SP Transmission 2015 NIC submission: Future Intelligent Transmission Network SubStation (FITNESS)

ISP Q&A: 22 April 2015

Q1: In order to pass ISP, the project must meet at least one of the specific requirements. We note that you have indicated that this project meets three of the specific requirements.

- Please provide some evidence to demonstrate that the equipment is unproven in GB.
- Please provide further explanation of the specific novel arrangement or application of existing equipment in the proposed project.
- Please elaborate on the specific novel operational practice directly related to the operation of the **electricity transmission and/or distribution** system in the proposed project.

A1:
(1) **Please provide some evidence to demonstrate that the equipment is unproven in GB:**
SP Energy Networks (SPEN) has carried out extensive internal and external stakeholder engagement to assess the level of implementation of sampled value based process bus architecture (IEC61850-9-2) standard in GB Transmission environment.

Conventionally, measurements are made by Voltage Transducers (VTs) and Current Transducers (CTs) that connect to the high voltage equipment, and analogue electrical measurements are connected over copper wires from the primary high voltage plant to the secondary control and protection cubicles. The analogue electrical signals are connected to secondary transducers and analogue acquisition within each of the secondary devices; there can be many of these secondary monitoring, protection and control devices. There is therefore a considerable wiring effort to connect the high voltage CTs and VTs through to many secondary devices, and the electrical connection between high and low voltage equipment requires particular attention to safety processes and equipment isolation.

In the IEC 61850-9-2 design concept, is an addition to IEC61850 standard (Appendix 1) the high voltage measurements are digitised once, at the high voltage equipment, and the measurements are communicated over a fibre optic digital network (the process bus), inherently isolating the high voltage and low voltage equipment. Thus, each secondary device receives its input data simply by a fibre communication network interface onto the process bus, avoiding the need to receive, isolate and digitise the electrically noisy signals from primary CTs and VTs within the unit. The installation process is much easier and safer as no electrical termination and outages are required, and the units can be smaller and arranged more flexibly. Furthermore, the process bus and digitisation within the high voltage equipment area enables new concept sensors to be used, such as optical transducers (Non-Conventional Instrument Transformers, NCITs) that could not be used in the conventional analogue approach.

While the principles of the new design concept are established by the IEC 61850 standard, any utility looking to adopt the standard (and particularly the process bus) must significantly change its substation design approach, and introduce new equipment, practices and skills to the system as a step change, rather than an incremental change. Because of these hurdles, utilities in GB and worldwide have not yet adopted the process bus standard as business-as-usual.

SPEN has discussed this concept with NGET and SSE and assessed the outcomes of the digital substation NIA projects undertaken by GB TOs. The conclusion derived from these meetings was that there has been no live substation implementation of a complete IEC 61850 architecture including a live Process Bus (61850-9-2) and Non-Conventional Instrument Transformer (NCIT) in GB. Such an implementation demonstrated by project FITNESS will be a “**pilot full-scale digital substation**

secondary side deployment in the GB Transmission Network" fully satisfying European standards for SMART grids (Appendix 1) for substation automation. The trials undertaken under NIA projects have assessed offline/piggy-back performance of individual components. It is our position that such methods have been exhausted and do not generate sufficient confidence for an actual substation deployment of protection system based on the process-bus architecture.

SPEN has also engaged with multiple suppliers such as ALSTOM, ABB, SIEMENS, INGETEAM, SEL, and ZIV. SPEN has received proposals from each of these individual suppliers supporting the project FITNESS and need for proving the process-bus concept and associated equipment in a live-substation trial for GB wide roll-out. These proposals can be made available on request.

As supporting evidence, we would point out a number of information sources (in addition to our own standard practices) that indicate that these technologies are unproven in GB.

ENA Assessed Equipment List

The Energy Networks Association (ENA) provides a service to assess protection equipment for use in the GB network. This assessment is generally required for business-as-usual deployment of substation secondary equipment by GB transmission licensees. A list of assessed protection equipment is provided on the ENA website.

http://www.energynetworks.org/modx/assets/files/electricity/engineering/assessment_notices/PAP_Documents/ALP_2-6_April_2015.pdf

It may be noted that there are no Merging Units or Process Bus based protection equipment or NCITs from any manufacturer in the ENA assessed equipment list. After consultation with internal stakeholders who are engaged in ENA assessments, we have concluded that there have been no assessments of process bus functions of any protection device to date.

It can therefore be concluded that ENA has not assessed the relevant equipment for an IEC61850-9-2 process bus implementation for use in the GB grid, and it is therefore not proven for use in GB.

(2) Please provide further explanation of the specific novel arrangement or application of existing equipment in the proposed project

A key novel aspect of the arrangement is the Process Bus implementation in the substation equipment. As shown in the diagram below, the implementation includes fibre and Ethernet based process bus communication of Sampled Values over IEC 61850-9-2. The source measurements are provided from conventional CTs and VTs and digitised by a Merging Unit, and from NCITs.

Following novel arrangements to the substation architecture will be demonstrated as a part of this project:

1. In addition to the substation architecture, there is also a **novel architecture** used in the 3-level hierarchy of information management and control based on **complete IEC61850 standardised approach as a pilot trial in GB transmission network**:

    - Substation-level IEC61850-9-2 architecture as described
    - Wide-area control level, with inputs and outputs applied in the IEC61850 environment, and integrated with conventional measurements.

- Central level of information management, deriving operational and planning benefits from the detailed data sources available in the 61850 substation architecture, and combining with existing SCADA/EMS and Wide Area Monitoring information.

2. The extensive integration and management of information resources is a key novel feature of this project. It will provide the foundation for new control solutions for renewable integration, and also demonstrate that benefits can be derived, such as reduced line outage time, better protection co-ordination, enhanced voltage control and more informed management of inertia and harmonics issues as renewable penetration increases.

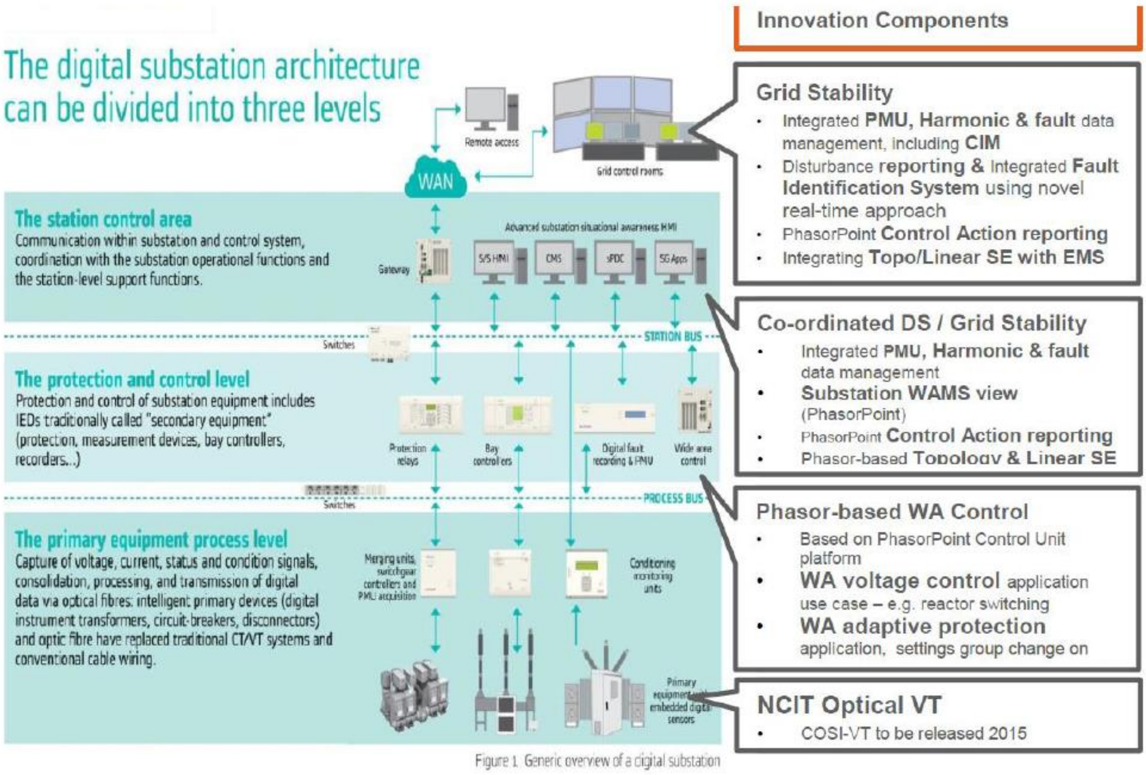

Figure 1. Generic overview of a digital substation

(3) Please elaborate on the specific novel operational practice directly related to the operation of the electricity transmission and/or distribution system in the proposed project.

The following novel operation practices will be demonstrated as a part of this project:
1. Protection Device measurements from the local and remote ends of the line will be tested for accuracy and reliability of operation with the process bus inputs locally and conventional inputs from the remote end. This will be first such live trial in a GB transmission environment and will prove the business as usual deployment of the digital substation concept avoiding the need to replace existing assets before end of life.

2. Protection Devices from multiple suppliers will be tested for interoperability within the process-bus architecture for the first time in GB transmission network proving the necessity of standardised communication protocols such as IEC61850-9-2.
Thus, the technology readiness will be proven from the perspective of the business-as-usual requirement to deploy different manufacturers’ equipment in redundant configurations.

3. The Hot-Standby protection concept will be demonstrated for the first time in a live substation environment, reducing the number of relay panels installed in a transmission substation and enhancing the availability of primary circuits in the event of secondary system failures.

4. Remote access and configuration of protection relays will considerably improve operational flexibility.

Q2: Under criterion (a), please provide some quantification for how the project would deliver benefits that outweigh the costs.

A2:

CAPEX Benefits

There are various areas in which the project is expected to deliver CAPEX benefits, for example:

1. Reduced installation costs by replacing copper wiring and termination with optical fibre.
2. Reduced substation space requirements, reducing building size and potentially avoiding the need for rebuilding as new bays are added.
3. Reduction in installation, commissioning and planning time.
4. Enabling new control solutions for new generation connections, avoiding or deferring capital investment.

The benefit of reducing copper wiring, termination effort and wiring-related problems over the lifetime are estimated in a reported Total Lifetime Cost approximation to be of the order of 25% cost saving for retrofit and 50% for new build. A US report on a trial 61850 substation reports[1]:

"Gains in efficiency and productivity in the aforementioned areas translate into specific cost savings… It is estimated that the fiber-based solution can be approximately 25% more cost-effective with respect to TLC in a retrofit situation, with cost savings approaching 50% in new installations."

Although this report suggests a cost reduction of 25-50% of substation instrumentation lifetime costs, a more conservative estimate of potential CAPEX benefit would be around 10% of the substation installation cost for the purpose of this project.

Noting that the average cost of refurbishing a transmission bay (transformer and switchgear) is in the region of £XXXX, and that the current rate of new or refurbished bays in the SP Transmission (SPT) system is XXXX, a conservative estimate of the expected CAPEX benefit in the area of substation cost savings is in the region of:

XXXX = £2.25m per year for SP Transmission

Purely based on the study highlighted above and assuming a figure of 25% in CAPEX benefits, the savings will be in order of

XXXX = £5.6m per year for SPT

[1] Hodder S. et al. "IEC 61850 Process Bus Solution Addressing Business Needs of Today's Utilities", Power Systems Conference, Clemson, SC, USA 2009

We therefore estimate that the project would pay back within 2-4.5 years based on this benefit area alone. It should also be noted that the benefits can also be transferrable to the distribution system, and further cost benefits can be achieved.

OPEX Benefits

There are various areas in which the project is expected to deliver OPEX benefits, for example:

1. Reduced line outage time in new-builds or refurbishment
2. Reducing operational line outage time by providing real-time fault management enabled by the information resources
3. Reduced outage time and engineer's time on site for maintenance, in particular, in enabling the replacement of protection devices without primary system outages.

Reduction in the number of outages and outage scheduling requirements for protection modernisation and maintenance alone can mitigate the risks of up to £10m/year of constraint costs for the System Operator and ENS penalty payments for SP Transmission.

Reduction in maintenance time results in savings of XXXX per week for an engineer/contractor on site. Assuming saving 1 week per maintenance work for 2 contractors on site, the savings on an average of 50 maintenance works per year is £0.7m.

Project FITNESS with its CAPEX and OPEX benefits combined with its aim to facilitate standardised substation automation architecture according to European Standards for SMART grids justifies the project costs. SPEN will endeavour to further justify costs and quantify benefits in detail in the final submission proposal.

Appendix 1

Final report of the CEN/CENELEC/ETSI Joint Working Group on Standards for Smart Grids

http://www.etsi.org/WebSite/document/Report_CENCLCETSI_Standards_Smart%20Grids.pdf

Logical overview of IEC-61850