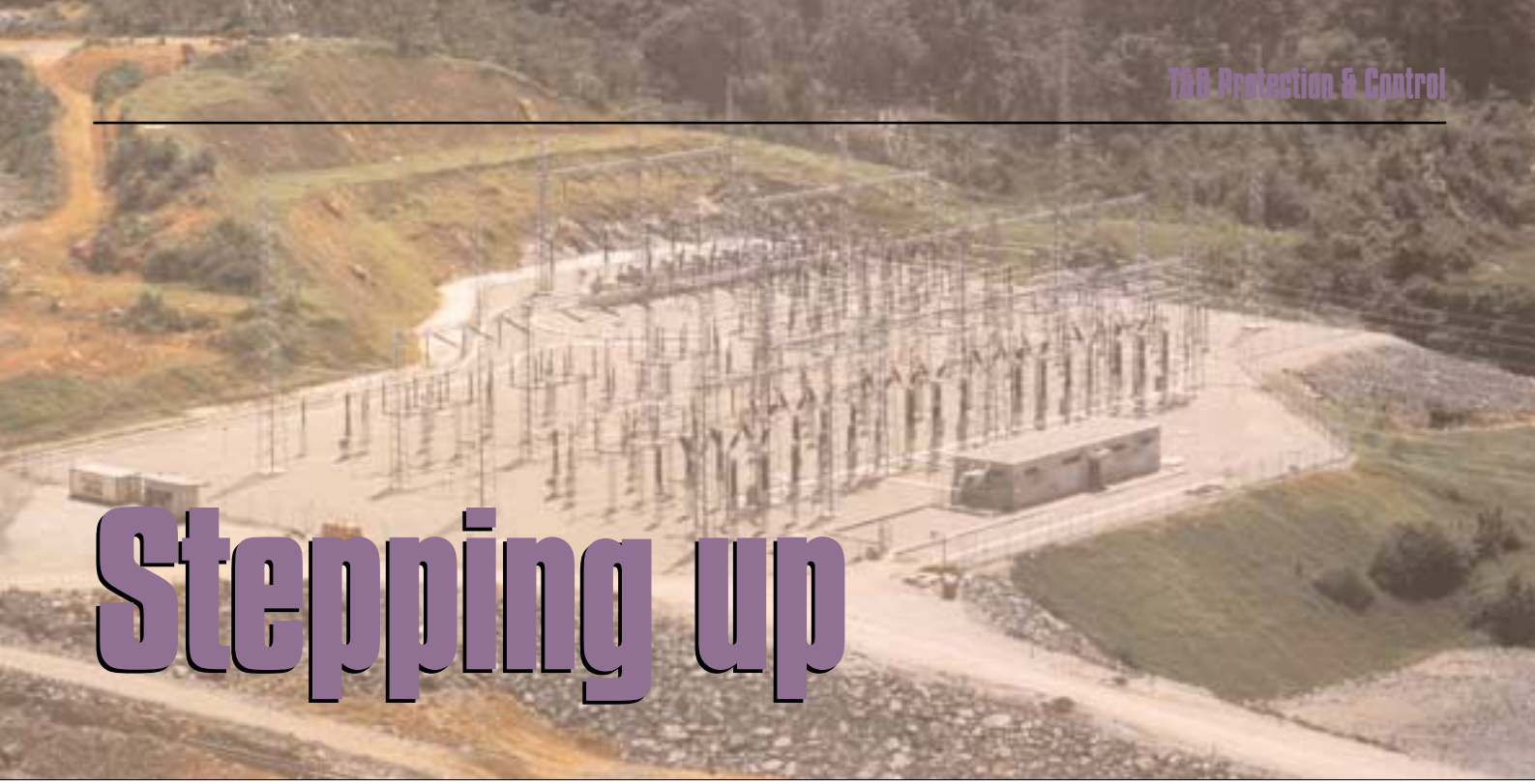


Stepping up

Utilities can increase the availability of their power systems through stepwise investments. Maarit Nyström of ABB Substation Automation provides an overview of a concept for making investments in protection and control, step-by-step.

Over the last two decades power utilities in the Middle East have made heavy investments in their power networks. Since the late 1990s the investments started to replace old electromechanical and static protection relays with modern numerical protection technology and continued with substation monitoring system up to full-scale substation automation system.

Stepping up technology is required since both power generation capacity and consumption of electricity in the Middle East are growing faster than anywhere else in the world.

Extension capabilities

Even though significant investments in power systems are required to meet the increased demand for electricity and ensure reliable operation, the retrofit and extensions are often made in smaller steps due to technical and economic constraints. This calls for solutions which can easily be extended and/or communicate with equipment from different suppliers. Solutions that allow stepwise investment paths can meet these requirements.

• Step 1: Numerical technology – this was introduced in protection relays more than 20 years ago. Use of numerical technology in protection relays improves equipment performance and flexibility and incorporates new features such as self-supervision and recording of disturbance values. These improvements increase the reliability of the secondary system and allow more efficient use of the primary equipment.

Today's technology also allows protection and control functions using the same information from the primary equipment to be integrated in one terminal. No separate pushbuttons and equipment are needed for operating devices and meters for various purposes. The basis for these terminals lies in the platform concept consisting of hardware modules and a library of software functions for protection, monitoring, control and communication. The terminal concept offers greater functional flexibility and is able to provide more data about the primary system performance than older generations of protection relays, e.g. through condition monitoring functions (monitoring of CTs and VTs, etc.). This data is refined and used on the substation

level and transferred to network control systems for operation and maintenance purposes. Numerical technology allows a high sampling rate, which improves accuracy and enables complex and adaptive algorithms to be used.

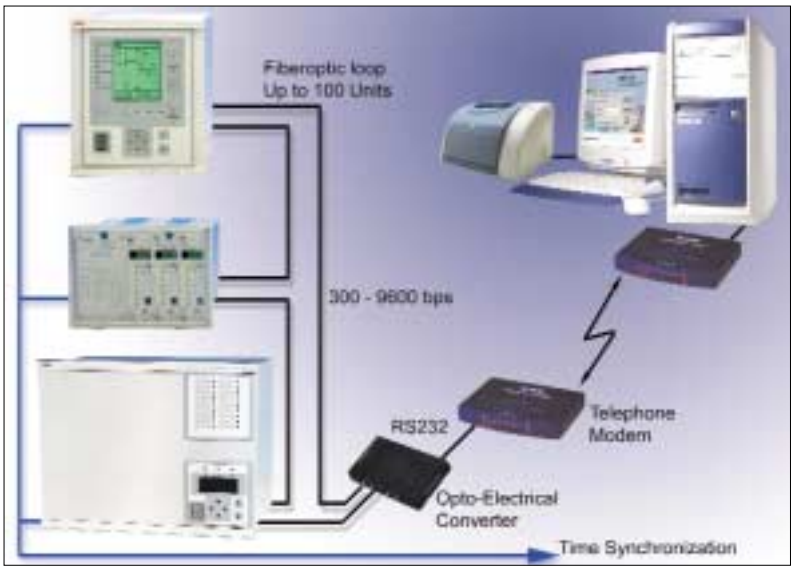
Numerical technology reduces wiring and space requirements, resulting in increased functionality and performance of a protection and control system, and improved overall reliability and availability. At the same time this technology cuts both investment costs and operational costs.

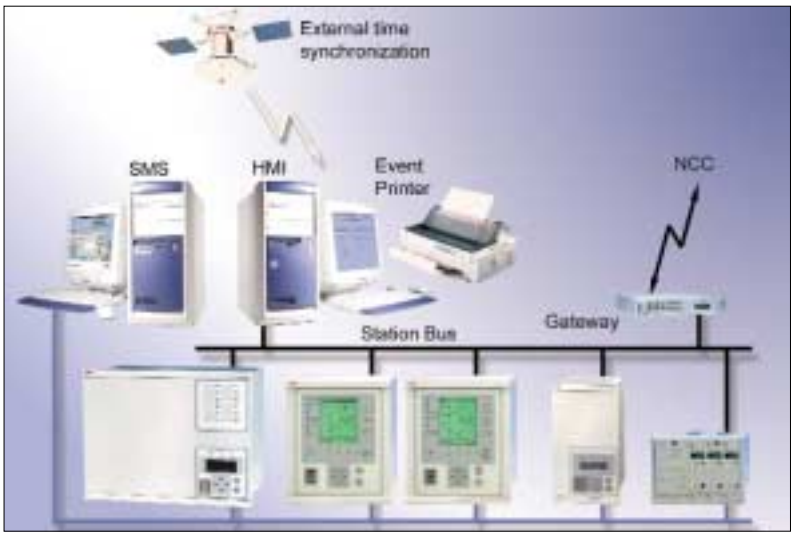
Numerical technology provides a lot of advantages even when protection and control terminals are used as stand-alone units. However, these terminals are able to communicate with upper-level systems, such as substation monitoring systems (SMS), local control and automation systems, and network control systems, which opens additional opportunities for obtaining the full benefits of numerical technology. Together with serial communication, numerical technology reduces wiring and space requirements, resulting in increased functionality and performance of a protection and control system, and improved overall reliability and availability. At the same time this technology cuts both investment costs and operational costs.

Handling information

• Step 2: Information handling with SMS – numerical protection and control terminals have a high functionality and contain huge amounts of information. To benefit from the flexibility of the terminals, a number of parameters need to be set.

The SMS is a tool for structured handling of information. It can be used for setting parameters, monitoring service values and self-supervision status, and event handling for instance, collection





Left: SMS is a tool for structured handling of information in numerical protection and control terminals. It can be used for instance for parameter setting, monitoring, and collection and evaluation of disturbance information.

Below: Substation automation system, with protection, local control, monitoring and serial communication within a substation, and a gateway to a network control system allows on-line monitoring and control of primary and secondary equipment. Disturbance analysis is handled with SMS locally or remotely.

and evaluation of disturbance information. The functions can be implemented locally at the station or remotely in a central office via a public dial-up telephone network or standard TCP /IP network. With direct access to selected information the data stored in the numerical devices can be utilized in a much more efficient way.

• Step 3: Fully automated substation – when it comes to operation, maintenance and fault analysis, a substation automation system with protection, local control, monitoring and serial communication within the substation, and a gateway to a network control system, offers new opportunities and cost benefits.

Such a system allows on-line monitoring and control of primary and secondary equipment. Integrated functions mean reduced wiring, e.g. for communication, and space requirements, and result in increased functionality, such as peer-to-peer inter-bay communication enabling automatic interlocking. Also new automatic restoration systems based on information from a substation can be considered to reduce outage times.

The physical structure of a fully automated substation consists of bay and station levels. In substations, the entire substation is controlled and supervised from the station level, while individual lines, transformers etc, are protected and controlled from the bay level. A truly dsitributed system is achieved by distributing intelligence to the bay level terminals.

A substation automation system requires a fiber-optic Local Area Network (LAN). This network provides a fast and reliable communication medium between protection and control terminals and substation HMI (Human Machine Interface).

Efficient protocols are available, today mainly as propriety protocols, even though they are based on open and published standards.

The operator's workplace provides a safe interface for local control and monitoring of the substation. Process information from the terminals, e.g. service values, events and alarms, is available to the operator in real time. Disturbance analysis is handled locally or remotely via a public dial-up telephone network or standard TCP /IP network with SMS.

Compared to automated substations, retrofit of substations that are remotely controlled via a conventional RTU (Remote Terminal Unit) can only provide limited functionality. In such a substation, the full advantage of numerical protection and control terminal capabilities cannot be obtained.

Promising future

• Next step: IT in substation automation – the future promises even more significant developments to reduce costs and improve operating performance for users. Information Technology (IT) adapted for substation automation and standardization improves the availability of real-time information and the processing of it. Searching information from different locations and various systems in different formats from on-line islands of reference material to paper copies is time-consuming. Additionally, there is a risk that the information is not up-to-date.

By consistent linking of electronic information with the assets, so called "information enabled" products, and a single open architecture, IT allows information to be managed in a way that has not been possible before. As information, say, technical data, circuit diagrams, maintenance information and location, from every piece of equipment is kept together and thus easily managed, plant operation and asset lifecycle management will be improved. A reliable and intuitive operator workplace facilitates smooth and safe operation of a substation and minimizes the risks for mistakes.

Future-proof

Utilities can use this step-by-step approach for optimising their investments in spite of technical and economic constraints. Decisions made should not limit future possibilities. Investments will be safeguarded only if the products and systems installed in a substation are forward compatible with what will come in the future. This means that functionality in today's products must be available in future systems, and that future products operate together with today's products. The solution for this need is the use of open systems based on international standards.

An investment strategy that is based on a step-by-step approach with future-proof products supports the extension of an existing installation with e.g. a new bay, or a step towards IT-based substation automation in a changing market. MEE