International Perspective
Broadband Access for Railways & Utilities

Vino Vinodrai
Consultant to RAC
Agenda

• Railway White Paper
• World Radio Conference
• Standards
• Examples of Broadband Network for Railways & Utilities
  • Europe
  • Brazil
  • South Korea
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Transport Canada’s Advisory Council on Railway Safety (ACRS) established the Train Control Working Group. It was given the mandate to study existing and developmental fail-safe train control systems—also known as Enhanced Train Control (ETC).

Although no specific technology or combination of technologies have yet to be determined, a common factor among all technologies reviewed by the Working Group was the need for a reliable wireless communication infrastructure to support ETC.

Railways must seek spectrum in a band that is compatible, as much as possible, with existing network infrastructures. The propagation characteristics of the spectrum must also be compatible with railway operations. There are currently two “available” bands that meet those requirements: 600 MHz and 700 MHz.

The RAC should initiate discussions with potential partners outside the railway industry. Through a LTE capability known as “network slicing”, which allows multiple logical networks to be created on top of a common shared physical infrastructure, networks can be shared seamlessly amongst different services and competing entities (such as CN and CP). Furthermore, ISED looks favorably at initiatives that can both maximize the utilisation of radio spectrum and the sharing of infrastructures, especially antenna towers. The RAC should seek the support of both TC and ISED on the issue of partnership.
Technology Progression

1G Analog
2G Digital
3G
4G
5G

Evolution

How long would it take to download the two-hour-long “Guardians of the Galaxy”?!

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Time</td>
<td>26 hours</td>
<td>6 minutes</td>
<td>3.6 seconds</td>
</tr>
</tbody>
</table>

What you could do while waiting:
- Fly from New York to Sydney, including check-in times
- Run a quick mile
- Catch up on Facebook
- Ask, “Is it downloaded yet?”
Vision Beyond 2020

Usage Scenarios of IMT-2020

Future IMT

Ultra-reliable and low latency communications
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World Radio Conference

Organization of the ITU-R conference preparatory work

- World radiocommunication conferences (WRC) are held every three to four years. WRC reviews, and, if necessary, revises the Radio Regulations, the international treaty governing the use of the radio-frequency spectrum and the satellite orbits.
- Last WRC was in 2015.
- Countries submit proposal for next WRC.
- China/Japan proposed item on railways.
- Studies are carried out by Working parties over four years.
- Over 2500 delegates attend WRC from 193 countries.
- Lasts for 28 days.
- On last day a report is produced which binding treaty, each country has to abide by it.
WRC AI 1.11 - Railways

- Resolution **236 (WRC-15)** invites WRC-19, based on the results of ITU-R studies, to take necessary actions, as appropriate, to facilitate global or regional harmonized frequency bands, to the extent possible, for the implementation of railway radiocommunication systems between train and trackside (RSTT), within existing mobile service allocations.

- **1.11** to take necessary actions, as appropriate, to facilitate global or regional harmonized frequency bands to support railway radiocommunication systems between train and trackside within existing mobile service allocations, in accordance with Resolution **236 (WRC-15)**;

- RAC has participated in Canadian Preparation for this conference since 2017
Proposal for WRC to Consider

- To address agenda item 1.11, ITU-R (WP5A) has undertaken studies towards the development of two ITU-R Reports and one Recommendation
- Three methods have been proposed to satisfy this agenda item:
  - Method A: No change to the RR except suppression of Resolution 236 (WRC-15);
  - Method B: Add a new Resolution [A111-METHOD B] (WRC-19) specifying frequency ranges for RSTT and referencing the most recent version of Recommendation ITU-R M.[RSTT_FRQ] and consequently suppress the Resolution 236 (WRC-15);
  - Method C: Add a new Resolution [B111-METHOD C] (WRC-19) without specifying frequency ranges for RSTT, while referencing the most recent version of Recommendation ITU-R M.[RSTT_FRQ] and consequently suppress the Resolution 236 (WRC-15).
Likely Outcome

- Americas – support no change
- Europe – support no change
- Russian Block – support no change
- Africa – Some form of Resolution
- Middle East - Some form Resolution
- Asia/Pacific – Split
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Demise of GSM-R

GSM-R is being phased out from 2020 onwards:

- The system life-cycle is coming to an end, with vendor support uncertain beyond 2025/2030
- Severe interference with LTE out of band emissions
- UIC wants to have a successor technology in place by 2020 for trials and by 2022 for deployment
- UIC has already published a user requirement specification in their paper “Future Railway Mobile Communication System”
TETRA Terrestrial Trunked Radio

The Standard
Developed by ETSI
Open digital standard in Europe
Adopted worldwide
Used by various verticals/segments

A Success
TETRA Association represents more than 150 organizations worldwide
More than 100 companies are involved in the development of applications
Over 110 countries have adopted TETRA
UIC is moving towards next generation wireless communication technologies for rail operations to replace GSM-R
- UIC has recently published a set of technology independent user requirements for the FRMCS (Future Railway Mobile Communication System)
- **UIC and TCCA are cooperating** to define the next generation broadband communications for railway operations
- The aim is to use standard technologies like 5G, and not a specialized system like GSM-R
LTE Release 12 onwards supports Mission Critical Train communications

### Standards Aligned to 3GPP Release 12

- 3GPP: GCSE Phase 1
- 3GPP: ProSe Phase 1
- OMA: PCPS* v1.0
- ETSI TCCE: CCA** Stage 1
  * Push-to-Communicate for Public Safety
  ** Critical Communications Architecture

<table>
<thead>
<tr>
<th>3GPP Release</th>
<th>Main Radio Features</th>
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<tbody>
<tr>
<td>Rel-99</td>
<td>WCDMA FDD &amp; TDD</td>
</tr>
<tr>
<td>Rel-4</td>
<td>TD-SCDMA</td>
</tr>
<tr>
<td>Rel-5</td>
<td>HSDPA</td>
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<tr>
<td>Rel-6</td>
<td>HSUPA</td>
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<tr>
<td>Rel-7</td>
<td>HSPA+, EDGE evolution</td>
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<td>Rel-8</td>
<td>LTE</td>
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<tr>
<td>Rel-9</td>
<td>LTE enhance</td>
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<tr>
<td>Rel-10</td>
<td>LTE-A air interface</td>
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<tr>
<td>Rel-11</td>
<td>HSPA+ and LTE-A enhancements</td>
</tr>
<tr>
<td>Rel-12</td>
<td>HSPA+ and LTE-A enhancements</td>
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</tbody>
</table>

**LTE for mission-critical users**


- Group commns system enablers for LTE (3GPP GCSE_LTE), proximity-based services (3GPP ProSe)
- Frequency bands

### Standards Aligned to 3GPP Release 13

- 3GPP: MCPTT Phase 1
- 3GPP: Isolated Operations (IOPS - Stage 1)
- 3GPP: GCSE Phase 2
- 3GPP: ProSe Phase 2
- ETSI TCCE: CCA Stage 2 (Stage 3 TBD)

### 3GPP Release 14 & 15 Standards

- Isolated Operations (IOPS - Stage 2 &3)
- Later phases of GCSE, ProSe, MCPTT
- MC Multi-Media
- End-to-End Security (including User Identity)
- PS Broadband Consoles
- 5G, Spectrum (Unlicensed, Sensing, Dynamic, etc.)
GSM-R Replacement for ETSC (European Train Control System)

International Railway Union (UIC) calling for a GSM-R replacement:
• Published user requirements in “Future Railway Mobile Communication System (FRMCS)” white paper (Mar 2016, http://www.uic.org/IMG/pdf/frmcs_user-requirements.pdf)
• Expecting complete GSM-R obsolescence by 2030
• Calling for successor technology in place by 2020 for trials, and by 2022 for deployment

Standards for Mission Critical features are still evolving...for Railways
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Europe Today

• Today 876 - 880 MHz / 921 - 925 MHz harmonised for GSM-R
  • 2x4 MHz for GSM-R only

• **No spectrum harmonisation** of 873 - 876 MHz / 918 - 921 MHz
  • Only on a national basis
  • 3 countries so far: Germany, Switzerland and Liechtenstein (rights of use)
    + planned in Belgium
Europe Studies

• CEPT tasks
  • FRMCS spectrum needs (only for critical applications)
  • Feasibility of the 900 MHz range while ensuring parallel operation with GSM-R during the migration
  • Feasibility of the 1900-1920 MHz band (and further bands if relevant)
  • Feasibility to use commercial mobile networks
  • Develop harmonised technical conditions

• Target date: November 2020
Europe Future…

To FRMCS and beyond! - A possible ending

Core band: 874.4 - 880 MHz / 919.4 - 925 MHz FDD
Both GSM-R and FRMCS, including guard-band towards SRD

Complementary band: probably 1900 - 1910 MHz TDD
Or 10 MHz in 2290-2400 MHz TDD as a tuning range
FRMCS only
Canadian utilities have been granted access to 30 MHz of spectrum in the band 1800-1830 MHz for intelligent electricity networks.

Extract from ITU – WP5A Report

Annex 9 to Document 5A/976-E
16 November 2018
Brazil – Private LTE Network

• First private LTE deployment in Brazil for grid automation, allowing fast power restoration in the event of an outage and improving power delivery in parts of the State of Sao Paulo

• The LTE network will link smart meters and other equipment to track power usage and enable more than 75,000 customers to shift consumption patterns to save money

• The 4G LTE network will be deployed in 3.5 GHz

• The network will provide business-critical connectivity for grid equipment, smart meters, substations and distributed energy generation sources throughout the service area,
Establishment of Integrated Public Network (2014)

Need for Public Safety Network

- Sewol Ferry Disaster (2014)

Integrated Public Network

- LTE-R (LTE-Railway)
- PS-LTE (Public Safety LTE)
- LTE-M (LTE-Maritime)

Frequency Allocation of 700 MHz Band (UL 718-728 MHz, DL 773-783 MHz)
Future Intelligent Railway Services (Examples)

Railway Safety
- Monitoring infrastructure status
  - Railway asset management
- Image information
  - Cab and coach CCTV real time transmission
- Train control
  - GIS location-based Central Traffic Control

Maintenance Enhancement
- Wire-wireless integration
  - Wired & wireless integrated system
    - (Inside) WIFI ↔ (Outdoor) LTE-R
- Maintenance technical support
  - Emergency recovery support including image transmission

Customer Service
- Logistics information
  - Provide real-time logistics information (Cargo information)

RailCanada
www.facebook.com/RailCanada
www.linkedin.com/company/railway-association-of-canada
www.railcan.ca

Railway Association of Canada
Future 6G?

- Inherently support a large dynamic range of novel usage scenarios that combine extreme data rates with agility, reliability, zero response time and AI.
- Cost-efficient and flexible provision of high-speed data connections guaranteed, zeroing the 'digital divide'.
- Extend the fibre optic systems QoE and performance reliability to wireless.

Courtesy of Wireless World Future Forum (www.wwrf.ch)
National Flagship on wireless communications

6G Enabled Wireless Smart Society & Ecosystem

- National Flagship for 2018-2026
- Volume 251M€
- Operated by University of Oulu
- Collaboration with Nokia, VTT, Aalto University, BusinessOulu, OUAS.

6Genesis was elected as Finlands high-tech Flagship, by Finnish Government through Academy of Finland

1. Wireless Connectivity
   - Ultra-reliable low-latency communications
   - Enabling Unmanned Processes

2. Devices & Circuits
   - THz communications materials & circuits
   - Enabling Unlimited Connectivity

3. Distributed Computing
   - Mobile edge intelligence
   - Enabling Time Critical & Trusted Apps

4. Services & Applications
   - Multidisciplinary research across verticals
   - Enabling Disruptive Value Networks
Last Thoughts

• Need for creating Eco System for User Equipment (UE)
• Work through WP5A & CITEL to harmonize spectrum band
  • USA first
  • South & Central America
• Synergy with Utilities
• Spectrum Possible Partners
  • Public Safety
  • Public Mobile Service Providers – New Entrant
  • Ancillary Terrestrial Component (ATC)
    • Terrestrial network of cell-phone towers to supplement a Mobile Satellite Service (MSS)
  • Network Slicing
Thank You

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