Component of STATION LEVEL

1- Station Server/Gateway

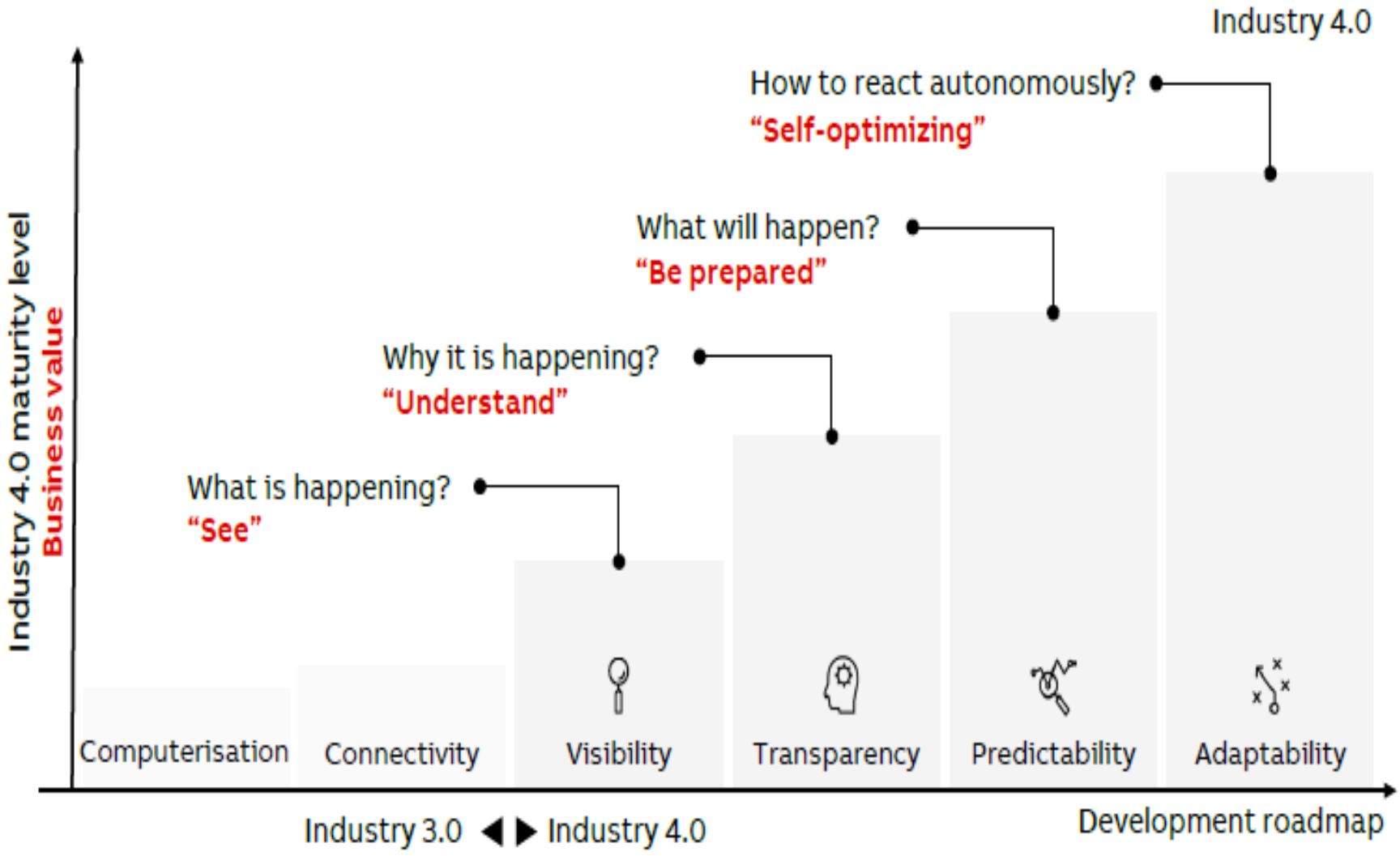
2- Operation workstation

3- Color Laser printer

4- GPS



The power of data analysis



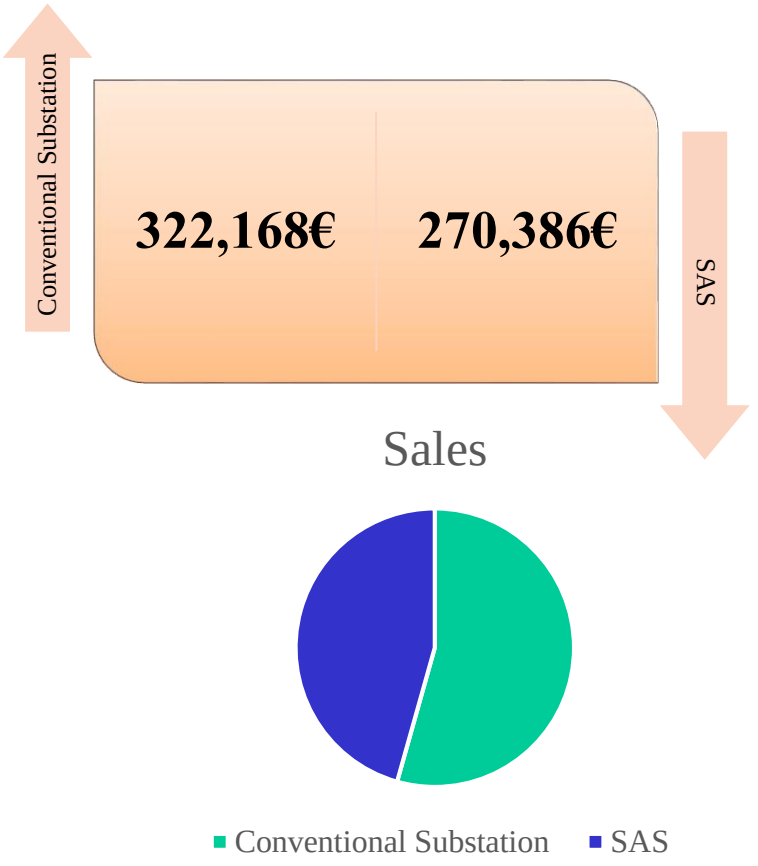
Cost Comparison between conventional and SAS

Cost Comparison

Conventional Substation **VS** SAS

BAY LEVEL component Cost

Reduction cost of equipment by 16%

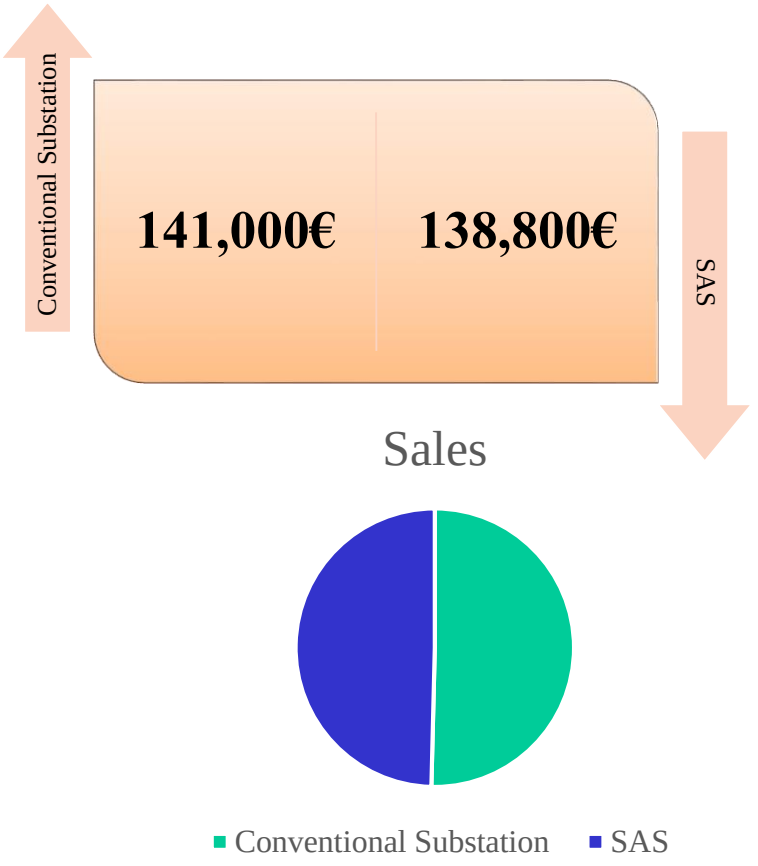


Cost Comparison

Conventional Substation **VS** SAS

STATION LEVEL component Cost

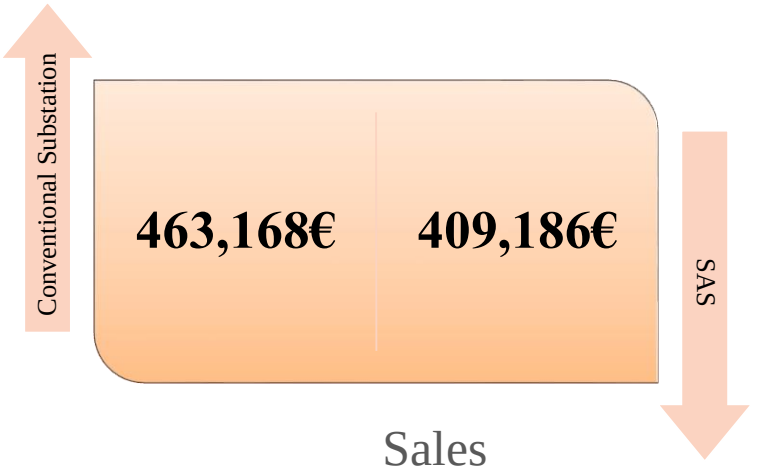
Reduction cost of equipment by 2%

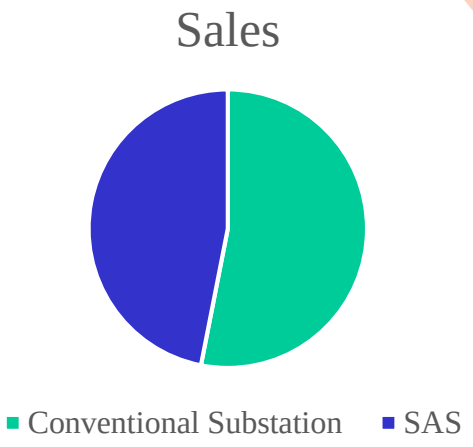


Cost Comparison

Conventional Substation **VS** SAS

TOTAL component Cost





Reduction cost of equipment by 12%

Thank you