Cross-Acceptance of Signalling Systems - The Myths and the Reality

Written on behalf of the International Technical Committee,

by Wim Coenraad

The IRSE International Technical Committee produced their first report more than ten years ago. In this first report the fundamentals of safety appreciation procedures as a basis for cross-Acceptance were addressed. In the meantime CENELEC has produced a number of European norms for safety applications within the railway industry and some CENELEC safety standards for railway signalling are now in force for IEC standards in the context of globalisation.

However, experience shows that the processes for the approval of safety cases and the associated certification of applicable equipment are still not unified within Europe and thus Cross-Acceptance is not common practice.

Within some countries Cross-Acceptance is already practised, but elsewhere the introduction of a system already approved in another country requires an almost completely new approach to the safety case. Provision of documentation ranges from requiring as much as possible, to as little as practicable.

The IRSE wishes to encourage a culture of new signalling technology application which can be recognised internationally by manufacturers, safety authorities, consultants and railway operators, and to develop processes whereby Usage in national railway organisations is made much easier in order to achieve rapid deployment.

A sixth report from the ITC has examined current (cross-) acceptance processes in various countries to establish both the strengths and weaknesses that exist, and, from this, to produce a best practice 'code of conduct' to operate in the future.

The reader needs practical help into what is required and the pitfalls that can be encountered. The suggested practices should be used by safety authorities, operators and suppliers to achieve a common understanding. They should help the design and installation of new signalling systems to a common standard across many countries.

1 HISTORY

Signalling is a prisoner of history in that operating rules evolved "without any synchronisation" within countries and signalling philosophy was designed to fit the operating rules. Whilst the higher order rules are essentially similar, the rules at application level are different between countries, and whilst some are similar, no two countries are exactly the same.

With most countries having their railway system under state control, the price pressure to reduce the cost of new signalling systems was not as intense ten years ago as it is now. Signalling supply companies enjoyed a comfortable market and could make reasonable margins.

This 'cosy' state of affairs has had to change for seven main reasons:

- The growth of the high-speed train networks, particularly in Europe, offering seamless travel across borders;
- The higher speeds of trains have forced the need for in-cab signalling systems;
- The privatisation of railways and the consequential demand for 'better value for money' has triggered a need to contain and reduce the cost of signalling systems;
- The globalisation of the signalling industry because home markets were no longer able to sustain a profitable business;
- The encouragement by the EU to develop a standard signalling system for the future;
- The divergence of ownership in some countries of infrastructure from train operations and the granting of usage rights to other train operators as a means of stimulating competition;
- The emergence of the 'safety case culture', which has driven up the cost of system acceptance procedures.

2 MANAGING THE DEVELOPMENT CYCLE

The increased complexity of systems puts a strain on the development resources of the supply industry. Innovation cycles in technology are getting shorter and shorter. The resources required by the safety case, assessment and acceptance processes are immense. There is a real risk that technology is obsolete by the time it reaches the market and suppliers will not be able to afford to stay in this business.

The demand for faster project implementation and lower costs means that interoperable systems are needed to give better performance at a lower price, with technology common to several countries.

3 CROSS-ACCEPTANCE TO THE RESCUE?

The time to market must be improved and the cost of system acceptance lowered dramatically if infrastructure owners and safety authorities are able to accept, without further additional investigation, systems that have been accepted for the same purposes elsewhere by another authority. The European directives for high speed and conventional rail already mandate this concept, known as cross-acceptance. It is also endorsed by the European Railway Agency (ERA).

It is widely felt that independent safety assessors and safety authorities need guidance in applying the principles of cross-acceptance.

The IRSE should offer guidance on cross-acceptance to parties involved in cross-acceptance projects such that a common understanding of the rules is achieved. The IRSE ITC report No.6 shows how the principles of Cross-Acceptance can be used to contain the cost of system acceptance by avoiding unnecessary and unproductive repetition of effort.

The report identifies principles and processes for Cross-Acceptance of signalling products that should be adopted by railways and safety authorities.

4 DEFINITION OF CROSS&ACCEPTANCE

The concept of Cross-Acceptance is that "if a technology/system operates safely and reliably in one country, then it should be able to do so in another country without the need for back to basics approvals".

Cross-Acceptance is defined in EN 50129 as "The status achieved by a product that has been accepted by one Authority to the relevant European Standards and is
acceptable to other Authorities without the necessity for further assessment”.

Cross-Acceptance should also be applicable if recognised accepted standards other than European standards are used. Cross-Acceptance can be applied to subsystems or parts of products as well. Cross-Acceptance is not only technical, it is also a matter of political and commercial will, trust and engagement, strongly conditioned by the national regulatory framework.

This article deals with “voluntary” Cross-Acceptance, i.e. not regulated by the European directives 96/48/EC and/or 2001/16/EC.

5 WHY IS CROSS-AcCEPTANCE NOT YET COMMON PRACTICE?

If the economic advantages of cross-acceptance appear to be so obvious, why is it so difficult to achieve in practice? The acceptance processes for railway technology are similar across Europe. In almost all countries the safety authority is either the Ministry of Transport, or an independent organisation closely related to that Ministry. The system and design authority for generic products is the supplier; for generic applications it is either the railway itself, or the infrastructure provider.

The supplier prepares product related safety cases. For generic applications it can be the task of the supplier or the infrastructure manager / railway. In most cases independent safety assessors are employed to verify the safety cases.

Accepting the safety case and system acceptance is the responsibility of either the ministry of transport or an independent safety authority. The infrastructure manager / railway can accept the safety case but needs approval from the safety authority that a system be accepted for use in service.

Analysis of existing cross-acceptance practices

Cross-Acceptance of generic product platforms for safety systems including related software e.g. the operating system, pose the least problems. Design strategies and system architectures for processor based systems in signalling applications are well established and there is a consensus on their acceptability, which is reflected in EN 50128 and EN 50129.

The situation is very different at the application level. For historical reasons, rules and regulations of seemingly similar functions vary widely across the various railways, which necessitates different application designs for each country and/or railway. In countries that report Cross-Acceptance of each other’s systems e.g. Germany, Austria and Switzerland, similar operating rules and practices exist!

How did this situation evolve?

In the past, countries with a large technical capability developed new products supporting their own Railways and their Signalling industries. National standards were created within this development process, which contributed to the creation of significant barriers for product Cross-Acceptance between countries.

Countries without their own signalling industry have a more flexible approach to accepting technologies and products from other countries. A logical process of Cross-Acceptance has evolved based on quality guarantees (including safety) and proven experience of the products. This process can result in trials of the generic product, which may then be altered to achieve the specific requirements of the country.

It is apparent that as well as signaling applications, the approval processes are not interoperable, despite indications that the approval processes in almost all countries are essentially similar. Most countries insist on independent approval of the design and functional performance before new systems are introduced into service to prove compliance with local operating rules.

The European Commission rules for new systems require procedures to be in place that enable a universal use of the same standardised product provided by the supply industry. These products require a common Functional Specification to cover the technical aspects and also to try and obtain harmonised operational procedures including Safety Regulations. The suite of CENELEC Standards are seen as the foundation for all of this.

Formal Cross-Acceptance to achieve interoperability is limited to European high-speed lines and conventional lines across international boundaries under the directives 96/48/EC and 2001/16/EC. The Notified Bodies for the work are defined. Elsewhere, Cross-Acceptance will be encouraged by the ERA.

Two arguments predominate in this respect:

- Differences in system functionality and/or rail operations:
  - A minimum system functionality to set down the essential features of railway operation has never been defined by the railways. This relates to operation control centres, interlockings, level crossings, and block systems;
- Differences in rail system conditions: Non standardised power supplies, earthing concepts, installation processes, electrification standards, specific rules for signal sighting, etc. lead to difficulties in Cross-Acceptance of components for train detection devices, point machines, interlockings and signals.

These two arguments will remain an issue unless railway rules and regulations, together with national railway legislation can be harmonised towards a common European perspective.

To help this harmonisation goal, the EU has since set up the ERA and sponsored the SAMNET and SAMRAIL projects to achieve a greater common set of operational rules, safety targets and common safety methods.

6 HOW CAN CROSS-AcCEPTANCE BE ACHIEVED?

A sensible process for cross-acceptance needs some basic rules and responsibilities:

- Product certification is required for platforms, systems, subsystems and components on a generic level;
- Product certificates aid the process of Cross-Acceptance, with evidence of prior independent and impartial evaluation of a product, plus the conditions and limitations under which the certificate is valid on a generic level;
- The supplier produces the safety case for generic products (see EN 50129);
- The supplier / infrastructure manager / railway company produces the safety case for generic use;
- An independent body assesses the conformity with all requirements (including safety case) and issues the certificate;
- The railway company or infrastructure manager accepts the product and its certificate;
- The safety authority approves the safety case and / or other evidence of “fitness for use” and authorises the railway company or infrastructure manager to start using the product in the “live railway”.

A successful systems acceptance process will result in a certificate or an approved safety case for a product being issued. Cross-Acceptance of an approved product will be proposed by a supplier to a
client. This client, usually a railway organisation or infrastructure manager, will seek safety approval by the relevant safety authority. To achieve this, a safety case must show that the existing certificate (or approved safety case) is approved at a generic level. In short, the "case for cross-acceptance" will have to prove that all requirements of the new application are covered by the existing "cross-accepted safety case", that all assumptions, pre-conditions and ensuing application requirements underlying the original certificate or acceptance are embodied in the new "application" and that the body that issued the original certificate is known and trusted.

**Conditions for Cross-Acceptance**

Any form of Cross-Acceptance has to embrace the ultimate need of being able to ensure that the system being introduced is safe in itself and in its considered application.

For successful Cross-Acceptance the following must be considered:

**Operating environment**

A system can only be considered safe when it fulfils the requirements of being fitted to the particular operations and physical constraints for which it will be used.

**Physical constraints**

If the physical constraints are not the same, do they affect the safety case? (e.g. temperature range, access for maintenance, speeds, train frequency, radio coverage, effects on timing, latent fault detection, etc.). Power supplies and the Electro-Magnetic Compatibility environment must also be taken into account.

**Traffic**

The nature and density of the traffic will dictate the level of risk associated with failures of the equipment both in terms of severity and its probability. An example is the interlocking used on a single-track freight only railway versus a heavy metro. Both could use the same interlocking design but would need a different generic application safety case.

**Culture**

How the system will be operated, the adherence to operating rules, the level of training of the operational and maintenance staff, etc. can affect the requirements for the system. The system must be designed for day to day usage by the operators and maintainers. The assumptions built into the original design must be explicit.

**Rules**

Any new rules associated with a new system and use of the old rules, both written and tacit, need to be considered. The rule set assumed in the original design, and any need to change the rules, must be made explicit.

**Neighbours**

The new system must be compatible with the environment into which it will be introduced such as physical and operational interfaces to neighbouring railways, modes of transport, emergency services, etc.

---

**Requirements for Cross-acceptance**

The requirements for Cross-Acceptance of a system or product can be summarised as:

- The system has been shown to meet the standard of safety prescribed;
- The required safety standards are sufficient for the particular application;
- The assumptions made in the original proof of safety are valid for the new system;
- All external factors that could invalidate the assumptions have been considered;
- The safety authority cross-accepting a product must be confident of the independence and expertise of the earlier acceptance;
- The existing acceptance must be documented to show that no pre-conditions, assumptions or other factors exist that would impose restrictions on the new product;
- All existing documentation must be made available to the cross-accepting safety authority. Issues of Intellectual Property Rights can be settled by using Non-Disclosure Agreements;
- If a safety case certificate is withdrawn or if problems with the product arise, the supplier should inform customers and safety authorities of the product on this certificate.

---

**7 THE CROSS-ACCEPTANCE PROCESS**

The process is illustrated in the process diagram (left) which shows how a product is eligible for Cross-Acceptance.
Weighing the Balance between Technology Transfer and Market Admission

China RailWorld Summit 2006

Oct.19th & 20th, 2006 | Shangri-la Hotel Beijing | China

Features

- Three ministerial government authorities including Ministry of Railways, National Development and Reform Commission and Ministry of Construction show great support to the event.
- Two specially designed streams focusing on the emerging High-Speed Rail and Rail Financing
- One exclusive project briefing led by China’s Ministry of Railways to get to the heart of major rail projects in China
- Exploring various capital market products to facilitate rail financing following Daqin’s successful IPO
- Gaining insight into world’s rail engineering marvel Qinhai-Tibet Rail Line

The Eminent Speaker Panel includes:

Chen Zhihong, Deputy Director General of Development and Planning, Ministry of Railways, PRC
Li Guoyong, Deputy Director General of Transportation, National Development and Reform Commission, PRC
He Huazhu, Engineer in Chief, Ministry of Railways, PRC (invited)
Liu Gang, Director, Equipment Department of Transportation Bureau, Ministry of Railways, PRC
Qin Guodong, Deputy Director, China Metro & LRT Research Center, Ministry of Construction, PRC
Wang Daxing, Chairman, Beijing Subway Corporation Ltd
Wang Hao, General Manager, Beijing Infrastructure Investment Co., Ltd
Luo Furong, Vice General Manager, Beijing Railway Construction and Management Co., Ltd
Li Jincheng, Chief Designer of Qinhai Tibet Rail Line, First Survey and Design Institute of the Ministry of Railways, PRC
Feng Aijun, Secretary General, Promotion Committee of Urban Rail Technology
Zhang Zhiqiang, President, Siemens (China) Communications Group
Jack Short, Secretary General, European Conference of Ministers of Transport
Ludwig Boelkow, Director of International Business Development, Deutsche Bahn AG
Antonio Berrios, Director for Technology Innovation, Administrador de Infraestructuras Ferroviarias (ADIF)
Mannohar Parkash, Transport and Communications Division, East Asia Department, Asia Development Bank
John Duffy, Director for Asia, HSH Nordbank
Justin Smith, Managing Partner, Blake Dawson Waldron
Helmut Baehr, Director International Transport Department, OBERMEYER Planen+Beraten
Helmut Gehnen, Chief Representative, Transrapid International

Is China worthwhile your investment? Definitely
Can it make money in China? Absolutely
How to make money in this emerging rail market?

Join us for this highest-caliber rail event in China responding to a growing market of USD 250 billions by 2020

Jointly-Organized by

Presenting Sponsor

Co-organized by

Official Supporter

Supporter

Endorsor

Media Partner

For registration or further inquiries, please contact the Organizing Committee:

Event Website: www.chinaraillworld.com Tel: 86-21-68407631 Email: info@chinaraillworld.com
Confidence in the authority

For cross-acceptance to be successful, a safety authority must be able to rely on the prior acceptance on the original product assessment and the independence, impartiality and competence of whoever carried it out. The original assessment may have excluded certain aspects or requirements that will be relevant to the new use of the new system. However, if cross-acceptance was intended from the beginning, the original assessment should give wider frameworks than those existing in the country of first prior acceptance.

If the new safety authority is uncertain of the original assessor’s competence, then it must audit that original assessor, or evaluate and assess any particular issue found to be lacking.

Examples of “cross-acceptable” Safety Cases

A product is eligible for cross-acceptance if one or more of the following conditions are met:

- A safety case conforming to EN50129/EN 50128 exists and an Independent Safety Assessor (ISA) has issued an assessment report that supports this claim. If the ISA is also a Notified Body or if relevant accreditation by a recognised body (e.g. UKAS, OAR, Raad voor de Accreditatie) or a national safety authority already exists, this may be sufficient evidence of the ISA’s competence and impartiality;
- A safety case conforming to an older standard exists2, this being acceptable to the cross-accepting authority and the product has been authorised for in-service use by a national safety authority;
- A product can be demonstrated to have grandfather rights, i.e. it has a proven safety record obtained by a substantial number of years of safe operation.

Cross-Acceptance can be applied to subsystems that have been approved in a similar manner. The safety authority should check that all assumptions, pre-conditions and limitations upon the prior acceptance, still hold good and can be demonstrated to be valid in the context of the proposed usage.

Factors complicating Cross-Acceptance

Cross-Acceptance requires a common set of references between the authority accepting the cross-acceptance request and the authority that issued the original certificate (approval). A safety case conforming to CENELEC standards EN 50128 and EN 50129 facilitates this. However, as there are no standardised safety targets between railways, safety authorities may find it difficult to cross-accept safety cases even if designed and assessed to the highest safety requirements. It is hoped that the work on common safety targets and safety methods in SAM RAIL and SAMNET will address this issue.

Cross-Acceptance rules need to be understood by suppliers, customers and safety authorities. Rail infrastructure companies may not have the technical expertise that once existed and will often employ consultant engineers to do this technical assessment. Some consultants may see an opportunity for obsessive adherence to the acceptance criteria, thus increasing the time-scale and the cost of the work.

Most product development is evolutionary in nature. Therefore safety cases contain references to evidence that; pre-date the EN 50126 - 50129 standards.

If a product is to be Cross-Accepted, care should be taken that all hardware and software versions are identical to those of the original certificate. Should the supplier wish to supply a newer version of its product, the existing certificate may be invalid and therefore Cross-Acceptance would not be possible. In some cases it would be wiser to apply for Cross-Acceptance of the existing product and introduce modifications subsequently.

If the railways do not have fully documented signalling principles, codes of practice etc, assumptions relating to design, system layout and maintenance practices may not be explicit. The safety practices, work methods and maintenance regimes of one railway or infrastructure operator may be deemed too trivial to require documenting.

In another culture these may not be trivial at all and hence could be overlooked. An example of this is the multitude of designs for level crossing protection and their interfacing with the interlocking and lineside signals. It is relatively difficult, even for experienced signal engineers from other countries, to understand all the implications. Documenting and reporting of in-service experience, reliability data and incident reports still differ greatly between railways and as yet there is no obligation to inform suppliers and others of these factors3. This situation might change when a new EU directive regarding railway safety comes into force.

1 The Independent Safety Assessor is not a protected title, hence, ISAs undertaking cross-acceptance work are required to be formally accredited.
2 e.g. MU 8004
3 Increasing concern regarding criminal and product liability may even discourage this openness further.
8 CONCLUSIONS

- Cross-Acceptance of Signalling systems and equipment between countries should become essential to combat the severe criticism levelled at the profession that signalling equipment is too expensive and takes too long to implement;
- With the ever increasing costs associated with system development and acceptance, Cross-Acceptance will become a condition sine qua non;
- Unless operational rules and procedures can be harmonised, Cross-Acceptance may be limited to generic products. When a generic product can be applied in a number of generic applications considerable savings are possible if these could be cross-accepted as well;
- Other industries, such as air transport and telecommunications have shown that Cross-Acceptance and universal acceptance of products and rules can be applied successfully on an international basis;
- The responsibilities for safety enforcement, design, safety case preparation, assessment and acceptance amongst the various countries are remarkably similar and thus the conditions for Cross-Acceptance could be made considerably easier;
- Commercial aspects relating to Cross-Acceptance must be understood and realised. The signalling industry should cease to pander to historic practices and work towards a suite of products with a high level generic commonality together with a listed range of options appertaining to specific application / operational rules of the various countries that form the main customer base.

9. RECOMMENDATIONS

All parties within the Railway industry should be encouraged to:

- Adopt a policy to develop modular systems in which the different requirements of individual customers can be configured;
- Produce methods, tools, and interfaces to achieve a common basis for process and requirement description and an easier adaptability of units from different suppliers;
- Universally accept CENELEC standards EN 50126 to 50129 and/or the relevant IEC standards, and any subsequent derivatives or additions, as the basis for signalling system development and supply in the future;
- Existing documentation, including the full safety case, the assessment report and the certificates (or approvals) issued, must be made available to the cross-accepting safety authority. Intellectual Property Rights can be protected by using Non-Disclosure Agreements;
- If a safety case certificate is withdrawn or if problems with the product arise, the concerned supplier should inform all customers, safety authorities and assessors that may have based their acceptance of the product on this certificate;
- If a product is to be proposed for Cross-Acceptance, all hardware and software versions should be identical to those of the original certificate;
- Independent Safety Assessor is presently not a protected title. Unified procedures for the qualification and supervision of ISAs, comparable to those applying to Notified Bodies are recommended;
- In-service experience of accepted systems should be made available to facilitate Cross-Acceptance. This is especially important where Cross-Acceptance has to be based on "Grandfather rights".
CHINA INTERCITY RAIL SUMMIT 2006

September 7th and 8th, 2006     Grand Hyatt Shanghai, China

High Level Exposure to 300+ Powerful Decision Makers!  
Do Business with Ministry of Rail, PRC and  
Project Teams of the Three Biggest China Intercity Rail Networks!
It is one 45 Billion US Dollars VERY FRESH market here in China!

Distinguished Speakers

LV Chengping  
Deputy General Secretary  
CHINA RAILWAY SOCIETY

Lin Liangpeng, Director  
SHANGHAI RAILWAY BUREAU

Jung Min Yoon  
General Director of Engineering  
SEOUL METROPOLITAN RAIL Transit Corporation

Patrick K. Cuadle  
President and CEO  
ALASKA RAILROAD CORPORATION

Marc Chamberlain, Senior Vice President  
ASIA PACIFIC REGION  
ALSTOM TRANSPORT

Lewis Ames  
Senior Program Management Analyst  
SAN FRANCISCO MUNICIPAL TRANSPORTATION AGENCY (MUNI)

Key Issues

- Policy Trend for Intercity Rail Sector  
- Intercity Rail Network Development  
- Planning and Integration of Intercity Rail Transit  
- Investment Opportunities in China  
- Privatization of Intercity Rail in Asia  
- Hi-Tech Solutions of Intercity Rail  
- Briefing of China Intercity Rail Projects

Yang Jianming, Deputy Chief Engineer  
MINISTRY OF RAILWAY, PRC, CHINA

Yang Yibing, General Manager  
PEARL RIVER DELTA INTERCITY RAILWAY COMPANY

Gu Cong, General Manager  
CHINA RAILWAY INVESTMENT CO.

Jin Bajun, Deputy Director  
EAST ASIA AND THE PACIFIC REGION,  
WORLD BANK

Michel Quettier, Chairman  
THE REGIONAL AND SUBURBAN RAILWAYS COMMITTEE OF CERP

Gao Jingwei, General Manager  
CHINA RAILWAY ENGINEERING CORP.

Fan Peizhong, General Manager  
CHINA RAILWAY CONSTRUCTION GROUP

Derek Bola, General Manager & Vice President, China  
SIEMENS TRANSPORTATION SYSTEMS

Organized by

Supported by

Endorsed by

Support Media

Official Media

www.globaleaders.com
Railway Signalling has always been an interesting and highly diverse engineering field. It encompasses safety critical systems such as the Interlocking and Automatic Train Protection (ATP) systems that safeguard train movements; and control systems like the Automatic Train Supervision (ATS) and Automatic Train Operation (ATO) systems that relieve the operators from repetitive work and allow them to focus on assuring a committed headway could be met. The study of these systems is challenging and highly rewarding.

With the Thorowgood scholarship from the Institute of Railway Signal Engineers (IRSE), I was able to embark on a study tour in May 2005 of these signalling systems and get a first-hand appreciation of their application in the metros and railway systems of Paris and London.

The RATP Paris Metro is Europe’s fourth oldest metro system after London, Glasgow and Budapest. Paris Metro consists of 16 lines, identified by the numbers 1 to 14, with two spur lines 3b and 7b. These two are branch lines split off from the original lines 3 and 7. The system has a total route length of more than 200km.

Trains running in the system are formed by 5-car (on Lines 1 to 13) and 6-car (on Line 14) consists. Traction power is fed to the trains via a 750V DC third rail. Rolling stocks on five of the lines (i.e. 1, 4, 6, 11 and 14) are running on rubber tyres, while others are running on conventional steel wheels. Platform Screen Doors (PSD) are installed on the platforms of Line 14, which is a Fully Automatic Operations (FAO) or driverless system. Apart from the train doors of the rolling stocks on Lines 1 and 14, which are opened by the train operator or are opened automatically, the train doors on the other lines have to be opened manually by passengers after the train has stopped at platform. The closing of train doors is performed by the train operator on all lines, except the FAO Line 14.
My visit began from the office of Alcatel France in late May when the signalling testing and commissioning of Line 13 was underway. In 2002, Line 13 was targeted for upgrading with new Automatic Train Control (ATC) technology. RATP’s major requirement was the improvement of headway from 105 to 90 seconds. RATP chose the Alcatel SelTrac S30 as an overlay solution. It is a Communications Based Train Control (CBTC) system with continuous ATP and ATO functions. SelTrac S30 is a virtual block system. The primary positioning is done by the calculation in the Vehicle On Board Controller (VOBC). In case of trainborne equipment failures, there are track circuits to detect the presence of trains. Train-to-track communications are implemented with commercial off-the-shelf digital spread spectrum radio data communications based on Ethernet networks. Alcatel and RATP developed a detailed cut-over strategy and all testing and commissioning work was scheduled during the non-traffic hours from mid-night to early morning. This made the signalling upgrading work transparent to the passengers.

Arranged by Alcatel France, I visited the RATP Paris Metro Line 14 Operations Control Centre at Bercy Station in one afternoon. This is the newest RATP metro line which opened in 1998. It is an FAO system and is implemented with the Siemens Meteor System. It is a CBTC system with continuous ATP and ATO functions. It is a virtual block system. The primary positioning is done by the calculation in the On Board Controller Unit (OBCU). Track circuits are used to detect the presence of the trains in case of trainborne equipment failures. Train-to-track communication is implemented with low-frequency inductive loops. Two signallers monitor the traffic operations. There are no provisions for remote driving from the Operations Control Centre. However, CCTV are installed inside the saloons and could be used to monitor the situation inside the trains. PSDs are installed along all station platforms to protect passengers and staff. In case the staff is required to access the track, say for the reasons of train recovery or maintenance work, the concerned tracks could be deactivated and protected from the FAO trains.
We use unparalleled domain expertise and a system-based approach to deliver added value and risk management solutions for the rail industry.

BECAUSE SAFETY MATTERS

Asset management services
Operations and maintenance optimisation
Risk management and systems and safety services
Infrastructure and rolling stock engineering
Signalling and telecommunications consultancy
Independent verification and validation
Independent safety assessment
Engineering support
Management consultancy

For more information contact lain Carmichael
E lain.carmichael@lr.org

Lloyd’s Register Rail
T +852 2287 9341
F +852 2845 2616
E hongkong@lrail.com

www.lrrail.com

Services are provided by members of the Lloyd’s Register Group.
Visit to London Underground

London Underground (LUL) is the oldest underground railway in the world. The first line, the Metropolitan Line was opened in 1863. With the ongoing efforts in developing and expanding the system over more than 140 years, the system now constitutes 12 lines with a total route length of over 400km.

Trains are formed by 4-car (on East London, Waterloo & City), 6-car (on Circle, District, Hammersmith & City, Jubilee, Northern, Piccadilly), 7-car (on Bakerloo) and 8-car (on Central, Metropolitan, Victoria) consists. Traction power is fed to trains via a 630V DC fourth rail system. All rolling stocks are running on conventional steel wheels. PSDs are installed on the underground platforms of the Jubilee Line, which is the newest line in the system. The opening and closing of train doors on all lines are performed by the train operator.

A Metro-Cammell 8-car rolling stock on the Victoria Line (a tube line). The tunnel of a tube line is deep underground to avoid conflicts with water mains, sewers and other underground services. The height and width of the rolling stock are 2.9m and 2.6m respectively to fit the standard 12 ft deep tunnels of tube lines.

A two-day visit was arranged with the LUL. Apart from having a briefing on the signalling equipment, I visited the training centre in Acton Town, and the signalling equipment rooms on the Metropolitan and Jubilee Lines.
A Metro-Cammell 6-car rolling stock on the Circle Line (a sub-surface line).

A sub-surface line is constructed by the “cut and cover” method. They are referred to as sub-surface lines because of their proximity to the surface. The height and width of the rolling stock are 3.7m and 2.9m respectively.

Mechanical Interlocking is used extensively in the network. In contrast, newer lines like the Jubilee Line use the Electronic Interlocking system.

LUL uses air operated trainstops to protect trains from passing the signal at danger (SPAD). The equipment consists of a mechanical arm fitted to the track next to each signal. If the signal ahead is permissive, the arm is lowered by air pressure. If the signal ahead is restrictive, the arm is raised by a large spring. If the train attempts to pass a signal at danger, a tripcock on the train will strike the raised arm. The power to the motor will be cut off and the train will apply emergency brake.

Trainstop at Training Centre in Acton Town

Neasden Control Centre - Jubilee Line
Asian Rail Outlook – Challenges, Issues, Obstacles, Opportunities and Innovations

- A 3-day high level congress for rail decision makers in the Asia Pacific region
- Asia’s premier and definitive rail congress addressing critical issues on the latest developments, current and proposed projects, corporate restructuring and new technology

AsiaRail 2006 International Congress will examine the latest developments in the following areas:
- Regional rail projects
- Finance and investment including corporate restructuring
- Management and operations
- Planning, construction and maintenance
- Equipment and products to the rail sector
- Safety and security in rail
- Rail freight
- Branding the new railway

PLUS!!

Full Day Site Visits (optional)
- MTR Tsing Yi Station, Maritime Retail Centre and Disney Line at Sunnybay Station
- KCRC Ma On Shan Rail and tour of Tai Wai Maintenance Depot

For detailed program agenda and event updates, visit www.AsiaRail.com. IRSE members can register with a preferential 15% rebate for the Congress using the following registration code: 458IRSE. Contact Beacon now to reserve your seat on +852 2219 0111 or info@BeaconEvents.com.

www.AsiaRail.com
The Victoria Line, operated since 1968, was the first passenger railway in the world equipped with continuous ATP and ATO functions. Safety speed codes are generated by the signalling system and transmitted to train via the running rails. The speed codes consist of the maximum safety speed for this block as well as the target speed for the next block. The safety box on the train will continuously compare the actual train speed with the maximum safety speed. It will trip the train to a stop when the maximum safety speed is exceeded. The ATO function is delivered by the Auto Driver Box that drives the train automatically within the ATP safety envelop.

In early 1990, Central Line commenced its resignalling project. The ATP and ATO system for the Central Line was the improved version from the system used on the Victoria Line. Electronic Interlocking system was used.

To continuously improve its service, LUL will upgrade its lines with CBTC ATP and ATO systems. The Victoria Line, Hammersmith & City, District, Metropolitan and Circle lines will be upgraded with the Westinghouse Electronic Interlocking and the "Distance To Go - Radio" TBS ATP/ ATO systems. The Jubilee and the Northern Lines will be upgraded with the Alcatel SelTrac System.

I paid a half-day visit to the Docklands Light Railway (DLR) Operations and Maintenance Centre located in Poplar. The DLR was primarily deployed to help regenerate the derelict docklands area to the east of the City of London. DLR was installed with the Alcatel SelTrac S40 Moving Block system that is fully automatic in nature. It was a pleasure to travel on the DLR while enjoying the beautiful scenery through the front-car windows.

The system is characterized by its 4-car train consists. Traction power is fed to the trains via a 750V DC third rail. Rolling stocks are running on conventional steel wheels. Train doors open automatically but are closed by the Train Captain on-board.
The SelTrac S40 is a CBTC system, fully automatic with continuous ATP and ATO functions. The primary positioning is done by calculation in the on-board VOBC. Axle counters are employed to detect train presence in case of any trainborne equipment failures. Train-to-track communication is implemented using low-frequency inductive loops.

One Train Captain is assigned per train. He/she is responsible for manual train driving when required, ticket inspection, train fault handleings and public relations activities.

Visit to Network Rail

Network Rail is the operator and maintainer of UK’s rail infrastructure. Currently Network Rail owns and maintains more than 33,000 km of track, more than 9,000 level crossings and more than 40,000 bridges and tunnels. Network Rail also owns more than 2,500 stations, and operates the largest 17 of them. Network Rail is also responsible for all the signalling and electrical control equipment needed to operate the rail network. A two-day visit was arranged with Network Rail.

Network Rail uses 2-, 3- and 4-aspect signals. Various types of track circuits (DC, AC, audio frequency and high-voltage impulse) as well as axle counters exist across the network. Network Rail utilizes Mechanical, Relay and Electronic Interlockings. For train protection, the Automatic Warning System (AWS) and Train Protection and Warning System (TPWS) are used. Approximately 20% of the network is fitted with ATP systems.

The AWS system is formed by a non-contact inductor placed at around 185m on the approaching side of the signal. The inductor contains both a permanent magnet and an electromagnet. When a train passes over the inductor, the permanent magnet sets up a trigger for a brake application. If the signal ahead is green, the electromagnet is energized, a bell inside the driving cab is rung and a black disc is displayed to the train operator. If the signal ahead is red or yellow, the electromagnet is de-energized, a loud siren warning is sounded and a black and yellow disc is displayed. Train operator has to acknowledge the warning, otherwise train brake will be applied automatically.
One Link Further
One Step Closer
The residual risk of using the AWS is that the driver may acknowledge the warning but then fails to stop and results in SPAD. To reduce the risk of SPAD, another system has been implemented, that is the TPWS. The TPWS consists of two pairs of electronic loops placed on the approaching side of the signal. Each pair of the signal consists of an arming loop and a trigger loop. The loops will become activated if the signal is showing a red aspect. When the train passes over the arming loop, an on-board timer is activated to detect the elapsed time of the train travelling from the arming loop to the trigger loop. If the train is found to be travelling too fast, a full brake application will be initiated. In the case that the train passes through the first set of loops travelling at an appropriate speed within the maximum safety speed but still fails to stop at the signal, the second set of loops at the signal will trigger a brake application. The implementation of TPWS across the entire national railway network was completed before the end of 2003. According to the News Release of Network Rail, TPWS reduces the risk from SPAD by some 52%.

It was an exceptionally interesting experience to visit a Signal Box at King’s Lynn. I was elated to have the opportunity to operate the Interlocking levers to control a series of mechanically interacting rods, and of course under trained supervision!
Discussion and Conclusion

Signalling technology has evolved over two centuries, from the traditional mechanical installation to the state-of-the-art computer controlled system. The railway industry continued to evolve and improve over time by introducing systems that enhance railway operational safety, services and efficiency. The successful implementation of TPWS on the UK mainlines by Network Rail is a good example of such efforts.

With the maturity of market products and the unique operating environments particularly in metros and underground railways, for example with short headway, difficulty and inconvenience to access to tunnels, the CBTC technology is now gaining acceptance and is being considered by an increasing number of metro/railway operators when they come to upgrade their signalling systems; for examples, RATP, LUL and MTR Corporation. It could also be observed that adaptation of FAO technology is becoming a trend for new lines; for example, the London DLR (opened in 1987), the Paris Line 14 (opened in 1998), and our Disneyland Resort Line (opened in 2005). In addition, deployment of Electronic Interlocking systems is the standard for future signalling projects of metros & underground railways and software-based ATS systems have been becoming essential provisions in modern Operations Control Centres.

With the ever increasing number of software-based signalling systems, software quality has become one of the most, if not the most, critical elements in the delivery of system safety and reliability. The delivery of a safe and reliable signalling system will depend more and more on the following success factors:

1. The project team should consist of both the supplier and operator and that they should have competent knowledge and relevant experience, firstly in the operation of the signalling system(s) to be delivered, e.g. Interlocking, ATC, ATS etc. (to assure clear and correct requirements) and secondly in the software development (to assure sufficient abilities to realize the requirements).

2. Close collaboration between the supplier and the operator in the project team to assure a common understanding of signalling requirements and an effective communication between the supplier and the operator.

3. Close cooperation between the project team and the Independent Safety Assessor (ISA) to assure all actions arising from ISA findings are completed in time.

4. Strengthen the process of software quality management during the acquisition stage, giving consideration to the following:

   ▲ **Design:** Adopt a simple and modular approach.
   ▲ **Manufacturing:** Conduct software audits for pre-defined milestones and monitor the implementation of the actions arising from audit findings. Extensive use of testing tools in verification and validation.
   ▲ **Testing and Commissioning:** Maximize testing coverage of Factory Acceptance Test (FAT) by using simulators. Allocate a reasonable period for on-site testing and trial running.
   ▲ **All phases:** Adhere to robust processes of software configuration management and change management. Conduct quantitative reliability growth prediction on the software.
Aba Located in the northwest of Sichuan Province and along the southeastern fringe of the Qinghai-Tibetan Plateau, the Aha Tibetan and Qiang Autonomous Prefecture has jurisdiction over 13 counties that are home to concentrated settlements of the two minorities. Aba Prefecture has rich tourism resources and is home to some of the few remaining giant pandas in the wild. The region also includes the Sleeping Dragon Nature Reserve, the mountaineer’s paradise at Siguniang Mountains, the Miyaluo Maple Leaves Scenic Resort, Jiuzhai Gully, the Yellow Dragon Scenic Resort, and the Nuoergai Grasslands.

Jiuzhai Gully, situated some 450 kms from Chengdu, is named for the 9 Tibetan villages in the gully. The lake, waterfalls, snow-capped mountains, and virgin forests provide colorful views all year-round. Six scenic resorts have been opened in the gully. These are Baojingyan, Shuzheng, Rize, Jianyan, Changhai, and Zharu. In 1992, Jiuzhai Gully was listed by UNESCO as a World Natural Heritage.

Not far from Jiuzhai Gully, in Songpan County, the Huanglong (Yellow Dragon) Scenic Resort is 340 kilometers from Chengdu. Along a milky-yellow slope at 3,000 to 3,558 meters above sea level, thousands of small lakes have formed on the mountainside. The myriad colors, shapes, and sizes create a mysterious and fantastic impression. Included in the resort are the scenic districts of Huanglong, Mouni (Buddhism) Gully, Danyun (Red Cloud) Gorge, and Xuebao Pond. The UNESCO listed it as a World Natural Heritage in 1992.

Located at the juncture of Xiaojin, Lixian, and Liuchuan counties, the Siguniang Mountains (the Four Maidens Mountains) is the highest peak in the Qionglai Mountain System and lies on the eastern edge of the Hengduan Mountain Range. Four peaks span from the north to the south. Because Tibetans revere mountains as sacred and female, these peaks have been long regarded as four beautiful maidens, and their snow covering is thought of as a delicate white veil. The tallest peak is snow-capped year-round, and the second tallest is surrounded by a glacier-fed river.
Maosian County) is home to a large group of Qiang. The high watch tower is unique Qiang architecture. During the Qiang New Year and other native festivals, the locals enjoy horse racing, drinking locally-produced wines, and dancing. The Qiang women are known throughout China for their skill in embroidery.

**Itinerary:**
Day 1: Chengdu Metro Visit
Day 2-4: Aba Tour
Day 5: Chengdu back to Hong Kong  - Please note the tour is traveled by Four Wheel Vehicle

Tour 1’s date: 8 - 12 July 2006
Tour 2’s date: 23 - 27 August 2006
Tour 3’s date: 28 Sep - 2 Oct 2006

Tour size: The visiting group is limited to 15 – 20 persons. Please make your registration in advance. First come first served basis.

Registration Fee: HK$200
Price: On cost sharing basis.

**Booking Arrangement:**
Kindly post your cheque payment to IRSE HK at the below address. Please make payable to “The Institution of Railway Signal Engineers HK Section”. Deadline for booking is one week before the departure date.

Postage Address: Ms. Catherine Chan
10/F., MTR Tower, Telford Plaza
Kowloon Bay, Kowloon Hong Kong

For Enquiry:
Mr. Sung Yuen Fat - Mobile no. 98196106
Mr. Francis Hui - Mobile no. 94387293
Interesting Signals No. 64

by John Francis

This issue's Interesting Signals item is a combination of two separate contributions from John Francis. Both deal with indicators involved with the safe despatching of trains from a station. Over the years there have been several cases of trains starting off from stations on the guard's say-so, whilst the starting signal was still showing a stop aspect. The two indicators discussed provide extra indications to the driver, in the first case, and to the guard in the second, to reduce the likelihood of such SPADs occurring.

Right Away (RA) Indicators found widespread use during the era of locomotive hauled passenger trains when single manning on the footplate became the norm. They are provided to transmit the conductor's 'Right Away' signal to the driver whilst facing forward in the cab in lieu of the driver (or no longer provided secondman) having to look back along the train to see the green flag.

A plunger on the platform, operated by the conductor or dispatch staff, causes the indicator to illuminate, provided the platform signal is showing a proceed aspect. The indicator is positioned below or alongside the signal and displays the letters 'R' or 'RA' when lit. The driver may take this indication as the order to depart. Additional indicators may be provided at relevant places along the platform if curved and if varying length trains require to be catered for.

At intermediate stations where there is no platform starting signal it is still possible to deploy a stand-alone RA Indicator.

Modern, unit type trains are fitted with on-board communication between the conductor and driver allowing the RA signal to be audibly announced in the cab thereby reducing the need for special wayside RA signals. However, many routes are now operated by Driver Only (DOO) passenger trains. Here the driver is responsible for closing the doors and, at unmanned stations, for departing on his own authority, provided any relevant signal is clear, and once the doors are safely closed. At manned stations where the assistance of staff is available, RA Indicators are provided, along with Close Door (CD) Indicators. Both are operated by station staff.

Our photographic example of an RA Indicator, Fig 1, shows the double-sided unit at Pickering on the North Yorkshire Moors Railway (NYMR). It is fitted to the bracket carrying the associated NB4 signal which is a three-aspect platform starter controlled from New Bridge signal box.

The purpose of the indicator is to transmit the guard's Right Away to the driver. It is needed here due to the curvature of the platform which obstructs direct line of sight between each end of the train and hence members of the train crew. To cater for occasions when long trains start...
from the station and therefore the locomotive stands out beyond signal 4, the RA indicator is double sided. The rear indicator illuminates with orange letters rather than white, as in the case of the forward viewing indicator (Fig 2). The unit was constructed by the NYMR S&T department using fibre optic technology involving one light source and a beam splitter.

Thanks to John Boyes for information and the photographs.

The second example, from the Australian State of Queensland interestingly works the other way round. It tries to prevent the guard giving the ‘Right Away’ instruction if the starting signal is not showing a proceed aspect.

The extensive Brisbane suburban rail network is controlled using two, three and four-aspect route signalling. Operations are overseen from a single control centre at Mayne on the north side of the city.

Electric trains run in three-car sets, either singly or paired at busier times. Guards ride in the rear of three-car sets and in the centre when two units are coupled. To assist guards when giving their ‘Right Away’ bell signal to the driver many platforms are fitted with “Signal Aspect Indicators” or Guards Repeaters as they are more commonly known. When the platform starting signal is at red the associated indicator(s) is dark. When a proceed aspect is displayed the indicator(s) shows a white lower quadrant signal symbol with a black stripe, similar to the rear face of such a signal (Fig 3). This perpetuates a semaphore indication in this modern colour light era. Note that lower quadrant is the only form of main semaphore that was used in Queensland, upper quadrants having never been employed in this state of Australia.

The example shown here, at Brisbane Airport International station, uses fibre optic display technology. Older, stencil type units, also exist in use.
A NEW ERA

ALSTOM Transport Information Solutions provides totally integrated information systems for application in railway and urban transit automation, train control, management and passenger information. Our objective points us firmly towards the future, so that we can deliver the maximum performance in terms of flexibility, efficiency and safety.

- 1000 engineers in R&D projects,
- present in all continents and 70 countries,
- 6 billion people are using ALSTOM transportation per year,
- over 100 years of experience in safety design and signaling systems.

ALSTOM Transport Information Solutions
48, rue Albert Dhalenne - 93482 Saint-Ouen Cedex - FRANCE
www.transport.alstom.com
### 2006 - 2007 Activities of IRSE (HK Section)

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
<th>IRSE</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Sep 2006</td>
<td>Technical Talk - IRSE Singapore AGM</td>
<td>IRSE</td>
<td>Welcome all IRSE members</td>
</tr>
<tr>
<td>28 Sep – 2 Oct 2006</td>
<td>Cheng Du Metro Visit and ABA 4WD Tour – 5 days</td>
<td>IRSE</td>
<td>Welcome all IRSE members</td>
</tr>
<tr>
<td>10 – 12 Oct 06</td>
<td>Hainan Railway Ferry</td>
<td>IRSE</td>
<td>Welcome all IRSE members</td>
</tr>
<tr>
<td>December 2006</td>
<td>Annual Dinner</td>
<td>IRSE</td>
<td>Welcome all IRSE members</td>
</tr>
<tr>
<td>To be advised</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 2007</td>
<td>Shen Zhen Nuclear Power Plant</td>
<td>IRSE</td>
<td>Welcome all IRSE members</td>
</tr>
<tr>
<td>To be advised</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Happy Birthday!
Our best wishes to the following IRSE (HK Section) members.

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>TANG SIU WAH</td>
<td>1-Sep</td>
</tr>
<tr>
<td>PUN CHUN YU</td>
<td>1-Sep</td>
</tr>
<tr>
<td>CHOI YUN YING</td>
<td>1-Sep</td>
</tr>
<tr>
<td>CHAN WING TIN</td>
<td>3-Sep</td>
</tr>
<tr>
<td>CHAN CHI CHEUNG, STEPHEN</td>
<td>3-Sep</td>
</tr>
<tr>
<td>LAU HOR TSAI</td>
<td>3-Sep</td>
</tr>
<tr>
<td>LEUNG PAK HIM, PONMY</td>
<td>10-Sep</td>
</tr>
<tr>
<td>LAI TIM WAH</td>
<td>12-Sep</td>
</tr>
<tr>
<td>YAN KWOK YUI</td>
<td>14-Sep</td>
</tr>
<tr>
<td>YIM WING KONG</td>
<td>14-Sep</td>
</tr>
<tr>
<td>WONG HO NAM</td>
<td>14-Sep</td>
</tr>
<tr>
<td>WONG LAI SHEUNG</td>
<td>21-Sep</td>
</tr>
<tr>
<td>CHEUNG YUEN WAI</td>
<td>24-Sep</td>
</tr>
<tr>
<td>WONG KIT MING</td>
<td>25-Sep</td>
</tr>
<tr>
<td>LAW KIN KWONG</td>
<td>26-Sep</td>
</tr>
<tr>
<td>SHEK HIU HA</td>
<td>26-Sep</td>
</tr>
<tr>
<td>ROSENDO WONG, JR.C</td>
<td>30-Sep</td>
</tr>
</tbody>
</table>
**Hainan Railway Ferry Technical Visit**

**October 10-12, 2006**

**Itinerary:**

10 Oct. – Bus from Shenzhen – Guangzhou  
- 10:26 pm Train Departure from Guangzhou – Haikou

11 Oct. - 10:30 am Arrival in Haikou  
Visit Haikou Railway Station, City Tour, stay in 4 stars hotel.  
游萬綠園; 假日海灘; 國家 4A 級熱帶海洋世界; 海南特產大世界.

12 Oct. – 10:20 am Departs Haikou Airport, Arrival to Shenzhen Airport at noon, then travel to Lu Wu,  
End of the trip.

**Cost:** HK$1,200.00 per person (Option: for single room additional of HK$400)

Standard: 3-4 stars hotel; including breakfast, lunch and dinner, normal sight seeing tickets and travel insurance. The visiting group is limited to 36 persons. Please make your booking in advance. First come first served basis.

**Booking Arrangement:**

Kindly post your cheque payment to IRSE HK at the below address. Please make payable to “The Institution of Railway Signal Engineers HK Section”. Deadline for booking is on 1st of March 2006. *In addition, please provide your Chinese name and Return Permit No. for flight booking.*

Postage Address: Ms. Catherine Chan  
10/F., MTR Tower, Telford Plaza  
Kowloon Bay, Kowloon Hong Kong

**For Enquiry:**  
Mr. Sung Yuen Fat - Mobile no. 98196106  
Mr. Francis Hui - Mobile no. 94387293
Corrosion Protection Coatings
High penetrative rust adherent anti-rust coatings; Acid, Alkaline, Salt & Sea water and Age Resistance; Reduce both labor tense and cost of project; No flake off and swell up

威獅君宝涂料

Tel: 86-757-86281536
Fax: 86-757-86281579
E-mail: yfsung@w-n-p.com

W&P (China) Company Limited
Add: Shop 1-2, Xia Xi Liang Xi Ind’l Zone, Gui Lan North Rd, NanHai, Foshan City, Guangdong, China
To all members:

If you have change address, employers. Don’t assume the IRSE knows where you are.

You can miss out on receiving institution mail because they fail to notify their change of address.

Please if you move drop a note, fax, call or email to the IRSE office.

Also for up to date information about the institution or its activities, or to download a membership application form log on to the IRSE (HK Section) website http://www.irse.org.hk

Myla Pilarta-Li
Editor

Myla Pilarta-Li
Editor
“For me a perfect premiere also includes a safe journey home by subway!”

Frieda McKenzie, theater fan in New York City

More safety for stations, tracks, trains and people. With our RailCom Manager, we can combine ultramodern surveillance, automation, and information and communication technologies in transit systems with differing degrees of complexity the world over – whether in Hanover, Guangzhou, Hong Kong or New York.

RailCom from Siemens ensures “traveling at ease”, thus increasing acceptance by the passengers and profitability for the rail operators. And RailCom is a future-proof investment, because our systems are always open for anything new, e.g. automatic operation or telematic applications.

www.siemens.com/transportation

SIEMENS

efficient rail solutions