# What Utilities Need to Know About IEC61850 Process Bus?

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# Agenda

- What is IEC61850?
- Do Utilities Realize maximum benefit out of IEC61850?
- Questions an Utility need to Raise to Vendors
- A Practical Architecture

# What is IEC 61850?

A **standard for communication interoperability** in which devices from various manufacturers could be connected together to share data, services, and functions

# Industry Trends and Expectations

The phrase “sixty-one-eight-fifty” (sĭks'tē)(wŭn)(āt) (fĭf'tē)

has become a designator for the next generation substation secondary system with a higher degree of integration, reduced cost, greater flexibility, communication networks replacing hard-wired connections, plug-and-play functionality, reduced construction and commissioning time, and other advantages

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# The Content of IEC 61850

**Core concepts related to Protection & Control are:**

- **Standardized data models and access to data (SCADA/EMS)**
- **Virtual DC wiring – GOOSE & GSSE**
- **Virtual AC wiring (averaged values) – GOOSE**
- **Virtual AC wiring (sampled currents and voltages) – Process Bus**
- **Standardized IED configuration file format**

**A broad array of ideas touching almost every aspect of relay design and operation (1,174 pages)**

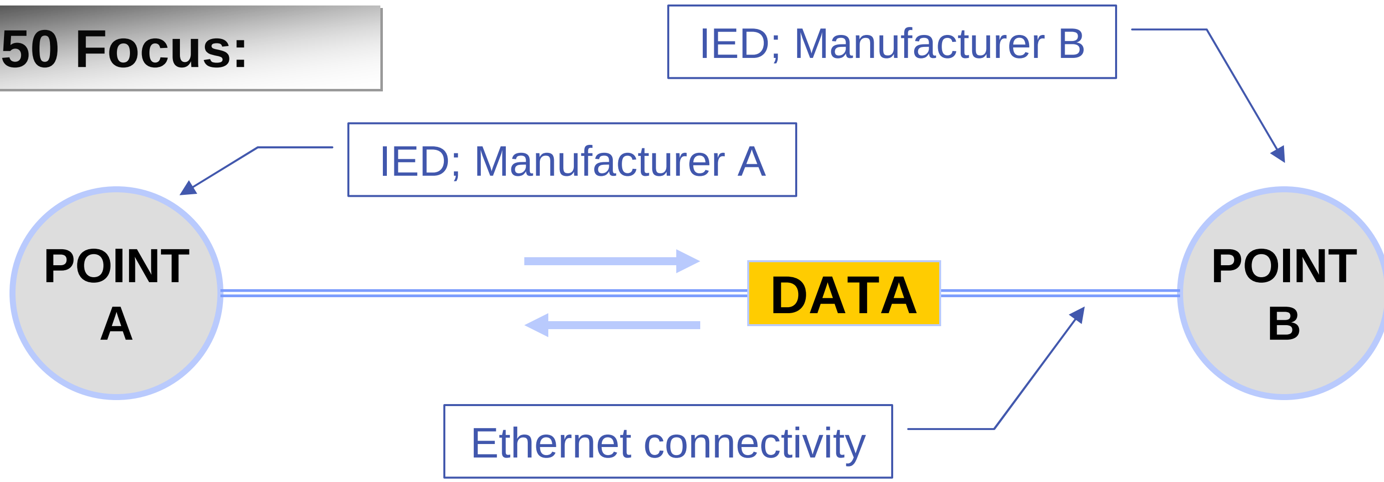
# Keys to a Successful Architecture

## Purpose-driven design

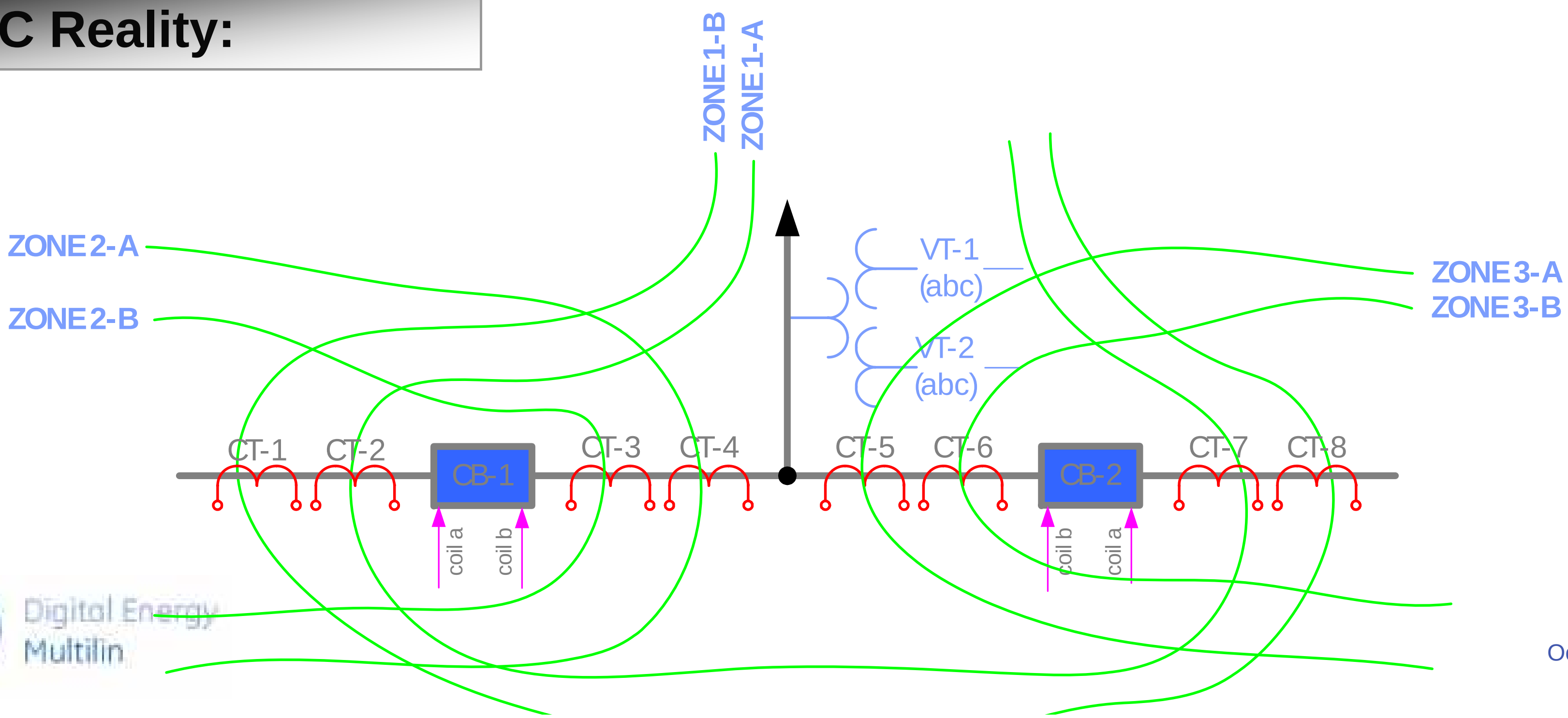
The cost and simplification benefits need to drive practical architectures, and those architectures should drive the interoperability standards. When reversed, the unfortunate result may be a lack of important features and/or the introduction of concepts that will never be used.

# Purpose Driven Design

**IEC 61850 Focus:**




**P&C Reality:**

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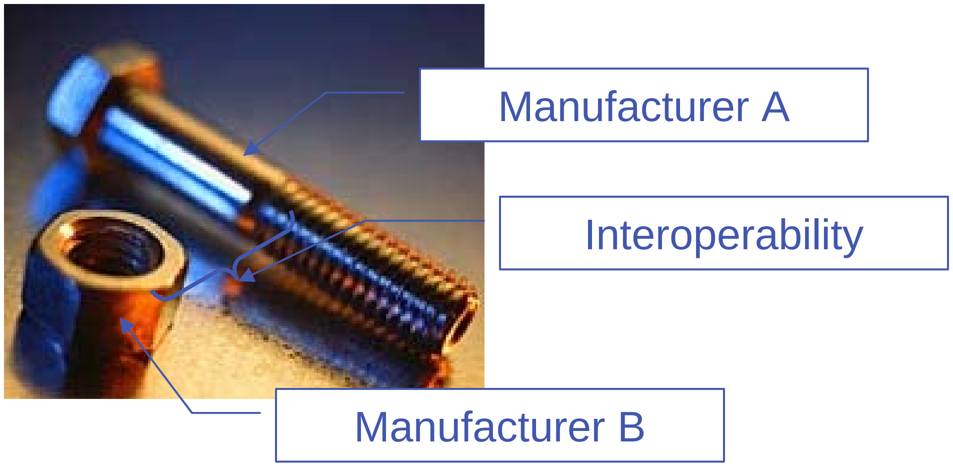
# Purpose Driven Design

## IEC 61850 Focus:




## P&C Reality:

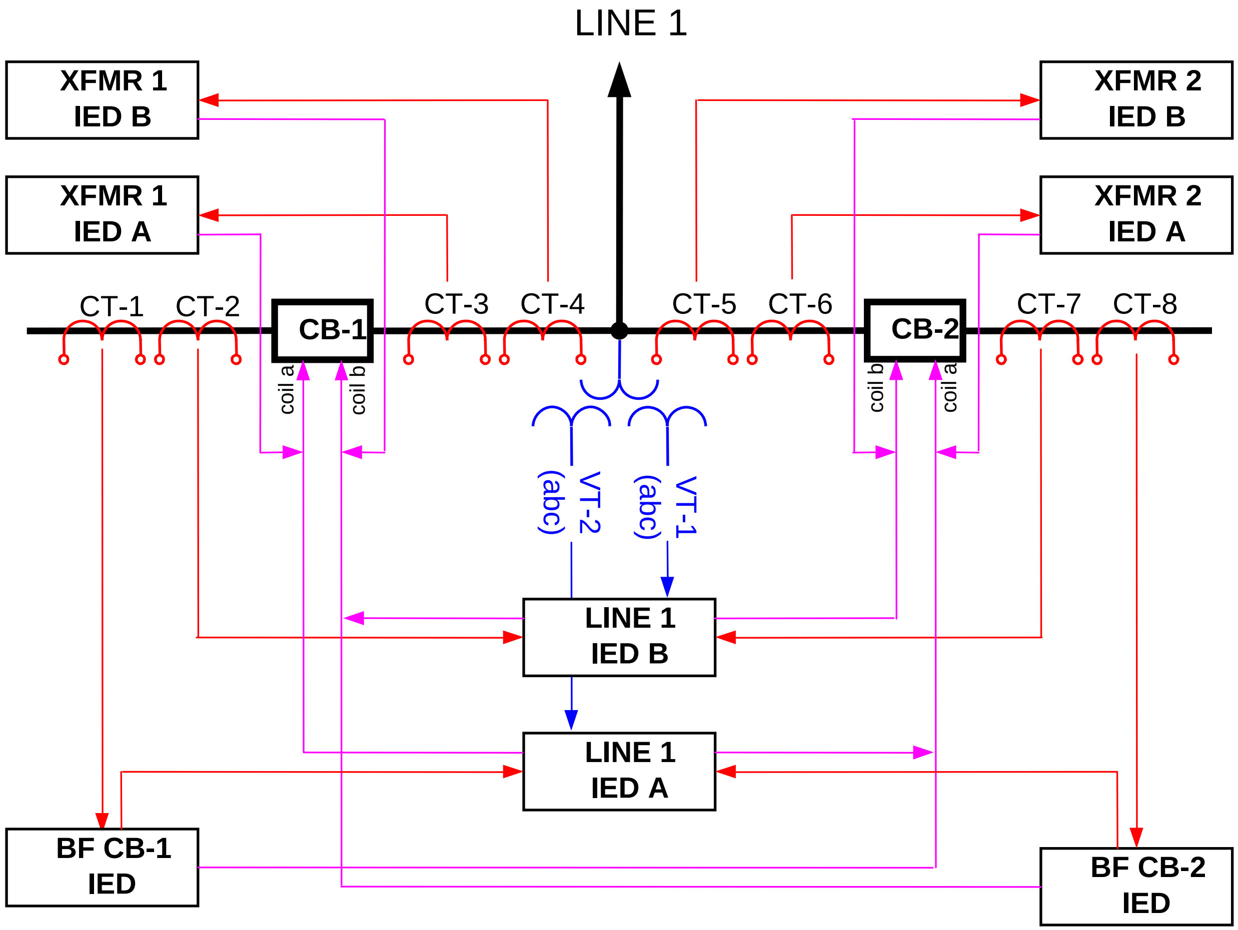
# Keys to a Successful Architecture

## Purpose-driven design

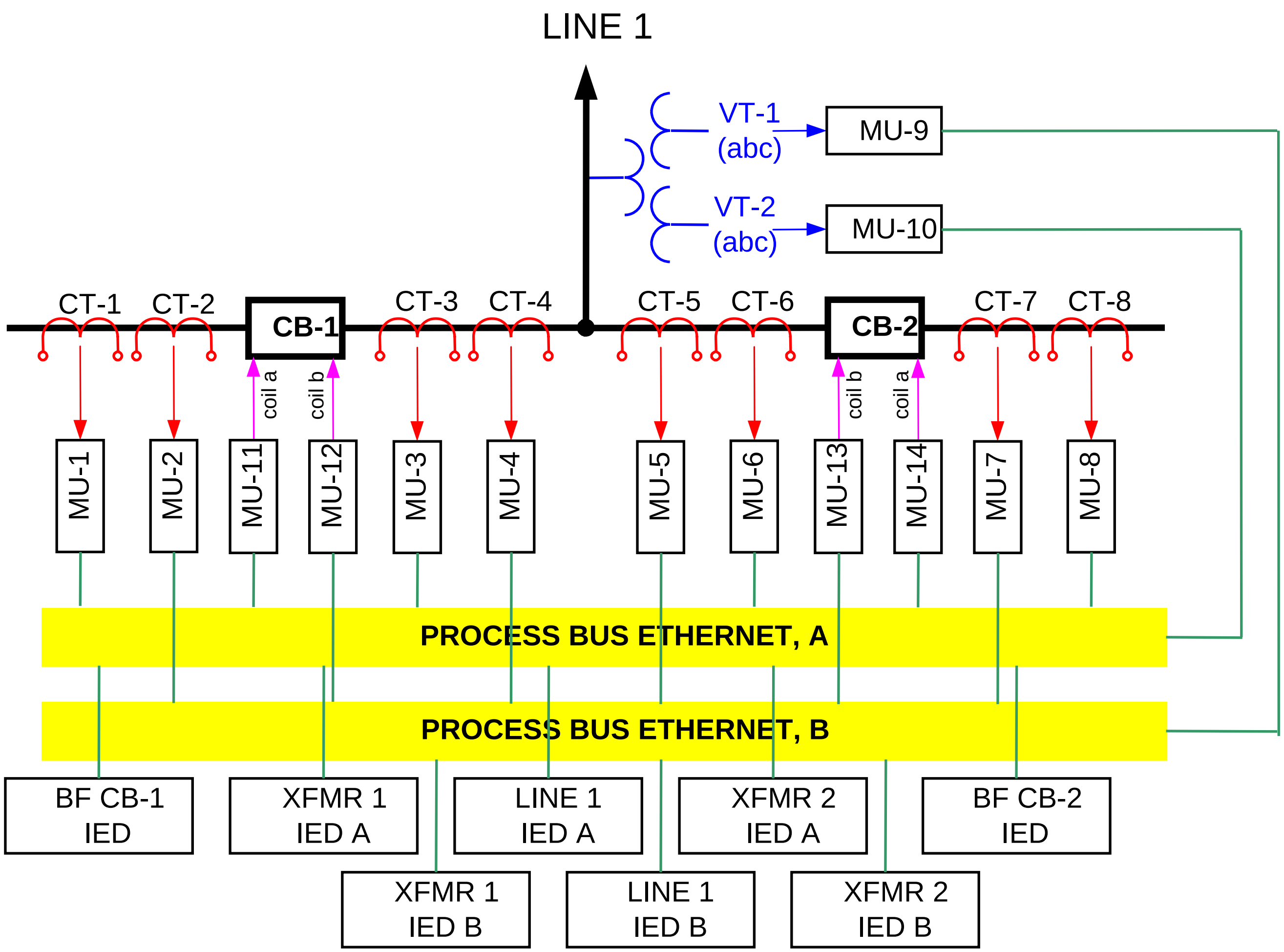
## Count of IEDs

Building tightly-coupled mission-critical systems out of several microprocessor-based devices designed and delivered by several vendors brings extra risk and complexity, probably doubling with each device, or vendor added to the equation.

# Count of IEDs (today)



# Count of IEDs



# Keys to a Successful Architecture

**Purpose-driven design**

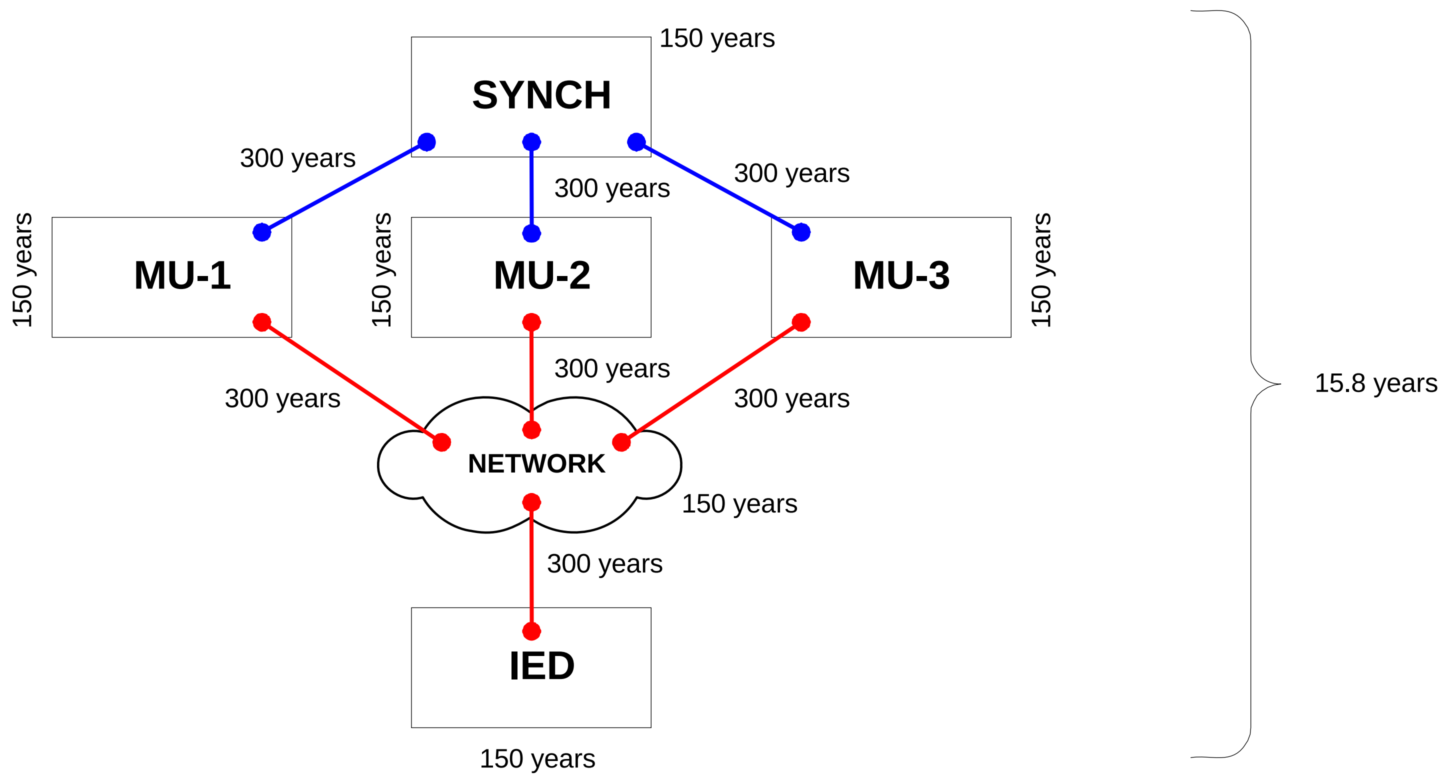
**Count of IEDs**

**Availability / Reliability**

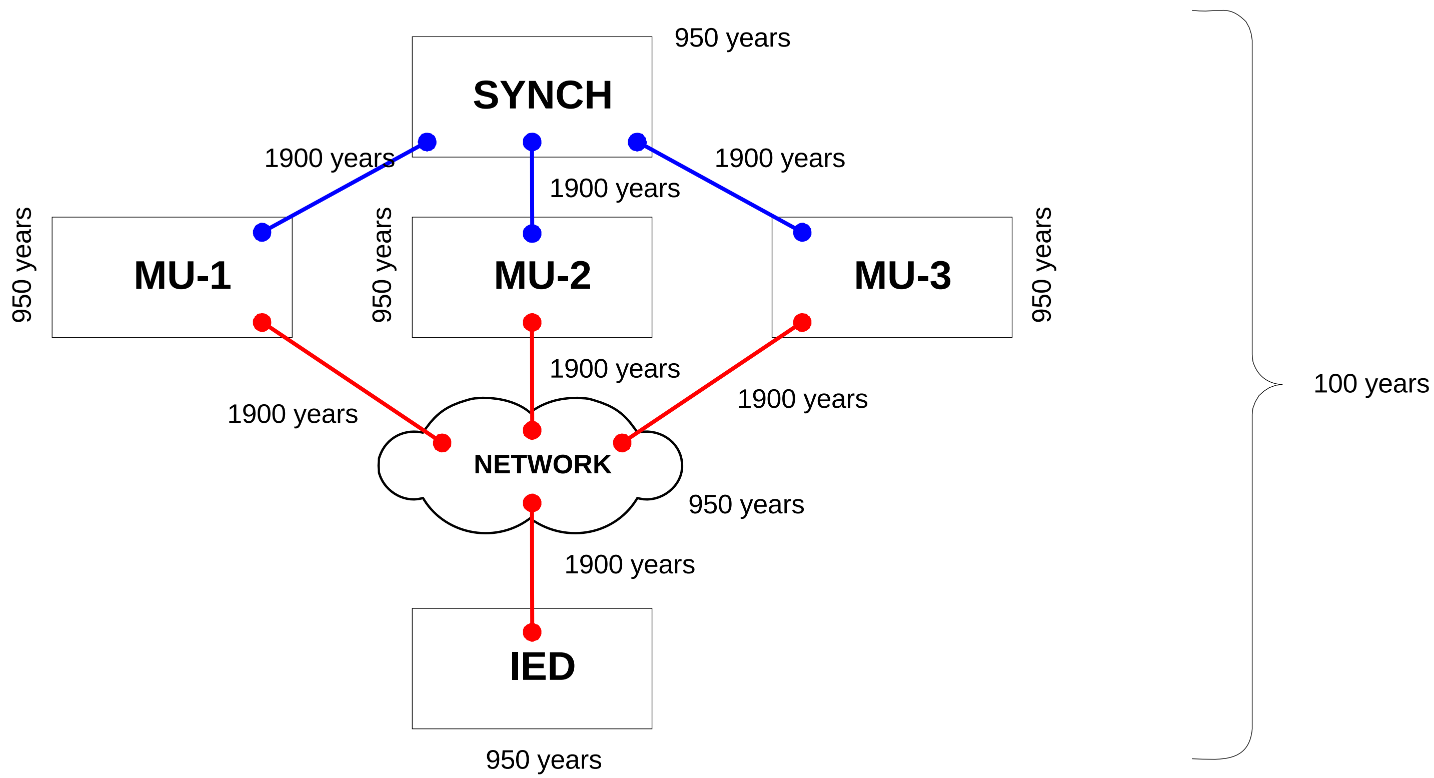
A successful architecture will have to be engineered to retain high availability of today's P&C systems regardless of the number of devices in the scheme.

Not meeting this requirement will be damaging to the concept and its present momentum, and may result in erasing all initial savings by increasing the actual cost of ownership.

# Availability & Reliability



# Availability & Reliability




A successful process bus architecture will have to keep the total number of components at the level of today's IEDs

# Keys to a Successful Architecture

**Purpose-driven design**

**Count of IEDs**

**Availability / Reliability**

**Cost-savings**

A successful architecture will have to prove significant reduction of the total cost of installation and ownership. It is the cost and value equation that separates what is technically possible from what is eventually manufactured, given a chance to mature, and be deployed in the field.

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# Keys to a Successful Architecture

**Purpose-driven design**

**Count of IEDs**

**Availability / Reliability**

**Cost-savings**

**Performance**

The new system needs to meet or exceed performance levels of today's solutions. Value added in the P&C domain, such as adaptive protection, is a plus but not a primary goal.

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# Keys to a Successful Architecture

- Purpose-driven design
- Count of IEDs
- Availability / Reliability
- Cost-savings
- Performance
- Segregation

A successful architecture will have to maintain clear boundaries between system elements (IEDs, functions, software, manufacturers, etc.), or users will become overwhelmed with interactions and complexity while engineering their P&C systems.

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# Keys to a Successful Architecture

**Purpose-driven design**

**Count of IEDs**

**Availability / Reliability**

**Cost-savings**

**Performance**

**Segregation**

**Maintainability**

Users engineer today's systems for maintainability taking advantage of common interfaces between the relays (copper wires), and relative indifference of the way the relays are designed, on the operational and maintenance procedures at various utilities. In new architectures, the user experience and training base will have to be considerably re-visited

# Keys to a Successful Architecture

**Purpose-driven design**

**Count of IEDs**

**Availability / Reliability**

**Cost-savings**

**Performance**

**Segregation**

**Maintainability**

**Determinism**

P&C systems require high level of determinism, and must be designed assuming worst-case scenario within the secondary system itself. Determinism is a must for practical engineering of mission-critical systems. Lack of determinism could become a liability (extra engineering, troubleshooting, and testing after initial commissioning).

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# Keys to a Successful Architecture

A successful solution needs to deliver on interoperability in the areas that are truly required while addressing all practical aspects such as performance, ease of use, future-proofing, determinism, testability, and maintainability.

**Purpose-driven design**
**Count of IEDs**
**Availability / Reliability**
**Cost-savings**
**Performance**
**Segregation**
**Maintainability**
**Determinism**
**Right degree of interoperability**

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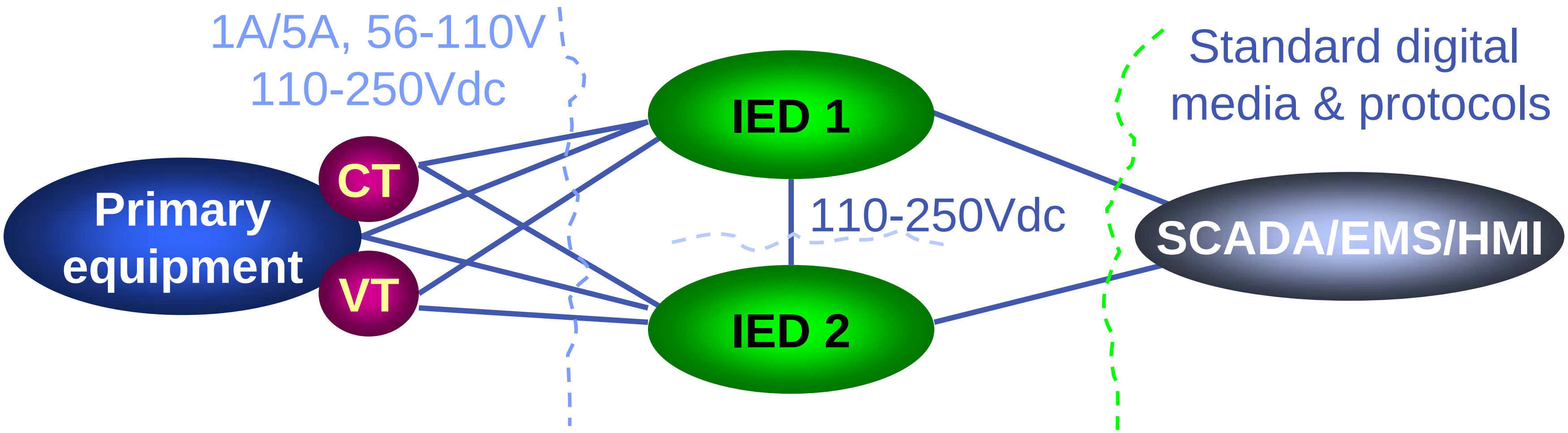
# Interoperability




**CONTINUUM OF INTEROPERABILITY**

**Single-vendor substations:**

-Primary equipment
-Instrument transformers
-Secondary system A
-Secondary system B

**Multi-vendor protection zones**

Protection zone built upon multiple IEDs from multiple vendors

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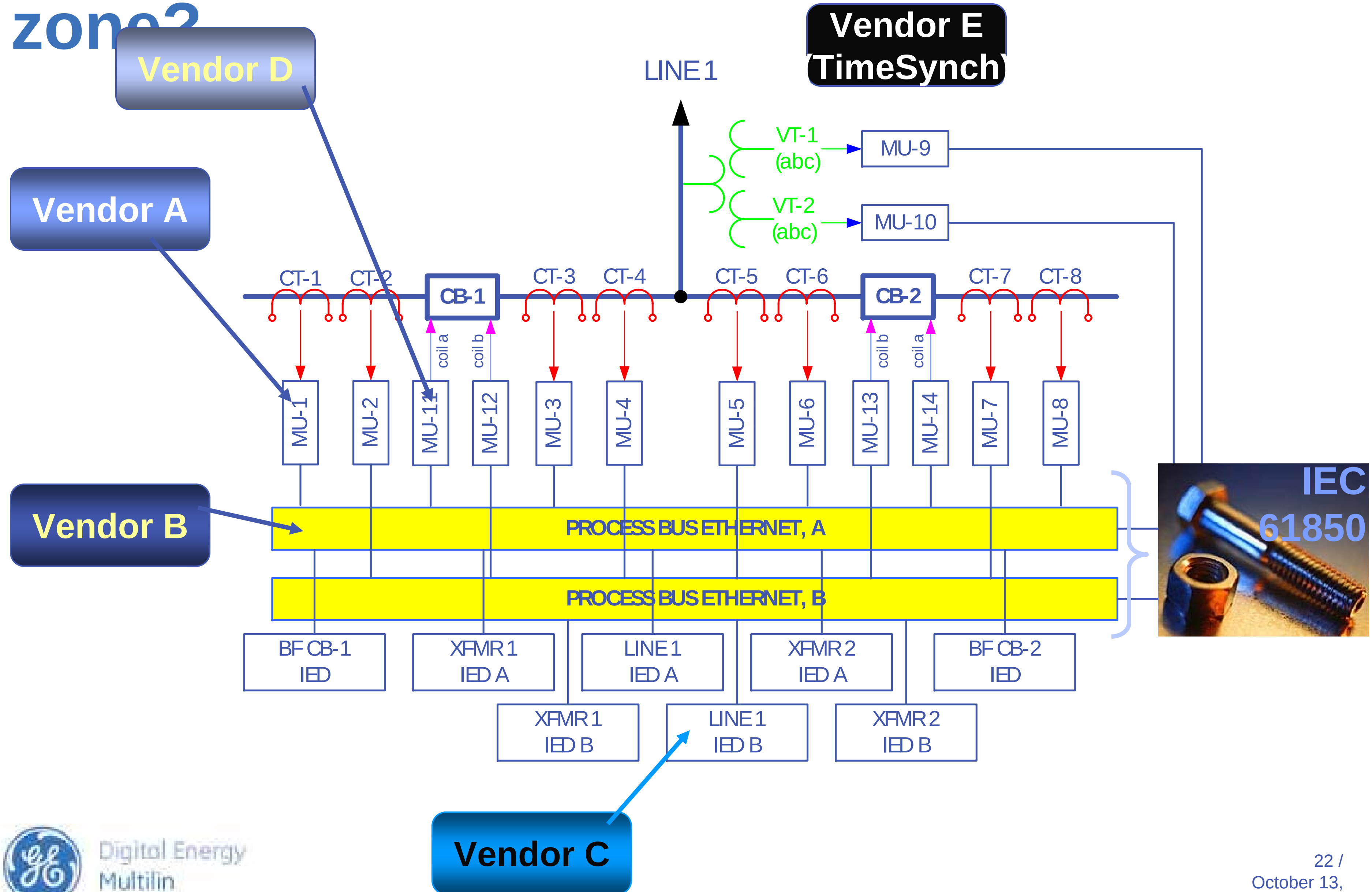
# Interoperability within a protection zone?

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# Interoperability

## Right degree of interoperability:

- Each P&C "solution" spans a single zone of protection (one vendor "owns" a zone)
- Vendor A can be replaced with vendor B on a per zone basis with minimum re-engineering on the user side
- Minimum impact of expansions on the secondary system
- No impact on the primary system

**CONTINUUM OF INTEROPERABILITY**

## Single-vendor substations:

-Primary equipment
-Instrument transformers
-Secondary system A
-Secondary system B

## Multi-vendor protection zones

Protection zone built upon multiple IEDs from multiple vendors

# Keys to a Successful Architecture

Given its complexity and performance requirements, a successful solution will have to come from parties focused on the complete system, not on its detached elements.

- Purpose-driven design
- Count of IEDs
- Availability / Reliability
- Cost-savings
- Performance
- Segregation
- Maintainability
- Determinism
- Right degree of interoperability
- Filling application gaps

# Filling Application Gaps

**Lockout (example):**

- Prevent re-energization of the catastrophically failed equipment until a local inspection has been carried out and corrective actions have been taken
- Lockout position latched after the reset of initiating protection
- Sustained trip command to all zone breakers
- Interlocked close command to all zone breakers
- Reset-able locally to force inspection

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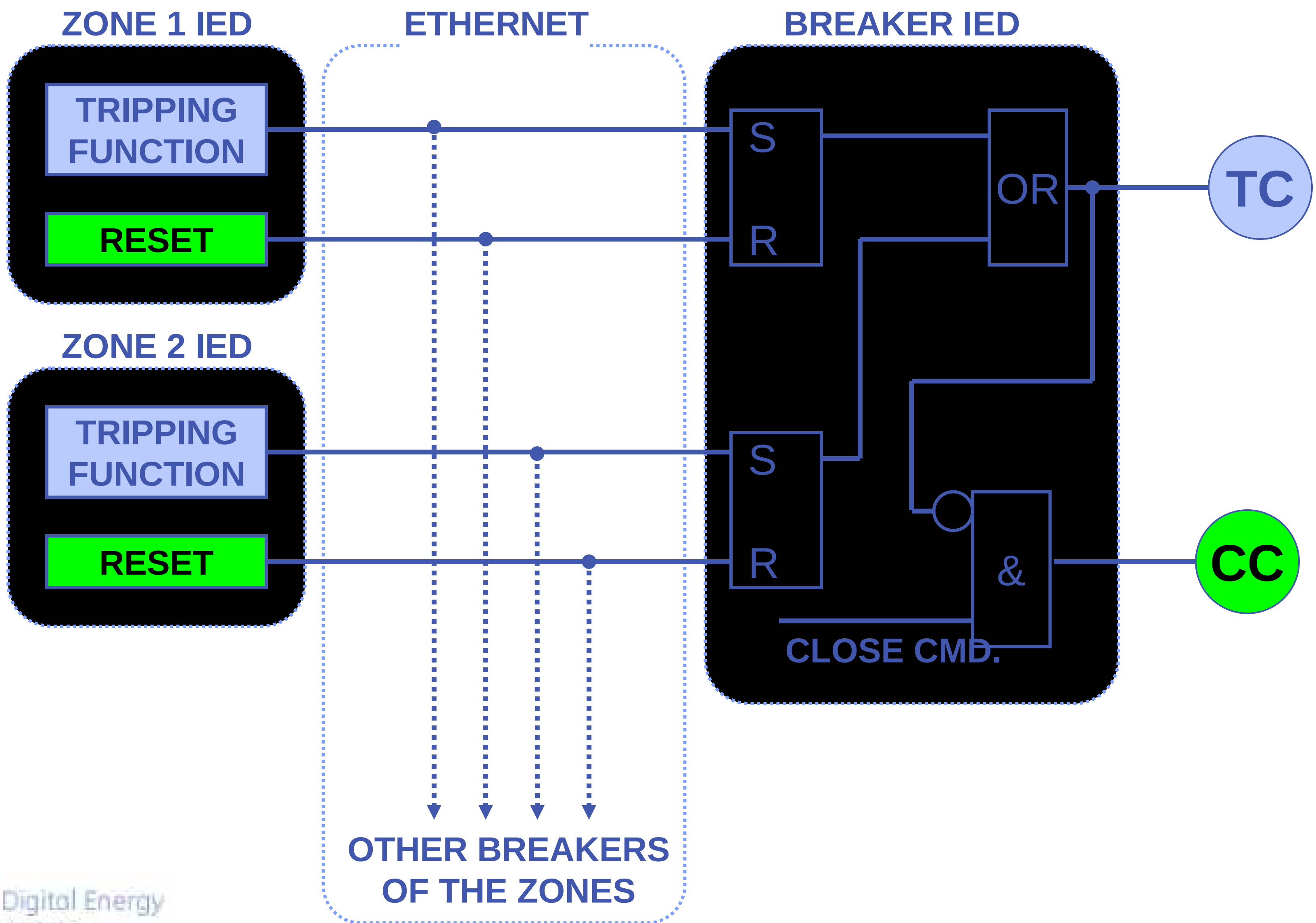
# Lockout Design (sample solution)

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# A Practical Architecture for Process Bus

g imagination at work

# Trends and Expectations for P&C

Cost pressure → Reduction in TIC

Available workforce → Less labour and relaxed skill-set requirements

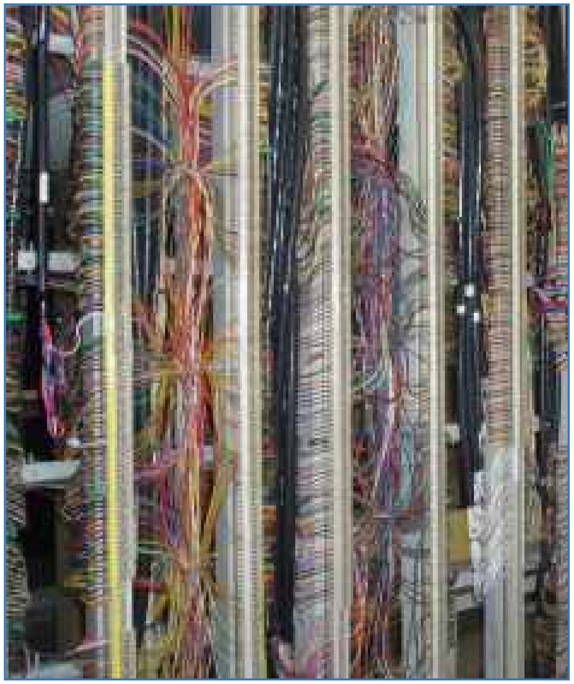
Focus on key competencies → Transfer of work

New external environment → Simple solution with minimum deployment time

# Design principles

## Designing-out copper wiring

- Maximum pre-connectorization
- Early and comprehensive acquisition of signals
- Fiber-based signaling
- Ruggedness and security paramount
- Risk mitigation with built-in redundancy



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# Design principles

## Ready to use today and future-proof

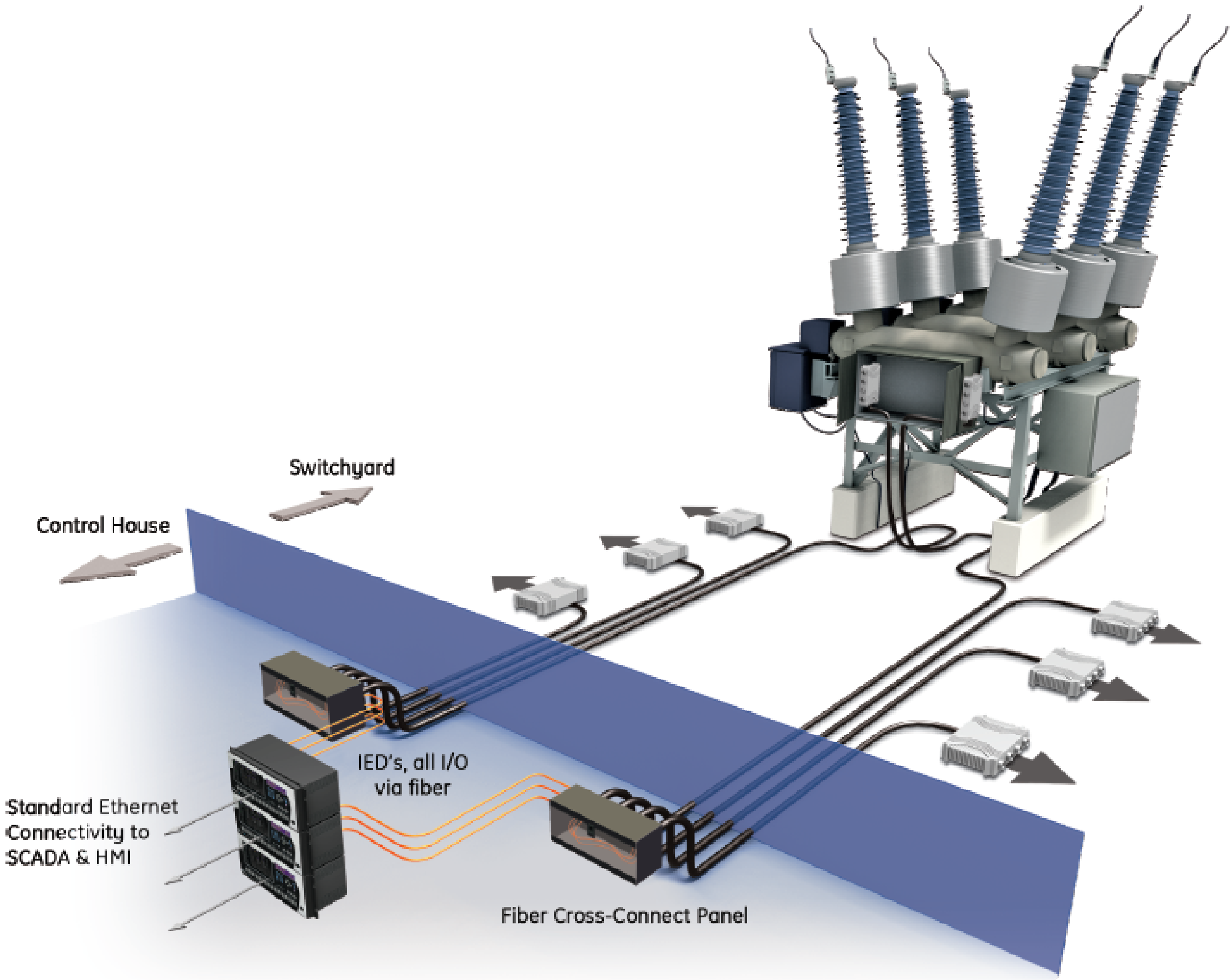
- Accepts reality of substation switchyards
- Open standard – IEC 61850
- Complete, simple and robust architecture
- Does not introduce new problems
- Respects the art of protection and control as practiced today

# Design principles

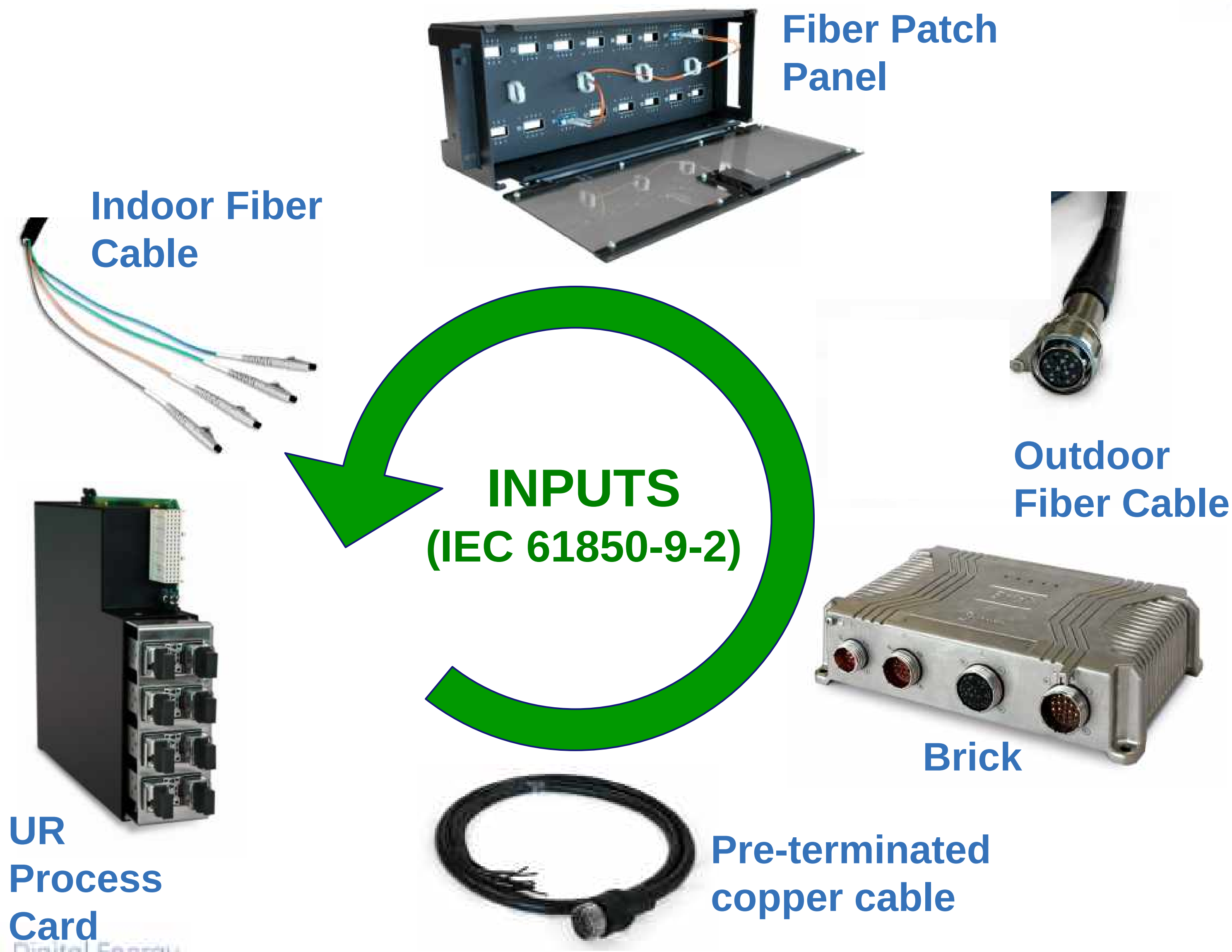
## Labour & Work transfer

- Optimum partitioning for multiple suppliers
- Standardization of components and physical interfaces
- Minimum variability of material
- Minimum on-site labour and maximum quality control

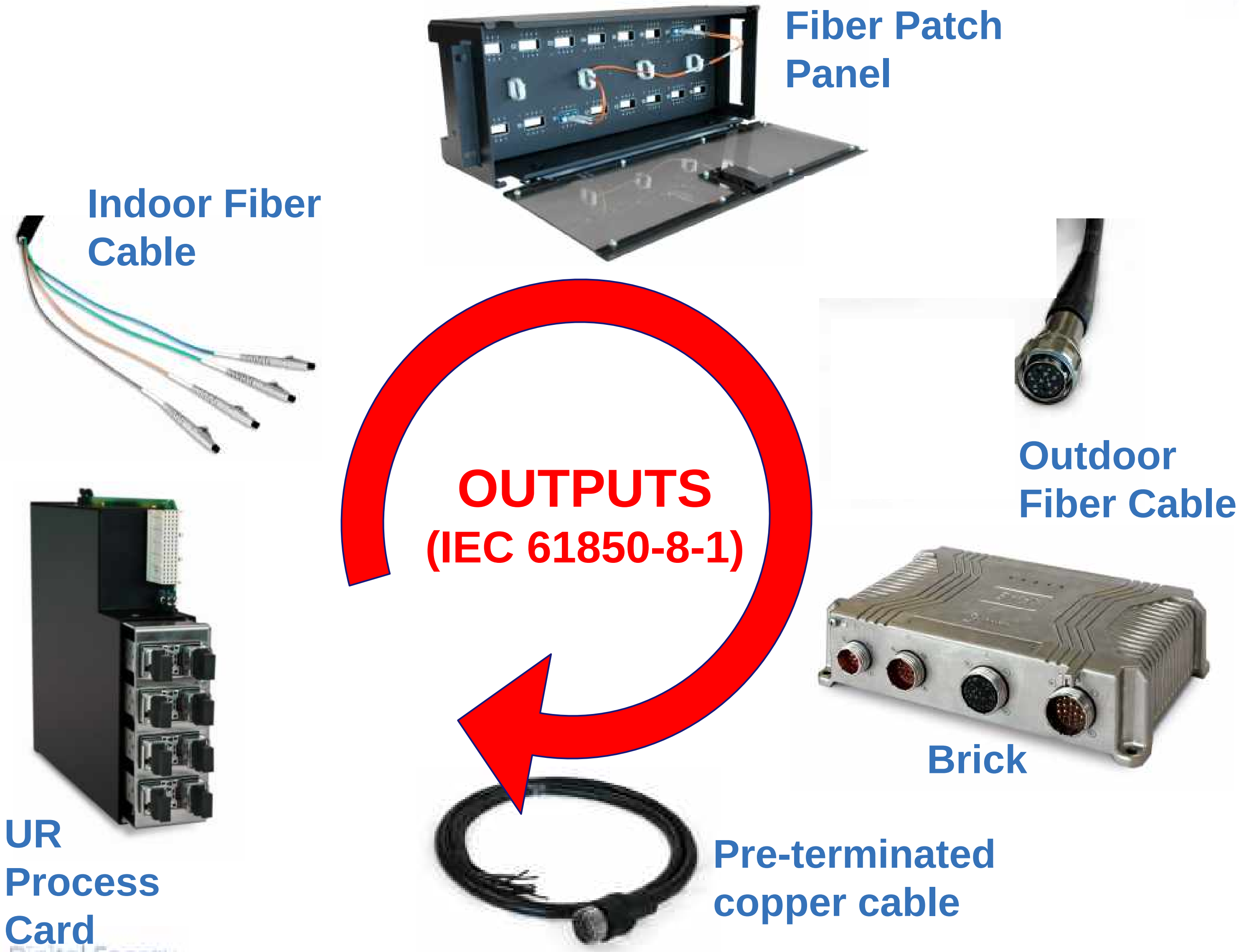
# Architecture - Overview



# System components



# System components

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# Brick mounting scenarios

External, on a Circuit Breaker

Internal, old oil-type Circuit Breaker


External, below VT marshalling box

External, on a structure

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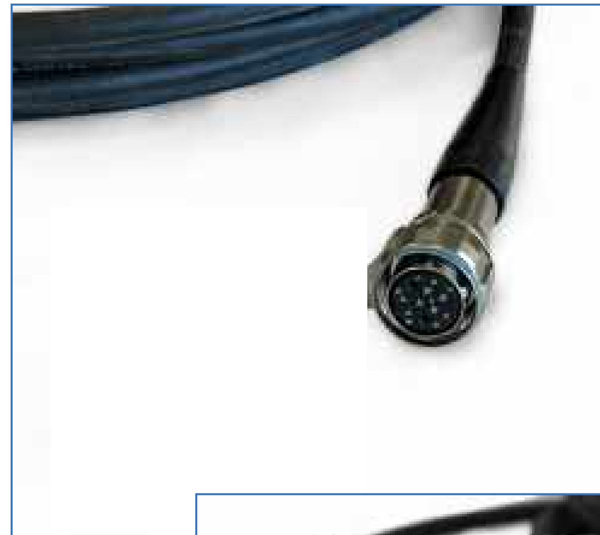
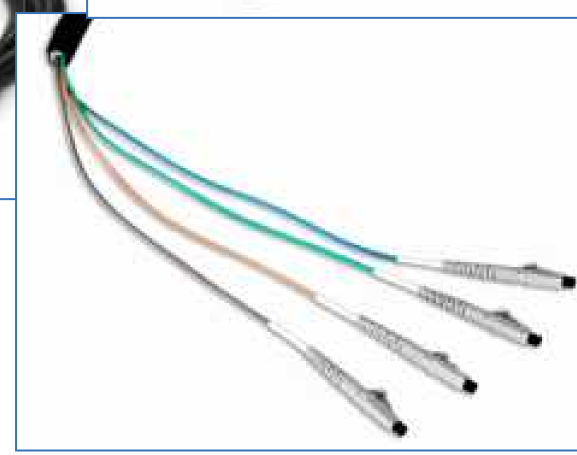
# Cables

- All copper wires "connectorized" with MIL spec 38999 connectors (IP67)
- Single rugged connector for communications & power
- Outdoor fiber cables ordered to length and terminated at both ends
- Outdoor fiber cables protected with fuses





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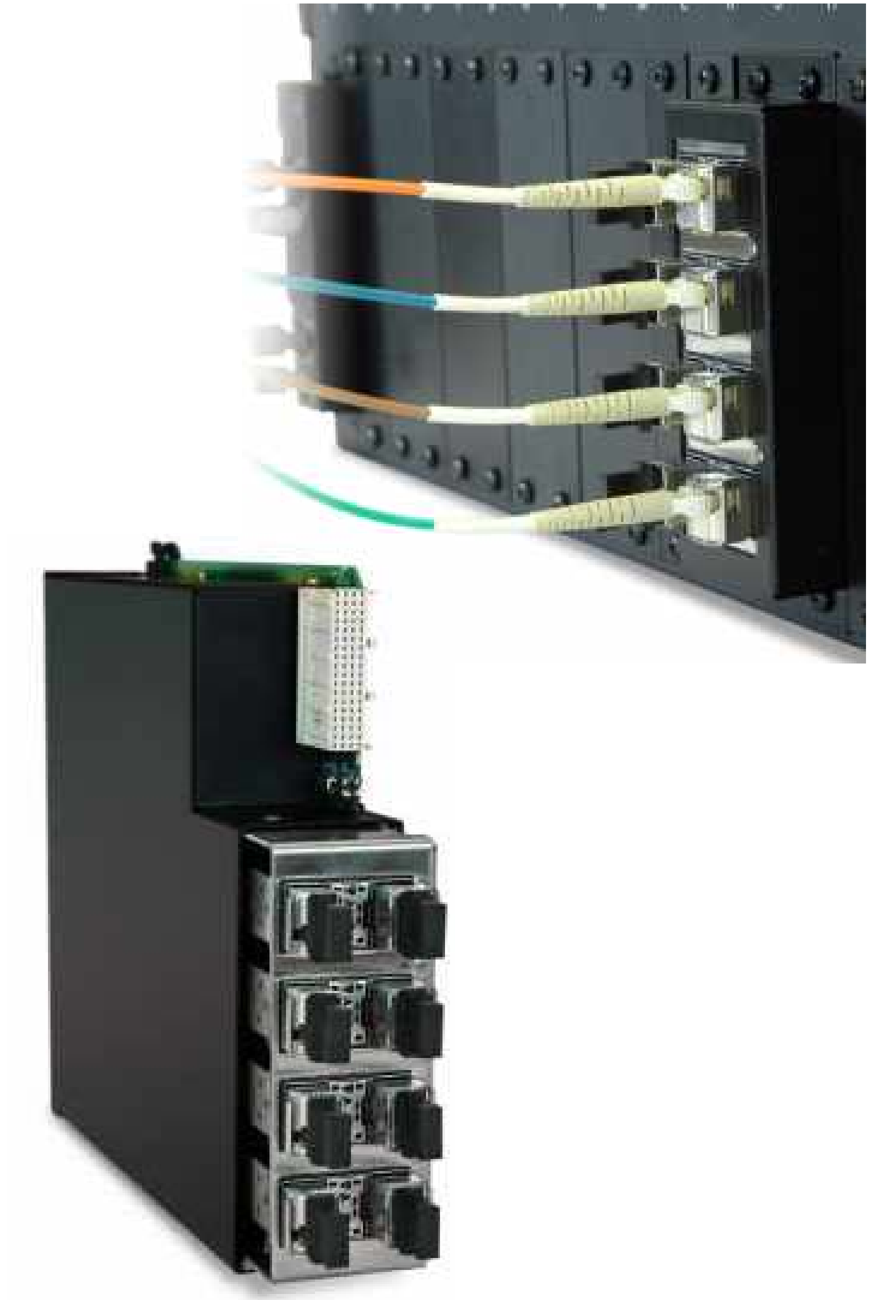
# Relay

- UR family, all existing and new functions
- New communication card interfacing up to 8 bricks
- Up to 6 sources for configuration (equivalent to a hardwired UR)
- No new software required to set-up

**Optional**

- Conventional I/O card
- Communication card for teleprotection



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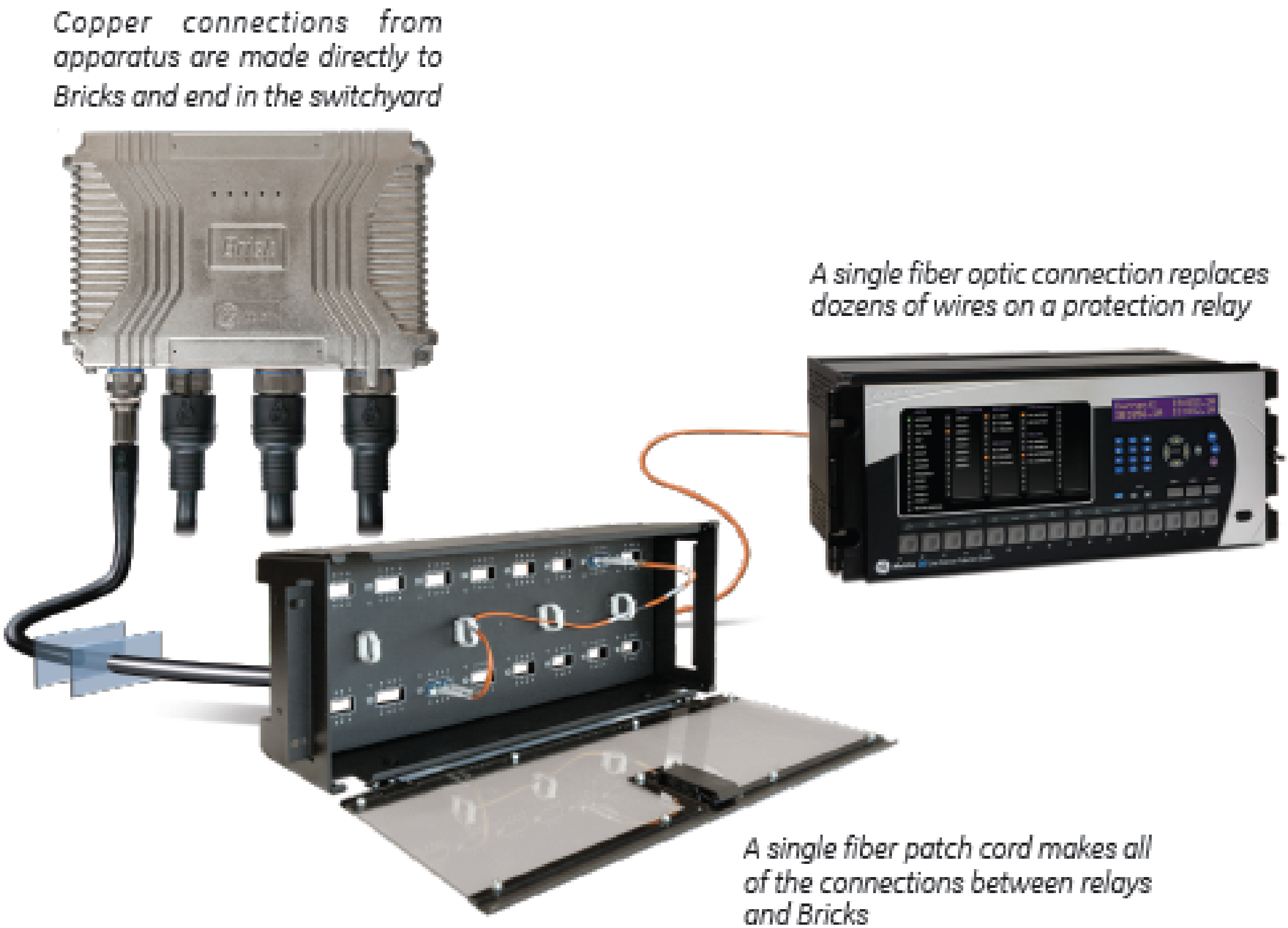
# Process Bus System

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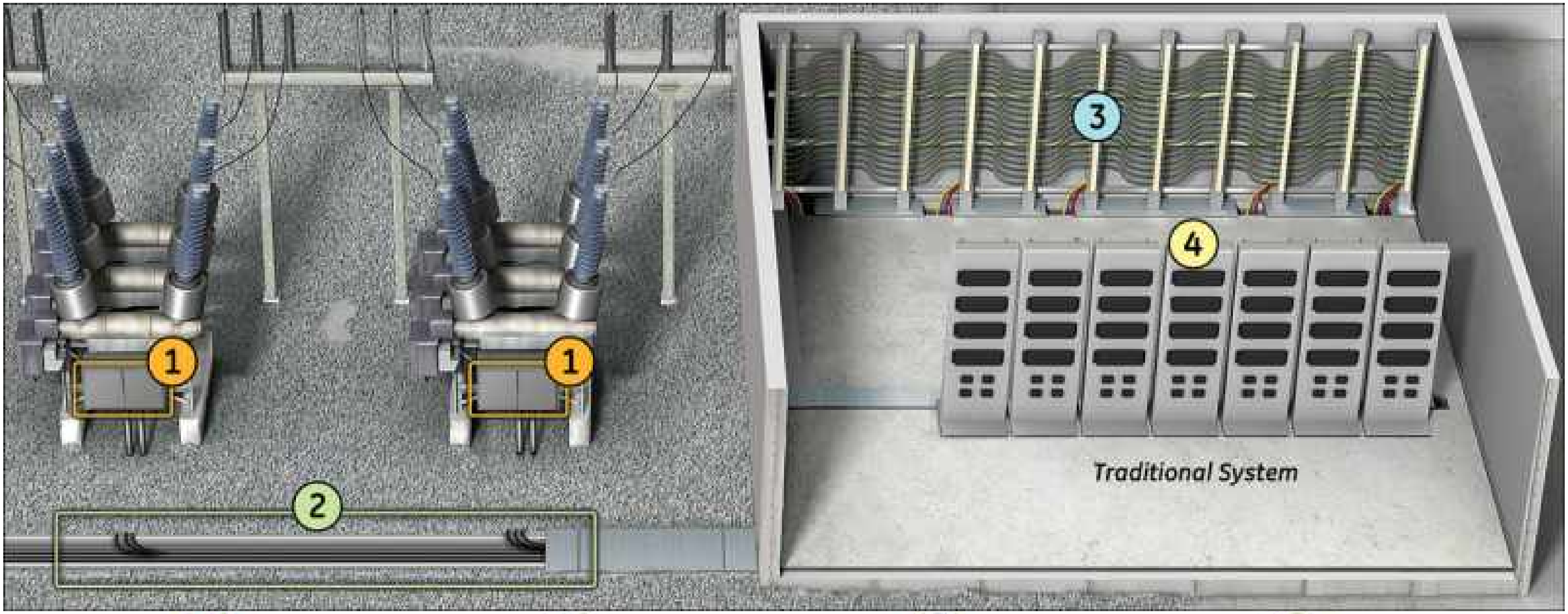
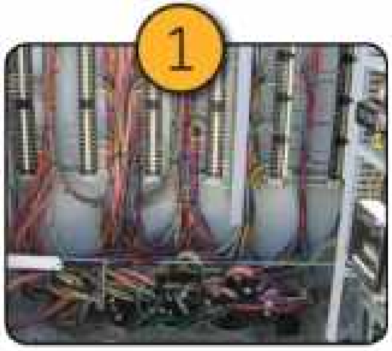
# Traditional Switchyard Construction

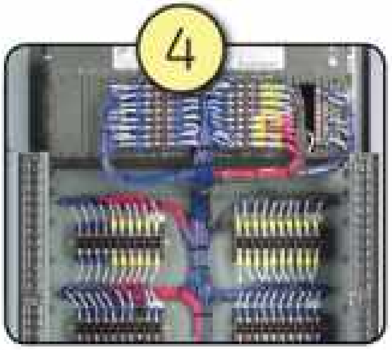



Traditional Breaker Wiring

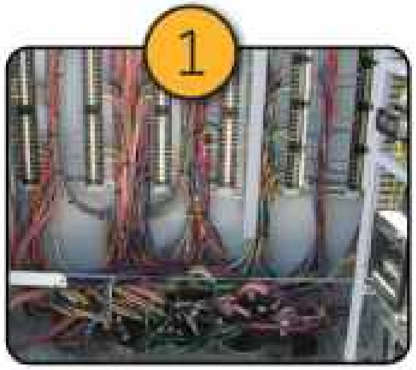

Traditional Cable Trench


Thousands of Copper Wires from Switchyard




Labor Intensive Copper Wiring on Relay Panels

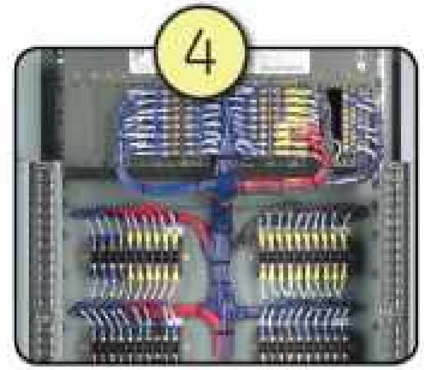
# Eliminating Complexity



Traditional breaker wiring

Traditional cable trenches

Thousands of individual copper wires from switchyard

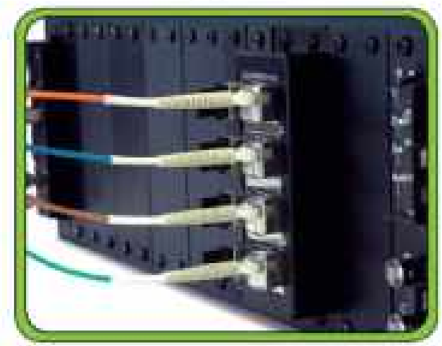


Labor-intensive copper wiring on relay panels

Eliminates 33% of breaker terminations

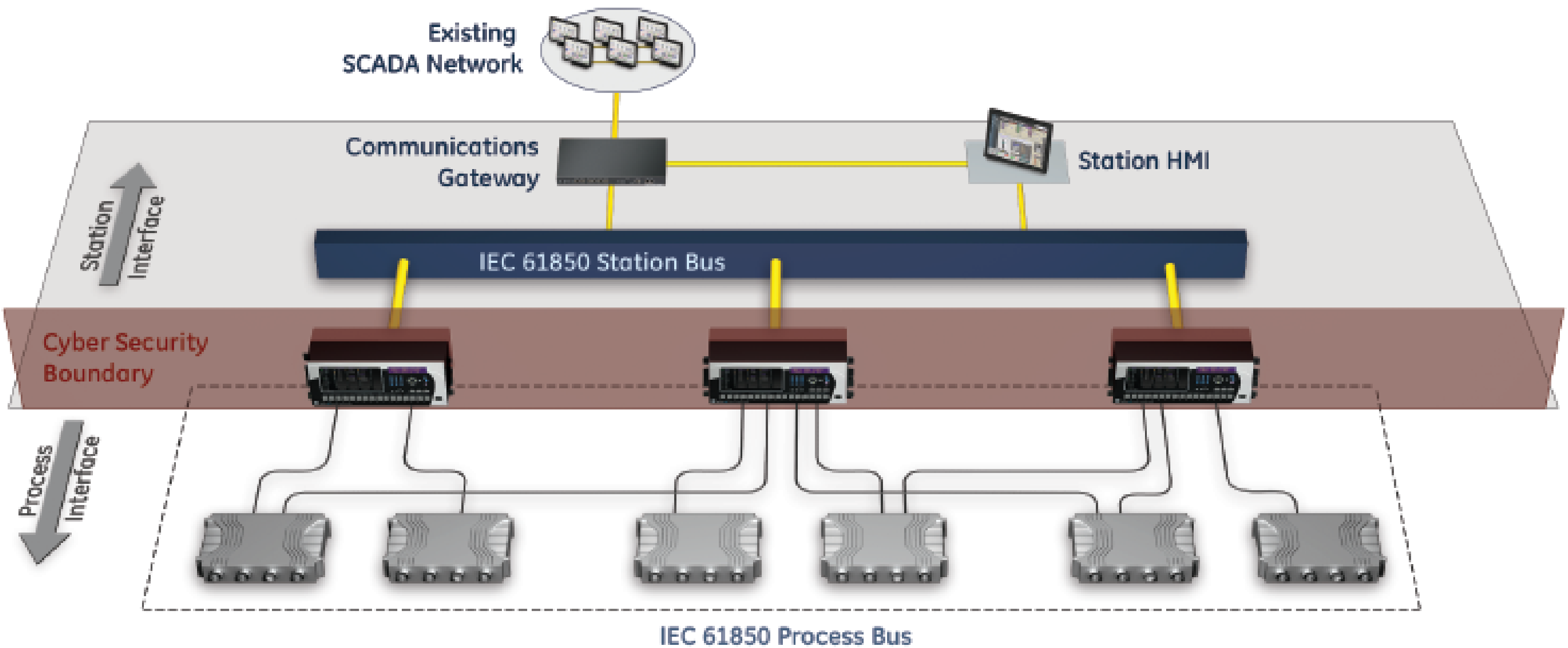
40% less cabling with no terminations required

Eliminate 90% of control building terminations



1,000's of wires replaced with few communication cables

# Complete IEC61850 Solution

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# Benefits & Advantages

- Head Office
- On-site
- Long-term

# **Benefits – Head Office**

## Engineering

- Intuitive architecture
- Simplified design and drafting
- Seamless integration
- Proven Universal Relay family

## Project Management

- Reduced cycle time
- Easier procurement
- Shorter outage windows
- Comprehensive FAT for turn-key projects

# Benefits – On-site

## Construction

- Reduced on-site labor
- Higher quality, repeatability
- Optimum partitioning of work
- Relaxed skill sets

## Commissioning

- Reduced time
- Fewer mistakes
- Improved safety
- Consistent testing practice

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# Benefits – Long-term

## Maintenance

- Simplified testing
- Minimized replacement time
- Fewer spares
- “Run-to-fail” operation

## Operations

- Improved security, reliability
- Easy additions/modifications
- Reduced outage times

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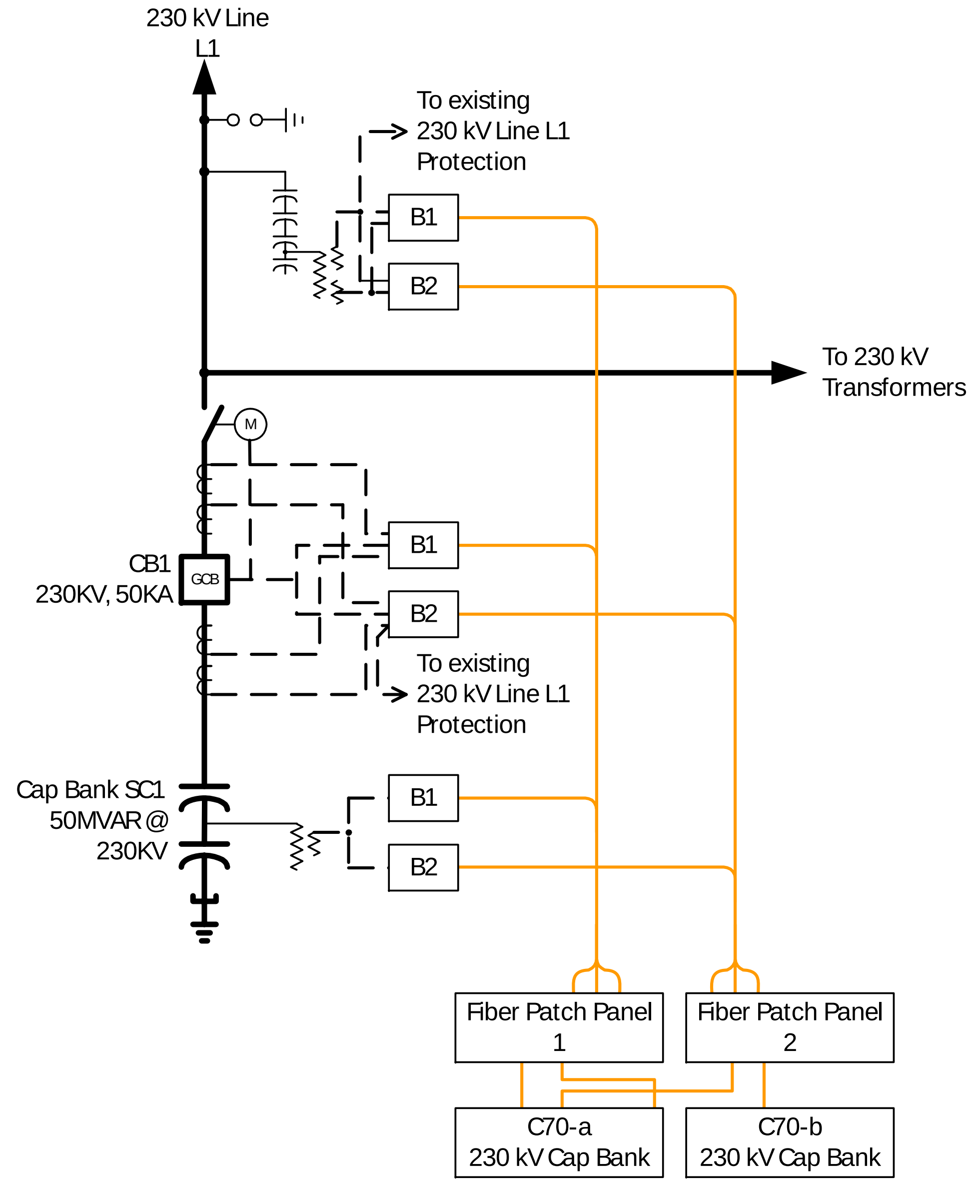
# Customer Installations

## 230 kV Cap Bank

- 230 kV Cap Bank (1st of four to be installed)
- Two C70s – first ones installed in this utility
- Copper I/O modules to interface to existing adjacent protection

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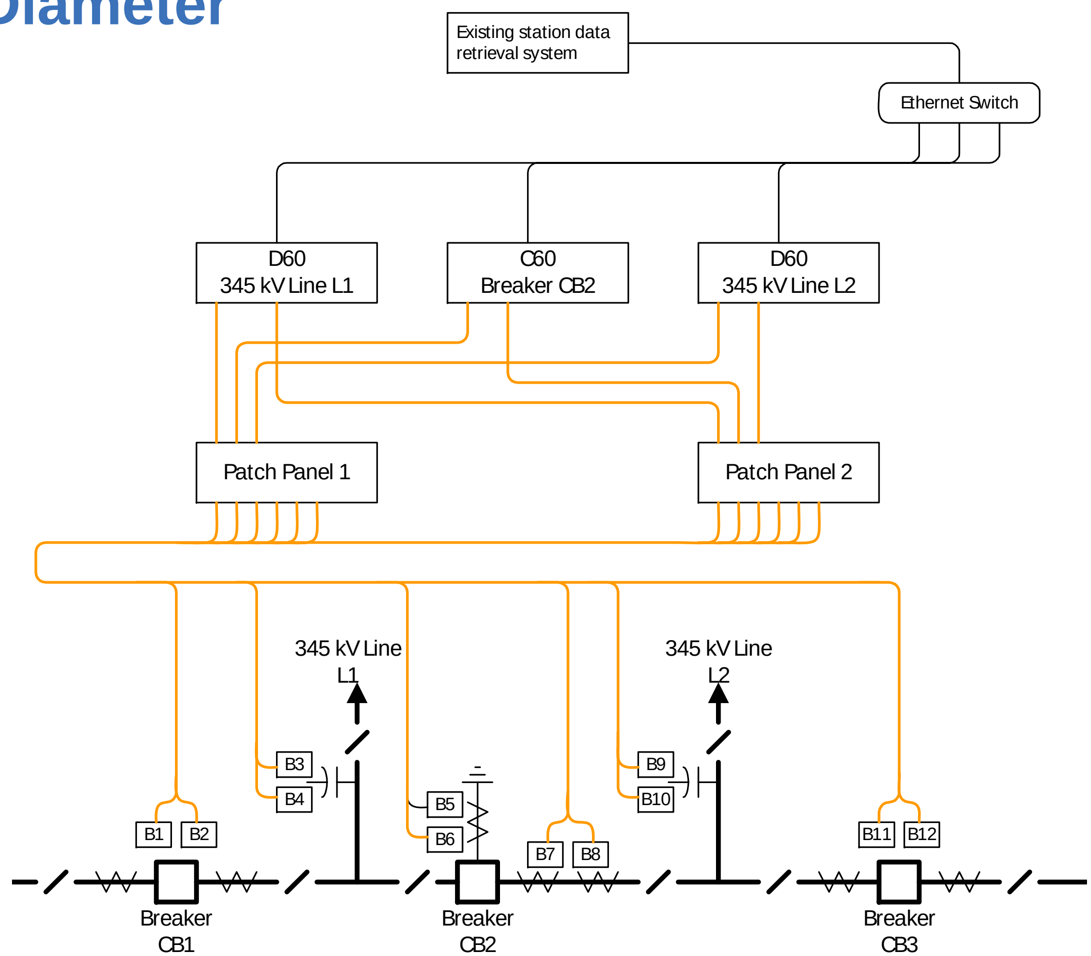
# Customer Installations

## 345 kV 1-1/2 Breaker Diameter

- Two 345 kV Lines
- Single breaker failure & frame leakage
- Two D60s, one C60
- Delivering complete solution
  - engineering design
  - materials
  - on-site commissioning support

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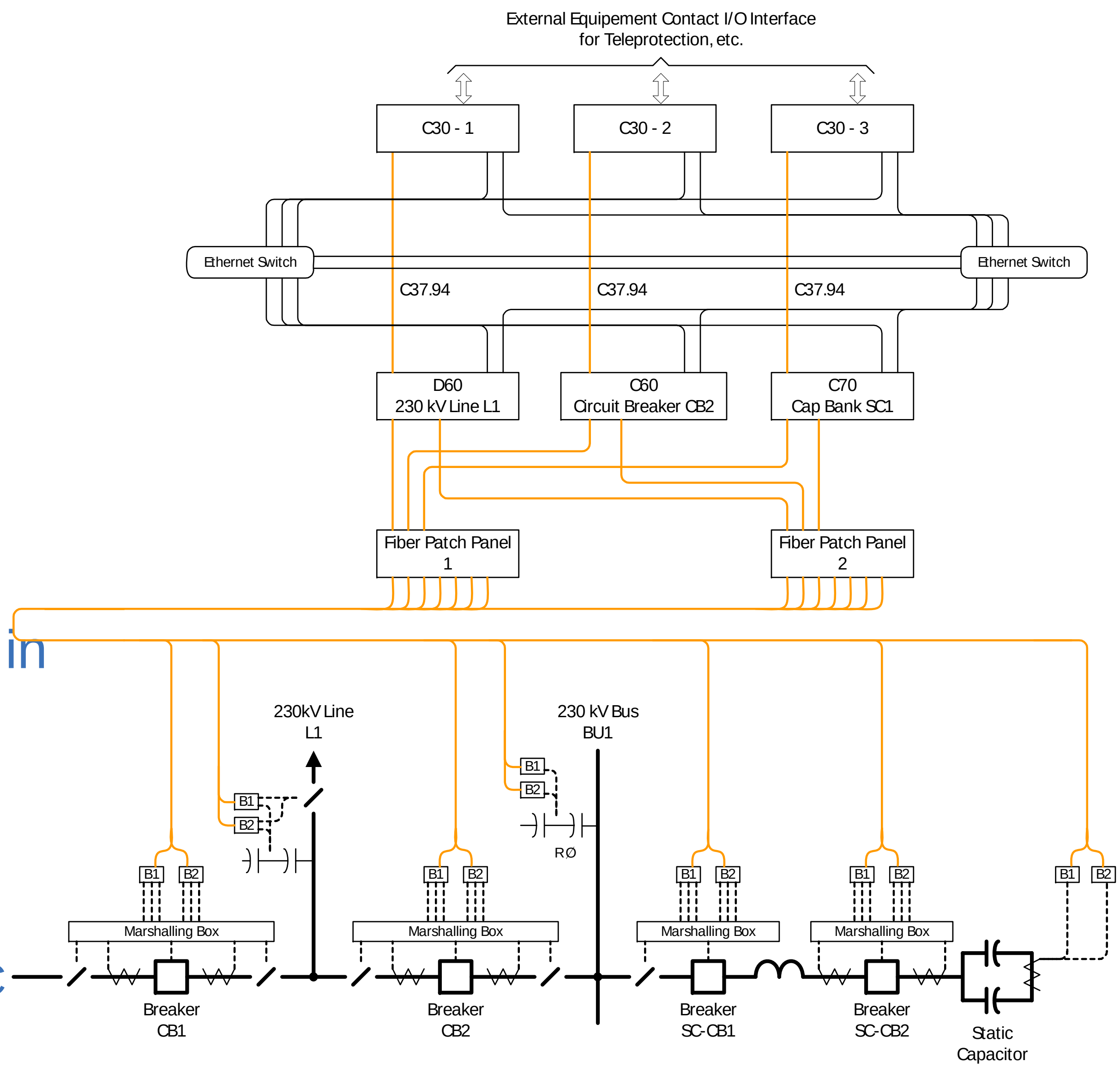
# Customer Installations

## 230 kV Switchyard

- 230 kV Line
- 230 kV Cap Bank
- Single breaker failure
- D60, C70, C60, C30s
- First C70 installed in this utility
- C30 – Interface to copper via C37.94
  - No copper on panels except DC power

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# Moving towards the "Slope of Enlightenment"


**Possible Translations:**

- RTUs are eliminated, Ethernet used as a primary EMS/SCADA integration medium
- 61850 Client-Server capabilities used for the EMS/SCADA integration
- GOOSE applied to reduce dc wiring
- GOOSE applied for tripping in parallel with copper wiring
- Application with non-standard CTs/VTs, single vendor, legacy system upgraded to conform with the 61850 process bus interface