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Standardisation Roadmap for Next Train Radio Telecommunication Systems

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Nets4Trains 2016
San Sebastian, June 6th, 2016

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

  => 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

  => 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
      - *Railway Mobile Communication System User Requirement Specification* released in Oct. 2010
    - 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

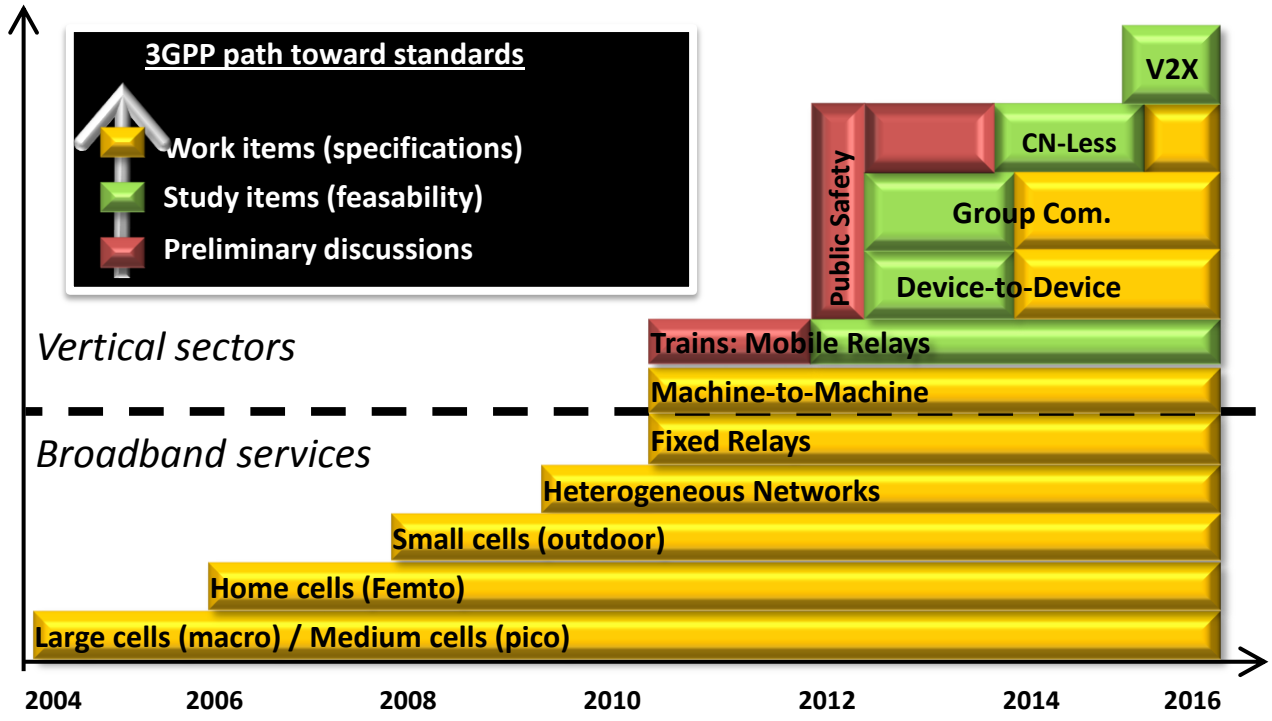
Preparing the future

- 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

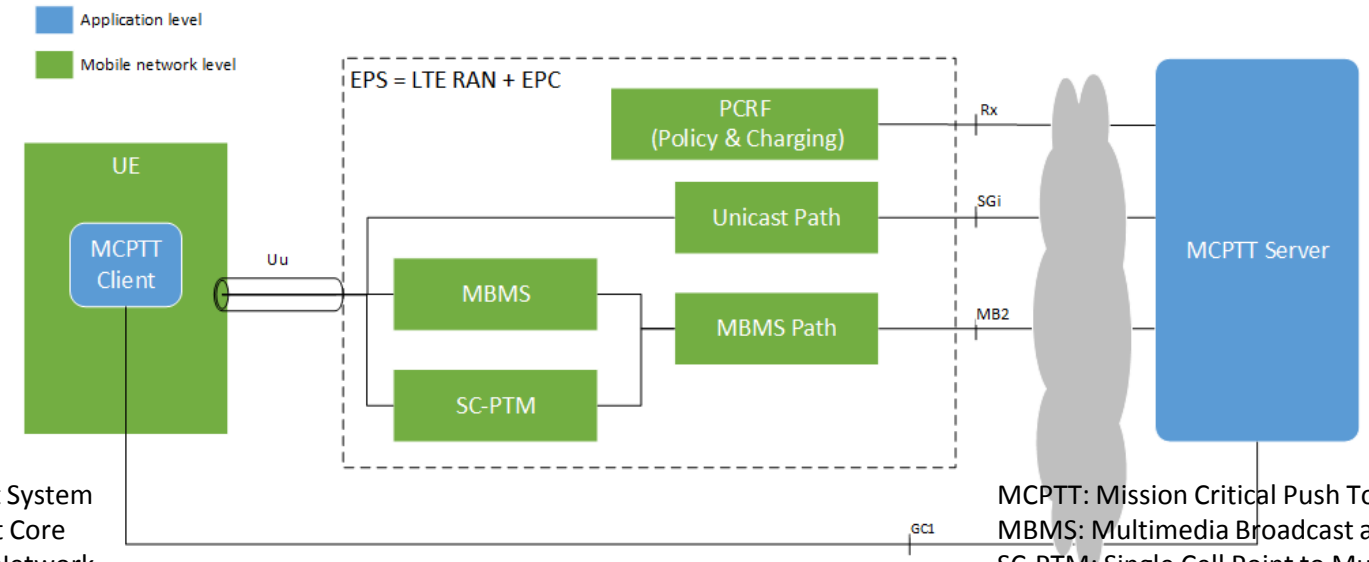


3GPP LTE

- 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



EPS: Evolved Packet System
EPC: Evolved Packet Core
RAN: Radio Access Network

MCPTT: Mission Critical Push To Talk
MBMS: Multimedia Broadcast and Multicast Service
SC-PTM: Single Cell Point to Multipoint

Possible resource optimisation by Unicast or Multicast path selection

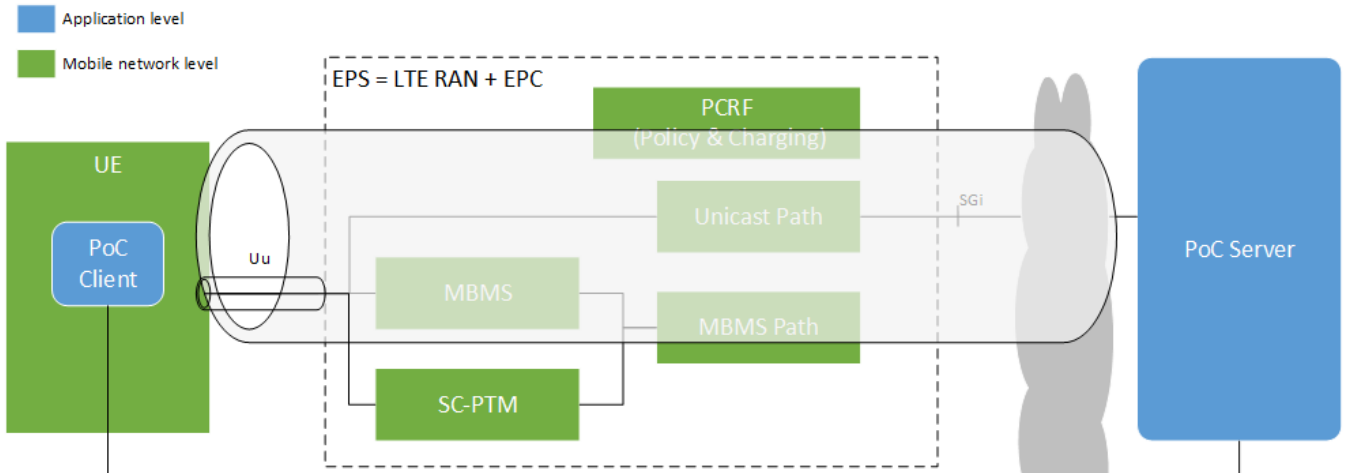
- MCPTT client may report data to MCPTT server
  - Link quality
  - UE location (serving Cell and neighbouring cell)
  - MCPTT broadcast services availability...
- MCPTT server can select the best data path

- MCPTT server rather independent from EPS
- But is aware of some radio-level knowledge

  => This allows radio optimisation

Over the top vs Integrated

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



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Access network used as a pipe

- 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

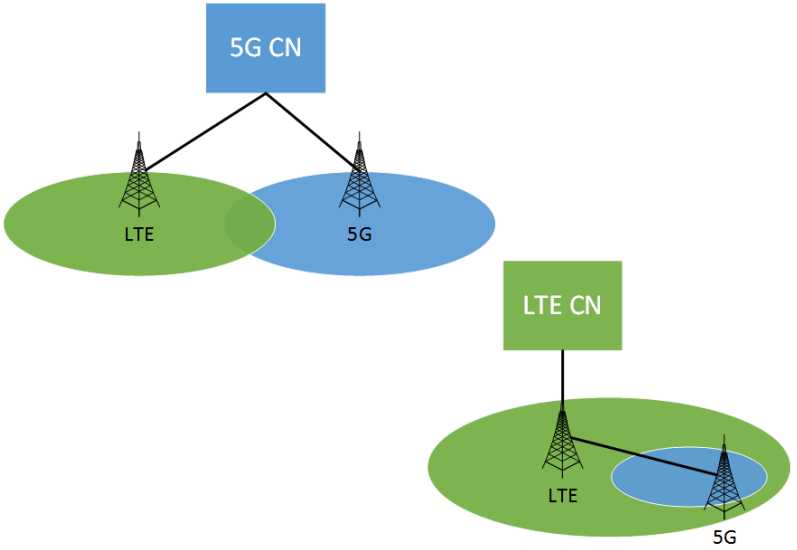
- What could be expected
  - 5G shall address different services from its beginning
    - Mobile BroadBand (MBB)
    - Massive Internet of Things (mIoT)
    - Critical Communications (CRIC)
  - 5G shall address different sectors
    - Public access
    - 'Verticals'
      - Automotive, energy, factory 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

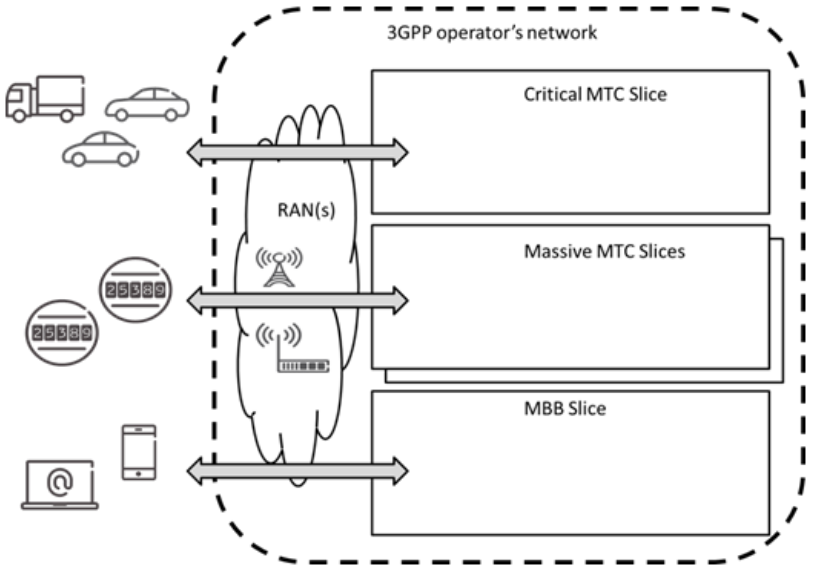
Toward 5G

- 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



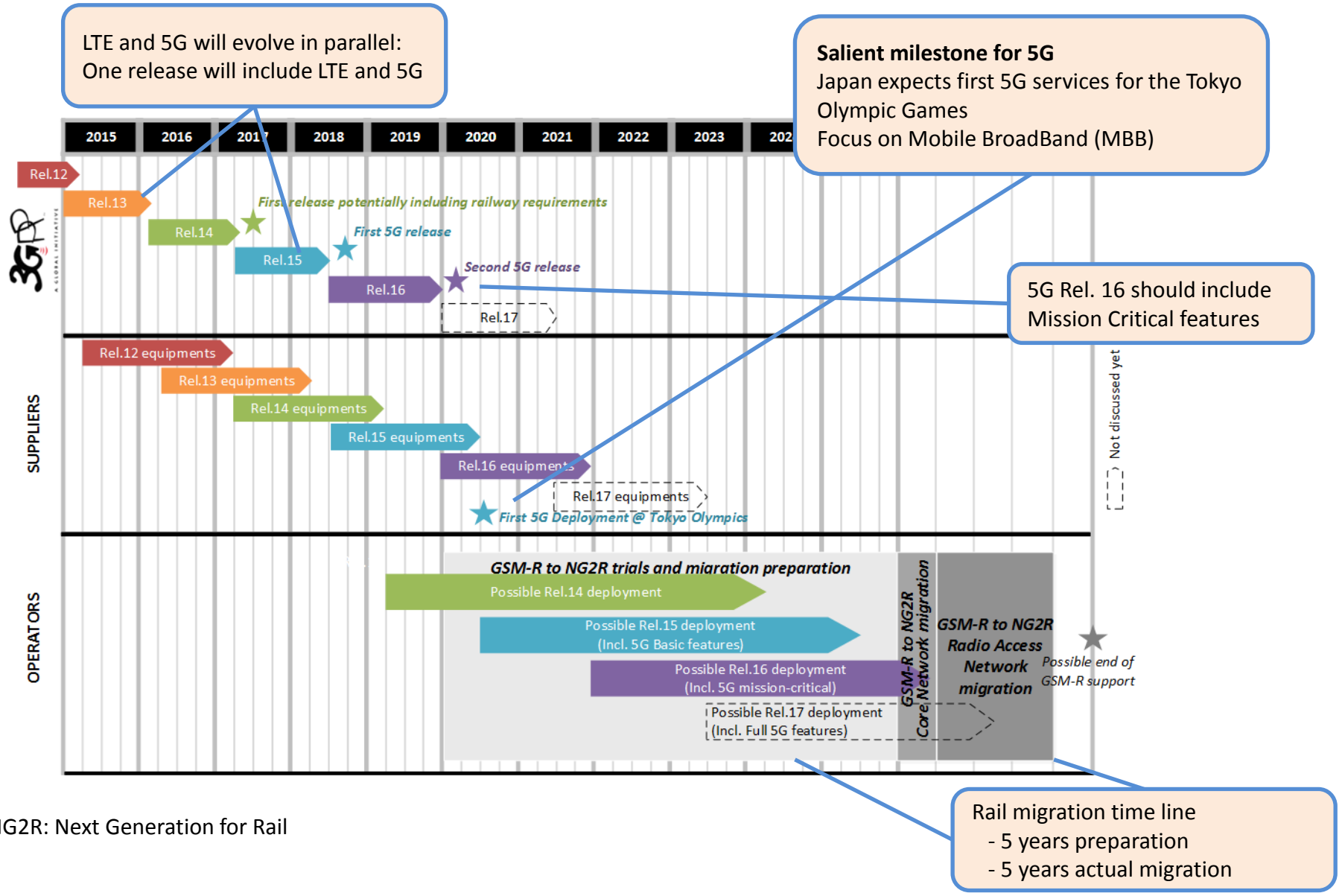
- Mobile network design evolutions
  - Network Function Virtualisation (NFV) and Network slices
    - To cope with the various requirements

  => Easier to have a dedicated slice with limited impact on the other ones



(Source 3GPP TR 22.891)

Possible roadmap



NG2R: Next Generation for Rail

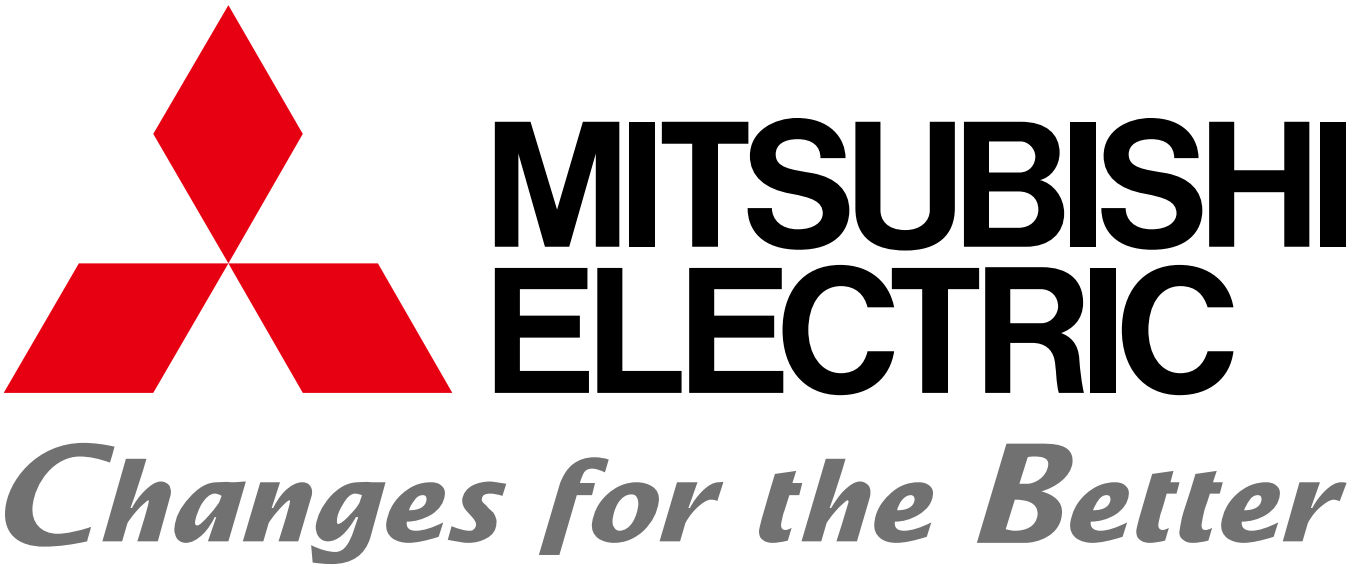
Possible actions

- 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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