MULTI VENDOR IEC 61850 IMPLEMENTATION

A UTILITY’S PERSPECTIVE

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POWER GRID CORPORATION OF INDIA LTD
27.09.17 AMSTERDAM
* Owns & operates 1, 42,433 circuit kilometers of EHV & UHV Transmission Lines
* 224 Sub-Stations at 400 kV & 765 kV voltage level.
* 295,673 MVA Transformation Capacity
* Out of 224, 118 IEC 61850 based substations at 400 kV & 765 kV level.
A Glimpse of the Evolution of the Indian National Power Grid

October 1991
East & North-East synchronized

March 2003
West synchronized With East & North-East

August 2006
North synchronized with Central Grid

Dec'2013
South synchronized with NEW Grid

One Nation - One Grid – One Frequency

Five Regional Grids Five Frequencies

Raichur-Sholapur
Inter-Regional Link commissioned

One Nation
One Grid
One Frequency
* 765kV/400kV lines: about 142,433 ckms
* HVDC Bipole (±800kV): 2600 ckm
* 3 no.s HVDC Bipole (±500kV): 7,500 ckms.
* HVDC Back-to-back: 7 nos. (3000MW)
* FSC – 40 nos.; TCSC – 6 nos.
* SVC- 03 under operation & 1 under execution.
* STATCOM- 01 under operation & 13 under execution.
* Bipole VSC HVDC- 01 under execution
* Bipole LCC HVDC- 01 under execution
Interconnection with Neighboring Countries

- Geographically wide spread Indian Grid facilitates interconnections with Neighboring countries.
- India provides a good demand market to harness energy resources of other countries too.
ADOPTION OF IEC 61850 IN POWERGRID INDIA

* The first substation based on IEC 61850 was commissioned in the year 2007.
* Over the last decade 118 substations having IEC 61850 based automation system were commissioned.
* Pilot project on IEC 61850 Process Bus commissioned in 2014.
PROCESS BUS PILOT INSTALLATION AT 400/220 kV BHIWADI SUBSTATION

- **Contol Room HMI**
  - Reports/Data for HMI over FO (IEC 61850 based MMS Reports)

- **Distance Protection IED**
  - Current & Voltage Sampled Values to the IED from MU (IEC 61850, 9-2)

- **Merging Unit(s)**
  - Current values stream over FO Cable

- **Optical CT**
  - Moga 1 Line
  - Optical Fibre Cable

- **1PPS - GPS Time Synch**
  - Outdoor Panel (near CB)

- **SGC 1, SGC 2**
  - Protection (Trip) commands over FO Cable (IEC 61850 based GOOSE messages)
  - Alarms, Status From Switchgear over FO Cable (IEC 61850 based GOOSE messages)
  - Control (Open/Close) commands over FO Cable (IEC 61850 based GOOSE messages) via Protection/Control IEDs in the Kiosk

- **Copper Hardwiring**
  - Data Flow over Ethernet
ARCHITECTURE FOR DIGITAL SUBSTATION PROJECTS UNDER CONSTRUCTION

Diagram showing the architecture for digital substation projects with various components including DR and Engineering PC, Redundant HMI, Redundant SAS, Control and Protection Panels, PRP Network A and B, Outdoor Merging Unit (MU) Panel, Outdoor Switchgear, and PTP based GPS Time Synchronizer Unit.
**BENEFITS REAPED THROUGH IEC 61850 ADOPTION**

* **Advanced diagnosis** - e.g. Single screen, filter enabled, easily identifiable, multi IED, relevant event logs.

* **Superior Automation with Advance Safety** - we have Automatic Bus Shutdown/Back in Service schemes, Automatic Spare Phase ICT selection/deselection schemes, which enables enhanced safety while performing the operation automatically, in step check coordination with operator intelligence.
Lower environmental footprint - extremely less cables & cable trenches as compared to conventional substations.

Ease of implementing the complex schemes - e.g. spare phase selection/deselection for ICT/ Reactor Bank Protection in single phase ICT/ Reactor schemes, especially at 765 and 1200 kV.

Integration of different monitoring & control devices to a common system - e.g. Transformer diagnostic devices such as online DGA system, Remote Tap Change Controller, Controlled Switching Devices, etc.
The journey of hitting a CENTURY in commissioning of IEC 61850 based substations has not been easy. It has been bumpy but enriching and exciting. The upcoming slides will show some of the issues encountered by us, most of which were resolved and for some we need the industry to ponder upon our concern as a Utility.

Nevertheless

POWERGRID India would always be a front runner in adopting this thriving futuristic technology to its fullest.
Augmentation of substations has been a major challenge. At some of the substations, we have IEDs from more than four different vendors and integrating them to interoperate & to the existing HMI, on a turnkey basis with a proprietary configuration tool is both an economical and technical challenge.

The number of IEDs that can be accommodated in a project is also a key issue. At some of our substations, the number of IEDs has crossed 150 and the servers are not able to handle the large number of IEDs.

Windows version compatibility with new version of IEDs also has become an issue for augmentation projects.
In the Edition 1 IEDs, the non-reception of GOOSE messages did not generate an alarm in some vendor’s IEDs, which was critical for detecting non-receipt of GOOSE message by a subscriber IED in GOOSE based schemes. Alternate methods, such as taking the quality bits in an AND function to create an alarm were used to resolve the issue. This issue has been addressed in Edition 2 by providing the LGOS logical Node.
Because of the hexadecimal App ID of the datasets of IEDs of some vendors, other vendor’s IEDs had subscription issues. This lead to problem in some cases where the subscriber IEDs understood only the decimal form.

The sequence of selecting status value and quality in SCD configuration tools was fixed in some vendor IEDs which impacted the communication.

In some cases, the control command from the HMI to the bay controllers of different vendors did not work. This was resolved after some modifications in the visible string of the control command.
Issues faced during initial Installations - APPROPRIATE SPECIFICATION REQUIREMENT

Using the incorrect Logical Node, e.g GGIO for Distance Protection Operated can introduce delay in appearance of the event on HMI for analysis of the event and defies the basic concept of Logical Node classification for exact identification in an SCD file.
Specifying the nomenclature of IEDs in an SCD file helped in removing the identification ambiguity during testing and diagnosis.
For station wide switchgear reservation function and for transfer of special protection signals from one bay to other, GOOSE interoperability between Existing Edition 1 & Edition 2 devices is required in our augmentation projects. Most of the vendors have not demonstrated/confirmed this interoperability.

For our augmentation projects where in we have the HMI Client and IEDs of Edition 1 and the substation bay augmentation project has IEDs of Edition 2, due to interoperability limitation, vendors are demanding up graduation of the existing HMI software to integrate Edition 2 IEDs which is expensive.
* Edition 1 IEDs did not have the simulation bit provision, as such testing of the GOOSE based protection schemes often lead to mal operation during testing on account of simulation mistakes.

* Though the provision of simulation bit has been provided in Edition 2, the processing of GOOSE message with a lower StNum, by a subscriber IED is still important from the security point of view.

* Mere detection of such GOOSE messages is of no importance to us. We need the subscriber IEDs to discard them and trigger an alert in such a case from cyber security point of view.
LIMITED AVAILABILITY OF PTP COMPLIANT MERGING UNITS.

- Non availability of proper logical nodes, e.g. XCBR in some vendors Circuit Breaker IEDs.
- Non availability of sufficient ports in some vendors IEDs for flexible network configuration.
- Non availability of IEC 61850 systems for HVDC & FACTS. Integration of such systems requires protocol conversion.
Availability of Tools and Our Expectations

- Limited availability of Tools which generate SSD files.
- Similarly there are limited tools that have the compatibility to SSD files & can configure the system as per our SSD file.
- If a Publisher and Subscriber Matrix can be generated out of an SCD file, it would be of immense help in commissioning of Digital Substations and later in Maintenance.
THANK YOU

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