Trainguard MT
The Scalable Automatic Train Control System for Maximum Flexibility in Modern Mass Transit

Transportation Systems
The Advantages of Trainguard MT

Key Factors for Efficient Transportation

Performance
Trainguard MT enables operators to maximise their network capacity and throughput. Headway times of 90 seconds are achieved by making best use of the moving block working principle in combination with continuous, bi-directional communications over WLAN (CBTC). This means, the number of trains in operation can be increased and more passengers can be transported at the same time, resulting in a more punctual service and higher passenger satisfaction.

Scalability
Trainguard MT can operate in different modes. In suburban and commuter areas, where the required headways and train intervals are medium, intermittent communication is used. In metropolitan areas, where minimal headways and high train intervals are essential, continuous communication provides the required performance. By offering two distinct modes of operation, Trainguard MT is a highly scalable solution in terms of performance and costs. Thanks to its modular system design Trainguard MT can be configured to exactly match the customer requirements.

Upgradeability
When the demand for higher transport capacity arises, existing Trainguard MT installations can easily be upgraded from fixed block to moving block operations. The level of automation can be upgraded from supervision and control operation (SCO) to semi-automated operation (STO) or to driverless operation (DTO), step-by-step, in accordance with the required functionality and performance. Upgrades can be implemented without interrupting operations and it is not necessary to uninstall any of the old equipment.

Mixed Traffic / Mixed Mode
Trainguard MT can handle trains with different communication equipment at the same time on the same network. This allows for mixed fleets to be used on the same line. Trainguard MT is therefore the optimum choice for mixed traffic environments. The range that each train can travel is expanded, whether normal, express trains, suburban trains, mainline or freight trains. At the same time, Vehicles equipped for semi-automated or driverless operation can seamlessly change over to supervision and control operation on suburban line sections. This also increases system availability during upgrade or migration phases of an existing train fleet or signalling system.
Solving Tomorrow’s Challenges

Optimal Mobility through Reliable and Efficient Automation Systems

There is a continuous increase in the need for transport in the world’s rapidly growing metropolises. More and more passengers have to be carried by public transport – on their way to work or home, to leisure or education facilities or for shopping. Efficient mass transit systems, which are capable of being quickly adapted to new requirements, are therefore to be seen as one of the most important factors for maximum mobility in cities and for the promotion of urban and regional economic development.

The overall performance of a mass transit system depends largely on the performance of the Automatic Train Control (ATC) system employed. With increasing automation, the responsibility for operations management gradually shifts from the drivers and operators to the system. An ATC system comprises functions for the monitoring, execution and control of the entire operational process. It can feature different levels of automation such as driver-controlled train operation, semi-automated train operation and driverless operation. The ATC system continuously indicates the current driving instructions on the cab display and supervises the permissible train speed. Colour light signals are therefore no longer required.

The design of automatic train control systems focuses on an ever-growing need for economic efficiency.

The modular and scalable train automation system Trainguard® MT is the Siemens answer to the comprehensive requirements of urban transport today and offers the latest standard in automation at different levels.

The major benefits of Trainguard MT
- Short headways
- Cost-effectiveness
- Scalability
- Upgradeability
- High Reliability
- High Availability
- Optimal Safety
- Economical maintenance
- Flexible refurbishment and migration solutions

As a modern modular ATC system, Trainguard MT offers all these features providing the basis for attractive, safe and efficient mass transit systems which satisfy the needs of both passengers and railway operators throughout the world.
Matching Operator Requirements
Upgradeable Communication Methods
and Automation Levels.

Trainguard MT is a versatile and modular system which can be individually tailored to the railway operator’s needs. Different communication methods and automation levels can be implemented, depending on the requirements for performance and functionality.

The following communication methods can be used jointly or separately:

**Intermittent Communication (ITC)** Intermittent track-to-train communication allows fixed block operation with continuous supervision and offers already an Automatic Train Operation (ATO) functionality. The intermittent communication level can be used for parts of the line with lower headway requirements or optionally as a fall-back level for parts with continuous communication.

**Continuous Communication (CTC)** Trainguard MT with continuous communication features a bi-directional WLAN transmission channel providing full moving-block functionality in combination with comprehensive ATO capabilities. Train separation according to the moving-block principle results in minimum headways, thereby enhancing system performance significantly. Colour light signals can be reduced to a minimum or even completely omitted.

Depending on the chosen communication method, the following levels of automation can be implemented:

> **Supervision and Control Train Operation (SCO)** The driver, assisted by the cab display, controls the train manually under full supervision and with continuous speed control of the Automatic Train Protection (ATP) system.
> **Semi-automated Train Operation (STO)** The train is driven automatically from station to station and the driver merely initiates train departure.
> **Driverless Train Operation (DTO)** In this mode, train operation is fully automated and a driver is no longer required. A train attendant, who will only take actions in emergency situations, will still remain on the train.
Greenfield Installation
The ideal solution for a greenfield installation of a modern mass transit signalling system is the combination of Trainguard MT and the following well proven Siemens components and systems used already successfully in various applications worldwide.

> Vicos® OC 100 and Vicos OC 501 for Automatic Train Supervision (ATS)
> Trainguard MT for Automatic Train Protection (ATP) and Automatic Train Operation (ATO)
> Sicas® as Interlocking (IXL)
> Axle Counting System Az S 350 U or Track Circuits for Track Vacancy Detection (TVD)
> Eurobalise S21 (COM)
> WLAN-based radio communication (COM)

Refurbishment and Migration
When lines are refurbished, Trainguard MT can be installed as an overlay offering enhanced performance while preserving existing investment and minimising the disruption to revenue service. Thanks to its open system architecture and standardized interfaces Trainguard MT is designed to work with any installed signalling system and rolling stock.

A step-by-step refurbishment starting with intermittent communication which is later upgraded to continuous communication mode is also possible. Headways and the safety of existing systems can be improved by connecting balises to the existing trackside signals to implement Trainguard MT with intermittent communication. As performance requirements rise, Trainguard MT allows cost-effective upgrading to a higher system performance by adding components and subsystems such as WLAN communication for moving block functionality. Headways are reduced and thus transport capacity is increased still further.

### Types of Communication and Levels of Automation

<table>
<thead>
<tr>
<th>Trains</th>
<th>Unequipped</th>
<th>SCO</th>
<th>STO</th>
<th>DTO</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrading Equipment</td>
<td>Continuous Communication</td>
<td>n.a.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
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<td>Intermittent Communication</td>
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<td>+</td>
<td>+</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>Interlocking only</td>
<td>+</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
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### Mode of Operation / Functionality

- **SCO** – Supervision and Control Operation
- **STO** – Semi-automated Train Operation
- **DTO** – Driverless Train Operation
- **n.a.** – not applicable

Comprehensive greenfield solutions.
Efficient refurbishment and flexible migration strategies.
With Mixed Operations on one Track

Trainguard MT minimises investments and offers more flexibility

Trainguard MT – Technical Solution ITC with SCO
Intermittent Communication with Fixed Block
Trainguard MT – Technical Solution CTC with STO or DTO
Continuous Communication with Moving Block
Modular System Setup
Innovative and Proven Components

Trainguard MT integrates tried-and-tested systems and components that have been in service worldwide for many years. Trainguard MT is based on the fail-safe Simis® computers and the proven train control solution LZB 700 M. The system employs Communication Based Train Control (CBTC) and European Train Control System (ETCS) technology. Trainguard MT is compatible with various third-party systems via standardised interfaces.
Scalable Vicos Automatic Train Supervision Systems (ATS)
The Vicos OC 500 and Vicos OC 100 operations control systems provide a wide range of proven Automatic Train Supervision (ATS) functions from the local operator console to the highly automated centralised supervision and control centre.

High-availability Sicas Interlocking (IXL)
Trainguard MT employs the Sicas electronic interlocking system currently in service for mass transit systems and regional railways worldwide. Optionally, Trainguard MT also offers integrated interlocking functionality.

WLAN Communication (COM)
Trainguard MT uses WLAN for continuous communication (CBTC). Since any train control application requires very high system availability, the WLAN system employs various redundancies. The WLAN access points distributed along the track are connected alternately to two independent WLAN routers and overlap each other with their radio coverage. This way, full radio coverage is maintained even if every second access point malfunctions. The WLAN servers are connected with mutual (cross-) redundancy and serve for example a complete line of a metro system, including depot areas.

Balises and Lineside Electronic Unit (COM)
The ETCS-compliant Eurobalise S21 is used for intermittent track-to-train communication. The balise system uses a transmission system that is based on electro-magnetic coupling and data transmission with frequency shift keying. There are two different types of balises:

Fixed-data balises are passive elements for train location without any connection cable. They transmit only fixed telegrams which tell the passing trains their absolute position.

Variable-data balises are connected to a signal via a Lineside Electronic Unit (LEU). The LEU will reprogram the balise telegram every time, the signal aspect of the connected signal changes. This way the variable-data balise will always transmit the current signal aspect.

Precise Train Locating using Radar and Odometer Pulse Generator
The Doppler Radar Sensor measures the vehicle speed over ground by applying the Doppler Effect. This effect causes a frequency shift between the transmitted and the received wave. A digital evaluation method ensures that the speed-output signal is largely independent of the condition of the reflecting ground and of vibrations of the train.

Reliable Track Vacancy Detection (TVD)
The Simis-based axle counting system Az S 350 U serves as a reliable track vacancy detection system.

Ergonomic Human-Machine Interface (HMI)
The ergonomic Human-Machine Interface is the driver’s multifunctional operation console. It combines a high-resolution colour TFT display, touch-screen operation and audio alarms.
Siemens is designing the signalling system for Guangzhou Metro Lines 4 and 5, using Trainguard MT as the automatic train control solution with CBTC technology and intermittent train control as fallback level. Line 4 is 37.8 km long with 10 stations from Huangzhou to Huangge. Line 5 is 31.3 km long with 21 stations from Jiakou station to Wenyuan station. 30 trains will run on Line 4, and 45 trains will run on Line 5 with only 90 seconds headway. Beside the operations control, electronic interlocking and train control system, the project also includes two test tracks and a training centre.

Guangzhou’s University Line has been opened for public in 2005. This line covers a 14 km section of Line 4 and was built within a period of only 16 months. The Trainguard MT train control system is due to start operation in June 2006. Commissioning for Line 5 is planned for 2009.

The project is realised in three stages, demonstrating the scalability of Trainguard MT. In stage one, only interlocking functionality without automatic train protection (ATP) was available. In stage two, ATP functionality with intermittent communication (fixed-block) was added. In the final stage, full moving-block functionality with WLAN radio is introduced, allowing highest performance and shortest headways.

Guangzhou Line 4 and 5 marks a cornerstone in the development of Siemens state-of-the-art-technology, aiding to improve public transport in a growing megacity.
Beijing Metro Line 10 and Olympic Branch Line

Beijing’s Metro Line 10 will also be equipped with the most up-to-date signalling and control system from Siemens. This is the second project in China after metro lines 4 and 5 in Guangzhou to be equipped with the innovative automatic train control system Trainguard MT.

Trainguard MT will make it possible to run trains at shorter headways and adjust operations more quickly to changing passenger volumes.

Line 10, which will also serve the Olympic Park, is about 25 kilometers long and extends from Wanliu in the northwest of the metropolitan area over a total of 22 stops to Jinsong in the southeast. With its four stops and about 6 kilometers of track, the Olympic Branch Line branches off at Xiongmaohuandao Station and heads north in the direction of the Olympic center. Both lines will run completely underground and will commence passenger service in 2008.

This is the first time that moving-block technology in combination with continuous bidirectional data communication by WLAN radio (CBTC) is used in Beijing’s Metro network. Additionally, intermittent communication between the vehicle and the line, based on lineside electronic units and balises, will be installed as a fallback solution.
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The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract.