Control Systems from Siemens for Operations Centres

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**Introduction**

DB Netz AG operates a line network in Germany that covers around 40,000 km. In addition to the tracks with the points and signals, the network also includes an extensive infrastructure with level crossings, tunnels, bridges and all equipment of the signalling and control systems together with the communication systems required for railway operation. In the entire network area, around 70,000 train runs and their interchange relationships must be managed every day.

The objective of German Railways (DB AG) is to combine the systems and components used in the area into a unified whole. This is to be achieved by using powerful and reliable systems, while taking into account the commercial and operational requirements of the market.

In order to meet this challenge, DB AG is implementing seven operations centres for main-line railways (OC) as the centrepiece of modern operations management. In addition, this system is used on the Berlin S-Bahn.

In the area of an operations centre, 7000 to 8000 trains are dispatched and controlled over 3000 to 4000 route kilometres with 6000 to 7000 main signals and 6000 to 7000 points.

This article introduces the key systems that Siemens Transportation Systems provides for implementing the operations centre concept.

**The Operations Centre Concept of DB AG**

The objective of the concept is to link up the equipment of the signalling and control systems and combine the basic functions of operations management such as planning, dispatching and control in one location, namely the operations centre. Moreover, it is planned to extend the concept to include local control of interlocking levels in order to optimise operation. The use of systems with high availability and reliability is the basis for the overall operations centre system.

An overall technical concept (Figure 1) has been established in order to fulfil the requirements of automatic operations management. The objective of this concept is to divide the systems of the operations centre into an operating area, a dispatching area and an area for external data communication. Direct route control and primary train tracking is performed from subcentres distributed within the line network. They essentially contain the El S electronic interlockings and the local systems for automatic route setting (ZLS 901) and train identification (ZNS 901). With the inclusion of integration components, several subcentres are combined in control centres with joint operator control in the operations centre. All essential information for planning operations and concerning the current operating process is gathered together in the higher-level dispatching facilities. Continuous train supervision and dispatching take place on this basis. The centralised equipment for automatic route setting and train running management accesses the control centre and allows for direct implementation of the dispatching decisions in control instructions for the local automatic route setting systems. Methods for computer-aided conflict recognition and conflict resolution are used in this process. Consequently, continuous process management is ensured from dispatching and train supervision through to route control.

The additional essential basic functions of this concept are:
- centralised data management for topology data, timetable data and other system-describing data of the operations centre
- protection against unauthorised external access through categorisation of the segments into areas with graded safety responsibility (technical compartmentalisation)
• option of mutually independent use and operation of functional complexes such as the subcentre and control centre as well as the dispatcher level
• provision of external customers, e.g. DB Station & Service, with current data

Status of Implementation

Siemens Transportation Systems has completed the development of the operating area equipment. This includes, for example, a new generation of the El S Electronic Interlocking, the BPS 901 Man-Machine Interface (MMI) System, the ZLS 901 Automatic Route Setting System, the Security Gateway and the integration components of the control centre. At present, these systems are gradually being incorporated into the operations centres and connected to their dispatching area. Existing systems such as old El S interlocking models in the subcentres are being upgraded and also integrated into the control centre. The key innovation compared with conventional electronic-interlocking operation is the flexible allocation of the subcentre areas to the operator MMIs in the operations centre. This allows the manning of these MMIs to be targeted to the operational loads.

In the dispatching area, the construction of the Magdeburg operations centre by Siemens as a pilot system constituted the first milestone of modern operations management. The full range of main operations centre functions was implemented here, such as centralised train supervision, dispatching with automated conflict recognition and conflict resolution as well as direct implementation of the dispatching decisions in automatic route setting requests. The experience gathered in developing this pilot system and the expertise built up during implementation is fully applied to the construction of subsequent operations centres for main-line railways.

A consortium has been contracted to carry out the extensive construction of operations centres. Siemens Transportation Systems, Rail Automation, has overall management responsibility for the consortium.

For all seven contracted operations centres in Germany, the first stages of operations centre dispatching have been completed on schedule and commissioned. Main functions such as extension to the control level and automatic conflict recognition and resolution will be added in subsequent implementation stages.

Operating Area Equipment

The operating area equipment is part of the core activity of Siemens Transportation Systems, Rail Automation.

This essentially includes implementing the subcentres with the decentralised electronic interlockings, train describer systems and automatic route setting systems, as well as equipping the corresponding control centre with the MMI systems and integration components.

1.1 Fail-safe Standard Man-Machine Interface

The fail-safe standard man-machine interface is implemented in the shape of the BPS 901 MMI system. Electronic interlockings are operated from this standard man-machine interface. Because of the modular design, the MMI system provides various configuration options. In addition, user-specific configuration of individual MMIs (e.g. for operators, helpers or observers) is possible. Operation in accordance with a uniform style guide of the connected systems such as the train describer system or the automatic route setting system is possible with the user interface of the MMI system.

The software procedure applied ensures fail-safe displays. It is based on the comparison of the processing results of an operator communication computer with those of an independent reference computer. Consequently, optional display of detail views or area overviews on the monitors is permissible.
The fail-safe standard man-machine interface offers:

- ergonomic operability
- integrated operation of train describer systems, automatic route setting systems and electronic interlockings
- operation of several subcentres with up to 4000 controlled elements from one man-machine interface. In medium-sized control areas, this corresponds to around 10 subcentres.
- protection of operation and display by means of software procedures

The electronic interlocking, the train describer system and the automatic route setting system are operated using the mouse in a track diagram-oriented manner. Special fields are displayed in the diagram for command release. In addition, the MMI system reliably and fully documents logging and fault indications in machine-readable format. A mirror disk system is used as a recording medium, and a CD writer serves as an archiving medium. For data supply, the fail-safe standard man-machine interface is connected to a central data server (ZDBP), which is described below.

Integration Components (Operating Area)

1.2 Central Data Server for Man-Machine Interfaces

Each control centre from Siemens is fitted with a central data server for man-machine interfaces (ZDBP). Its function is to supply the connected computers of the control centre with software and configured data and enable authorised personnel to manage this data easily.

1.3 Central Documentation

The central documentation component (ZDOKU) stores information in accordance with the documentation requirements in the control centre, and makes it available to the operator communication computers.

1.4 Centralised Automatic Route Setting System of the Operating Area

The centralised automatic route setting system of the operating area distributes the information received from the centralised automatic route setting system of the dispatching area to the decentralised automatic route setting systems and passes on the data received from these systems to the centralised automatic route setting system of the dispatching area. Functional characteristics of the automatic route setting systems of different manufacturers are considered in this process.

1.5 Centralised Train Location System of the Operating Area

The centralised train location system of the operating area (ZSSO) communicates with the train describer systems of the subcentres via the Security Gateway. The system receives train running data from the train describer system, displays it on the display systems of the control centre and transfers the train running data via the Security Translator to the centralised train location system of the dispatching area (ZSSD).
1.6  Non-fail-safe Standard Man-Machine Interface

The non-fail-safe standard man-machine interface is the multifunctional user interface of the dispatching area of an operations centre.

The individual operation and display functions of operations management, systems management and logistical support are implemented in a largely non-segment-dependent user interface.

The MMI system of the non-fail-safe standard MMI offers:

- responsive, authorised operation and flexible allocation of functions
- operator guidance compatible with the fail-safe standard MMI
- standardised display of the applications on the user interface
- adaptation and upgrading options
- system maintenance and repair when integrating the various individual systems over a prolonged period

The MMI system can support up to 99 different operator functions. 80 MMIs can be linked into the overall system in a first stage. The overall system is scalable. Up to 8 monitors can be triggered on these MMIs using the mouse.

1.7  Centralised Data Management

The centralised data management software system (LeiDa-S) manages and distributes the topography data, vehicle data and timetable data, etc., for the entire area of the operations centre.

In this process, the following data is managed and maintained:

- infrastructure data
- timetable data
- process data (data on operations)
- organisational data
- system data

The data management functions of LeiDa-S ensure data integrity and data consistency of all data centrally stored in the operations centre.

1.8  Centralised Automatic Route Setting System of the Dispatching Area

The centralised automatic route setting system of the dispatching area creates the link to the automatic route setting functions of the control centres and subcentres integrated into the overall concept.

A topographical display shows the train location information, the train and signalling statuses of the automatic route setting systems in the subcentres and selected electronic-interlocking element statuses

- Enables dispatching changes to the route setting plan
- Implements direct electronic-interlocking and automatic route setting commands
• Displays conflicts

1.9 Centralised Train Location System of the Dispatching Area

This component provides the current image of all train locations within the operations centre. If additional dispatching information, for instance a train not running on schedule, is known, it is assigned to the train concerned. The train locations and additional dispatching information are transmitted to the display equipment of the standard man-machine interfaces so they can be shown.

Safety Management

In order to preclude corruption of data communication in the operations centres, Siemens has created and implemented a comprehensive safety concept. In conjunction with experts from the Federal Railways Office in Germany and DB AG, the requisite protection against every possible attack on the system has been described and developed.

This safety concept comprises the following systems:

• Firewall that ensures protection against unauthorised external access
• Security Translator that isolates the fail-safe area from the centralised dispatching on the basis of a defined and testable filter for data telegrams
• Security Gateway that ensures cryptological encoding of the data via the open network

1.10 Security Gateway

Because the operating and dispatching control systems are combined in one location, the operations centre, it is necessary to exchange safety-related data between the man-machine interfaces and the interlockings. In this context, it is sometimes necessary to span considerable distances. The Security Gateway is a system that makes it possible to link subcentres and control centres by means of public networks with no separate wiring system.

Two alternative procedures are provided for managing the data security modules and for the code change to be carried out:

• Lean security management (LSM) is used for local administration and activation of the data security modules. This consists of a laptop, connected to the DSM link via an interface, with corresponding software and a chip-card reader and writer.
• A security management station (SMS) is used for the centralised administration of the data security modules with the option of automatic online code change via the data channel. This system is constantly linked with all data security modules of the connected fail-safe terminal equipment via the network.

1.11 Security Translator

The Security Translator system (STS) is a coupler with defined properties for telegram filtering that connects the “closed” network of the operating area with very high safety requirements to the dispatching area. Key system functions are:

• testable filter for defined telegrams
• cyclical self-tests of the filter functions
1.12 Firewall

As part of security management, access to the network of the operations centre and all downstream equipment is regulated by means of firewall systems. The system enables
- protection against unauthorised external access
- project-specific configuration of the communicative relations

Outlook

Siemens Transportation Systems will develop further innovative technical systems in order to increase the cost-effectiveness of operations management in train operation. To this end, new ideas will continue to be generated and implemented. One example of a potential application is a diagnostic system concept for entire operations centres. The design work for this is largely completed and will ultimately result in an overall diagnostic system whose functions will include displaying and further improving the availability of the operations centre control systems.

As centralised communication nerve centres in the network of German Railways, the operations centres enable effective data supply for a wide variety of customers such as DB Station & Service as well as a targeted deployment of resources.

The measures will therefore contribute to the continued increase in cost-effectiveness of operation from the operations centres.

Author:

Key

ARS Automatic route setting system
COMS 901 Communication server
DOCU Documentation computer
EI S Electronic interlocking from Siemens
MMI Man-machine interface
OCC Operator communication computer
RDT Remote data transmission
REF Reference computer
ZLS 901 Automatic route setting system
ZNS 901 Train describer system

Fig. 1 Concept of the operations centre