

Electricity Network Innovation Competition Full Submission
Supplementary Answer Form

Project: _____ **SPT_FITNESS** _____

Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q1
Question date	20/08/2015	Answer date	24/08/2015
Submission section question relates to	Section 4, Page 19, Appedix B		
Topic	Benefits of FITNESS		
Question	<p>All benefits accrued from new digital substations built are ascribed as a benefit of FITNESS.</p> <p>The full benefit of such a transition will not be caused in its entirety by a single test substation. Has any analysis been performed comparing the benefits and uptake numbers to the expected progression to digital substations without FITNESS? Please provide supporting data.</p>		
Notes on question	N/A		
Answer	<p>Without FITNESS, the GB industry would follow established international trends instead of addressing GB interests in the technology direction. We believe that digital substation technology will become established over time and obsolescence will eventually force GB to follow the digital substation route. Without FITNESS, we believe that the GB uptake of digital substation technology would be delayed at least until after the RIIO T2 period, thus a delay of around 8 years would be expected.</p> <p>In addition to the cost implication of the delay, a GB live demonstration will still be needed before the technology is used in business-as-usual. Advantages of early uptake are not only the direct cost benefit, but also in ensuring that GB requirements are formalised in international standard revisions. In this response, we consider:</p> <ul style="list-style-type: none">• The benefits directly accounted for in the FITNESS proposal, including reasons that that the particular benefits claimed can be derived from the FITNESS substation experience rollout.• The impacts of not proceeding with FITNESS, delaying digital substation technology take-up until after it is widely adopted in		

international standard practice.

FITNESS Benefits Directly Accounted

All benefits detailed in FITNESS full proposal Section 3, 4 and Appendix B have been estimated conservatively for replicating FITNESS solution in future load, non-load related investments and modernisation works. Since the direct benefits relate specifically to replication of FITNESS in similar switchgear bay projects, the benefits can be ascribed to FITNESS. Of course, there are further benefits of FITNESS as an enabler for control solutions and for different protection functions, but these were not included in the claimed benefits. Our financial benefit cases only take into account:

- 10% of substation Costs
Literature research suggest the CAPEX savings from digital substations are upto 25-40% (Hodder S. et al. "IEC 61850 Process Bus Solution Addressing Business Needs of Today's Utilities", Power Systems Conference, Clemson, SC, USA 2009), however after detailed discussion with network planning and regulation and engineering services we conservatively estimated this saving to be 10% through replication of FITNESS solution.
- Transmission load, non-load related switchgear bay related investment.
There has been no benefit calculations for transformer or overhead line related investments. Successful demonstration of switchgear bay replacement using FITNESS digital solution will enable TOs in GB to apply FITNESS solution to RIIIO T2 load and non-load switchgear related investment.
- Transmission network related investments only:
FITNESS solution is also replicable in distribution networks. However DNO benefits have not been included to ensure benefit calculations only reflect application of FITNESS solution for transmission networks.

There are several benefits that are not included in the direct cost benefit analysis for example:

- Site cost of replacement/new-build of a switchgear bay
FITNESS solution also reduces pre-site engineering design and planning time as in future work related to building foundations for CVTs and adding or building trenches for copper cables. It also simplifies design of control building. As pre-site planning time benefits cannot be accurately demonstrated through this demonstration project, these benefits are not included in final benefit calculations.
- Enabling new monitoring and control solutions
FITNESS reduces barriers to entry for other innovative monitoring and control projects, such as SPEN & partners' VISOR and National Grid's EFCC and Humber Smartzone. These are scheme-specific and the FITNESS benefit cannot be assessed accurately.

We therefore submit that the direct benefits claimed can be ascribed to FITNESS, and that benefits that cannot be ascribed to FITNESS alone were described but not incorporated in the overall benefit analysis figures.

Impacts of not proceeding with FITNESS

FITNESS demonstration is unique from other global digital substation demonstrations in aspect of live demonstration of multi-vendor interoperability, full-substation and central system integration and use of non-conventional instrument transformers for wide area monitoring and control applications further explained in (SPTEN02_20082015_Q4).

Letters of support from NGET, SHE TL and PAC world highlight the potential and importance of this demonstration project to bridge the gap between piecemeal demonstrations and Business-as-Usual implementation of digital substations. FITNESS will also address gaps and issues in international standards and will contribute in development of multi-vendor solutions. Without FITNESS, GB inputs to standards and practices would come late into the international working groups, and may take much longer to incorporate the standards.

The operational and financial risks relate to fundamental changes to measuring, monitoring and protecting transmission network assets. These risks are further highlighted in Pg 25 and Pg 26 of the proposal. In practice, a live demonstration project is essential for introducing a substantial change to substation design, as a means of mitigating the risk. Without FITNESS, a substitute demonstration project would be needed prior to business-as-usual deployment.

Adopting new standards also requires new/additional skill set and change in operational practices within network planning and regulation, engineering design and services, and transmission operations for Transmission Owners. Lack of knowledge and confidence in perceived benefits of digital substations, and the requirement to deliver business investment projects in schedule, on time and at low cost has created the issue of lower "User-Readiness" rather than "Technology-Readiness" for adoption of digital substations. "User-Readiness" can be improved through demonstration project FITNESS by co-ordinated training for all TOs and hands-on implementation and through successful demonstration of multi-vendor solutions.

Analysis of expected progression to digital substations without FITNESS in GB will follow a slow piece-meal approach resulting delayed realisation of benefits as shown in following comparison graphs:

Graph 1: Digital Substation uptake and benefits after FITNESS for GB TO/SO

Graph 2: Comparative Digital Substation uptake and benefits with and without FITNESS for GB TO/SO

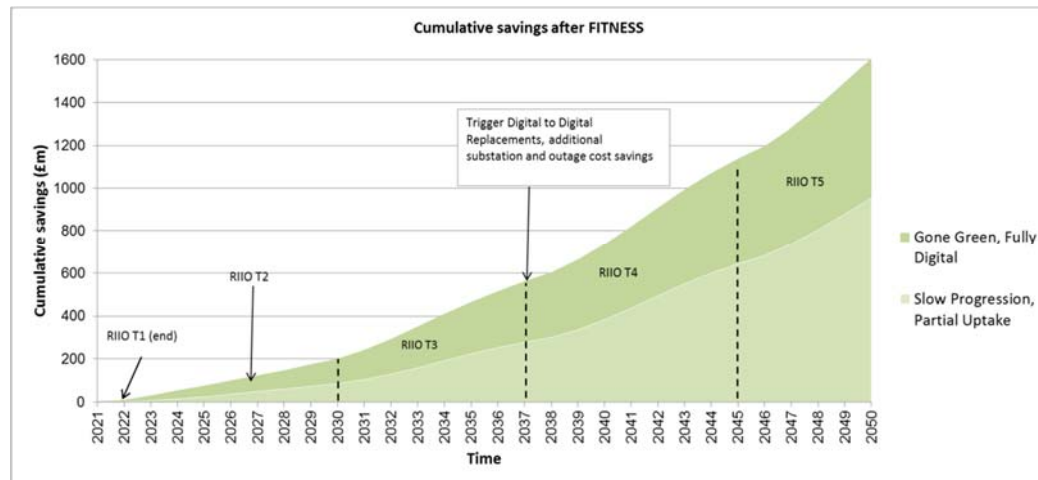
Assumptions for graph 2: Delay of 8 years in realisation of integrated digital substation business-as-usual implementation and resulting benefits due to benefit case studies to be derived from international pilot projects. As asset replacement will be conventional in this period it will also delay the realisation of digital to digital benefits by 8 years from 2037 in FITNESS case to 2045 in without FITNESS case.

Reduced uptake of digital substations by a factor of 0.25 due to

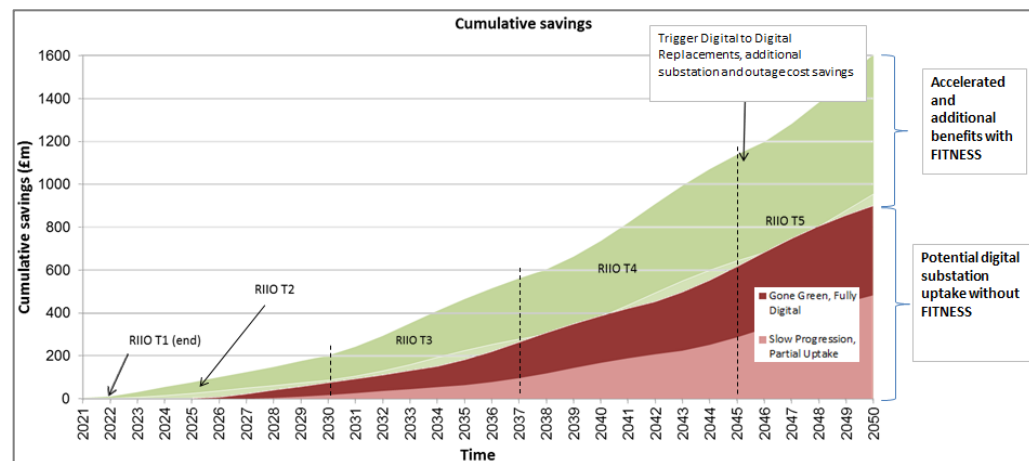
- Delay in co-ordination and combined skill-set building among all TOs.

- Delay in change of GB operational practices and reduced input from GB TOs in international standards development.
- Delay in development of GB digital substation market and solutions

Graph 1 with FITNESS



Graph 2 Comparative Analysis with and without FITNESS



Attachments

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Project: _____ **SPT_FITNESS** _____

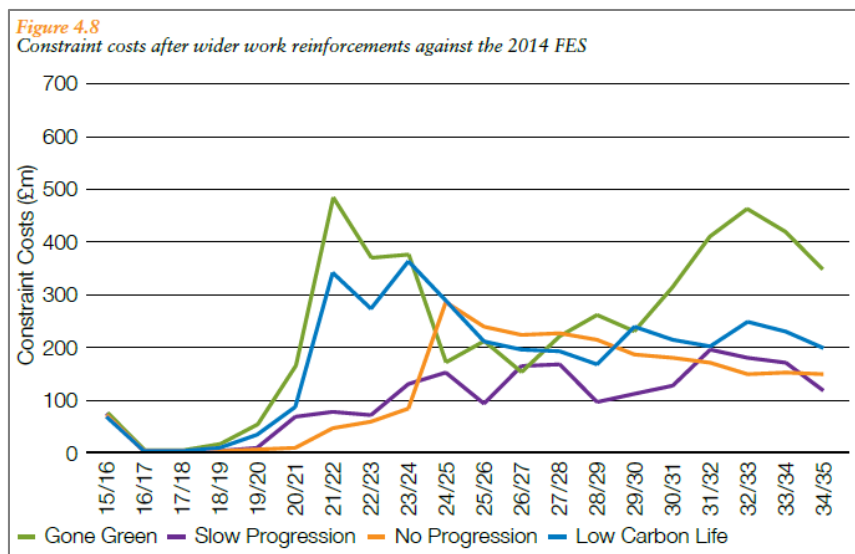
Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q2
Question date	20/08/2015	Answer date	24/08/2015
Submission section question relates to	Appendix A, Page 57		
Topic	Constraint payments		
Question	<p>Please provide a more precise qualification for the increase in constraint payment assumptions provided than the Electricity Ten Year Statement. What assessment has been performed for constraint payment benefits in a case where:</p> <p>a) Constraint payment regulation is changed to reduce payments, and place constraint risk on the generator and not the operator? Has this risk been factored into costs?</p> <p>b) Has any assessment been performed on expected constraint payments with less severe wind growth, due to decreased wind subsidies, and government regulatory changes?</p>		
Notes on question			
Answer	<p>In summary, we note that:</p> <p>a) The cost of constraints is ultimately a cost to the consumer. In its role as a transmission owner, SPEN is neutral to whether the constraint costs are borne by the System Owner or by individual generators, and we assume that the regulatory process in either case reflects the underlying costs of curtailment and balancing, which are reduced by FITNESS. It is therefore not considered to be a significant risk.</p> <p>b) The assessments on sensitivity to the level of wind growth is determined by applying the range of Future Energy Scenarios (FES) published by National Grid, and we assume that these scenarios define the boundaries for transmission asset planning. Beyond the FES, the impact of government regulatory changes on the cost of constraints is not assessed. In general, as FITNESS reduces outage times and yields more flexibility for asset planning, it reduces the exposure of the TO to the</p>		

regulatory changes, and allows TOs to be more responsive to changes in policy.

The FITNESS assumptions on constraint payments are based on the Reinforced System Constraints outlined in ETYS 2014 pg. 219 and picture below according to the preferred least regret scenario between asset investment and constraint payments.

FITNESS assumes that all reinforcement works outlined in ETYS 2014 will be successfully completed and the constraint payments will initially increase (2021-2023) in all scenarios, and will subsequently decrease (except in Slow Progression) as a result of reinforcements. FITNESS also further assumes that after 2035 network asset investment will continue and that system constraints will follow a similar pattern. These values were further checked using the ELSI V2 tool available on NG website with limited modelling.



The driver for FITNESS is reduction in requirement of planned outages in future for replacement and modernisation works. Planned outages are required to make changes to substation secondary systems due to hardwiring which is eliminated in digital substations.

- a) FITNESS perceives planned outages as an additional cost to network customers in the form of constraint payments during the outages (included in the benefit analysis) and potential barriers to transmission reinforcements and smart monitoring and control technologies (outside the benefit analysis). As an example in Pg. 19 and Pg. 20 of the full proposal, implementation of GB WAMS system can be significantly accelerated by implementing FITNESS solution.

The future constraint risk placed on generator and/or system operator will still be a cost to GB economy. Outage scheduling restrictions imposed for system operational requirements in either case is a potential roadblock to modernisation work on electricity network. The key benefit of FITNESS solution reduces the duration of outages for replacement works and enables certain modernisation work to be carried out without the need of an outage.

As the FITNESS solution concentrates on reducing planned outages and its effect on future network requirements and one of the aspects

	<p>of the cost benefit analysis focuses on</p> <ul style="list-style-type: none"> • Reducing the costs for constraints associated with outages on network • Avoiding the risk of incurring an ENS payment due to a fault in the network during outages • Reducing costs for the additional work for transmission owners and system operator to plan outages on networks. <p>A change in constraint payment regulation to reduce payments can be easily factored in linearly into all benefit cases however <u>does not directly affect the original SPEN business case for FITNESS</u>. Further, in any future regulatory framework that optimises societal cost subject to environmental targets, there will be network constraints, and reducing the periods of constraint will result in consumer cost reduction.</p> <p>b) FITNESS benefits associated with constraint payments are modelled using FES and the range of savings vary depending on the scenario selected in our CBA tool. The slow progression scenario accounts for decreased wind growth and subsidies and forms the lower end of benefits i.e. Cumulative non-discounted benefits of £37m by 2030 and £260m by 2050 (see also Question 3 for discussion of scenarios)</p> <p>Government regulatory changes have not been accounted for, as constraint payment benefits calculated are a result of benefits of FITNESS solution related to reduction in planned outages. Planned outages are a current requirement for replacement and modernisation works which result in network constraints and are not directly affected by regulatory changes.</p>
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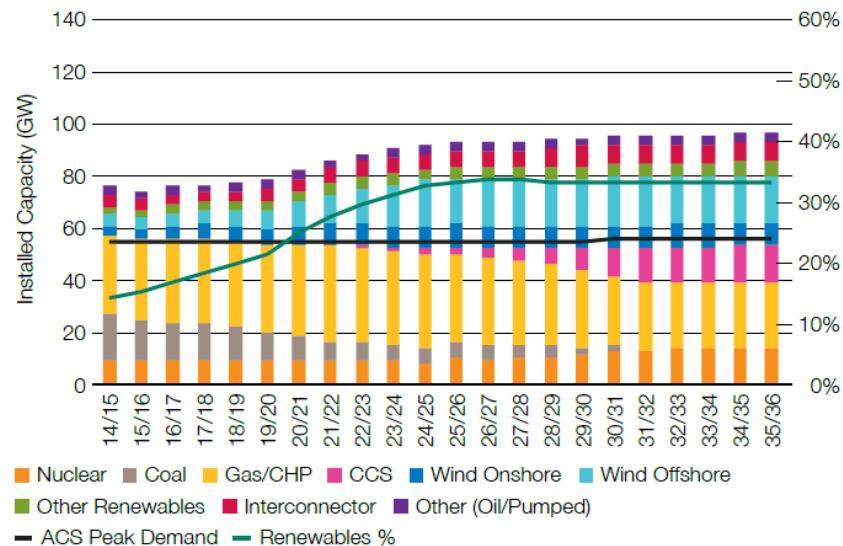
Project: _____**SPT_FITNESS**_____

Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q3
Question date	20/08/2015	Answer date	24/08/2015
Submission section question relates to	Section 3, Page 13		
Topic	Future energy scenarios.		
Question	<p>Future Energy Scenarios Factors are incorrectly ascribed to the Electricity 10 year statement cases. Slow Progression and Low Carbon Life are reversed. Low Carbon Life includes high growth in the economy and energy consumption, leading to an increase in substation new build and replacement, as the building of substations is driven more by energy demand rather than green energy aspirations, which is the difference between GG and LCL.</p> <p>Slow progression has low GDP growth and low demand growth. In terms of electricity network investment (translating to increased numbers of new build substations) this will lead to a reduction in substation new build and replacement.</p> <p>Please provide cost-benefit analysis with revised uptake factors, based on a projection of substation replacement and new build would have with Going Green and Low Carbon Life with similar substation investment, but differing uptake factors.</p>		
Notes on question	None		

Answer	<p>The question suggests the reader's expectation that the Low Carbon Life scenario should lead to a greater number of substation bay new builds and replacements than in the Slow Progression scenario. However, deriving the transmission asset requirements takes account of the number, type and expected locations of generation connections, not simply the overall demand and installed capacity. For the transmission owners, Low Carbon Life emphasises central generation connections (notably nuclear) where the transmission network is relatively strong. It therefore involves less new-builds than Slow Progression, where the emphasis on renewable generation is stronger, resulting in greater numbers of more dispersed and remote connections.</p> <p>Thus, it is reasonable that Slow Progression leads to more transmission network new builds and replacements than Low Carbon Life.</p> <p>It should also be noted that the implications for the transmission and distribution systems are different. Low Carbon Life may involve greater demand-side measures, active network management and other distribution resources, and may require more distribution reinforcement and modernisation than Slow Progression. However, FITNESS is evaluated essentially as a transmission project, and further benefits to the distribution system are outside the scope of the cost benefit analysis.</p> <p>We justify our assumptions for Slow Progression and Low Carbon Life and thus our CBA as follows:</p> <p><u>Low Carbon Life (LCL)</u></p> <p>Low Carbon Life predicts improved economy and shift of focus to de-carbonisation rather than integration of renewable energy sources into transmission networks. This scenario predicts a rise in nuclear generation. For transmission network owners this means more centralised generation with fewer larger substations. A rise in demand profile will require more local renewable generation and active management of energy which refers to the distribution network. Although the FITNESS solution is replicable in distribution networks; our benefit cases only consider the transmission voltage levels to make a conservative estimate of benefits.</p> <p>Improved economy and increased investment in innovation in LCL scenario in our interpretation will lead to more innovative active network management, demand side management and large-scale network reinforcements such as larger transformers, more OHLs, more HVDC links but will not necessarily result in more transmission substation bays. The FES and ETYS 2014 predict lower transmission installed capacity and slower growth of renewable distributed generation such as wind in LCL as shown in picture below:</p>
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Figure 2.10
Low Carbon Life (transmission) generation mix

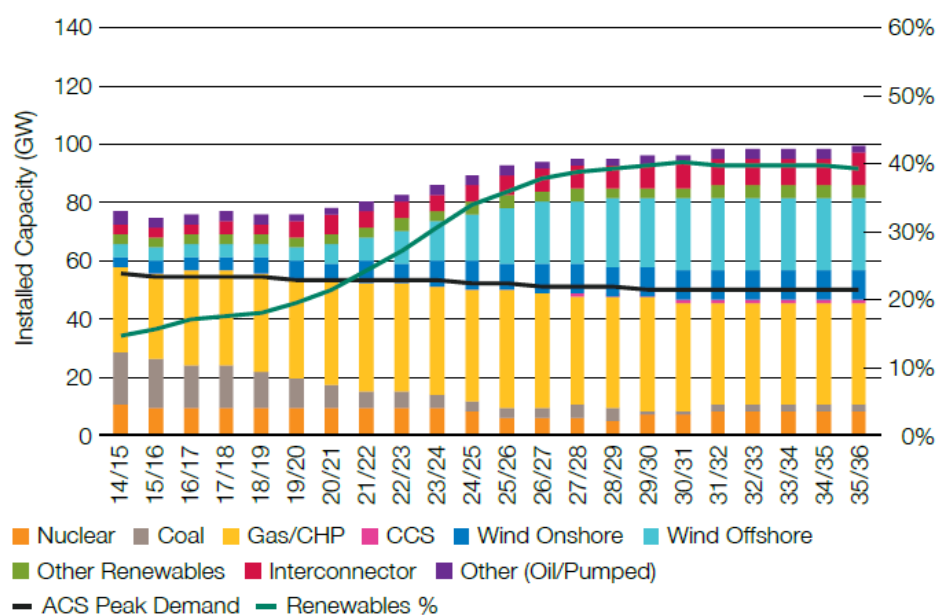


Slow Progression (SP)

Slow Progression scenario has a lower GDP growth, but a stronger focus on renewable generation (wind) in the transmission generation mix. Remote distributed generation such as wind requires more transmission substations to be built to be able to transfer power from distributed pockets of generation. Slow Progression also predicts less investment in innovation in future, increased efficiency and reduced constraint costs. This scenario will require more transmission substations to be built to connect renewable generation and also will require more digital substations to reduce planned outage requirement, and to be able to cater for decrease in inertia and fault levels, which directly affect transmission protection and control systems and will make a stronger case for wide area monitoring and control.

The FES and ETYS 2014 predict more transmission generation installed capacity for Slow Progression and a faster growth in wind and other distributed generation in transmission system as shown in figure below.

Figure 2.8
Slow Progression (transmission) generation mix



	<p>The purpose of using FES to analyse FITNESS benefits was to predict a low, medium and high range of realistic benefits depending on the future transmission generation mix after successful demonstration of FITNESS solution. Thus Gone Green represents the higher end of benefits, SP medium and LCL lower range of benefits for FITNESS i.e. £71m -£107m by end of RIIO T2 related to transmission substation costs.</p>
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Project code	SPTEN02	Question Number	Q4
Question date	20/8/2015	Answer date	24/8/2015
Submission section question relates to	Section 6, Page 38		
Topic	Technology Readiness Level		
Question	Please provide a version of Table 7 with international TRL information, not just the state of the technology as demonstrated on the GB Power System.		
Notes on question			
Answer	<p>The TRL in GB is broadly in line with the general international technology readiness level. While there are examples of deployments of digital substations around the world, the FITNESS project has unique elements of innovation. Dr Alex Apostolov, as an international pioneer and recognised expert, writing in support of FITNESS, states <i>"The scope of your project to combine protection, automation and control and wide area monitoring and control based on process bus architecture is globally innovative and the outcomes of this project will add valuable lessons learnt to the international standards organisation and especially to IEC61850-9-2 working groups."</i></p> <p>The FITNESS project is differentiated from other global experience by:</p> <ul style="list-style-type: none"> • Multi-vendor interoperability demonstrated, without which the IEC 61850-9-2 process bus approach cannot be rolled out in GB, due to the established design principles for reliability requiring diversity of equipment • Integrated protection, monitoring & control. Several international deployments address part of the substation design, typically for protection only. Monitoring and control are vital elements of future substation design, and in SPEN view, must be demonstrated as an 		

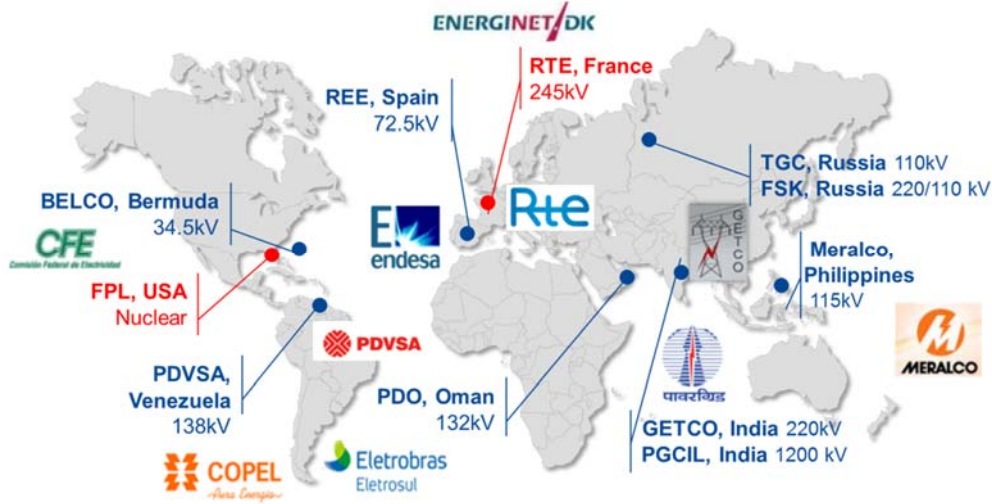
integrated system, which is beyond the international experience. Furthermore, trialing the potential for new capabilities made possible (or

- **Novel Instrument Transformers.** The project involves use of new instrument transformers. Non-conventional voltage transformers are new to the industry, with the first demonstrations running in parallel in RTE France and in FITNESS. The distributed optical sensors have not been deployed in transmission or distribution. Non conventional current transformers have been used internationally (Alstom has global deployment experience over a decade at transmission & distribution), but they are not used as BaU with process-bus application in GB transmission.

The international TRL level in the table below represents to individual pilot demonstrations in the US and few other countries and do not reflect the TRL level of all countries combined. Digital substations are to the best of our knowledge in pilot demonstration stages in these countries and address different business cases in each case. It should be noted that the countries and utilities have specific needs and targets, and use different elements of digital substation technology for addressing issues and adapting to their unique operational practices.

Item	GB TRL	INTL TRL
NCIT-MU transformers, publishing to Process Bus		
• Voltage transformers	8	8
• Current transformers	8	9
Process bus equipment and architecture	8	9
Protection IEDs using process bus	8	9
Synchrophasor and fault recording using digital sampled waveform input from Process Bus	7	7
Redundant GPS/Glonass time synchronisation, IEC 1588 v2 format	7	7
Synchrophasor data from parallel conventional and Digital Substation, delivered to central wide area monitoring	7	7
Distributed Optical Sensor Technology (distinct from NCIT listed above)	5	5
Substation-based topology validation and data quality checking prior to communication to external subscriber	5	6
Flexible wide area control capability incorporating synchrophasor measurement, and implemented over IEC 61850 GOOSE over Process Bus or Station Bus	5	7
Harmonics and fault information extracted from Process Bus data, processed and communicated in standard form, and analysed for real-time and post-event users.	5	5
Protection IED group settings selected from operational condition of system	7	9
Substation Control System for use with protection, monitoring and control devices from multiple vendors, in 61850 Process Bus/Station Bus implementation	8	8
Full substation system with multi-vendor equipment and integration to external information and control requirements	6	6

The FITNESS project draws on the international experience in digital substations from Alstom and ABB as two leading suppliers in this domain. The figure below shows Alstom references for digital substation technology deployment from which experience is gained.

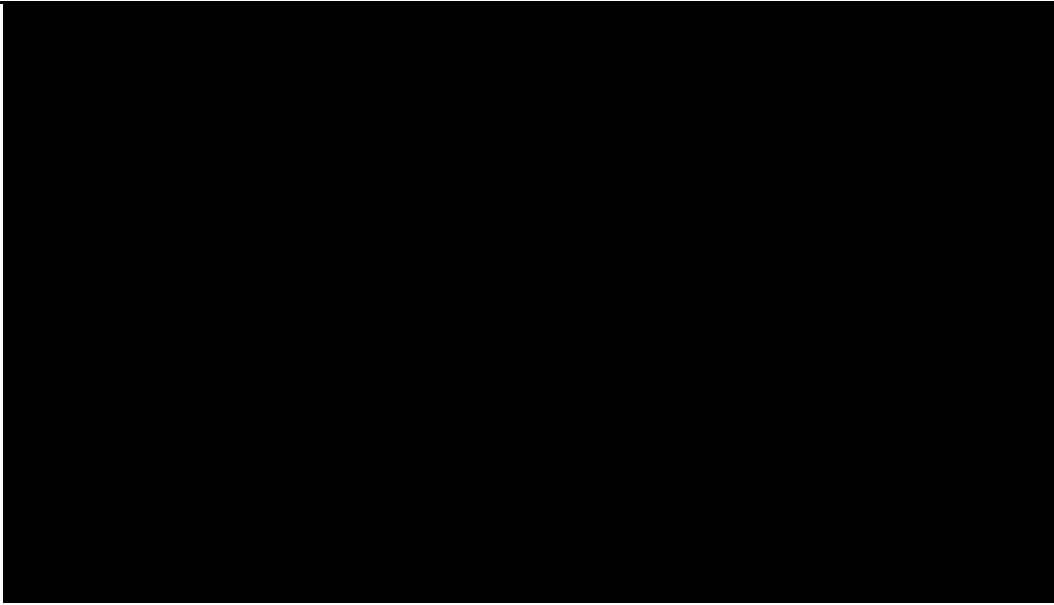
	<div data-bbox="331 107 1327 609"><p>ENERGINET/DK</p><p>REE, Spain 72.5kV</p><p>RTE, France 245kV</p><p>TGC, Russia 110kV</p><p>FSK, Russia 220/110 kV</p><p>Meralco, Philippines 115kV</p><p>GETCO, India 220kV</p><p>PGCIL, India 1200 kV</p><p>PDVSA, Venezuela 138kV</p><p>PDVSA</p><p>PDVSA, Oman 132kV</p><p>COPEL</p><p>Eletrobras Eletrosul</p><p>FPL, USA Nuclear</p><p>BELCO, Bermuda 34.5kV</p><p>CFE</p><p>endesa</p><p>Rte</p><p>पावरग्रिड</p><p>मालको</p></div>
Attachments	

We conclude that the FITNES project as a whole addresses gaps in the international industry experience in the areas of system integration and interoperability. Thus, the project is innovative not only in the GB context, but also in the international arena. Demonstration of the integrated system in live service is a necessary step for GB transmission and distribution owners to adopt the design approach.

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Project code	SPTEN02	Question Number	Q5
Question date	20/08/2015	Answer date	24/08/2015
Submission section question relates to	Section 2.1 Page 5		
Topic	Parallel Live Trials		
Question	Which existing substation will be used to provide the facility? Will any funding go into the maintenance of this existing substation?		
Notes on question	N/A		
Answer			
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Project: **SPT_FITNESS**

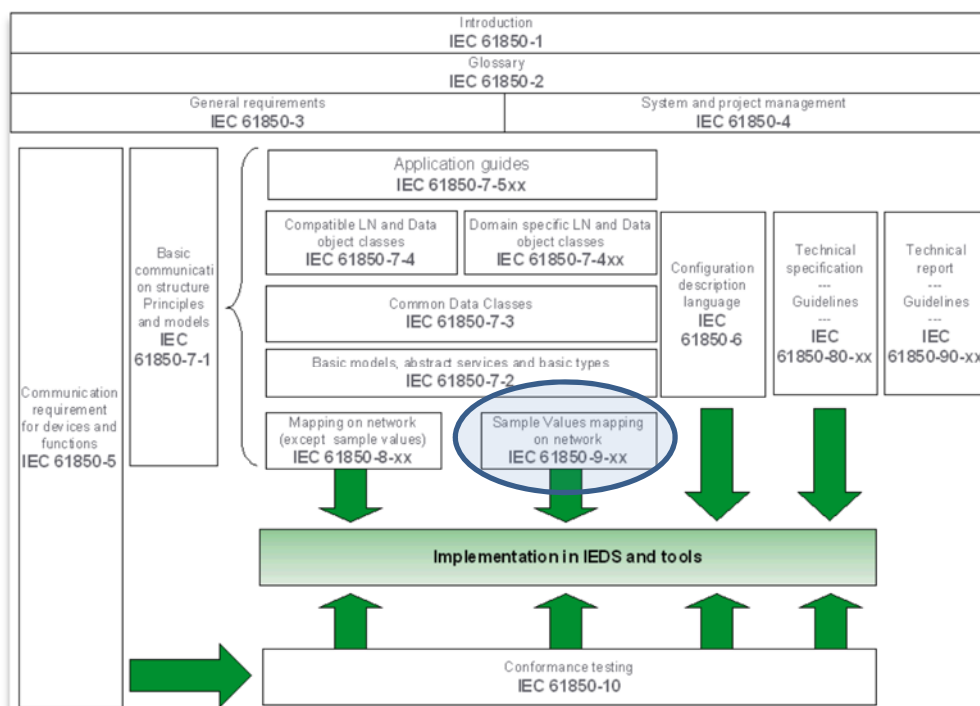
Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q6
Question date	08/09/2015	Answer date	11/09/2015
Submission section question relates to	Criteria (d)		
Topic	Innovation		
Question	Where else in GB is IEC-61850 used? How does that fall short of what this project could deliver?		
Notes on question			
Answer	<p>IEC 61850 is the new set of international standards of communications for substations. It enables integration of all protection, control, measurement and monitoring functions within a substation and provides the means for high-speed substation protection applications, interlocking and intertripping. It is important to note that some elements of IEC 61850 have been used in GB, a particular focus of the FITNESS project is in the IEC-61850-9-2 standard which significantly changes the architecture of a substation, and has not been used live in GB previously.</p> <p>The IEC 61850 set of standards combines the convenience of ethernet with the performance and security which is essential in substations today. IEC 61850 is combination of a set of several protocols as shown in the picture below (source: Final report of the CEN/CENELEC/ETSI Joint Working Group on Standards for Smart Grids).</p> <p>Each set of protocols such as IEC 61850-7, 61850-8, 61850-9 defines a different set of rules for various aspects of substation communication. All existing implementations in the GB are an application of different protocol from this set of protocols for SCADA and protection related applications. The existing applications of IEC61850-8-1 standard specializing in Manufacturing</p>		

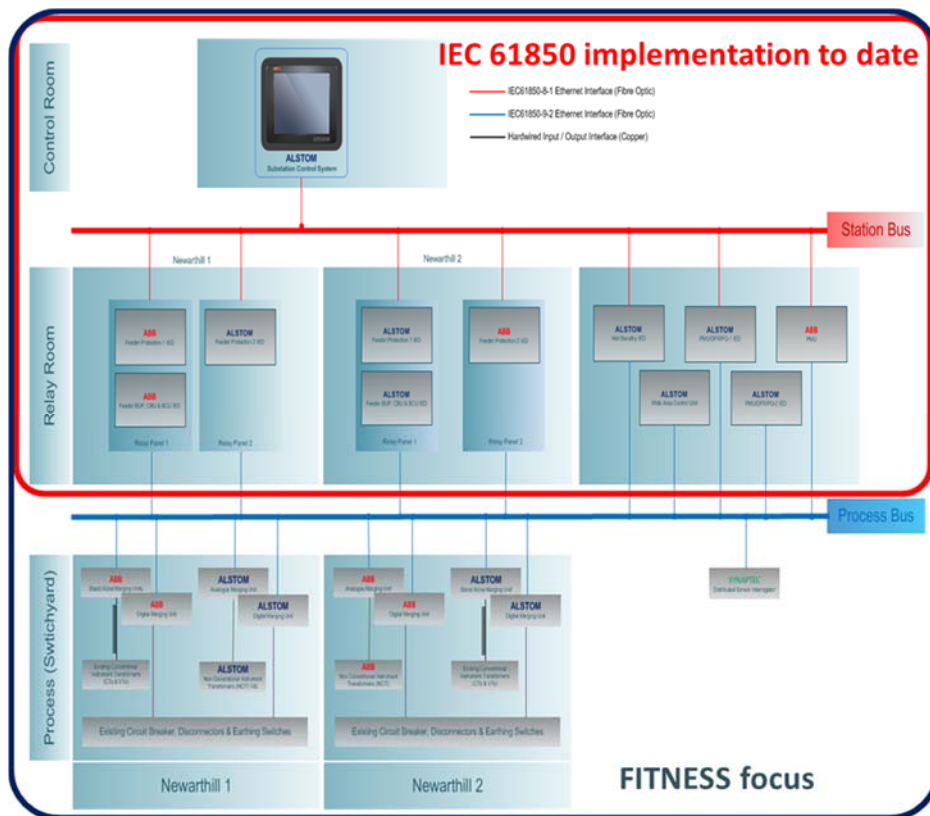
Messaging Specification (MMS) protection which defines communication **within the substation control room** and among various intelligent electronic devices (IED)s has been applied on NGET, SPT and Network Rail network. UKPN flexible plug and play project used IEC 61850 for **inter substation communication**.

FITNESS addresses the complete integration of protection, monitoring and control systems with a focus on IEC 61850-9 series which defines communication networks and systems in substations **between switchyard and substation control room** fundamentally changing the aspects of substation measurement from **analog to digital signals**- Specific Communication Service Mapping

- **IEC 61850-9-2**: Sampled values over ISO/IEC 8802-3 (released end of 2011)



Logical View of IEC 61850



Focus for project FITNESS

IEC 61850-9-2 standard has never been implemented in GB network and application of this protocol fundamentally changes the way current and voltage are measured in substations. This protocol enables analog voltage and current measurements to be digitized at the source and carries the digitized sampled values over a fibre optic and ethernet network (process bus) to control room. This enables substation planners to reduce dramatically the use of copper in substations (up to 80%) and replace it with a simple fibre optic network known as the “process bus”, and the resulting instrumentation, control and protection system is commonly referred to as “digital substation”.

This application of this standard although has major financial and environmental benefits is a huge step change in the basic design of substations. Also digitization of analog signals at source relies hugely on accurate time synchronisation and interoperability of various devices all of which receive measurements from a common source. Further, it enables the use of new instrumentation technologies that cannot be used with conventional hardwiring, thus the IEC 61850-9-2 is an enabler for measurement devices that are physically more compact, better quality of data, and wider application of the data sources. The standard decouples the primary and secondary equipment and reduces and/or eliminates requirement of planned outages increasing network availability and reduce footprint reducing substation building costs. However the reliability and security of this solution as compared to conventional substations and multi-vendor interoperability is still unproven in the GB.

NIA project AS3 led by NGET and with SPT participation concluded that manufacturer products at the end of the project were not fully-interoperable and defined a set of recommendations to improve reliability and operation times. Since then, manufacturers have improved their products and claim to

	<p>be fully interoperable, achieve the same operational times and be as reliable as conventional substations. There is still the inherent risk of reliable substation protection and control using this technology which can only be proven through a live demonstration proposed by FITNESS.</p> <p>FITNESS aims to bridge the gap between technology readiness from vendors and user readiness for seamless integration of digital substations with its huge perceived but unproven benefits to business-as-usual application in RIIIO T2. FITNESS recognises that demonstrating the integrated substation system readiness is vital, and that individual component readiness is not sufficient for transition to business as usual. This system integration applies not only inside the substation, but also with its linkages to external network systems and applications.</p> <p>Additionally, FITNESS will also prove that the digital substation infrastructure is beneficial and far more suitable for accelerated roll-out of wide area monitoring and control applications currently being developed under NIC projects VISOR and EFCC.</p>
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Project code	SPTEN02	Question Number	Q7
Question date	08/09/2015	Answer date	11/09/2015
Submission section question relates to	Criteria (b)		
Topic	Costs		
Question	Please provide a detailed breakdown of the project budget against tasks, with timings.		
Notes on question			
Answer	<p>Project FITNESS is planned to be delivered in 5 work packages (WP). WP1, WP2, WP3 are the main streams for delivery of FITNESS solution. WP4 and WP5 cover the overarching requirements for the successful delivery of the project.</p> <p>The details of each work package, tasks, timings and costs are as follows:</p> <div style="background-color: black; height: 150px; width: 100%;"></div>		

Total project cost £11.1m,

Network licensee compulsory £0.96m,

External Funding £1.14m

NIC Funding request £8.442m

Contractual arrangements: project inception, procurement, delivery

[REDACTED]

Project FITNESS team has already initiated contractual negotiations with its partners. These negotiations will be finalised and the contracts will be signed as the 1st phase of the project in line with NIC funding direction.

WP1 - Substation Design

[REDACTED]

Description: WP1 in FITNESS includes detailed substation engineering design, reliability and availability analysis of the process bus architecture selected for implementation and development of pre-site testing plan.

1.1.1 Architecture & design of substation system

[REDACTED]

Description: Analysis of recommendations and specifications from AS3 project and literature research for selection of process bus architecture for substation implementation.

1.1.2 Reliability / availability analysis

[REDACTED]

Description: Perform reliability and availability analysis on a selection architectures to select the most appropriate architecture for project FITNESS. Develop architecture selection procedure for future implementations.

1.1.3 Bay selection, site survey, engineering feasibility

[REDACTED]

Description: Substation bay selection through site survey and approval by stakeholders. Perform feasibility analysis for actual installation.

1.1.4 Engineering design for NCIT & MU installation

[REDACTED]

Description: Define the multi-vendor equipment to demonstrate interoperability and standardised design. Finalise engineering design for

substation implementation.

1.1.5 Define high level lab environment requirements

[REDACTED]

Description: Design the test environment configuration and test plan for pre-installation tests.

WP2 - Substation Lab & Live Performance Trials

[REDACTED]

Description: WP2 focusses on testing the architecture developed in WP1 in low and high voltage laboratory environment leading to site parallel installation and finally live operation multi-vendor digital substation concept.

2.1 Lab Functionality & Interoperability Testing

2.1.1 Functionality & Interoperability Test Plan (LV Lab tests)

[REDACTED]

Description: Create an extensive test plan for lab based functionality and interoperability test plan with combined input from all TO

2.1.2 Design & Implement Test Lab environment

[REDACTED]

Description: Design and procure devices for low-voltage laboratory testing (planned in University of Manchester with existing AS3 infrastructure).

2.1.3 Perform functionality & interoperability tests, and report

[REDACTED]

Description: Low voltage laboratory interoperability testing of the architecture developed in WP1 for implementation in site. Publish interoperability testing report after testing.

2.1.4 Diagnosis of outstanding issues and plan for resolution

[REDACTED]

Description: Analysis of any outstanding issues from laboratory testing and identification of any non—compliance in standards to be resolved before site installation.

High Voltage Testing

2.1.5 Functionality & Interoperability Test Plan (HV Lab tests)

[REDACTED]

Description: Repeat the same for a high voltage laboratory testing at ALSTOM high voltage laboratory in France.

2.1.6 Design & Implement Test Lab environment

[REDACTED]

Description: Set up test equipment and devices for high voltage laboratory testing.

2.1.7 High Voltage Tests, and report

[REDACTED]

Description: Perform high voltage laboratory tests and publish findings in report.

2.1.8 Diagnosis of outstanding issues and plan for resolution

[REDACTED]

Description: Identification and analysis of any outstanding issues to be resolved before site installation.

2.2 Bay #1 Installation & Commissioning

2.2.1 Bay #1 Substation installation & commissioning, and report

[REDACTED] [REDACTED]

Description: Installation of ALSTOM and ABB non-conventional instrument transformers and ALSTOM main and ABB backup substation secondary system and ALSTOM substation automation system.

2.2.2 Bay #1 Piggy-back trial phase, and report

[REDACTED] [REDACTED]

Description: Perform commissioning tests and operate parallel to the conventional system, closely monitoring performance under transients and faults.

2.2.3 Bay #1 Live operational trial phase, and report

[REDACTED] [REDACTED]

Description: After successful confidence build-up only with sufficient analysis go live with the 1st digital bay.

2.2.4 Bay #1 Distributed Optical Sensor installation & test

[REDACTED] [REDACTED]

Description: Install and test Synaptec distributed optical sensors and its compatibility with standard process bus architecture and comparison with NCIT architecture.

2.3 Bay #2 Installation & Commissioning

2.3.1 Bay #2 Substation installation & commissioning, and report

2.3.2 Bay #2 Piggy-back trial phase, and report

2.3.3 Bay #2 Live operational trial phase, and report

2.3.4 Bay #2 Distributed Optical Sensor installation & test

2.4 Substation Extended Performance Trials Report including recommendations

WP3 - Substation-to-System Information & Control Integration

- a. VISOR-NIC real-time synchronised phasor & scalar (@50Hz & 200Hz)
- b. EFCC NIC - robust wide area control infrastructure
- c. Smart Transmission Zone NIA – boundary stability control

Demonstrates that digital substations can be easily integrated with

existing central system for a seamless transition to business as usual.

3.1 Integrating Information with WAMS/EMS Monitoring Applications

3.1.1 Implement & test NCIT/MU to PMU/DFR/harmonics measurement chain

[REDACTED]

Description: Demonstrate flexible addition/enhancement of substation monitoring without outage, and opportunity for measurement redundancy.

3.1.2 Topology & measurement validation of substation-to-system information

[REDACTED]

Description Using WP2 installation of process-bus-enabled synchrophasor/fault recorder/PQ device, demonstrate delivery of data over standard protocols to receiving applications in central EMS and Wide Area Management System (WAMS), Fault Management, etc.

3.1.3 Central information infrastructure enhancement (WAMS, CIM, new data sources)

[REDACTED]

Description: Prove that data quality can be enhanced by substation-level topology and measurement validation stage prior to sending to central information system, improving quality of EMS/WAMS applications.

3.1.4 Central application enhancement #1 Fault information management

[REDACTED]

Description: Enhance existing phasor point software from project VISOR and existing fault recording software to include fault information management from digital substations.

3.1.5 Central application enhancement #2 Harmonics

[REDACTED]

Description: Enhance existing central system software to include harmonics mapping based on enhanced measurement quality and accuracy from digital substations.

3.2 Demonstrating Wide Area Control Infrastructure and Applications

3.2.1 Demonstrate flexible phasor-based control platform & interfaces

[REDACTED]

Description: Implementation of wide area control unit in digital substation.

3.2.2 Demonstrate EFCC use case and associated substation-to-system

interaction



Description: Demonstrate the feasibility and accelerated roll-out mechanism of enhanced frequency control in digital substation.

3.2.3 Investigate feasibility of wide area voltage stability control use case



Description: Demonstrate that requirements of the NIA and NIC wide area monitoring and control can be implemented in the digital substation using a standard design, with flexibility to apply various algorithms and logic to meet current and future requirements, using fast-acting control and without direct hardwiring or outage. NIC/NIA use cases will be implemented, using the outputs of the above NIA/NIC projects, and performance studied.

3.2.4 Demonstrate adaptive protection central logic and substation-to-system interaction



Description: Demonstrate that protection group settings can be selected from wider system observations, thus enabling adaptive protection in case of low carbon generation and fault level changes.

WP4 – Security



Description: WP3 is designed to assess the security issues associated with the Digital Substation open standard architecture, and develop a risk-assessment tool and strategy for identifying mitigation measures and processes can be applied to minimise and control the risks. This work package will also investigate new security issues arising with wide area monitoring and control and define the processes to address them.

4.1.1 Report on cyber security measures in the substation



Description: Literature review of different cyber security measures undertaken in other implementations of IEC61850 worldwide. Drawing on the experience from RTE Poste Intelligent project.

4.1.2 Risk assessment tool for the FITNESS substation



Description: Develop and demonstrate a risk assessment tool to assess all devices against security risks and publish tool to be used by other TOs and DNOs.

4.1.3 Demo remote access, data transfer and security measures – LAB



Description: Demonstrate secure remote access to protection and

monitoring equipment in substations, remote change of setting saving time spent on site.

4.1.4 Demo remote access, data transfer and security measures - LIVE SS

[REDACTED]

Description: Demonstrate secure remote data transfer and test security measures through cyber security threat simulation.

4.1.5 Investigate / compare IEEE C37.118 and IEC 61850-90-5 wrt cyber security

[REDACTED]

Description: Compare the two widely used protocols used for phasor point data transfer against security parameters.

4.1.6 Report on cyber security for Wide Area Control infrastructure

[REDACTED]

Description: Analyse security issues with wide area monitoring and control and define parameters for enabling secure wide area control through digital substation architecture.

WP5 - Knowledge Dissemination

[REDACTED]

Description: Knowledge dissemination is described in detail in section 5 of the full proposal and a detailed training plan is described in Appendix C C.5.

Bringing large-scale innovations such as FITNESS from demonstration to business-as-usual is a challenging feat, and although we have received support from the necessary business areas the progression into day-to-day operations will require comprehensive internal stakeholder engagement, and through open debates with external parties to ensure all concerns are considered. Our project plan accommodates for regular stakeholder events, to grow confidence of the technology, highlight findings, discuss challenges and, ultimately demonstrate the successful operation of the IEC-61850-2 principles. In order to ensure this feat is overcome, we have made allowances within the budget for the development and management of a dedicated project website, regular and effective publications and explanatory material (infomercials, interviews, etc), the facilitation of biannual stakeholder events.

5.1.1 Training & Workshop plan and setup

[REDACTED]

Description: Develop a detailed hands-on training and work package plan for TOs and DNOs (Appendix C.5).

5.1.2 Training and Workshops

	<div></div> <p><i>Description:</i> Organise 2day training bi-annually for all system users, planners, engineering design experts and transmission operations experts. Organise a day workshop biannually for all TOs and project advisory group.</p> <p><u>5.1.3 Cigre B5 working group and contributions to standards bodies</u></p> <div></div> <p><i>Description:</i> Maintain constant communication with international standards organisation and communicate efficiently issues found during interoperability testing and improve standard definitions where required. Learn from new emerging standards development.</p> <p><u>5.1.4 GB Stakeholder Dissemination Events (incl TOs & DNOs)</u></p> <div></div> <p><i>Description:</i> General stakeholder event for wider industry engagement and knowledge dissemination.</p> <p><u>5.1.5 Annual Innovation conference participation</u></p> <div></div> <p><i>Description:</i> Presenting at least one innovation conference annually.</p>
Attachments	

Electricity Network Innovation Competition Full Submission
Supplementary Answer Form

Project: SPT FITNESS

Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q8
Question date	08/09/2015	Answer date	11/09/2015
Submission section question relates to	Criteria (e)		
Topic	Partners		
Question	Please specify the role of each of the partners		
Notes on question			
Answer	<p>FITNESS project has carried out extensive stakeholder engagement to identify its project partners. FITNESS project partners and project advisory group covers a range of industries who will play a key role in the successful delivery of the project: OEMs, SMEs, Academia, GB and European TOs, International Experts.</p> <p><u>OEMs and SMEs</u> The key aim of the project is to prove standardised multi-vendor interoperability. This is essential for the business-as-usual roll-out of digital substations. A single vendor solution will lead to market dominance and will be comparable to proprietary solution and not acceptable under current procurement policies of transmission owners.</p> <p>In order to prove multi-vendor interoperability ALSTOM Grid and ABB will deploy interoperable solutions with ALSTOM measurement units combined with ABB protection and vice versa. Interoperability will be further proven through integration of Synaptec's distributed sensing technology. Upon successful completion this will prove that any vendor solution compliant with international standards can be easily interfaced other vendor devices providing flexibility to TOs to choose from range of solutions from multiple vendors.</p>		

It may be noted that Alstom's contribution is relatively large, as their involvement includes the substation architecture, management system, cyber security and the interaction between the substation and external EMS, WAMS and control mechanisms. This is consistent with a practical roll-out scenario where there will be only one management system. The arrangement also leverages the knowledge and innovations in the VISOR and Smart Frequency Control (ie EFCC) projects.

Academia

FITNESS will encourage co-ordinated knowledge dissemination regarding standardisation and digital substations among all TOs and DNOs. In recent years there has been significant interest in IEC61850 standard and its various applications in substation automation.

The **University of Manchester** (UoM) through its previous participation in AS3 and VISOR innovation projects has the necessary laboratory set-up to undertake the set of interoperability tests required for project FITNESS. These set ups will be further utilised for hands-on training and workshop purposes.

Dr Haiyu Li from **UoM** is also involved various IEC61850 working groups and will be key to encouraging continuous improvement of international standards through the lessons learnt in project FITNESS.

GB and European TOs

Development of international standards and new integrated protection, monitoring and control solutions requires collaboration among TOs and SOs. FITNESS acknowledges the importance of input from GB and European TOs especially experts from different TOs dealing directly with protection and control. **NGET** and **SSE** have kindly extended their support and willing to participate in project FITNESS as project advisors. FITNESS has engaged with **NGET** and **SSE** protection and control experts during FITNESS scope definition in order to avoid any potential duplications from previous NIA, IFI projects and also to carry forward lessons learnt.

French TSO **RTE** is currently executing a related project "Poste Intelligent" funded by French Government. The scope of "Poste-Intelligent" does not cover multi-vendor interoperability and wide area monitoring and control integration (see letter of support). **RTE** is keen to participate in project advisor group of project FITNESS to encourage knowledge dissemination amongst European TOs to promote route of standardisation and digital substations from innovation demonstration projects to business as usual.

International Experts – PAC World

PAC World magazine is internationally renowned for publishing innovations in the field protection, monitoring and control. PAC World editor-in-chief Dr Alexander Apostolov is a pioneer of IEC 61850 standard. FITNESS undertook a wider industry stakeholder engagement at the recent PAC world conference held in Glasgow in June'15.

Dr Apostolov extended his full support to project FITNESS and provided a letter of support (pg. 93 full proposal) for the project full submission. **PAC World** will be an excellent medium for knowledge dissemination internationally from project FITNESS and Dr Alexander Apostolov's involvement will provide us necessary insight into adoption and the latest developments in international standards for substation automation.

The individual project partner specific roles are as listed below:



ALSTOM Grid will deliver a full suite of digital substation solutions and innovative developments including the interaction with external systems for

control and monitoring. The intended delivery includes:

- Protection systems, including hot standby protection devices;
- Process bus;
- NCITs and MU;
- PMUs interfaced with process bus architecture and with WAMS platform;
- Enhanced synchronised measurements introduced in VISOR for sub-synchronous oscillation;
- Wide area monitoring, power quality and disturbance features extracted from digital substation data
- Flexible wide area control infrastructure, including Aggregator and Phasor Controller functions based on the EFCC use case, but adaptable to other control needs;
- Substation Control System (SCS).

ALSTOM Grid in its response to partner selection criteria included delivery of innovative NCIT, wide area monitoring and control solutions and interface to existing PhasorPoint software deployed in project VISOR. ALSTOM will provide R&D labour contribution of £1m in kind contribution in development of its substation automation software and wide area solutions during project FITNESS.

Previous Innovation Experience: VISOR, EFCC, AS3, Poste Intelligent France



ABB will also deliver a full suite of digital substation solutions primarily to demonstrate interoperability with other technology partners and to indicate the maturity of the supply chain to deliver redundant multi-vendor

solutions including:

- Protection systems, including hot standby protection devices;
- Process bus;
- NCITs and MU;
- PMUs interfaced with process bus architecture and with WAMS platform.

ABB in its partner selection criteria demonstrated strong focus on digital substations and interoperability concepts. ABB will provide £0.4m in form of R&D labour and testing equipment in kind contribution to project FITNESS.

Previous Innovation Experience: AS3, Loganlea Australia, Braemar Australia.

ALSTOM and ABB are global leaders in developing power system protection and wide area monitoring applications. Each company has invested in research and development of digital substation solutions and are constantly striving to improve their solutions through live demonstration projects such as FITNESS. ALSTOM and ABB will demonstrate multi-vendor interoperability, integration of smart grid standards at substation and central system level. ALSTOM's High voltage test facilities are available for use by the project. The multidisciplinary team of ALSTOM and ABB will also participate extensively in training, workshops and other knowledge dissemination to support the wider acceptance of the technology by internal and external stakeholders.



Synaptec is a UK based SME and spin out from University of Strathclyde. Synaptec is designing and developing its distributed sensing technology as a part of an existing NIA project. In project FITNESS Synaptec will develop interface of distributed sensors onto process bus architecture and output in IEC 61850 9-2LE format for development of future applications based on this innovative technology.

	<p>Previous Innovation Experience: Distributed Photonic Grid Instrumentation</p> <div data-bbox="304 170 624 304">  </div> <p>University of Manchester (UoM) has been involved in the past with NIA projects AS3 and NIC projects VISOR and EFCC. The testing facilities established in UoM as a part of AS3 and the offline testing laboratory facility can be utilised to test the digital substation architecture, interoperability to ensure reliability of solution before live implementation. UoM will also aid the FITNESS delivery team in knowledge capturing and dissemination activities through Cigre working Groups associated with international standards development. UoM will provide an in kind contribution of £0.15m to project FITNESS in form of RTDS simulator, technical laboratory support and project consultancy.</p> <p>Previous Innovation Experience: VISOR, EFCC, AS3</p> <p><u>Project Advisory Group</u></p> <div data-bbox="304 725 807 819">  </div> <div data-bbox="304 893 603 992">  </div> <p>SPEN has engaged with NGET, SSE and RTE during FITNESS proposal development, and technical experts from NGET, SSE and RTE will be part of FITNESS advisory group. Their role will be to assess FITNESS scope, avoid duplication of solutions, and define key deliverables and disseminating knowledge captured internally in NGET and SSE. All trainings and workshops will open to NGET and SSE engineers for participation and learning. RTE will add value by sharing lessons-learnt from its ongoing Poste-Intelligent project and aiding in knowledge-dissemination among all ENTSOE members.</p>
Attachments	<div data-bbox="373 1263 440 1323">  </div> <p>Letter_of_support_RTE.pdf</p>

Electricity Network Innovation Competition Full Submission
Supplementary Answer Form

Project: SPT FITNESS

Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q9
Question date	08/09/2015	Answer date	11/09/2015
Submission section question relates to	Criteria (e)		
Topic	Partners		
Question	Two manufacturers are to be involved in this project. What impact will this have on the market for this activity after project completion?		
Notes on question			
Answer	<p>The involvement of two OEMs and one SME in project FITNESS will have a very positive impact on the GB the market for digital substations and future business-as-usual roll-out to realise all benefit cases highlighted in the full-submission.</p> <p><u>Business as Usual Roll-out</u></p> <p>GB TO transmission protection security, reliability and availability standards require multi-vendor protection schemes to be implemented in transmission substations. This is required to ensure that failure of a particular vendor protection scheme will not result in failure in detection of faults on the network.</p> <p>The procurement processes and practices in place to procure substation secondary system equipment require multiple-vendor solutions to be available in market to ensure that appropriate tendering processes can be followed for due-diligence and ensuring value for money to GB network owners and customers.</p> <p>Participation of two major OEMs in FITNESS and successful demonstration of</p>		

interoperability will encourage seamless transition of digital substations to BaU in RIIIO T2.

Supply Chain Engagement and Market Competition

TO experience to date has shown that both proprietary and standard protocols are used. While there are standards that are extensively used (for example for SCADA/RTU communications), there are also functions required in the substation where proprietary protocols or different interpretations of standards can be a problem (such as fault management). The use of proprietary systems limits the possibilities for expansion and competitiveness. Encouraging more than one manufacturer to develop standardised solutions reduces the risks of monopoly of a single vendor in the market.

Standardising the substation hardware and functions disconnect the central management systems from the substation equipment, enabling more flexible and competitive substation equipment selection. The demonstrations of IEC 61850 standards to date have mostly applied single vendor solutions and more experience with interoperability is required. Without proven interoperability, an IEC 61850 design suffers from the same market disadvantages as proprietary solutions.

The limitation to two vendor solution is a decision to efficiently balance between demonstration of interoperability, project management requirements and delivering the project on time, and to reflect the practical implementation scenario. IEC61850 is an international standard and that there are other suppliers (e.g. SIEMENS, GE, ZIV) with equipment/systems/product that meets the requirements of the standard. It should be noted that Alstom and ABB are two of the leading suppliers of substation equipment in GB, and therefore provide a valid and representative reference for interoperable solutions. Part of the intent behind FITNESS is to demonstrate that it can be delivered as a multi-vendor solution and learning outcomes should ensure that the solution does not create barriers to supply chain competition in the long term.

FITNESS will prove multi-vendor interoperability and encourage competition in the market and this will ultimately encourage vendors to reduce costs as digital substations and solutions will be adopted increasingly in load and non-load related investments.

Development of standards and accelerated adoption of digital substations

It is widely recognised that a standard approach provides savings for all, suppliers, TSO and customers. However, since 61850 has not been widely proven in service to date it is slowing progress and not resolving the uncertainty around unproven benefit cases for TOs. This is major hindrance for TOs to progress with digital substations and for manufacturers to test their equipment to improve their solutions in a live substation environment.

FITNESS will thus accelerate the move towards a digital substation, which as the full proposal states has huge financial and environmental benefits.

	<p><u>European directives for Standardisation</u></p> <p>FITNESS solution is in line with European smart Grid Co-ordination Group “Methodologies to facilitate Smart Grid system interoperability through standardization, system design and testing”. Multi-vendor solutions are the only way of proving the validity of standards and giving two manufacturers the opportunity to test the standard and prove interoperability in a real substation environment will help alleviate concerns and accelerate the uptake of this technology.</p> <p>FITNESS will provide manufactures a opportunity to test their solution in live substation environment and validate interoperability in operation with another vendor. This will provide manufactures and international standards groups huge insight into the shortfalls if any in the solutions and definition of standards to date. This is in the spirit of what IEC61850 substation automation standard was created for and will be monitored closely by international utilities, working groups and vendors.</p> <p>FITNESS contains a large knowledge dissemination content which is crucial in the education of the industry in the benefits of a standardised, interoperable, fully digitised closed loop substation.</p>
Attachments	

Electricity Network Innovation Competition Full Submission
Supplementary Answer Form

Project: SPT FITNESS

Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q10
Question date	08/09/2015	Answer date	11/09/2015
Submission section question relates to	Criteria (a)		
Topic	Benefits		
Question	Please provide clarity how certain you are about the project benefits. Confidence intervals around the figures may help.		
Notes on question			
Answer	<p>The FITNESS project undertook a Cost Benefit Analysis (CBA) and developed a tool (see attachment) as described in Appendix B of the full proposal, which is the result of an extensive process of reviewing several areas of anticipated benefits.</p> <p>The sensitivities considered were based on the number of transmission bays projected to be built or replaced in RIIO T2, T3, T4, T5 load and non-load related schemes under the 2014 Future Energy Scenarios (FES) Gone Green (GG), Slow Progression (SP) and Low Carbon Life (LCL) FES Scenarios. A further sensitivity analysis was applied based on the uptake of digital substations. The No Progression scenario has not been included in the analysis as it is thought to be the most unlikely scenario. The sensitivities applied are as described:</p> <ul style="list-style-type: none">• For GG scenario, the number of bays that were built and refurbished in RIIO T1 has been multiplied by a factor of 1.2 for T2 to T5.• For SP scenario, the number of bays that were built and refurbished in RIIO T1 has been multiplied by a factor of 1 for T2 to T5.• For LCL scenario, the number of bays that were built and refurbished		

in RIIO T1 has been multiplied by a factor of 0.8 for T2 to T5.

In addition to the FES, two other scenarios have been developed which are related to the expected success of the FITNESS demonstration project, and hence the expected uptake of the digital substation solution. The two scenarios are PU and FD.

- FD Scenario – more viability of Digital Substations (80-100% depending on the scenario)
- PU Scenario – lesser viability of Digital Substations (50-70% depending on the scenario)

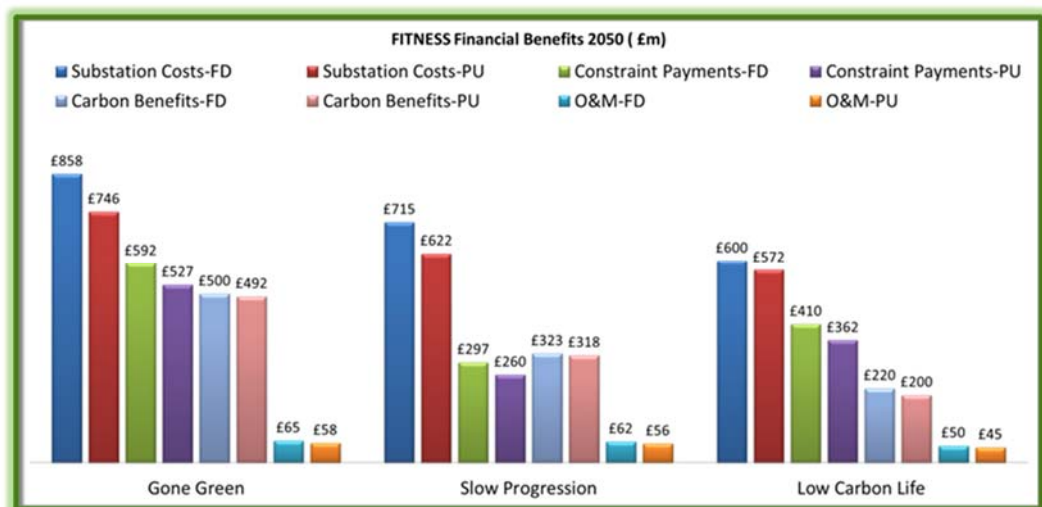
The confidence intervals for the benefits calculated are built around the future energy scenarios. The FES defines different set of parameters for each scenario

- GG scenario predicts significant uptake of wind and innovation
- SP scenario predicts lower uptake of wind and innovation and slower economic growth
- LCL scenario predicts more nuclear generation connected to the transmission network and large economic growth promoting more innovation.

The analysis of the benefit cases determine that the following issues addressed by FITNESS remain in all scenarios and thus it can be confidently stated that FITNESS project upon successful completion will deliver benefits to GB customers regardless of future energy parameters and policies

- Replacement of aging asset base (Substation Costs)
- Requirement of planned outages for replacement and modernisation work (Constraint Payments and Energy Not Supplied (ENS) penalties)
- Requirement of a flexible infrastructure to accelerate integration of smart technologies such as wide area monitoring and control (Operation and Maintenance)
- Requirement to reduce environmental impact of substations (Carbon and Environmental benefits)

Furthermore the application of sensitivity of different uptake scenario for the digital substations based on the FES further confirms that FITNESS will deliver benefits in all categories.



Our confidence intervals for various benefit cases are as indicated in the

table below

Benefit Case	Confidence Interval	
	UPPER BOUND	LOWER BOUND
Substation Costs	£858m (GG-FD)	£572m (SP-PU)
Constraint Payments	£592m (GG-FD)	£260m (LCL-PU)
O&M Costs	£65m (GG-FD)	£45m (SP-PU)
Carbon Benefits	£500m (GG-FD)	£200m (SP-PU)

Our confidence in the benefit calculations are further enhanced by the extensive review process undertake and the accuracy of the information sources as described below.

Extensive Review Process

The benefits thus calculated were reviewed within SPEN by the Transmission Network Manager and his team before a final review and approval by the SPEN Board of Directors. The overall process for verification of the project involves a number of stages of stakeholder engagement:

- Initial engagement, information exchange on needs, ideas and offering;
- Selection of lead partner and consultants, on basis of quality of solution offered, engagement with the innovation process, and cost;
- Workshop on project proposed contents, SPEN stakeholders and suppliers, reviewing and refining the planning for the project.

The proposal is drafted by the SPEN team with support from partners. The accuracy of the information was verified as follows:

- Review by SPEN Future Networks Team with partners on the accuracy of the information in the proposal;
- Draft approved by SPEN Future Networks Team for review by wider SPEN stakeholders;
- Review by engineering management stakeholders, particularly in asset management;
- Review and approval by SPEN board.

Verification of Information sources

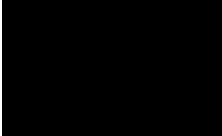
Technology and innovation related information is crucial for NIC projects to ensure the technology and solutions demonstrated have future applications and have not yet been proven in GB. Following information sources were used in development of the CBA tool.

Technology and innovation

Key sources for technology readiness and innovation components for FITNESS include:

- GB TOs and international TOs experience in designing and deploying substations;
- Suppliers base and projects undertaken and executed internationally and in GB;
- IEC 61850 working groups representatives and wider industry experts;
- ENA Approval list for approved protection and control equipment in GB;
- Reliability studies University of Manchester.

Commercial information

	<p>Key sources for commercial information include:</p> <ul style="list-style-type: none"> • RIIO T1 business plans from SPT (internal), NGET and SSE (public domain); • RIIO T2 estimates from SPT Network Planning and Regulation Team; • Constraint Payments from MBBS NGET website; • Digital substation benefits quantification from international experience and research articles; • Iberdrola Environmental Engineering Life Cycle Analysis Report. <p><u>Future needs of GB transmission network</u></p> <p>Key sources for information on the future needs of GB transmission networks include:</p> <ul style="list-style-type: none"> • FES, ETYS, SOF, UK Carbon Plan; • VISOR project delivery experience; • Previous NIC and NIA projects.
Attachments	

Electricity Network Innovation Competition Full Submission
Supplementary Answer Form

Project: SPT FITNESS

Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q11
Question date	08/09/2015	Answer date	11/09/2015
Submission section question relates to	Submission Spreadsheet		
Topic	Resource allocation		
Question	Please explain why the project manager and technical resource have been allocated the same time as each other for most technical tasks? It is expected that the PM would require fewer man-days than the technical resource.		
Notes on question			
Answer	<p>The role of the project manager (PM) in project FITNESS is crucial in each task. It should be recognised that project management is a major part of any substation project, conventional or innovative. The logistics and planning tasks are significant, including safety, environmental issues, engineering design, access, risk assessments, equipment supply, contractor availability, etc. The project management tasks in the FITNESS project are even greater than a conventional project for reasons outlined.</p> <p>The multitude of tasks and day to day involvement of the project manager is listed below:</p> <ul style="list-style-type: none">• FITNESS will be delivered by a multi-faceted team comprising of 2 OEMs, 1 SME, 1 Academic and involving 3 TOs and international standards organisation during project delivery. The co-ordination and seamless collaboration amongst all partners is crucial to successful delivery of the project. Based on experience gathered from delivering previous innovation projects, a PM receives on average 2 high-priority non-technical requests per day related to invoicing, business issues management and project-coordination. These issues sometimes can be delegated to other parts of the business but needs to co-ordinated by the PM.		

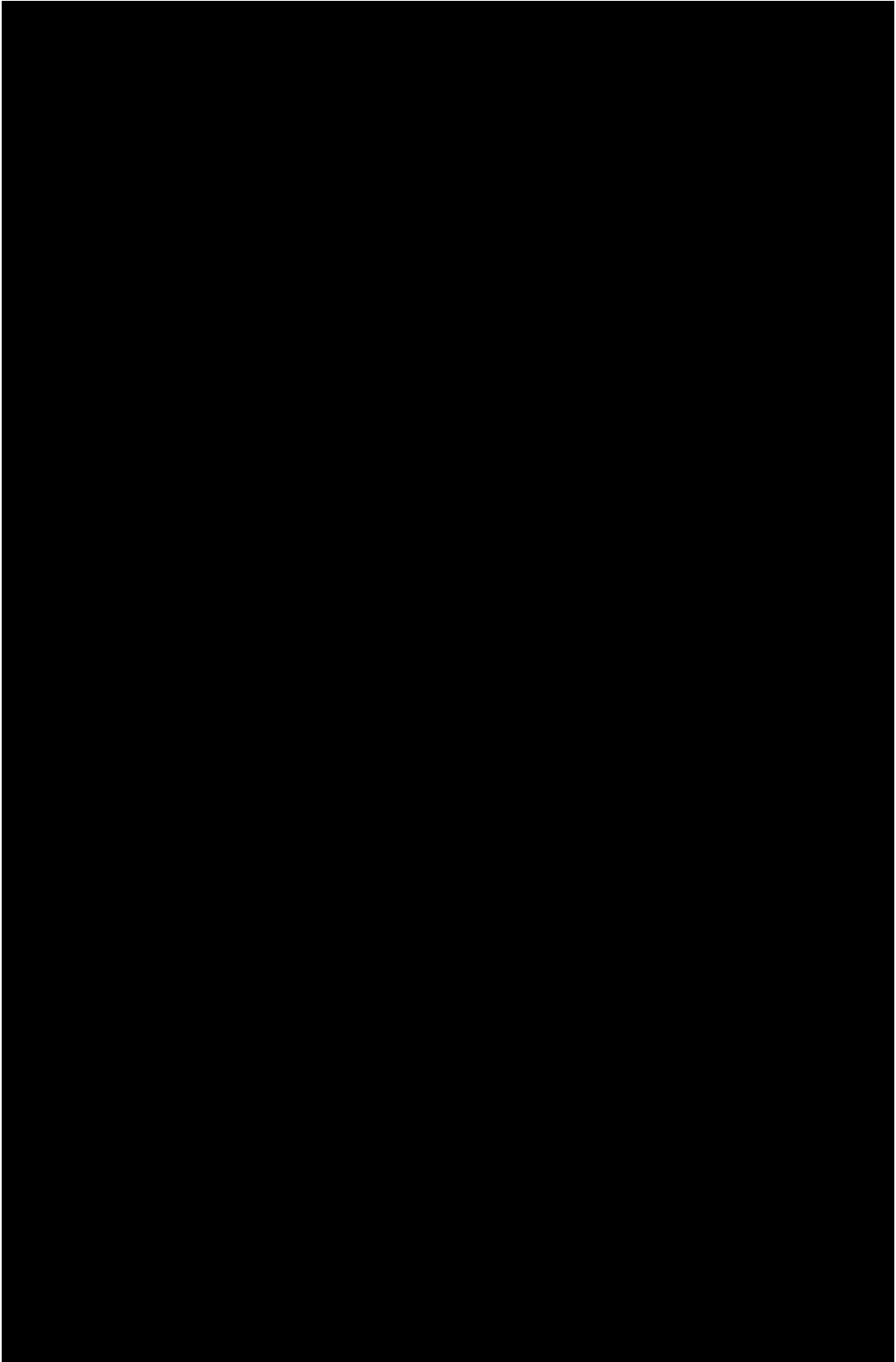
	<ul style="list-style-type: none"> • Multi-vendor interoperability is a key deliverable of project FITNESS. This requires involvement from the PM in addressing areas such as IPR issues, competition and confidentiality, and to ensure each vendor delivers its solution on time. A potential delay and failure to deliver the required solution will delay progress from the other vendor. These kind of delays will need to be managed, escalated and acted upon immediately to deliver the project on time. • Previous experience with projects implementing standardised solutions from various competing vendors indicate the project manager needs to be aware of the conflicts that can arise subject to non-conformity of any one vendor to the standard, or different interpretations of the same standard. There are different degrees of sensitivities involved around these issues. It will be the PM's duty with help from technical resource and experts in international standards to decide which vendor should modify their solution or a gap has been identified in the standard open to interpretation which needs to be resolved by the international standards committees. • There is a large degree of site work involved in project FITNESS which needs to be delivered alongside and within the time frame of a business-critical replacement work. In order to ensure that all engineers and contractors have access to the site and all health and safety guidelines are followed the PM will need to co-ordinate with the site PM to ensure the planned outage period is efficiently utilised and there is no delay in any site commissioning and testing work. Any issues thus resulting will be the 1st priority of the PM. • Prior to the site work mentioned above there is a period of engineering design which requires the PM to co-ordinate and ensure that information is accurately exchanged and all necessary communication is undertaken to avoid any errors in the final design. Following discussions with the SPT engineering design team FITNESS team concludes that even slight engineering design errors and lack of information can lead to cost-overruns and delays unacceptable in any project delivery. As FITNESS project is proposing a new innovative solution which the existing design team has to work with for the 1st time in this pilot installation there is a risk of design errors which will need to effectively managed by the PM, technical resource, the vendors and the engineering design team. • Knowledge dissemination is an emphasis of the project, and requires co-ordination to organise internal and external events. An objective of the project is to achieve the level of familiarity with the technology and related design processes within SPT and other GB transmission and distribution owners to roll out the technology in business-as-usual. <p>We thus conclude given the step change in design aspects of substations, involvement of various vendors and the technical nature of the project the PM will be required to be closely involved in most technical tasks.</p>
Attachments	

Electricity Network Innovation Competition Full Submission
Supplementary Answer Form

Project: _____ **SPT_FITNESS** _____

Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q12
Question date	22/09/2015	Answer date	24/09/2015
Submission section question relates to			
Topic	Method		
Question	Is it intended that the proposed solution will be applied to any substation replacements/refurbishments or will there be a criteria for selecting the "best practise candidates"?		
Notes on question	N/A		
Answer	<p>SP Transmission intends to demonstrate FITNESS digital substation solution in a live substation environment parallel to a conventional replacement and after successful demonstration roll-out the digital substation solution in RIIO T2.</p> <p><u>FITNESS Solution Roll-Out in RIIO T2</u></p> <p>After successful demonstration of project FITNESS in RIIO T2, the proposed approach is that, should the outcome of the FITNESS project be favourable for the business as usual adoption of the solution, it would be the default option for new build, replacement and modernisation projects.</p> <p>There will be site specific constraints which may require consideration when dealing with ageing assets on modernisation projects - optimising asset replacement and fully utilising existing assets. In these circumstances, the adaptation of the FITNESS solution which may be required to operate within the constraints would be balanced against a conventional solution to produce the most economic, efficient and co-ordinated solution.</p>		

	
Attachments	

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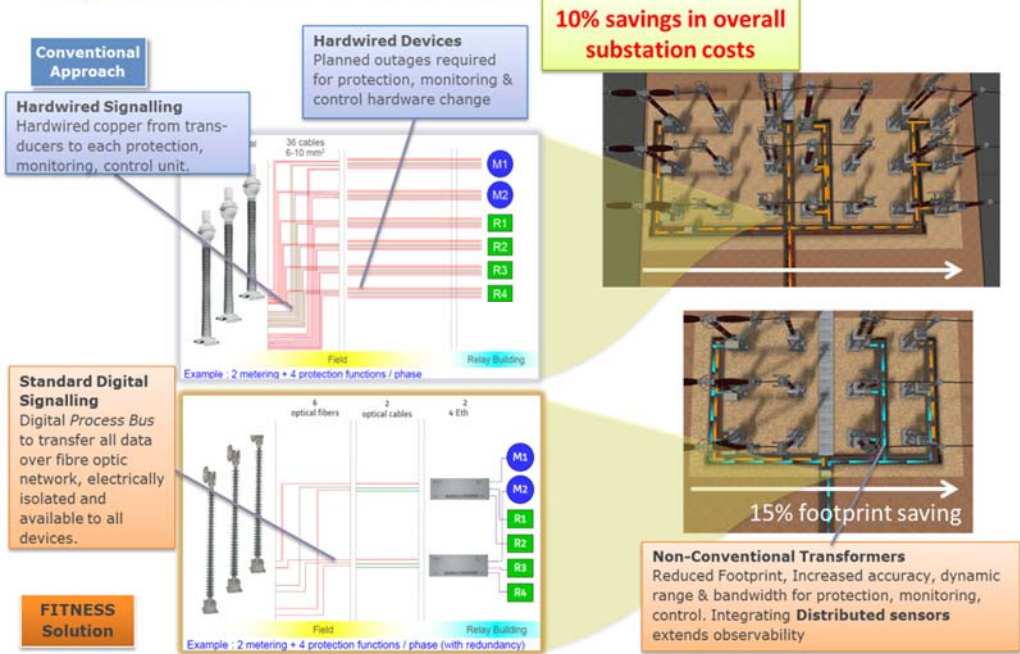
Tick if this answer has been provided verbally: ☐

Project code	SPTEN02	Question Number	Q13
Question date	22/09/2015	Answer date	24/09/2015
Submission section question relates to			
Topic	Method		
Question	Isn't some of what is being proposed already current practice for new substation? E.g. replacing analogue with digital, using fibre for comms		
Notes on question	N/A		
Answer	<p>New build substations currently use fibre optic for communication purposes only, however, these fibres generally communicate between secondary devices and/or devices in the substation and the central system. Project FITNESS is proposing a fully digital substation solution for measurement, control and communications.</p> <p>In all conventional substation designs to date the voltage and current analogue signals from the primary equipment (such as transformer and switchgear) are measured using hardwired multi-core copper cables. These analogue signals are carried over 100s of km of copper cables to the control building which houses the secondary equipment (protection, monitoring and control equipment). These secondary devices then individually convert analogue voltage and current measurements to digital signals to process them and run the applications.</p> <p>Digital substations are substations where the voltage and current signals from the primary equipment (such as transformer and switchgear) are digitized once at the source, close to the primary equipment, then carried over a simple network of optical fibre cables to the control building. Since all secondary equipment (protection, monitoring and control equipment) connected over a process bus architecture (ethernet cables) need to</p>		

understand the digital voltage and current values that are defined in a standardised format according to IEC61850-9-2. This standard defines the common language that all vendor equipment should speak and understand. Therefore multi-vendor interoperability is very important in digital substations.

The commissioning and implementing a digital substation architecture has never been demonstrated live in GB. FITNESS will demonstrate a pilot digital substation solution in a live substation environment deploying a multi-vendor fully integrated end to end (from substation to central system and back) process bus solution.

Digital Substations - Overview



Attachments