

# Siemens Transportation Systems —Shaping Tomorrow's Railways

## Innovation and Trust —Basis of Joint Success

Throughout its long history, Siemens has been a major driving force behind the development of successful rail-based transportation systems, delivering a number of important milestones—from the first trackside electric warning bell in 1847 to the magnetic levitation technology seen in first commercial service on the Shanghai *Transrapid* in 2003—all made possible by the Siemens Global Network of Innovation.

Rail solutions from Siemens have always been ahead of their time and the company is proud of its reputation as a trusted partner to operators providing mass transit to main line services worldwide. With access to over 55,000 Siemens design engineers, a central R&D department and a range of synergies between other Siemens' businesses, such as telematics systems, Siemens is well placed to deliver complex customer requirements ranging from system components to turnkey transportation projects.

With proven competence in the fields of rail automation, electrification, mass

transit vehicles, trains, locomotives, turnkey systems, and integrated services, Siemens Transportation Systems (STS) supports customers worldwide in all aspects of rail-bound mass transit and regional and main line transportation. In addition to innovative technology, our portfolio also includes a wide variety of services designed to enhance the flexibility and profitability of customers' transportation systems. Areas of expertise, such as financing, service, maintenance, online spare parts management, system tests and commissioning services in our test facilities, help make Siemens a longstanding and trusted partner.

## Automatic Success

High levels of efficiency, flexibility and adaptability along with the ability to understand and respond quickly to rapidly changing customer and passenger requirements are key factors for success in designing mass-transit solutions.

In addition to expertise in rolling stock and electrification, Siemens has developed a modular train-control system as a wide

ranging, future-oriented product family for providing maximum investment security and migration safety.

We pride ourselves on our track record of not just delivering life-cycle solutions but also in planning these solutions from the long-term perspective. In combination with customized maintenance and service concepts for rolling stock and infrastructure, we effectively and successfully reduce system costs while maintaining and improving availability.

## Shanghai *Transrapid*—30 km in just 7.5 minutes

From pilot status to commercial passenger service in only 3 years—Shanghai's turnkey *Transrapid* airport link demonstrates our capabilities to convert advanced technologies quickly into cost-effective success stories.

Siemens was a joint partner with Thyssen Krupp and *Transrapid* International in the development and supply of the *Transrapid* magnetic-levitation (MAGLEV) high-speed transit system, supplying the traction technology, power supply, operations control and communications systems. The basis of MAGLEV transportation is a wheel-less 'guideway' that requires neither a traction transmission system nor a catenary pickup because it uses magnetic levitation and a linear motor. Since there is no adhesion between rails and wheels, it can achieve very high speeds exceeding 500 km/h along the guideway while producing exceptionally low noise and power consumption levels.

## Paris metro (RATP)—greater appeal through greater capacity

The fully automated Véhicule Automatique Léger (Val) operations on Line 14 of the Paris metro deliver better passenger loads during peak and off-peak periods, resulting in improved passenger satisfaction levels.

Developed by STS and introduced in 1983, the Val is the world's first fully automated



Shanghai *Transrapid* MAGLEV system

(STS)

light metro without an on-board driver or guard—the entire system is supervised just by several operators in the control centre. The system is being upgraded continuously to provide increasingly higher levels of comfort and safety, and today's new Val 208 and Val 258 carriages are the ideal transportation solution for cities and airports.

Some benefits of the Val are summarized below:

- Capacity of up to 30,000 passengers per hour in each direction
- Service speed of better than 35 km/h
- Speeds up to 80 km/h
- Headway of less than 1 minute
- Higher comfort and safety levels
- Reduced energy consumption
- Low life cycle costs

### New York City subway—built-in security

Siemens has provided the New York City subway with an extensive network of CCTV monitoring, automation and I&C technologies called RailCom Manager to improve security for passengers, trains, tracks, and stations. RailCom Manager is the first communication management system of its kind to provide access to all information, communication and monitoring systems via a single, integrated user interface. It is the culmination of Siemens' many years of global experience in developing public address (PA) systems, customer information screens (CIS), closed-circuit TV (CCTV) surveillance, help-point intercom (HPI) emergency call stations, and supervisory control and data acquisition (SCADA) solutions for rail-related communications. In its baseline version, RailCom Manager features:

- Scalability for small-to-large communication systems
- Adaptable modular design for many requirements
- Easy configuration, modification and expansion
- Adaptable architecture and topology

- Compatibility with all interface standards
- Flexible retrofitting
- High safety and reliability
- Good cost-performance

Depending on requirements, RailCom Manager can be integrated with Automatic Train Supervision (ATS) and other passenger information systems, providing timetables and real-time information on train location. It is being enhanced continuously with additional capabilities to enable operators to react rapidly to unexpected events, including unauthorized persons on tracks, and even provides operators with effective response procedures.

### Houston light rail transit—one-stop turnkey solutions

This turnkey project revitalized light-rail transit in Houston, creating both an attractive mass-transit alternative and a faster way to get around the city.

The 12-km long system started operation in January 2004 using the Siemens Avanto/S70 with a top speed of 105 km/h for speedy access right into the city centre. The multi-system Avanto/S70 carriage design is adaptable to different platform heights and the low-floor entrance of about 350 mm is the best height for flexibility. The Avanto/S70 guarantees easy boarding whether from street level, from a simple street platform in a downtown area, or from platforms of main intercity lines. The comfortable car interior creates a friendly impression, enhanced visually by the continuous 70%–80% low-floor step-less area and facilitating access to the comfortable seats—an advantage for older people, children, wheelchair users and people with baby carriages.

### Madrid de Metro—going easy on budgets and resources

The Sitras SES energy storage system developed by Siemens and used on the

#### Avanto/S70 Data

Three-car articulated low-floor vehicle for uni/bidirectional operation

Track adhesion	66% approx.
Wheel arrangement	Bo'2'Bo'
Track gauge	1435 mm
Length over coupler	26.5 m
Width	2400 and 2650 mm
Height over TOR	3520 mm (pantograph down)
Max. axle load	166 uni/169 bi
Capacity (at 4 people/m <sup>2</sup> )	83 uni/64 bi
Max. speed	105 km/h
Catenary voltage	600/750 Vdc
Traction motors	4 × 200 KW at 2500 rpm (IEC 349-2)
Wheel diameter	660 mm/580mm (new/worn)
Minimum curve radius	20 m
Minimum vertical radius	>250 m
Converter	2 × IGBT-PW Minverter
On-board power	24 Vdc, 3-phase 460 Vac, 60 Hz
Low-floor ratio	70%
Aisle width	600 mm
Door height (clear)	2100 mm

**Prague Metro Technical Data**

Train configuration	MC+M+M+M+MC
Wheel arrangement	Bo'Bo'+Bo'Bo'+Bo'Bo'+Bo'Bo'+Bo'Bo'
Carriage body	Aluminium
Track gauge	1435 mm
Length over couplers	96.99 m
Carriage width	2712 mm
Floor height over TOR	1150 mm
Wheel diameter	850 mm
Tare weight	140 tonnes
Total weight	250 tonnes
Max. axle load	12.6 tonnes
Number of seats	224
Train capacity at six people/m <sup>2</sup>	1154
Passenger doors per car	Four each side
Min. curve radius	300 m
Max. grade	4%
Max. speed	80 km/h
Line voltage	750 Vdc
Power supply	Third rail
Main service brake	Self-excited regenerative/rheostatic
Secondary service brake	Electropneumatic disc

Madrid de Metro combines economic and ecological benefits by using regenerative braking to help stabilize the power-supply system, reducing power consumption and offering higher availability. Field tests showed that average power consumption per train is reduced by 50 kW, permitting 30% cuts in substation requirements and lowering both maintenance costs and CO<sub>2</sub> emissions. For light-rail operators, the Sitras SES energy storage system also offers the important advantages of reduced voltage losses and auto-switching between energy-saving and voltage-stabilizing modes. Advanced double-layer capacitors (DLCs) with an extremely large surface area packed into a 500-ml volume ensure a very high capacitance of 2400 farads. By using some 1300 of these capacitors, the storage system is optimized in terms of the output and energy content balance.

**Prague metro—top quality with high local content**

Teamwork between our sales and project teams, local partners and local manufacturers led to successful production of the new M1 cars at Siemens' Prague plant, providing a high level of local content and local delivery.

In 1995, the first series of modern M1 heavy rail vehicles was awarded by the Prague metro (Dopravní podnik hl.m. Prahy) to a Czech–German consortium centred around CKD Dopravní Systémy (CKD DS). The contract called for the supply of 22 five-car units with Siemens carrying responsibility for the electrical parts. All the cars were motorized in order to meet the high performance requirements of metro operation. Ultramodern SIBAS 32 traction control and IGBT converters ensured the tractive power and high availability of these trains. The success the first series led to a follow-

up order for 20 five-car units with Siemens Kolejová vozidla (SKV), which had taken over the fixed assets of CKD DS.

**Vienna ultra-low-floor (ULF) tramcars—unbeaten by none**

The Vienna Transport Authority (Wiener Linien) operates the largest fleet of trams in the western world and the majority of its 1000 tramcars were supplied by STS (see *JRTR* 38, pp. 30–40). With the world's lowest step height of just 19 cm, the ultra-low-floor (ULF) tramcars provide easier and speedy boarding and alighting for passengers almost on a level with the road surface, eliminating the need for an awkward step up or expensive platform adjustments. And the 100% low floor throughout provides barrier-free passage for wheelchair users, baby buggies, etc. Drivers appreciate the fully air-conditioned cab too. After the success of two prototypes, the first 150 ULF carriages were ordered in 1997 to modernize the fleet. The ULF trams have become an integral part of Viennese city life as demonstrated by the delivery of car number 100 to the operator in early 2003.

The key characteristics are as follows:

- World's lowest step height of 19 cm
- Level floor throughout



Vienna Transport Authority's 100% ULF tram (STS)

- Radially adjustable single-wheel bogies for optimal running characteristics
- Air-conditioned driver's cab

### Bangkok MRTA—record growth

Siemens is supplying the mechanical and electrical equipment for Bangkok's first subway (MRT Chaloem Ratchamongkhon Line) to the Metropolitan Rapid Transit Authority's (MRTA) concessionaire, Bangkok Metro Company Limited (BMCL). Revenue service started in 2004 with 17 three-car units just 24 months after the turnkey system contract was signed. This project continues Siemens' successful local partnership in mass-transit systems that started with *SkyTrain* in 1999. The rolling stock was developed in cooperation with Porsche Design.

### Malaysia Express Rail Link (ERL)—proven a million times

This fast, but attractive and environment-friendly alternative to buses and taxis runs 57 km in just 28 minutes between Kuala Lumpur City Air Terminal and Kuala Lumpur International Airport (KLIA). It offers two services—the *KLIA Express* and *KLIA Transit*, which have already provided over 1 million passenger-km of service (see *JRTR* 35, pp. 21–27).

Siemens headed the consortium and was responsible for project management, track works, equipment for depots and workshops, signalling, automatic train control (ATC), telecommunications, building electrical and mechanical services, catenary power, SCADA, and carriages.

#### Bangkok MRTA Technical Data

Train configuration	MC+T+MC
Wheel arrangement	Bo'Bo'+2'2'+Bo'Bo'
Carriage body	Stainless steel
Track gauge	1435 mm
Length over couplers	65.1 m
Carriage width	3120 mm
Floor height over TOR	1160 mm
Wheel diameter	850
Tare weight	107 tonnes
Gross weight	175.4 tonnes
Max. axle load	15.4 tonnes
Number of seats	126
Train capacity at six people/m <sup>2</sup>	886
Passenger doors per car	Four each side
Min. curve radius	190 m
Max. grade	5%
Max. speed	80 km/h
Line voltage	750 Vdc
Power supply	Third rail
Main service brake	Self-excited regenerative/rheostatic
Secondary service brake	Pneumatic wheel disk

#### Malaysia ERL Technical Data

Stations	<i>KLIA Express</i> : 2 <i>KLIA Transit</i> : 5
Carriages	Desiro
Max. speed	160 km
Headway	30 minutes <i>KLIA Express</i> 15 minutes, <i>KLIA Transit</i> every



Malaysia's ERL air-rail link

(STS)

**Features of Carriages for Desiro UK**

**Appealing and comfortable interior design**

- Standardized furnishings
- Large windows for brightness and unobstructed view from all seats
- Hard-wearing, easy-to-clean surfaces
- Large, strong and easily accessible luggage racks with optional integrated seat lighting
- Pleasant air-conditioned multifunctional and special-purpose compartments
- Low noise levels
- Good ride comfort
- 100% level floor
- Open gangway between carriages
- Wide door and aisles for good passenger flows
- Generous seat spacing in inter-car gangway
- Contoured comfortable reclining seats with armrest option
- Customized seating layouts with tables
- Barrier-free layout

**Information systems**

- State-of-the-art passenger information system with clear views from all seats
- Clear PA announcement systems

Operating profitable cross-border rail services is still a challenging area for train operators where interoperability requirements are particularly difficult.

In Europe, the Siemens' multi-system (MS) *EuroSprinter* supports international passenger and freight service based on its strong design support for the European Train Control System (ETCS) standards and future adoption of the Europe-wide European Rail Traffic Management System (ERTMS) combining ETCS and the enhanced Global Systems for Communications (GSM-R). Our TRAINGUARD product family simplifies the work of bringing a train-control system into conformance with the ETCS Level 1 and 2 standards, providing operators with the benefits of modular components, and easy upgrading of rolling stock and infrastructure matching individual requirements.

Moreover, our activities in train-control systems are not limited to Europe and we are currently developing a similar system for Chinese Railways called the Chinese Train Control System (CTCS).

***EuroRunner*—the quiet locomotive**

Siemens latest *EuroRunner* DE locomotives for passenger and freight

**Desiro UK—right on time**

The Desiro UK train tested and commissioned in our renowned Wegberg-Wildenrath Test Facility is delivering improved performance and comfort for rail passengers in the UK and Ireland using both EMU and DMU Vmax configurations. The first Desiro UK order came from Angel Trains Ltd., the world's biggest leasing company for passenger trains. These trains will operate throughout the entire Greater London system, which means they can run on both voltage systems and can still be adapted to satisfy individual operator requirements.

and the ICE 350 E (or *Velaro E*) for the AVE high-speed line of Spanish National Railways (RENFE). Running at 350 km/h to connect Madrid and Barcelona in just under 2.5 hours, the *Velaro E* is presently the world's fastest production train. But not only is the *Velaro E* fast, it provides a good balance of profitability for operators and comfort for passengers.

**Comfortable Fast Cross-border Travel**

In these days of severe modal competition, fast, comfortable, punctual trains and good customer service are critical for passengers' acceptance of trains. These are all areas where Siemens has demonstrated considerable success with its ICE-3 for Deutsche Bahn AG (DB AG)



*Velaro E* high-speed train set for RENFE

(STS)

**EuroRunner RH 2016 for Austrian Railways (ÖBB)**



Diesel rating	2000 kW
Continuous rating	1600 kW
Starting tractive force	235 kN
Maximum speed	140 km/h
Weight	80 tonnes
Track gauge	1435 mm

services are based on the *EuroSprinter* concept and offer lower fuel consumption, reduced emissions, and quieter units with speeds up to 160 km/h, ratings up to 4200 kW and axle loads up to 20 tonnes. Since the first locomotive was delivered to Austrian Railways (ÖBB) in 2002, a second variant has already been delivered from our Munich locomotive works for Hong Kong. *EuroRunner* locomotives will also be part of the Siemens Dispolok GmbH fleet described later in this article.

**Harbin–Dalian Electrification Technical Data**

**General**

Completion date	2002
Route length	950 track-km
Max. speed	200 km/h

**AC Traction power supply**

Nominal voltage	25 kV; 50 Hz
Substations	17

**Catenary**

Type	Re200C
Supports	Aluminium



Electric four-system high-performance locomotive ES64F4 for Siemens Dispolok GmbH, Germany (STS)

**Chinese Railways electrification —partner for projects of all sizes**

In the world's largest electrification project covering 950 track-km from Harbin to Dalian in China, Siemens supplied the components for the catenary line and the substations and was responsible for the project engineering and management.

**Cologne–Rhine/Main high-speed line—setting pace for Europe**

The 204-km high-speed link between Cologne and Frankfurt completed in 2002 halved travel times and created a major route within the Trans-European Network (TENs) system. As well as electrification, Siemens' role as a turnkey partner included project management, interlocking technology, LZB continuous (inductive)

**Cologne–Rhine/Main High-speed Line**

Delivery period	1996–2002
Route length	204 km
Stations	3
Max. speed	300 km/h
Services	8 trains per hour in each direction

ATC system, telecommunication equipment and remote monitoring.

The new line connects two of Europe's most important economic regions—the metropolitan areas of Rhine/Ruhr (Cologne) and Rhine/Main (Frankfurt). The high-speed ICE-3 trains run at speeds of 300 km/h, cutting the journey time to just 59 minutes over a line featuring special track parameters, such as a 40‰ grade.

**Heavy Locomotive Rental —Dispolok GmbH**

In 2001, Siemens established Siemens Dispolok GmbH to lease advanced Siemens locomotives to European freight operators, permitting them to achieve maximum traction with minimum tied-up capital. Typical locomotive classes include the *EuroSprinter* ES64F4 multi-system locomotive for cross-border traffic between Munich and Verona.

Further details of lease contracts, etc., can be found at [http://www.dispolok.com/index\\_en.htm](http://www.dispolok.com/index_en.htm). ■

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