# Challenges and Solutions Testing in Digital Substations

**Alexander Dierks, Alectrix (Pty) Ltd**



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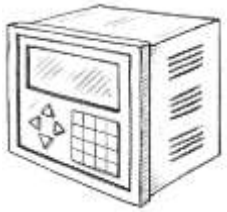
# Overview

Challenges facing a Protection, Automation and Control (PAC) engineer / technician:

1) Managing and maintain legacy (classic) as well as digital (numerical) PAC technology
2) Diverse applications:

   Protection relays, Metering applications, instrument transformers, circuit breakers, etc.
3) Loss of technical expertise & experience
4) Diversity of personal
5) Time and cost pressures
6) IEC 61850 Station bus / GOOSE / Sampled Values communication
7) Cybersecurity in digital substations
8) Personal safety in substations

# Versatile solution



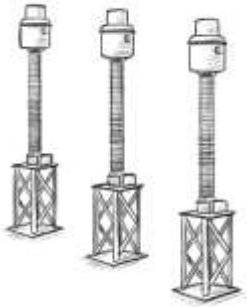
**Protection relays**

Electro-mechanical
Static
Digital
IEC 61850

**Circuit breakers**

**And much more...**

Energy meters
PQ analyzers
Measuring transducers
Wiring
etc.



**Current transformers**

# Testing efficiency

- Standardized testing
  - One test document for pre-qualification, FAT, commissioning, SAT, maintenance
  - Consistently high test quality

- Protection Testing Library:
  Templates for all relay types
  and testing of entire PAC system

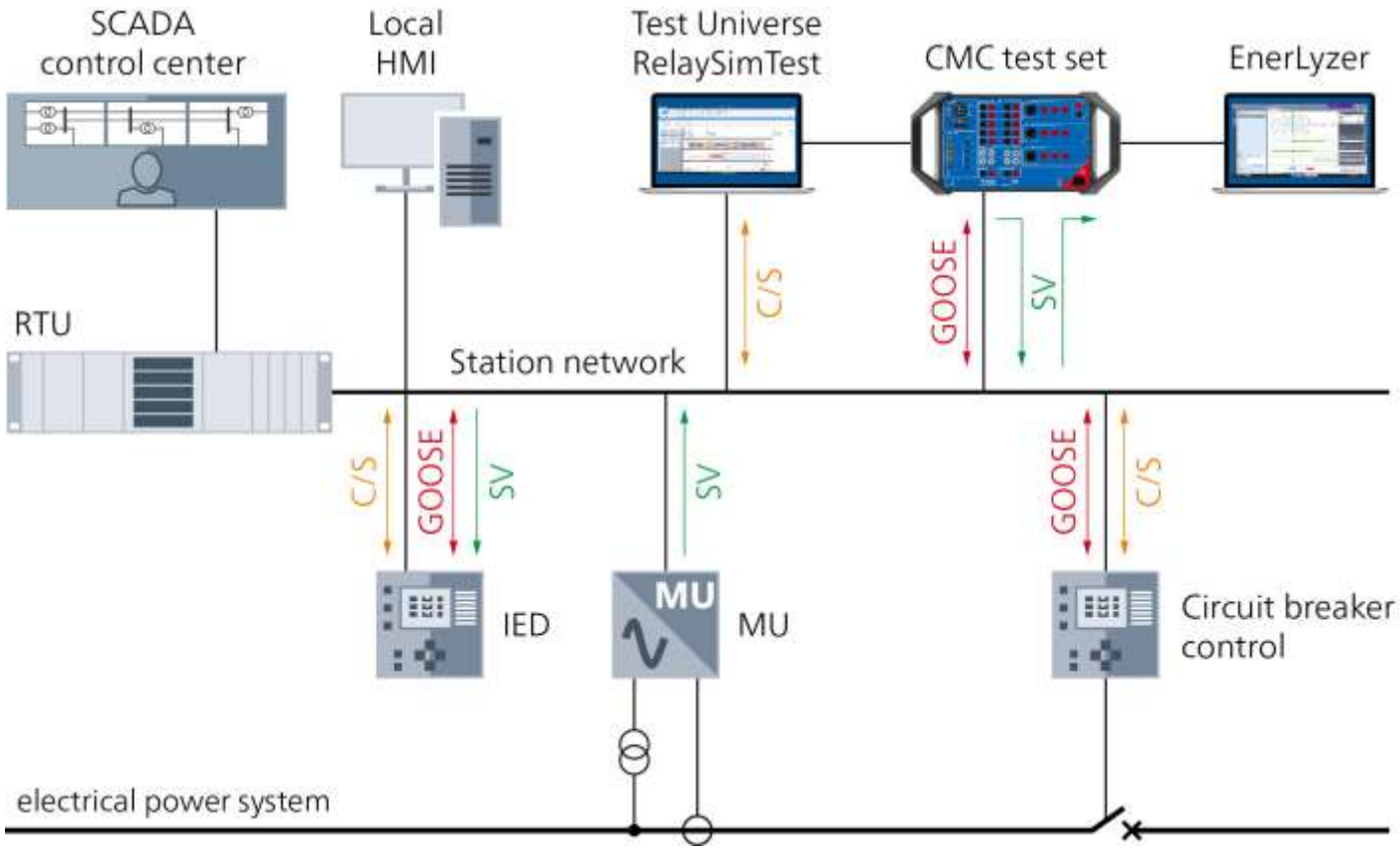
GE VERNOVA SEL Schneider Electric sprecher automation …

- Parameter import into existing templates

- Quick creation of test plan variants
  (e.g., for similar relays)

# IEC 61850: Testing of digital substations

- Station bus / Process bus
- Types of communication protocols
  - GOOSE / R-GOOSE
  - Client/Server (MMS)
  - Sampled Values (SV) according to IEC 61869
  - PTP synchronization (IEEE 1588)
- Testing requirements
  - Simulate GOOSE, C/S & SV
  - Subscribe to GOOSE, C/S




*C/S: Client/server (MMS)* *SV: Sampled Values*



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# Measurement and recording

- Efficient troubleshooting during commissioning and after incidents
- Real-time measurements and signal recordings
  - Hardwired binary and analog signals
  - Digital Sampled Values and GOOSE
  - Hybrid measurement
- 40 kHz sampling rate
- Flexible analysis (time signal graphics, vector diagrams, R/X plots, harmonics histograms


**Open-close time measurement of a circuit breaker (optional analog measuring inputs required)**



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# Cybersecurity

- Cybersecurity across the entire life cycle
  - Established software development process geared towards cybersecurity
- Comprehensive protection against…
  - **Man-in-the-middle/spoofing attacks**
    Secure device identification with digital certificate
  - **Manipulation of firmware**
    "Secure boot" and "Measured boot" with TPM2.0 (ISO/IEC-11889)
  - **Unauthorized use**
    Password-protected communication
  - **Disclosure of sensitive information**
    Encrypted configuration/customer data and communication during operation/upgrades

# Maximum user safety

- Multi-level safety concept
  - Functional safety as per ISO 13849-1
  - Product safety as per IEC 61010
  - Test setups per EN 50191
- INTERLOCK key
  - No unauthorized operation
- Operational mode button
  - Safe rewiring when device is switched on
  - No unintentional operation
- Signal lights (red/green)
  - Unique operating states
- External emergency switch off button
- Safety and wiring instructions in the test procedures

*"If several people are working in the same substation, it is particularly important to guarantee safety for the test personnel."*

# CMC 500: The new benchmark in protection testing

Highly efficient

IEC 61850

Cybersecure

Safe

Versatile

Lightweight and reliable