EDITORIAL

Dear Readers,

This is now the third edition of the GSM-R Focus. It should give an overview about the work of the different UIC GSM-R working groups and provide an outline about actual achievements. GSM-R is now no longer a baby as in the 1992 to 1995’s, this baby has grown rapidly and has already passed the teenage phase. Looking from the beginning, where the decision had been taken to start with adapting GSM instead of TETRA and to mention railway specific features, via the phase of specification and standardization of these railway features, via the piloting phase into the implementation.

K. KONRAD
Chairman ERIG

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GSM-R – THE SUCCESS STORY IS GOING ON

GSM-R has reached a maturity stage. It is operational on almost 60000 km all over the globe. In Europe it is the new Rail radio digital communication system, being in an implementation stage (planning/tender – implementation, or migrated). End 2007, we have registered more than 45000 km of railway migrated to GSM-R.

The performance figures are very good:
- Overall network availability: 99, 97%;
- GSM-R for ETCS network availability: 99,999%;
- Average non-availability per incident: 1.2 hr (figures offered by ProRail). We can say that we are in a good stage, but still work is to be done. Features are still to be specified and gaps are to be filled. We will detail more in the following lines.

Status in Europe end 2008

GSM-R’s deployment has continued since 2007. There are 17 implementers end 2008: Austria, Belgium, Lithuania, Bulgaria, Czechia, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Slovakia, Spain, Switzerland, Sweden, U.K.

(Follow up this article in Page 2)
phase, we can now state, that GSM-R is a success within and outside Europe. Implementation has already reached a level, where several countries have already finalized their migration from analogue radio towards digital radio via GSM-R and where all signatories of the Agreement of Implementation from year 1999 have started their implementation.

More than 60,000 km are equipped with GSMR including commercial operation. Most applications used with GSM-R today are train-radio communications and non-safety related data-communications. Interest from railways outside Europe is also permanently growing and support from UIC for newcomers is requested.

The chairpersons of the working groups will give an overview about their tasks and main achievements in the last month’s and personally I am proud to be the chairman of this ERIG group and also the Project-Manager of the UIC project since more than 10 years now. As already stated, GSM-R is one of the most successful projects within UIC and has achieved a never expected target in a very short time. Therefore I would like you to be interested in following our work and take all necessary steps to contribute in your own railway organization to this success.

Outside Europe, GSM-R is installed in China, and is under deployment in Algeria, India, Turkey and Saudi Arabia. It is under discussion in Australia.

**GSM-R - crossing the borders**

In Europe, the international interconnections and the related traffic started to grow. End 2008, the GSM-R baseline was EIRENE Functional Requirements Specification version 7 and System Requirements Specifications version 15. Nevertheless, in Europe versions 5/13, 6/14 and 7/15 are in operation, with no major issues reported.

This does not mean that the situation could stay as it is, Backward compatibility between 7/15 and 6/14 is almost general, but as soon as new features will be in the next EIRENE versions, the backward compatibility is planned to be limited from version n to version n-1. A migration strategy towards a harmonized baseline 7/15 is therefore to be evaluated. From the time where the technology had to be tuned up to become robust and stable for the Railways needs, we have reached now a new step. The International traffic started to appear more and more, and specific activities had to be set up.

The international traffic is monitored by the new working groups ENIR and NMG. You can see here below the actual existing interconnections, and traffic measured beginning 2009. The values are still small, but we can see a 90% increase, compared to the average traffic load beginning 2008.

**Statistics**

In Europe, GSM-R is planned to be deployed for 149,210 km; taking into account the networks where such plans are prepared (224,135 km of Railways), it means that 66,57% of the European Railway Network is planned to be covered with GSM-R.

From this, 73,293 km are already constructed (49,12% from the planned), and 56,991 km are in operation (38,5%).

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Source: The UIC ENIR Group.

Table 1, The GSM-R European Planning

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FOCUS
On the mobile side, 198,525 mobiles are planned, from which 65,318 are activated (32.9%). From this, 27,943 are activated cab radios, which include also EDOR’s (ETCS Data Only Cab Radio).

As for Dispatchers, 5063 are planned, from which 1557 are activated, which means 30.7%. For 2009, we expect a continuous advance of the implementation, according to plans. Denmark, Portugal, Poland, Hungary and Romania should start/finalize the tenders, and start the implementation. The international traffic is expected to grow, on a more abrupt curve than 2007/2009.

The applications using GSM-R will also grow and diversify. Here below, you can see the implementation roadmap, according to National Implementation Plans:

**Frequency Capacity constraints**

The Spectrum occupancy is seen to be maximal in the near future, when ETCS Level 2 and higher will be in place, especially in crowded areas or big hubs. In fact the spectrum is seen in such as insufficient. Several studies performed by individual Railways have shown similar results – Network Rail – Clapham Junction Study; DB Netz – Mannheim Study and RFF - Additional frequencies needs study performed on Paris Nord – Paris Est.

The applications using GSM-R will also grow and diversify. Here below, you can see the implementation roadmap, according to National Implementation Plans:

**Two actions are followed to prevent such situation:**

1. **GPRS for ETCS.** The idea is to use packet switch for ETCS instead of Circuit Switch. In case of Circuit Switch, at least one channel is occupied for a train, during its journey. In case of packet switch, in the tests performed until now, minimum 3 trains can continuously transmit on one single channel, which mean that in real life the number is bigger. GPRS was chosen as packet switch technology, since it is the simplest to install, and the cheapest solution.

   More than this, since the ETCS packets are small (128 bytes in average for the MA) GPRS throughput seems to be enough. UIC has opened the way in 2006, when they have released the GPRS for ETCS White Papers. Yet, the CR that followed was not agreed. We have seen technology improvements and the traffic growing lately. A Work Plan has been set up between EEIG/UNISIG/UIC to prove by real tests that GPRS is feasible for ETCS. A first step was to see if Subset 093 - the GSM-R QoS requirements for ETCS – is suitable for GPRS. From here we have developed together a set of Test Cases, where we have focused on having data on the main GPRS behavior (GPRS Attach, PDP Context Activation, PDP Context Deactivation, GPRS Detach, First Packet, etc.) We have performed Lab and On Board Tests, in Belgium, on Bruxelles Liege, and in Italy, on Milano Bologna. We had very good support from the B-Holding, RFI experts and from NSN. The tests campaigns are actually ongoing. The preliminary results seem promising. GPRS is fast and in High Speed conditions, there were no packet lost, and no transmission errors. Issues are to be solved, but we are getting close to our target.

2. **Additional frequencies.** We had finally a chance to ask for additional frequencies, but in the so called Trunk Band (PMR/PAMR Band). The reason is that the Extended/Public GSM bands are already occupied with the Mobile Public Operators (see Figure 1).

(Follow up this article in Page 4.)
We were supported in our lobby by DB Netz, who already applied for 3 MHz paired in this bandwidth, linked with the GSM-R bandwidth. The steps done until now were successful: CEPT WG FM (CEPT Working Group for the Frequencies Management) have agreed with the idea and the matter was sent in the specialized FM #38 Group, who recommended to support the extension. The matter is now in Public consultation (from March 6th to May 6th, 2009).

The extension is requested to be non harmonized in a first step due to unbalanced needs between the implementers, since we are still in implementation stage in Europe. In addition, the traffic needs are different and depend on location in Europe. GSM-R will be introduced in the specific bandwidth legislation (EC (04)06), as one of the accepted technologies. The chances to obtain good results are relevant.

**Frequency Interferences**

The GSM-R interferences are growing, due to GSM-R network expansion, as well as of the UMTS 900 Public Operators. Work has started to define the Cab Radio Blocking Conditions, together with the maximal admitted Noise Floor. The Cab Radio is extremely exposed, being a sensitive Mobile Station, connected to an exterior antenna, 4 m high. The idea is to identify and prove the new figures based on tests, and introduce them in the standard specification.

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**UIC ERTMS/GSM-R Functional Group**

The UIC ERTMS/GSM-R Functional Group (FG) is composed by experts from UIC Member Railways. The group has been enlarged lately with four new members and also a representative from the European Railway Agency (ERA) who joined the group as observer. The aim is to have around 10 experts in FG covering the different European Regions. The group normally meets once each quarter. Between the meetings the group deals with emerging issues using emails and the UIC Extranet.

The main task of FG is to maintain the Functional Requirements Specification (FRS) of GSM-R. The FRS has been included in Annex A ‘List of Mandatory Specifications’ of the technical specifications for interoperability relating to the control-command and signalling subsystem of the trans-European conventional rail system and high-speed rail system. All changes therefore have to follow the ERA Change Control Management process.

FG is involved in preparing the Change Request (CR) based on Implementation Reports (IR) received from involved parties. In preparing the CR it is the main task of FG to ensure consistency of the requirements when introducing modifications taking into account the operational rules that would be influenced by the CR.

It is also the task of FG to keep the FRS as independent as possible from technology and to discuss new technologies emerging. The Functional Group reports to UIC ERTMS/GSM-R ERIG and interacts with the UIC ERTMS/GSM-R Operators Group in the discussions related to IR’s and CR’s. Recently FG has dealt with issues related to Shunting, Data Only Radio and Group Calls/Emergency calls.

The Shunting FRS CR is now in the final stage before being implemented in the specification. The main changes are more detailed requirements to the equipment in general and creation of a special chapter for the shunting handheld radio. Several Railways had requested that the requirements to the shunting equipment were more detailed in order to harmonise and thereby provide manufacturing economies of scale.

At the request on the Notified Bodies, work was undertaken to extract the requirements for a “Data Only Radio”. It was agreed to prepare a new section to the FRS. The new section identifies the functional requirements for the ETCS Data Only Radio (EDOR). It covers the functionality to be provided by a data radio that is dedicated to ETCS communications. EDOR therefore provides a limited set of functions and services compared with other EIRENE mobile equipment used also for voice communication.

The CR for EDOR is now undergoing the final modifications before entering the ERA Change Control Management process. Several issues related to Group Calls/Emergency calls have been discussed.

Overlapping Group Call Areas and Quality of Service have been among them. Overlapping Group Call Areas related to Emergency calls have been discussed to fine-tune the requirements. E.g. the required behaviour of the system in case of two different emergency calls in overlapping areas.

During the latest years the turnover of FG members has been limited; this has helped and ensured consistency in the work undertaken. I would like to take this opportunity to thank existing as well as former members for their contributions to creating and maintaining the Functional Requirements Specification for GSM-R now implemented widely throughout Europe and further.

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1. INTRODUCTION

The Operators Group is a structured group integrated within the UIC ERTMS/GSM-R project organisation. This Group is composed of experts mainly from Railway Organisations addressing issues related to EIRENE System Requirements (E-SRS).

The conditions for membership and participation are mainly:
- To be proposed by Railways members of ERIG following a call for candidates issued by the Chairman,
- To be co-opted by the Operators Group based on the experience and the expertise in the GSM-R field and in particular the know-how of the specifications.

OG meetings could include, on invitation by the Chairman, a third party representative as observer or a rapporteur from ad hoc groups when needed. OG might include consultants whose duty is based on the work to be performed.

The Operators Group is aiming at standardisation of features for Railway use to form the basis of GSM-R by:
- Maintaining specifications for interoperability based mainly on reports from implementers (ex. SRS wording improvement, QoS aspects, Late entry, IOT results, FFFIS for ERTMS interface, Roaming conditions, Networks Interconnection)
- Working on improving harmonization (such as eLDA, eREC, QoS requirements and testing, Common set of test cases for Cab radio, etc.)
- Ensuring follow up of specifications for optional features (ex. GPRS, UUS field content...)

2. THE BASIS FOR INTEROPERABILITY

Defining a common set of requirements

The following figure 2 shows an overview of the common set of requirements expressed by UIC, and summarised by the EIRENE FRS (Functional Requirements Specifications).

Maintaining the common set of specifications

The result of the European MORANE project consisted in defining a set of EIRENE SRS (System requirements Specifications) and a set of detailed Specifications. These initial set issued in 2000 at the closure of EIRENE and MORANE projects required maintaining. This task is allocated to OG who is working together with the Functional Group (FG) and the Technical Industry Group (TIG) to create and follow up the Change Requests which become the basis for the next release of EIRENE FRS and SRS associated with the update, when required, of the Detailed Specifications (a new release was published on the UIC in liaison with the EIRENE release 7/15).

In order to achieve this task, the following organisation was set up in liaison with the ERA (European Railway Agency) who is the System Authority for Interoperability. Figure 3 gives the different organisations involved in this task.

3. GSM-R FEATURES AND FUNCTIONS ADDRESSED AT OG

GSM-R is based on the GSM standard technology (Fig.4). GSM-R uses additional functionalities customised for railway applications such as functional addressing, presentation of functional numbers, access matrix, location dependent addressing and specific frequency range.

(Follow up this article in Page 6)
of addressing all subjects deemed essential for interoperability and improvement of the Railway operation. For this reason, OG created Ad Hoc Groups to take in charge these new activities efficiently.

4. OG ACHIEVEMENTS

OG is in charge of maintaining and developing the EIRENE specifications to fulfil the current and future needs of Railways. This task includes the elaboration of Change Requests toward the current specifications and their follow up until approval by the various committees and ultimately by ERA to become part of either the next maintenance releases (FRS7.X; SRS 15.X) or the new releases (FRS8; SRS 16) for approval by the former Article 21 Committee.

In addition to the essential work of handling Implementation Reports issued by Sector Organisations and creating Change requests, OG within the task of improving Railway operation created several Ad Hoc Groups to address these issues, which included:

- International Numbering aiming at defining in detail the format of the numbering used for all types of calls, point to point as well as group calls.
- Interoperability Ad Hoc Group has been in charge of monitoring the tests conducted by Industry for different interconnections of networks. It monitors that the features developed by Nortel Networks and Siemens (today Nokia Siemens Networks) were not impacted when performing interconnection of neighbouring networks (phase 1 and 2) and when sharing a common group call area at border.
- Updating of the FFFIS for SIM cards resulting in an updated revised document including correction of mistakes in the original document.
- Late entry for REC (Railway Emergency Call) allowed trains entering an emergency area to be notified with a much higher efficiency.
- Enhanced Location Dependant Addressing improved the initial mechanism to take into account Train Location Information System to route the call with a granularity lower than the Radio Cell.
- eREC defined a new mechanism to improve the selectivity of the REC while maintaining as a backup solution the existing REC. This mechanism could improve the regularity of trains by discrimination of REC to specific tracks.
- The QoS for ETCS Group developed the conditions for testing of GSM-R networks QoS requirements.
- The definition of Common handheld and Cab Radio tests sheets for the feature unnecessary for interoperability will improve the conditions of radio acceptance.

5. CONCLUSION

This work represents an essential milestone toward maintaining an interoperable system for Railways. It answers to the initial goal of UIC and EU when starting the EIRENE and MORANE projects to ensure interoperability through a trans-European railway network. Moreover, this System is today adopted in most continents by Railways as the Standardized Railway Radio communication System.
In Germany, several analogue radios systems are in use for shunting. In some locations, local channels of the train radios system in the 0.7m-band are in use. In other specific shunting areas, additional systems in the 2m-band and/or in the 4m-band were implemented. Some of those systems were already installed in the 1970s and have reached the end of life. Therefore a replacement is necessary urgently.

In the GSM-R project of DB the replacement of those systems by GSM-R shunting was planned from the beginning. Based on that, first activities were already started in 2003. From 2004 onwards, first tests with GSM-R shunting mobiles (OPS) could be carried out.

FIELD TRIALS

In 2005 DB started with first field trials using GSM-R group calls for shunting. At first, two small shunting areas in Freiburg and in Mannheim were chosen. Those trials made clear that a lot of improvements were necessary until GSM-R is fit for shunting. Since then improvements were specified for the mobile terminals, for the dispatcher terminals and - in combination with that - also for the system itself. End of 2006 some improvements were already available. Based on that, a pilot in a medium size shunting area could be started middle of 2007. For this Saarbrücken was voted as best approach due to some specific operational conditions. Again, there were lessons learned about what needs to be improved. Till today, GSM-R shunting is in use there.

In parallel to the improvements on system and terminal side, GSM-R shunting also needs specific radio coverage. Especially today’s Group call implementation in GSM-R requires a certain cell configuration so that the needed capacity can be provided in the limited number of frequencies, that are available in GSM-R.

To be able to start GSM-R operation also in a real big shunting yard, another pilot area was identified in northern part of Germany, in Seeleze. The installation works for the coverage were started in 2006 and finalized by autumn 2007. Since the beginning of 2008, the amount of users and operational scenarios increased step by step. That pilot was finished by end 2008. GSM-R shunting is in regular operation now.

SYSTEM IMPROVEMENTS

The different field trials gave a lot of feedback on what needs to be improved. Together with the other railways intending to use GSM-R for shunting, the needed changes to the EIRENE specifications were defined and addressed in the UIC ERTMS groups OC/FG.

SIMPLIFIED SHUNTING APPLICATION

In addition to the improvements on the GSM-R shunting application with group calls, a simplified shunting application using point-to-point calls was introduced. In a lot of small stations where shunting activities are carried out, no group calls are needed. (Follow up this article in Page 8)

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<td>Dispatcher terminals</td>
<td>DTMF tones of only 70msec</td>
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<td>Mobile terminals</td>
<td>Feature for simplified call from shunting member / driver to switch controller out of an existing group call</td>
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<tr>
<td></td>
<td>- Alerting controller</td>
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<tr>
<td>Mobiles terminals</td>
<td>- Increased number of registered members in shunting groups</td>
<td>Available</td>
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<td></td>
<td>- Participation in shunting groups without registration</td>
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<td></td>
<td>Enhancement of user rights, for example “leave group call”</td>
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</table>
There, the GSM-R system can be used without additional configurations or installations, as long as the radio coverage is sufficient. To be able to introduce this application, modifications were necessary again, especially on the shunting handheld terminal (OPS).

As the number of frequencies in GSM-R actually is very limited, the capacity requirements of big shunting yards lead in some areas to a situation, where not enough radio channels are available to provide all group calls without risk of blocking.

An approach to overcome this situation is to ensure, that the shunting yard is only covered by one cell. Then the capacity of radio channels is only needed on this one cell and not on any neighbouring cells. Through this, the frequency limitation can be solved in a lot of areas. Such an approach was chosen for the pilot area of Seeleze. There, in total 26 group calls are provided for the pilot operation.

This requires 4 radio channels on the serving cell. That shunting yard was initially covered by 2 radio cells from the GSM-R train radio installation. Following picture shows the radio coverage before modification. The red lines mark the boundaries of the shunting yard:

Another solution through sophisticated features is still under evaluation by the industry. Improved cell reselection behaviour of the mobiles could help to overcome the issue. In-between such a solution was specified in ETSI and approved in OG. A decision for the way forward is awaited in the next months.

**THE ROLL OUT PHASE**

**Achievements so far**

In parallel with the field trials and system improvements the DB project has also driven the preparation for field roll out. In total about 1600 shunting areas were evaluated. For about 200 of them group calls are necessary. For this, the radio planning was carried out and, where finished, the planning phases for any kind of modifications / construction works were started. In about 1400 areas point-to-point calls for shunting are sufficient.

(Follow up this article in Page 9)
Some of them will be covered with the future extensions of the GSM-R network for train radio.

In most of them, GSM-R is already available. Therefore in around 1200 areas the existing GSM-R coverage was measured and evaluated. In parallel, also the coverage of the Public GSM roaming partner was measured. Out of this data the areas were selected, where the use of GSM-R / GSM can be introduced without any further implementation or configuration works.

Until now, more than 880 areas are already in operation based on the point-to-point shunting communication. The analogue systems are in process of dismantling. For DB, GSM-R shunting is now a success story.

Future Migration

The modification of the radio network through change of existing sites and installation of new BTSes and radio repeaters is ongoing. Around 50 shunting areas shall be migrated per year. End of migration is planned for 2012.

Drivers for Evolution Toward GSM-R

Railways are major users of mobile radio systems. They use radio for a wide range of services, e.g. track to train radio communication, operation and maintenance, shunting communications, passengers’ information. The prevailing situation (Fig. 2) was that not only track to train radio systems were different throughout Europe, but also different frequencies and technologies were used for various applications, such as Operation and Maintenance or shunting radio.

EUTMS / GSM-R

Introduction

TC-RT is a structured group integrated within the ETSI (European Telecommunications Standard Institute) which includes experts representatives of Railway Organisations and Industry aiming at developing the standardisation of telecommunication features for Railway use to form the basis of GSM-R. The conditions for participation are mainly:
• The valid membership to ETSI and
• The involvement in the work of development of standards for GSM-R.

The content of the work addressed by the Group is driven by Terms of Reference which have to be approved at the TC-RT Group and by the Board of ETSI. These Terms of References specifically aim the development and maintenance of ETSI standards for application of GSM-R to railways as required for the fulfilment of the Technical Specifications for Interoperability of the High Speed (96/48/EC) and Conventional Rail (2001/16/EC) Directives.

Drivers for Evolution Toward GSM-R

Railways are major users of mobile radio systems. They use radio for a wide range of services, e.g. track to train radio communication, operation and maintenance, shunting communications, passengers’ information. The prevailing situation (Fig. 2) was that not only track to train radio systems were different throughout Europe, but also different frequencies and technologies were used for various applications, such as Operation and Maintenance or shunting radio.

Most of this equipment was based on analogue technology and have exceeded their product life cycle. In 1993, UIC decided to face the following questions:
• Which digital radio system should be used to replace ageing analogue radio systems currently in use?
• How to ensure the continuity of service and respect the budgetary constraints of investment if new system is to be implemented?
• How to guarantee the future evolution of a new system?

Following a detailed technical and economical survey of existing and potential digital technologies, it was decided to base the new system on GSM (Global System for Mobile Communications). This would allow railways to participate to the evolution of the public standard to include their specific needs as well as benefit from the economy of scale of the existing GSM public market for the cost of their network and their mobile equipment.

GSM-R Network Features and Functions Addressed at TC-RT

GSM-R Features

GSM-R is based on the GSM standard technology (Fig. 3, idem p6). The Professional Mobile Radio (PMR) features are gathered in the ETSI Advanced Speech Call Items (ASCI) specifications, which allow the voice broadcast and voice group calls as well as priority and pre-emption of calls, are part of the GSM-R features. They have been introduced by ETSI within the Global System for Mobile communications (GSM™) and the Third Generation Partnership Project (3GPP™) standards GSM-R uses.

Follow up this article in Page 10.
Functionalities customised for railway applications such as functional addressing, presentation of functional numbers, access matrix, location dependent addressing and specific 4 MHz frequency range. This customisation is part of the development work of TC-RT.

The GSM-R benefits from the GSM data transmission and includes CSD (Circuit Switched Data) services as well as General Packet Radio Service (GPRS) which would allow efficient handling of applications such as ETCS.

It could also allow developing applications such as logistics, diagnostics, remote control and passenger services, time scheduling and tariffs, automatic seat reservation by giving operational railway staff access to data bases through intranet (Fig. 4).

The introduction of Direct Mode Operation (DMO) within GSM-R is an important evolution which answers the requirements of the railways.

TC-RT continues to work closely with the Third Generation Partnership Project (3GPP) on enhancing Advanced Speech Call Items (ASCI) features which could impact on the interoperability of railway telecommunications, particularly with a view to improving the efficiency of PMR operations.

Additional liaison with 3GPP on enhanced Voice Group Call Service (VGCS), including the encryption of group calls, has been completed and will be available in the marketplace soon.

**Frequency range**

In Europe, a common frequency range is used in all GSM-R networks to achieve international interoperability. For roaming considerations with existing public GSM networks, terminal equipment operate within the full 900 MHz frequency range. The system allows switching from and to the public GSM range and the UIC frequency range. With the development of GSM-R applications and to take into account some areas with high traffic concentration, TC-RT is now addressing in coordination with UIC the need for additional frequencies (SR Doc TR 102 627) for Railway Transport Systems Operation in liaison with TC-ERM and ECC.

**TC-RT ACHIEVEMENTS**

TC-RT is in charge of maintaining and developing the ETSI specifications to fulfil the current and future needs of Railways. This task includes the elaboration of Change Requests toward the current specifications and their follow up until approval by the various 3GPP committees; to give an idea of the work achieved, since the last published version of ETSI TR 102 281 v2.0.0 in 2006, more than 553 new Change Requests have been addressed and are approved.

In addition, the following documents were created and are maintained:
- **EN 301 515** dealing with ensuring:
  - Requirements for GSM operation on railways
  - Basis for Technical Specifications for Interoperability (TSI) related to EU High Speed and Conventional Rail Directives
- **TS 102 281** which:
  - Details requirements for GSM operation on Railways
  - Lists the CRs introduced in 3GPP related to PMR/GSM-R
- **TS 102 610**
  - Usage of the User to User Information Element for GSM Operation on Railways
- **TS 102 627**
  - System reference document on Land Mobile Service
  - Additional spectrum requirements for PMR/PAMR systems operated by railway companies (GSM-R)

**CONCLUSION**

This work represents an essential milestone toward a standard open and interoperable system for Railways. It answers to the initial goal of UIC when starting the EIRENE project in 1993 as indicated above when deciding for a new digital system. This choice of GSM-R is also included in the European choice of a common cross-border system all over Europe. Moreover, this System is today adopted in most continents (Asia, Australia, Africa, South America) as the Standardized Railway Radio communication System.
Introduction of European Network Interconnection Group (ENIR)

Based on the increasing convergence of the railway communication networks in Europe and the high requirements for secured operation of the railway system, a European wide GSM-R interconnection must be developed on a common base. Therefore the ENIR group was founded in the beginning of 2006.

ENIR is a railway expert group, consisting of railway representatives, with the aim to establish European GSM-R interconnection on technical level. This means a step by step evolution and migration of stand alone GSM-R networks to a European wide overlay network, offering a high availability of services and low cost consumption. These GSM-R interconnections are necessary to provide the first roaming services into foreign GSM R networks.

Retrospect: In December 2004 the first international GSM-R interconnection between SBB (Switzerland) and DB (Germany) was established, followed by the GSM-R interconnection between ProRail (The Netherlands) and DB (Germany) in January 2005. Meanwhile the next 3 railways (Belgium, France and Czech Republic) planned to interconnect their GSM-R networks with Germany. The ENIR group has currently 12 active members (Austria, Belgium, Czech Republic, France, Germany, Italy, Netherlands, Norway, Poland, Sweden, Switzerland, United Kingdom).

Achievements made by the end of 2008:
• 10 national GSM-R networks are interconnected
• 16 direct interconnections are in operation
• 13 transit routing paths (via third GSM-R network) are in operation
• The ENIR guideline GSM-R “Common Design Document” have been developed and released in version 1.0
• Technical issues were discussed and solutions specified
• The UIC ERNST database have been re-designed to meet the GSM-R requirements
• Workspace on UIC Extranet was created

The main tasks of ENIR are:
• Continuous development of the overall interconnection network architecture.
• Standardised and harmonised rules & routing principles
• Identify needed physical interconnection(s) based on communication demands
• Planning of the migration to the future overlay network
• Calculation and provisioning of routing tables for border crossing traffic
• Monitoring of actual implementation details
• Monitoring of load on interconnections
• Documentation of work results

In order to achieve the ambitious goal, we practice a close relationship with the Network Management Group (NMG) and the UIC. Every GSM-R network operator who is planning to join the GSM-R overlay network is welcome to contribute. A quick exchange of information will be guarantied by scheduling 3 one-day meetings a year. The next meeting will be held on 2nd of July 2009 in Paris.
At the start of the first implementations of GSM-R networks in Sweden, Germany and the Netherlands in 2001/2002, the need for international cooperation and exchange of information was already recognized. Not only the "normal" problems related to the rollout of a GSM-R network were discussed, but also issues regarding borderline design and but frequency allocation were on the agenda of the so called "early implementers workshops". Some meetings later also Switzerland joined and the interest came from other countries implementing GSM-R.

In the mean time the first networks went into operation and on a bilateral basis the first roaming and interconnection tests were performed. Project-agreements for offering roaming services were signed and the first international trains with GSM-R crossed borders.

In the spring of 2007 a local technical problem of the - single - interconnection link between the Netherlands and Germany caused the total standstill of ICE and Thalys services in the Netherlands. This demonstrated that international traffic would never be the same anymore: it will be - from now on - fully dependent of the availability of the interconnection between GSM-R networks.

The first implementers of GSM-R decided to have a better and agreed way of designing, operating and maintaining the interconnection network and to cooperate within a more formal organisation. Supported by UIC ERIG, both ENIR and NMG were founded mid 2007.

The ENIR and the NMG have different responsibilities. The NMG is tasked to perform the coordination of roaming services and takes care for the requirements to the interconnection network. These requirements are mainly related to the capacity and availability, but also the way the upcoming extensions of the actual network can be realised, have to be taken into account. In fact the interconnection network is in a continuous migration.

The ENIR designs the interconnection network and prepares the logical configuration for call routing on the different links of the network. The individual network operators are responsible for the formal bilateral planning of the implementation and maintenance of their part of the interconnection network.

Part of the work of the NMG is to facilitate the GSM-R Network Operators with documents for a generic way of working, which is normally not covered by Eirene. These documents are:

- Guideline for border area configuration: coverage, shared group call areas, frequency management
- Template for Roaming Agreements, to be used bilaterally
- Template for Operation and maintenance agreements
- Template for the technical description of interconnection and roaming
- Standardized testcases, not only for the initial interconnection projects, but also to be used after changes in the operational phase

Of course the planning of the rollout of roaming and interconnection is discussed. The aim is to have roaming available just before train operators will need it. Usually this has a direct relationship with the start of operational GSM-R use in "new" GSM-R countries. The fact that more and more interoperable locomotives and trainsets are available and are crossing borders in Europe, causes an increase of roaming needs. In the NMG information regarding the available roaming facilities between countries is collected and published.

On the UIC extranet the meeting minutes and the documents can be found.

The NMG has an open character, there is no official membership. Meetings (or better said workshops) which take place three times a year, can be attended by representatives of GSM-R network operators; representatives from Germany, Sweden, the Netherlands, France, Switzerland, Belgium, Norway and Italy attended the last meeting. The way of working is based upon initiatives for subjects and information from the network operators.

Some of the recently discussed issues - outside the documents mentioned above - are the use of CT3 and CT4, public roaming for foreign simcards, and the requirements to the interconnection network. In case of interaction with Eirene specifications, an Implementation Report will be written and sent to the appropriate body.
ERIG CELEBRATED 10 YEARS OF FRUITFUL ACTIVITY

At its 40th meeting that took place in last December, at Gent, Belgium, the ERIG (European Radio Implementation Group) celebrated 10 years of activity.

“The idea of creating ERIG came up after several years of work in EIRENE and MORANE with specification work and first ideas of implementation. In the early ninetieth, railways had problems in getting additional frequencies for their permanently growing telecommunication applications. Therefore the former UIC 7B10 group started to work on a study to move from analogue radio towards digital radio, in a safe way for the future. The main idea was to bundle all existing radio applications into a unique frequency band and, in parallel, to switch from analogue to digital all in looking for a useful technology for railways. (...) So, a study was launched and two technologies investigated – TETRA and GSM. Finally it was decided to move towards GSM, but to add some functionality so that it becomes usable in the railway environment”, explains Klaus Konrad, Chairman of ERIG.

How ERIG does actually works today?
ERIG is a railway information platform composed of all the signatories of the UIC Memorandum of Understanding (MoU) about the support of the railways for GSM-R, launched in 1997 and initially signed by 32 railways, where all the participants can share the problems they encounter, their solutions, opinions, ideas and their different experiences regarding the implementation and the exploitation of the GSM-R networks. Besides the technological exchange created via this platform, a part of the shared information becomes “raw material” for the related UIC Working Groups: Functional Group, Operators Group, TC-RT – the Railways ETSI Interface, Network Management Group, ENIR (European Railways Interconnection Group). The GSM-R Industry is regularly invited at the ERIG meetings, where its delegates can present their issues and discuss directly “with the customer”. Also, every meeting we invite a GSM-R or Telecom related supplier company to present its product / concepts.

ERIG results after 10 years of work

Issued from the ERIG works, UIC offers today to the members 7 versions for the EIRENE FRS (Functional Requirement Specifications), 15 versions or EIRENE SRS (System Requirement Specifications), the MORANE documents, plus more than 1000 documents produced in all this period.

Separately, other important documents like the GSM-R Procurement Guide, or the upcoming GSM-R Procurement and Implementation Guidelines, Cross Border Common Design Document, Roaming Agreement template, etc are or will soon be available on the UIC GSM-R website.

The EIRENE 7/15 specifications are part of the Technical Specifications for the Interoperability (TSI).

But, above all, the most important result of this 10 years long cooperation seems to be the strong European railway community created through and around this exchange platform, counting today 14 GSM-R Railway networks interconnection links and more than 55,000 km of GSM-Rail in operation.

Starting with 2008, ERA, EIM and CER have active representatives participating to the ERIG Programme. In the 2008 September we had for the first time representatives from the Chinese Railways, which expressed their interest in taking part of the future works.

In the closed future, ERIG will be even more involved in the new GSM-R Change Request Process, being a decisive step on the validation of a Change Request, together with matters like GPRS for ETCS, Additional GSM-R Frequencies or the GSM-R European Test Lab.
GSM-R is a success story in Europe and goes towards the same status in the world. It is specified through the EIRENE (European Integrated Railway Radio Enhanced Network) FRS (Functional Requirement Specification) and SRS (System Requirement Specification). The actual baselines are 7 for FRS and 15 for SRS.

The EIRENE FRS and SRS are the basis for any GSM-R equipment purchase, and they are part of the TSI CCS, Annex A.

The system is a “living system” and needs to be maintained for many reasons:
• Introduction of new features
• Error corrections
• Closing Specifications Gaps
• Functionalities improvement

This technology allows exploitation of new business opportunities, operational improvements and efficiency streamlining. The need to ensure interoperability establishes the obligation to protect the investments.

To reach this, the European Railway Agency in its role as System Authority, has installed a transparent process managing the system changes, with the contribution of the sector representatives, CER and EIM.

This process was defined together with the UIC; the following chart is showing the process and tasks responsible.

The process itself is fully in line with the existing ERTMS-ETCS change process and is based on the same assumptions. UIC has hereby taken over the role to prepare together with the GSM-R Industry possible solutions for problems and introduction of new functionalities. The trigger for starting studying such issues is decided in a group, called the Pre Qualification Group, gathering the experts from ERA, CER, EIM and UIC, after being approved in the Control Group, a qualified opinion will be given to the European Commission. Close cooperation with UIC is a logical choice avoiding duplication of work by maintaining full independency. Coordination of tasks is ongoing.
The UIC is undergoing fundamental change in its transformation to a more effective global organisation. Its mission remains firmly fixed on being a vibrant technical platform and a source of dissemination for all Members where issues of standardisation, harmonisation, best practice solutions and innovative ideas for future implementation will remain close to its core.

We have been committed from the early 1980s to an interoperable Trans-European Rail Network, in close collaboration with the European Commission (EC) and the supply industry, and, as such, an interoperable traffic management and signaling system was one of the very first challenges. The earliest conception of the European Traffic Management System (ERTMS) can be traced back more than 20 years.

To date, the term ERTMS has encapsulated three distinct sub-projects:

• ETCS – European Train Control System
• GSM-R – Global System for mobile telecommunications for railways, and
• ETML – European Traffic Management Layer

The influence of interlockings on the overall ERTMS architecture for higher application levels has now prompted the railways and industry to engage in a joint EU funded project called Integrated European Signaling System (INESS).

This project started in October 2008 and will be coordinated by the UIC, leveraging on the results of past work in the UIC EuroInterlocking project. INESS is expected to develop unified functional requirements based on the convergence of railway signaling principles.

The rapid migration to GSM-R has resulted from at least four supporting factors:

• the decision to base the rail system on GSM
• railways were already anticipating a move from analogue to digital technology
• telecommunications increasingly forms the backbone of many existing and new customer services, and
• relationship building between the telecommunications industry and railways.

Thanks to the extent of GSM-R implementation in Europe is impressive, with more than 65,000 km constructed, 25,000 cab radios activated and 120,000 mobile users. The challenge for the GSM-R project in the future, in relation to ERTMS, will be to keep pace with telecommunication innovation while ensuring that the requirements of the ETCS signaling system are met in relation to frequency bandwidth, non-interference, capacity utilisation and protection against obsolescence.

In recent years railway domain knowledge in every sphere of technical activity, including telecommunications, has been spread and many parts of the knowledge regeneration process, from innovation to standardisation or technical Specification, is now placed under the responsibility of different organisations, such as UIC, CEN/CENELEC, CER/EIM and ERA. The custodianship of this knowledge for future generations is an important issue. In the European area, the European Commission (EC) continues to promote new policies and a central role for rail transport in terms of transport modal shift and economic and environmental sustainability. Consequently, railways divide their resources between proactive actions (research, knowledge sharing, benchmarking, innovation and future planning) and reactive responses to current and pending legislative change affecting their business. The Norms and Standards in force, at any point in time, represent the dividing membrane in an ongoing osmosis between the process of research, innovation and consensus building and compliance with existing mandatory norms and specifications. The former may be considered as a bottom-up process involving the continuous regeneration of ideas for the future while the latter can be viewed as a top-down process to ensure system conformity with current legislative directives and higher-level governmental ordinance.

At a technical level, this interaction is depicted in the following pyramid of continuous knowledge replenishment:

A comprehensive and continuous technical appreciation as to how the infrastructure domains (track, structures, signaling, telecommunications and power supply) each combine and interface with the railway rolling stock is a fundamental part of the rail system knowledge which will need to be preserved and nurtured. The telecommunications discipline is a clear example where technological innovation does not stand still and where knowledge needs to be continuously updated.
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