More, Faster, Less, Less

the business drivers for IEC 61850

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1 Abstract Summary

The development of IEC 61850 based substations will lead to exciting new opportunities and challenges for the utility as a whole and its staff in particular.

This paper describes the impact of IEC 61850 to deliver more projects in a shorter time using less resources and less money and provides a guideline for an approach

2 Introduction

The utilities in Australia have embarked on yet a another Regulatory Period of five years with challenging capital expenditure programs increasing their required performance with up to 100% compared to the last five years . At the same time utilities recognise the commercial imperatives to deliver projects more efficiently and with lower costs to yield direct benefits to the shareholders and stakeholders of their operations.

Of course the same pressures apply to the generation sector and the industrial sector, with as much if not more complexity and difficulty. These organisations generally don't have large in house engineering resources on tap and hence must compete for scarce resources whilst finding increasingly clever ways to deliver the projects with less production disruption.

Furthermore, existing systems are already ageing and the newer systems provide shorter operation life spans of only 15 – 20 years for various technical and operational reasons. On this basis and apart from any new substation projects, typical Transmission utilities in Australia and New Zealand, just as elsewhere in the world, are faced with replacing **seven to ten substation secondary systems per year**. Distribution utilities face several times more than that with several times more devices involved due to the greater number of feeders.

CIGRE (www.cigre.org) Technical Brochure 246 : "The automation of new and existing substations: why and how" : published 2004, chapter 1 states

> *"Primary equipment has an average lifetime of approximately 40 years and secondary equipment such as protection, control or communication equipment approximately 20 years.* ***Consequently, the secondary equipment has to be refurbished*** *[at least]* ***once during the lifetime of the substation****."*

Even this statement a few years ago is arguably over stating the life of some elements of the secondary systems. Hence due to the life of these systems, at the end of 15-20 years of continual effort to replace all these systems in existing substations the whole process will have to start all over again not only with the substations you have just completed the refurbishment, but also all the new ones built being built today which will then already be 15 years old - the work load will simply explode. The demand for our precious engineering resources and the work load they face will just grow and grow. The following chart is clearly a simplification but shows the effect on the number of engineering projects of increased development of new substations (green field) over just the next 10 years returning to "normal" levels thereafter, with the additional work of a 15-year refurbishment cycle of all the existing substations (brown field), extrapolated over the next 100 years.

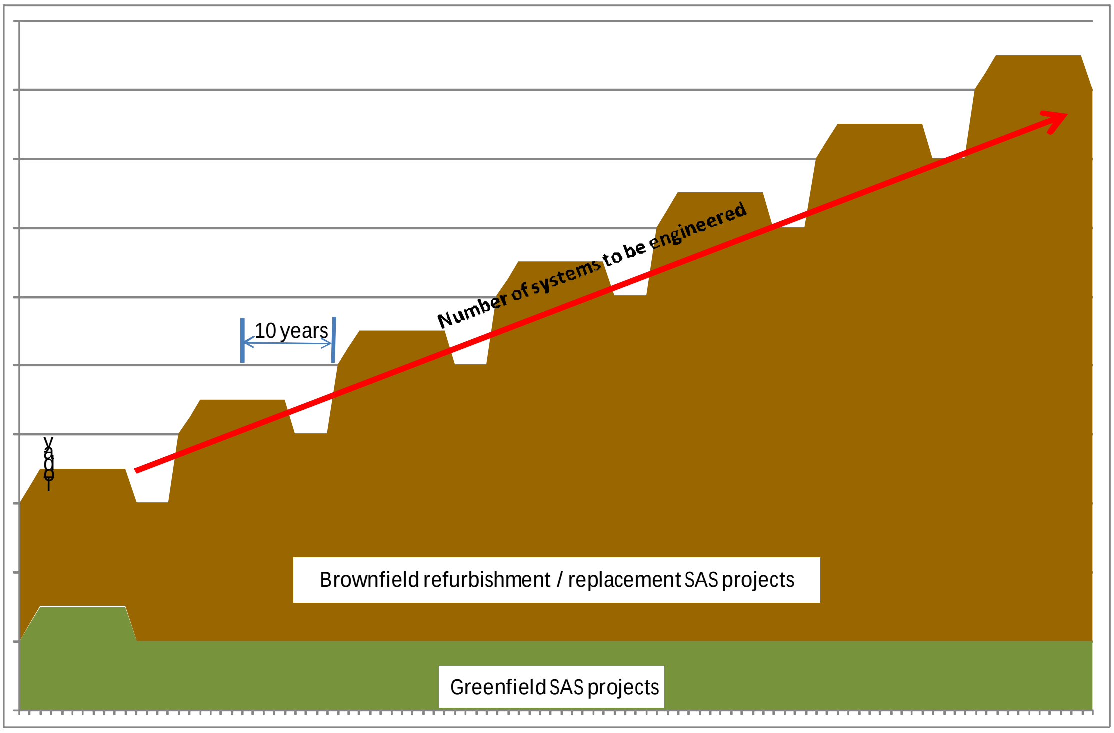

Figure 1: Demand for SAS engineering will increase

We must realise that the graduate working on a new substation development today, will probably see the third replacement of that secondary equipment before he retires! Hence our guiding principles for our technical solutions for whole of life costs are being extended to not just the life of the current asset, but to enable easier birth of the next asset life. We need systems to be built now that enable replacement and refurbishment in the future without having to start the whole engineering design again from scratch.

Such increased demands on our engineering processes cannot be met in respect of cost, time and effort with our traditional engineering approach and solutions to the SAS.

Organisations are clearly being driven by more diverse and compelling objectives than pure technical excellence, which was the driver for so many years in our past. Technical excellence is not shunned, but the corporate drivers are summed up in a phrase we have coined as "***More, Faster, Less, Less***". More projects delivered in faster time frames with less money and less resources. We could also add "***Higher, Lower***" to the phrase to include with higher reliability and with lower operational cost.

One avenue to achieve this outcome is through innovation in technical and project delivery strategies, undertaken in an environment where the market is generally considered to be resource constrained and there is strong competition for essential resources. One such technical option being considered is through the implementation of a new technology defined under IEC 61850.

3 Business Case

The implementation of IEC 61850 technologies as a means to achieve business operational goals must be based on sound business reasoning and not on the whim of a new technology fad. As technology changes as this is implemented, there will be initial project engineering effort required in order to develop the new technology solutions. Most utilities should expect this to continue over the first 2-3 projects as key enhancements associated with the technology are enabled.

This implementation strategy and project plan recommends inter alia, that the implementation of IEC 61850 technology is completed in association with a real CAPEX project. For such a project significant investments are required for upfront engineering research & development funds will be required to achieve a suitable IEC 61850 based solution. This could however be offset in part through consideration of a tax offset through the Australian Taxation Office R&D scheme.

The return on investment for the first projects will not be within the cost of the project itself. However in considering the next Regulatory Period's capital program, industry reports indicate that utilities could expect significant savings, even through moderate deployment.

The mechanism to achieve these savings is through improved efficiency in engineering design, commissioning and operation. This includes reducing wires, standardising engineering, reducing numbers of drawings, producing re-usable solutions and facilitating automated testing.

The development of the IEC 61850 technology provides utilities with the opportunity to create a training, simulation and ongoing development facility. This will create opportunities as the technology is taken up throughout Australia to

- investigate viability of future technology, innovations and new ideas
- identify further costs savings and improved operational performance
- provide key technical services internally and externally
- provide training on a commercial basis to the wider industry.

4 Technical Strategy

In order to achieve more output with less resource, utilities should invest in the development of an implementation strategy and project plan. This strategy is the basis for the integration and deployment of IEC 61850 based solutions in the utility's design standards for substation development.

In the development of the strategy, three key questions have to be reviewed:

1. Is the utility ready to implement new technology?
2. Is the new technology consistent with the utility's business objectives, vision and balanced score card?
3. Is it proven technology that will deliver true benefits to utility?

Most utilities have successfully implemented a number of technology steps over the last 10 years. This has brought an understanding of the limitations of piecewise technology development and the need for a holistic asset technology strategy and deployment to obtain significant reductions in cost and engineering time. This however is only if a utility has the capability and desire to undertake a new technology implementation such as IEC 61850.

Utilities in Australia recognise the significant ageing asset problem and the need to utilise new technologies, to drive step change improvements in the network. This is supported by IEC 61850's capability to improve efficiency in engineering design, commissioning and operation of its network. The implementation of the technology will improve the long term profitable growth of the organisation to increase shareholder value by reducing life cycle costs of substation secondary systems. In addition, the technology will provide added value through increased substation functionality with access to more comprehensive asset performance data and enable further ongoing innovation. By implementing proven state-of-the-art technology, utilities will be recognised as major thought leaders.

Worldwide substation experience is demonstrating that IEC 61850 is a technology which has already revolutionised the design and operation of substations since it was released in 2005. The standard itself is the result of co-operation between vendors and utilities over some 12 years with the aim of reducing life cycle costs of substations. Various reports of real implementations are indicating life cycle cost reductions of 10-30% and project lead times being reduced by 6 – 12 months.

Through the IEC 61850 definitions and structured approach, the amount of information (as distinct from data) available when using IEC 61850 based systems is better than utilities current solutions. This information is available virtually for free as it is an integral part of the IEC 61850 standard. The availability of this information at the same time enables utilities to develop new applications that enhance the asset management abilities, speed of fault location and restoration, enabling integration of embedded generation and demand side management, loss reduction applications.

The benefit of such a structured approach to device operation affects the traditional capital areas of engineering projects such as:

- **Design** – the use of integrated specification tools and standard design elements reduces the effort involved in the development of Substation Automation Systems (SAS) with the added benefit of automated documentation processes
- **Implementation** – automatic generation of validated device configuration files
- **Construction and installation** – elimination of extensive field wiring and potential wiring errors throughout the substation and in the control room through the use of optical fibre connections
- **Commissioning** – automatic creation of test programs and the ability to model and simulate the system reducing on site testing
- **Documentation** – provides on line access to “as operating” documentation without the need to continually re-create as built documentation and eliminate database issues

5 Implementation Objective

Based on business cases and a technical strategy the implementation objective of IEC 61850 should be as follows:

- to commence integration of IEC 61850 into the utility’s design standards and
- to establish training, simulation and development capabilities within the utility

There are at least three fundamental requirements of an IEC 61850 implementation strategy to achieve the objectives:

1. Development of an essential knowledge base and intellectual property within utility & its stakeholders
2. Selection of a project in order to focus key R&D effort
3. Identifying an ongoing regime for integration of IEC 61850 in future substation projects as a migration process

One key element for the success of any IEC 61850 deployment is that there should be process put in place to develop expertise to engineer, deploy, commission and operate IEC 61850 based systems. This requires utilities to develop, simulate and test new operational schemes and to enable stakeholders to undertake full hands on training. Ideally utilities should develop knowledge around all elements of IEC 61850 based solutions, including intelligent primary plant in combination with secondary system, training, simulation and development capabilities.

6 Selection Criteria For The First Capex Project

When selecting the first CAPEX project for the implementation of IEC 61850 one should look for any project that provides a reasonable time frame for both the development of the IEC 61850 solution and the essential training to the utility and its maintenance service providers. The development of the substation using IEC 61850 should fit well within a reset period so that it can serve as a basis for further projects during this period. Further selection criteria are the criticality in the network and whether it is a green-field development. The latter ensures that it is free of encumbrances associated with having to develop interface solutions between legacy systems and the new IEC 61850 solutions – these interfaces will be able to be considered in future projects on the basis of the experience gained in deployment of a “clean” IEC 61850 system.

A very common approach when starting with IEC 61850 is to retain conventional primary plant with standard IEC 61850 interfaces to mitigate delivery risks. This will enable full IEC 61850 operational experience to be gained and a possibility to identify future scheme enhancements without having a major impact on primary plant deployment in the switchyard. Hence whilst some potential savings in primary plant and installation may be foregone for this project, the maximum savings in engineering processes and design philosophies can be taken forward in the development of new design standards.

The choice of a green field site also provides the advantage that any design solutions based on IEC 61850 can be limited to within the substation fence, i.e. remote ends, telecommunication and SCADA system interfaces can be deployed using conventional solutions without cascading network upgrade implications.

7 Consequences For The Organisation

The implementation of IEC 61850 means that a specialist and new engineering processes is required. Any strategy an utility develops for such an implementation should provide for development of internal intellectual property and skills. One aspect to keep in mind is that essential knowledge from experienced IEC 61850 sources can be crucial for th success of the introduction and deployment.

Most utilities face having to deal with partners that are not experienced in the use of IEC 61850 technology or the design of such substation automation systems. It is therefore recommended to segregate the SAS system from the traditional D&C arrangements and appoint an experienced IEC 61850 specialist organisation for the SAS specification & design responsibility.

The involvement of an experienced and senior oversight committee will enable the utility to identify required training programs throughout the first CAPEX project and beyond. This will provide a means to identify new operational requirements to be integrated into the design solutions. The oversight committee will therefore be able to initiate the development of new solutions and the development of standards to be used in future projects through a “Learn More, Do More, Learn More” process.

There are a several existing risk factors in current design portfolios that will be mitigated to a significant degree through the use of IEC 61850 technology. In broad terms, as an integrated engineering and configuration process, risks of network outages and safety risk due to design, wiring and commissioning errors will be significantly reduced. Additionally enhanced operational reliability will be achieved with pre-engineered fall back states in the event of equipment failure or isolations of equipment.

New technical strategies involve a range of new potential risks ranging from the possible lack of competent resources to the possibility that the final implementation does not provide the required functionality. Through a careful selection & training process guided by experienced engineers, these risks can be mitigated. The maintenance service providers and contractors must also be up-skilled and equipped. By involving these parties in training and support programs at an early stage these risks can be managed.

A fall back scenario should be developed for the deployment of the first project including agreements with contractors, service providers and vendors to deliver alternate solutions if required. The scenario shall include go / no go decisions at key stages in the project.

8 Conclusions

Bringing IEC 61850 to the substation would not only allow the utility to have more agile and better manageable networks. An additional motivator for IEC 61850 is the fact that it sexes up the industry making it cutting edge thus giving back the engineer its status and associated compensation.

At the same time IEC 61850 will enable utilities to deal with the commercial imperatives to deliver projects more efficiently and with lower costs to yield direct benefits to the shareholders and stakeholders of their operations or in other words “More, Faster, Less, Less, Higher, Lower”

9 References

[1] INTERNATIONAL STANDARD IEC 61850, Communication networks and systems for utility automation

[2] CIGRE Technical Brochure 326

[3] CIGRE Technical Brochure 246

10 Biography

Marco C. Janssen received his BS degree in Electrical Engineering from the Polytechnic in Arnhem, The Netherlands. He has worked for over 18 years in the field of Protection, Control, Monitoring, Power Quality, Advanced Metering Infrastructures and Substation Automation. From 1990 he was a Technical Specialist in the Protection and Automation group at NUON, The Netherlands. In 1995 he joined KEMA as a Senior Consultant. From 2001 he was a Marketing Manager at Electron Automation, The Netherlands. Since 2005 he is the president and CEO of UTInnovation providing consulting services for Substation Automation, Protection, Communication, Power Quality, Advanced Metering Infrastructures and Smart Grid.

He is member of IEC TC57 WG 10, 17, 18, 19, the IEEE PES Power System Relaying Committee and working groups within CIGRE SC B5. He is editor of the Quality Assurance Program for the Testing Subcommittee of the UCA International Users Group, holds one patent, has authored and presented more than 20 technical papers and is the author of the "I Think" column in the PAC World magazine

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Rodney Hughes has more than twenty five years in the international power industry. His perspective from supplier, utility and consultancy organizations has given Rod a wide range of expertise in the strategic direction of substation, power system and telecommunication design at both technical and commercial levels.

He has served as General Manager for AREVA (then GEC & Alstom) Protection & Control in Australia and as High Voltage Protection Business Line Director in France. He then became the Plant Strategy & Technology Manager for ElectraNet, the 132kV and 275kV transmission utility in South Australia. He was the State Manager for a multidiscipline consultancy in South Australia.

Rod is now the Technical Director leading Maunsell AEOM's Power & Energy business in South Australia with general responsibilities for developing IEC 61850 based expertise and applications.

He is the Convenor of the CIGRE Australia B5 Panel on Protection & Automation and has assisted in the preparation of CIGRE Technical Brochure 326 – "The Introduction of IEC61850 and Its Impact on Protection & Automation Within Substations".

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