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Experiences of IEC 61850 Engineering
– Designing good systems the right way.

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1 Abstract

As one of the key differentiators between it and mere ‘conventional’ SCADA protocols, IEC 61850 deals with the engineering process to specify and implement the substation automation system (SAS).

In order to achieve the objectives of the Standard, key files are defined for specific purposes to ensure that the benefits of vendor independence and reusable engineering are achieved. However over the last six years of the Standard, various vendors, systems integrators and utilities have suffered much confusion in naming of the System Configuration Language files and their correct use at each stage – often missing some file types and steps of the Part 6 process. Although they may work, systems based on such poor understanding of the Standard are not just non-compliant to the Standard but will also cause much grief in the next refurbishment or augmentation of the substation as some in the industry have already started to suffer.

In the physical operation of the SAS, solutions need to be well engineered to provide network topologies and physical mechanisms for operation, test, maintenance and isolation in a virtual environment whilst keeping the entire integrated system operational.

This paper explains the correct use of IEC 61850 Part 6 file exchange – what defines each file and why it is used in the process in order that the users can weed out poor implementations of tools and devices. The paper then describes the process of specifying IEC 61850 systems from a real time functional perspective as well as satisfying the in service needs to operate the system and be able to take sections out of service for maintenance or test. .

2 SAS Standardization

IEC 61850 provides the essential technology definitions to be able to build any SAS. It is therefore not prescriptive on the functions and schemes that may be required in any respect. The Standard does not define network architectures, redundancy and reliability requirements nor the operational mechanisms and procedures.

Asset owners and maintainers require consistent facilities for reliable and safe operation of the SAS at multiple sites with consistent operational procedures and operating and test equipment.

Consistent SAS implementation designs and configurations will also provide benefits in cost, engineering time and most importantly operating reliability from the “Reusable Engineering” processes of IEC 61850.

Reliability is particularly enhanced as it is not necessary to start the engineering process with new drawings, equipment wring and all the associated testing to prove correct passage of the design requirements through the engineering and construction phases. Signals engineered in IEC 61850 between one function and another remain the same message definition regardless of the IED in which they are implemented. Reliability is therefore enhanced by reusing the message definitions (data sets) in the new IEDs as have been successfully in operation since commissioning of the old IEDs.

It is therefore imperative that consistent SAS implementations are created, catering for the variety of project specific requirements. It is therefore recommended that any project implementation be done under the overarching SAS Design Concept Specification. This DCS should identify amongst many aspects :

- System Overview and Architecture
- SAS Interfaces – external and internal
- SAS Functionality
- IEC Implementation Constraints
- System Security Provisions and Security Governance
- Engineering Processes, Documentation and Tools for the SAS Life Cycle
- Equipment Procurement Requirements
- Operation and Maintenance Facilities and Procedures

3 IEC 61850 Conformance

IEC 61850 Conformance and Certification must be carefully understood so as not to incorrectly interpret performance that may otherwise be assumed.

Test Agencies are authorized by the UCA International Users Group. The Test Agencies conduct tests to validate that the implementation of the IED model and communication services cannot be shown to be in error ("This device has not been shown to be non-conforming"). This does not imply that all elements described in the Standard – mandatory or optional - have been implemented, i.e. Mandatory requirements only apply to IEDs where that item has been implemented. Equally the test is only in respect of the elements to be tested as nominated by the manufacturer. The test processes for conformance to the Standard are defined in IEC 61850 Part 10. Such Conformance Certificates therefore do not in themselves confirm correct operation in all application with any other IED. The development of the SAS design should include a process of interoperability testing for the schemes and LAN environment in which the device will be connected.

There are many vendor-dependent elements of IEC 61850 implementations which provide for industry requirements for ongoing innovation and competition. Some of these aspects may include prescriptive limitations in the definition of the SAS schemes as a result of one particular vendor's implementation of the Standard. A common example is the length of prefix names will limit the descriptive nature of the name to the lowest number characters supported by all the different vendors equipment capabilities in use in that system. Such issues must be identified as part of the SAS specification and IED procurement processes in order to ensure interoperability is achieved in practice and validated in a proof of concept interoperability test facility prior to specific project implementation. This is not a failing of the Standard itself but a failure to specify and procure IEDs that provide the required capabilities in ALL respects.

Full details of the IEC 61850 implementation as represented by the Conformance Certificate are provided in supporting documents :

- PICS — Protocol Implementation Conformance Statement
- PIXIT — Protocol Implementation eXtra Information for Testing
- MICS — Model Implementation Conformance Statement
- PICOM — Piece of Information for COMunication

The Conformance Certificate represents the tests done on the IED at a particular point in time according to the requirements of Standard at that time. Subsequent to the conformance test, various augmentations or modifications of the Standard may occur which fundamentally change the required behaviours or compliance to the Standard. These changes are recorded through a TISSUE process (http://www.tissues.iec61850.com). The procurement process and interoperability considerations must therefore include review of the TISSUES that have or have not been implemented in the current equipment models supplied by the manufacturer. The implemented TISSUES post Conformance Certificates are identified in the manufacturer's TISSUES Implementation Conformance Statement (TICS) which should be reviewed with each purchase.

The Standard itself has many parts including the following which therefore requirements which must also be followed by the asset owner, engineering design groups, as well as operational and maintenance staff:

- IEC 61850-4 System and Project Management
- IEC 61850-6 Configuration Description Language (engineering process)

Parts 4 and 6 of the standard in particular place requirements in addition to the test and commissioning procedures themselves, to develop appropriate

- procurement specifications,
- system specifications,
- IEC 61850 engineering collaboration processes across multiple technical domains and organizations (communication, protection, control, primary plant, operation & maintenance etc),
- IEC 61850 engineering tools
- engineering tool interfaces to non – IEC 61850 processes
- documentation and approval processes

Test processes must be developed associated with commissioning an individual IED and/or a complete system as part of Factory Acceptance Test (FAT), Site Acceptance Test (SAT) and placing the system into operational service. This is generally achieved using a Proof Of Concept test facility to confirm the design of the system, selection of the correct IEDs and their configuration prior to the urgency of a particular project implementation. The subsequent project and IED commissioning can then focus on validating the equipment is correctly implemented and ready for service. Certain elements of commissioning a system and placing into service are based on various prior testing of the system concept, functional implementation and system performance capabilities. General in principle reference is made to such prior testing due to the variety of aspects that may need to be investigated and validated. The general system explanations of this report will give general guidance on what these test objectives and POC system definition may need to contain. Indeed responsibility for such POC and system functional testing may fall into the responsibility of different parties depending on the project delivery model and engineering responsibilities within that cycle.

4 Companion Standards

IEC 61850 specifically defines the elements associated with the power utility automation systems. In order to provide a comprehensive specification for all aspects of the SAS, it refers to various other Standards that should be read in conjunction with IEC 61850.

Note that to be compliant with IEC 61850, not only implies compliance to all parts of IEC 61850 but also to these associated Standards such as:

- IEC 60255 Protection Relay specification
- IEC 61400-25 Wind farms specific implementation

- o IEC 61346 Naming conventions
- o IEC 62271 HV interfaces
- o IEC 62439 High security networks
- o IEC 62350 System Security

5 IEC 61850 Files

IEDs are configured for their individual purpose in the SAS. This includes:

1. IED Proprietary Configuration
    a. Front panel HMI controls – pushbuttons, switches, indicators, displays
    b. Internal logic operation
    c. Input / output terminal characteristics and allocations to functions
2. SAS Configuration
    a. Communication configuration - IEC 61850 and legacy
    b. IEC 61850 model configuration
    c. Function parameters and settings - IEC 61850 and legacy

Configuration of the IED is therefore a combination of the IED Proprietary Configuration and the SAS Configuration files.

In general the IED Proprietary configuration is dependent on the product type and particular capabilities of the IED. These aspects are generally configured as part of the vendor and IED specific engineering tool.

The SAS Configuration is mainly configured as part of the IEC 61850 engineering process using the System Specification Language defined in IEC 61850 Part 6. However depending on the IED and the IED vendor specific tool capabilities some elements of the SAS Configuration, e.g. IED settings, may to be done in the IED/vendor specific engineering tool.

IEC 61850 Part 6 Edition 2 defines six core engineering files associated with transferring information between different engineering tools and ultimately the IED.

1. ICD
2. SSD
3. SCD
4. CID
5. SED
6. IID

These six files are summarized below and are depicted in Figure 1 and Figure 2:

- o IED Capability Description **ICD** is a complete model of the capabilities and any pre-configuration of the generic IED to be used in the SAS. Regardless of the filename, the IED name within the file is always “TEMPLATE”. This file is able to be instantiated in the SCD file as many times as there are IEDs using the same data model. This file may be preconfigured according to the utility requirements to simplify subsequent configuration. The ICD file may have been created from a “superset” file for the class of product i.e. the class file may provide more options and functionality that can operate in a single IED and must be tailored to make an ICD file which can be instantiated as necessary as direct copies in the SCD file.

- System Specification Description **SSD** establishes the primary plant configuration and the functional elements of the SAS. This file is nominally optional with many vendors not using this file at all. However it is a vital component for future engineering steps involving replication of an entire bay. Good engineering processes will have established bay and function libraries to suit the utility operational and procurement decisions to simplify the Systems Integration effort.
- System Configuration Description **SCD** provides the complete configuration of the SAS including the Substation Section detailing the primary plant topology (sourced from the SSD), the IED Section functional allocations of each IED and the Communication Section detailing the information exchange configuration of the IEDs. Each IED is represented as an instantiated model in the SCD file, i.e. there is a 1:1 relationship between each IED and it's section within the SCD file. The instantiated IED will now have a name other than "TEMPLATE" (as was required in the ICD), e.g. "IED1".
- The Configured IED Description **CID** is a subset of the SCD relative to one particular IED. This file may or may not be the file used to download into the IED depending on the particular vendor's tools and IED capabilities. The CID file, if produced, should be a subset of the SCD relative to each particular IED i.e. there is a 1:1 relationship of CID to each physical IED. The CID file should include some portion of the Substation Section sourced from the SSD, and the Communications Section of the SCD file. However some vendors' tools and systems integrators may bypass the creation of the SSD and SCD engineering files, effectively converting ICD files to a partial CID file which may not include the Substation and Communications sections in their entirety. It is NOT recommended to use partial CID files as they may compromise the ability to undertake augmentations and modifications of the SAS in the future using the SCD file.
- System Exchange Description **SED** file is used to coordinate the Systems Integration of two SCD files where there is to be an exchange of signals between the SAS they each represent. This may relate to signals to be sent from one substation to another or from one section of a substation to another section where there are two independent SCD files. The SCD file of the first SAS contains the definition of the signals to be sent to the second SAS so they can be configured into the SCD of the second SAS in as much as the SAS each need to identify messages being generated within their own environment.
- The Instantiated IED Description **IID** file is used to permit changing of the base IED data model after the SCD has been created to allow the modified data model to be updated in the SCD without restarting the engineering process – refer Figure 2. Note: some vendor's references to IID files are in reality ICD or CID files. The IID file is only to be used to update the existing data model of an IED in the SCD. The IID file has a device name associated with the actual instance of the device as distinct from the ICD file which has the device name as "TEMPLATE". The IID file only contains the model of the device without the Substation Section and Communications Sections contained in the CID file.

Figure 1 shows the use and evolution of the SCL files through the engineering process. Different tools are used at each step as:

- Systems Specification Tool – creates SSD
  Uses data from the Single Line Diagram (SLD) and the operational functions

- System Configuration Tool – creates SCD and SED
  Uses data entered regarding the LAN network configuration, GOOSE/Report data set and control block definitions, device settings etc.
- IED Configuration Tool – creates ICD and CID
  Uses the class file to create instantiable ICD files
  Incorporates the internal scheme logic definitions, the IED user interface configuration (HMI) and any remaining settings for the IED not contained in IEC 61850 structured models.

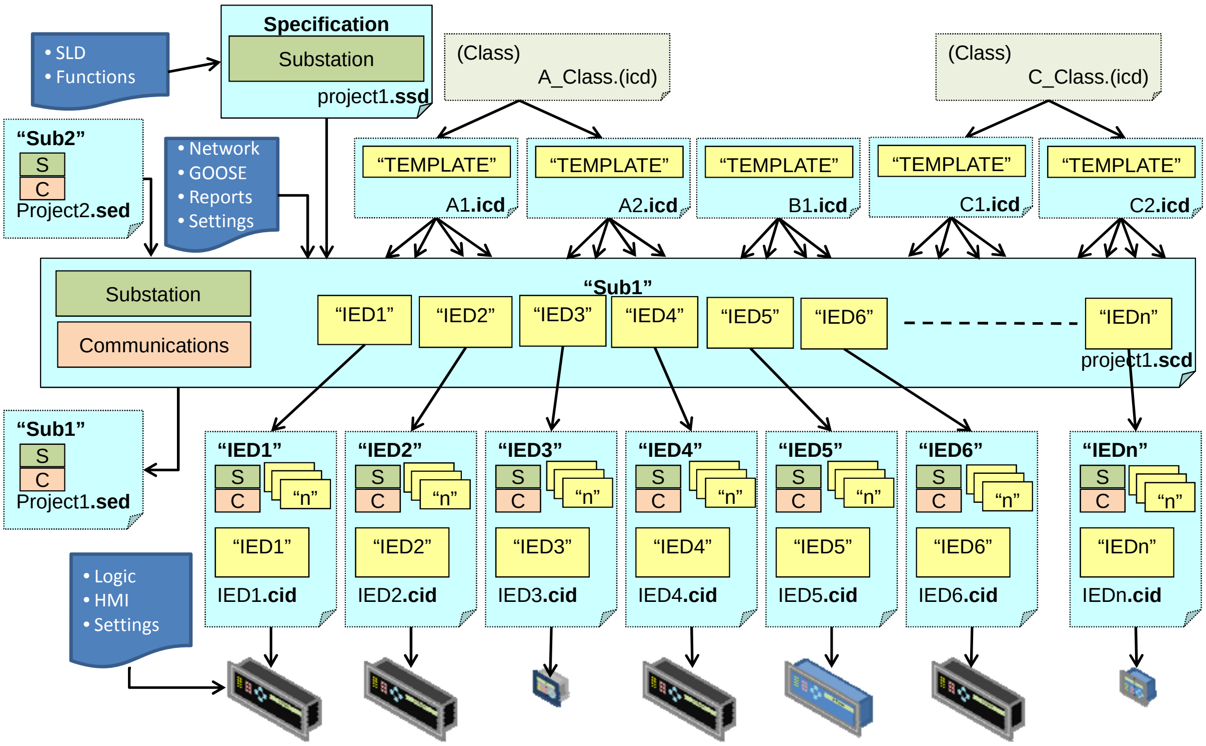

Figure 1 IEC 61850 File Coordination

Figure 2 shows the use of the IID file to identify the changes to an individual device model after initial instantiation – e.g. additional Logical Nodes added to the model using an IED Configuration tool. This IID file can then be imported into the Systems Configuration Tool to update the instance of the IED. Ultimately this changed data model for the instance of the device should also be reflected in a new ICD for future projects.

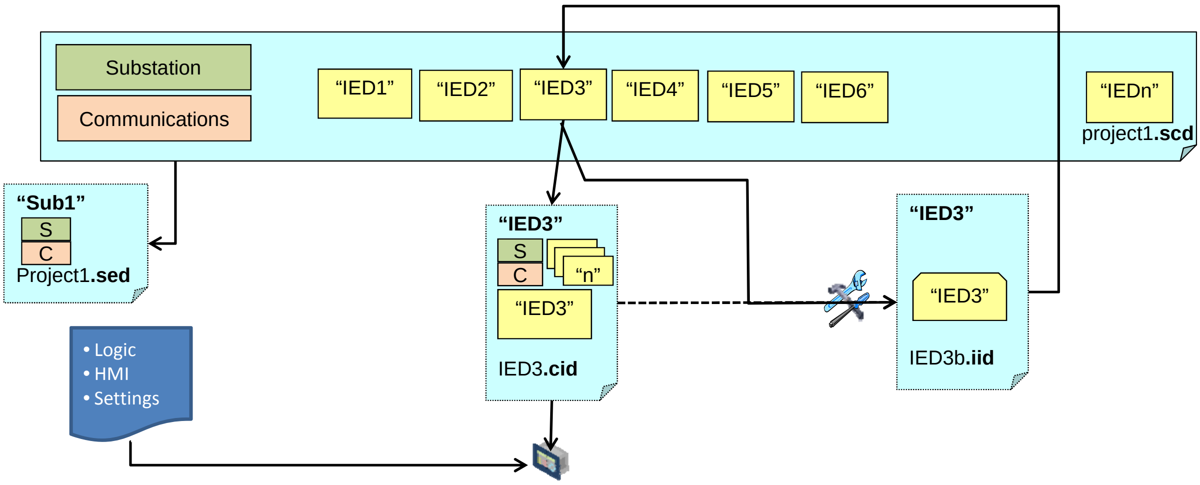

Figure 2 IED Data Model Modification – IID file

6 CIGRE Reference Documentation

In addition to the Standard and in many cases more directly relevant to the issues associated with IEC 61850 implementation CIGRE (www.cigre.org) publish various Technical Brochures specifically relating to SAS and IEC 61850 implementation.

These include the Technical Brochures listed in Table 1 CIGRE Publications - SAS and IEC 61850 Implementation and ongoing Working Groups for future publications. These brochures may be ordered on line at www.e-cigre.org, or CIGRE members can download PDF versions for free.

Table 1 CIGRE Publications - SAS and IEC 61850 Implementation

Publication*	Year	Title
246	2004	The Automation Of New And Existing Substations: Why And How,
326	2007	The Introduction Of IEC 61850 And Its Impact On Protection And Automation Within Substations
329	2007	Guidelines For Specification And Evaluation Of Substation Automation Systems,
401	2010	Functional Testing Of IEC 61850 Based Systems,
404	2010	Acceptable Functional Integration in HV Substations,
427	2010	The Impact of Implementing Cyber Security Requirements Using IEC 61850
448	2011	Refurbishment Strategies based on Life Cycle Cost and Technical Constraints
WG B5.06		Maintenance Strategies for Digital Substation Automation Systems
WG B5.12		Engineering Guidelines for IEC61850 Based Substation Automation Systems

Publication*	Year	Title
WG B5.39	In progress	Documentation Requirements From Design To Operation To Maintenance For Digital Substation Automation Systems

7 Engineering for Future Augmentation

Good engineering design principles at the outset of the engineering process will assist in minimizing the need to reconfigure, and hence re-commission, the exiting IEDs during future augmentations or modifications of the SAS.

E.g. a GOOSE message in an existing IED may be defined as instructions to "Trip CB 1 and Trip CB 3". Associated with the addition of a new bay or operational changes to the power system arrangement, this may need to be re-engineered to add "and Trip CB 6". All IEDs – the publisher and subscribing IEDS - must be loaded with new configurations and re-commissioned due to the new GOOSE message definition.

However if the original engineering defines the instruction as "Trip Group 1" and separate mechanisms are used with the individual CB IEDs to define 'membership' of Group 1, the existing IEDs need not be modified as the GOOSE message doesn't change. It merely requires setting the new IED as belonging to Group 1 and subscribe to the appropriate "Trip Group 1" GOOSE.

8 IED Configuration/Setting Changes

The total SAS IEC 61850 configuration is defined in the System Configuration Description SCD file. Any changes to the SAS should be reflected in the SCD file as the "as operating" representation of the system so that replacement of any IED can use the SCD file to extract the correct operating configuration as in service with the old IED.

Mechanisms must be included in the SAS design to trigger notification of any setting changes in the field. Processes and mechanisms must also be established to remotely extract details of these changes including extract of the device configuration file so that the SCD file can be updated. The logging of these changes should also raise alarms if indices are reported less than the previous values or where there are missing indices indicating that old files have been used and hence may be erroneous.

The SAS must also include mechanisms to report and record time stamp and details of IED Setting Group changes, i.e. toggle from one predefined Group to another, in order to identify the active settings at any point in time.

IEC 61850 Part 7-3 Edition 2 identifies different configuration revision indices in Annex C:

- **configRev** identifies revision to the device model
- **paramRev** identifies changes of setting groups and settings
- **val Rev** identifies changes of any particular attribute of a Logical Node.
- **confRev** identifies changes in the definition of the trigger and content of messages

These indices are incremented according to the mechanism to make the change.

- If the change is done as part of an engineering process using the SCL files then loaded to the IED, each change is incremented by 10000.
- If the change is done directly via the IED user interface or commands sent to the IED via the communications port whilst in service, such changes are incremented by 1.

E.g. existing revision index 10050

- Setting changed from 5A to 5.1 Amp by operator using IED front plate HMI: new revision index 10051
- Setting changed from 5.1 to 5.5 Amp using commands over the LAN: new revision index 10052
- New CID file created and loaded into relay: new revision index 20052

The SAS system and processes should therefore include reporting of all changes to these indices and processes to update of the SCD file and any other asset management data bases.

9 Operator Facilities

The SAS must be able to be effectively and safely operated whilst in service without compromising the normal operation of the SAS and the power system. The operator facilities must be:

- Familiar and recognizable by operators as the standard operating and test facility so as not to cause confusion in operating procedures. This must be so in every substation regardless of the choice of IED vendors, now and in the future,
- Able to carry out defined operating and task sequences for safe operation and test of the SAS,
- Independent of the types of functions and degree of functional integration now and in the future,
- Physically safe for the operator to use,
- Secure for only authorized access and use.

There are various activities associated with operating the SAS specifically associated with operators on site. These activities include:

- Enable/disable specific function(s)
- Enable/disable individual IED(s)
- Change the operating mode of a function
- Change the operating mode of IED(s)
- Place individual IED(s) into test configurations
- Configure the SAS to maintain operation with certain units out of service/in test configuration
- Provide authorized connection of laptops and test equipment to the LAN

Wire based secondary systems incorporate a number of essential operating and test facilities required in the substation such as links, switches and indicator lamps. In applying the LAN based technology, the same principles apply as have formed the basis of the hardwired operating facilities but tailored to the requirements and benefits of the technology.

The IEC 61850 SAS LAN will also pass various signals between IEDs which represent the same types of information as has been to date provided in the wire based systems. Various measurements, status and control signals are passed between IEDs via the SAS LAN for which there must be similar mechanisms for operation, control, isolation and testing of the IEDs and functions of the SAS. These mechanisms must allow the operators and/or test equipment to instruct, perhaps in combination, the sending or receiving IEDs to achieve the functional performance.

The Operator & Test Interface (OTI) unit is an example of a patented solution to providing the human interface to the SAS – providing the Human Interoperability – as shown in Figure 3

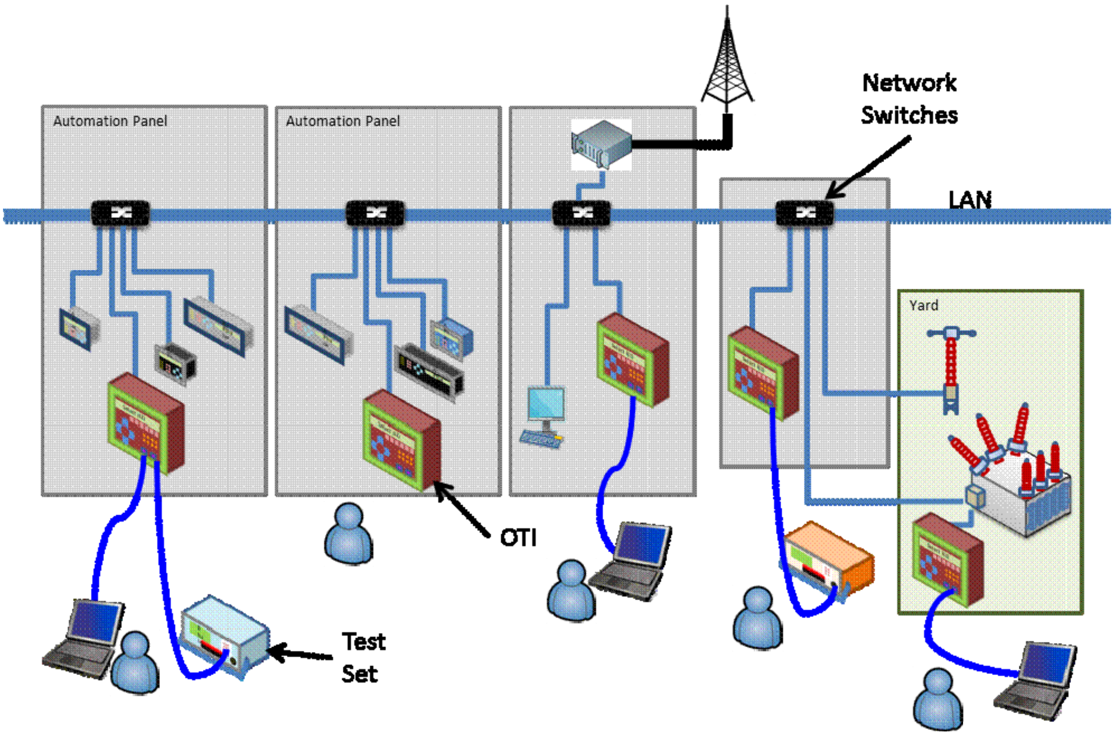

Figure 3 Operator & Test Interface concept

The patented OTI satisfies the essential "Human Interoperability" requirements of

- Front access
- No special equipment requirement
- Clear individual labeling
- Single function control
- Ease of control
- Independent of choice of IED suppliers
- Independent of the system integrator
- Standardized procedural sequences
- Not dependent on number of buttons/indicators on different IEDs
- Direct function status indication
- Controls directly related to specific panel
- Can be used with conventional controls

9.1 Operator Control Facility Interdependencies

The SAS design must give appropriate facilities in consideration of the hierarchy and interdependencies of the controls.

The following control locations are generally provided in a hierarchical arrangement:

- Remotely outside of the substation e.g. SCADA master station/control center or remote engineering access
  - Local at the substation HMI or operator laptop connected to the SAS LAN
    - Local at the bay panel through the bay controller
    - Local in the bay through a switch on the panel
      - Direct in the field (mechanical control on the switchgear mechanism)

The following facilities may also exist to select the active control location:

- A physical switch in the substation that is used to switch between remote control and local substation control such that remote control is disabled to some degree when personnel are on site. This switch applies to the whole substation or to a predefined part of the substation. It is not possible to change the position of that switch remotely.
- The local / remote key switch on the bay controller. That switch applies to the whole bay

Interdependencies must be defined for all these controls – some can operate regardless of others, some block other controls in certain modes and some require agreement of controls (e.g. both set to “on”) before the configuration change is implemented in the SAS.

Just as important is to define the interdependencies when the communication system has failed in some way. The system must still be operable with safety for personnel and the power system.

10 System Design and Performance Validation

Total commissioning involves several steps involving test sequences at different stages.

- Design and performance validation
- Device configuration & correct configuration verification
- Scheme operation & performance verification
- Site installation, connection and operation verification

These steps also apply to maintenance activities with different emphasis before, during and after operator intervention on the live system.

As part of the overall process of commissioning the SAS system, it is first necessary to prove the overall system design provides the functional operation and performance required for the correct functioning and operation of the power system.

This is generally achieved in the development of the SAS Design Concept Specification (refer Section 2) and the creation of a Proof Of Concept facility (refer Section 2). The POC may be a generic facility representative of the typical SAS requirements for the utility.

The POC provides the essential test platform to validate scheme functional implementation and performance issues including:

- Interoperability testing of the specific IEDs to be used in the SAS
- Validation of correct migration of wire based schemes to IEC 61850 implementation systems, e.g. Circuit Breaker Fail schemes, interlocking, trip/close signals etc. This essentially involves the same scheme testing as for wire based systems with additional considerations of the virtual environment
- Proof of satisfactory failure mode management systems

- Evaluation and standardization of operator facilities – including automation of task sequencing
- Proof of suitable system security implementation
- Proof System Ethernet VLAN performance
- Proof of Ethernet priority tagging performance
- LAN network performance and correct scheme performance in consideration of:
- Network latency and deterministic performance for IEC 61850 message class performance
- Bandwidth saturation test (data storming)
- Network Quality of Service
- Network failure recovery times (Rapid Spanning Tree, Parallel Redundancy Protocol fail over etc.)

Engineering of the POC will also permit development and evaluation of the engineering procedures, tools, and documentation requirements as well as the process interfaces and collaboration between departments and organizations.

The POC should also be used for Operator, Maintenance and Testing staff training and detailed procedure development and evaluation of operating and testing tools and facilities.

The POC can be expanded to a full suite of IEDs associated with the SAS in order to test complete operation of the total system as part of a FAT type test environment. However it is generally more practical to use system simulators in the POC system to model larger system functionality and to test indicative behaviour. The System Integrator's FAT process and complete SAS system can then be used to validate critical performance issues identified in the POC.

The purpose of the complete commissioning process is to verify the system is operating according to the design requirements and has been connected to the power system correctly.

11 IED Capability and Network Architecture Implications for Testing

Testing procedures are generally carried out either as an overall test program of a scheme or by test programs designed to provide overlap with adjoining elements of the scheme

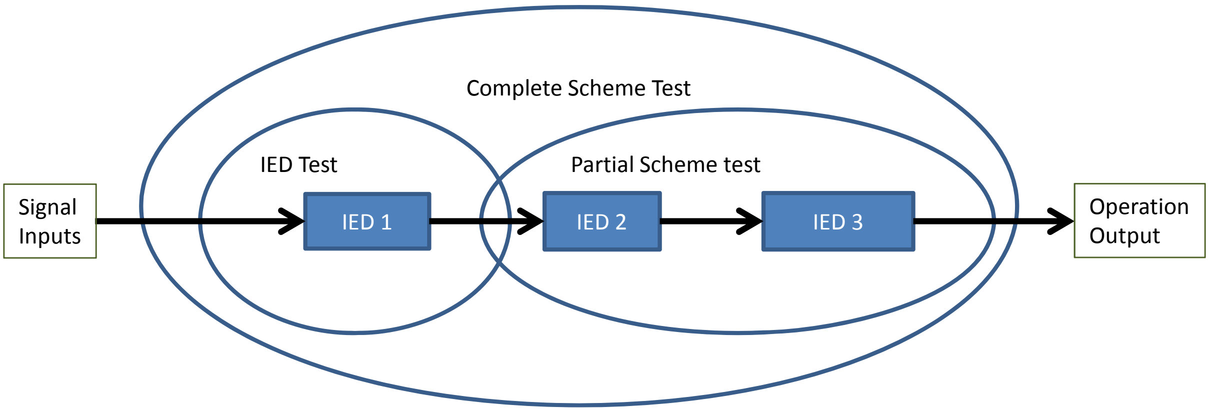

Figure 4 Overlapping Test Zones

In order to prove correct operation of the system, procedures must be developed to cater for the variety of IED communication arrangements and the topology of the LAN. This is indicated in the following arrangements:

11.1 Single Connected IED, Single SAS LAN:

e.g. IEDs connected to one switch

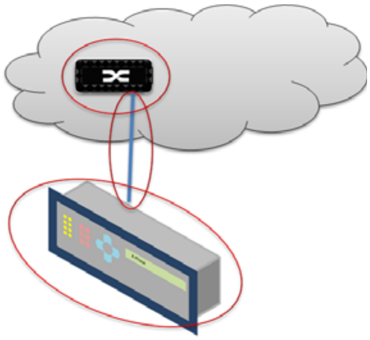

Figure 5 Single Connected Single LAN

This configuration provides the simples to of testing solutions. However appropriate "Make Safe" mechanisms must be provided in the SAS design to deal with the rest of the SAS continued operation and minimizing power grid disruption if primary plant must also be taken out of service.

11.2 Dual Connected IED, Single SAS LAN:

e.g. IEDs connected to two separate switches in the same LAN, e.g. cross connected redundancy or High Security Ring (HSR)

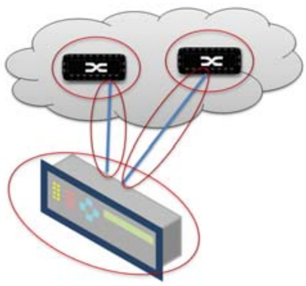

Figure 6 Dual Connected Single SAS LAN

The procedures required for this arrangement are similar to those required in Section 11.1. In addition, either the second connection should be disabled or removed in order to test one communication mechanism at a time. The test procedure must also include a fail over test of disconnecting one of the comms ports to verify switch over to the other.

11.3 Independent Redundant SAS LAN:

e.g. fully duplicated and segregated "A" and ":B" systems

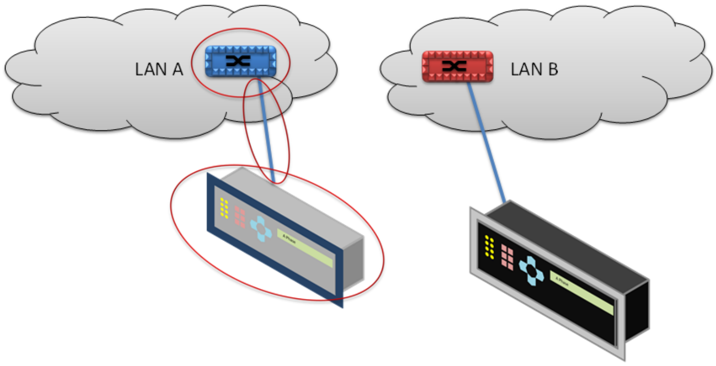

Figure 7 Independent Redundant SAS LAN

This arrangement is a "classical" dual independent redundant system fully duplicated. These arrangements have been well proven over many years in conventional protection systems.

These systems are often based on using two different vendors for the A and B systems which provides for

- Minimization of common equipment failure modes
- Increased reliability using different operation principles

This provides the simplest and least impact on substation operation. One SAS LAN and IED can be totally disabled leaving the other system in service and the power system able to be left energized. Procedures should be designed so as to optimize the time that only one SAS in is in service in order to reinstate the N-1 contingency of the duplicated system as quickly as possible. Procedures for this arrangement are similar to those required for the arrangement in section 11.1

11.4 Codependent Redundant SAS LAN:

e.g. standby, failover or Parallel Redundancy Protocol (PRP)

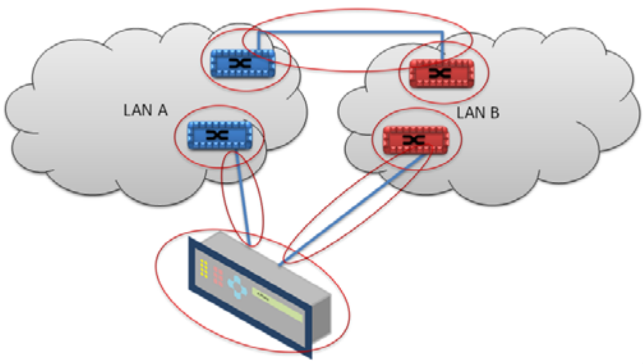

Figure 8 Co-dependent Redundant SAS LAN

This configuration requires special procedures to identify which LAN communication is active to the IED in order to follow correct "Make Safe" procedures.

12 Testing of Process Bus & Station Bus IEDs

The distinction between Process Bus and Station Bus as physical entities is relative to the IED implementation of common or independent ports for the network traffic. This is further dependent on the LAN implementation in respect of independent or common networks. This is shown in Figure 9, Figure 10 and Figure 11

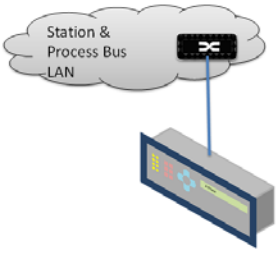

Figure 9 Combined Station and Process Bus Single Port

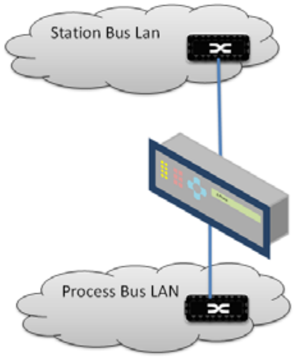

Figure 10 Independent Process Bus and Station Bus Port IED

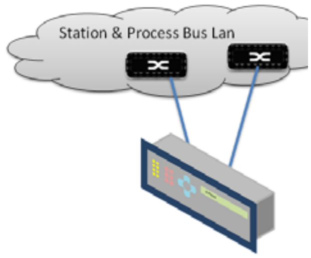

Figure 11 Independent Process Bus and Station Bus Ports over Common LAN

However testing of Process Level, Bay Level and Station Level IEDs requires the same fundamental process for standalone testing and testing whilst connected to the network and hence distinction is not drawn at this level of testing requirement specification. Detailed procedures will need to address the test routine requirements.

13 Conclusion

The benefits of IEC 61850 are in "*More projects, Faster engineering, Less money, Less resources, Higher Reliability, Lower operational cost*". However if these benefits are to be realised, the Standard must be implemented correctly in regards to the processes defined in IEC 61850 Part 6 and the correct understanding and use of all the six SCL files.

With this as a base, careful specification of the requirements can begin catering for a raft of issues and engineering disciplines. This process requires a complete new way of thinking and a complete new engineering process which requires more than just an 'overnight' decision to adopt IEC 61850.

References

1. CIGRE Australia SEAPAC 2011, Paper 38, "IEC 61850 Edition 2 – what does it mean for the end user?", C. Brunner & R Hughes, March 2011

Biography

Rod Hughes has over 30 years' experience in protection and automation systems. He has been the General Manager of one of the major relay vendors in Australia/New Zealand, Technical Director for development and marketing in Europe, Engineering Manager for a transmission utility in Australia and a State Manager and Technical Director in large multi-disciplined consultancies.

Rod is currently Convener of CIGRE Australia B5 Panel for Protection & Automation and Australian representative to the international Study Committee B5.

Rod has been a co-author of CIGRE Technical Brochure 326 "Implementation of IEC 61850" and has been involved in a number of other TBs as author or final editor.

Rod is convener of CIGRE Working Group B5.39 “Guidelines for documentation of digital substation automation systems”.

Rod is now an independent consultant specialising in assisting organisations through the change management, business case, specification, implementation and training for IEC 61850 systems. Rod has presented many papers and provided various training courses from introduction to practitioner training in IEC 61850.

Christoph Brunner is (Less than 200 words per author)