zenon – the Distribution Network Maestro

What does zenon have to do with distribution networks? What is a DMS? And is it possible to turn an HMI/SCADA system into a fully-fledged DMS? This article will answer all these questions and more.

A Distribution Management System (DMS) is required in order to manage an electrical network. In general terms, an electrical network can function completely unmanaged – as can be seen by the electrical installation within a house. However, a home network represents a very small network; virtually insignificant in the scope of a whole region. If a home network goes down, it has no effect on other households. Plus, home networks are rarely rebuilt or expanded.

NETWORK MANAGEMENT SYSTEM REQUIRED FOR COMPLEX DISTRIBUTION NETWORKS

When you scale up an electrical network to cover a city, a district, or even a whole region, this is known as a distribution network. Inevitably, this scaling results in new challenges: a fault in a section of the network could affect several households, while a total failure can affect hundreds of thousands of people. In contrast with a home

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network, a distribution network is "alive". It is constantly being extended and adapted as houses are added and new businesses open up. With increased energy demand come new supply lines. In such conditions, a network simply cannot go unmanaged as this would lead to permanent blackout. This is why a network management system is required, i.e. a system with a constant overview that displays what position the high-voltage switches are in and which switching operations are required in order to integrate new lines and cables or to carry out maintenance. The network management system must prevent the interruption of energy supply or limit an interruption to as few customers as possible.
Previously, it was enough to put up a network map on a pinboard and track the switch positions with different colored pins, carefully noting all switching operations in a logbook. Communication with service technicians took place via phone or radio, while specialists conducted network calculations manually.

Today, the person responsible for the network management system (operator) needs technical support due to the sheer volume of data that accumulates in a network control center. This system is called a Distribution Management System, or DMS. Broadly classified, a DMS does two jobs. First, it maps the measured values and positions of high-voltage switches and records their operation. This part is usually referred to as SCADA (Supervisory Control and Data Acquisition). The second part involves calculating the network with regard to load flows, short circuit calculations, setting of suppression coils, step switches for transformers, etc. Both parts are necessary in order to keep the network operational. After all, the network can be influenced by a number of factors. These can include planned switching operations that are necessary to extend the network or carry out maintenance work, but much trickier are factors like variable loads, power generation, and faults. In order to be able to respond quickly to these influences and keep the network running smoothly, the operator is provided with various pieces of information. For one, they receive real-time information from the switchgear in the form of messages, alarms, and status notifications. They also use non-real-time data to gain other information, such as the location of a problem or how many customers are affected. This information can come, for example, from a geographical information system (GIS) or a business system such as SAP.

WHAT A DMS MUST BE ABLE TO DO

Now let's have a look at the DMS from a technical perspective. The first questions we should ask ourselves are where is all this data coming from and how can a DMS replace a pinboard with a network map on it? The first part of the question is easy to answer: the data is provided through interfaces. A DMS requires interfaces with all areas it is connected with. Information that was previously communicated via telephone now arrives automatically via the telecontrol technology in the DMS. Unfortunately, this is not the case for every switch required for a network management system. Depending on the configuration of the remote network or the operational necessity, there may still be switches which are not remotely controlled. In order to properly map these switches in the DMS, you need a function that matches that of the manual tracking on the pinboard. In zenon, this function is called "manual correction". The advantage of manual correction in the DMS compared to the pinboard is that the DMS simultaneously calculates the status of the network and provides the operator with additional information. The operator can find out if a line is electrified, switched off, earthed, or used for multiple supplies. At the same time, the DMS

HIGHLIGHTS AT A GLANCE:

- A Distribution Management System (DMS) is required to manage an electrical network.
- Previously, it was enough to put up a network map on a pinboard and track the switch positions with different colored pins.
- A DMS requires interfaces to all areas it is connected to – and to geographical information systems (GIS) and business systems.
- The load flow calculation is used to monitor a network and to flag up critical situations.
- The state estimator provides information about network segments that are not measured and can only be estimated.
- COPA-DATA continues to add DMS functions to zenon.

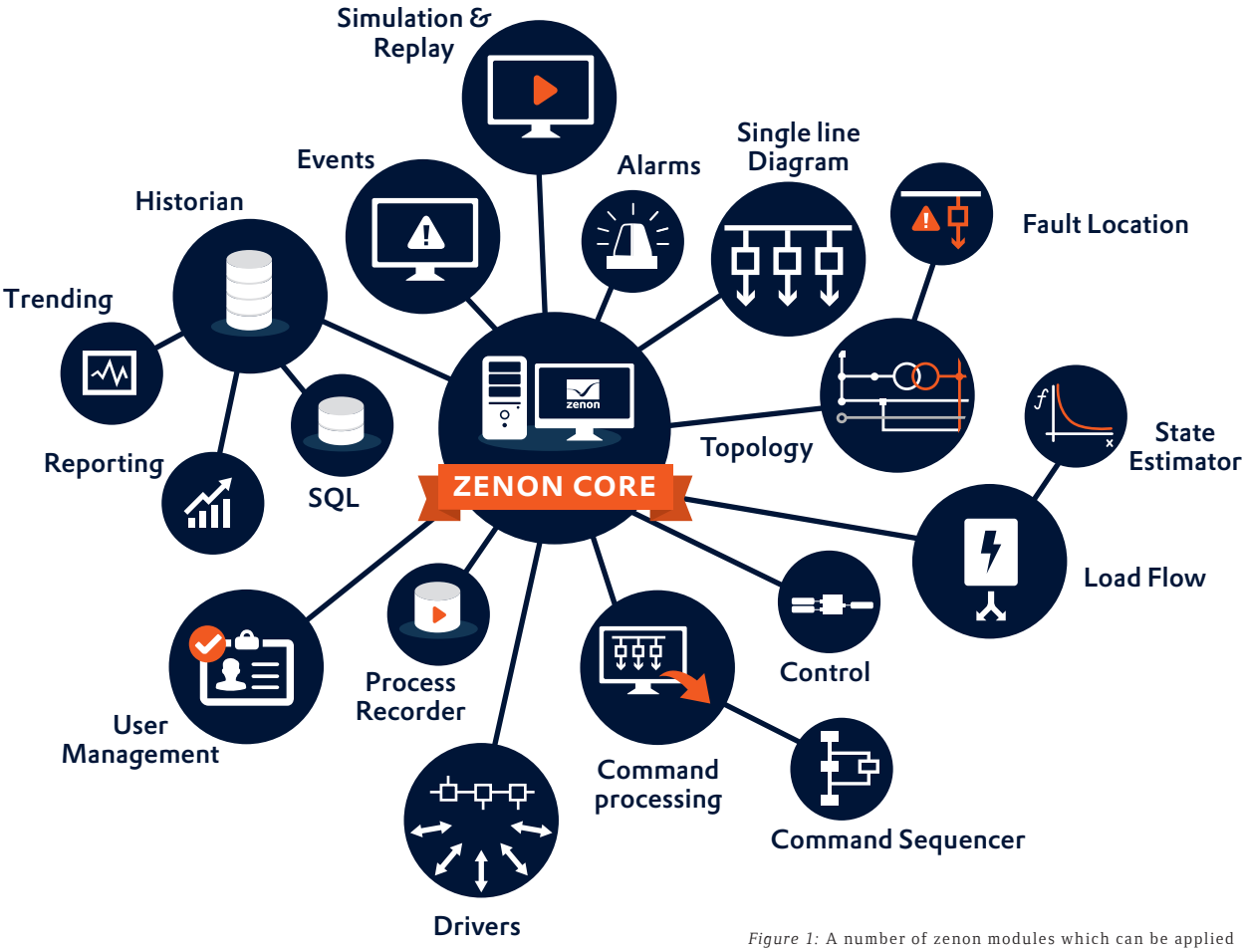

Figure 1: A number of zenon modules which can be applied to control and monitor a distribution network system for smaller to mid-sized municipal utilities.

can work out before switching whether an intervention will cause consumers to be without power or whether it will cause other network sections to be overloaded. As such, the system assists the operator and prevents them from making mistakes.

In addition to the interfaces for detecting network status and the remote control of equipment such as switches, transformers, protective devices, etc., the DMS also needs interfaces to other systems for geo-information, customer data, and storage of data collected for further use by other systems. Thus, the DMS serves as an intersection or gateway for a variety of different information types.

And the DMS is not exempt from trends, either: data required by multiple systems can be stored in the cloud.

When using a DMS, it's important to always have visibility of the status of the network. The calculations necessary for this are carried out by a load flow module. The module takes into account the topology of the network and its feeds and loads and uses this information to calculate the voltages and distribution of power and currents.

These calculations can be used to derive functions that are necessary to monitor the network or to indicate the possible overloading of equipment during switching operations. In addition, the load flow calculation can be used in simulation mode.

During monitoring, "N-1 calculations" are performed in order to address the question of what would happen if a resource fails. Would this push another resource to its limits, cause it to fail, or even trigger a chain reaction? With the results of the N-1 calculation, counter-measures can be taken before the worst case ever occurs.

Figure 2: A medium-voltage grid displayed in a zoomable worldview offers the necessary overview.

SMART RESOURCES HELP KEEP THE GRID STABLE

The load flow calculation assumes that the network features many consistent measured values. This status is not, however, strictly necessary for the state estimator.

The state estimator calculates the current state of loads and feeds. It checks measured values, detects incorrect measured values and estimates missing measured values (hence the name "estimator"). This is based on the current measured values, from the process control system. Using this data, the state estimator for the network model can find a solution to the complex voltages that best matches the existing measured values.

The goal of state estimation is to provide a consistent and complete set of measured values, which serves as the basis for further load-flow calculations or short-circuit calculations. In addition, the calculated measured values are checked against predefined limit values.

The calculated values are usually visualized with their own identifier. Operators or system supervisors will be informed of any large deviations from existing measured values.

The load-flow calculation and state-estimator functions are among the most important network management functions and are intrinsic parts of a DMS. That is why COPA-DATA is working to implement these functions. Not only to expand its business in the direction of distribution networks, but also to consolidate its position in the field of substation automation, because here, too, there is an increased demand for algorithms for complex electricity and voltage calculations.

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