IEC 60870-5-104 AS A DRIVER TO EVOLUTION OF SUBSTATION AND DISTRIBUTION AUTOMATION AT EDP

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ABSTRACT

IEC 60870-5 is mainly used in Utilities of European Countries in SCADA networks. Following the development of network technologies, IEC 60870-5-104, which covers transmission over TCP/IP, is nowadays growing in use for communications between RTUs and Control Centres.

In this context, and having in mind the telecontrol and automation evolution strategy in EDP, EDP Distribution, a Portuguese electricity distribution utility of EDP group, with the support of KEMA, a leading consultancy company, have been involved in a process focused on the definition of the companion standard IEC 60870-5-104.

EFACEC, a leading Portuguese industrial company and the main SCADA provider to EDP Distribution, is also involved in the implementation and validation of 104 protocol at the Control Centre side.

In order to optimize EDP’ benefits from using a standardized protocol like 104, the protocol definition process includes the definition of the information to be exchanged, the translation of system functionality into protocol functionality and the definition of the Protocol Implementation Document (PID) – including PICS (Protocol Implementation Conformance Standard) and PIXIT Protocol Implementation eXtra Information for Testing).

Besides both PID definition – a “full functionality” PID for Substation Automation, and a “light functionality” PID for Distribution Automation - requirements for wireless (GPRS and TETRA) communication networks that could be used in the Distribution Automation, have also been defined.

Substation and Distribution Automation pilots have been foreseen to verify the 104 protocol implementation

In this paper we intend to: (i) introduce and discuss the requirements supporting both PID and requirements for wireless (ii) present the present status of the pilots to address such requirements.

INTRODUCTION

IEC 60870-5-101 is currently used for serial communication and is also used for telecontrol purposes at utilities. An advantage is that the existing point to point lines with the modems can be re-used, because 101 is using serial point to point lines (can als be used in multidrop configurations).

Nowadays, at the utilities, a clear trend is the use of IEC 60870-5-104 for communications between control center and substations/MV stations. Advantages of 104 are that it is based on 101, not very complex and relatively easy for equipment to change from 101 to 104. A lot of utilities are now using/planning a high-speed telecommunication network to all their substations and to use IP based communication. 104 is using the TCP/IP suite and can be used on these communication lines. Combining the communication channel for more than one purpose is cost effective and efficient. The 104 standard has been implemented the last 5 years more and more and more equipment will become available with 104.

There is an EDP policy to bring IP based communication to all outstations: for wired substations by installing proper telecommunication equipment (optical fiber); for not-wired stations by installing wireless solutions (Public GPRS or a TETRA network).

In the next paragraphs, the general steps followed by EDP, with the help from KEMA, to define both PID and wireless requirements will be presented.

Substation and Distribution Automation pilots’ status will also be updated.

STRUCTURED PROJECT APPROACH

A structured project approach with clear and fixed milestones is mandatory for proper quality assurance.

The general steps for a proper quality assurance focusing on the communication protocol and implementation at EDP are:
- Define the amount of information to exchange between locations (HV and MV substations and Control Centres) within about 2-5 years;
- Translate system functionality into protocol functionality;
- Define a Protocol Implementation Document (PID) to...
close all open ends in the standard and specifies the use of the standard for EDP;
- Settle the PID as the contractual document between vendor and user;
- Before installing the equipment on-site, submit the delivered product (EDP PID) to an Attestation of Conformity issued by a third party and make interoperability testing on-site for detecting and solving configuration mismatches and telecom problems.

**PID SCOPE AND REQUIREMENTS**

PID defines how the IEC 60870-5-104 protocol will be used in EDP, in both controlling and controlled stations.

Fig.1 presents an overview of the scope of the PID.

![Fig.1: Scope of EDP PID 104](image)

The creation of an EDP overall IEC 60870-5-104 PID has considered two versions:
1. A comprehensive one for the bigger substations and control center
2. A slim one for the smaller substations (1)

Future requirements and EDP needs (inputs based on phase I report [1]) for telecontrolling and monitoring substations and MV stations, were considered to create the PID.

![Fig.2: Future requirements for HV/MV Substations and MV stations](image)

(1) Reason is that smaller stations need less functionality and high requirements may increase costs without the necessity for this functionality.

PID presents sets of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of "structured" or "unstructured" fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system.

Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications.

Not part of the PID is:
- Functional requirements (e.g. number of outstations to be controlled or number of data points);
- SCADA performance requirements;
- Low level communication network requirements.

To define the PID, 104 standard structures were followed.

Description of procedures to exchange data and format of data to be exchanged were done.

Definition was particularly focused on:
- Station initialization (Start/Stop DT, End of Initialization , Start of a GI procedure and Reset Command);
- Acquisition of events;
- Clock synchronization (via ASDU 103 or GPS);
- Commands transmission;
- Parameter load;
- Integrated totals;
- Test procedures;
- File transfer;
- Bit string;
- Redundancy.

**Full PID**

The so-called “Full PID” is a document [2] that specifies the protocol functionality at HV/MV substations level.

It will be used for telecontrol purposes at that level and it’s to be implemented at substation Remote Terminal Units (RTUs) and Control Centres.

**Light PID**

The “Light PID” is a document [3] that specifies the protocol functionality at MV substations level.
It will be used for telecontrol purposes at that level, and it’s to be implemented at MV network remote terminal units (NRTUs).

**WIRELESS REQUIREMENTS**

The requirements of the wireless GPRS network to be used in the Distribution Automation (DA) project in combination with the use of the IEC 60870-5-104 protocol were defined in a deliverable of the project [4].

The scope of this document is shown in Fig. 3.

![Fig.3: Scope of the wireless network requirements](image)

The document describes the requirements of the wireless GPRS network such as:

- Availability
- Security
- Maintainability
- Compatibility
- Flexibility
- Expandability
- Reliability
- Capacity
- Performance

**PILOT STATUS**

Instead of using a GPRS network for testing the 104 protocol (Light PID), EDP had access to a TETRA (Terrestrial Trunking Radio) network.

**SIRES** – Sistema Integrado de Redes de Emergencia e Segurança – is the Portuguese Government TETRA Network for emergency and security forces, and through a protocol signed between the Portuguese Government and EDP, we were able to use SIRES for testing the 104 protocol.

Given the similarities between the GPRS and the packet data services (PDS) of TETRA, this network met the “Requirements for the wireless network for the Distribution Automation (DA) Project” [4].

In fact, the main difference between technologies is the bandwidth available for the RTUs. Instead of the typical 40 kbit/s available in a GPRS network, SIRES delivers 7.2 kbit/s. Theoretically, this difference isn’t enough to reduce the expected performance, and will be monitored during the pilot.

In October we conducted a pre-trial successfully, in a SIRES test facilities, with 2 RTU (EFACEC URR).

![Fig.4: SIRES-EDP network](image)

Later, a 2 Mbit/s Ethernet line was installed between EDP SCADA SYSTEM and SIRES to guarantee connectivity between the two networks.

The pilot is made of 30RTUs (25 EFACEC URR and 5 EFACEC MAP3100B) with 104 protocol loaded firmware.

The SIRES network provides a fixed IP address to each unit and scada system (command center).

All the work was concluded and the PILOT began officially in December 22 and will run for six months.

Initial reports show that the requirements of the wireless network are being met.
REFERENCES


