The ABB - SIEMENS IEC 61850 interoperability projects (January 2002)
IEC 61850 - proven technology and innovation

Communication concepts
Data Models

UCA 2.0  IEC 60870

IEC 61850

Configuration Language
Process Bus

Ethernet Technology
Comm Architecture

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IEC 61850 - system architecture
Prototyping activities - Overview

- OCIS, 1998 - 2000: Communication between Station and Bay Level
- GOOSE demo, 2001: Transmission of trip - signals over serial communication
- IEC 61850-9-1 interoperability, 2001 - 2002: Communication between CT/VT’s and protection relays
The OCIS - Project

Project goals

- Assist the standardization process to reach one world-wide standard IEC 61850
- Assist the harmonization process between IEC 61850 and UCA.2
- Test and compare original IEC 61850 and UCA.2 drafts with respect to feasibility, applicability and efficiency
- Test the independence of IEC 61850 from the communication stack (Verify the basic communication architecture)

Project duration

- The project started in 1998 and terminated with a conference in 2000
Summary of results

- The **communication concepts** as defined in IEC 61850 drafts fulfill the requirements of substation communication.
- The **object model** of UCA needs extensions to be applicable by the European market.
- **Ethernet** is suitable as station bus.
- IEC 61850 based applications are independent from the communication stack and therefore **future proof**.
- IEC 61850 provides **interoperability** between devices from multiple vendors.
The GOOSE Demo

GOOSE: Generic Object Oriented System Event

Project goals
- Verify the concepts of the IEC enhanced GOOSE
- Verify the basic concepts of the substation configuration language
- Demonstrate interoperability and configurability between multiple vendors

Project duration
- Project start January 2001
- Demonstration at Utility Initiative Meeting in Vancouver, May 24, 2001
Basic Demo setup

Analog inputs

Test Equipment

OMICRON

Relay

SIEMENS

Relay

ABB

Ethernet Network

Network Analyzer

GHF automation

Switchgear Sim

ABB

TAMARACK CONSULTING
GOOSE - concepts: the UCA approach

- GOOSE: Generic Object Oriented Substation Event
- The message content in UCA - GOOSE is fixed and predefined

Interoperable only by exchanging private data with a private non standardized data format

Standardized and pre-configured
no configuration data exchange for interoperability necessary
The GOOSE demo

GOOSE - concepts: IEC approach

- IEC - GOOSE added flexibility
- The message content is defined with a configurable dataset
- The configuration may be done either online (using MMS services) or offline (using XML)

```
<LN0 LNType="LLN0">
  <DataSet Ref="GOOSE_2" ConfRev="1">
    < DOName LNRef="1" LNClass="RREC" DORef="Oper" Attr="general" />
    < DOName LNRef="1" LNClass="RREC" DORef="Mode" Attr="stVal" />
  </DataSet>
<GOOSEControl Ref="GOOSE_ABB_US_2" DataSetRef="GOOSE_2"
  MACAddress="0xBF FF FF E7 00 01"/>
```
Demo case 1 and 2: protection scenario

- The Omicron equipment simulates the power line
- One of the two relays simulates a protection relay, the other simulates the reclosing device
- The switchgear simulation simulates the circuit breaker

Content of GOOSE messages:

<table>
<thead>
<tr>
<th>Switchgear</th>
<th>Protection</th>
<th>Autorecloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>XCBR0.Pos.stVal</td>
<td>PSCH.Oper.general</td>
<td>RREC.Oper.general</td>
</tr>
<tr>
<td>XCBR0.Mode.stVal</td>
<td>PSCH.Mode.stVal</td>
<td>RREC.Mode.stVal</td>
</tr>
<tr>
<td>XSWI1.Pos.stVal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XSWI1.Mode.stVal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XSWI8.Pos.stVal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XSWI8.Mode.stVal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Case 1: Trip and auto-reclosing

1. Simulated fault
2. Trip generated
3. New position
4. Reclose command
5. New position

Analog inputs

OMICRON Test Equipment

SIEMENS Relay

ABB Relay

ABB PASS Simulation

Ethernet Network

Goose Message: Trip

Goose Message: Positions

Goose Message: Reclose
IEC 61850-9-1 interoperability

Project goals

- demonstrate the interoperability between non conventional sensors, protection relays and revenue meters achieved with IEC 61850-9-1
- develop first prototypes of devices supporting IEC 61850-9-1

Project duration

- Cooperation of ABB and SIEMENS to support IEC 61850-9-1 announced at CIGRE 2000 meeting
- Interoperability between ABB and SIEMENS verified end of October 2001
- Interoperability tests at KEMA November 19 - 23, 2001 ongoing
IEC 61850-9-1 interoperability

Basic test setup

Protection relays

Point-to-point link according to IEC 61850-9-1

Merging units

to instrumental transformers

Revenue meter

SIEMENS

SIEMENS

SIEMENS

SIEMENS

ABB

Revenue meter

SIEMENS

SIEMENS

ABB
The concept of the 61850-9-1 link

- The message content is defined with a configurable dataset
- The configuration may be done either online (using MMS services) or offline (using XML)

DatSetRef | List of Values | Counter

IEC 61850-9-1 interoperability
From point-to-point link to process bus

Protection Unit

Merging Unit

Other Bays

Protection Unit

Merging Unit

Ethernet Switch

Merging Unit

Merging Unit

Other Bays

Other Bays

IEC 61850-9-1 interoperability
IEC 61850-9-1 interoperability

61850-9-1 Ethernet;
- sample rate: 1000/s - 4000/s
- package rate: 1000/s

ABB / Siemens proprietary signal interfaces

Detailed test setup

Commercial Ethernet Switch

ABB Merging Unit
- 500BU03 Prot.relay
- ABB Merging Unit
- U-/I-PISA

Siemens Merging Unit
- 7SA525 Prot.relay
- Siemens Merging Unit
- U-/I-Transducer Unit

Omicron Test Set

GPS (1 PPS)
Summary and outlook

- The concepts of IEC 61850 have been verified
- The point-to-point link connecting non conventional instrumental transformers according to IEC 61850-9-1 is ready to be used and will be supported in future by ABB and SIEMENS
- Communication links supporting IEC 61850-9-1 may be connected with an Ethernet switch implementing a first step of a process bus solution.

→ The verification of the real time behavior of a process bus approach will be the focus of future prototyping activities