Testing a Process Bus Based Multi Zone Protection Relay

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Typical distribution

Multi-Zone Feeder Protection

CPC: Centralized Protection and Control
Background

PIUs: all analog to digital at circuit breakers
- SV for analog measurements
- GOOSE for status and control

Some process bus network architecture is applied
- Beyond the scope of this paper
Translating testing to IEC 61850

Isolation
- TEST mode (at device, LD, LN level)

Controlled data for testing
- SV, GOOSE

Simulation Substitution of input data
So how do you test?

- CIGRE Technical Bulletin 760 “Test strategy for Protection, Automation and Control (PAC) functions in a fully digital substation based on IEC 61850 applications”
  - Also the latest version of IEC 61850-10

- Think:
  - Subsystems
  - FAT/lab testing
  - Redundancy of the multi-zone relay/CPC unit
Test as subsystems

- Testing the PIU proves all of this correct.
- Testing the MULTI-ZONE/CPC proves all of this correct.
- These messages are the same!
Testing a multi-zone relay/CPC unit

Created by IEC 61850 test tool or digital simulator
Commissioning

FAT of PIU proves:
- Wired correctly
- Configured correctly (generically)

FAT of MZ/CPC proves:
- Configured correctly (61850)
- Configured correctly (p & c)

SAT of PIU proves:
- Configured correctly (specifically)
- Turns ratio / phase rotation

SAT of MZ/CPC system:
- Turns ratio / phase rotation
- System check

System check:
- Trip check / exercise breakers
- Open I, V to verify analogs

Created by IEC 61850 test tool or digital simulator
Maintenance Testing

- Maintenance testing is limited to verifying PIU performance
  - Multi-Zone / CPC is fully digital / self-monitored
  - Must at least verify output contacts on PIU

- Multi-Zone / CPC testing only required when configuration changes
  - Example: New feeder protection settings
  - Redundancy of Multi-Zone / CPC units simplifies this testing
Maintenance Testing - PIUs

Testing PIU process:
- Equipment outage
- PIU in TEST mode
- Force output contacts
- Inject I, V if desired
Verifying settings

Retrieve MZ/CPC files
Update configuration w/new settings
Test new configuration In lab MZ/CPC
Load new configuration into field MZ/CPC

Do this in a lab environment
Field test w/redundant
Field Testing single Relay / CPC

Lab Verification Test:
- Retrieve existing multi-zone relay/CPC unit configuration
- Update configuration with new settings
- Test new configuration in lab multi-zone relay/CPC unit
- Load new configuration into field unit

Testing MZ/CPC w/o redundancy process:
- Requires equipment outage
- Place LD to test in TEST mode
- Place MZ/CPC in Simulation
- Place associated PIU in TEST mode
- Simulate SV, GOOSE necessary for test conditions
- Restore device: turn Simulation off, turn LD ON
- But....
Test an individual LD

Place this LD in TEST
Then place Device in Simulation

How do I test this function?

Simulate this SV stream for testing.
All other SV streams use live process data

Simulate this incoming GOOSE for testing.
All other GOOSE messages use live process data

Data from LNs in this LD have q=test, ignored by devices that are ON
Testing the 67 function (PTOC/RDIR)

The 61850 answer: substitution of test data

- Define setTestref attribute for every SV InRef for every LN. Every SV InRef is controllable
- Not supported in most device today

Simple solution: Redundant devices
Conclusion

For Multi-zone / CPC:
  o Test as subsystems
  o FAT/lab test as much as possible
  o Commissioning is better than conventional (much of the work is done during FAT)
  o Redundancy of Multi-Zone / CPC units simplifies testing
Thanks for the time