Novel Structure for Power Distribution Automation

For a number of years now the electric power distribution business has been in a period of transition. Deregulation, restructuring of the business, aging networks and distributed power production have posed new challenges to the business. Under the pressure of these changes it has been a real challenge to maintain a reliable, safe and cost-effective power distribution. “One way to meet these growing challenges is to increase the use of distribution automation”, says Erkki Antila, Development Manager from ABB Oy Distribution Automation.

Intelligent devices and effective system integration have paved the way for new distribution network automation solutions. Multifunctional intelligent electronic devices (IEDs), subsystems and communication are crucial building blocks of the new automation solutions. The large-scale use of IEDs and the full-scale implementation of network automation enable both energy companies and industries to benefit from comprehensive electricity distribution services.

NETWORK AUTOMATION STRUCTURE

To secure the flow of energy from transmission to consumption, it is of vital importance to be in full control of the energy distribution process. Network automation is the solution to the management of this process. Electricity distribution is traditionally handled by primary processes and management processes. Based on their location, these processes can be divided in six horizontal levels. The levels are, starting from consumption side, the Low Voltage Network, the Medium Voltage Network, the Bay level, the Station level, the Control level and the Enterprise level.

The monitoring and control of the process is based on automation technology. The new frame of network automation is composed of five main operation sectors uniting the process levels vertically. The management sectors are Protection Management, Operation Management, Distribution Management, Asset Management and Business Management. The functionality of the vertically managed sectors is implemented by IEDs and systems. In a system solution an intelligent multifunction device is capable of producing all the services required in its own operational environment.

VERTICAL FUNCTIONALITY OF DISTRIBUTION AUTOMATION

The aim of the multivariate approach of distribution automation is to improve controllability, efficiency, reliability, continuity of supply and productivity. The use of powerful IEDs and system integration enable cost-effective operations. The new distribution automation concept provides the means for managing the distribution system on market terms. Distribution automation depends heavily on comprehensive and versatile communication systems and services. The evolving new IEC standards also fully support the new distribution automation structure. A good example of this is the IEC 61860 station and bay level process bus. A powerful standard available for telecontrol equipment and systems today is IEC 60870-5-104. An issue that needs continuous attention is data integrity, which secures reliability of management. The vertical concept generates real value for the customer, and it adds to improved customer satisfaction.

PROTECTION MANAGEMENT

In a vertical hierarchy, protection is implemented on the bay and station level of the substation. It forms an integral part of the functionality of the IEDs in the primary process. On the station level, the protection devices are normally used for tripping CBs to isolate faults, and just occasionally for mere indications and alarms. Via parameters settings the functional grading of the protection is optimized with regard to the operational status of the distribution network at any given time. The information provided by the protection is of vital importance for network control, network information and asset management. Additional protective devices used in the distribution network are lightning arresters, spark gaps and fuses. Automatic meter reading, which is facing a major breakthrough in business management today, allows power outages...
caused by fuse failures to be indicated as well. The overall protection of the network is engineered and documented on the enterprise and control level.

OPERATION MANAGEMENT
Operation management is based on the collection of status information and measured values. The process information presented on displays in the control room give the operator a visual overview of the operational status and connection of the distribution network. The supervision of normal network conditions is based on boundary conditions determined in the operation plan. Once the boundary is exceeded, the system alerts the operator who takes action to normalize the situation of the network. In a serious disturbance situation, the operator takes control of the network to restore boundary network operation. These control operations are carried out via the programmable IEDs, either by remote control or by local automation solutions. In the event of a major network interruption, the fault is limited to as small an area as possible.

The operational status of the entire network thus obtained by calculation can be presented on geographical maps and all the events of interest to the operator can be rapidly located.

ASSET MANAGEMENT
The distribution of electricity involves tremendous assets and it is understandable that the owners want to optimize the return on their network investment as regards maintenance and operational reliability. In a fault situation, the primary equipment may be subjected to extreme stress, which substantially affects the life cycle of the equipment. By continuous measurement and analysis of the behaviour of the equipment, the need for maintenance and renewal can be estimated. IEDs used for supervising the process also provide the information required for asset management.

BUSINESS MANAGEMENT
The supply of electric energy either from the transmission network or straight from generation to consumption forms the basis for the electricity distribution business. An adequate and reliable supply of power is a key factor for the profitability of the business. The distribution of electric energy is conveniently measured through the rapidly increasing implementation of real-time automatic meter reading (AMR) systems, which also provide the data needed for the billing of electricity. Continuous measurement of the consumption of electricity increases the accuracy of energy-demand forecasts. In addition, intelligent meter reading systems provide information about supply interruptions and power quality. Thus other management levels can benefit from this functionality as well. The new communicating metering equipment also enables an active tariff policy and customer information, providing the basis for power outage compensation now in use in many countries.

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