Substation automation for a better Baltic power supply

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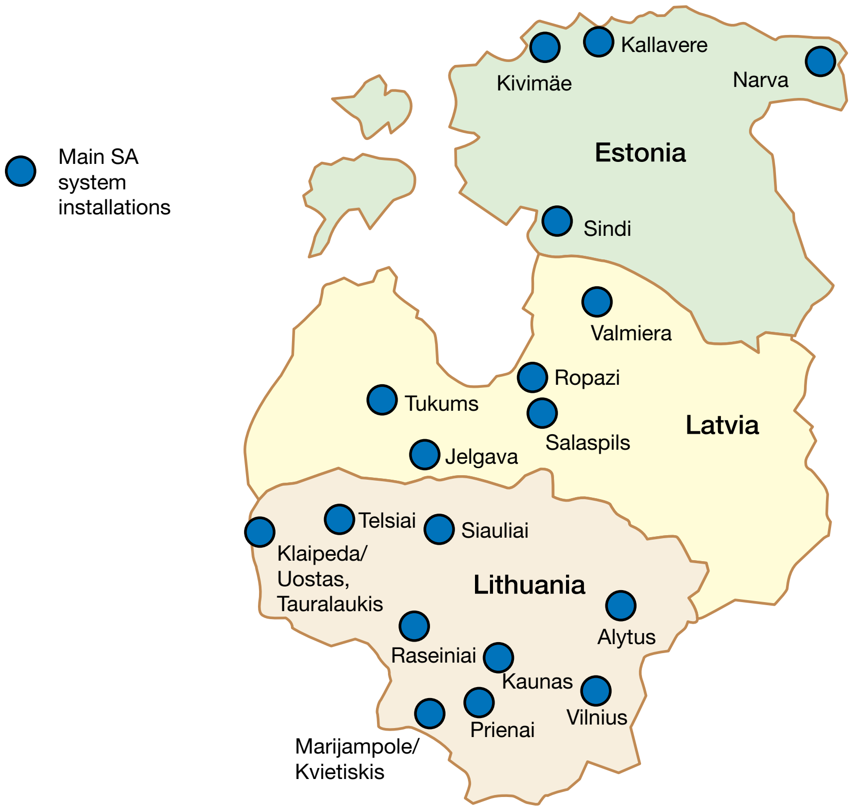
Three Baltic states – Estonia, Latvia and Lithuania – have undertaken major upgrade projects to improve the capacity and reliability of their power networks. Besides reinforcing and modernizing their transmission and distribution networks, the three countries are improving their infrastructure and building up know-how in the field of power management. ABB is making a significant contribution to these efforts by supplying primary high-voltage and secondary protection, monitoring and control equipment.

Financing of the projects is split between proprietary funds and foreign credits, mainly from the IBRD (World Bank) and the EBRD (its European counterpart). The investments have resulted in a large number of orders being awarded to ABB for Substation Automation (SA) systems for transformer substations throughout the region 1. SA systems are designed to handle the control, monitoring and protection of a substation and its incoming and outgoing feeders.

Two-level station automation

SA systems work at two levels: the *station level* and the *bay level.*

The *station level* features computer-based man-machine communications based on ABB's MicroSCADA[1] software. By means of the operator consoles, station attendants can easily:

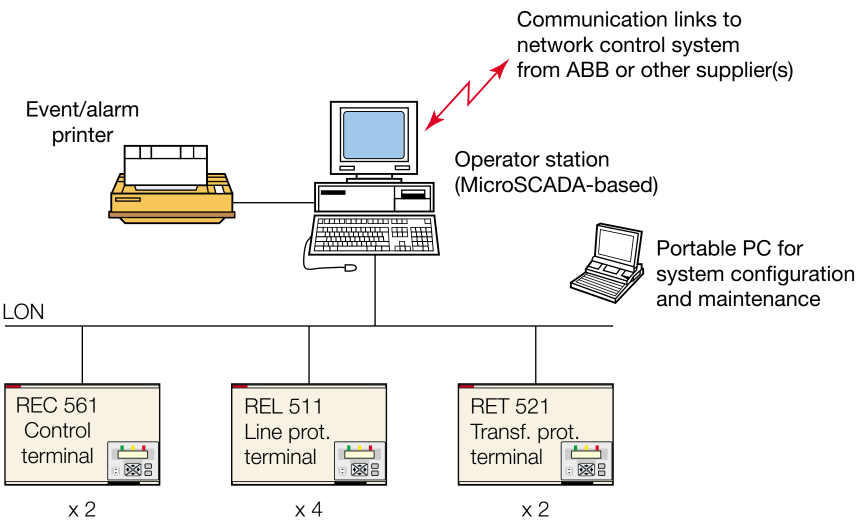


1 Map of the Baltic region showing some of the main ABB SA system installations

- Monitor the entire station for alarms and important events.
- Examine the station as a whole or any part of it on color-graphic, diagram-type displays, updated in real time with status indications and measured values.
- Operate breakers, tap changers, disconnectors, etc.
- Generate reports on vital aspects of operation, eg disturbance oscillograms, fault location information and disturbance statistics.

[1] MicroSCADA software is available for both network control and SA applications.

2 Typical configuration used for ABB's SA systems installed in the Baltic states



The block diagram shown in 2 is typical of the installed systems, while 3 and 4 show the exterior and interior of one of the substations with this equipment.

At the *bay level* are the various terminals (see *Table*), with field inputs and outputs, communication ports and software, for:

- Protection (eg, distance, overcurrent and earth-fault)
- Monitoring (eg, disturbance recording and fault location)
- Control (eg, on/off operation of circuit-breakers and interlocking)

In terms of functionality and I/O capacity, one terminal of the type installed typically corresponds to 1 to 3 floor-standing, 19-inch cabinets full of conventional electromechanical or static components. Since one cabinet can house 6 to 8 terminals, the savings in floor space can be dramatic.

More than 100 such terminals have been installed to date in the three Baltic states.

Table: Some technical data of the installed terminals

Width	1/1, 3/4 or 1/2 of the standard 19" rack width
Height	267 mm
Depth:	245 mm
I/O signal levels	24/30 V - 220/250 V
Communication protocols	LON, SPA, IEC 870-5-103 (fiber optics)

Electromagnetic compatibility and insulation as per IEC standards

High availability and reliability

The terminals and the operator station work together and exchange information but do not depend on each other functionally. For instance, a peer-to-peer LON bus (LON = Local Operating Network) without critical bus master is used as it will carry on operating even if the bus interface of a system node develops a fault. By ensuring that a fault in one of the nodes is unable to bring down any other, this bus gives the system a high fault-tolerance level. Extensive self-supervision and diagnostics improve the dependability and security even further. As a result, the cost of operating and maintaining SA systems is significantly lower than for conventional systems.

The availability and reliability of the control, monitoring and protection equipment, since they greatly affect the availability and reliability of the entire power network, have an importance that goes far beyond the equipment itself. It is because of this that investments are often made in protection, control and monitoring before they are made in primary equipment, such as transformers and switchgear.

The worldwide trend towards deregulation and the ongoing privatization of power producers and utilities is focusing attention on short-term returns on investment and on cost-cutting. Hand in hand with this, companies are expected to show profitability faster. Major investments made to ensure the reliable operation of a network are often staggered, calling for solutions which can be easily extended

3 One of the substations at Ropazi, Latvia, which ABB equipped with a station automation system. The 110-kV switchgear can be seen in the background.

4 Operator station and cabinets with terminals

and which are also able to communicate with equipment from other suppliers. This and the closing down of gas turbines and thermal power plants providing peak load or back-up capacity are causing power networks to be run closer to their critical limits – which further emphasizes the importance of having reliable systems for control, protection and monitoring. Against this background, an evaluation of whether or not to install an SA system has to look beyond the price tag to its impact on the operation and maintenance of the primary equipment.

The capability of the SA systems installed in the Baltics to contribute to better performance of the overall network will become even more important when, at some later point, the power networks around the Baltic Sea are fully interconnected into the so-called Baltic Ring.

Network control level

A network control system normally controls and supervises numerous substations in a given geographical area. In Lithuania, several districts have invested in S.P.I.D.E.R. Compact SCADA and MicroSCADA systems from ABB. The main features of these systems are:

- SCADA server(s), featuring either single or dual redundancy
- Operator workstations with 1–3 color-graphic VDUs, alphanumeric and graphic printers
- Communication server(s) for remote, 'vertical' communications with substations or other local equipment

The SCADA functionality includes remote data acquisition from and control of substations within the district, either via remote terminal units (RTUs) in substations with conventional mimic panels for local control or through SA systems.

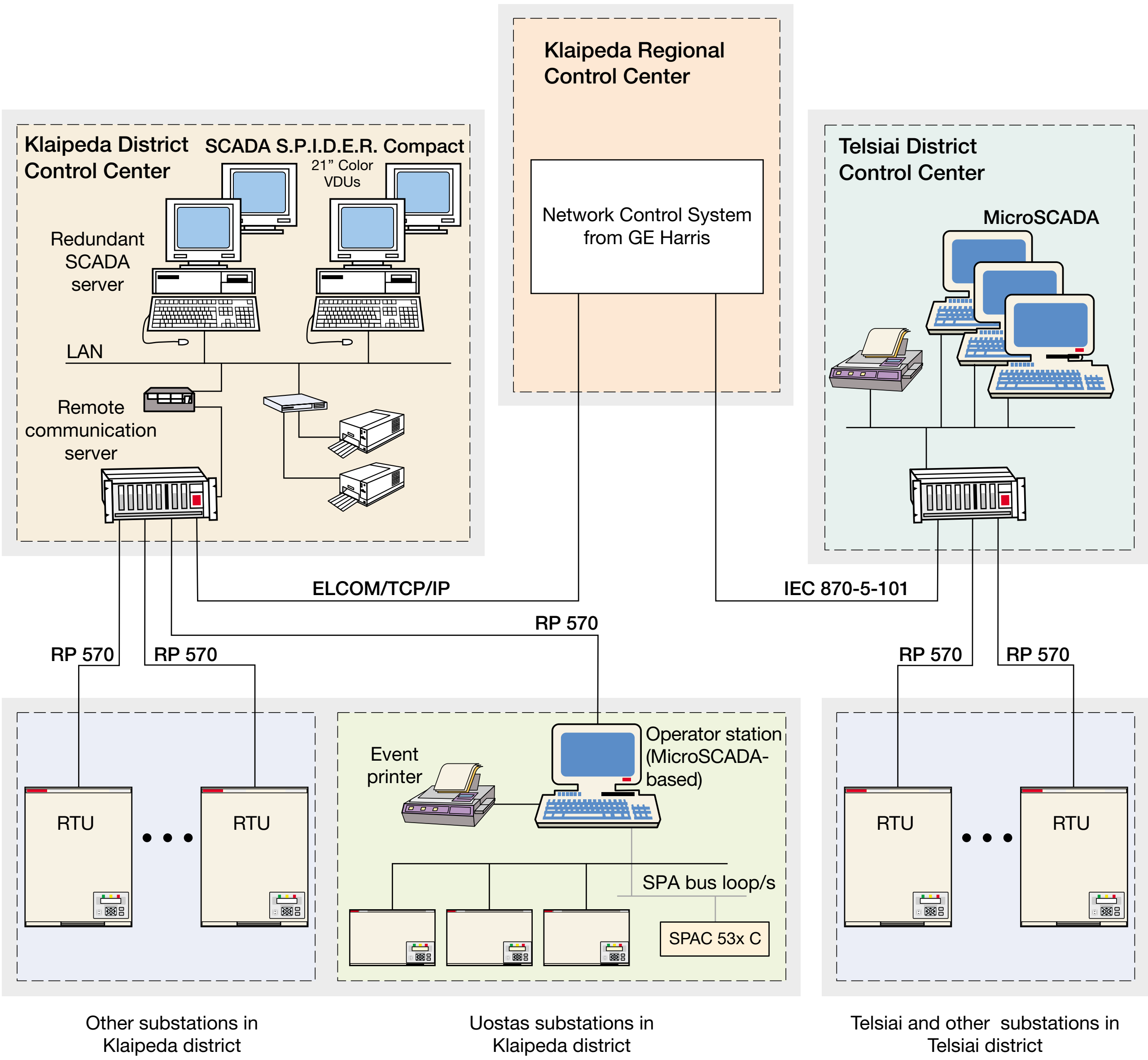
Network control systems for intermediate district levels often also communicate with higher-level network control systems.

Vertical integration

One of the hallmarks of ABB's SA concept is the integration of all three functional areas, ie control, protection and monitoring, in bay equipment used for both local station control and network control. This integration reduces the amount of signal cabling and other hardware required in stations, thus saving space and first-time costs.

In Lithuania, Klaipeda Electricity Networks has installed an SA system as well as terminals from ABB in the Uostas substation, plus a network control system based on S.P.I.D.E.R. Compact in the Klaipeda District Control Center. The systems communicate with each other via ABB's standard communication protocol RP 570. In addition, the S.P.I.D.E.R. Compact system communicates with four RTUs (type RTU 210) in other substations and with a network control system supplied by GE Harris in the Klaipeda Regional Control Center. The system from GE Harris also

5 Configuration of the network control and station automation systems delivered to Klaipeda Electricity Networks



communicates with a MicroSCADA system in the Telsiai district. 5 shows the system configuration.

System compatibility allows incremental investment

Control, protection and monitoring equipment at station level must be capable of working with both old and new high-voltage equipment, such as transformers and switchgear, as well as with network control systems. However, this equipment is often supplied by different manufacturers. Thanks to their modular design and a wide range of I/O boards, communication boards and communication protocols, SA systems offer the required compatibility at all levels in the power management hierarchy. This has the advantage that they allow investments to be made in new technology step-by-step.

The above-mentioned installations in Klaipeda and Telsiai are a good example of:

- Vertical integration between the network control, station and bay levels

The Baltic electricity market: Some facts

Electricity in the three Baltic states, Estonia, Latvia and Lithuania, is generated, transmitted and distributed by the state-controlled companies Éesti Energia, Latvenergo and Lietuvos Energija, respectively. Power is generated in various facilities, including a nuclear power plant, hydropower plants, condensing units, combined heat and power plants, a pumped storage plant, and two wind power generators. The single largest production unit is the Ignalina nuclear power plant in Lithuania

Installed capacity in 1999

In MW	Estonia	Latvia	Lithuania	Total
Nuclear power			2600	2600
Thermal power	2563	586	2618[3)]	5767
Hydropower		1523	909[2)]	2432
Others		1		1
Total	2563[1)]	2110	6127	10800

Production in 1999

In GWh	Estonia	Latvia	Lithuania	Total
Nuclear power			8716	8716
Thermal power	7415	1346	2387[3)]	11148
Hydropower		2757	409[4)]	3166
Others		2		2
Total	7415	4105	11512[4)]	23032

Power consumption in 1999

In GWh	Estonia	Latvia	Lithuania	Total
Total	6819	6060	8638	21517

The power network of the three countries include 4000 km of 330-kV lines, 570 km of 220-kV lines and 12,500 km of 110-kV lines.

[1)] Available net capacity [2)] Includes 800 MW pumped storage power
[3)] Includes CHP [4)] Excludes losses in pumped storage plants

Source: BALTREL

- Compatibility with different types of equipment at station level (RTUs and station automation systems)
- Compatibility with systems obtained from different suppliers (ABB and GE Harris)
- Compatibility with all generations of primary equipment

This kind of compatibility is an important customer requirement and applies to every network control or station automation system, regardless of the supplier.

A good basis for future development

The described projects have contributed to the build-up of the local ABB organizations in terms of sales, engineering, project management, customer training and service. To establish long-term partnerships with the end customers, ABB has recruited a number of software engineers from universities in Lithuania. These engineers are located in the ABB office in Vilnius and participate in ABB projects worldwide. They cooperate closely with their peers in Västerås, Sweden, through high-speed communication links. Their tasks are typically power system data engineering, software development, system integration and commissioning.

The established base and the local resources that have been developed, combined with ABB's international resources in the power management field, constitute a promising foundation for further improvements to the supply of electricity throughout the region, benefiting both suppliers and consumers.

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