3GPP Mobile Systems Evolutions

David MOTTIER

Paris, Sept. 11th 2013

MITSUBISHI ELECTRIC
Changes for the Better

Mitsubishi Electric R&D Centre Europe - COM Division

# 3GPP Specifications & Impact

- 3GPP produces evolving technologies and specifications for commercial /cellular mobile systems since 1998

- 3GPP impact is increasing: it becomes the focal point for mobile systems beyond 3G (B3G)

  – Inside AND outside the community of public mobile cellular systems

- Long-Term Evolution (LTE) is now considered as a candidate radio access technology for next generation train radio

  - Under discussion in UIC/ERIG, also addressed by the Urban rail community

How Close is LTE to Railway Requirements?

- User Requirement Specifications (URS)
  - V1.0 produced by ERIG on Dec.1st, 2010

- Few information in URS to assess candidate radio access technologies
  - Focus on the needed applications & services
  - Page 36
    - *"Provision of real time CCTV picture transmission via radio between train and ground based systems "*
  - Page 74
    - *"The technology used shall be capable of operating at speeds up to 360 km/h."*
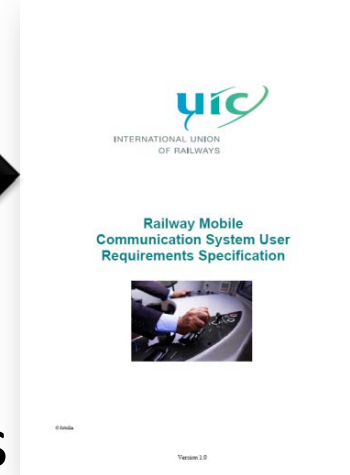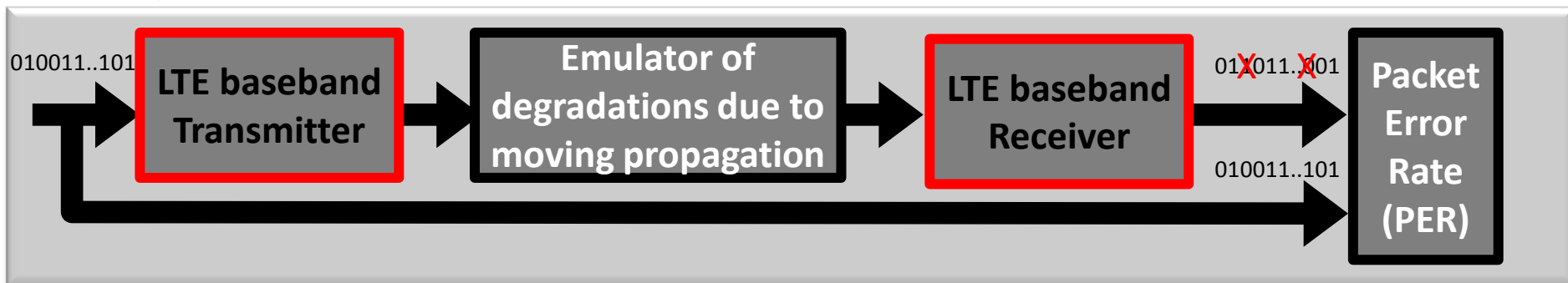
LTE Evaluation at Railway Speeds

- Mobility support in LTE [3GPP TR 25.913 Section 7.3]

  B3G
  LTE

  - *"Optimized for low mobile speed (0-15km/h)"*
  - *"High performance for intermediate speeds (15-120km/h)"*
  - *"Support of high speeds (120-350km/h)"*

- From the radio frame design, the limiting radio link to high speeds is the reverse link (i.e., from the train to the ground)

  ➡️ Let's evaluate the reverse link by computer simulations!

010011..101 → **LTE baseband Transmitter** → **Emulator of degradations due to moving propagation** → **LTE baseband Receiver** → 01X011..X01 / 010011..101 → **Packet Error Rate (PER)**

Simulation scenario

- *800 MHz Carrier frequency, 4 MHz bandwidth*
- *Up to 4 trains connected in the same time at the same base station*
- *LTE reference receiver design*

Figure of merit

- ***Achievable throughput*** *for a 20 dB operating Signal-to-Noise Ratio (SNR)*
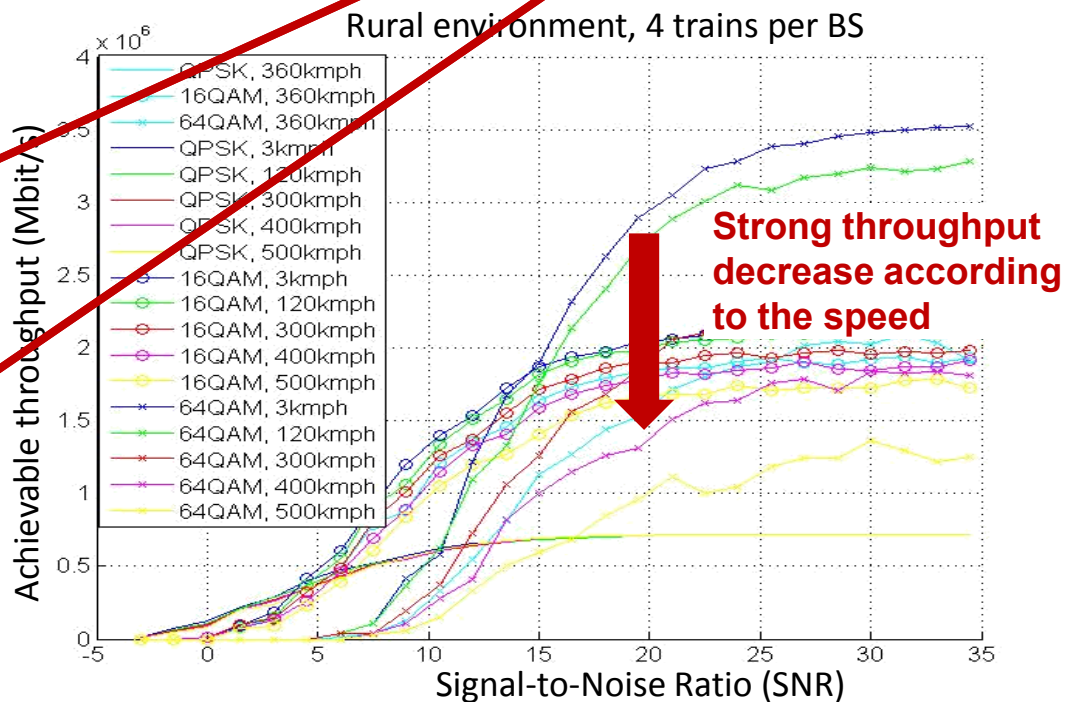- *= Maximum throughput x (1-PER)*

LTE Results at Railway Speeds

$$\div 4$$

- Maximum throughput for ➡ various modulation formats

Modulation format	Max. throughput (1 train/BS)	Max. throughput (4 trains/BS)
64QAM 5/6	14.4 Mbit/s	3.6 Mbit/s
16QAM 3/4	8.64 Mbit/s	2.16 Mbit/s
QPSK 1/2	2.88 Mbit/s	720 kbit/s

- **Achievable throughput**

4 trains / BS

	Velocity (km/h)	Achievable Throughput (Mbit/s)
Urban environment	3	1.44
	120	1.4
	300	1.18
	360	1.05
	400	1.02
	500	0.95
Rural enviornoment	3	2.94
	120	2.75
	300	1.92
	360	1.86
	400	1.79
	500	1.66

Rural environment, 4 trains per BS

Achievable throughput (Mbit/s) vs Signal-to-Noise Ratio (SNR)

Legend: QPSK, 360kmph; 16QAM, 360kmph; 64QAM, 360kmph; QPSK, 3kmph; QPSK, 120kmph; QPSK, 300kmph; QPSK, 400kmph; QPSK, 500kmph; 16QAM, 3kmph; 16QAM, 120kmph; 16QAM, 300kmph; 16QAM, 400kmph; 16QAM, 500kmph; 64QAM, 3kmph; 64QAM, 120kmph; 64QAM, 300kmph; 64QAM, 400kmph; 64QAM, 500kmph

Strong throughput decrease according to the speed

=> Throughput limitation even in optimistic scenarios (only mobility impacts)
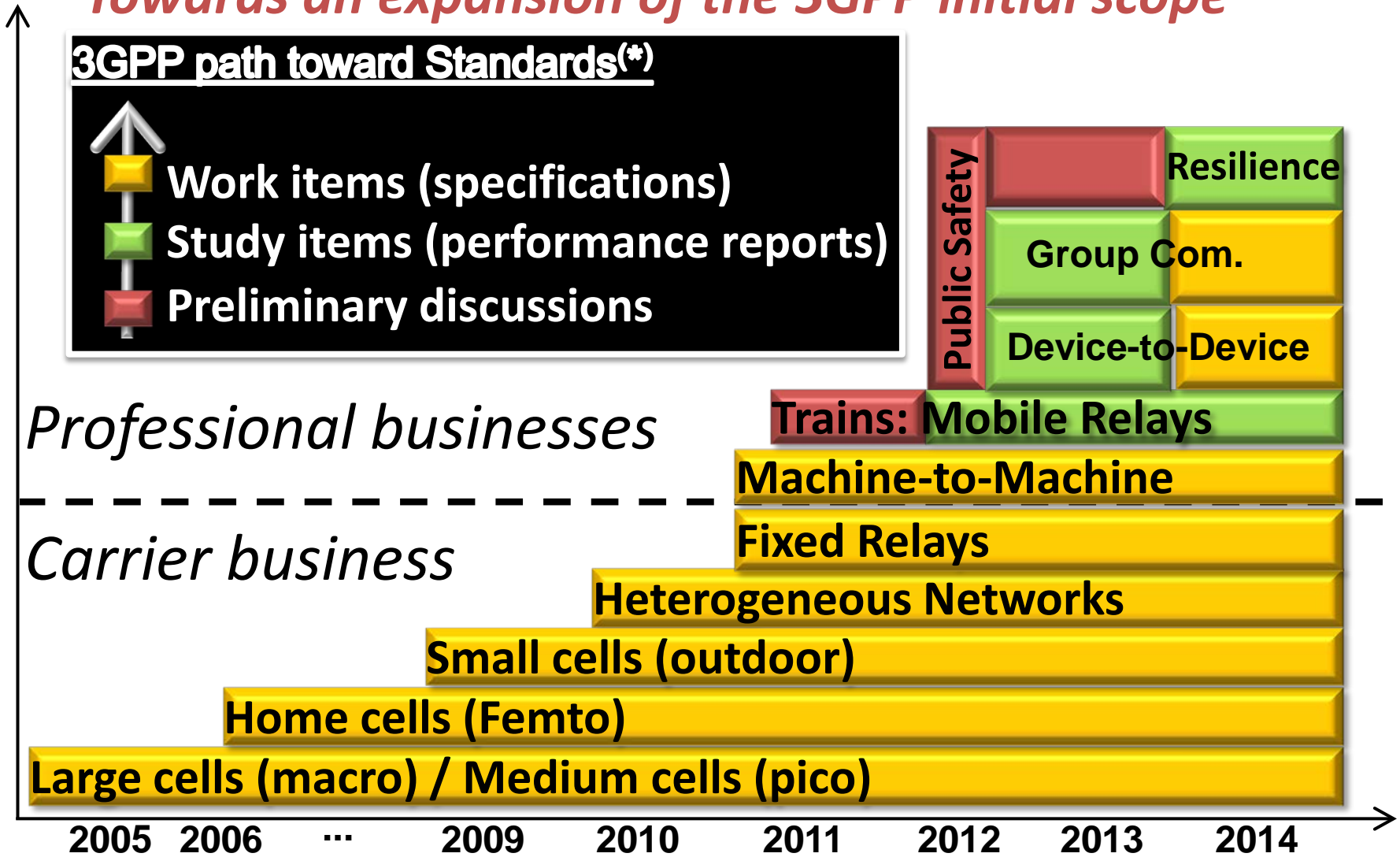
- CCTV traffic for 1 camera   **NOT OK with mobility**

OK Low quality: 350 kbit/s . Typical: 3 Mbit/s for 640x480 pixels @ 10 frames/s, MJPEG

3GPP Recent Evolutions

Towards an expansion of the 3GPP initial scope

3GPP path toward Standards(*)

- Work items (specifications)
- Study items (performance reports)
- Preliminary discussions

Professional businesses

Carrier business

Public Safety

Resilience

Group Com.

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)

2005 2006 ⋯ 2009 2010 2011 2012 2013 2014

(*): The progress of each item is prioritised according to 3GPP members' interests

Railway-related Work @ 3GPP: Mobile Relays

- Discussions initiated in 2009

- Target: public on-board access only
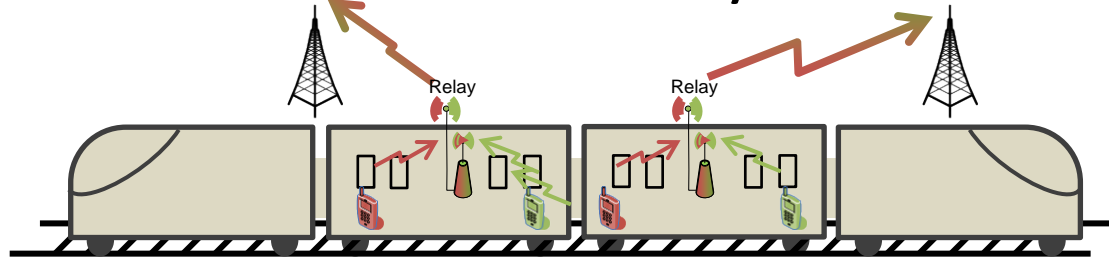
- Study Item launched in Sept. 2011

- Study objectives

  – Identify the scenarios and their requirements

  – Assess the benefits of mobile relays over existing solutions

    • From Radio point of view (high speeds)

    • From Architecture point of view

- Study status unclear due to the low number of contributors

Public Safety-Related Work @ 3GPP

- First Study Item started in Sept. 11
- First Target: Proximity-based Services
  - Use cases and requirements for Device-to-Device (D2D) Com.
  - √ Requirements captured in TR 22.803 (Mar. 2013)
- Second target: Group Communication Enablers for LTE
  - Service requirements to support Group Com. for critical communications such as Public Safety
  - √ Requirements captured in TS 22.468 (June 2013) ➡

  > - Group call setup <= 300 ms
  > - No audio delay difference from 2 nearby terminals
  > - 4 priority levels at least
  > - Unlimited group members

- Now Running
  - 2 Work Items on architectures for D2D and Group Com.
  - 1 Study Item on radio aspects for D2D
- Status: Many contributions but work is late
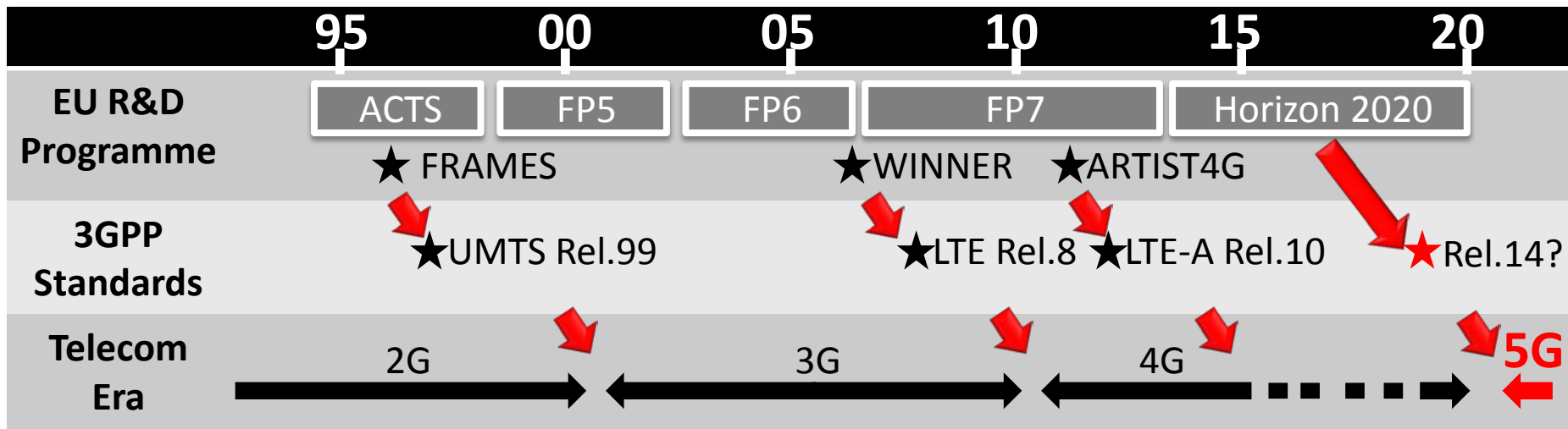 - Some tensions to define priorities in order to have at least basic D2D features available in Dec 2014

➡ **Potential impact on railways**

What's coming after

5G

- Every 10 years, a new G on the market
- 3GPP strongly influenced by EU R&D projects

	95	00	05	10	15	20
EU R&D Programme	ACTS	FP5	FP6	FP7	Horizon 2020	
	★ FRAMES			★ WINNER ★ ARTIST4G		
3GPP Standards	★ UMTS Rel.99			★ LTE Rel.8 ★ LTE-A Rel.10		★ Rel.14?
Telecom Era	2G	3G		4G		5G

Wordle of new EU R&D projects (e.g. METIS)

Conclusions

- ## 3GPP LTE for next generation train radio?

  - Interest has recently been shown from the rail and the light rail communities

  - Future decisions on spectrum at WRC will have an influence

  - An optimization is needed to meet very strict railway requirements

Additional Standardization	**OR**	**Proprietary Approaches**

depending on 3GPP members' interest

- ## A 3GPP window is now open for professional businesses

  - Still, the carrier business remains the priority

  - But enough players involved in Public Safety could start impacting the work

  - Possible key features as part of 5G

Reliability

Availability

Device-to-Device

Thank you for your attention