7 Danger Management System

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7.1 Summary

Buildings require a multitude of administrative measures of which danger management as part of technical building management constitutes an extremely significant part thereof. The danger management system (DMS) is responsible for managing time-critical, hazardous situations. Data must be concentrated to give consideration to human receptiveness.

This data concentration is achieved by the hierarchical structure and classification at the field level, automation level and management level, each of them having its proper network. In addition, the DMS merges the various specialized subsystems, from gas warning and fire detection to intrusion detection and access control, in order to make a complete and consistent representation of the current hazard situation possible on one user interface.

To live up to all expectations, a DMS requires a flexible and scalable system structure. Only this way is it possible to easily integrate the requirements of different industries, company sizes and growth steps into the system.

Event handling is the core functionality of a DMS, with the top priority being on the fast and complete recognition of the hazardous situation, which is followed by the guided handling of the problem. To achieve this goal, the subsystems are integrated into the system and operated by the DMS. To be able to retrace what has happened, the DMS includes different extensive reporting choices.

User-friendliness is by far the most important feature of a DMS. Only an intuitively operable, informatively designed user interface adapted to the specific situation facilitates quick and stress-free problem handling.

Flexibility and open system architecture are prerequisites for the integration of the different subsystems with as little expenditure as possible. Apart from that, a DMS must take fail-safety into account and must make a simple, individual system setup possible by means of software tools.

The use of a DMS already makes sense with compact systems. The user benefits from considerably enhanced building safety and from significantly reduced time expenditure required for building safety issues.

Danger management systems reduce complexity
7.2 Basics

Today, terrorists and criminals develop increasingly more imagination, and the number of combined attacks is steadily increasing. Attackers deliberately try to outsmart security equipment, and what would be easier than setting fire in one place in order to break in at another, unnoticed in the general chaos?

Concise, sophisticated system structures are of central significance for the extendibility, flexibility and maintenance of DMS. As investments can only be as good as the way in which they fulfill future requirements, some important aspects of the system setup will be described in detail in the following sections.

7.2.1 Tasks in Buildings

To be able to structure the variety of technical systems in a better way, it is worthwhile to take a closer look at the different building management tasks. Three fields of functions are typically distinguished:

- Commercial administration is ensured by more specialized systems supporting the company's business processes and comprising many different subareas from procurement and logistics to sales and maintenance. Depending on the solution, these systems are more or less integrated and can be summarized under the name ERP (Enterprise Resource Planning). The best-known companies in this field are SAP and Oracle.
- Infrastructural building management comprises, among other things, systems for building maintenance such as facility management systems (FMS), which provide for maintaining the technical facilities.
- Technical building management consists on the one hand of building automation such as heating, ventilation, air conditioning (HVAC), lighting and elevator control and, on the other hand, of safety management (fire, intrusion, access control, video surveillance, etc.).
As safety is an integral part of the technical building management, the following chapter presents a brief overview of technical building management and will then focus on safety engineering.

In the sense of a data concentration, building management can be represented as a hierarchical pyramid.
It must be taken into account that the different levels work autonomously and are interlinked by means of high-performance communication networks.

The pyramid shown in Figure 7.2 reflects the data concentration from one level to the next. The field level acquires an enormous amount of information, but only a small part thereof is passed on. Intelligent fire detectors continuously record parameters, such as smoke density and temperature, but they normally transmit the danger level to the control unit only periodically. However, in case of an alarm, they immediately report the event to the control unit. Medium-sized systems already encompass thousands of data points on the field level.

The centrally managed subsystems transfer data to the building management system in exceptional cases only, and only a small part of these data is required for the ERP (e.g. energy consumption data).
7.2.2 Distributed Intelligence and Hierarchy

Twenty years ago, microprocessor-based devices were large, expensive, slow, energy-consuming and rather inflexible. Building up a system with such components necessarily led to highly centralized systems with low functionality. The technical progress that can be seen in daily life—systems that are smaller, faster, more intelligent and more economic—also led to completely new possibilities in device and system engineering. The resulting benefits for the user are not only reflected by lower purchasing and operating costs but also by the following aspects:

- increased reliability and improved self-surveillance
- quick hazard recognition, immune to deception
- actuation of immediate and automated, interdisciplinary interactions for danger management
- clearly arranged, graphic-oriented reporting of hazards to the safety staff
- the possibility of geographically distributed systems to be monitored and controlled from one or several workstations

In the following, we will focus on the field of safety engineering and take a closer look at the management, automation and field levels:

- **Management level**: DMS with the functionalities required to control the subsystems, particularly including central observation and operation of the subsystems but also the possibility of visualizing, archiving, logging and evaluating.
- **Automation level**: Automation controllers that are usually denominated control units, with the functionalities required for decision-making, distribution and controlling the processes.
- **Field level**: Sensors and actuators with the functionalities required for detecting, activating and transmitting hazard messages, or appropriate countermeasures respectively.

Each of the three aforementioned levels is provided with a high-performance network in order to link the decentralized components of the own level, or to integrate the subordinate level's networks.

Information flowing from a subordinate level to a higher level is condensed and filtered according to predefined criteria. Information flowing top-down may be multiplied according to predefined criteria, for example to open several smoke extraction dampers with one single command.
7.2.3 Scalable System Structure

When selecting a safety management system, it is important to know whether the system supports possible future extensions and modifications. The step-by-step extensibility of a system and the correspondingly easy and efficient system extension are central quality features of a DMS.

Flexible, scalable structures allow setting up different configurations with one system technology, including, for example:
- compact systems
- LAN systems
- WAN systems
With compact systems, the complete DMS software is installed on one workstation. The system usually communicates with one or more subsystems via a serial connection.

**Figure 7.5: Setup of a DMS with LAN**
LAN is the abbreviation for Local Area Network (see Glossary starting on page 297). A LAN system comprises several DMS operating stations (clients) by means of which the building can be simultaneously monitored from different workstations. The operating stations are connected to one or several servers via the LAN. Such a server is also called a client station, as they serve other clients while they can still be used as clients themselves.

Figure 7.6: Setup of a supraregional DMS network with WAN

With a WAN (see Glossary starting on page 297) solution, geographically distributed systems can be monitored and operated either locally or centrally. This facilitates monitoring and control of many small bank subsidiaries by one or more central DMS, for example.
7.3  Main Functionality

The key tasks of a DMS are the handling of events, the operation of subsystems and reporting.

To make these main functions possible, a whole range of additional functions is required which, to some extent, constitute the infrastructure of the DMS. To name only the most important additional functions: Access rights concept, user administration, password administration, object administration in tree structures and graphic structures, graphic level administration.

The three following subsections describe the main functionality of a DMS.

7.3.1  Event Handling

The handling of actual events, sometimes simply referred to as alarm handling, is the core function of a DMS. Hence, its central elements are

− hazard recognition,
− hazard reporting,
− adequate intervention.

When a detector recognizes a hazard source, the operator at the workstation must immediately be alerted. Appropriate means to call the operator's attention are acoustic signals transmitted by loudspeakers, flashing elements on monitors or, in case of the operator's absence, mobile signaling via SMS or pager. The operator usually has a set of questions that need to be answered as quickly as possible:

− what kind of problem is reported?
− where has this problem occurred?
− what must be done next?

Event handling includes therefore:

• Indication of all pending events, both in clear-text and as dynamic symbols on the building’s ground plan.
• Acknowledging the receipt of the event signal (acknowledgement).
• Resetting the event message.
• User guidance by providing individual handling steps, depending on the type and importance of the event, in accordance with the general conditions and requirements of the system.
The typical procedure is the following:

- The DMS recognizes an event and reports it to the operator in charge. The system simultaneously triggers a countdown.
- The operator localizes the alarm and reports to the DMS that he/she has noted the alarm (acknowledging the alarm). The countdown is canceled.
- When the system notices that no reaction (acknowledgement) has occurred within the countdown period, an external alarm receiving center is informed automatically.
- After acknowledging, the operator makes sure which tools are currently available to verify the event and takes care that the alarm is investigated. With compact systems, it is usually the operator who is responsible for this.
- Depending on the results, the intervention forces are alerted (police, fire brigade or other intervention forces), or the alarm has turned out to be irrelevant and is canceled (reset).

Figure 7.7: Event list and event on the building overview
7.3.2 Integrating and Operating the Subsystems

State-of-the-art DMS support all important types of subsystems such as fire detection, gas warning, intrusion detection, access control or video surveillance. In addition, a DMS must be able to integrate other subsystems, such as safety-related sections of HVAC systems or other technical installations.
As far as possible, and for all subsystems connected, the DMS shall
− indicate events and facilitate their handling (see section “Event Handling” starting on page 247)
− enable the activation of subsystem-specific functions
− enable the activation of preprogrammed control sequences (macros)

Usually, the subsystem-specific functions of a fire detection system comprise the following processes:
− switching individual detectors or groups of detectors (zones) on and off in order to perform maintenance work on the fire detection system
− changing the alarm organization (e.g. day / night mode)
− activating fire control installations, for example:
  − closing the fire dampers in the event of fire
  − initiating smoke extraction
  − positioning elevators in emergency position

Examples of other, subsystem-specific functions are:
− positioning camera
− activating video recording
− opening doors

Subsystem-specific functions can be operated both via a text-oriented tree structure and via graphics. A uniform operation of different subsystem types with different operating concepts is only possible when the conceptual setup of the DMS takes the particularities of the different subsystems into account and flexibly integrates individual, subsystem-specific functions.

7.3.3 Reporting Functions

State-of-the-art DMS today work with integrated database applications, making it possible to store an almost unlimited number of past events together with their handling steps recorded. These system-specific recordings and the corresponding polling possibilities may help to answer questions such as:
− what has happened during the past 24 hours?
− how many faults occurred last year?
− who did what and when following yesterday’s intruder alarm?

Such reporting possibilities support the optimization of building operations and the technical facilities.
7.4 Operation

DMS are typically operated via a graphic-based user interface on which the ground plan of the floor concerned is indicated in case of alarm, including the room in which the alarm occurred. Today’s DMS cannot be imagined without features like graphic navigation and operation via photos, ground plan and other images. As ground plans may be very large, the DMS must support vector graphics. Functions such as automatic scaling, zooming, small overview windows (bird’s eye view), etc., are only possible with vector graphics. Since ground plans today are normally available as CAD files provided by the architect, advanced DMS make it possible to directly read in ground plans in AutoCAD format, for example. This makes time-consuming copying and editing processes a thing of the past.

State-of-the-art DMS also support multiple graphic layers, allowing to show more details on the lower levels. The visibility of different levels can depend on the operator’s access rights, which in turn results in a better overview (focus on what is essential for the operator).

The user-friendliness of a DMS is probably one of the most important criteria to opt for a system. Not only experienced security and safety experts shall be able to accomplish their tasks quickly and easily with the DMS. Untrained staff with little PC experience must also be able to respond safely and quickly in case of emergency with the help of a DMS. This is aggravated by the fact that these systems are generally rarely operated, as no hazards are reported in normal operation. An emergency situation is a stress situation for most operators.
Getting a correct overview of what is going on and reacting correctly in a stress situation is only possible if the system informs the operator in a possibly simple way, at the same time supporting the operators so that they can initiate the correct measures in the right sequence.

Clearly structured, logic processes that are easy to control are a prerequisite for successful hazard prevention.

It is thus essential for the operator to rely on a few simple and intuitive rules. These rules must remain constant, independent of the current state of the system, the instant at which the event occurs, or who is handling it.
A DMS should make it possible to configure some workstations as exclusive DMS workstations, meaning that only the DMS application can run on these PCs, while all other applications or operating system functions can neither be seen nor used. But also for workstations that are not exclusively configured for DMS, monitor regions exclusively reserved for DMS with a clearly defined functionality in stress situation are a crucial advantage.

In addition, it must be ensured that the DMS allows for step-by-step, guided event handling in case of important events. Of course, this kind of event handling must be project- or customer-specific and adapted to company-internal security and safety processes and conditions. Whether a DMS allows such adaptations and how complex and costly this would be must be clarified in advance.

The state of subsystems, such as the number of currently deactivated detectors, etc., must be constantly visible. This is the only way to make sure that the operator has a correct overview of the actual situation at any time.

**Easy operation prevents excessive demands on the operator and human error**
### 7.5 Integrated Systems

The concentration of all safety-related information in one DMS has the following advantages:
- improved overview and thus increased safety
- reduced costs in comparison to several independent management systems with regard to purchase, configuration and maintenance
- consistent operation concept requiring less training and bearing no risk of confusion in case of emergency
- only one safety system to be integrated into the company’s IT infrastructure
- easier interactions between subsystems

The goal is thus to integrate the subsystem into the DMS as completely as possible. Perhaps a complete integration may rarely be possible, but the aforementioned advantages are obvious.

The disadvantages of system integration are focused in two areas:
- The higher complexity renders operation more complicated for the user. Excessive demands and an inappropriately long adjustment period must be avoided for the operators and their deputies. To avoid these disadvantages, leading system suppliers have introduced access and visibility levels which can be allocated to the different user types. Each operator sees only what is relevant for him or her.
- Complex systems are more susceptible to errors than systems using a simpler structure. To eliminate error sources from the beginning, development and support tools are used which detect existing errors and avoid the generation of new errors by means of continuous testing of data consistency.

Provided that the aforementioned measures are adhered to, the safe operation of DMS with integrated subsystems is possible.

**Figure 7.12: Versatile integration of different disciplines into DMS thanks to open system technology**
Advanced DMS offer different possibilities to integrate subsystems. Some examples are manufacturer-specific protocols, open gateways for integration or open protocols, such as:

- **OPC standard** for an easy but frequently functionally limited, direct integration into the PC.
- **BACnet** for a more sophisticated, functionally more detailed integration into the PC. This protocol is equally suited for the communication without a PC, i.e. directly between the automation controllers for so-called peer-to-peer communication. This type of communication is suited for quick, safe interactions avoiding the error-proneness of PCs and PC networks.
- **LON, EIB, PROFIBUS, Modbus** and other protocols which may as well be used on the automation or field level.
7.6 Fail-safe Operation

Fail-safe operation must be accommodated by different measures. Two different aspects shall be mentioned in brief below.

7.6.1 Standby Solutions

A possibility to improve the fail-safe operation of PC-based solutions is the use of standby servers. In a DMS set up as a typical client-server solution, the server is the weak point of the system. If it fails, the clients connected are no longer functional. When an emergency server or standby server is used, the system automatically switches to that standby server in case of a main server failure. Thanks to constant data mirroring, the standby server may continue exactly where the main server stopped. Typically, there is a separate high-speed communication link between the main server and the standby server, allowing for quick and trouble-free data mirroring.

![Figure 7.13: Increased network safety on account of a standby server](image)

7.6.2 Power Supply

In safety technology, emergency power supply for the subsystems is usually ensured. It is also recommended to provide the emergency power supply for the network modules and the DMS itself. Generally, a power failure of 4 hours should be bridged by an uninterruptible power supply unit, for example.
7.7 Planning

In the era of digital image processing, digital photography, 3D-CAD systems and GUI (Graphic User Interface), the provision of photos and diagrams is no longer a problem. Consequently, it becomes more important that they are thoroughly selected:
- identical graphic representation formats for the entire building
- same degree of detailing and information contents
- same viewing angles, brightness, etc.

To be able to make the best possible selection, the following decisions should be made in advance:
- scale of the complete overview
- scale of the smallest details to be viewed
- number of intermediate steps
- zoom factor for each step (constant)
- navigation structure
- access rights concept

To answer the aforementioned questions, the DMS provider’s experts can provide valuable input depending on the situation.
7.8 Installation, Commissioning and Acceptance

Although it is possible to set up the safety management networks simultaneously with the rest of the building’s cabling, commissioning calls for functioning subsystems that are usually only available after the building has been set up completely.

System integration implies that system acceptance includes integration tests. The correct configuration of each data point must be ensured, i.e. the management station indicates this data point with the correct designation, at the right location and allocates the correct data type to it.
7.9 Profitability and System Evaluation

DMS are already profitable with compact systems, i.e. systems with more than 150 data points (detectors or sensors). This has the following advantages:

- **Fast reaction**: In contrast to the subsystem’s operating panels mounted close to the exits, the DMS is located at the working place of the staff responsible for safety. Therefore, in case of an alarm, the time to get from the working place to the subsystem’s panel is omitted. A fact that increases reaction speed while reducing stress of the responsible persons.

- **Increased productivity**: To operate the subsystems, the persons responsible not only spend unnecessarily time to walk from their working places to the operating panels, but they need to permanently recall the different handling modes of the various subsystems because the handling procedures of an intrusion detection system are not identical to those of a fire detection system, for example. By using a DMS, time will no longer be spent for walks to the operating panels and to recall handling procedures. In addition, reliability of operation is increased since event handling on a DMS is quite the same for the different detection systems.

- **Cost reduction**: Due to the centralized DMS, safety monitoring can also be centralized, resulting in minimum numbers of local safety staff.

- **Better system overview**: Considering a building as a system or as an entity is only possible with a central management system. And combined threats will increase in the future. The burglar making use of a fire alarm is only one classical example.

- **Better decision basis**: Due to the abundant information they provide, combined systems allow for the correct assessment of a situation. Video surveillance, for example, makes it possible to correctly assess an emerging fire in real time. Access control informs on the number of persons present in the fire section, or makes it possible to accurately locate a burglar. Only a central management system makes this information available on a network.

- **Targeted reaction**: If an operator makes decisions based on graphic, spatial representations, then this is for sure a better decision basis than a simple subsystem display. Is the supply shaft located in the immediate vicinity of the fire location, or does currently the gas cylinder store represent a much higher risk? Thanks to precise geographic information, such questions can be answered in case of alarm.

Concerning system selection, the optimum representation of the own organization in the management system is decisive. The flexibility of selecting new organization forms on short notice, or, of adapting the responsibility to the new staff organization, or of quickly and correctly integrating a new subsystem will prove worthwhile during the course of time. The functionality should thus always ensure optimum operation – even if it has not been provided for two safety officers sharing tasks, for example.

The economic efficiency of a DMS is guaranteed time and again