From GSM-R to Future Railway Mobile Communication System (FRMCS)

Bologna, 9 Maggio 2018
Topics

1. Standardization Overview and Status

2. FRMCS and Migration Aspects from GSM-R
Driver for Next Generation Broadband Communication - FRMCS
Future Railways Mobile Communication System

Demand for Broadband Application

- Increasing operational efficiency
- Improving Customer experience

Optimization of networks

- Further unifying network technology
- Reduce complexity
- Increase flexibility

Long Term Support

- Support ERTMS/ETCS for next decades
- Manage obsolescence of GSM technology
Broadband enables new services

**Customer loyalty**
- Passenger Information
- News & travel information
- Travel route visualization
- Internet, email, chat *)
- Passenger suggestion box

**New revenues**
- BBoT: Broadband on Trains
- Video on demand, Audio books
- Gaming
- “On the fly” seat reservation
- Bistro shopping
- Advertising (indirect revenue)

**Efficiency & process automation**
- Real time CCTV
- Alarm notifications
- Fleet management
- Energy metering
- Real-time vehicle tracking
- Ticketing
- Passenger counting
- Optimizing bistro processes
- Automated Train Operation
- Replacement of wireline communication
- Sensors
- Predictive Maintenance
- Self Organized Networks (SON)
Ground to Train trends

**EUROPE:** France allocating B38 (2.6GHz TDD) to the Public Sector on a regional basis. Spain regional SP’s interested in Mission Critical LTE (eg MdM, B42). Israel Tel Aviv LRT opening to Voice, CCTV Data and Internet on single RAN. UK Broadband on Train compelling event, HS2 in 2026. SNCF PoC.

**AFRICA:** Mass transit systems are still a handful. Spectrum generally not available to railways, but trend is evolving. Transnet applied for LTE450MHz, and will deploy LTE1800 for port operations. RFI for Sitarail in Cote d’Ivoire.

**LATAM:** MEX: possible allocation of spectrum to govt, incl. railways. BR: Nokia strong footprint.

**ASIA:** Dhaka L6 will use LTE. Malaysia open to LTE. Thailand interested in LTE.

**RUSSIA:** Broadband applications via SP’s or in unlicensed spectrum with proprietary solutions. Tele2 successful trial with MEC.

**INDIA:** Possible acceleration of Next Gen Radio. CP/CN expressing strong intention to introduce Next Gen. CBRS upcoming.

**AUS:** Spectrum available. BHP under deployment. Several PTA’s deploying LTE.

**SK:** Spectrum available. SKT doing LTE for Busan Metro. Japan: ITEC planning to serve Tokyo metro with LTE.

**ME:** General interest in LTE. Qatar early adopter. Iran willing to investigate.

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Remote Train Control is next gen pushed by railways vendors
Russian Railways evaluating remote train control at railways yards

Project details:
**Train control system:** MALS by Siemens
**Average train speed:** up to 3 km/h
**Control method:** 2 way communication – Telemetry/Train signaling
**Monitoring method current:** visual by Control Center tower located in the center of railways yard

**Number of tracks at the station:** 30 tracks in average
**Railways yard spread:** up to 30km
**Number of railways yards in Russia:** ~1500 yards
Example of trends in Italy

Smart mobility, scatta l’ora dell’integrazione treno-taxi

Via all’intesa Italo e AppTaxi che consente a chi viaggia in treno di usufruire dei vantaggi della app e pagare la corsa con la carta di credito. Si rafforza la partnership Trenitalia-Mytaxi: buono taxi per chi compra online ticket per Roma, Milano e Torino. Spunta l’asse RadioTaxi-Tinaba

Video of the Week: How is Trenitalia using the Internet of Things to transform their high-speed fleet?

Thanks to the Internet of Things (IoT), digital technology has transformed the way railway operators control train functions. Italy’s Trenitalia is looking to the future by using new technology for their high-speed fleet. Sensors combined with IoT solutions allows Trenitalia to provide its customers a more efficient and reliable service to save maintenance costs by 8-10 percent. Great new IoT use cases are possible to further improve operational efficiency, passenger experience and the operators’ return on investments. Legacy infrastructure is gradually being replaced by train management systems in which trains become interconnected communication hubs, transmitting data among themselves and to network control centres and receiving instructions from control centres.
Convergence towards one integrated technology for rail

Services
- Train Control (ETCS, CBTC, PTC,...)
- Mission critical voice
- Operational applications
- Passenger applications

Radio technologies
- **GSM-R** for operational communication & ETCS
- **Public GSM & others** for maintenance, electricity meters,...
- **Wi-Fi** for traffic offload in train stations
- **Analog** for shunting on low traffic lines & non-critical com.
- Separate **ERTMS** and **CBTC** radio
- **Passenger BBoT** via public 2G/3G/4G, SAT, Flash OFDM

**LTE** for all services
GSM-R is expected to be supported until about 2030
Different speed of LTE/FRMCS deployments in Europe and other regions

Europe

- Support of GSM-R from ROC Industry Group until 2030
- Train Control / ETCS Level 2 Europe until 2050

China

- LTE trials and early deployments

Korea

- LTE trials and early deployments

Australia

- LTE trials and early deployments, LTE Mining Deployment

Timeline as currently discussed

Next Generation – High level overview on involved bodies & activities

EU Agency for Railways: Coordination WP

**Others?**
- China
- Korea

UIC
- FRMCS, URS

Studies, TSI
- European regulation. Coordination

EU Agency for Railways: Coordination WP

TC RT

ETSI

3GPP
- SA 1/SA 6

System Reference document for spectrum
Development and publication of standards. System Architecture

3GPP Specification for mission critical communication

Work Item Rapporteur by Nokia

Requirements and conditions related to ETCS

Metro, Suburban

Studies, Pilots

Industry:
- ROC-IG (Nokia, KCC, Funkwerk, Siemens, Alstom, Frequentis, Leonardo, Sierra Wireless)

Others

Operator

ERA

UIC
UIC User Requirement Specification

Critical Communication Applications
- Voice incl. Group calls
- Train Control
- M2M & Telemetry (critical)

Performance Communication Applications
- M2M & Telemetry,
- CCTV, Passenger Info,
- Staff communication,
- Lineside (fixed)

Business Communication
- WiFi on Board

FRMCS / URS

Future Railway Mobile Communication System

User Requirements Specification

Comparison to GSM-R/EIRENE. Existing enhancements of EIRENE like features
1 Standardization Overview and Status

2 FRMCS and Migration Aspects from GSM-R
e2e railway Nokia solutions
Industry vision:
FRMCS will be implemented on LTE Network

LTE infrastructure (radio/core/data portfolio)

- Multiradio/small cells
- LTE core
- Application servers
- LTE dispatcher equipment

Efficiency & automation
- Fleet management
- Energy metering

Trackside & stations
- M2M communication
- CCTV

On board
- Passenger Information Service
- Emergency call points
- Broadband on Train
- CCTV
- Ticketing

Flexible deployment scenarios depending on customer strategy

End-to-end LTE railway trackside, station & onboard services

Future evolution towards 5G
LTE: IMS / VoLTE Domain – Network Architecture

IMS Voice domain main components:
- TAS
- CSCF
- Open BGW
- iNUM
GSM-R to full LTE migration
A stepwise approach, flexible for different markets and segments

**GSM-R + LTE pure data overlay**
- Mission critical voice & location over GSM-R
- High speed data over LTE (database access)
- Over the Top PTT (proprietary)

**GSM-R + LTE multimedia**
- Mission critical voice over GSM-R
- Multimedia over LTE (incl. voice, video, maintenance applications, PTT)

**Full LTE for Railways**
- All services over LTE
- Multiple user communities (highest priority: Rail, Public Safety; lower priority: Service Provider)

Railway layer over IMS
- LTE
- IMS
Spectrum for LTE – under discussion in Europe in ETSI/UIC/ERA

GSM-R spectrum in Europe
Possible reuse for LTE-R

<table>
<thead>
<tr>
<th>873/918</th>
<th>876/921</th>
<th>880/925</th>
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<tbody>
<tr>
<td>E-GSMR</td>
<td>GSMR</td>
<td></td>
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<td>3 MHz</td>
<td>4 MHz</td>
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- **LTE 1.4 Mhz (7 Mb/s max with MIMO)**
- **LTE 3 Mhz (21 Mb/s max with MIMO)**
- **LTE  5 Mhz (35 Mb/s max with MIMO)**
- **LTE 2*3 Mhz Carrier Agg, (42 Mb/s max with MIMO)**
- **LTE 1.4 Mhz (7 Mb/s max with MIMO)**

This is currently focused in ETSI NG2R as most applicable solution for the mission critical features defined by FRMCS.

CEPT WG-FM56 (discussions in FR, etc...)
From GSM-R to Next Generation Railway Communication

GSM-R voice & data

- OSS
- IN
- HLR
- MSS
- MGW
- GGSN
- SGSN
- BSC
- 2G BTS

GSM-R + LTE for Railways

- OSS
- IN/AS
- HLR/HSS
- MSS/MGCF
- MGW
- SAE GW/GGSN
- SGSN/MME
- PDG
- MS
- 2G/4G Node
- MULTEFIRE
- WIFI

**HLR evolves to HSS**
IMS application server. ICS architecture option

**GPRS evolves to EPC**
Nokia: same HW&SW today

**MSS & MGW**
Interworking (functionality of a MGCF/MGW) with VoIP IMS networks (eSRVCC).

**LTE BTS**
Same Node for 2G and 4G Non 3GPP WiFi access: Core or Radio aggregation

*) TAS comprises of MMTel services (IR.92, IR.94 and beyond), SCC AS (Session transfer, T-ADS,CAMEL Homing)
IP-SM-GW (SMSip, SIP IM, T-ADS), IM-SS, MRFC (tones and announcements, conference)
Regulatory services (LI, ACR, MNP), Charging (online, offline), VMS, IVR interfaces
Repository interfaces: Sh, MAP and LDAP
RFI Network Evolution towards 2030

2017

Radio Access
- 2G BTS
- BSC

CS CORE
- R4 MGW (R99 MSC)
- R4 MSS

PS CORE
- GGSN
- SGSN
- HLR
- IN
- OSS

2020 (Coexistence GSM-R / FRMCS)

- 2G BTS / eNodeB
- BSC
- R4 MGW (R99 MSC)
- R4 MSS
- GGSN & SAE-GW
- SGSN & MME
- HLR & HSS
- IN
- OSS

2030

- eNodeB
- IMS
- SAE-GW
- MME
- HSS
- IN (Application)
- OSS
Virtualization

- Less Footprint
- Less Power
- Less Complexity
- More resource flexibility
How About 5G?
5G is expected to be introduced in ~2020

- 10 Gbps network speeds
- Extremely low latency
- New applications based on massive broadband capabilities

LTE provides a foundation for 5G and will remain the main cornerstone in 5G for railway communication

5G phase 2
New 5G core network and standalone 5G radio access without the need for an LTE anchor

5G phase 1
5G radio in a dual connectivity mode with LTE as an anchor

5G core
Distributed radio and core architecture to deliver the required low latency

NEW
Both LTE and 5G access 5G core via common interface

5G User plane via LTE or direct

LTE core + 5G compatible functionality

LTE core

5G Control plane via LTE
LTE technology for mission-critical voice

+ 5G for non-critical massive broadband

- LTE is intrinsic part for 5G introduction
- LTE as such already provides support for 5G concepts like IOT support (with LTE-M, NB-IOT, cloudification of core and radio)
- 5G focus initially on high density deployments (6GHz up to 30/60/60 GHz)
- 5G to rely on OFDM technology as well -> we are talking about evolution of radio, not revolution. Especially for low band (e.g. MiMo like LTE)
Thank You