

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

**The experience of organization PMU data transmission networks in the automa-
tion and control systems**

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Changing the characteristics of modern power system associated with the introduction of renewable energy sources and technologies for flexible control of the power system operation mode. This necessitates changing requirements to the functionality of Protection, Automation and Control Systems (PACS). These requirements are based on the need to adapt the PACS algorithms to the new operating conditions of the power system and consider advances in digital technology and information and communication technology.

One of the most important conditions for solving this problem is the need to use in PACS the information about the processes of new quality occurring in the power system. Currently, the technology that provides measurement of electric modes parameters of power system with standardized accuracy and time synchronization not exceeding 1 μ s, as well as data transmission over arbitrarily long distances with minimal delay and data losses is synchrophasor technology.

Phasor measurement units (PMUs) and phasor data concentrators (PDCs), installed at power stations and substations, measure and transmit hundreds of the electrical mode parameters to the control centers for the purpose of application synchrophasor data into monitoring and control tasks. Thus, from the WAMS substation, which includes 10 PMU, is transmitted about 7000 parameters every second, and per hour – more than 25 million parameters in real time. In total, the hierarchical three-level automatic PMU data collection system in control centers (WAMS SO) receives about 1.5 billion parameters every hour in real time.

Under these conditions, non-optimal architectural solutions in the creation of a PMU data communication network can significantly constraint the possibility of PMU data using in PACS, which will be a limiting factor of technical performance of the PACS.

Development of software based on synchrophasor technology and its implementation for monitoring and control of the electric mode of the power system leads to a constant increase in the amount of data transmitted to the control centers of the

System operator and puts forward additional requirements to improve the quality of information received.

Therefore, there is a task of maximum use of the resource of existing communication networks, which requires the adoption of complex technical solutions related to the optimization of the architecture of communication networks, improvement of information transfer technologies, organization of automatic life cycle monitoring of PACS (WAMPAC), namely:

- optimization and improved utilization of the bandwidth of data transmission channels;
- development and implementation of communication network architectural solutions to optimize data flows;
 - data ranking for PACS (implementation of the prioritization of data flows function in the PDC, the use of adaptive approaches for data transmission at higher hierarchy levels);
 - improve data flow logistics by deploying software at the lower levels of the control centers hierarchy;
 - transition from distributed system to distributed data store – control centers data storage area redistribution;
- data quality monitoring in each regional PDC in real time, real time communication network failure identification;
- implementation of microservices architecture in order to avoid single point of failure and make large-scale software system robust to changes;

Specialists of the System operator developed and implemented technical solutions to optimize the architecture of communication networks WAMS SO, which significantly improved the quality of delivery of PMU data to control centers:

- the percentage of PMU data loss decreased from 5% to 0.3%;
- the data frame delay of the PMU data has been reduced from 1 s to 200 ms.

The paper presents the practical experience and research results of the System operator on the organization of communication networks, providing reliability in the transmission of a large amount of data in real time with the necessary quality for their application in monitoring and control tasks in real time.

Keywords

LFO, PACS, PMU, PDC, PSS, synchrophasor, WAMS, WAMPAC