Standardisation Roadmap for Next Train Radio Telecommunication Systems

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Train Communication System

- **ERTMS**: Unified train control system in Europe
  - High speed trains support
  - Line densification
  - Facilitate train movement across borders in Europe
- Studies started in the 90s, system available 10 years after
- **GSM-R**:
  - Radio part of ERTMS
  - Based on GSM, but with train specific features
    \[=> \text{GSM-R is a branch of GSM, not an of-the-shelf component}\]
- **Life cycles**
  - Train domain: life cycle is 20 / 30 years
    - In France, ERTMS deployment to be complete by 2017
  - Mobile public access domain: 1 generation every 10 years
    \[=> \text{Life cycles are very different}\]
Drivers for Next Generation

• New services envisaged
  – CCTV (monitoring, look-ahead,...)
  – Train maintenance & configuration
  – Personal Information Service
  – Public internet access

• Current Issues for these new services
  – Avoid having to deploy 1 communication system per service
  – GSM-R lack of capacity and flexibility

• GSM-R obsolescence
  – GSM-R industry promises support until 2030

=> Time to think about the next train communication system
Preparing the future

- Initiatives toward the next train communication system
  - UIC (International Railway Union)
    - Studies started in 2009
    - FRMCS (Future Railway Mobile Communication System)
    - Project launched in 2014, 3 years duration
    - Railway operators requirements and use cases
  - ERA (European Railway Agency)
    - Survey among all railways stakeholders
  - ETSI RT-NG2R group (Next Generation Radio for Rail)
    - Created in 2015
    - Collect requirements
      - Urban, suburban, regional, long distance
    - Provide standards for applications
    - Coordination with European and international bodies
  - European Commission expectations
    - Decision expected to be taken by 2018
    - Next Generation System expected available for deployment by end of 2022
Preparing the future

• Some hot topics
  – Sharing with PPDR (Public Protection & Disaster Relief) services?
    • System and spectrum sharing
    • Wider market
    • Responsibility issues
  – Convergence between urban and long distance rail?
    • Some commonalities, but also some different requirements
    • Different communities not used to interact
  – Off-the-shelf or dedicated system?
    • Life cycle difference
    • 3GPP LTE / 5G are candidates
      – Do they support all train operators’ requirements?
    • Other candidates: Satellite in rural areas, wifi in stations,...
    • Over the top applications vs Integrated services
3GPP LTE

- Initial work started in 2004
- Designed to replace UMTS
- Focus on public data and voice Mobile BroadBand (MBB) services
- First release in 2008 (Rel.8)
- Evolved from then toward more versatility and Vertical sectors:
  - Small cells
  - Machine-Type Communications
  - Device-2-Device
  - MCPTT (group communication)
  - SC-PTM (Single Cell Point to Multipoint)
  - V2X

Current release: Rel.13

3GPP path toward standards
- Work items (specifications)
- Study items (feasability)
- Preliminary discussions

Vertical sectors
- Public Safety
- Group Com.
- CN-Less
- Device-to-Device
- Trains: Mobile Relays
- Machine-to-Machine
- Fixed Relays
- Heterogeneous Networks
- Small cells (outdoor)
- Home cells (Femto)
- Large cells (macro) / Medium cells (pico)

Broadband services

3GPP LTE

• On-going work (Rel.14 plan)
  – MCPTT enhancements
    • Group call priority management
    • Video and data support
  – V2X
    • Vehicle to vehicle, vehicle to pedestrian and vehicle to infrastructure.
  – MBB public access in high speed trains improvements
    • up to 350 km/h
    • Doppler compensation
    • ...

• Some missing functions
  – Location-dependent addressing
  – Function-dependent addressing
    • Could be implemented as ‘over the top’ applications

• High-speed performance enough?
  – Depends on available spectrum

• Train dedicated spectrum bands not in LTE
Over the top vs Integrated

- Integrated service example: 3GPP LTE MCPTT
  - MCPTT client may report data to MCPTT server
    - Link quality
    - UE location (serving Cell and neighbouring cell)
    - MCPTT broadcast services availability...
  - MCPTT server can select the best data path
  - MCPTT server rather independent from EPS
    - But is aware of some radio-level knowledge
    - => This allows radio optimisation

Possible resource optimisation by Unicast or Multicast path selection

- EPS: Evolved Packet System
- EPC: Evolved Packet Core
- RAN: Radio Access Network
- PCRF (Policy & Charging)
- Unicast Path
- MBMS
- MBMS Path
- SC-PTM
- MCPTT Server
- Rx
- SGI
- MB2
- SCL
- MCPTT: Mission Critical Push To Talk
- MBMS: Multimedia Broadcast and Multicast Service
- SC-PTM: Single Cell Point to Multipoint

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Over the top vs Integrated

- Over the top service example: Push To Talk over Cellular (PoC)

- PoC server has limited interfaces with the access network
- Unicast communication

⇒ Application more independent from radio access technology
⇒ But not possible to optimise radio access
Toward 5G

• First studies as soon as 2012
  – EU project METIS for example

• 5G strategic organisations put in place in 2014
  – 5G Infrastructure Public Private Partnership (5G PPP) in Europe
  – Fifth Generation Mobile Communications Promotion Forum (5GMF) in Japan

• Concrete discussions in 3GPP started in autumn 2015

• 3GPP work started in 2016
  – The big machine moved off
Toward 5G

• What could be expected
  – 5G shall address different services from its beginning
    • Mobile BroadBand (MBB)
    • Massive Internet of Things (mIoT)
    • Critical Communications (CRIC)
  – 5G shall address different sectors
    • Public access
    • ‘Verticals’
      – Automotive, energy, factory automation, e-health
  – High performance targets
    • Bandwidth: several magnitude increase
    • Latency: down to the 1 ms
    • Supported user number increase
  – New air interface, new spectrum
    • From below 6 GHz up to millimetre waves above 24.25 GHz
  – New core network

⇒ Opportunities to influence the standard
⇒ High speed trains explicitly in the scenarios to be studied
Toward 5G

• What could be expected
  – CN (Core Network) should be as independent as possible from the RAN (Radio Access Network)
    • Possible interworking with LTE RAN
  – New RAN should be able to interwork with LTE

• Mobile network design evolutions
  – Network Function Virtualisation (NFV) and Network slices
    – To cope with the various requirements
    => 
    `Easier to have a dedicated slice with limited impact on the other ones`

(Source 3GPP TR 22.891)
Possible roadmap

LTE and 5G will evolve in parallel: One release will include LTE and 5G

Salient milestone for 5G
Japan expects first 5G services for the Tokyo Olympic Games
Focus on Mobile BroadBand (MBB)

5G Rel. 16 should include Mission Critical features

Rail migration time line
- 5 years preparation
- 5 years actual migration

NG2R: Next Generation for Rail
Possible actions

• For railway actors to influence the 3GPP standard:
  – Rel.14 (on-going)
    • Still a bit late for new features, but
    • Support work items on high speed train enhancements (LTE)
    • Support 5G scenario definition for trains
  – Rel.15
    • More reasonable target for introducing specific requirements and dedicated features
    • ETSI NG2R proposed a new study item for 3GPP SA1
      – Gap analysis between UIC FRMCS and 3GPP features
      – Define features to close the gaps
      – To be submitted in June 3GPP SA plenary
Conclusion

- Drivers for looking at the successor of GSM-R for train communication system
  - Appearance of new services
  - Expected obsolescence of GSM and GSM-R
- Possible candidates
  - 3GPP LTE
  - 3GPP 5G
- Some issues
  - Spectrum
  - Sharing
  - Off-the-shelf / Dedicated system trade off
  - Co-existence with GSM-R
- On-going actions
  - UIC FRMCS
  - ETSI NG2R
  - ERA
Thank you for your attention