Distributed Data Recorders
The “Killer-app” for IEC 61850?

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Disturbance Recording - The Problem

• Needs lots of data sources to be useful

• Wiring for data sources tends to be scattered

• Upgrading a system to add a recorder can be a HUGE job

• Would be great if could “design once” and “use many times”
Fault Recording – why needed?

Why did this happen?
Centralized Recorder  Double-wiring

CT

Fault Recorder

PT

Relay 1

Relay 2
Adding a Centralized Recorder

• Very many barrier strips must be re-wired

• CT connections must be spliced (scary!)

• Resultant CT wiring has higher impedance (earlier CT saturation)

• Resultant CT wiring has more:
  o copper
  o barrier strips
  o switches
De-Centralized Recorder

- Use existing wiring – don’t add extra for recorder

- Each device already receiving data is part of the distributed recorder

- Each device assigns triggering conditions using only LOCAL data

- Triggers induce cross-triggering (global triggers)

- IEC 61850 GOOSE can help distribute triggers
GOOSE Concept in Distributed Recorder

- **CTs**: Local Logic (GOOSE Publish) → Recorder (Trigger) → Local Logic (GOOSE Subscribe)
- **PTs**: GOOSE Out to other recorders
- **“other signals”**: GOOSE In from other recorders

Recorder processes data and triggers other recorders or local logic.
Step back – why use IEC 61850?

- Use 61850 GOOSE send (Publish) to signal other recorders

- Use 61850 GOOSE receive (Subscribe) to capture remote triggers

- (Optionally) Use 61850 reporting to indicate (recording is “ready to retrieve”)
  - Unlike GOOSE, this needs a “full” 61850 Client/Server system
  - If 61850 is not native protocol, can use DNP/IEEE 1815 or Modbus
(Very) Brief introduction to IEC 61850 Technology

- IEC 61850 – comprehensive standard for Automation Systems
- Data Models – highly structured named information, well-defined semantics
  - Data Set: Group (list) of data names; used for reporting, GOOSE, etc.
- Services – Reporting and GOOSE – both spontaneous
  - Reporting – low-speed, changed data sent reliably to report client
  - GOOSE – high-speed, all data sent to ALL devices (receivers filter unwanted messages)
  - Data read/write/control – not used much during operation of the system
  - Most system transfer data spontaneously and do not depend upon polling
- Standardized configuration language (SCL)
  - All devices can potentially know about every other device in the system
(Very) Brief introduction to IEC 61850 GOOSE Publishing

• Publish – send (via multicast) one message to multiple receivers

• What is sent? Contents of a dataset (list of variable names with useful data)

• Why the hype of GOOSE?
  • Sends information when any part of dataset changes
  • Low network overhead to un-named receivers (subscribers)
  • Includes a built-in heartbeat mechanism

• How does it work?
  • Messages sent as a network Layer 2 “protocol type” (Ethernet is a another example)
  • Operates independently of other protocols such as IP and SNMP
  • This kind of GOOSE is not routable; automatically stopped at routers
  • Other details not important
(Very) Brief introduction to IEC 61850 GOOSE Subscribing

• Subscribe – receive interesting messages that happen to appear on the network

• What is received? The transmitted dataset

• Why the hype of GOOSE?
  • Subscribers need not coordinate with publishers
  • Can go into “safe” mode if publisher “disappears”
  • Built-in mechanism for “safe” simulated data

• How does it work?
  • Local LAN controller programmed to receive specific multicast addresses
  • Message parsed to pull-out relevant information (or assign data on timeout)
  • Other details not important
(Very) Brief introduction to IEC 61850 Reporting

• Reports
  • Are encapsulated datasets (can be same as GOOSE dataset)
  • Use connection-oriented messaging: one client/one server
  • Are spontaneous: sent by server when dataset contents change

• Only the CHANGED part of the dataset is sent: very low overhead

• Can add a “heartbeat” but it is bandwidth intensive (integrity reports)

• Why the hype of Reporting?
  • Parameters of reporting are controlled by client
  • Client can command server to temporarily stop reporting
  • Other details not important
GOOSE Concept in Distributed Recorder

CTs

Local Logic

Trigger

GOOSE Publish

GOOSE Out
to other recorders

GOOSE In
from other recorders

PTs

GOOSE Subscribe

Reports

“other signals”
Cross-Triggering and Collection

- GOOSE publish – trigger other recorders
- GOOSE subscribe – trigger this recorder
- 61850 Reporting (or DNP3 or Modbus) – ready to get recording
- 61850 Client (or DNP master or ...)
  - Retrieves all recordings and
  - Makes master recording file
Alternate recording sources

GOOSEs from other devices – analogs or binary data
Merging Units – digitized analog samples
Stand-alone Merging Unit (SAMU)

- Receives conventional 5A/120V signals; digitizes at 4800/15360 Hz
- Output is multicast data stream (like GOOSE but another EtherType)
Generalized Merging Unit

• Receives inputs from NCITs (Faraday-effect optics, Rogowski coils, etc)
• Identical output as SAMU
Why are we doing all this?

- Save panel space
- Save wiring and “screw-drivering”
- Reduction in CT wiring lengths (safety!)
- Suitable for Greenfield or Brownfield
- Ease of retrofits
- Ease of configuration
- Ease of expansion
Digital Fault Recording (DFR)
Conventional Centralized Approach

• All CTs and PTs terminated in centralized DFR cabinets
Digital Fault Recording (DFR)
Recorders Distributed on Relay Panels

- Reduced CT and PT wiring
- Recorders can tie into relay PT and CT circuits
Fully Distributed Approach

- Distributed recorders installed in the substation yard; on breakers, transformers, etc.
- LAN connects all recorders.
- Individual records consolidated into a single substation record
Fault Recording – Possible Outcome

F1 fault depressed bus voltage – caused sympathetic trip of F3

Increase F3 TOC delay on F1 trip
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