Monitoring of Power System and Communication Infrastructures based on IEC 61850 and IEC 61400-25

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► The problem to solve
► Title and Scope IEC 61850 and 61400-25
► Model of 3-phase electrical system
► Object Models for Monitoring
► First example: Overview IEC 61850
► What is the difference compared to DNP3?
► Examples of models
► RWE Pilot project
► Model for Ethernet switch
► Summary

Substation (high costs for copper and work)

Source: Sergio Kimura et al, RottaElektroEletricidadee ServiçosS.A., Brazil; SEL
Which standard should I use?

- IEC 60870-5-101/104
- IEC 61850-8-1
- IEC 60870-6 TASE.2
- DNP3.0
- ProfiNet
- EthernetIP
- Modbus TCP
- OPC DA
- OPC DX
- OPC XML-DA
- XML, SOAP
- Web Services, ...
- 100+

Which bus?

- A-bus
- Arcnet
- Arinc 625
- ASI
- Batibus
- Bitbus
- CAN
- ControlNet
- DeviceNet
- DIN V 43322
- DIN 66348
- FAIS
- EIB
- Ethernet
- Factor
- Fieldbus Foundation
- FIP
- Hart
- IEC 61158
- IEEE 1118
- Instabus
- Interbus-S
- ISA SP50
- IsiBus
- IHS
- ISP
- J-1708
- J-1850
- LAC
- LON
- MAP
- Master FB
- MB90
- MIL 1553
- MODBUS
- MVB
- P13/42
- P14
- Partnerbus
- P-net
- Profibus-FMS
- Profibus-PA
- Profibus-DP
- PDV
- SERCOS
- SDS
- Sigma-i
- Sinec H1
- Sinec L1
- Spabus
- Suconet
- VAN
- WorldFIP
- ZB10
- ...
Title and Scope IEC 61850

► Old title:
  Communication networks and systems in substation

► New title:
  Communication networks and systems for power utility automation

► Standard has 17 (6 wind) parts; 7+ new parts

► Project started in 1995
Re-use of IEC 61850

IEC 61850:2004/2005
Substations (HV, MV)

IEC 61850 extensions 2010 (Statistical, hist. Statistical, ...)

Model of 3-phase electrical system

current / voltage samples from instrument transformers by sampled value exchange services of IEC 61850-7-2 / IEC 61850-9-2 (e.g., from Merging Units)
Parts with Object Models for Monitoring

- IEC 61850-7-4 (Object Models, Core, 150 LNs)
- IEC 61850-7-410 (Object Models, Hydro, 60 LNs)
- IEC 61850-7-420 (Object Models, DER, 50 LNs)
- IEC 61400-25-2 (Object Models, Wind, 16 LNs)
- IEC 61850-25-6 (Object Models, Wind, CMS, 1 LN)

First example of application: modeling

Virtual World

- 61850-7-2 services
- 61850-7-4 logical node (circuit breaker)
- 61850-7-4 data (position)
- 61850-6 SCL configuration file (XML)

Real world = Circuit Breaker

Virtualization of real world objects

Single line diagram

Models of the real world Objects

Communication Mappings

Client

Communication Network

Information Exchange Services

Binding real world to models

Mapping real world to models

Information Exchange Services
First example of application: communication

Reports/GOOSE from server/publisher to client/subscriber
(or store entries into IED log or Read value)

stVal
(Status Value)
TRUE
FALSE

value (tn)
value (tn+1)
value (tn+2)
value (tn+3)

Any change of Position of Circuit Breaker to be communicated.

,,Layer model“ of IEC 61850

Logical node, data objects, and common data classes; parts 61850-7-4 and 7-3, 61400-25-2

Abstract communication service interface (ACSI); part 7-2 and 61400-25-3

Mapping to e.g. MMS in part 8-1 and WebServices, 101/104, OPC XML and DNP3 in IEC 61400-25-4

CIM
61968/ 61970

IED Description (online)
IED Description (off-line)

What?
When?
How?
### What is the difference compared to DNP3?

<table>
<thead>
<tr>
<th>IEC 61850</th>
<th>DNP3/101/104</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Communication protocols</td>
<td>• Communication protocol</td>
</tr>
<tr>
<td>– SCADA</td>
<td>– SCADA</td>
</tr>
<tr>
<td>– Real-time</td>
<td></td>
</tr>
<tr>
<td>– Selfdescription</td>
<td></td>
</tr>
<tr>
<td>• Information models</td>
<td></td>
</tr>
<tr>
<td>• Configuration language</td>
<td></td>
</tr>
</tbody>
</table>

### IEC 61850-7-4 Supervision LNs

- Monitoring and diagnostics for arcs – SARC
- Circuit breaker supervision – SCBR (new) → see next slides
- Insulation medium supervision (gas) – SIMG
- Insulation medium supervision (liquid) – SIML
- Tap changer Supervision – SLTC (new)
- Supervision of Operating Mechanism – SOPM (new)
- Monitoring and diagnostics for partial discharges – SPDC (new)
- Power Transformer Supervision – SPTR (new)
- Circuit Switch Supervision – SSWI (new)
- Temperature supervision – STMP (new)
- Vibration supervision – SVBR (new)
- LNs for Cable, Tower, etc are under development
**LN SCBR (status)**

<table>
<thead>
<tr>
<th>Status information</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpCntRs</td>
<td>Resettable Operation Counter</td>
</tr>
<tr>
<td>ColOpn</td>
<td>Open command of trip coil</td>
</tr>
<tr>
<td>AbrAlm</td>
<td>Contact abrasion alarm</td>
</tr>
<tr>
<td>AbrWrn</td>
<td>Contact abrasion warning</td>
</tr>
<tr>
<td>MechHealth</td>
<td>Mechanical behavior alarm</td>
</tr>
<tr>
<td>OpTmAlm</td>
<td>Switch operating time exceeded</td>
</tr>
<tr>
<td>ColAlm</td>
<td>Coil alarm</td>
</tr>
<tr>
<td>OpCntAlm</td>
<td>Number of operations (modeled in the XCBR) has exceeded the alarm level for number of operations</td>
</tr>
<tr>
<td>OpCntWrn</td>
<td>Number of operations (modeled in the XCBR) exceeds the warning limit</td>
</tr>
<tr>
<td>OpTmWrn</td>
<td>Warning when operation time reaches the warning level</td>
</tr>
<tr>
<td>OpTmh</td>
<td>Time since installation or last maintenance in hours</td>
</tr>
</tbody>
</table>

**LN SCBR (measurements)**

<table>
<thead>
<tr>
<th>Measured values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AccAbr</td>
<td>Cumulated abrasion</td>
</tr>
<tr>
<td>SwA</td>
<td>Current that was interrupted during last open operation</td>
</tr>
<tr>
<td>ActAbr</td>
<td>Abrasion of last open operation</td>
</tr>
<tr>
<td>AuxSwTmOpn</td>
<td>Auxiliary switches timing Open</td>
</tr>
<tr>
<td>AuxSwTmCls</td>
<td>Auxiliary switches timing Close</td>
</tr>
<tr>
<td>RctTmOpn</td>
<td>Reaction time measurement Open</td>
</tr>
<tr>
<td>RctTmCls</td>
<td>Reaction time measurement</td>
</tr>
<tr>
<td>OpSpdOpn</td>
<td>Operation speed Open</td>
</tr>
<tr>
<td>OpSpdCls</td>
<td>Operation speed Close</td>
</tr>
<tr>
<td>OpTmOpn</td>
<td>Operation time Open</td>
</tr>
<tr>
<td>OpTmCls</td>
<td>Operation time Close</td>
</tr>
<tr>
<td>SIK</td>
<td>Contact Stroke</td>
</tr>
<tr>
<td>OvStkOpn</td>
<td>Overstroke Open</td>
</tr>
<tr>
<td>OvStkCls</td>
<td>Overstroke Close</td>
</tr>
<tr>
<td>ColA</td>
<td>Coil current</td>
</tr>
<tr>
<td>Tmp</td>
<td>Temperature e.g. inside drive mechanism</td>
</tr>
</tbody>
</table>
RWE Pilot project (in operation 2010)

LN LCCH (Ethernet Switch)

<table>
<thead>
<tr>
<th>Measured values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RxCnt</td>
<td>Number of received messages; MIB 1.3.6.1.2.1.2.1.10.x, x = port number, number of received octets.</td>
</tr>
<tr>
<td>RedRxCnt</td>
<td>Number of received messages on redundant channel; not used for switches</td>
</tr>
<tr>
<td>TxCnt</td>
<td>Number of sent messages; MIB 1.3.6.1.2.1.2.1.16.x, x = port number, number of sent octets.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Settings</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ApNam</td>
<td>Access point name to which this channel belongs; only needed, if more than one access point and more than one physical channel exist. Not used for pure switches; might be used on application IEDs with additional switch functionality.</td>
</tr>
<tr>
<td>ChLivTms</td>
<td>Timeout time for channel live supervision; default 5s</td>
</tr>
</tbody>
</table>
Summary

► IEC 61850 is THE international accepted and used standard for information, information exchange and system and device configuration in electric power systems
► The standard IEC 61850 and related standards will be extended by many new information models inside and outside the electrical world (gas, …)
► The main focus was on protection and control
► In the future Monitoring Information will be a crucial focus
► Products are available

Additional information

► Contact: schwarz@scc-online.de
► http://www.nettedautomation.com
► These slides: http://www.nettedautomation.com/news
► http://iec61850-news.blogspot.com
► Visit UCA IUG booth 1932