State Of The Art Asset Condition Monitoring Systems with IEC 61850

By

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STATE OF THE ART ASSET CONDITION MONITORING SYSTEMS WITH IEC 61850

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Abstract
Reliability is a key objective for the power industry in all respects. Equally the pressures of ageing assets and the dramatic increase in consumer prices, if not partly to fund the move to Smart Grid, is a major concern. The asset owner must engineer solutions to manage all of their assets using a diverse range of performance and condition information whilst catering for a diversity of vendor's equipment in each asset class.

Condition monitoring by its nature is about collection of vital information on the asset dynamically and continuously throughout its life. The advent of sophisticated Intelligent Electronic Devices (IEDs) and Systems introduces a vast array of information that will improve the ability to manage the asset life. However every utility is faced with a variety of primary plant manufacturers and third parties each with their own integrated condition monitoring facilities and softwares. Coordination of information then becomes a difficult task with different data structures and naming conventions further hampered by a variety of communication protocols.

The scene is therefore set to integrate the Asset Condition Monitoring System (ACMS) into the overall engineering process of the Substation Automation System (SAS). In this respect, Asset Owners can now use the vendor-independent engineering processes of IEC 61850 because of its defined data structures, naming conventions and communication systems. In particular, the new Part 90-3 defines extensions to the standard to address condition monitoring requirements for primary equipment such as switchgear, transformers and power lines.

This paper discusses the two vital benefits of IEC 61850-90-3. The first is that the ACMS can be specified, engineered and implemented across all substations and assets in a complete vendor-independent process integrated to the SAS. The second is the creation of the new concept of truly "reusable engineering" which allows augmentation of the substations and replacement of equipment to be achieved with minimal additional engineering

Key Words:
Condition Monitoring, Substation Automation System, IEC 61850, Systems Engineering, Vendor Independent

Introduction
Australia is by no means any different to the rest of the world in its drive to efficiency and the ubiquitous Smart Grid including the change from reactive to preventive to predictive maintenance [2].

Technology is at the heart of the information gathering process with Intelligent Electronic Devices now being common place and integrated parts of the primary equipment itself. This has enabled the asset monitoring teams to gather a vast array of data on the performance and condition of transformers, switchgear, cables, transmission lines

Figure 1
IEDs on the tank of transformer [1]

The purpose of providing a range of sensors and IEDs to capture information is clearly to provide a means by which information can be accessed. Access to information means communication between IEDs as well as between IEDs and computers. In this respect there is much confusion in the industry that therefore IEC 61850 is *"just another protocol" and as a result many conclude "I'm happy with my current protocol so why bother to change*".

However this view ignores the move towards ever increasing amounts of data in order to provide for the new asset management techniques and technologies. As an example SCADA systems have seen more than a five-fold increase over a 15 year period in SCADA related data points as shown in Figure 2.

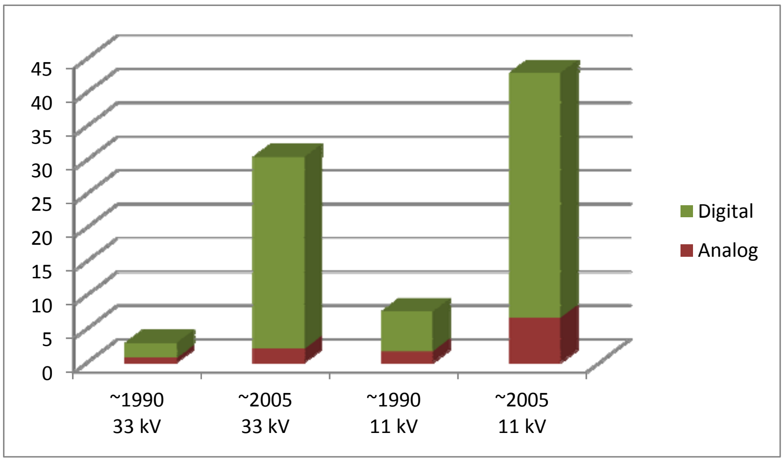

Figure 2
Typical Distribution Utility growth in SCADA I/O Points Per Bay

Asset management systems undoubtedly have similar trends with even much larger range of potential sources and point counts as indicated in IEC 61850-90-3 (refer selected comparisons shown in Table 1 below). Furthermore, the objectives and pressures of Smart Grid are only just starting to be formed which will demand even more individual pieces of information across a more diverse range of equipment and functions.

Table 1
IEC 6180-90-3 System Characteristic Comparison Table (part)

	SCADA, DMS, EMS	Substation Automation	Asset Management
Number of points acquired from Condition Monitoring Device IEDs	Small	Small to medium	**Large**
Type of system processing	Continuous	Continuous	Batch or continuous
Type of data acquisition	Online, real-time	Online, real-time	• Deferred time-series acquisition • Manual entry • Online • Real Time
Source of information	SA, IEDs, primary equipment	IEDs, primary equipment	**IEDs, primary equipment, offline test reports, SCADA, DMS, EMS, SA, Historian, ERP systems**

There is no "plug and play" or ad-hoc choices in applying IEC 61850. Asset owners and equipment/system specifiers have to be far more well informed on how to specify the real requirements - in some cases for the first time in long time [3]. System integration engineers and how to put a system together to the same degree that you don't buy a wheel, then design a vehicle to suit. Procurement specifications have to be far more than "*all IEDS shall be IEC 61850 compliant*". Maintenance and operation staff need to have the physical facilities (how do they physically monitor/enable/disable individual signals [4]), skills and tools [5] to deal with a primary system, the physical secondary system and a virtual world.

Certainly IEC 61850 must provide protocol type capabilities and indeed it uses industry standard communication as TCP/IP Ethernet. However, the objective is to provide an engineering operational environment for the ***entire*** Substation Automation System. In fact IEC 61850 Part 1 clause 4 states:

> *"…but the purpose of the standard is neither to standardise (nor limit in any way) the functions involved in substation operation nor their allocation within the SAS."*

This does not say it is limited to the functions of just the protection relay system nor just the function of the SCADA system. Its focus is on the entire operation of the substation which includes the functions of asset management. Indeed it recognizes that these functions will exist in a variety of IEDs throughout the substation. The Standard therefore provides a means to satisfy the requirement of an all-encompassing engineering system for the entire SAS and provides the means that enables IEDs to share information.

Consequently old "ad hoc" statements like "the device shall have 'X' function" needs to be far more explicit in terms of the full data model and signals that are required for correct operation of the system. This may result in dozens of Logical Nodes and 'tens times' that as data objects and attributes used in the setting parameters and communication with other IEDs. These must all be specified if it is to b expected that the devices will provide them.

IEC 61850 has three aspects to achieve these objectives

1. **IEC 61850-6 engineering process and file structure** used by the design office (i.e. instead of "Autocad", "Word" and "Excel") – System Configuration Language (SCL)
2. **IEC 61850-7 IED data structure and naming** of information and parameters within the IEDS – Logical Nodes, Data Objects and Attributes
3. **IEC 61850-8 and IEC 61850-9 message and command formats** sent between the devices over the LAN – Reports, commands, Sampled Values and GOOSE messages - Abstract Communication Services Interface (ACSI)

It is a platform and set of building blocks that can be used for the engineering of the Asset Management infrastructure and the exchange of information from the Condition Monitoring equipment to the Asset Management processes.

The scope of IEC 61850 is to deal with the configuration of IEDs <u>only</u> in respect of signals that are communicated from one function to another. It is not intended or able to deal with every piece of engineering or configuration of the system. Such exclusions from IEC 61850 are

- *operating system,*
- *algorithms used within the IEDs which provide the intelligence of the application,*
- *physical nature of the IED in respect:*
    - *physical inputs/outputs,*
    - *push buttons,*
    - *indicators on the front plate of the IED,*
    - *its menu operation for the technician,*
    - *number and type of communication ports provided,*
- *scheme logic that is configured to suit the operational requirements.*

There is therefore ample scope for a competitive market place. In fact even more so with solutions aimed at providing better engineering tools and system capabilities than ever before.

IEDs have to be more truly competitive than just relying on proprietary facilities as a means of preventing alternative choices. The devices must be able to be used with confidence of compliance to the Standard which gives the Systems Integrator the ability to select IEDs for interoperability to whatever the system requirements are that have been identified. The requirements of being able to build any system's requirements now rules compared to a system being dictated by the vendor's implementation limitations. Perhaps some suppliers will be not be found suitable for the new system requirements whilst alternative suppliers and solutions will come into their own.

Compliance to the Standard simply indicates what has been chosen to be implemented by the supplier has been implemented according to the requirements of the Standard. The Standard must provide the flexibility for the users and the suppliers to have the functions they choose. Random procurement of "compliant devices" therefore does not guarantee the features required for the application are provided in the IED.

Many people flippantly make accusations that interoperability doesn't work. In reality this is most often they have simply not identified what their interoperability requirements of the system design are [3][4][5]. This can be simply understood that not only do you not buy a tyre then design the car to suit, but also buying a wheel with five mounting holes will not fit on a car axle with four mounting bolts as in Figure 3 – both comply to the standards for vehicles but are poor procurement choices in ignorance of the application requirements.

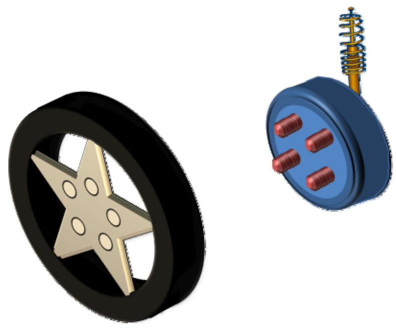

Figure 3
Interoperability requires specification of application requirements before procurement

Reusable Engineering
Whilst many involved in the industry focus on IED-to-IED interoperability of IEC 61850, one of the most significant benefits is the engineering process defined in IEC 61850-6.

Point based mapping protocols have no particular 'intelligence' regarding the information of the point itself, its syntax or semantics. In one system the "Insulation liquid temperature alarm" could be address "3456" whilst in another it may be "9876". Engineering becomes somewhat difficult and non-descript when a data point "1234" is reported with a value of "75".

The "magic" of IEC 61850 is unleashed when every system, including the engineering process done even before the first item is purchased, understands a common data model that "***SIML.TmpAlm***" no matter which manufacturer of that IED, is always "**Insulation liquid temperature alarm**". This is because the Logical Node "SIML" (Supervision Insulation Medium Liquid) defines the Data Object "TmpAlm". SIML also defines many other objects such as "SIML.Tmp" as the actual liquid temperature.

It is not surprising then that "SIMG.Tmp" is defined in the Logical Node SIMG "Sensor Insulation Medium Gas" and is the Insulation gas temperature value. "SIMG.TmpAlm" is the status of the temperature alarm. Similarly "SIMG.Pres" is the gas pressure, "SIMG.PresAlm" is the gas density alarm status. "SIMG.Den" is the gas density value and "SIMG.DenAlm" is the density alarm status. The naming of the data structures is therefore somewhat intuitive even to the human eye rather than some abstract point number "1234" with a value "75".

Furthermore the Data Object "***SIML.TmpAlm***" by definition has 13 possible additional items of associated information called Attributes defined by the Common Data Class for Single Point Status (i.e. it is on or off), some optional but certain key ones defined as Mandatory as shown in the following table:

Table 2
Extract of SIML.TmpAlm Attributes

Attribute	Type	Value range	Mandatory/ Optional Conditional
stVal	BOOLEAN	TRUE | FALSE	M
q	Quality		M
t	TimeStamp		M

Consequently from any IED in any system regardless of who engineers the system:

- *SIML.TmpAlm.stVal* is ALWAYS whether the Alarm is on (True) or off (False).
- *SIML.TmpAlm.q* is ALWAYS the quality of stVal, its source (real process or substituted value) and validity.
- *SIML.TmpAlm.t* is ALWAYS the time when the value changed <u>at its source</u> (not the scan time of a RTU).

Once the engineering file has been developed which defines how this signal is communicated under what circumstances, all that engineering is directly able to be cut and paste to the next transformer or the next IED that will serve that purpose. Our engineering process is now independent of the choice of IED vendor, since we haven't had to choose one yet and that engineering is directly transferable cut and paste in every scheme we deploy.

Moreover, if a new IED is chosen from a different vendor, the different point allocation, structure and naming does not need to be compared to the previous vendor's in order to re-map a new configuration. Indeed identifying that the new vendor's IED is capable of providing the same functionality is a simple matter to compare available data structures for matching Logical Node availability.

This process establishes Reusable Vendor-independent Engineering.

Accessing Data

Very few discussions on IEC 61850 last long without mentioning of the famous GOOSE message. The Generic Object Oriented Substation Event message is one of the key components for the real time fast operation of protection systems that makes IEC 61850 so unique and so much more than "just a mere protocol". In reality this is simply a unique mechanism that allows for very fast communication (less than 4 milliseconds) of the status of various functions to be communicated to other IEDs. The receiving IEDs then configured to respond in certain ways depending on the status of the source function. GOOSE is therefore not a command in itself but is an engineered group of information of what functions are on and off. GOOSE is a Publisher/Subscriber can be likened to a fire alarm system where, regardless of whether anyone is in the building or not, it is repetitively sending out (publishing) a message "no fire detected" (albeit it silent) and one day it may send out a message "fire detected". If someone is in the building they will be listening (subscribing) to the fire alarm as silent or active and deciding in their own mind what to do as a result – an employee may want to leave whilst a fireman would want to enter or vice versa depending on what they hear.

However GOOSE is not the only communication method and in fact there are many applications where GOOSE is by far NOT the right choice of implementing a particular function or process. IEC 61850 provides a range of communication processes and commands that should be used in their right context – "the right tool for the right job".

Whilst IEC 61850 does provide the process of requesting individual data point information, it also provides "Data Sets" as a means of grouping the information for more efficient communication and access to all the associate data for the particular function. Once a data set is defined with certain elements of information it is then able to be used or accessed by a variety of means, including GOOSE. However the more common use of the datasets for asset management will be through the Reporting and Logging processes as shown in Figure 4

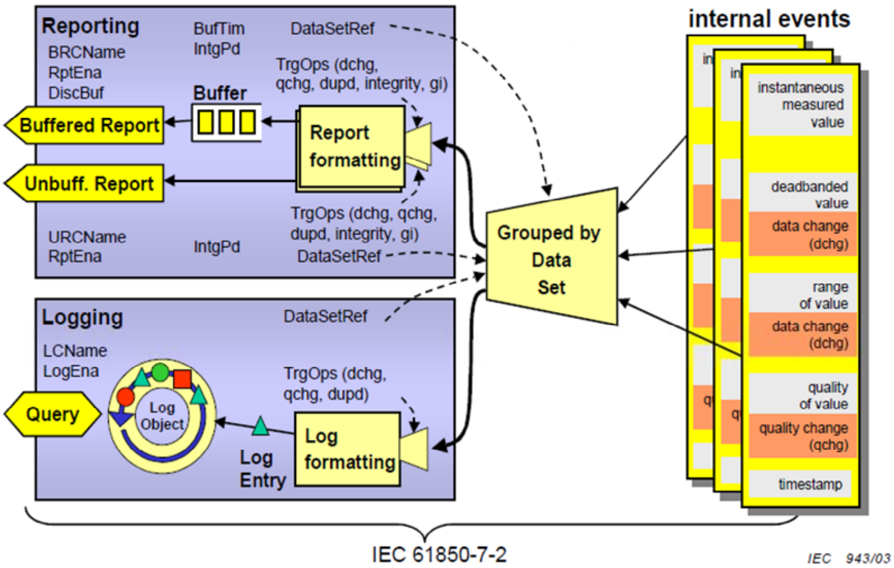

Figure 4
Accessing/Obtaining Data sets via Reports and Logs

Reporting is an automatic process where on the basis of triggers defined in the engineering process the Report containing the Data Set is sent to the destination address. Whilst this is similar to a GOOSE in that the communication from one IED is associated to a trigger configuration, GOOSE and Reporting are significantly different.

GOOSE is a continuously repeated message once every second and when the trigger occurs the message status information is changed and is repeated in fast succession. GOOSE is Publisher/Subscriber where the message is published as multicast (sent from one to many) and the sending IED has no concern about whether any other IED is actually subscribing – it job is to get the message out urgently for whatever system, IED or function may need to know.

Reporting is initiated as a once off message when the trigger occurs in a Client/Server arrangement. The source IED is the Server which will send the Report to a specific System or IED address as the Client. Reports are then available as Buffered and Unbuffered. This is a mechanism that allows for different conditions between the Server and the Client. In simple terms the Unbuffered Report is sent from the Server with little care as to whether the Client actually received the information or not. Buffered Reports however are stored in the Server so that if the Client has failed to receive the message for any reason, once that problem is rectified, those messages can all be resent.

Logs on the other hand are not automatically sent over the network but rather the Client application specifically requests the Log file to be sent from the Server.

Using IEC 61850 for Condition Monitoring Diagnosis and Analysis: IEC 61850 – 90-3

This document is currently in preparation which will describe the detailed Use Cases for the application of IEC 61850 for Condition Monitoring of equipment covering the following equipment:

1. Gas Insulated Switchgear
2. Transformer
3. Tap Changer
4. Underground Cables
5. Transmission Lines
6. Auxiliary Power systems

As an example, Condition Monitoring of power transformers involves an impressive array of sensors including those listed in Table 3 and are related to the range of IEDs as typically shown in Figure 5.

Table 3
Typical Transformer Sensors

1. Dissolved gas sensor	2. Bushing leakage current
3. Relative humidity (RH) sensor	4. Bushing voltage sensor
5. Oil temp sensor at RH sensor	6. Ambient temp sensor
7. Partial discharge sensor	8. Cooling bank status sensor
9. Direct winding temp sensor	10. Pump/fan current sensor
11. Load current sensor	12. Buchholz relay
13. Top oil temp sensor	14. Oil level sensor
15. Bottom oil temp	16. Pressure sensor
17. Winding hot spot temp	18. Conservator membrane rupture detector

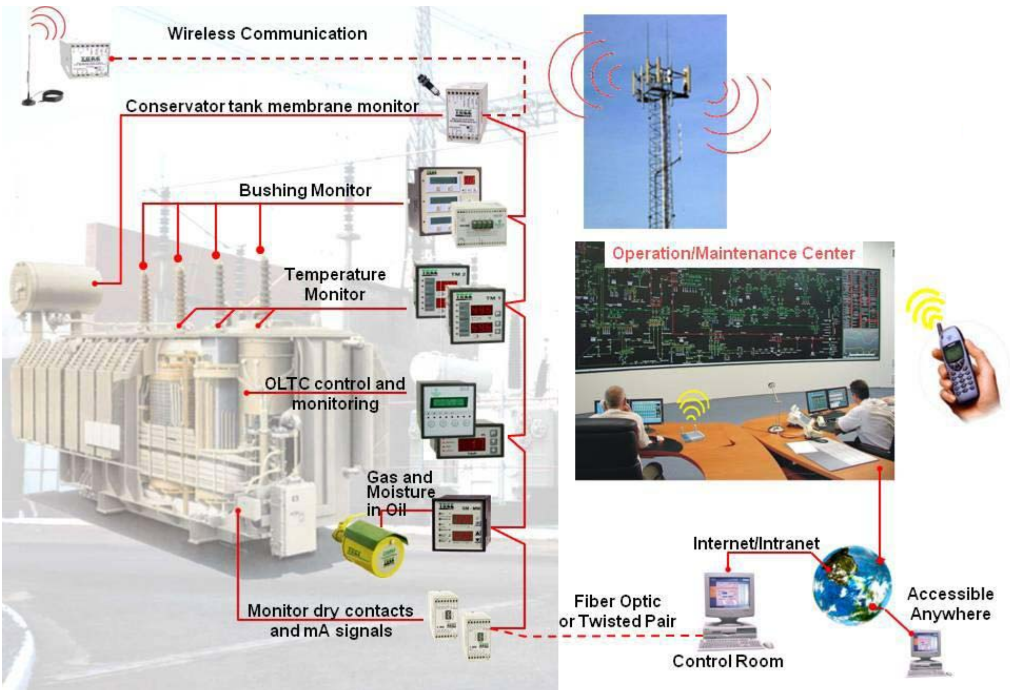

Figure 5
Typical Transformer IED Arrangements [1]

IEC 61850 -90-3 describes the potential use of a number of Logical Nodes for the Condition Monitoring of a power transformer. Each of these logical Nodes has a set of Data Objects (see Table 4 below) and associated Attributes which provide specific information points which can be used to provide essential information and control of the asset.

Table 4
Transformer Logical Node Data Objects
Note: each Object may have additional Attribute points

Logical Node	Description	Status	Measured Values	Controls	Settings
SIML	Insulation medium supervision (liquid)	30	19	1	22
SPDC	Monitoring and diagnostics for partial discharges	2	4	1	2
SPTR	Power Transformer Supervision	6	4	1	
SIMA	Insulation moisture and aging supervision (solid)	3	11	1	
SBTP	Bubbling temperature supervision	3	11	1	
ZBSH	Bushing	2	6		3
CCGR	Cooling group control	4	10	7	1

Of the 155 Data Objects (and many more Attributes) represented in Table 4, not all these are necessarily available in any one particular IED. IEC 61850 sets out the principles of Object Definition so as to provide the possibility for interoperability but also provides the essential flexibility for the IED manufacturers implementations. Some Data Objects are therefore defined as Mandatory if that Logical Node is implemented, some are Optional depending on the features the supplier wishes to offer and some are Conditional on whether certain other features are implemented.

It is therefore essential that the Asset Owners have a clear understanding of what their feature requirements are at the detail level in order to get the right mix of Mandatory, Optional and Conditional Data Objects required for THEIR system. Not surprisingly then as good engineering practice, stakeholder requirements capture and specification of those has to be the start of any system engineering.

IEC 61850 Engineering Process
IEDs are configured for their individual purpose in the SAS. This includes two key types of configuration

IED Proprietary and non communication element Configuration
- *Front panel HMI controls – pushbuttons, switches, indicators, displays*
- *Internal logic operation*
- *Input / output terminal characteristics and allocations to functions*

IED IEC 61850 and SAS Configuration
- *Communication configuration - IEC 61850 and legacy*
- *IEC 61850 model configuration*
- *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. Suggestions of a "single tool" are therefore somewhat impractical in view of competitive market places and features outside of the IEC 61850 engineering process and definitions.

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 as described in Table 1 and following.

Table 5
IEC 61850 Engineering File Types

IED Related	**System Specification Configuration Related**
▪ *ICD*	▪ *SSD*
▪ *CID*	▪ *SCD*
▪ *IID*	▪ *SED*

The use of these six files in the engineering process should be well understood [5]. They are not the files or messages exchanged between IEDs whilst in service which demands IED-to-IED interoperability. However they are rather the files that are exchanged between different engineering tools in different departments and organizations in order to undertake the specification of the system, the integration of devices and the communication definitions and the configuration of the IEC 61850 aspects of the individual IEDs. These files enable the engineering process interoperability in a multi-project, multi department, multi organization engineering environment.

Naturally each IED vendor has various proprietary tools for supporting their specific box for reasons of IED firmware and functionality as described above in respect of proprietary physical implementations.

IEC 61850 therefore defines the requirements for IED-to-IED interoperability as well as the Tool-to-Tool Engineering process interoperability.

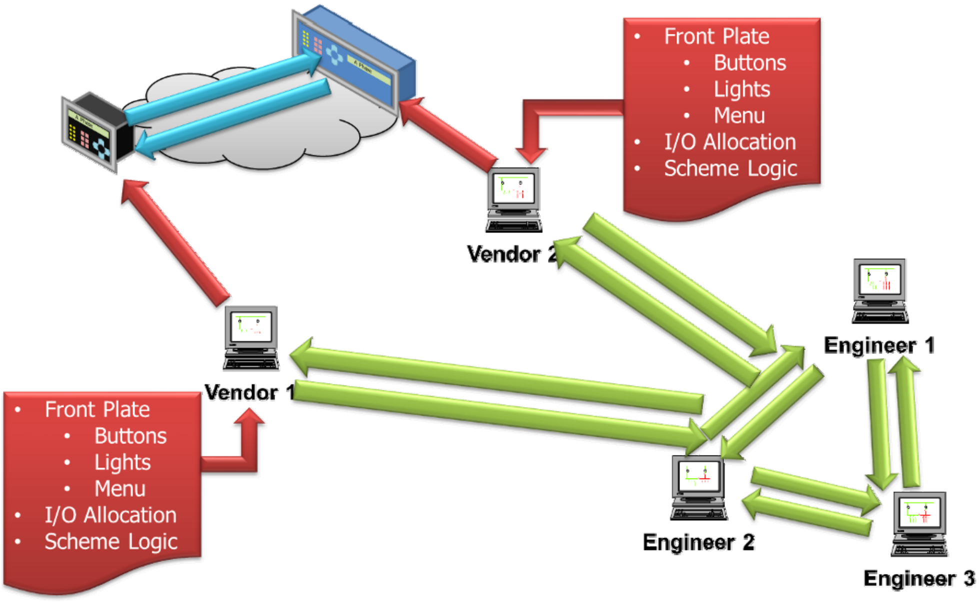

Figure 6
IEC 61850 Interoperability Definitions:
IED-to-IED communication (blue)
Tool-to-Tool Engineering (green)
Non-IEC 61850 definitions (red)

The final aspect is of course the choice of tools for the engineering process. A single tool is simply not a practical answer in as much as no single Swiss Army knife can provide all the gadgets for any job in any circumstance although there are some with dozens of gadgets but practically cannot be carried in our pocket!

The engineering environment must cater for the

- integration of the IEC 61850 with the other asset owners engineering processes and standards
- engineering of the IEC 61850 configuration independently of the ultimate secondary choice of IEDs
- system level equipment that benefit from the IEC 61850 engineering of the SAS

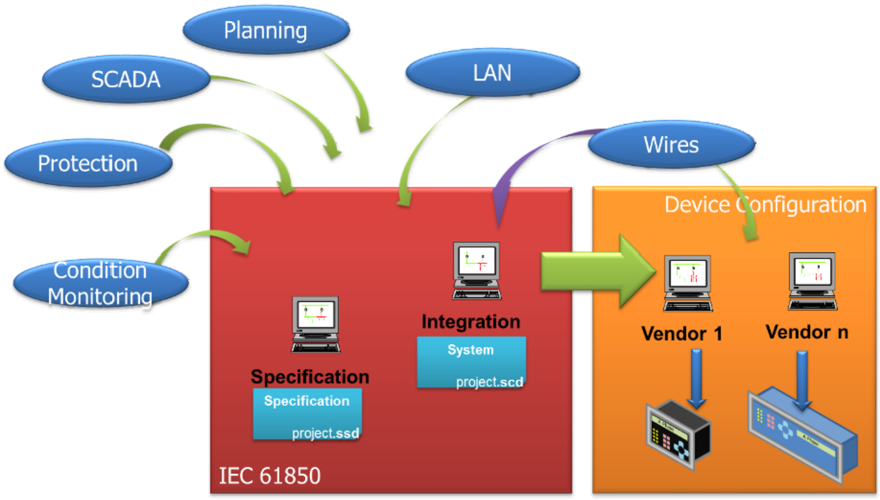

Figure 7
Integration of tools for complete engineering process

The search for tools is therefore a critical factor in a decision to adopt IEC 61850 however the tools market is ever evolving and expanding. [6][7][8]

Conclusion
The importance of primary equipment to the reliable and safe operation of a power system cannot be understated. However it has only been the advent of Intelligent Electronic Devices in the 1980's that the possibility to automate and expand the process and amount of data collection regarding the condition and performance of these asserts has been able to be improved.

With the expansion of sensors and types of IEDs with communication capabilities so has come many difficulties with integrating these systems from diverse sources.

The IEC 61850-90-3 document currently in preparation will provide guidelines on how the capabilities of the Standard can be applied to the vital area of Asset Condition Monitoring.

In applying IEC 61850, it is paramount to recognize that this is first and foremost a system. Systems must b specified in respect of their functionality and performance first, then the components chosen to suit those requirements.

Moreover, once the system is determined, efficient engineering in the light of vast numbers of pieces of information has to rely on Reusable Engineering processes such as using the correct process intent defined in IEC 61850-6 are followed. Unfortunately 'lazy shortcuts' happen all too often if the Asset Owners are blind to the benefits they need from new technology and fail to specify not only their system functional requirements but their system engineering requirements as well.

The nature of IEC 61850 is an ideal platform in which to create a coherent and efficient engineering process independent of the IED choice. Asset Condition Monitoring Systems will be a prime focus of where the IEC 61850 benefits will aid Asset Owners in engineering, operation and maintenance of their substation equipment. However random procurement and a lack of systems specification must be avoided by seeking good expertise advice when adopting IEC 61850 as the solution.

Acknowledgements

1. Image courtesy Treetech Sistemas Digitais Ltda and Martec Asset Solutions www.martecassetsolutions.com.au

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Biography

Rodney Hughes (rgh@rodhughesconsulting.com) is the Managing Director of his own independent consulting business specializing in assisting organizations 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. Rod also owns the patent for the Operator & Test Interface unit for IEC 61850 systems. Rod 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 was the immediate past Convener of CIGRE Australia B5 Panel for Protection & Automation and Australian representative to the international Study Committee B5 for eight years and was awarded the international CIGRE Technical Committee Award for contributions to SC B5 in 2011.

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 a Bachelor of Electrical Engineering from Sydney University graduating in 1980.

Christoph Brunner (christoph.brunner@it4power.com) is the President of his own independent consulting company it4power LLC based in Switzerland. He is Utility Industry professional with over 25 years of industry experience with knowledge across several areas within the Utility Industry and of technologies from the Automation Industry. He has worked as a project manager at ABB Switzerland Ltd in the business area Power Technology Products in Zurich / Switzerland where he was responsible for the process close communication architecture of the substation automation system. He is Convener of Working Group 10 of the IEC TC57 and member of WG 17, 18 and 19 of IEC TC57. He is senior member of IEEE-PES and IEEE-SA. He is active in several working groups of the IEEE-PSRC (Power Engineering Society – Relay Committee) and member of the PSRC main committee and the subcommittee H. He is international advisor to the board of the UCA international users group.

Christoph graduated as electrical engineer at the Swiss Federal Institute of Technology in 1983.

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IEC 61850-90-3

"Using IEC 61850 for Condition Monitoring Diagnosis and Analysis"

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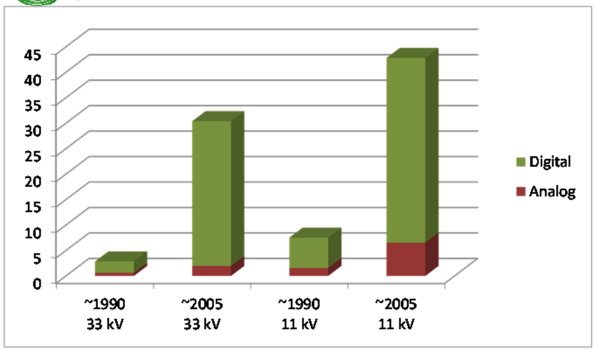
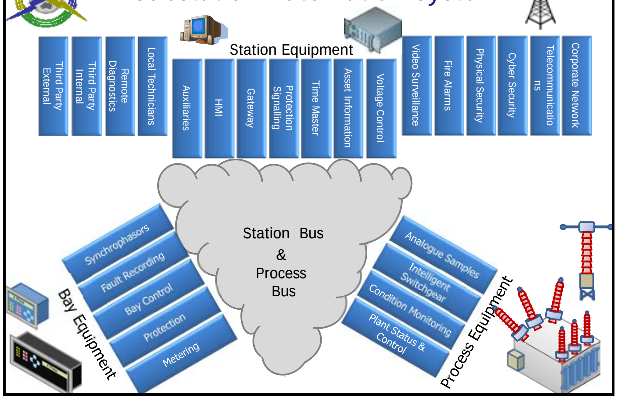
Demand for Information



Substation Automation System



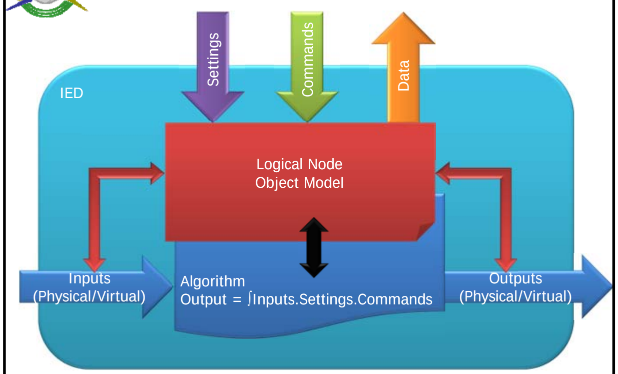
System Requirements

	SCADA, DMS, EMS	Substation Automation	Asset Management
Number of points acquired from Condition Monitoring Device IEDs	Small	Small to medium	Large
Type of system processing	Continuous	Continuous	Batch or continuous
Type of data acquisition	Online, real-time	Online, real-time	• Deferred time-series acquisition • Manual entry • Online • Real Time
Source of information	SA, IEDs, primary equipment	IEDs, primary equipment	IEDs, primary equipment, offline test reports, SCADA, DMS, EMS, SA, Historian, ERP systems

The Standard

- IEC 61850-6 engineering process and file structure
  - design office (i.e. instead of "Autocad", "Word" and "Excel") – System Configuration Language (SCL)
- IEC 61850-7 IED data structure and naming
  - Logical Nodes, Data Objects and Attributes
- IEC 61850-8 and IEC 61850-9 message and command formats
  - Reports, commands, Sampled Values, GOOSE, - Abstract Communication Services Interface (ACSI)

Object Models



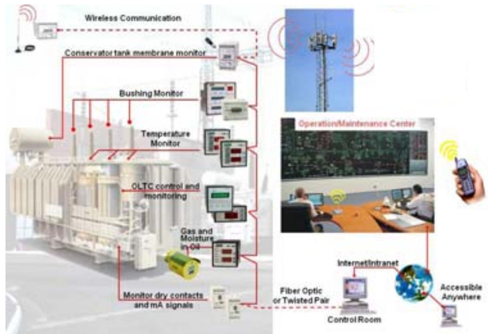
A picture is worth a thousand words,
but sometimes you also need the right words

Transformer Sensors

Dissolved gas sensor	Bushing leakage current	Relative humidity (RH) sensor
Bushing voltage sensor	Oil temp sensor at RH sensor	Ambient temp sensor
Partial discharge sensor	Cooling bank status sensor	Direct winding temp sensor
Pump/fan current sensor	Load current sensor	Buchholz relay
Top oil temp sensor	Oil level sensor	Bottom oil temp
Pressure sensor	Winding hot spot temp	Conservator membrane rupture

Extract IEC 61850-90-3

Transformer Sensing



Courtesy Martec Asset Solutions & Treetech

Transformer Logical Node Data Objects

Logical Node	Description	Status	Measured Values	Controls	Settings
SIML	Supervision Insulation medium (liquid)	30	19	1	22
SPDC	Monitoring and diagnostics for partial discharges	2	4	1	2
SPTR	Power Transformer Supervision	6	4	1	
SIMA	Supervision Insulation moisture and aging (solid)	3	11	1	
SBTP	Bubbling temperature supervision	3	11	1	
ZBSH	Bushing	2	6		3
CCGR	Cooling group control	4	10	7	1

Definitions on the Web

- The ability of information systems to operate in conjunction with each other encompassing communication protocols, hardware software, application, and data compatibility layers..
  - www.ichnet.org/glossary.htm
- the ability of one computer system to control another, even though the two systems are made by different manufacturers.
  - www.sunrise-comp.co.uk/glossary.html
- This refers to the ability of a system or a product to work with other systems or products without special effort on the part of the customer. ...
  - www.michigandtv.com/glossary
- The ability of any two computers that are interconnected to understand each other and perform mutually supportive tasks such as client/server computing
  - www.nitrd.gov/pubs/bluebooks/1995/section.5.html

Standardised Information

Attribute	Type	Value range	Mandatory / Optional / Conditional
stVal	BOOLEAN	TRUE | FALSE	M
q	Quality		M
t	TimeStamp		M

SIML.TmpAlm.stVal is ALWAYS whether the Alarm is on (True) or off (False).

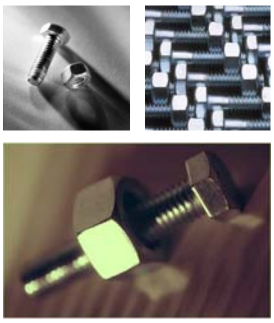
SIML.TmpAlm.q is ALWAYS the quality of stVal, its source (real process or substituted value) and validity.

SIML.TmpAlm.t is ALWAYS the time when the value changed at its source (not the scan time of a RTU).

Sample Certificates

A picture is worth a thousand words,
but sometimes you also need the right words

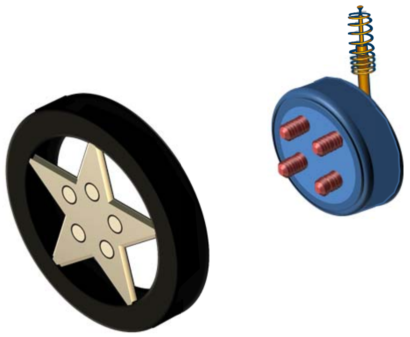
Interoperability
Nuts & Bolts



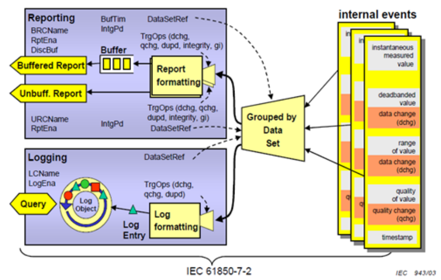
- 10mm nut, 8mm bolt are not interoperable
- Length
- Left / right hand thread
- Head
  - Spanner: Hex / square
  - Screwdriver: Phillips/flat
- Tensile strength
  - Steel/copper ...
- Galvanised/painted
- Shank/ full thread
- Lock nut
- Use with washer?
  - Flat, spring, internal star, external star

Buy a tyre....

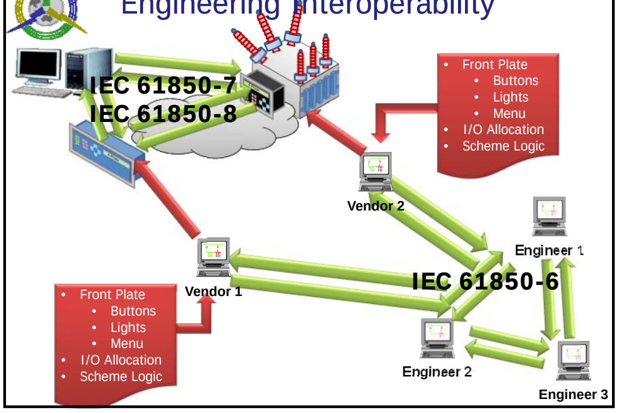
System Interoperability



Accessing Condition Monitoring Data



Engineering Interoperability



Engineering Files
IEC 61850-6

IED Related	System Specification Configuration Related
ICD IED Capability Description	**SSD** System Specification Description
CID Configured IED Description	**SCD** System Configuration Description
IID Instantiated IED Description	**SED** System Exchange Description

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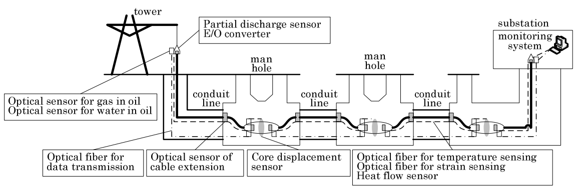
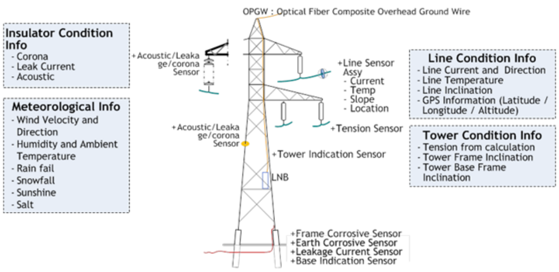
IEC 61850-90-3

- Gas Insulated Switchgear
- Transformer
- Tap Changer
- Underground Cables
- Transmission Lines
- Auxiliary Power systems

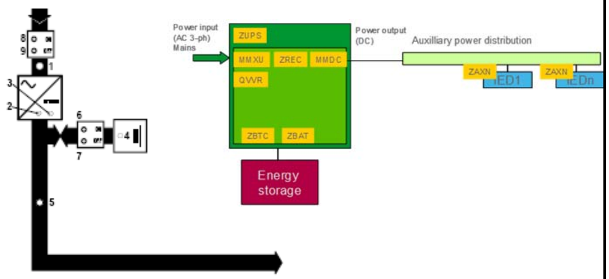
Under Ground Cables



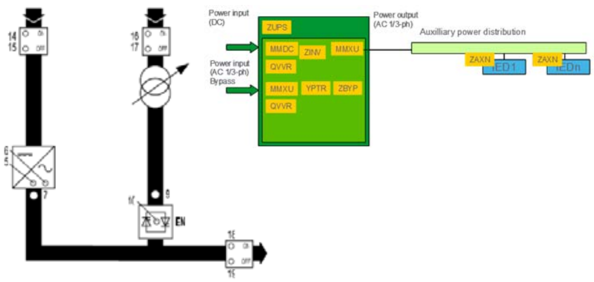
Transmission Lines



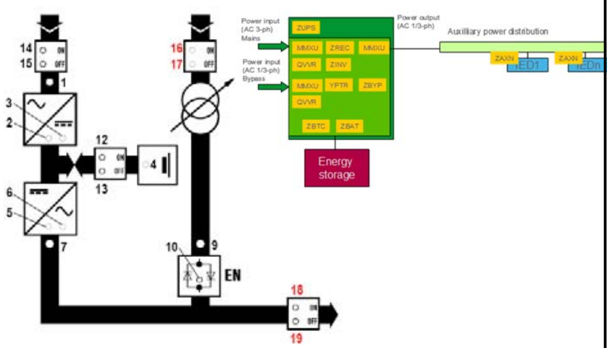
Secured DC system - AC input power



Secured AC system - DC input, AC backup



Secured AC system - AC input, AC backup



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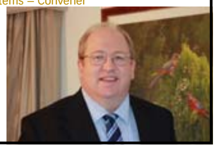
Condition Monitoring Using IEC 61850

- Increased demand for asset reliability
- Increased demand for information
- Increased range of devices
- Increased communication
- Increased integration
- Increased engineering interfaces
- Increased engineering efficiency
- Increased reusable engineering

Rod Hughes

- 30 years in protection engineering
  - GEC, ALSTOM: P&C Engineer, Engineering Manager, General Manager – Australia
  - ALSTOM: P&C Product Director - France
  - ElectraNet: Protection & Telecoms Manager, Plant Strategy & Technology Manager
  - SKM: State Manager - South Australia
  - AECOM: Technical Director - South Australia
  - **Rod Hughes Consulting Pty Ltd: Managing Director & owner**
- CIGRE
  - AP B5 Protection & Automation 1985 - 1998, 2001- current
    - (Convener since 2004)
  - AP D2 2001 – 2004 Information & Telecommunications
  - Technical Brochure 326 Implementation of IEC 61850
  - WG B5-39 Documentation for Digital Substation Automation Systems – Convener
  - South East Asia Protection & Automation Conference
- UCA® International Users Group
- IEEE Power Engineering Society
- Publications and Technical Papers
- Training courses – Protection & IEC 61850
- LinkedIn forum
- Owner IEC 61850 Patent: Operator & Test Interface



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- IEC 61850 and associated standards
- Automation & Control
- Protection design 11kV to 500kV
- Training
- Cyber Security
- Smart Grid and Smart Metering
- Telecommunications
- Substation LAN

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