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Prospects of application of synchrophasor technology for the development of monitoring and control systems for future power system

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Deployment of synchrophasor technology was driven by the development of global navigation satellite systems, information and communication technology, advances in electronics and computer technology. Use of synchrophasor technology for power system monitoring and control tasks provides precise measure of electric modes parameters with time synchronization with accuracy better than 1 μs, transfer large amounts of data with minimal delays, real-time data processing. Use of PMU data provided observability of the power system dynamic behaviour and measure of power system electromechanical transient process parameters.

In Russia, the implementation of WAMS was initiated by System operator in 2005. The hierarchical three-level automatic PMU data collection system in control centers (WAMS SO) in online and offline was put into operation in 2009. Currently, 750 PMU and 75 PDC in 110 power stations and substations have been put into operation in united power system of Russia, WAMS SO in real time receives more then 400 000 parameters per second.
Use of PMU data significantly expanded information platform of electric modes parameters of power system which allowed to initiate the development and implementation of new wide area monitoring and control systems (WAMC) in real time such as low frequency oscillation monitoring system with source identification of oscillations, system for monitoring the operation of system regulators as well as improve the efficiency of existing systems.
Current trends in the development of power system are associated with the large-scale employment of renewable energy sources and FACTS. This leads to a change in the characteristics of the power system: reduced rotational inertia leads to faster frequency dynamic and requires additional activities to ensure its dynamic stability. This requires the adaptation of WAMC systems to the new operating conditions of the power system. Improvement of WAMC systems is associated with the need to obtain new quality information about the dynamic processes of power system. The data of the classical SCADA system cannot provide this. The characteristics of synchrophasor technology allow to consider it as an information platform for further development of the WAMC system. This statement is based on the results achieved using synchrophasor technology in solving practical management problems.

This paper focuses on issues of synchrophasor technology use as an information platform of future power system, requirements for interaction of WAMS SO with WAMC system in conditions of digital energy system transformation, and the results

of the analysis of the achieved level of WAMS SO performance. It is this analysis that gives an assessment of the possibilities and prospects synchrophasor technology using for WAMCsystem development. This paper presents the technical solutions to improve the efficiency of WAMS SO performance and the removal of restrictions on system scalability (the increase in the number PMU and WAMS, WAMC, WAMPAC):

- integration of WAMS SO with existing monitoring and control systems: SCADA of next generation, Stability Margin Monitoring System (state estimation), System for Monitoring the Operation of System Regulators, System of low frequency oscillation monitoring;
- WAMS SO architecture improvements:
  - transition from distributed system to distributed data store – control centers data storage area redistribution;
  - implementation of microservices architecture in order to avoid single point of failure and make large-scale software system robust to changes;
  - implementation of multi-tenancy technology (when applications operate simultaneously with several configurations and datasets);
  - reduction of time delays in PMU data transmission between the levels of WAMS SO.
- development and integration of new software modules in WAMS SO:
  - data quality monitoring, real time communication network failure identification;
  - life-cycle management of PMU, PDC, synchrophasor based systems;
  - emergency automation operation monitoring;
  - real time SCADA data validation (by comparison with PMU data).

The proposals presented in the paper are important for the development of conceptual approaches to the construction of WAMC systems considering the Russian experience of centralized and decentralized management principles.