SMART AREA AACHEN: COMMUNICATION INFRASTRUCTURE FOR INNOVATIVE EQUIPMENT

Fjodor LAMM
NEXANS – Germany
fjodor.lamm@nexans.com

Pascal HAHULLA
STAWAG – Germany
pascal.hahulla@stawag.de

INTRODUCTION

The extension of energy networks is developing very dynamically. The integration of decentralized energy sources, photovoltaic and wind power plants, is becoming more and more important and the operators are confronted with new issues. In order to face new challenges, the network infrastructure is continuously updated and expanded to the so-called "Smart Grid". The term "Smart Grid" or "Smart Grids" is part of reality - but there is no detailed description or general technical design. However, it is very likely that a significantly increasing amount of information will exist on the network, as well as providers will be in need of a much more powerful data structure. The functionality of power stations will increase significantly in the long term, which will lead directly to a multiplication of communication volume. The previous typical substation doesn´t have dedicated communication links; at best, they are equipped with remote control connection via 2-wires. All these stations will be replaced by intelligent substations having a modern communication connection and various new features.

Intelligent electronic devices have been used for many years for communication via interfaces and protocols according to standards IEC 60870-5-101 or -104 in the control and management of complex systems in power systems, from production to distribution. The result of this development was a high manufacturer dependency leading to high costs for equipment. However, communication standard IEC 61850 has asserted itself for several years. In 1995, activities to develop a world-wide standard have already started. These have led to the publication of several editions and have reached user acceptance.

IEC 61850 - INTERNATIONAL STANDARD FOR ENERGY NETWORKS

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The IEC 61850 standard has been defined in collaboration with users and manufacturers and approved by the IEC. The objective of these standardization activities is the creation of common basics for protection units, management, switchgear and communication. IEC 61850 uses TCP / IP as the basic transmission protocol and has established itself as the communication standard in the market for automation and energy industry worldwide. Through the use of Ethernet all possibilities of modern communication infrastructure and new standards can be used. The transfer of device description for online engineering and monitoring functions are only some of the possible options. Ethernet with its higher level protocols connects entire corporate networks and enables global networking.

IEC 61850 is used deliberately and increasingly in many new power plants and substations and is required by many operators. Consequently, the manufacturers have to recognize this trend and implement communication mechanisms corresponding to IEC 61850 in their future smart devices, IEDs (Intelligent Electronic Device). It requires robust communication solutions, especially for critical applications, to enable fully automatic or remote operation of facilities

IEC 61850 poses specific requirements for the data network design and its components. Network components must meet extremely high environmental standards and ensure high availability in power energy networks.

The creation of open standard interfaces means less work for the combination of systems from different vendors, thereby securing investment in spare parts management. Implementation times of projects, CAPEX and OPEX can be reduced. As a result manufacturer dependencies are deleted by interoperability. In connection to the further development of IT-based technologies, the new interfaces secure long term investment and are backward compatible for further development of the whole system.

INNOVATIVE COMMUNICATION

Ethernet switches are used for the transmission of data. These are used as part of the standard IEC 61850 network for data exchange between IEDs, standardized services and network devices Communication takes place according to IEC 61850-8-1 /9-1 /9-2.

Since 2009, Nexans has already provided Ethernet-based systems and switches, with several optical and Twisted Pair Ethernet ports for use in IEC 61850 environments.

The establishment of components with universal and standard-compliant data models is in need of further general action and development. Regardless of the existing methods, it is important to develop and establish, at an early stage and through the participation of new market players, methods based on the standard. Today, network components are considered as a separate part of separate systems with their own servers and its own management. The intelligence and monitoring functions of the network components are insufficiently exploited. The extensive functions are now implemented using SNMP (Simple Network Management Protocol) or OPC integration. The connection works through its own partly proprietary systems. Therefore, Nexans has decided to invest in the development of new systems three years ago.

The essential point of the new development is the implementation of the SCL (System Configuration Description Language) configuration interface for system management. This interface allows seamless modeling and operation of substation automation. Furthermore, the development of a general data model for communication between energy supply infrastructure and new types of communication partners whose information is relevant, in the context of the development of supply networks, is required. In this model, data reduction and concentration of information towards power utility is taken into account. In general, the entire communication engineering, according to IEC 61850, is independent of the lower protocol layers. SCL uses only the data model defined in IEC 61850-7 for the system description. For communication between the devices, the abstract data models and communication services of IEC 61850-7 must be defined by means of specific protocols so that information can be exchanged physically. The data models are hierarchical, simple tree structure, defined and established. The models include "logical nodes", "data objects" and "control blocks". These are mapped to the corresponding MMS (Manufacturing Message Specification) objects. The communication services of the IEC 61850-7 parts 2/3/4 are mapped accordingly largely to the MMS services.

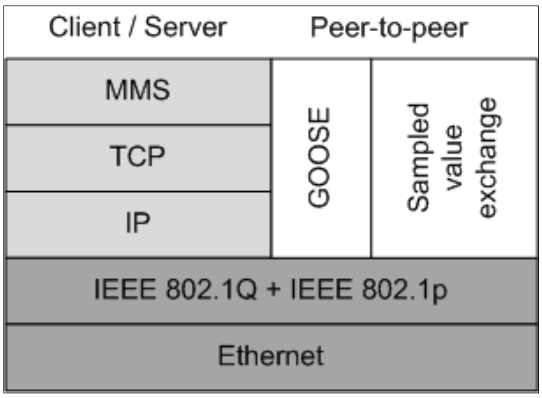

Figure 1: Schematic illustration of communication models

When transferring the modeling approach, the switch is described as a physical device in a common logical node with associated attributes. In addition to the general device information, the model includes records of joints, general status information and alarms. These services enable easy integration and management of network components in the overall system, and later in the smart grid.

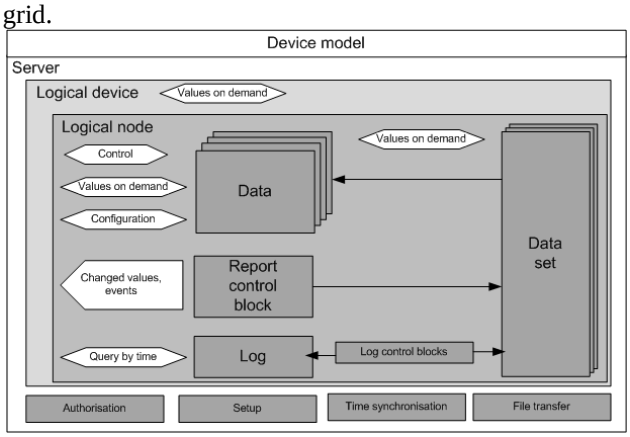

Figure 2: Schematic diagram of the equipment according to IEC 61850 models

TARGETS OF RESEARCH PROJECT

This modeling method uses industrial Ethernet switches as IEDs as a part of configuration ICD (IED Capability Description) file. This file contains configuration parameters of communication systems in addition to information on switchgear structure and their relationships. The file format of ICD is defined in such a way that the system description exists in a compatible form. In this way system descriptions can be exchanged between configuration tools and system configuration tools from different vendors. To create such a file SCL is used. SCL uses the structure and grammar rules of XML (Extensible Markup Language). The SCL file is as a result a default XML file, which is created in conformity with semantic rules of IEC61850. In the process of system engineering, the configuration file will be applied into the common system description. Thus, independently from manufacturer and general integration of network components is possible.

Figure 3: The new generation of Nexans switches for IEC 61850 applications

In the context of the research project, Smart Area Aachen, Nexans intends to make this technology already available in 2015. The functionality is provided by the integration of IEC 61850 stack and server function of the switches.
The project "Communication Infrastructure for innovative Equipment" will build the basis of open communication for all other joint projects. The project will provide an extension of the IEC 61850 standard. The knowledge and recommendations from this project will be used for the further development of the industrial partnership. The results will be published in national and international conferences and standardization processes.

Another most important part of the project is to guarantee the security and availability of the new network. The results of this evaluation process will be used for hardening of the new network according to suitable security standards. Furthermore, a universal list of recommendations for security improvements in a communication network of power utility will be created.

CONCLUSION

It is undisputed that the design and operation of communication infrastructure in transition to smart grids will play a central role in efficient network management. For this reason, new hardware and software components will be needed in the terms of communication infrastructure. The seamless integration of different systems under the umbrella of a world-wide standard will fit into the control stations of utilities and allow an extremely flexible use. The functional system integration will be only rudimentary possible with existing protocols. Through new developments of the key technology for future communication in the energy sector, improvements will be possible by direct and rapid implementation of the information parameters. Key benefits are provided through the faster modeling, usage of diagnostics and monitoring of information, as well as the simplified configuration by using the configuration language SCL. In the next few years, the structure of energy supply will transform dramatically and require an interdisciplinary use of communication and automation technology. The spread and better understanding of IEC 61850 data modeling will allow the new use cases and applications in many other sectors of industry. Already in the near future, the openness and flexibility of the IEC 61850 standard will allow full automation and intelligent energy networks.
With the spread and understanding of IEC 61850 data modeling will find its way into many other sectors and industries. Already in the near future, the openness and flexibility of the IEC 61850 standard will allow full automation and intelligent energy networks.

ABBREVIATIONS

IEDs Intelligent Electronic Device
MMS ISO 9506, Manufacturing Message Specification
SCL System Configuration description Language
XML Extensible Markup Language
IEC 61850 Communication networks and systems in substations
IEC 61850-3 Communication networks and systems in substations - Part 3: General requirements
IEC 61850-5 Communication networks and systems in substations - Part 5: Communication requirements for functions and device models
IEC 61850-6 Communication networks and systems for power utility automation - Part 6: Configuration description language for communication in electrical substations related to IEDs
IEC 61850-7 Communication networks and systems in substations - Basic communication structure for substation and feeder equipment
IEC 61850-7-1: Principles and models
IEC 61850-7-2: Abstract communication service interface (ACSI)
IEC 61850-7-3: Common Data Classes
IEC 61850-7-4: Compatible logical node classes and data classes
IEC 61850-8 Communication networks and systems in substations - Specific Communication Service Mapping (SCSM)
IEC 61850-8-1: Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
IEC 61850-9 Communication networks and systems in substations - Specific Communication Service Mapping (SCSM)
IEC 61850-9-1: Sampled values over serial unidirectional multidrop point to point link
IEC 61850-9-2: Sampled values over ISO/IEC 8802-3