SC D2- Information systems & telecommunication
PS1 The impact of emerging information and communication technologies on electric power utilities

Application of modern information and communication technologies for improving the effectiveness power systems

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The development of the modern information and communication technologies allows increasing the quality and volume of measurement data, ensuring their rapid transmission and online processing. It makes new approaches of solving control, protection, monitoring and diagnostics tasks available for implementing, thus increasing consequently the efficiency of power facilities assets management and the equipment life cycle.

The high-speed communications at the level of the power facility system allow using effectively the technology of digital substations, synchrophasor measurements for the implementation of both local and centralized control, protection and automation systems. These tasks can be effectively solved within the Wide Area Monitoring, Protection, and Control Systems (WAMPACS). Such systems are to operate with large amounts of data from many substations. To implement such systems, it is required to apply effective means of data transmitting and processing.

The aspiration to increase the scope of data processing tasks is faced with a number of new challenges. The report analyzes problems of the comparability issues of the measurement data being obtain from a large number of various sources, to the ambiguity in the choice of algorithms for data analysis and to ensuring high-speed calculations. Some approaches to solution of these problems are proposed.

To form a required structure of a dataset to be analyzed in a specific task, it is proposed to use the so-called data conversion schemes, each describing the data sources, the ways of obtaining the values to be measured, including synchrophasor values, the method of obtaining timestamps, as well as the location of the data in the formed structure. The corresponding procedure of data reduction is software-based. In addition, the method of calculating secondary values based on setting the graph of quantities interdependencies is implemented.

An approach to high-level description of computational schemes in the form of generalized graph structures with the possibility of varying the applied methods for solving subtasks is presented. This approach allows obtaining the separation of arranging the calculations at the general level and filling the computational schemes with the algorithms specific to the subject area. A software implementation of this approach is proposed.

One of the ways to increase the computation speed for the analysis of large data amounts is using parallel programming technologies for high-performance systems. Various ways to paralleling the computation scheme are reviewed: splitting of the input signal into fragments with subsequent restitution of the result; separation of the set of input signals into parallel processed groups; parallel execution of nodes, for which the start conditions are met. These parallelization strategies differ from each other by the balance of the necessary knowledge about the problem being solved and the achieved acceleration of the calculations. The report presents the results of computational experiments on a personal computer and on a computing cluster.

Based on the proposed methods, a software package is being developed for distributed processing of data, mainly synchrophasor measurements. This package may be used both for creating independent applications and as a part of SCADA, WAMS or WACS.

Within the proposed approaches and their software implementation, the experience in solving the tasks of monitoring both individual power system facilities and power systems based on aggregation and analysis of synchrophasor measurement data is presented. These tasks include monitoring the parameters of a power transformer equivalent circuit and analysis of environmental conditions impact on them; detection of damage in the distribution cable and overhead networks of 6-20 kV using data from digital sensors; monitoring the oscillatory stability of the power system, detection of low-frequency oscillations and detection of their source.

The increase in the volume and quality of the observed data, due to the development of functional, communication and computing capabilities, allows applying new approaches when implementing control, protection and monitoring systems for the power facilities.