Packet Switched Technology

ETCS under
GSM-R Packet Mode Conditions
Packet Mode for ETCS

Motivation

Status GSM-R Air-Int. Capacity

- ETCS data application widely used in low density areas (track)
- What about high density areas like stations?
  - Voice capacity demand increases!
  - ETCS in stations demands additional Circuit Mode channels!
  - Border regions have to share number of frequencies
- Capacity demand conflicts with the limited GSM-R(EIRENE) frequency band resources
- Increase radio channel multiplexing – keep QoS requirements → transition towards packet switched mode
GSM-R ETCS Bearer Service
Circuit (CS) versus Packet (PS) Mode

Circuit Mode
- Dedicated transmission resource per ETCS session
- Average GSM-R traffic channel duty cycle varies between 5% - 20%
- Sufficient transmission robustness (Radio Network design)
- Low air interface transmission capacity utilisation

Packet Mode (GPRS/EGPRS)
- Shared transmission resource(s) between several ETCS sessions
- Bearer Service bandwidth depends on:
  - Line Speed
  - Radio Network design
- Improved protection algorithms against transmission errors
- Multiplexing of several ETCS sessions improves resource utilisation
GSM-R ETCS Bearer Service
Circuit (CS) versus Packet Switched (PS) Mode

Radio Resource Allocation/Release
- **CS-Mode**
  - End User resource demand
  - End User release resource
- **PS-Mode**
  - End User demand
  - Network release

Mobility
- **CS-Mode**
  - Handover (Network commanded)
  - dedicated resources in source and target cell
- **PS-Mode**
  - Cell Change (Reselection)
  - Mobile self sustaining with/without Network assistance
  - Traffic resources between target cell and origin cell (Planning Task)
  - Handover (Network commanded)
    (Neither in Public-GSM nor in GSM-R Network/Mobile available)

Application - Priority based resource allocation
- **CS-Mode**
  - Dedicated transmission resource - allocation – ranking by pre-emption!
- **PS-Mode**
  - ETCS application
    - typical machine to machine interaction (location measurement to get track segment permission)
    - stringent and low delay → real time treatment

Applications
- Other «Best Effort»
- ETCS - «LOW» Delay

Packet Switched Mode for ETCS
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GSM-R GPRS/EGPRS
3GPP GSM features

Radio Resource Allocation/Release
- **PS-Mode**
  - Delay transmission resource release by the network
- Features:
  - Delayed-DL-TBF (Network)
  - Extended-UL-TBF (Network/Mobile)
- **Abbreviations**
  - DL-Downlink
  - UL-Uplink
  - TBF- Temporary Block Flow

Mobility
- **PS-Mode**
  - Reduce Cell Change (Reselection) time
- Feature:
  - Network Assisted Cell Change (Network/Mobile)

Application - Priority based resource allocation
- **PS-Mode**
  - Real Time treatment ETCS application
- Feature:
  - Packet Flow Context (Network/Mobile)

Applications
- Other «Best Effort»
- ETCS - «LOW» Delay
GSM-R GPRS/EGPRS
Test Cases (O-3023v0.73)

3GPP Features
- Delayed DL-TBF
- Extended UL-TBF
- Network Assisted Cell Change
- Packet Flow Context

Traffic Model 1 - Limit
- Train-RBC every 3 seconds 49 octets
- RBC-Train every 6 seconds 319 octets
- Reflects high GSM-R traffic channel utilisation

Traffic Model 2 - Typical
- Train-RBC every 6 seconds 49 octets
- RBC-Train every 20 seconds 319 octets
- Reflects medium GSM-R traffic channel utilisation

Mixed Traffic – Application dependent bandwidth allocation/reservation
- Traffic Model 1 – Best Effort data stream
- Traffic Model 2 – Best Effort data stream

Number of Mobile Modules
1 or 4 concurrent ETCS sessions

Transport Protocol
- ETCS-Application
- Safety Layer
- Allocation Function
- X.224
- Transport
- T.70
- HDLC/LAPB
- Network
- IP
- GSM-R
- CS-Bearer
- PS-Bearer
- Mobile Module

GPRS Test Specification
O-3023v0.73
Matrix Testing
→ To find optimum in feature, parameter and timer settings!

Testing Fields:
- Transmission Transfer Delay
- CS-PS Bearer Robustness comparison (high speed radio channel simulation)
- Network Registration Delay

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GPRS/EGPRS Bearer Service
Optimisation - Testing Procedure

Measurement Tool
- Control of min. 4 concurrent Mobile Modules
- Radio Access Technology Independent
- Traffic Model Emulation
- Timestamp generation
- Transfer Delay Computation
- Reporting

LAB Phase 1
- 17 Test Cases
- Performance Reference "Best Effort"

LAB Phase 2
- 83 Test Cases
- Feature Performance Gain
- Final-LAB Parameter Timer

Track
- 34 Test Cases
- Robustness Parameter Timer

Tool
- GSM Feature Activation
- GSM Feature Qualification

GSM
- Feature Activation
- Qualification

ETCS Traffic Model
- Traffic Model 1
- Traffic Model 2

Automated Cell Change

Mixed Traffic (ETCS/Non-ETCS)

Finished

On-going

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GPRS/EGPRS - ETCS Bearer Service

Test Results

Multiplexing Gain
one GSM-R Traffic Channel

- 4 concurrent ETCS sessions
- Confirmed by LAB and on-going Track testing

Impact
CS → PS Mode

- Circuit and Packet Mode
- Co-existence guaranteed - Matter of GSM-R capacity planning
- Requires one dedicated Packet Mode Traffic Channel!

Transmission Delay / Robustness

- 3GPP GSM features improves transfer delay significantly
- (TTD) equal/better than CS-Mode for ETCS
- Recovery of erroneous packets faster than in CS-mode

Packet Switched Mode for ETCS
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GPRS/EGPRS - ETCS Bearer Service

Conclusions

- GPRS/EGPRS can provide traffic capacity improvement!
- GPRS/EGPRS Engineering Guidelines
- No specific 3GPP GSM-R features are required!
- Can improve ETCS transmission robustness!
- Transformation “Best Effort” → “QoS Transmission System”
- (UIC) Measurement-Tool
  Independent to Radio Access Technology --> LTE etc.
- Specific GPRS/EGPRS timer and algorithms adjustments are necessary!

Can enable (future proof) IP based communication for ETCS!
Thank You
for the support of all involved parties!

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