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The Distributed System for Solution of Planning and Dispatching Problems in Large Interconnection

D.DEMCHENKO, V.MAKEECHEV, Y.SHAROV
LLC «Inter RAO-Engineering», Moscow
Russia
demchenko_da@interrao.ru

SYNOPSIS

Economical risks and efficiency of integrated electricity markets in large power interconnections depend on conditions of export-import contracts between adjoining countries in these markets, fulfillment of secure synchronous operation conditions and rules of national markets. This coordination system has to ensure joint solution of optimal operation problems in power interconnections by control centers of national power systems. The goal of coordination in this system is solution of optimal power flow problems in each of power systems and determination of optimal energy and power interchange between national power systems.

The market problem (i.e. determination of power flows between power systems and prices of energy interchange for each hour) in all segments of integrated market is formulated in this system as a mathematical problem which can be solved without transfer of data about internal state of national markets between computers. Solution of the market problems for interconnections in this system is carried out in such way that functions and authorities of national market operators, solving their internal problems, remain unchanged.

Maximum of consumer surplus in power interconnection market can be achieved only if it is possible to assure global optimality of power interconnection operation when solving optimal power flow and planning problems in such interconnection. Main obstacles to attaining this goal when using existing well known methods for solution of power systems modeling and control problems are the following:

- global optimality of power interconnection operation should be achieved when authorities of national power system operators remain unchanged;
- solution of internal control problems in each of national power systems is carried out independently;
- restrictions on access to internal information of national power systems should be observed;
- time limitations on obtaining solution of control problems should be taken into account.

Neither centralized nor decentralized systems intended for solution of power systems modeling and control problems can meet the whole set of these requirements.

Technology of distributed solution of simulation, planning and control problems in large power systems is based on the method of functional modelling (FM). These FM-algorithms form a base for creation of distributed control system, intended for achieving global optimality of operation in large power systems and interconnections. Existent organization of operation control system in these interconnections consisting of independent system operators, solving the problems of planning and dispatching in their own power systems and coordinating interchange of power and energy between power systems, through negotiations, makes it possible to achieve internal optimality of operation in each of power systems but cannot assure optimality of power flows and trade between power systems. According to the theory of FM-method global optimality of power interconnection operation can be achieved if and only if internal optimality of operation within each of subsystems is assured and power flows between subsystems are optimal.

Important advantage of this distributed system is that the problem of upper level in this system has dimension of number of boundary nodes between subsystems in power interconnection. Data transfer between computers is limited to information about boundary variables. No information about internal state of subsystems should be transferred between computers.