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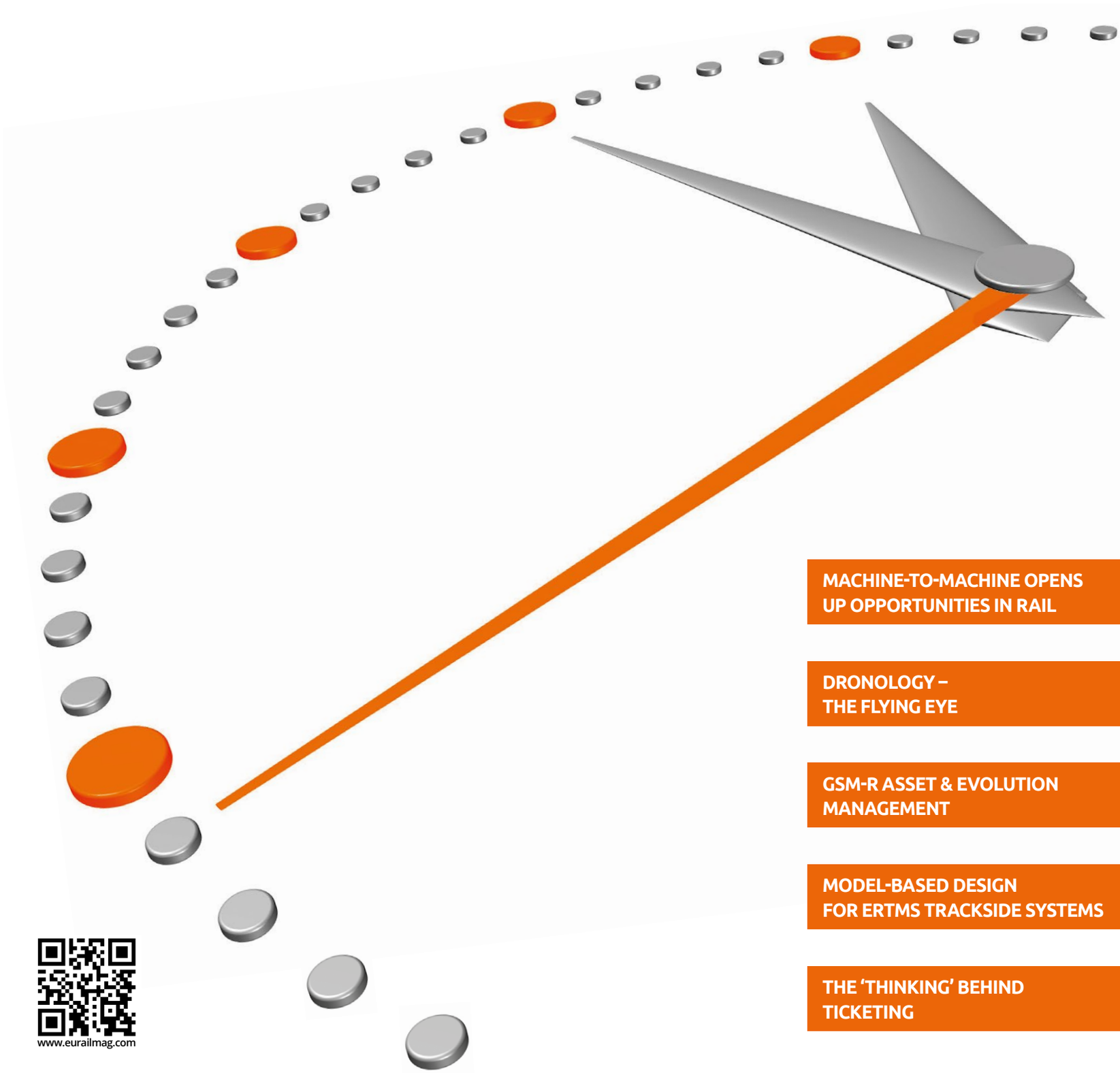

MACHINE-TO-MACHINE OPENS UP OPPORTUNITIES IN RAIL

DRONOLOGY – THE FLYING EYE

GSM-R ASSET & EVOLUTION MANAGEMENT

MODEL-BASED DESIGN FOR ERTMS TRACKSIDE SYSTEMS

THE 'THINKING' BEHIND TICKETING

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INFRASTRUCTURE

GSM-R ASSET & EVOLUTION MANAGEMENT

GSM-R IS A MUST-HAVE COMPONENT OF THE MODERN-DAY RAILWAY. FOR OVER A DECADE NOW, THIS RAIL-DEDICATED, MOBILE COMMUNICATIONS PLATFORM HAS ENABLED ENHANCED FUNCTIONALITIES AND IMPROVED PERFORMANCE, WHILE GUARANTEEING DATA AND VOICE COMMUNICATION AT SPEEDS UP TO 350KM/HR.

At the end of the last century, more than 35 different systems for railway communications were in use Europe-wide; not the best way to ensure interoperability for trains ever more rapidly moving from one country to another. In response, the railway companies of Europe sat down together in order to create a cost-efficient, interoperable and digital standard; the objective being to replace all analogue systems then in use. "GSM-R is a long story – it took a long time to choose the standardisation," explains Serge Bertrand from the GSM-R IG (Industry Group)[1] & Alstom. "It began in 1995 with the allocation of 876-880 and 921-925MHz frequency bands. In 1997, GSM-R was mandated by a European directive. Then, following the MORANE [**MO**bile radio for **RA**ilway **N**etworks in **E**urope] trial phase, the railways approved GSM-R as the future voice and data bearer in 2000. And today, it is a mature communications platform for the railways."

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- ERTMS – the system managed by European Union (EU) directives (Technical Specifications for Interoperability,TSI)
- ETCS – interoperable European Train Control System
- GSM-R – interoperable communications system for the railways, and one component of ERTMS
- GSM-R was first implemented in 2000
- GSM-R is the basis for using ETCS Levels 1 & 2
- 13 GSM-R networks are interconnected in Europe today
- the railways now starting to migrate to 2nd generation GSM-R, and the 3rd is under development
- about 60 countries in 5 continents are expected to select GSM-R by 2016

In addition to the GSM-R IG with its nine members, other leading characters in the GSM-R story are the UIC, serving the specific role of technical advisor/platform; the European Railway Agency (ERA) as system authority; the CER, representing both railway operators and infrastructure managers, as well as the final user (passenger) perspective; UNISIG – the industrial consortium created to develop the ERTMS/ETCS technical specifications; and the ERTMS User Group.

GSM-R ASSET & EVOLUTION MANAGEMENT

In September 2013, the UIC and GSM-R IG hosted a two-day technical conference, in Paris, dedicated to the precious and critical railway component that is GSM-R. "Over 70,000km of track are covered by the technology in Europe, out of a planned total of 154,000km," said Jean-Pierre Loubinoux, director general, UIC. "And worldwide it is proving an increasing popular choice, too."

Reflecting the operational (and commercial) significance of this particular element of the modern-day railway, the conference was packed. Through presentations and discussions, speakers and participants explored (and discovered) aspects such as the maintenance and specifications of GSM-R networks, issues (i.e. interference), studies, feedback on testing, and reports produced on the subject. Also omnipresent throughout the two days was thinking on the GSM-R roadmap over the coming years – what will be the next step for this technology?

INTERNATIONAL UNION
OF RAILWAYS

unity, solidarity, universality

FEEDBACK FROM A FRONT RUNNER

German infrastructure manager (IM) DB Netz boasts the largest GSM-R network in Europe – 26,900km of enabled lines currently in operation, representing approximately 80% of its entire network. "GSM-R is well accepted, and a success story," reports Achim Vrielink from DB Netz. "We decided to start the project in 1998 as a single system for all our railway communications applications; the network subsequently became operational in 2004." And the story isn't over either. A further 2,400km of equipped lines are being rolled out today, and 2,300km of lines are in preparation. "Step by step, GSM-R is replacing all the analogue systems, offering additional functions and capacity," says Mr Vrielink. Indeed the IM uses the technology for a considerable number of applications, namely:

- train radio
- maintenance radio
- shunting radio: a "well established" application, DB Netz uses GSM-R shunting with group calls. "Careful radio planning is essential for a proper working system," points out Mr Vrielink. A total of 1,304 shunting yards are today in operation with GSM-R or roaming; and 1,395 are planned for the end of 2014
- train approach with indication calls between dispatchers: for example, indications between dispatchers and level crossing posts line side. Telephony previously used in the case of technical faults on secured level crossings is replaced by GSM-R functions
- data calls, e.g. engine diagnostics, timetables for drivers
- ETCS calls: the first, full ETCS Level 2 is planned for the Erfurt to Halle/Leipzig high-speed (HS) line, due to open in 2015; and for the Nuremburg-Erfurt HS line in 2017

Technical provisions, and the configuration of networks to offer communication to GSM-R radios abroad, i.e. roaming, Mr Vrielink considers essential for the success of GSM-R and ERTMS in Europe. "National roaming is used as a cost-optimised fall-back to increase the availability of GSM-R," he explains. "And since GSM-R is a prerequisite for railway operations, its maximum possible availability is required." With these imperatives in mind, DB Netz has signed 10 roaming agreements with partner GSM-R networks. Plus it has 47 border crossing sites for international train traffic with GSM-R in operation.

THE INTERFERENCE ISSUE

In Mr Vrielink's view, one of the threats to the continued success of GSM-R is increasing interference between frequency bands, i.e. from public networks. Yet the GSM-R authorities are on already on the case. "The challenge is to enable the co-existence of railway radio and other services in a changing electromagnetic environment for the next 13 to 14 years," comments Libor Lochman, executive director, CER. Brussels, it appears, is aware of the issue, too. "It's not easy managing and resolving interference issues," says Isabelle Vandoome, from DG MOVE (Directorate-General for Mobility & Transport). "But in order to find and understand the best solutions jointly, it is

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Marshalling yard in Hagen, Germany

the first time the railways and the telecommunication frequency worlds have all worked together."

FURTHER STILL…

The next GSM-R steps for DB Netz include a reinvestment project to modernise its existing GSM-R network, whose components are reaching the end of their life cycles. At the same time, the company is preparing the foundations for introducing the Future Railway Mobile Telecommunication Systems (FRMTS), "which DB Netz actively supports," confirms Mr Vrielink.

SHIFTING SANDS

In the 1990s, GSM-R standards were developed on the back of GSM technology. And today they provide a single platform for all railway specific voice and data applications. But the GSM standard is predicted to reach the end of its lifecycle in around 2020; and the GSM-R Industry Group has committed to support GSM-R until 2025. With this eventual demise in mind, the UIC has carried out activities since 2009 on the subject, since the choice of radio technology in Europe is a choice harmonised among the railways and by European legislation, via the CCS TSI; the latter currently designating GSM-R as the European digital radio needed to fulfil the needs of ETCS Level 2 and beyond.

In a shifting telecommunications world, characterised by a technical evolution towards IP, widespread connectivity, and other wireless technologies, the railways are facing a number of tough questions. Which applications are we using today, and will be tomorrow? Communication needs over the long term? Spectrum? Also, with regards to the architecture, the need to separate the application and network layers. And the migration of existing apps, such as ETCS, to IP…

"We also have to take care of different organisations when trying to change something," warns Chiel Spaans, UIC. "And this requires cooperation, with standardisation bodies and the Critical Communications Broadband Group, over standards and spectrum for non-commercial uses, e.g. public utilities and safety, transport/railways, and defence."

FUTURE RAILWAY MOBILE TELECOMMUNICATION SYSTEMS

The FRMTS project was launched in 2013 by the UIC to provide information for decisions on the successor to GSM-R. Running up to 2016, the scheduled tasks have been divided into three main Work Packages (WP) – functionality; spectrum – what do we need, and why; technology and critical architecture. "Work on the successor to GSM-R has really started, but GSM-R, which has set the reference for interoperability, will remain the only solution for many years to come," comments Mr Spaans, FRMTS project leader.

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In January 2014, the project had its official kick-off meeting in Paris. Around 20 experts attended, including representatives of ERA. Importantly, the activities of the FRMCS and ERA are coordinated and convergent. This point was made clear during the meeting not only as a statement, but also by starting the work on the common programme, where each entity is respecting the role and the remit of its work.

The UIC will take action on different subjects. The main ones are standardisation – where a call for candidates for a UIC 3GPP representative is being launched; and in frequencies – lobbying with the ECC/ECO will be carried out to obtain spectrum, the basic need for radio technology. These items will be synchronised with activities in the field of other professional sectors, e.g. utilities and 'blue light' (police, fire brigade, etc.). More railway specific railways needs will be evaluated based on case studies, and on the business case – fostering railway operations and activities via real-time applications, which will make the information available. A percentage of the foreseen budget will be allocated to studying the border between soft- and hardware based solutions.

The UIC and ERA expect a decision on the future system to be taken by 2018, and for it to be made available for deployment by the end of 2022.

ERA & "LESSONS LEARNED"

Tasked with defining the evolution paths of the rail communications networks in Europe, ERA has already established three courses of action: carrying out studies on the next-generation radio telecommunication

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system; making an ex-post analysis of railway operational requirements for radio communication systems; and evaluating any remaining options. "However before defining any solutions for the next generation, we must fully take into account lessons learned from the existing set of operational requirements," points out Wouter Malfait, economic evaluation officer, ERA. "And the latter concern ETCS data and voice applications, besides others."

The "lessons learned" mission, which is being carried out over 2013 and 2014, encompasses the following steps:

- methodology and questionnaire
- issuing questionnaires and gathering the answers
- brainstorming session
- final report with findings to be published in June 2014

"For the short term, we are optimistic for solutions to GSM-R," says Ms Vandoome. "But ERA needs technical support. Let's share our expertise and cooperate. Organised cooperation will lead to well-organised results."

"Any strategic decision on the evolution of GSM-R requires support from CER for the business and customer side," says Mr Lochman. "We cannot risk disruption of rail services due to migration from GSM-R to the FRMTS. So there must be no gap in the transfer of technologies," he warns. Mr Vrielink concurs, adding: "A migration strategy based on a dual mode, i.e. mobile FRMCS and GSM-R, is probably the only solution for international traffic."

APPLICATION OPPORTUNITIES

"Most of the time, the on-board GSM-R cab radio is not used; the driver control panel normally just displays network information and the train registration number," says Ciro De Col, head of sales & marketing, Siemens.

Based on the premise *'how could we use the computing capacity of the cab radio, the driver control panel to display other useful information – to send and receive data without jeopardising the GSM-R voice application'*, Siemens has identified the following potential applications

- **a driver advisory system:** e.g. optimum route speed and driving approach in real time, single train dynamic advice to driver. The concept is based on using timetable data, speed limits, train characteristics, and so forth. "And there is no need to add extra installations to achieve this," points out Mr De Col
- **remote condition monitoring:** sensors on the train detect the track, points, etc. The data captured is processed on board and the results transmitted to the ground over the GSM-R radio link
- **event notification:** employing the existing GSM-R cab radio to enable 'live' updates from TCMS/TMC; using position information from the train-based system, e.g. GPS
- **e-learning solutions:** an interactive training application software for drivers

"The objective of developing such applications is to optimise the use of the on-board asset that is GSM-R," explains Mr De Col. "And so generate savings through more efficient fuel economy, by using all the trains

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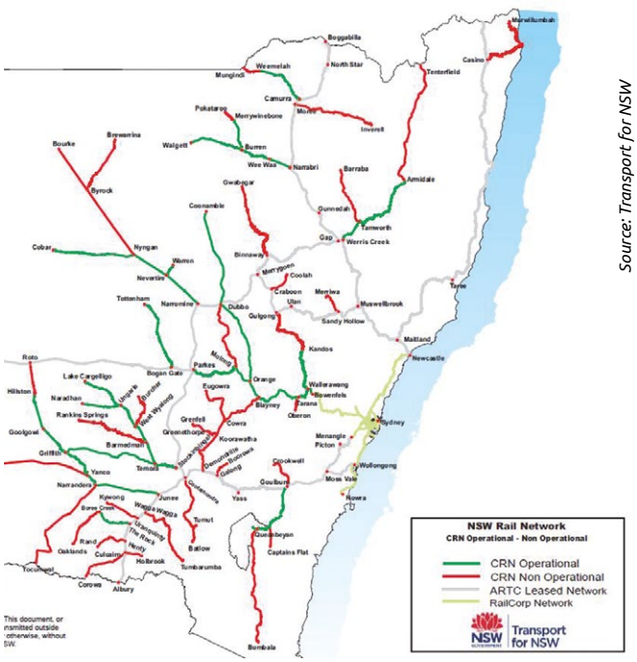

Source: Transport for NSW

to detect track deterioration, by reducing driver training days, and so forth." He suggests that those described above could be added to ERIG 3339 Doc – Additional A, outside of EIRENE specifications (see box).

SYSTUF – PREPARING FOR ENHANCED OPERATIONS

While agreeing that GSM-R is a "great success story," Olivier André, vp transport, Alcatel Lucent, says that the technology only really serves voice communication and ETCS. "Yet there are many other potential applications," he adds, citing passenger services such as in-train internet, operational data for public address systems, critical voice, and security/video on board. With this thinking in mind (and the Grand Paris project, too[2]), the SYSTUF[3] project has been ongoing in France since June 2012. Funded by the French National Fund for a Digital Society (FSN) [4] and scheduled to run for 36 months, its partners are Alcatel-Lucent, RATP, Alstom, Mitsubishi Electric, Simpulse, IFSTTAR, Eurecom, and Telecom Bretagne. Together they share the following ambitions:

- to demonstrate the feasibility of using a single communication technology to simultaneously meet the requirements of critical and non-vital (transport operator point of view) applications
- to enable the development of innovative services to boost seamless travel, and so help meet growing demand for 'smart' and 'environmentally friendly' mobility

The team is focusing on the deployment of reference architecture and its business model, and on considering cutting edge approaches. The final objective being to produce a proof of concept offering a unified framework for telecommunications needs in public transport, taking into account the constraints of safety-critical applications. "We first looked at industry trends among the three actors involved – service providers, operators, and manufacturers," explains Mr André. And this study led to the following findings:

- service providers: data explosion, video everywhere, 4G/LTE for dense urban areas, monetising data
- operators: more capacity, tight budgets, safety always paramount, the passenger experience
- manufacturers: CBTC/ETCS Level 3, 'greener' trains, all IP networks, delivering the 'full promise' of LTE

"We are looking at four different LTE network options," explains Mr André. "There are, however, challenges to be met," he admits. These include the long-term process of validation; spectrum; costs – depending on frequency, re-use of civil infrastructure? Economies of scale if commercial products are used; and the business model – private versus public network? PPP investment?

A trial demonstration of the proposed solution is planned to mark the project end, in June 2015.

DIFFERENT CONTINENT, DIFFERENT THINKING

Bringing an 'open' perspective to the conference proceedings, Derel Wurst, managing director of Australian technology service provider 4Tel Pty Ltd, spoke about open network usage for

The EIRENE specifications form the basis of any GSM-R equipment purchase. The EIRENE Functional Requirements Specification version 7.3.0, and System Requirements Specification (SRS) version 15.3.0, address the complete system requirements. In particular they contain those relevant to interoperability of the rail system within the European Community, according to Directive 2008/57/EC

Source: www.uic.org

railway telecommunications. Unlike in Europe, private GSM-R systems are used for rail services in Australia's capital cities, and public networks are employed for interstate railway services. "It's better to work on interoperability rather than harmonisation," reckons Mr Wust, describing the mobile phone as "interoperability at its very best", adding, "the internet and mobile telephone networks are the biggest open networks on Earth, and they are not harmonised." In his view, vital to the GSM-R industry, in order to achieve security and operational integrity goals, are a defined network connection and a methodology that describes data consistently.

PUTTING PUBLIC NETWORKS TO RAIL USE

4Tel Pty Ltd is providing train control and telecommunications systems support, using public networks, for the NSW Country Rail Network in New South Wales, Australia. The operator's scope encompasses a total of 16 lines covering 5,800 kilometres of track. All the lines are managed remotely from a single centre, located in the city of Newcastle.

For this contract, signed in 2010, 4Tel deployed two main train control technologies; train orders for most single track rural lines, and centralised train control using rail vehicle detection for a dual-track line in the mid-west area. Extensive voice and data communications are employed, with most voice-to-trains being satellite or mobile phone-based, and some UHF (Ultra High Frequency) using IP-over-radio base stations. Quick to anticipate, and allay fears over the security risks of using open public networks, "we are comfortable using them," Mr Wurst reassured his audience, "since they are more reliable and redundant than railway signalling. "How the applications handle the information determines your level of security, not how you receive the information," he expands. "Rail has freedom of technology choice. GSM-R is recognised as the safe option today. When you get into IP territory, security is the number one priority. You need to take measured intelligent responses to these risks."

He strongly disagrees with those industry players using the risk of hacking as a reason not to adopt the open network approach. "Any network, open or closed, can potentially be hacked," he points out. "The risks in any network are never zero. All it means is that during risk assessment, you have to be rigorous about what you want to protect. We mustn't remain handcuffed to old ways of thinking," he adds. "Safety lies not in the hardware, but in the applications."

TODAY, AND TOMORROW

The many topics raised at the conference illustrate the sheer complexity of the railway communications ecosphere. As far as EURAILmag was concerned, the event certainly achieved its objectives, namely to:

- provide detailed information on GSM-R today, its evolution, and strategies for the long-term future
- support the railways to look on wider opportunities for mobile applications
- promote discussions and debate (both concurrent and diverging!) around the topic, and
- demonstrate GSM-R technology & applications

Importantly too, the two days served as a reminder that when using a standard technology similar to public telecoms operators, it is vital to monitor technological trends, to avoid a system becoming obsolete and no longer supported ■

Lesley Brown

References
[1]www.gsm-rail.com
[2]ambitious government plan to develop Greater Paris, which includes a brand new automatic metro encircling the capital; see www.societedugrandparis.fr
[3]SYStèmes télécoms pour les Transports Urbains du Futur
[4]Fonds national pour la Société Numérique