Operations & Maintenance – facilitating condition based and predictive maintenance to support cost-efficient operation and maximum life-cycle of next generation IEC 61850 systems

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IEC 61850 Europe 2014

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Background to 61850 @ Iberdrola

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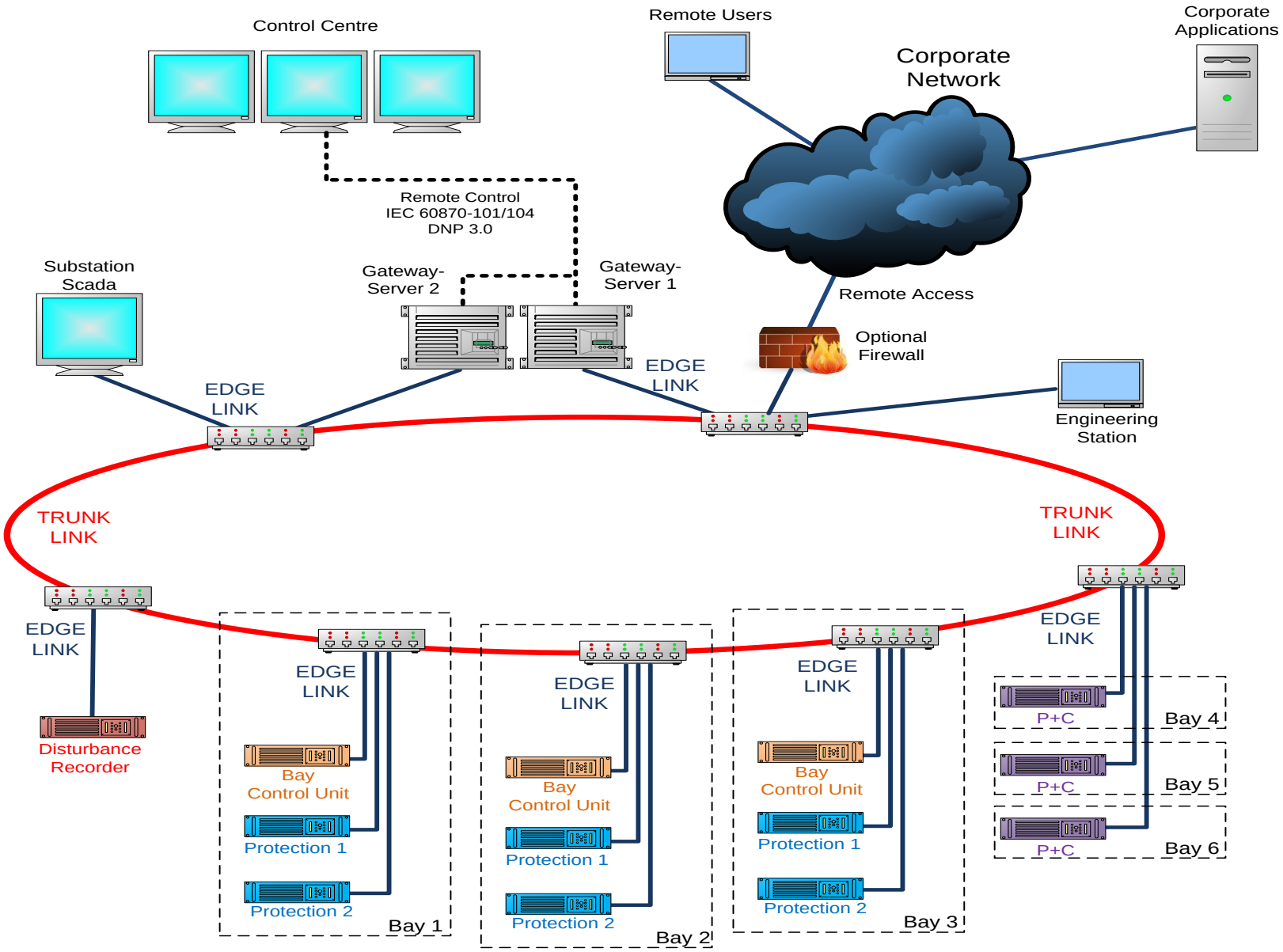

Maintenance Challenges
Configuration Management

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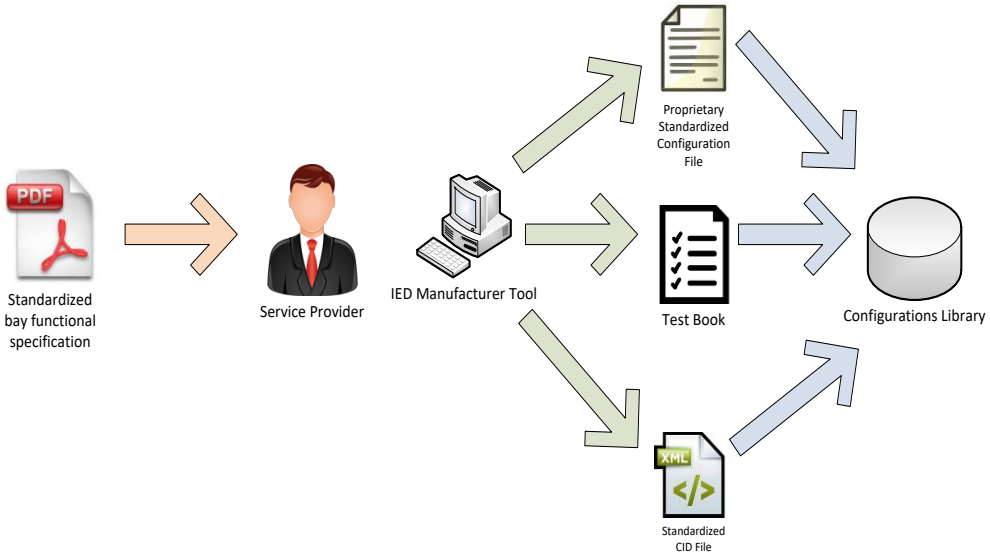

	E3 Standard	Multi Vendor System
	All Information in CID file	Part of Information in CID
File Storage	All CID files in SCU	CID files in central repository database
File Updating	Changes in CID file are trigger changes in configRev and ParamRev and the SCU makes automatic retrieval of updated CID file	Technician must remember to update repository

Human Error can result in the re-loading of an out-of-date CID file

IED Replacement

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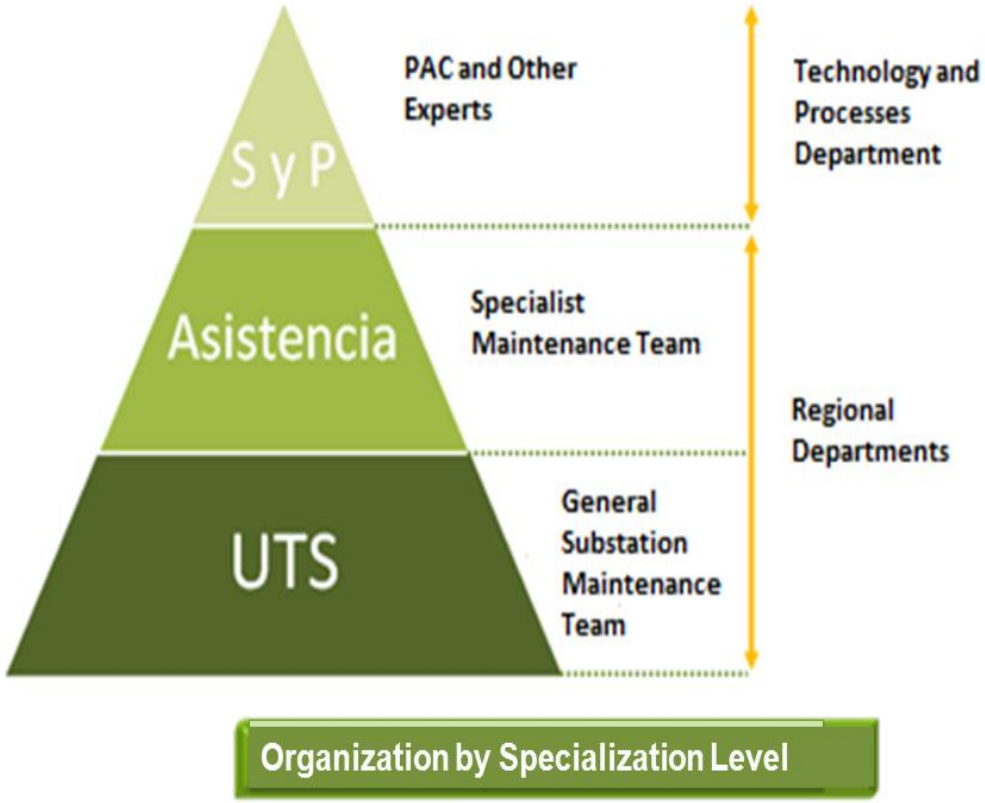
- Configuration is really maintenance
- In E3 systems means our standby staff can undertake relay replacement
- In a multivendor system we will need the propriety tool in order to upload the configuration file
- This is a challenge to our maintenance philosophy
- Solution could be IEDs configured directly from XML files



Further 61850 Maintenance Challenges

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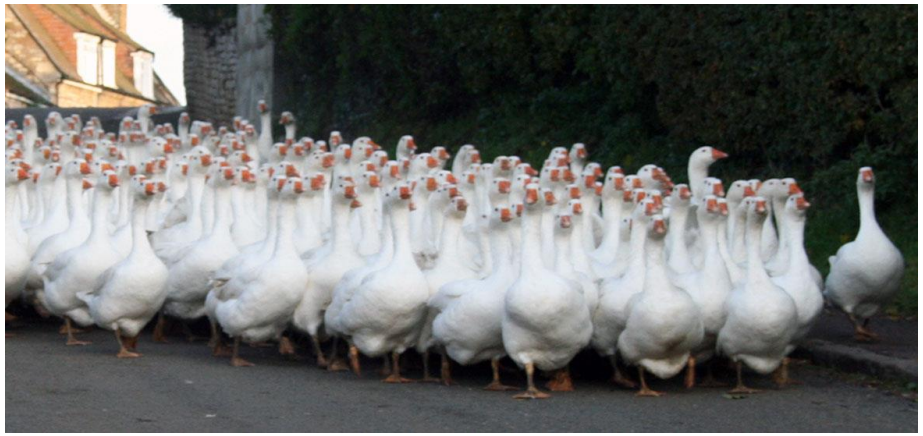
- **Multi Vendor Multi Edition System where New IED platforms are accompanied with New Software tools = Management and Operation of Tools V. Challenging**
- **Training Stipulated in Framework Agreements**
- **Application Virtualisation**
- **Good Config Management in Multivendor system but currently falling short of E3**

- Automatic Substation Restoration
- Automatic Transformer Transfer
- Automatic Line Transfer
- Neutral Protection Transfer



WHAT KIND OF ENTERPRISE SYSTEM CAN 61850 FACILITATE?

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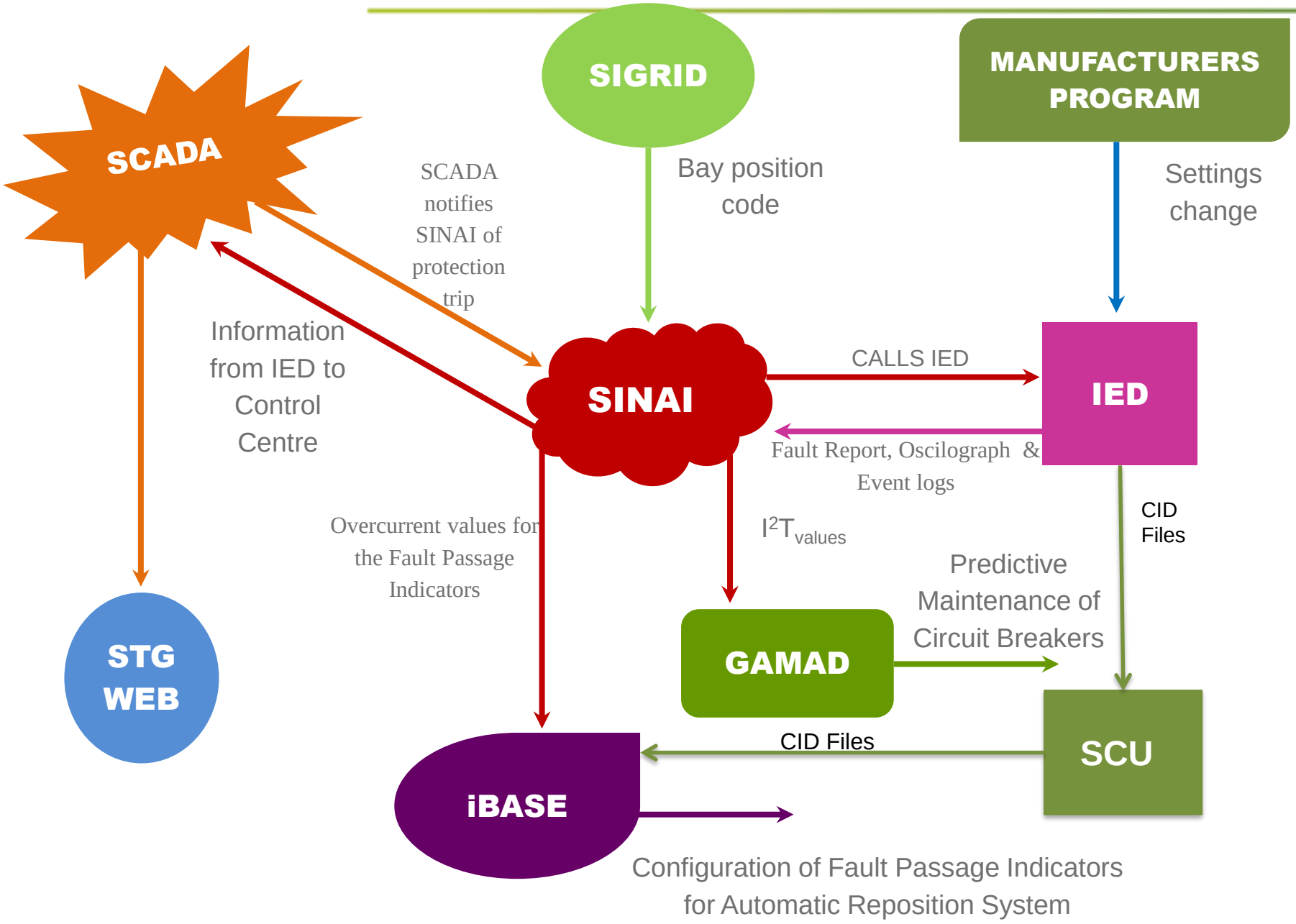
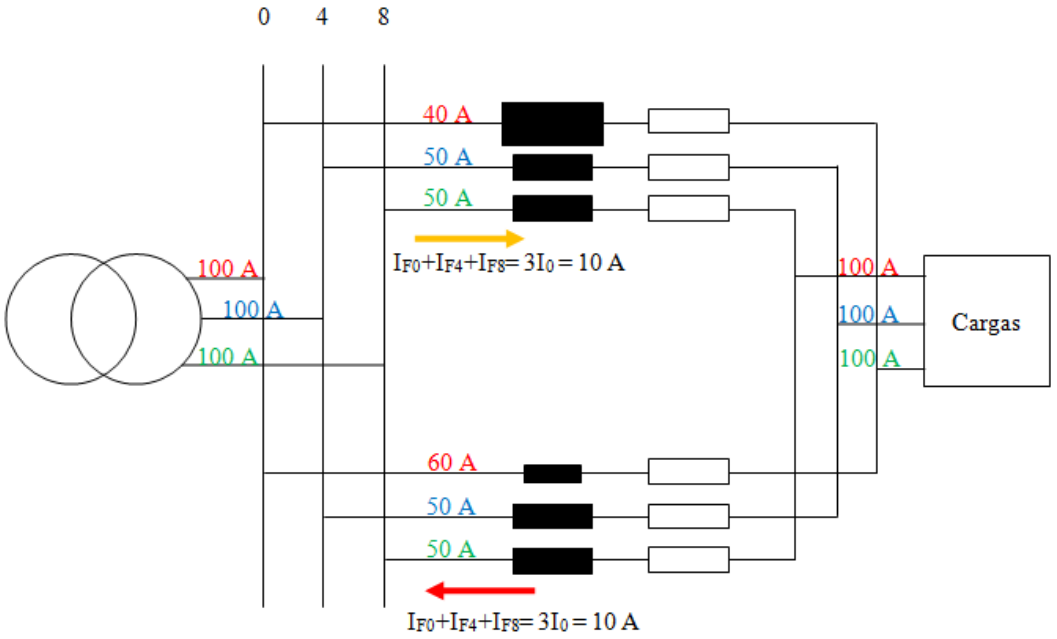


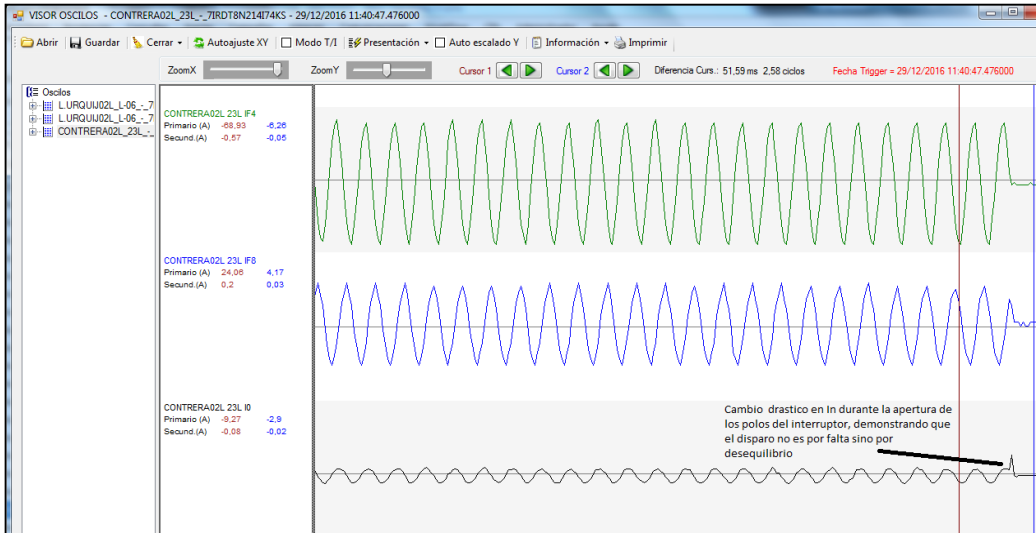
Fault Identification

- SCADA notifies SINAI which launches call to IED
- Uses relay fault report to show the Control Centre fault type, magnitude and protection unit tripped
- Results in Less stress on system after high energy permanent faults and quicker identification of medium voltage coupling errors
- IEC61850 has no standard format for Trip Summary Reports

Correct Trips	7	30
Incorrect Trips	8	18
Broken Jumper or Downed Conductor	2	4

Figura 17: Disparo por desequilibrio en dos líneas acopladas al mismo transformador





How does 61850 help with Fault Localisation

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	Incidents	Trips	Calculated 0-100 km	Error <30%	Error <10%
A	19	130	55 (42%)	8 (6%)	3 (2%)
B	14	136	55 (40%)	18 (13%)	3 (2%)

Suggestion is certain MV multifunction line IEDs are not prepared for accurate Distance to fault calculations

1. Load Current upon reclosing not same as pre-fault load current
2. DC component Offset, Inrush Effect
3. Phase Angle Measurement Error and Capacitive Loads

Iberdrola aim to solve this through the use of a oscilograph analysis module in the SINAI system

Can 61850 help with Restoration of Service

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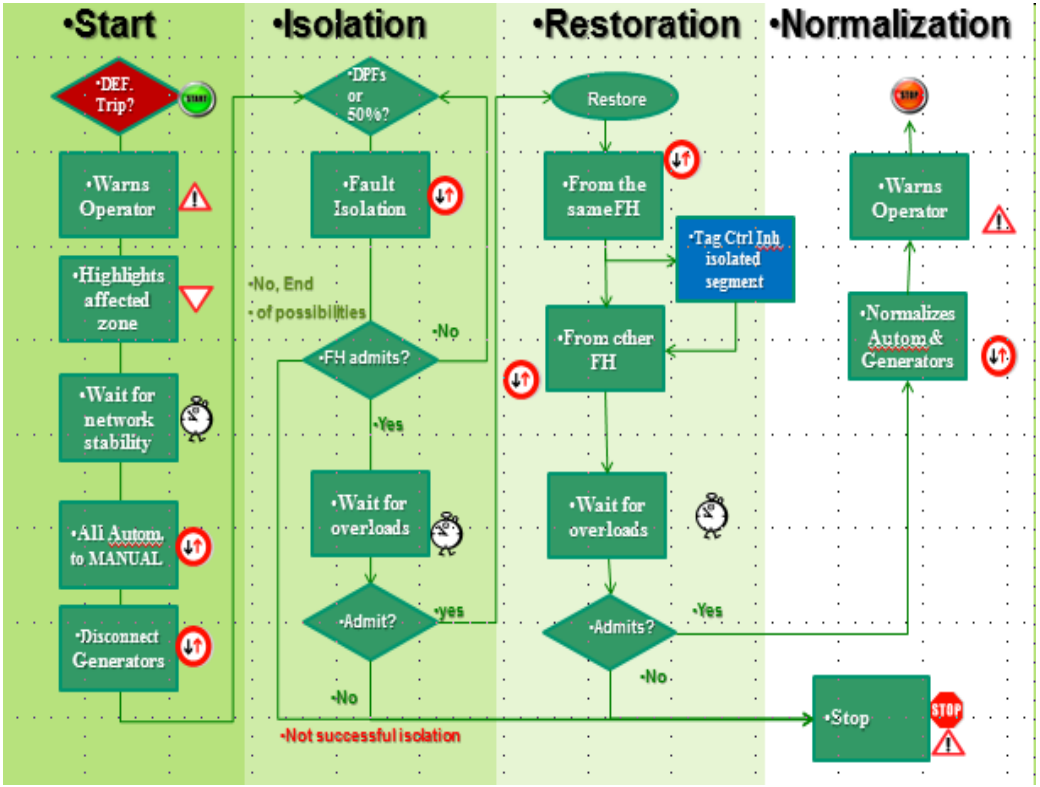
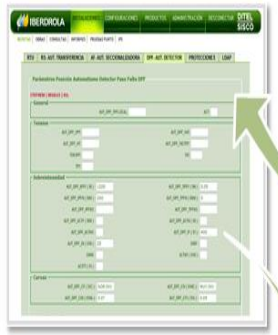
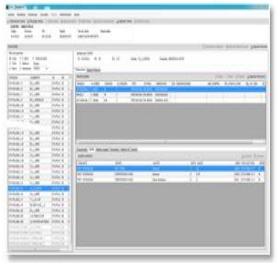


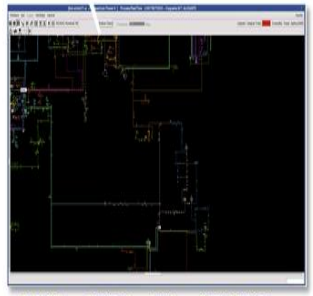
IBASE (Configuration Database for Fault Passage indicators)

SINAI Protection Enterprise System which stores Overcurrent Settings

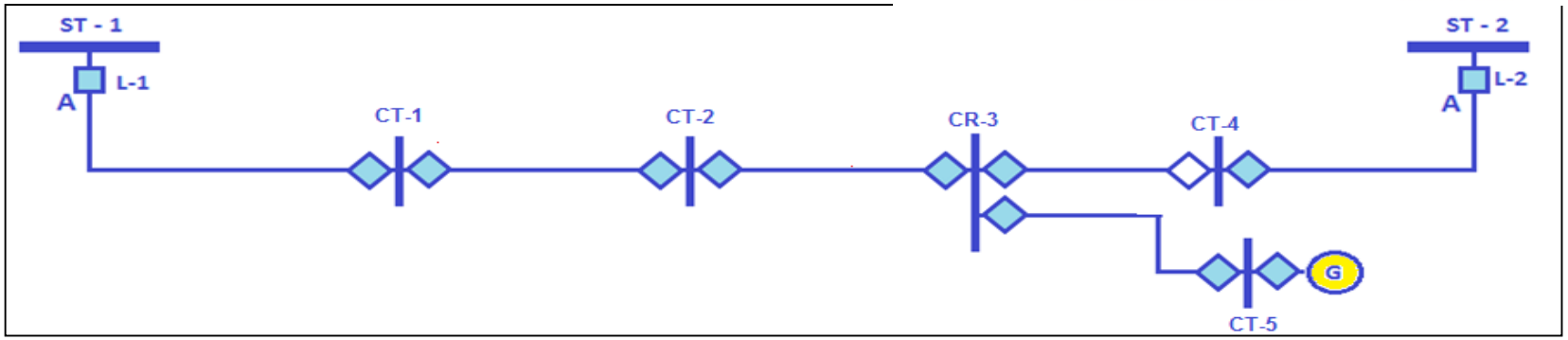




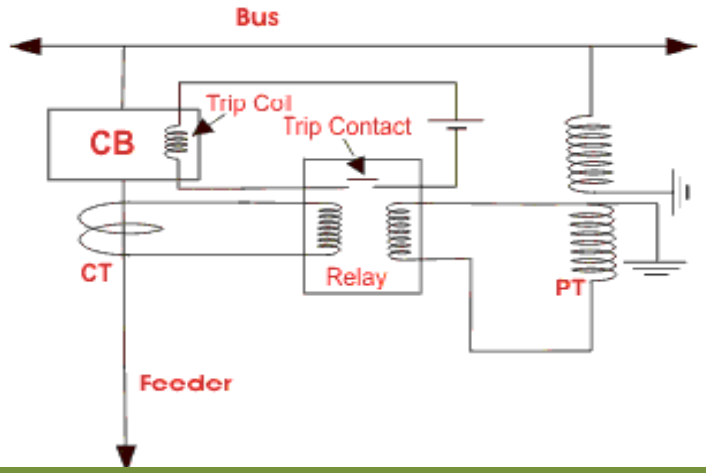
Secondary Substations with Telecontrol



SCADA system with Distribution Network Topology



Condition Monitoring



New Failure Modes
Switch failures need to be detected!

Even with IED Self Supervision we have gaps to monitor the IED Microprocessor Output, Transistor Driver Circuit and Relay Output Contact

- Failures affecting measurement or trip outputs have not activated Watchdog (1.8%Relay Failures)
- Not all IEDs have VT & CT supervision (0.5% Transformer Trips)
- Detection of Measured Values imbalances, Loss of Settings and Microprocesser Alarms
- Alternate use of the Trip Coil for Switching Operations
-

IED Failures

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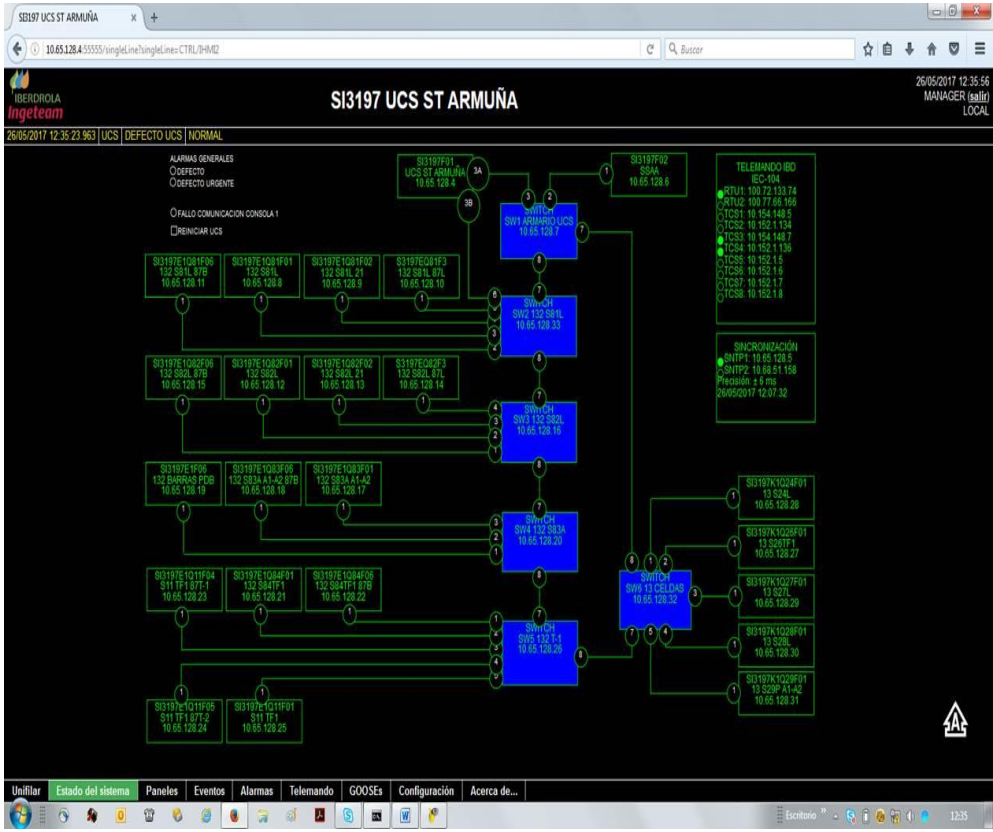
- Reduction in Failure Rates of 50% after preventative replacement of capacitors
- These campaigns have taken place in 31% of IEDs
- Difficult to identify which capacitors are going to fail before the alarm
- Large Population IEDs >20 years
- 61850 Logical Nodes which monitor analog signals such as temperature and input voltage

Failure Mode	% Failures
Capacitor	58%
Memory	8.7%
Diode	3.1%
Circuit Board	3%
Screen	1.4%
Other Failures	25,8%

61850 Logical Nodes present a great opportunity to eliminate preventative component replacement, increase IED reliability and optimize life cycle

PAC System Interconnection Monitoring

- 14% of Protection System Anomalies caused by Faults in Cabling
- Goose Interconnections can be continuously monitored
- Physical or Logical Link failures will trigger Communications failure alarm to SCADA and locate the problem on the HMI screen
- UCS monitors sending and receiving of GOOSE



61850 has allowed us to close the gaps in supervision by monitoring the interconnections

Event Based Condition Monitoring

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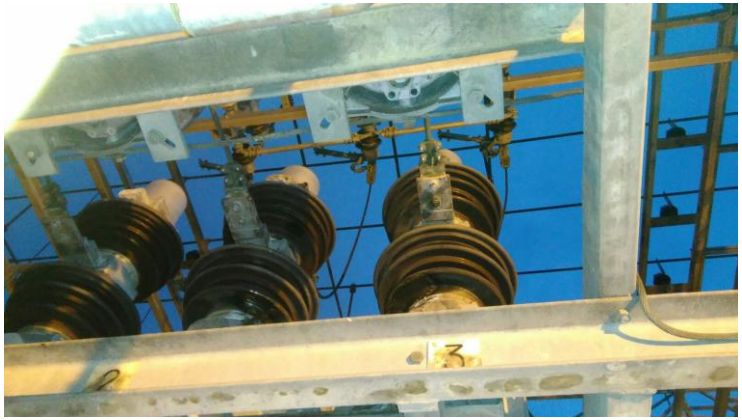
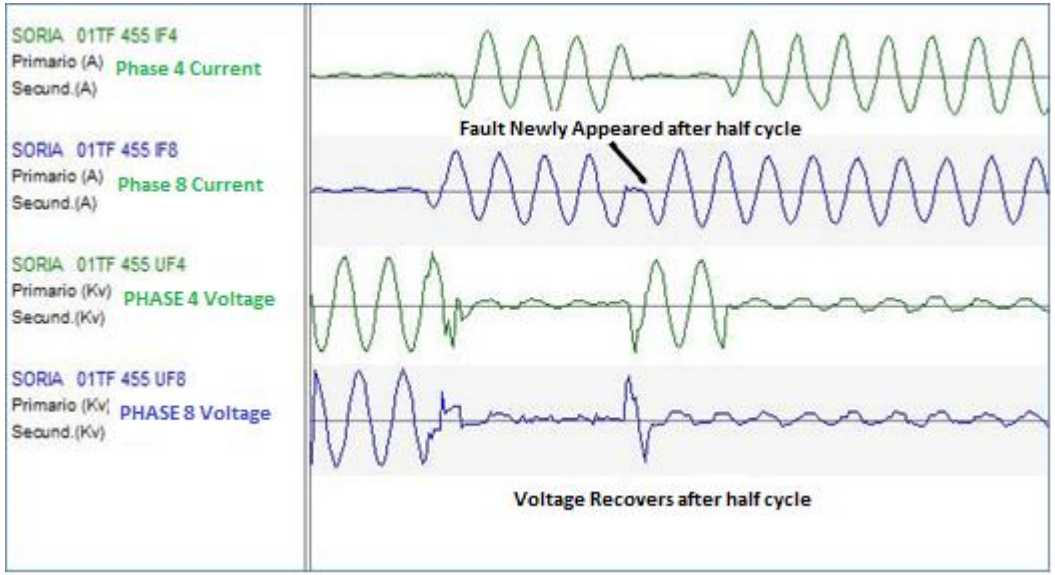
- Protection registers (Oscillography,) must be accessible by MMS or sFTP, and the Event Registers by IEC61850 Log Services must be available in standard or open formats, interpretable without the need of proprietary software
- Settings to be modelled as Protection Logical Nodes and therefore accessible by MMS services.
- What Happened, Why did it happen, How can it be corrected
- 43% Reduction in Transformer Trips over last six years





Condition Monitoring of Primary Equipment

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Circuit Breakers

1. Capture $\sum I^2$ for identification of contact wear
2. Capture Nº of Switching Operations from SCADA
3. Identify Breakers which have not tripped in last year for Trip Test
4. This has allowed us to increase maintenance intervals for Circuit Breakers in Medium Voltage inside Metal Enclosed Switchgear reducing maintenance hours by 27%
5. In SPEN we are Monitoring the Direct Current in trip coil to identify slow openings

Transformers

1. Long life plant so no need to monitor new transformers
2. Use 5 Early Warning Transistors in order to monitor hydrogen and humidity content in Transformers
3. After Incipient faults, CM gives confidence to put plant back into service
4. Has been used to decide whether or not to keep the plant in service

Business Case for Replacement of Periodic Testing with Condition Monitoring and Predictive Maintenance

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Level of Maintenance	Maintenance Procedure	Hours Saved Per Position per Year
Elimination of Partial IED Testing	Secondary Injection one point in curve. Insulation resistance test for CT, VT and DC wiring, Trip Test	0.25
Elimination of Preventive Maintenance with IED	Preventative Component Replacement at 10 years	0,16
MV Circuit Breakers in Metal Clad Switchgear	Increasing Medium Maintenance Interval from every 8 years to every 12	0,54
Estimated HH saving from periodic maintenance		0,85

CM cost is Enterprise Software

Conclusions

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Iberdrola Group have already experienced the benefits of;

- GOOSE for automatic transfer schemes
- Standard Language & Comms sevice allowing Event Analysis
- Fault Information to control centre and Settings to Fault Passage Indicators
- GOOSE, IED, Switch and Interconnection to SCU supervision
- Increased Primary Equipment Maintenance Intervals

Iberdrola Anticipate experiencing the benefits of;

- Reliable Distance to Fault Calculations
- Analog Measurements to indicate actual IED health
- Supervision of CTs, Microprocessor Alarms and Loss of Settings

Iberdrola would like to see in future editions of the Standard

- Great Configuration Management and Simple IED replacement in Multi Vendor Systems