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IEC 61850 as utility backbone for intelligence

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A vision created by EPRI in the early nineties...
Data integration for lower cost and greater flexibility
Seamless sharing of information
Compatibility
Ease of upgrading
Content

- Vision of a global communication infrastructure for operation and management of the power system
- Features of IEC 61850
- IEC 61850 is reality
- Use cases for a global communication infrastructure
Elements of the vision

- Single entry of data
- Seamless sharing of information
- Global access to devices
- Intelligence through new applications
Elements of the vision

Single entry of data

- Configuration data needs to be entered only once
- Automatic transfer of configuration data between different systems (e.g. from substation automation system to network control center)
- Reduces the risk of inconsistent configurations

Example

Adding a New Bay to a Substation

- The configuration of the substation automation system is extended with information concerning the new bay
- The network control center can extract information required (e.g. single line diagram)
Elements of the vision

Seamless sharing of information

- Process data is available everywhere in the power automation system
- No unnecessary data conversion required

Example:
Use of information from a Circuit Breaker

- Local operation
- Several network control centers
- Power plant control system
Global access to devices

- From one single point in the power automation network, it is possible to access all devices
- This includes access to name plate information of the process equipment

Example – Asset management System

- A central asset management can administrate all devices (devices status and nameplate, version control)
- SW upgrade can be handled from one single point
Intelligence through new applications

- The acquisition of as much process information as possible increases the controllability of the system
- Distribution of preprocessed information according to the requirements of the information users
- New automation functions possible through seamless information exchange

Examples

- Wide area protection: Distribution of phasor information
- Wide area interlocking: Distribution of switchgear position information to adjacent bays
Features of IEC 61850

- Object oriented data model
- Maintenance
- Configuration
- Communication services
- Self description
- Mainstream communication technology
Data model – domain specific

Primary technology

Secondary technology

Features of IEC 61850
Features of IEC 61850

Data model – object oriented

Tampa_Protection

+ LPHD
+ PDIS1
+ PDIS2

Tampa_Control

+ LPHD
+ Q0_CSWI
- Q0_XCBR

- pos
- stVal
- ctlVal

IED

Logical Device

Logical Node

Data

Data Attribute
## Features of IEC 61850

Semantic is part of the data

<table>
<thead>
<tr>
<th>Data Name</th>
<th>Type</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>INC</td>
<td>enable / disable</td>
</tr>
<tr>
<td>Health</td>
<td>INS</td>
<td>ok / warning / alarm</td>
</tr>
<tr>
<td>NamPlt</td>
<td>LPL</td>
<td>Name plate</td>
</tr>
<tr>
<td>Loc</td>
<td>SPS</td>
<td>Local / remote control</td>
</tr>
<tr>
<td>EEHealth</td>
<td>INS</td>
<td>ok / warning / alarm</td>
</tr>
<tr>
<td>EENName</td>
<td>DPL</td>
<td>Name plate</td>
</tr>
<tr>
<td>OpCnt</td>
<td>INS</td>
<td>Operation counter</td>
</tr>
<tr>
<td>Pos</td>
<td>DPC</td>
<td>position</td>
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<tr>
<td>BlkOpn</td>
<td>SPC</td>
<td>block opening</td>
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<tr>
<td>BlkCls</td>
<td>SPC</td>
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<tr>
<td>CBOpCap</td>
<td>INS</td>
<td>none / o / c-o / o-c-o / …</td>
</tr>
</tbody>
</table>

XCBR
Maintenance

Features of IEC 61850

Physical Device

Logical Device

XCBR
TCTR
TVTR
CSWI
PTRC

PhyHealth
Health
EEHealth
Health
Health

NamPlt
Mod

ABB / REB500
V1.0.4
SerNo 100.445.237
The configuration description

- **Formal configuration description language**
  - Based on modern internet technologies
  - A set of standardized files that can be exchanged between tools
Self description

Features of IEC 61850

**DeviceDirectory**
- QA1XCBR
- QB1XSWI
- QC1XSWI
- QA1CSWI
- QB1CSWI
- QC1CSWI
- MMXU

**QB1XSWI.NamPlt**
- vendor=ABB
- d=“Busbar 1 disconnector”

**QA1XCBRDirectory**
- Mod
- NamPlt
- Health
- Loc
- EEHealth
- EEName
- Pos
- ....
- HydrLeak
- TripCo1Err

**QA1XCBR.HydrLeak Definition**
- stVal: BOOLEAN
- q:quality
- t:TimeStamp
- d:VISIBLE STRING255

**QA1XCBR.HydrLeak**
- D=“Leakage in Hydraulic system”
Communication services

Features of IEC 61850

Client / Server communication

Application of “client – server” communication

- typical SCADA application like control of switchgear or transmission of events (Reporting)
- Store and retrieve sequence of events (log)
- Transfer of files (i.e. Comtrade files)
Peer to peer communication; time critical

Applications of "peer-to-peer" communication:

- **Tripping of circuit breakers**: Short information that needs to be transmitted with a low probability of loss within a few milliseconds.
- **Transmission of sampled values from instrumental transformers**: High amount of data, to be transmitted within a few milliseconds, loss of data needs to be detected.
Communication protocols

- Use of state-of-the-art communication protocols like TCP/IP and Ethernet with priority tagging
  - Immediate benefit from progress in communication technology (e.g. higher bandwidth and scalable configuration)

### Features of IEC 61850

- Application
  - Peer-to-peer
  - Client-server
  - Communication stack with MMS and TCP/IP
  - Ethertype

Abstract communication service interface (ACSI)
IEC 61850 is reality

- First projects
- Reuse of IEC 61850 outside the substation
Winznauschachen (Switzerland)

- In operation since 11/2004
- 16 kV Distribution
- Comprising Substation Controller, Relays, Engineering according to part 6
Laufenburg (Switzerland)

- First bay in operation since 12/2004
- 380 kV transmission substation
- Main 2 protection from different supplier
- Retrofit
  - Stepwise retrofit of 7 bays
  - Integration of the existing station control system
Utilities – projects under preparation (1)

- **RWE Rheinbraun (Germany)**
  - New substation Garzweiler II
  - Target date 04-2005
  - 110kV / 25kV / 6kV; 134 IEC 61850 devices

- **IBERDROLA (Spain)**
  - Substation Ciudad universitaria
  - Target date 02-2006
  - 132 kV GIS; IEDs from 7 manufacturers

- **TVA (United States)**
  - Substation Bradley
  - Target date 01-2007
  - 2 500kV lines / 1 500kV/161kV Trafo bay / 3 161kV lines
Utilities – projects under preparation (2)

- Terna (Italy)
  - Project SICAS; several substations ordered using IEC 61850 as station bus

- NGC (UK)
  - SICAP Project

- DEWA (Emirates)
  - Several substations over 5 years

- AEP (United States)
  - 345 kV Corridor substation
  - IEC 61850-9-2 interface with optical CT and VT
Wind power - overview

IEC 61850 is reality

Remote SCADA

Local SCADA

Client

Server

Router

Other components

other distributed source

IEC 61850 is reality

Propr.

Server (Proxy)

Client

Propr.
Principle of a DER system
Hydro power plant - overview

Unit control
- Production control
- Temperature supervision
- Vibration monitoring
- Leakage monitoring

Generator control
- Voltage control
- Protections
- Rectifier control

Turbine control
- Governor control
- Combinator
- Speed supervision

Water control system
- Guide wane setting
- Upper and lower water levels

IEC 61850 is reality
Use cases

- From a substation automation system to a power network automation system
Use cases

Substation automation system

Control Center

Gateway

HMI

Engineering

Contr
Prot

Contr
Prot

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Adding intelligent sensors and actuators

Use cases

Control Center

Gateway

HMI

Engineering

Contr

Prot

Contr

Prot

IED

MU

IED

MU
Use cases

The link to the network control center

Network Control Center

Engineering  HMI

Contr Prot Contr Prot

IED MU IED MU
Use cases

Substation to substation communication

Network Control Center

Interstation link
Use cases

A power plant

Power Plant

Power Plant Control

Substation

HMI Engineering

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Use cases

Global communication infrastructure

Asset Management System

Network Control Center

Protection Engineers Workplace
Conclusions

- **Today available**
  - IEC 61850 in the substation including process bus connections

- **Tomorrow**
  - IEC 61850 for windpower, hydro power plants and distributed energy resources
  - IEC 61850 from substation to control centers

- **Future**
  - IEC 61850 as utility backbone for operation and management of the power system