



# Session 5 Topic 4

## “Benefits from Packet Switching for ETCS”

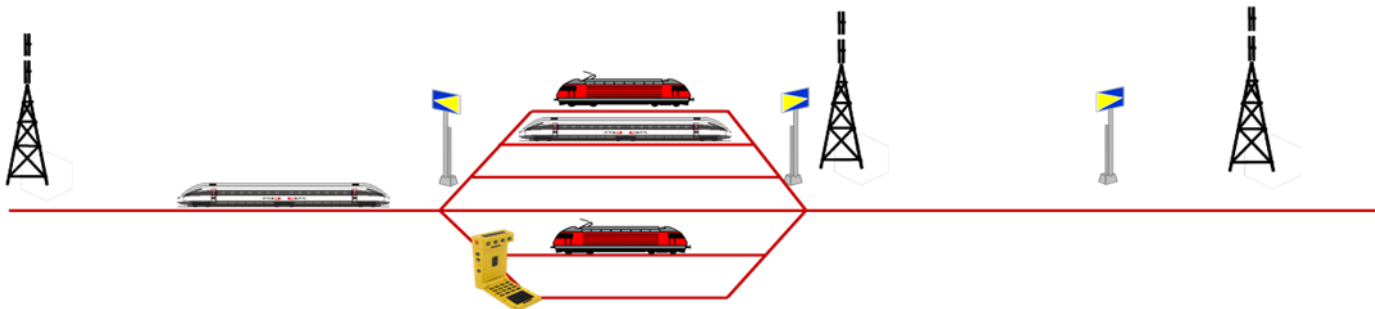
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# Frequency Status

## → GSM-R Air-interface

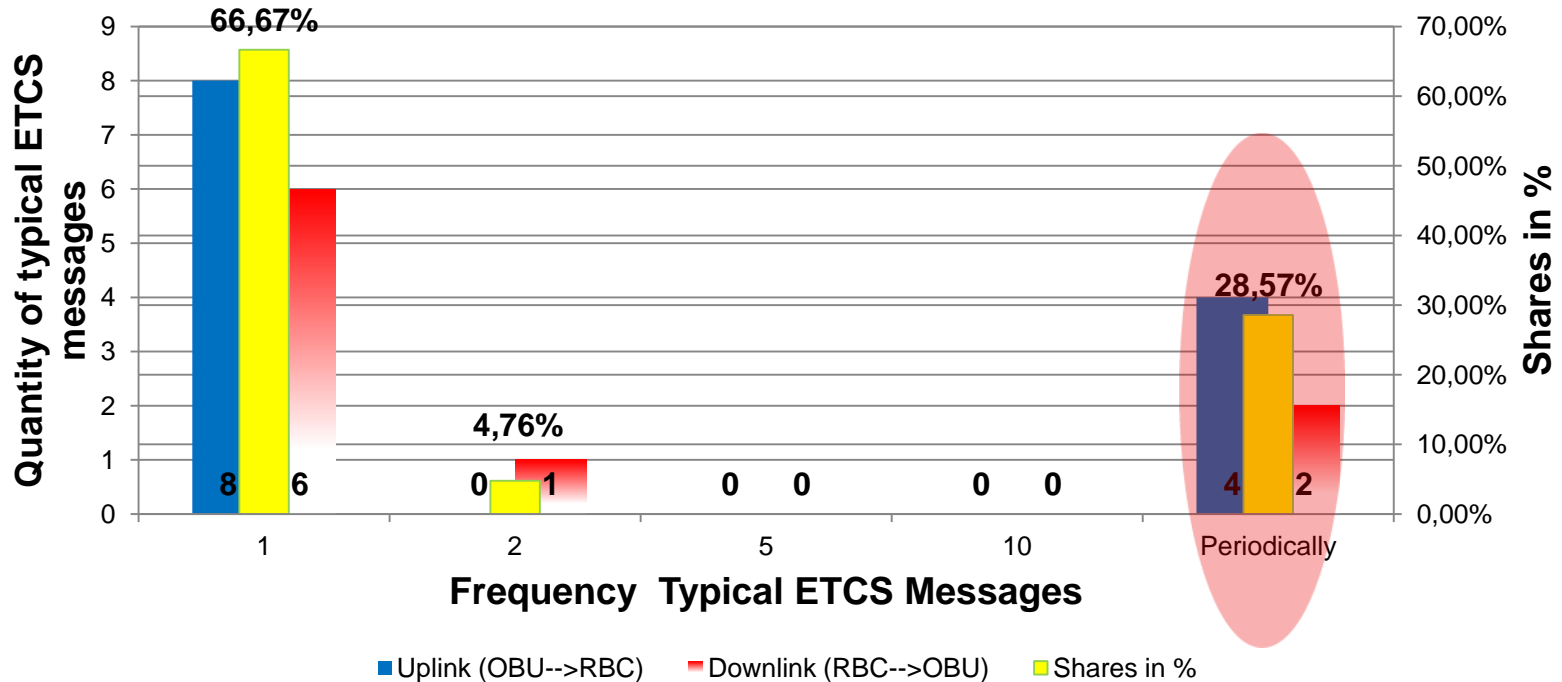
- UIC frequency band (paired spectrum 876-880 MHz Uplink 921-925 MHz Downlink) hosts 19 potential radio bearers
- Further radio bearers are available in the Extended UIC band
- Carrier bandwidth, Multiple Access Scheme, Carrier reuse i.e. C/I are examples of limiting criteria
- Shunting and simultaneous operation of ETCS Level 2 in CS-mode demands more traffic resources!





# ETCS operational requirements

- ➔ Frequency of ETCS user data packets are relatively low compared to other applications; Varies between 3 and 20 seconds
- ❖ Only ≈29% of the 21 typical ETCS messages are exchanged periodically!



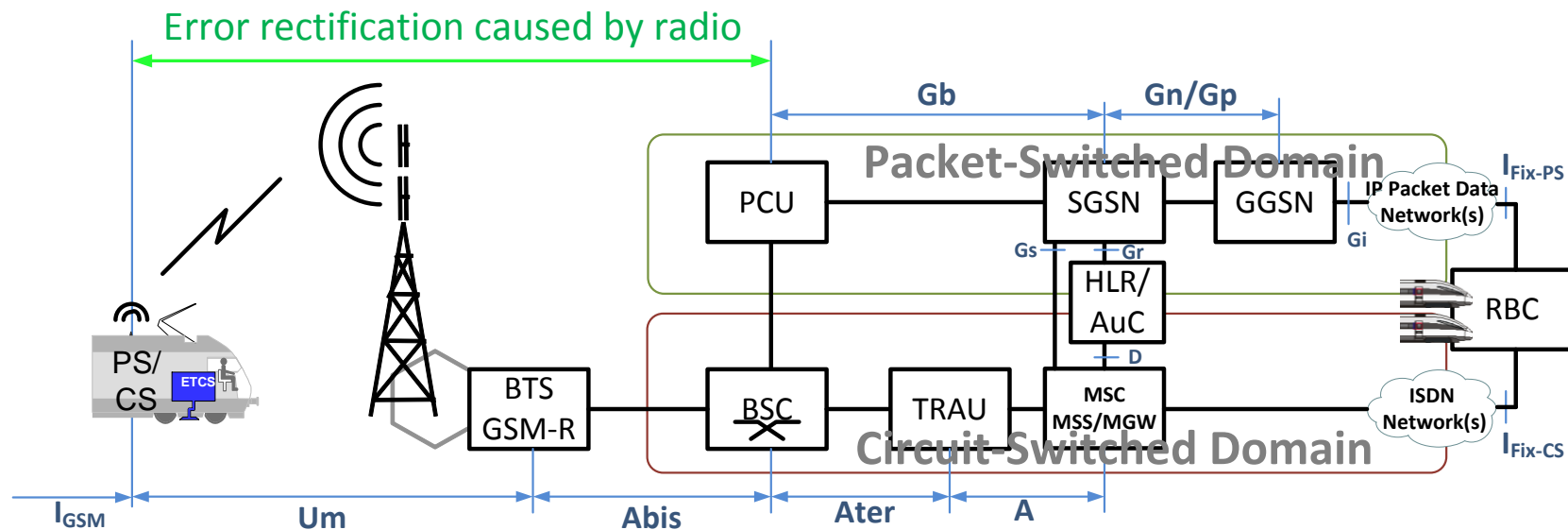
- ➔ Packet size of ETCS data units are relatively small!
  - Onboard to RBC: 13 – 60 octets
  - RBC to Onboard: 9 – 500 octets / 500 octets → Movement Authority



# Improved Transmission Error Correction

- Radio media might cause transmission errors
- ETCS in CS-mode applies an E2E error correction; messages can be delayed significantly
- GPRS/EGPRS will correct erroneous radio blocks at the lower layers; remaining transmission errors shall be corrected by the transport protocol

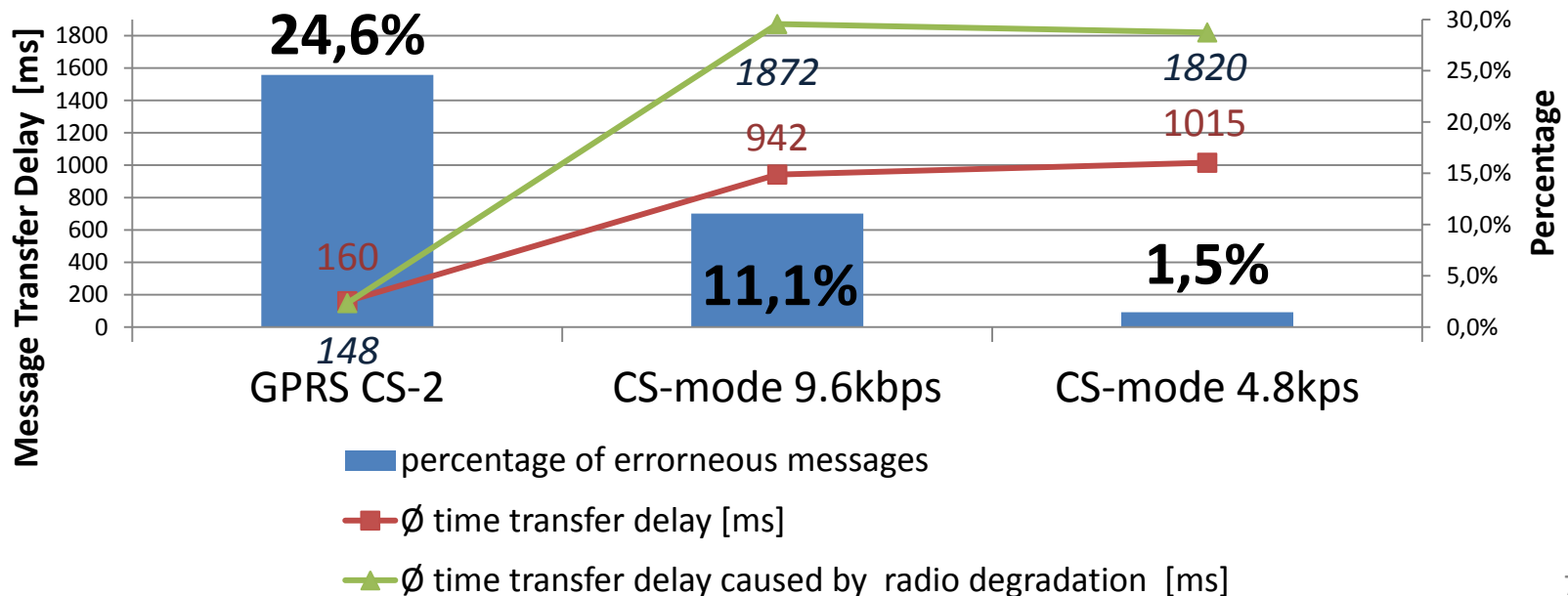
→ End to End Error Correction for remaining transmission errors@Transport Layer



→ End to End Transmission Error Correction

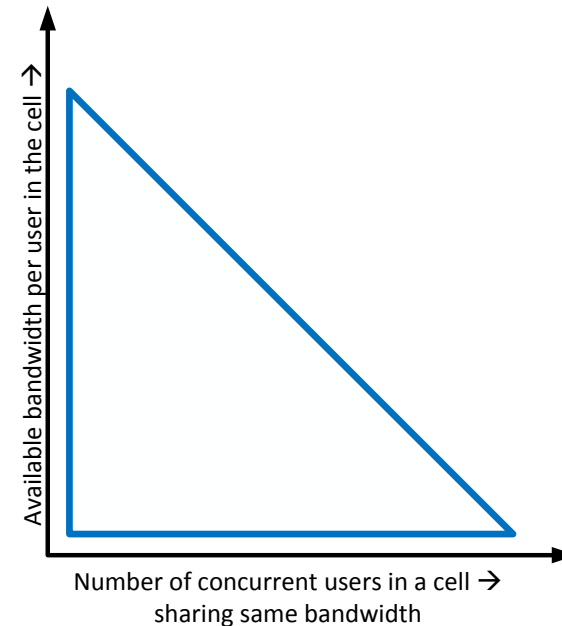
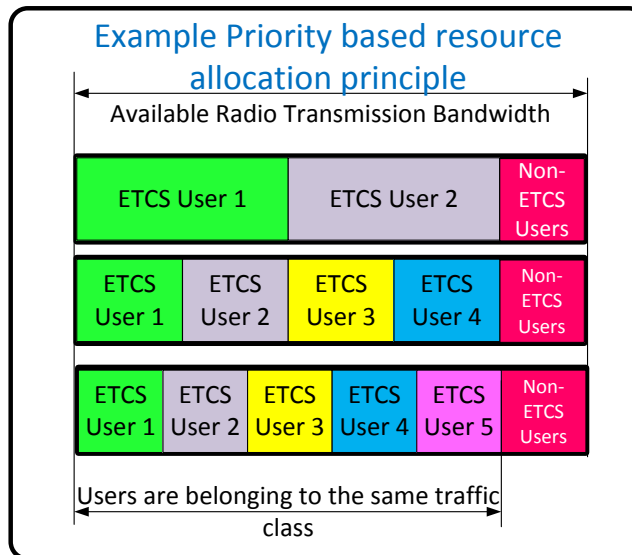
# Improved Transmission Error Correction

- ➔ GPRS/EGPRS provide different method of Forward Error Correction than GSM Circuit Switched bearer
- ❖ Transmission errors caused by radio degradation are much faster rectified in GPRS/EGPRS using the acknowledged mode of data link layer
- ❖ EoG Phase 1 testing result demonstrates, radio degradation affects more GPRS radio blocks, but fast retransmission can keep the message transfer delay level.



# Mixed operation of ETCS and non-ETCS applications

- ❖ CS-mode gets dedicated transmission resources allocated → Radio Resource allocation is based on priority!
- PS-mode shares transmission resources → Allocation of the available bandwidth in equal portions within the same traffic class → priority based!
- ❖ Consequence: Throughput per user is lowered → packet delay increases!

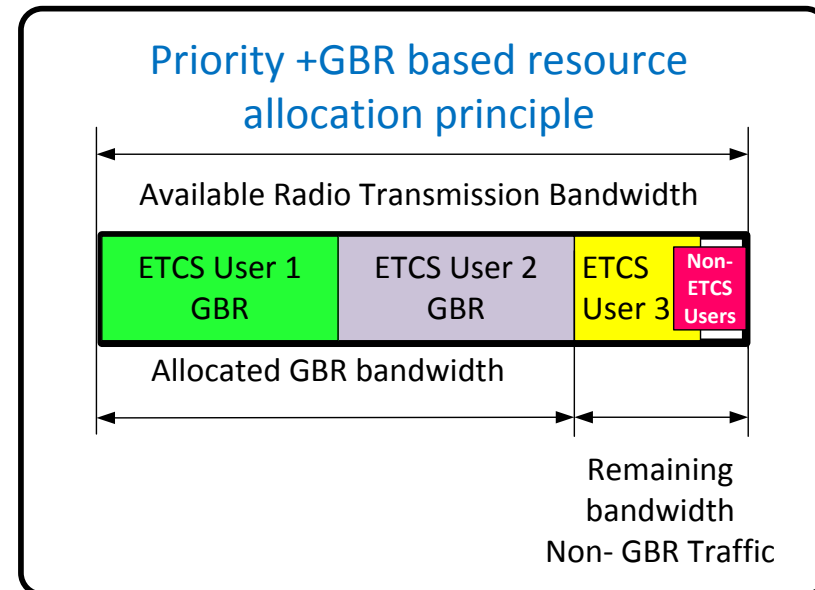




# Mixed operation of ETCS and non-ETCS applications

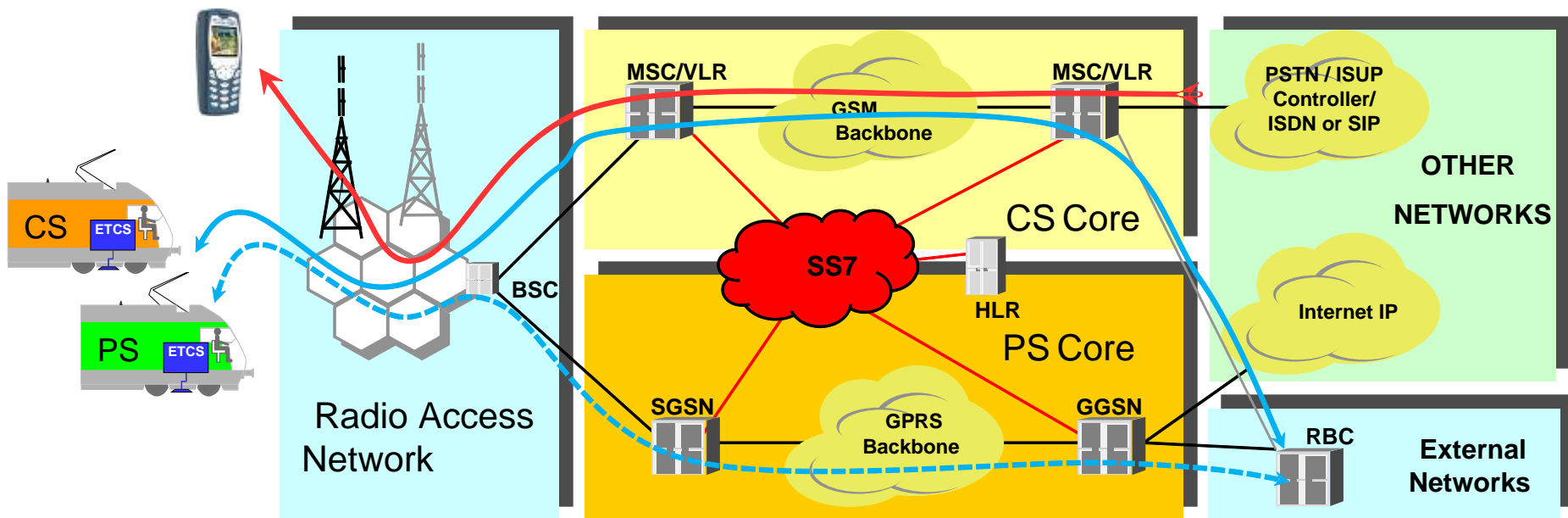
→ **Dedicated resources can be ensured by**

- ✓ **Guaranteed Bit Rate (GBR)** traffic class provisioning together with GBR allocation of e.g. 4kbps for ETCS subscribers.
- ✓ Non-Guaranteed Bit Rate traffic class provisioning for non-ETCS subscribers.
- ✓ Highest traffic handling priority within Non-Guaranteed Bit Rate Traffic class remains reserved for ETCS purposes.
- ❖ Exception handling: If no sufficient resources are available, then the network shall allocate the request to the highest non-GBR traffic class but having most demanding handling priority e.g. ETCS user 3.



# ETCS Circuit and Packet Mode will coexist during the remaining GSM-R life cycle

(CS) Circuit Switched Domain



(PS) Packet Switched Domain

# Advantages of GPRS/EGPRS for ETCS

## GSM-R PS-mode for ETCS

**Multiplexing of ETCS sessions per timeslot saves frequency resources → improves spectrum efficiency**

- GPRS (Coding Scheme 1&2): 4 sessions (confirmed) → up to 7
- EGPRS: 4 → 7; 8 - 14 sessions (depends on radio conditions and modified resource allocation timer handling)

### Reliability

- Transmission errors caused by radio degradations rectified on lower layers – retransmission is much faster than in Circuit mode
- Enhanced transmission error correction techniques in EGPRS
- Level of Transmission protection i.e. Coding Scheme adaptable on cell level!
- Higher transmission bandwidth by aggregation of timeslots can keep E2E performance under degraded radio conditions

### Mixed operation

- ETCS sessions take precedence over non-ETCS sessions
- Appropriate features in the packet access and core network allow an optimum on bandwidth utilisation and delay handling between the two application categories.

**Increases the number of degrees of freedom!**

# Benefits Packet Switching for ETCS

## ❖ Scalability

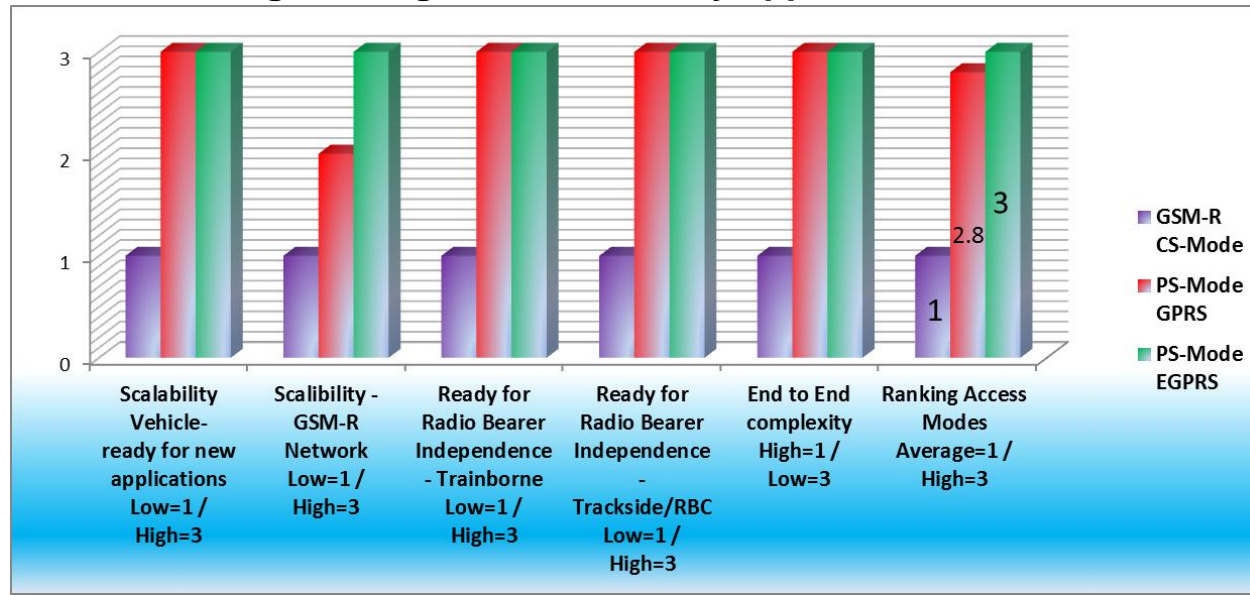
- Increases flexibility at trainborne side due to simultaneous operation of various applications e.g. ETCS and Online Key Management; Further automation of manual tasks are possible. CS-mode requires always dedicated Mobile Equipment and dedicated radio resources for each application.
- GSM-R network: Better resource utilisation due to ETCS session multiplexing.

## ❖ Radio Bearer Independence

- Trackside: RBC becomes radio bearer independent; IP based transport does not require specific interfaces per radio access. CS-mode remains as standalone access.

## ❖ E2E complexity

- IP based transport reduces system complexity between the communication entities; simplified addressing, routing and redundancy approaches.



**Thank you for the attention!**