The ETCS
Future Proof
Radio Link
GSM-R Applications

One single Platform for Voice and Data

ETCS Data

Train Radio Voice calls, FN, LDA, REC...

Shunting Point to Point, & Group Calls

Operational Voice Communication for Railway Staff Point to Point, Group Calls, REC, Data

Diagnostics, Energy Data, Train Maintenance Data, SMS

Fall back for GSM-R

GSM-R

GSM-R

GSM-R

GSM
GSM-R for ETCS

- GSM-R is the radio bearer for ETCS. It guarantees a high level of Quality of Service in order to fulfill the needs of ETCS.

- ETCS requires critical real time interactive data transfer - if the Movement Authority (MA) is not available at the right time, the train will brake.

- Today, the CCS TSI only allows only Circuit Switched Transmission Mode, for which the Quality of Service requirements are defined in the Subset 093.
**Circuit Switch Data** - one call occupies one transmission channel for all call duration

- Circuit Switch is proven to be suited for ETCS;
- It is a frequency capacity consumer and it is “locked” to GSM technology - and therefore not future proof
Packet Switched Data (e.g. GPRS) – up to 7 users share the same channel

- An immediate advantage for Packet Switch Mode is a more reasonable use for the frequency spectrum.
- Appropriate Quality of Service must be assured
GPRS for ETCS

- Packet Switch (PS) radio link for ETCS is essential:
  - Frequency capacity bottle neck
  - Future proof technology

- Tests must be performed in Railway GSM-R Networks, where the only PS technology available today is GPRS.
- Intention is to use standard GPRS, and not to develop additional Railways specific features.

- European Pilot, with partial funding from the TEN-T, with the participation of ERTMS UG, GSM-R IG, UNISIG and UIC starts in April 2012, and is scheduled to be finished in 2014.
- **Goal - achieve a technical solution for using GPRS for ETCS**
Main Challenges - Specificity of ETCS data traffic

Mobile web browsing
High Throughput – tens-hundreds of MBits
Asymmetric traffic model.
Long lasting transmission
Transfer delay not so critical, impact of 1st packet negligible
Packet loss corrected by TCP/IP.

ETCS
Small single packets – up to 500 Bytes
Symmetric traffic
Discontinuous transmission (delay impact from 1st packet)
Very sensitive on transfer delay duration, and to packet loss
ETCS needs to transfer up to 500 bytes in less than 1s, with a highest availability
Errors corrected by HDLC.

Existing GPRS networks & mobiles are focused on public commercial requirements (Internet, …)
ETCS needs GPRS networks & mobiles optimized for the ETCS specific traffic requirements.
Main Challenges – Mobility Conditions

- Previous tests campaigns carried in 2008-2011 have proven that GPRS is feasible for ETCS.
- They have noted a different End to End Delay distribution; cell reselection induces around 2 seconds delays, and there are lost packets.

<table>
<thead>
<tr>
<th></th>
<th>32b frames successfully received before 0.6s</th>
<th>32b frames successfully received before 2s</th>
<th>32b frames successfully received before 4s</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL</td>
<td>12911 frames 97,00%</td>
<td>13251 frames 99,56%</td>
<td>13281 frames 99,78%</td>
</tr>
<tr>
<td>DL</td>
<td>12334 frames 95,78%</td>
<td>12600 frames 97,85%</td>
<td>12643 frames 98,18%</td>
</tr>
</tbody>
</table>

- Essential engineering features (e.g. NACCH) were not available
- The networks were not “tuned” for ETCS applications, but for “best effort”
- The percentage of lost packets can be relevant reduced, while for the cell reselection engineering can reduce negative effects

Transfer delay distribution

![Transfer delay distribution chart](image-url)
Load tests done on 5th May 2010

- It was proved in a test performed on 19 of May 2010, in Brussels, Atrium Building, using the B-Holding GSM-R Live Network, that 4 ETCS users can be accommodated over a single TS, using ETCS Like traffic model.

- The test used only 4 mobiles due to test tool technological limitations.
The focus is on the mobile system transmission interfaces

Euroradio Interfaces between ETCS and GSM-R

- ETCS track-side
- ETCS onboard
- GSM-R mobile radio device
- GSM-R fixed network

The Communication system shall fulfill the needed QoS

Layer model for the radio based data transmission

GSM-R radio transmission
A phased approach to Railway Radio Digital System evolution

Robert SARFATI
Operators’ Group Chairman
ETSI Technical Committee Rail Chairman

Dan Mandoc – UIC
ERIG Chairman

Robert Sarfati – UIC
Operators Group Chairman

UIC ERTMS Conference
Stockholm, 26 of April 2012
In Europe, existing standard technologies were considered for the new digital radio technology. The choice of GSM was finalized in 1995.

GSM-R standards were developed based on GSM R99 technology and included all railways specific requirements and an allowance of a specific additional frequency range.

- Enhanced Location Dependent Addressing (eLDA)
- Enhanced Railway Emergency Call (eREC)
- Short Message Service to Functional Number

- Functional Numbering
- Location Dependent Addressing
- High speed – up to 500 km/h

- Voice Group Call Service (VGCS)
- Voice Broadcast Service (VBS)
- Enhanced Multi Level Precedence and Pre-emption (eMLPP)

- All functionalities available for GSM-R including
  - General Packet Radio Service (GPRS)
  - Enhanced Data Rates for GSM Evolution (EDGE)

Railway functional Requirements (EIRENE)

GSM enhancements for railways (ETSI EN 301 515)

Standard GSM functionality
Standardization: a continuous process

GSM

GPRS

EGPRS

3GPP/UMTS/LTE

Phase 2

Rel ‘99

Rel-4

Rel-N

Rel-12


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ERIG Chairman

Robert Sarfati – UIC
Operators Group Chairman

UIC ERTMS Conference
Stockholm, 26 of April 2012
Future evolution is on the track
The evolution process

- Analyze Users needed applications, “described in an understandable way” for a railway User.
- Adopt a technology free attitude
- Capitalize on the market size by allowing for a worldwide approach and a multi-transport applications view.
- Preserve the current assets of railways
- Take into account the Internet Protocol dominant trend in telecom.

Three steps anticipated towards an IP based network
Step 1: Needs analysis

- **Red** – Railway Network supported applications
- **Blue** – Potential Parallel networks supported applications

**Critically for Railway Operations**

- Train Radio ETCS
- Operation and Maintenance Teams
- Train Maintenance crew applications

**Narrow Band & Mission Critical Applications**

- Red
- Critical Applications

**Bandwidth**

- Broadband
- Driver Look Ahead CCTV
- Real time passenger video information
- Mail, WEB for passengers

Dan Mandoc – UIC ERIG Chairman
Robert Sarfati – UIC Operators Group Chairman

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Step 2a: NSS and FTS migration

- **NSS:**
  - From R99 to BICN R4 architecture
  - NSS to FTS:
  - SIP introduction at Interface
  - Transmission network
    - IP Guideline
    - IP QoS
  - Growing improved applications

- **FTS:**
  - From R9 To R4 BICN
  - Growing, improved applications

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ERIG Chairman

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Operators Group Chairman

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Step 2b: BSS & Terminals migration

- NSS: From R4 to R4+ architecture and features
- NSS to FTS: SIP introduction at terminals
- Transmission network: IP introduction within distribution network
- IP BSS:
  - Flexible BTS
  - Terminals
  - Software Defined Radio
  - VoIP over the Air interface

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Step 3: The ultimate evolution

Take advantage of IP world innovations and possibilities

Move from a services logic

Towards an application E2E logic

- Define the application by:
  - A QoS, Cost for Service basis
  - Based on commonality of functions
Conclusion

- The analysis showed that technology evolution is not complete, but the IP based technology is the only stable platform.
- The worldwide evolution shows that 3GPP UMTS is still the long term technology for voice and preserves more than 80% of railways assets while evolving toward IP.
- The roadmap can be « railways needs evolution » based, not « technology only » driven.
- It shall, if possible, address “all transport” needs, and if feasible worldwide through a 3GPP type organization.
- GSMR-IP is Global, allows from the Shelves delivery, ensures Multi-supplier environment, is Reliable, prepared for Innovation and answers Promises.