

SC B5 – Protection and Automation
PS2 – Communication networks in protection, automation and control systems (PACS): Experience and Challenges

IEC 61850 communications monitoring and diagnostics system implementation experience

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Transition to IEC 61850 in protection, automation and control (PAC) schemes introduces paradigm shift in principles of secondary measurement and control circuits implementation, as well as in PAC design, commissioning and maintenance approaches. Conventional PAC secondary circuits are replaced by local area network (LAN), which provides the transmission of not only remote control, measurement and status signals, but also transmission of current and voltage sampled values and PAC signals and commands. In new architectures of PAC communications network, single physical communication link carries dozens and hundreds of different signals over IEC 61850 communication services (Sampled Values, GOOSE, Controls, Reporting and etc.). Aforementioned changes call for implementation of new approaches to provide security and reliability of PAC communication channels and to support design, commissioning and maintenance procedures, taking into account communication constraints and specifics. The new tasks to be solved are as follows:

- Development of PAC configuration description documentation during the design phase.
- Verification of installed IEDs and generated IEC 61850 messages against the design.
- Verification of communications between IEDs according to IEC 61850 communication services.
- Verification of IEC 61850 communications stability.
- Analysis of waveform recordings and events based on data, captured from IEC 61850 messages.

One of the ways to resolve these tasks is to implement and use designated communications monitoring and diagnostics systems, capable of IEC 61850 messages analysis, taking into account the configuration of IEDs and communication schemes. The source of the latter for such systems – IEC 61850 System Configuration Language (SCL) files, namely, System Configuration Description (SCD) file. SCD file includes the description of PAC signals, of how these signals are distributed over messages, which communication characteristics are

used for certain messages, which IEDs are publishers and which IEDs are subscribers.

The possibility to interpret the results of operation of such monitoring and diagnostics systems and quality of such interpretation depend on the fact if semantic data model is used during the design stage. This paper focuses on the experience of IEC 61850 communications monitoring and diagnostics systems implementation in pumped-storage hydro power plant, being a part of Russia Unified Energy System, as well as on the experience of IEC 61850 profile for hydro power and pumped-storage hydro power plants, which covers specific PAC schemes available in these facilities.

IEC 61850 communications monitoring and diagnostics system implements the following functionality:

- Visualization of IEC 61850 communications on the basis of SCD file.
- Automated analysis of SCD file validity and configuration consistency.
- SCD file version control.
- Verification of actual data flow to match SCD file.
- Analysis of IEC 61850 communications with identification of data and quality changes, time sync status changes, message configuration changes, packet losses and etc.
- Network load estimation.
- Identification of unknown (not described in SCD file) hosts.
- Identification of unknown (not described in SCD file) messages.
- Event and waveform recording.

Prior to the implementation of this IEC 61850 communications monitoring and diagnostics system, IEC 61850 profile for hydro power and pumped-storage hydro power plants and appropriate SCD file have been developed. This profile covered specific PAC functionality for such facilities (e.g., rotation frequency and active power control, excitation control, group regulation, machines rational set control, etc.).

The results of the work present the unique experience of SCD file development for hydro power and pumped-storage hydro power plants and IEC 61850 communications monitoring and diagnostics system implementation. Series implementation of the presented solution provides an increase in quality of operation of facilities with PAC systems implemented according IEC 61850 standard.