CHALLENGE OF MANAGING ORGANISATIONAL CHANGES, NECESSARY FOR NEW SUBSTATION AUTOMATION SYSTEMS

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ABSTRACT

The functions in a substation are increasing. The approach of utilities was to use different boxes per function. With the upcoming of IEC 61850 and increasing processing power, functions are no longer restricted to one box. This new approach of substation automation systems has a great impact on the lifecycle of the system and indirectly on the organisational structure. In the conventional systems each department has its own box. By integrating the functions in one system, the responsibilities of different departments should be clear. Efficient working procedures and smart choices of hardware are proposed to optimize the rollout of new substation automation systems.

INTRODUCTION

Slowly utilities are changing from ‘every function has its own box’, to more integrated automation solutions. As new standards are embraced like IEC 61850 and processing power increases, more and more utilities upgrade their substations with modern Intelligent Electronic Devices (IEDs). The IEDs can handle multiple functions.

Outdated substations have Substation Automation Systems (SAS) from one manufacturer, with a manufacturer-specific data communication protocol. After the lifecycle of the SAS or with expansion of the substation, it is almost impossible to get parts that are compatible with the conventional SAS. New functions (for example Power Quality) for the substation have troubles of communicating with the conventional SAS. With new technologies based on Information Communication Technologies (ICT) these problems can belong to the past. With open communication protocols and integration (and/or decentralization) of functions, the new SAS will be simple and flexible.

The new modern SAS like SA\textsuperscript{Sensor}\textsuperscript{®} demonstrates the integration of digital control and protection systems [1]. It combines control, over-current protection, fault location, revenue metering and power quality within one system. This system is easy to maintain and the software is upgradeable with future functions. Other IEDs from different manufacturers can be connected; using the IEC 61850 protocols or through direct wiring. The new challenge is to manage the organisational change, which is essential for a successful rollout of the new SAS.

FUNCTIONS IN SUBSTATIONS

Within the substation different functions are used. In conventional substations every function has its own box. For all the boxes, generally different departments are responsible for installation and maintaining of one or more functions, as shown in Figure 1. The protection engineer will install, check and set-up the protection function boxes, while the revenue metering engineer will install, check and set-up the revenue meters. If the current transformer of the protection is changed, the protection engineer will update the protection functions and record the changes within its department. No communication is necessary between the protection engineer and the revenue metering engineer. This example clearly shows that the access rights of the engineers are strictly for their own function box and no interaction is forced between the departments. The integration of functions with a new SAS (see Figure 2) will introduce interaction between different departments.

![Figure 1: Conventional SAS overview of functions and the responsible departments](image-url)
for. If shared parameters or equipment is changed, every responsible department has to be informed to check the operation of their functions. This option will have a great impact on the way the engineers work, as they will have to take other departments into consideration when working with the SAS.

Another way to solve the interaction is to integrate departments and responsibilities to Service Teams. These Service Teams will be responsible for all the functions within the substation. When changing parameters or equipment, they can immediately update the SAS.

**Figure 2:** New SAS overview with proposed Service Team that combines all tools and skills to maintain the SAS

ITIL defines several ‘roles’ that should be defined within the organisation as shown in Figure 3. Each role is responsible for a specific part of the process. The main areas that are important for the functions of the substation will be processes as Change Management, Configuration Management, Release Management, Incident Management and Problem Management. To make a change within the SAS, it should be clear which departments shall be informed and who is responsible for the change. Then the proposed change will have to be released in one or more substations in a controlled manner. After the changes are implemented the new configuration of the system has to be updated within the organisation. All these procedures have to be defined and clearly documented for all parties that are involved.

**Figure 3:** ITIL overview of the main processes of Service Support

The integration of functions and the combination of information leaves a great risk of losing the responsibility for who is responsible for all the information. With the separated functional boxes, it was clear which department was responsible for the information. In the new situation measurement data is used by different functions over shared equipment and communication lines. The protection of the information has to be secured by a central department, which will help and audit the processes and responsible parties to secure the information to a reasonable level.

**ROLLOUT**

The rollout of a new SAS is changed tremendously in comparison with conventional Secondary System rollouts. Conventional protection relays (see an example in Figure 4A) installed in the ’40 and ’50 are still operating within several substations. The present generation of relays (Figure 4B) have an estimate lifecycle of 15 years. This fundamental difference in lifecycle will have a great impact on the current organisation, especially in perspective of the continuous shortage of technical staff. The new organisation will have to adapt to a higher frequency of changing the SAS. A solution can be the integration of all functions within one system. In such a system it is an advantage that after 15 years only the software has to be updated and that
the hardware in the bays do not have to be replaced. To reach this goal, all intelligence should be centralised. With Tele-service and Tele-maintenance (as used in ICT systems) it shall be easier to update software versions. With big SAS populations it will have the advantage of having an up to date SAS population and retention of knowledge will be reduced to only the latest SAS versions. This total approach will save engineering, erection, testing and maintenance time. Moreover the disruption of the grid will be minimized.

A) Conventional protection relay
B) New protection relay

**Figure 4:** Examples of relays within substations

Renovating a substation with a conventional system will save initially time, while the organisational structure can be left unchanged. If a choice is made to change the organisational structure and integrate departments to multidisciplinary teams that can cope with all substation functions, the new SAS will cost 25% of a conventional system and reduce time of engineering, maintenance and updating the functions [1].

**Figure 5:** Reduction of lifecycle for renovation of SAS

As the renovation frequency will increase from once per 45 years to once per 15 years, the organisation has to change to fulfil this goal. Technical staff is scarce and has to adjust to the new SAS. Efficient working procedure should be introduced, by making use of:
- Multi-skilled teams
- Clear procedures
- No doubles, no gaps
- Tele-service
- Tele-maintenance

Within Alliander a Pilot [2] has started in 2004 to implement 10 substations with the SASensor® system to proof the technology, which has been finalized in 2008. For an efficient rollout of the SASensor® system (or any other SAS) on a larger scale, procedures for engineering, installation, commissioning and maintenance have to be developed and tested. The different procedures must have a seamless connection to have a maximum growth in efficiency (no doubles) at higher quality (no gaps) (see Figure 6). For this sake an operational pilot will start in 2009 to evaluate the changed working procedures within the utility concerning multi discipline configuration responsibilities, configuration change management, overall system responsibility, cyber security [3][4], etc. Utility personnel needs additional training to fulfil their tasks in the new procedures. If these goals are met, significant efficiency advantages are within reach.
CONCLUSION

Due to the integration of substation functions and a shorter lifecycle of the digital electronic devices, hardware and organisation changes are necessary for SAS. A solution can be the integration of all functions within one system. In such a system it is an advantage that after 15 years only the software has to be updated and that the hardware in the bays do not have to be replaced. To reach this goal, all intelligence should be centralised. This approach will save engineering, erection, testing and maintenance time. Moreover the disruption of the grid will be minimized.

For the rollout of new SAS the working procedures and responsibilities should be clear. Multi-skilled teams should be assigned to install and test the system for an efficient rollout. The different procedures must have a seamless connection to have a maximum growth in efficiency (no doubles) at higher quality (no gaps).

REFERENCES


