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Seamless Engineering Process to Adapt IEC 61850 Standard for Substation Automation Through Requirements Specification

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Abstract. Whatever demographic one belongs to in the technology adaption life cycle, for a seamless implementation of IEC 61850 Standard it is required to answer the key concern related to extent of change. This paper provides guidelines on the evaluation of amount of change by going through the requirement specification process, interface evaluation, and configuration tools. All this information is presented in a process form which makes it easier to quantify the inputs for organizational change management.

1. Introduction

The comprehension and integration of IEC 61850 standard for an inexperienced operator and maintainer can be challenging at times. The company's protection engineers have to work closely with the vendor offering IEC 61850 enabled equipment and systems during implementation of systems as complex as substation automation.

Although the vendors will perform the detailed implementation of the IEC 61850 object and service models, the substation engineers must be able to decide what settings should be established for a particular substation. Therefore, the company's workforce needs to upskill so that all the potential benefits of IEC 61850 can be earned while attaining the change management sweet spot when smart substation automation systems and devices are implemented for the grid. A Six gate process for requirements specification management can help to attain that sweet spot for IEC 61850 adoption.
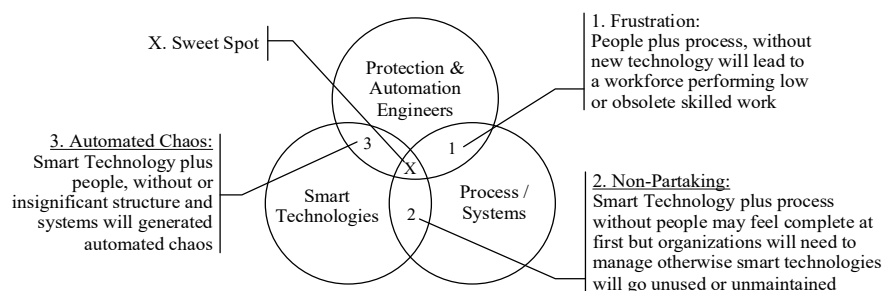

Figure 1 – A systemized change management approach for balancing the elements, anticipating value and facilitating engagement for implementation to attain sweet spot.

2. Six Phase-Gate Process:

A phase gate process deals with a project by dividing it into phases separated by decision points and at the end of each gate the management decides on continuation. Following are the six gate process for requirements specification of IEC 61850:

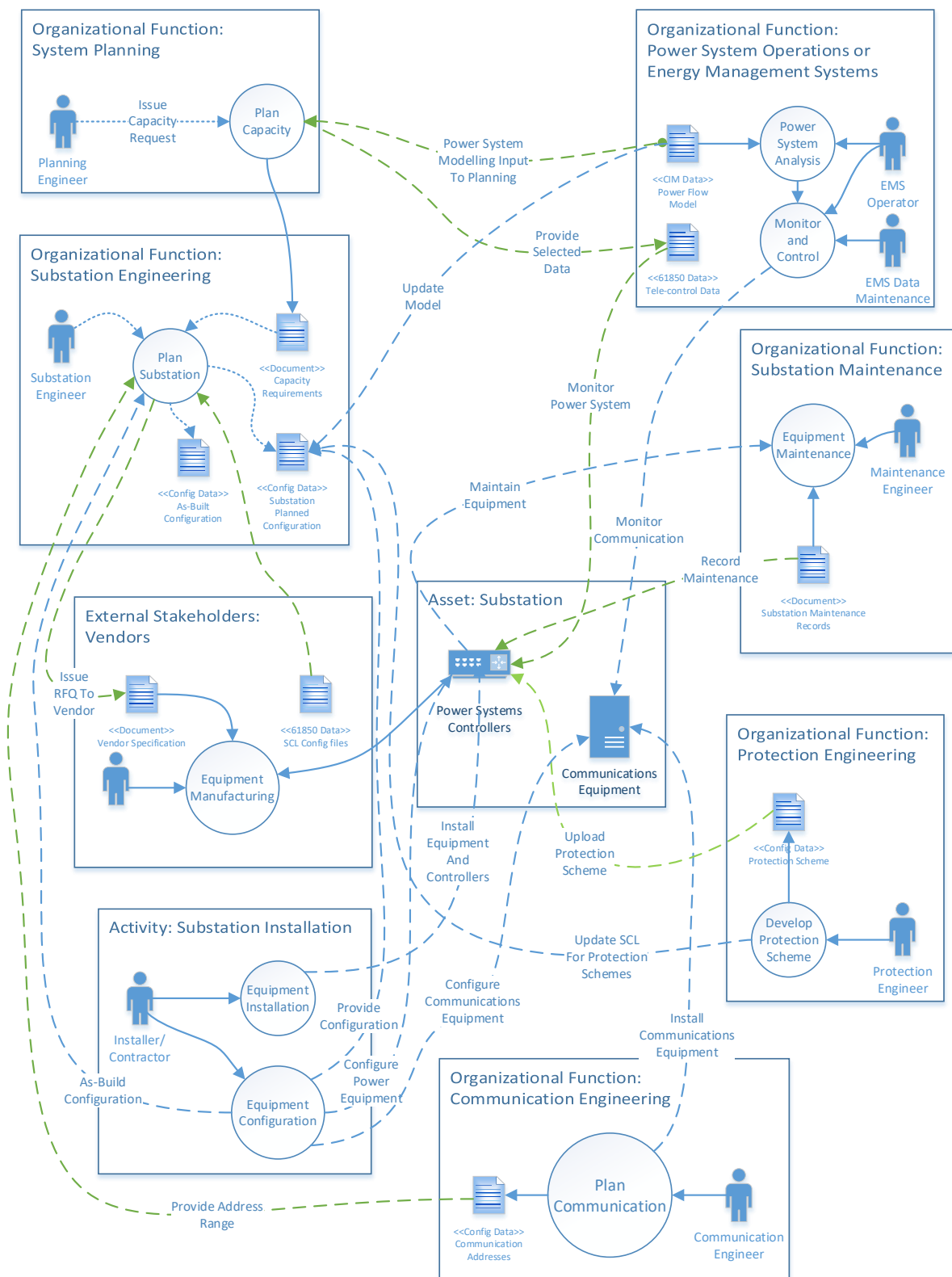| Stage - 1	Gate 1	Stage - 2	Gate 2	Stage - 3	Gate 3	Stage - 4	Gate 4	Stage - 5	Gate 5	Stage - 6	Gate 6
Define functional requirements		Establish IEC 61850 logical nodes and its parameters		Specify IEC 61850 data exchanges within the station		Specify IEC 61850 data exchanges with external interfaces		Specify conformance testing		Specify IEC 61850 configuration tools	

2.1. Stage/Gate 1 – Define Functional Requirements

By adapting a systems approach, functional requirements can drive the application architecture of substation automation system. A detailed functional requirement assessment can produce a comprehensive scope relevant to the organization. Following this step, the vendor independent outcomes in the form of technical requirements can be adopted by a sub-contractor (vendors/integrator) to execute the implementation of IEC 61850. Following are the basis of these requirements:

Substation Electrical Layout	Equipment Selection and Specification	Assessment of available or necessary data	Assessment of protection scenarios
Determine SCADA Requirements – Real time and control/set-point/parameter capabilities	I/O (Input/Output) List	Information security requirements	Network Management Requirements
Functional requirements around change in automation philosophy			

The functional requirement specification is more than a datasheet and should include the requirements of all stakeholders. This holistic approach will enable to reap the full advantage of smart protection system with the use IEC 61850. Following are some of the stakeholders involved:

- Planning Engineers
- Protection Engineers
- Maintenance
- Operations and Control Management
- Market operations

By answering "what questions" first rather jumping to "how" serves as the basis of functional requirement management. This brainstorming coupled by stakeholder management can be facilitated by modelling techniques such as depicted in figure 2. After progressive iterations of the model, a final model and specification can be created and at the first gate, a go- or no-go decision can be made. At this stage the effect on both conceptual and physical systems can be analyzed.

Figure 2 – A typical UML (Unified Modelling language) for substation automation using SCL (Substation Configuration Language) with the purpose of visualizing automation system along with its main actors, roles, actions and artefacts in order to document system information.

2.1.1. Stage/Gate 2 – Establish IEC 61850 logical nodes and its parameters
Based on the functional requirements, the data items are instantiated in to logical nodes.

2.1.2. Stage/Gate 3 – Specify IEC 61850 data exchanges within the station
The functional requirements in Stage 1 describe the types of data to be exchanged. Stage 3 defines following:

- what IEC 61850 data items are sent
- Where IEC 61850 data items are sent
- Under what conditions IEC 61850 data items are sent

In IEC 61850 terminology, these data exchange definitions are PICOMs (Pieces of information for communication), which are only for example and not normative. Thus, it is essential that actual data exchanges define following [6]:

- average and maximum transfer times
- the average and maximum response times
- the average and maximum size of messages
- security
- availability
- backup and/or redundancy

2.2. Stage/Gate 4 – Specify IEC 61850 data exchanges with external interfaces
The external interfaces for data exchange can be identified with system modelling. Further brainstorming on questions in following categories will finalize the interactions.

- Monitored data
- Controls and parameter settings

2.2.1. Stage/Gate 5 – Specify Conformance Testing
With IEC 61850-10, a standardized approach is available for interoperability. Interoperability is not only important for flexibility but also for reduced life cycle cost and obsolesce/future proofing.

2.2.2. Stage/Gate 6 – Specify IEC 61850 Configuration Tools
The decision to adopt a particular vendor specific tools is important as any change afterwards can have implications on people, systems and equipment.

3. Conclusion:
There is a degree of resistance in the industry to adopt the IEC 61850 standard for substation automation and a systematic approach involving change management can help derive the maximum benefit from an IEC 61850 enabled substation automation. The benefit offered to organizations in terms of cost and people in terms of skill development can convince users to implement smart substation automation solutions. A phase gate process can give confidence to decision makers by evaluation of change, reducing risk and cost.

It is concluded that a UML based visualization technique can help quantify change across all disciplines, departments and stakeholders.

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