GSM Evolution

How close can we get to the 'LTE like' experience with GSM EDGE?

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Content

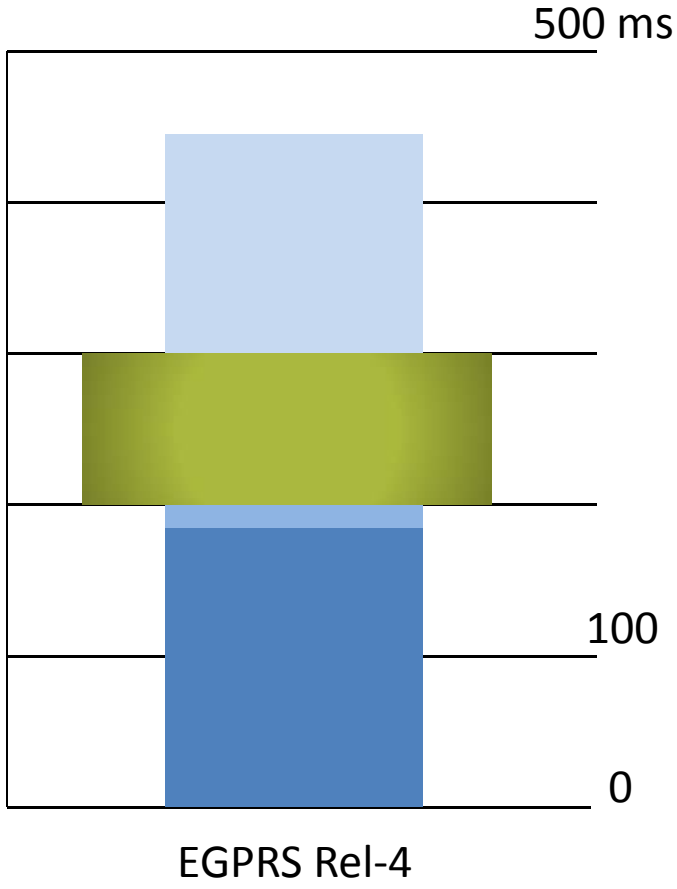
- Identify the gap between GERAN and LTE.
- Performance improvements
  - Latency
  - Data rates
- Features
  - GERAN – LTE interworking
  - Enhanced flexible time slot allocation
- Summary

Practical Constraints

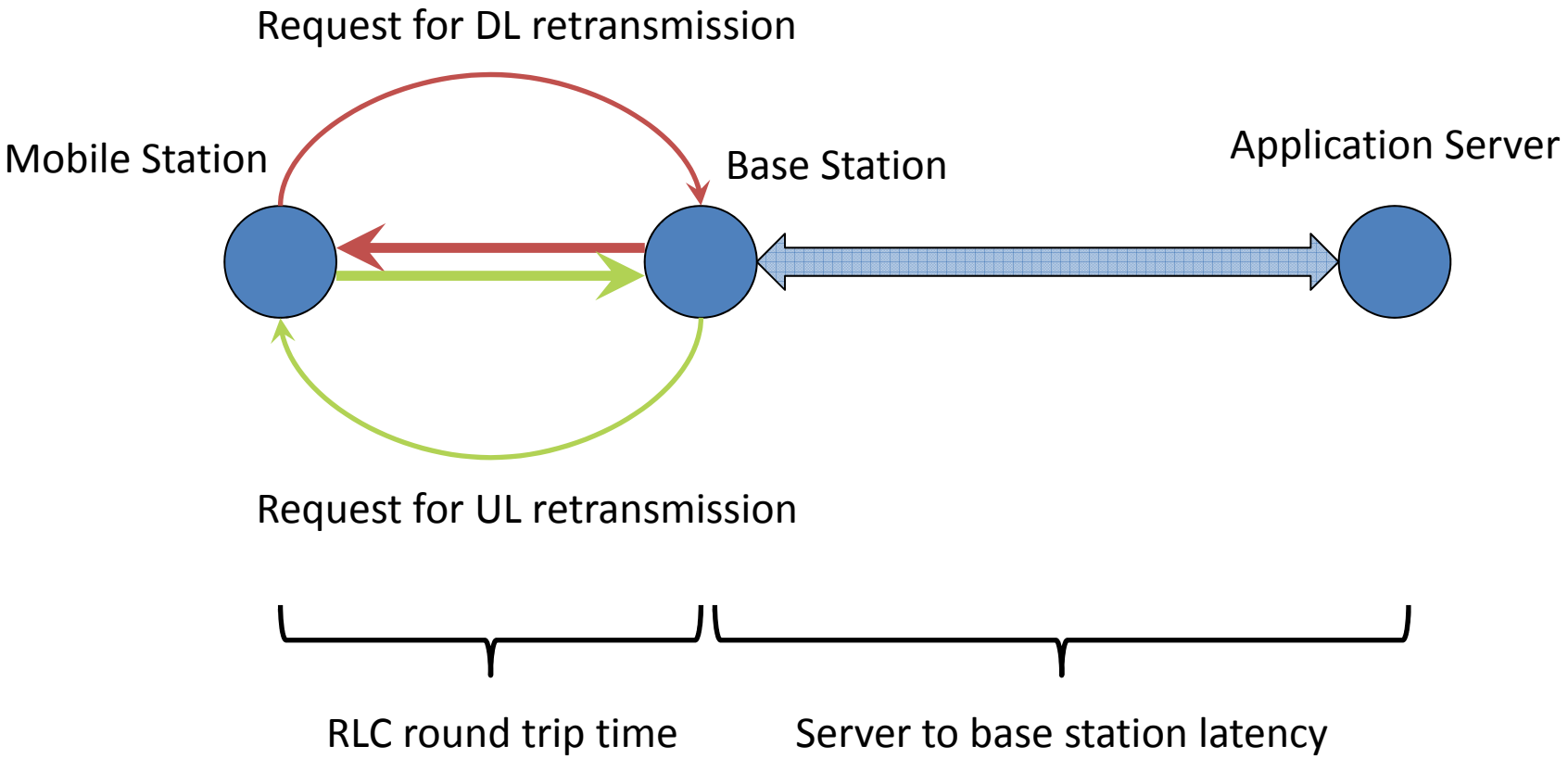
- Backwards compatibility.
  - Seamless integration and interoperation.
  - No impact to “legacy” services.
- Impact to infrastructure hardware.
  - Just a SW update?
- Complexity of the mobile station.

Latency – Conversational Services

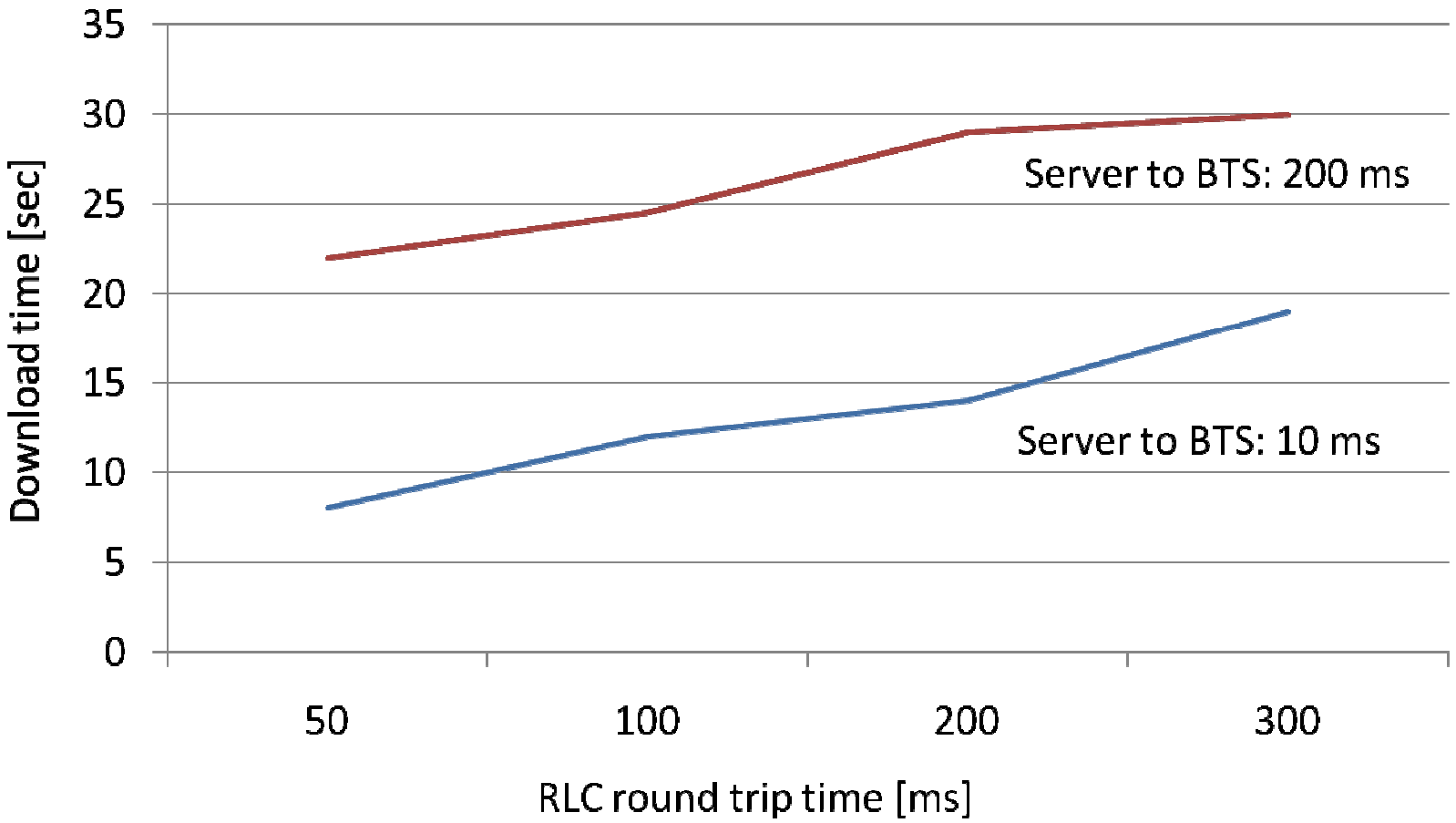
- End-to-end delay for PS conversational services (e.g. VoIP)
  - A-party MS/GERAN
  - CN/Transit including Gb
  - B-party MS/GERAN
  - ITU-T Recommendation G.114: 200 – 300 ms
    - Indicative figures.



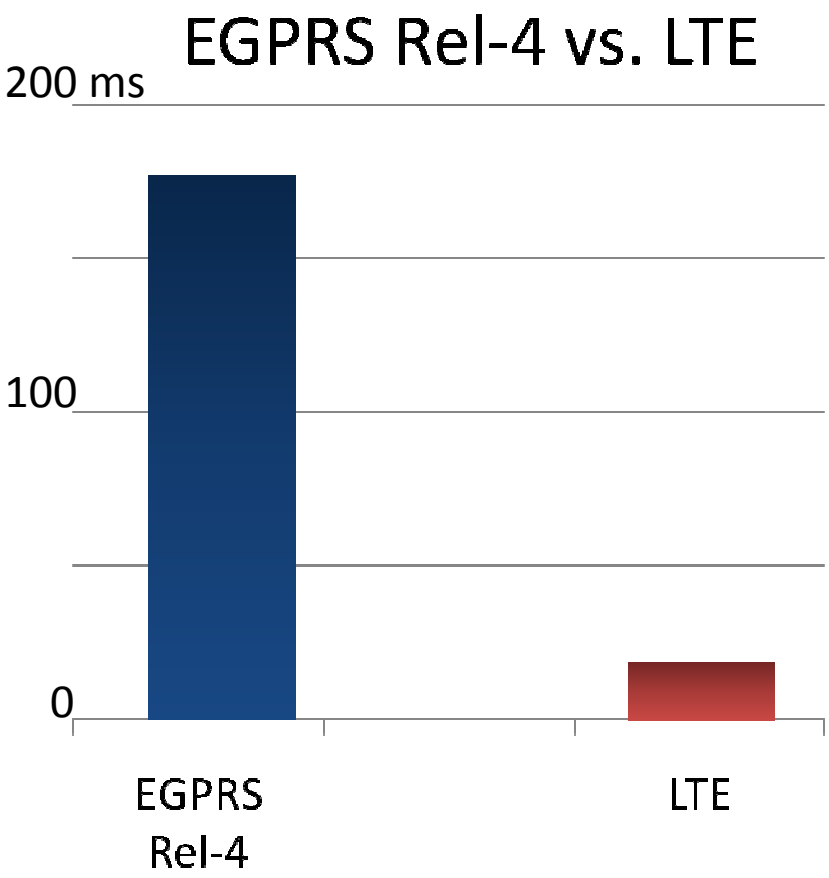
Latency – Model for Web Browsing



Latency – Results for Web Browsing



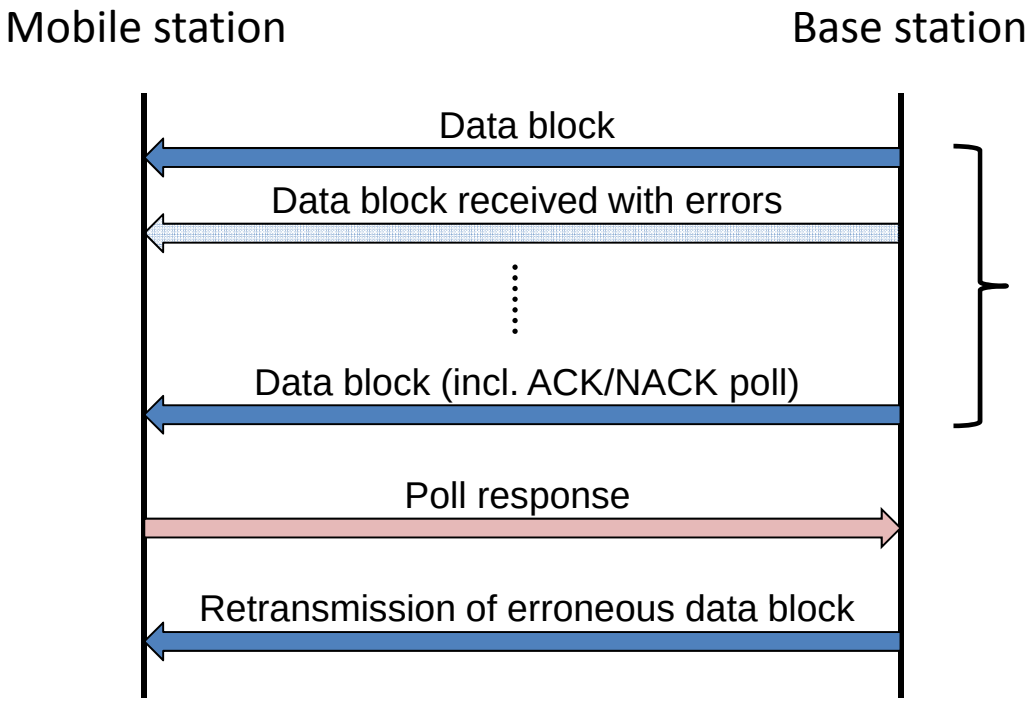
Latency



Benefits of reduced latency

- Decreased round trip time.
- Support of low delay applications
  - Conversational
  - Gaming
- Improved client server interactions.

Latency – Legacy Acknowledgement Procedure for DL Data



Trade off:
Reaction time vs.
Signalling load

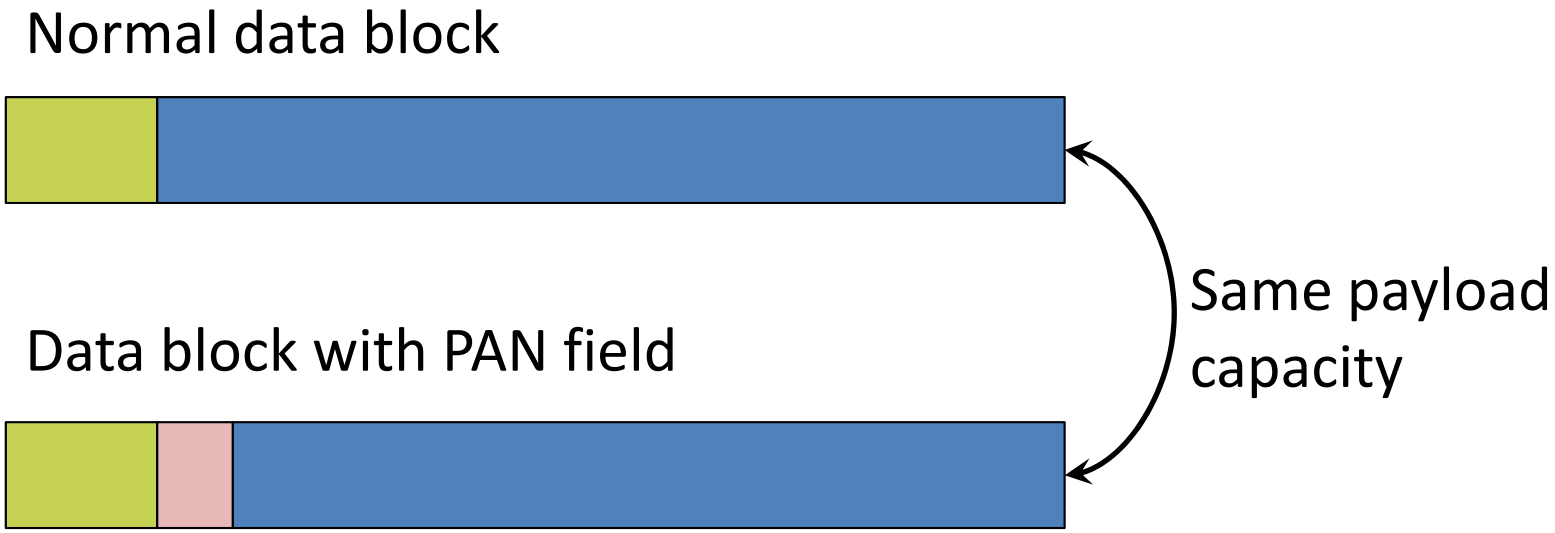
Latency Reduction

- Improved ACK/NACK reporting in uplink and downlink to enable a faster reporting scheme.
  - Don’t wait for polls.
  - Minimize signalling overhead.

- Radio blocks with a transmission time interval reduced to 10 ms over the radio interface.

Latency Reduction – Fast Acknowledgements (1/2)

- Fast ACK/NACK reporting (FANR) procedure
  - Allows to piggy-back, within data blocks for data transfer sent in one direction, the acknowledgement status (PAN field) of data blocks sent in the opposite direction.

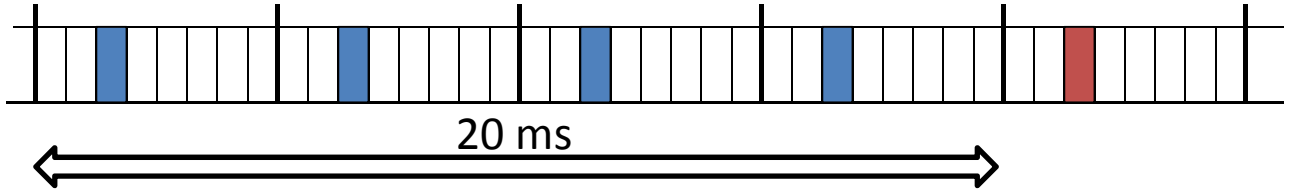


Latency Reduction – Fast Acknowledgements (2/2)

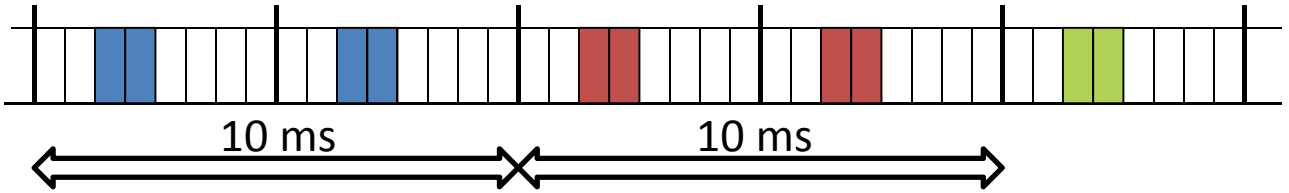
- Event based reporting
  - The mobile station inserts ACK/NACK information in uplink data if it detects that it did receive a data block in error.
- Polled reporting
  - Triggered by the base station
  - Mobile station sends the acknowledgement information piggy-backed in uplink data.

Latency Reduction – Reduced Transmission Time Interval

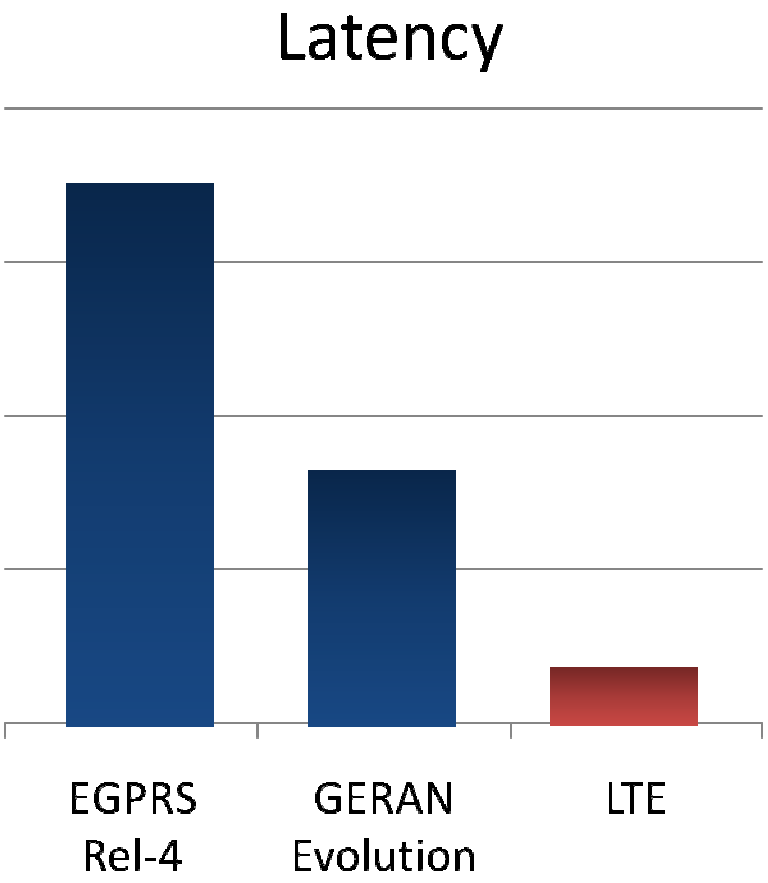
- Basic transmission time interval
  - A radio block, consisting of four bursts, is sent in 1 time slot in each of 4 consecutive TDMA frames.

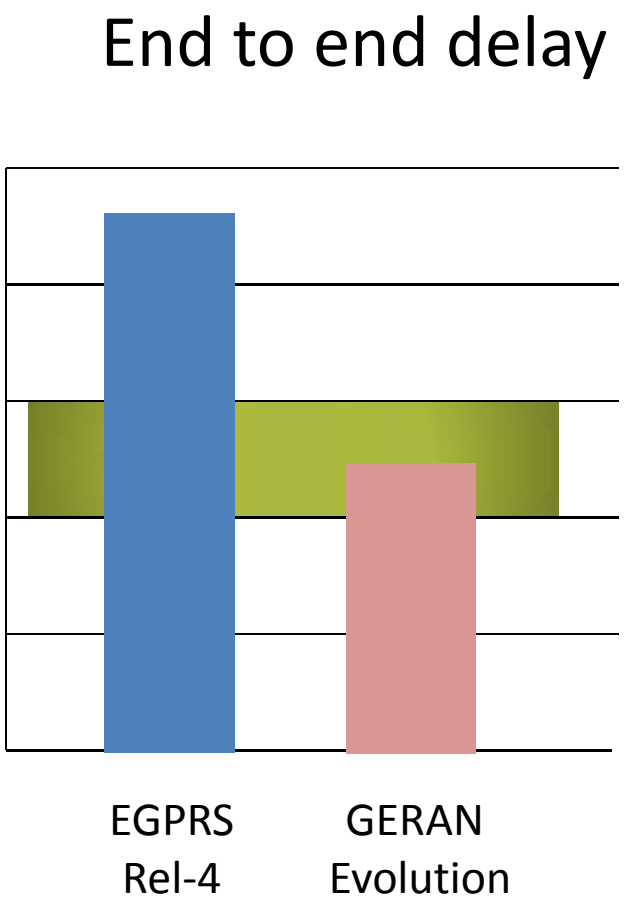


- Reduced transmission time interval
  - A radio block, consisting of four bursts, is sent in 2 time slots in each of 2 consecutive TDMA frames.



Impact of Latency Reduction Methods

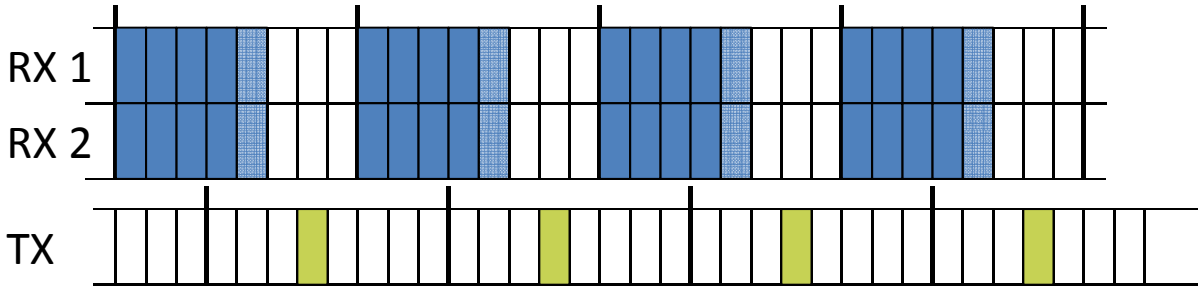




PEAK DATA RATES AND THROUGHPUT

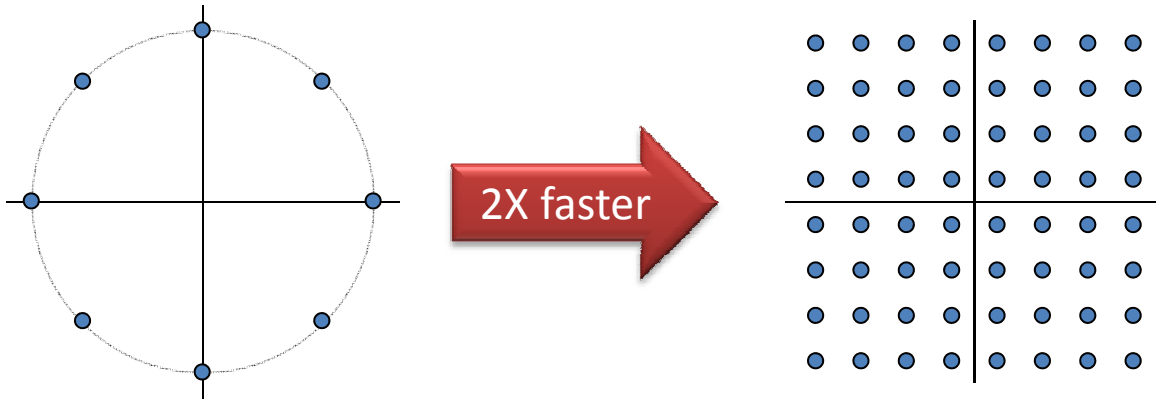
Downlink Dual Carrier

- A mobile station receiving on two frequency channels simultaneously.
- Transmission on a single frequency channel.
- For certain multislot classes, the data rate is increased by 150%.
  - Multislot class 10: 4 TS single carrier -> 10 TS dual carrier



Higher Order Modulation and Higher Symbol Rate

- More bits per symbol = more data transmitted per time unit.
- More symbols per time unit = more data transmitted per time unit.



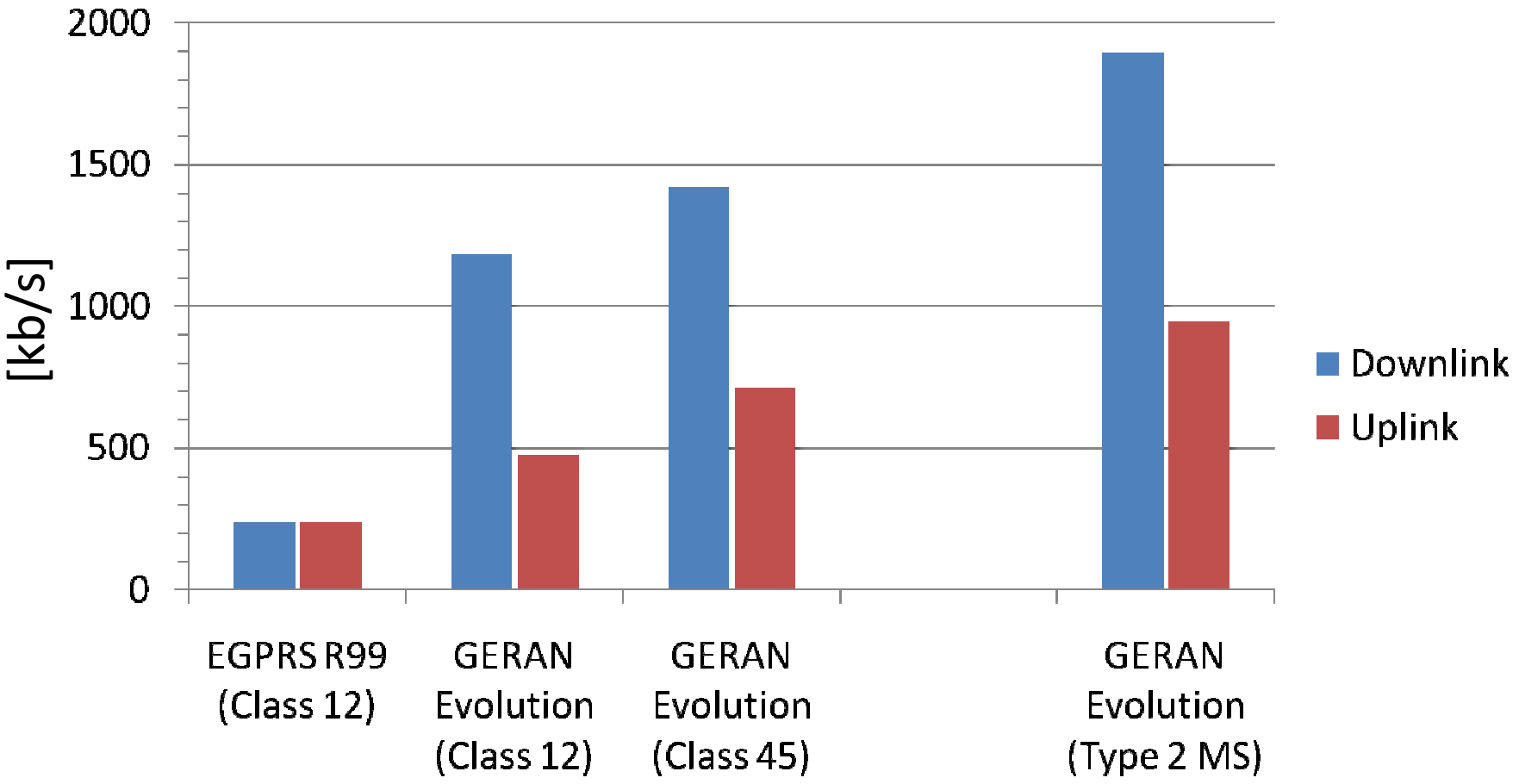
8PSK
59.2 kb/s per time slot

32QAM
118.4 kb/s per time slot

Modulation and Coding Schemes

- Uplink
  - Modulation up to 32QAM.
  - Legacy (271 ksymbols/s) and higher symbol rate (325 ksymbols/s).
  - Normal and spectrally wide transmit pulse to fully exploit the gains of the higher symbol rate.
  - Convolutional coding
- Downlink
  - Modulation up to 32QAM.
  - Legacy (271 ksymbols/s) and higher symbol rate (325 ksymbols/s).
  - Spectrally wide pulse under consideration.
  - Turbo coding.

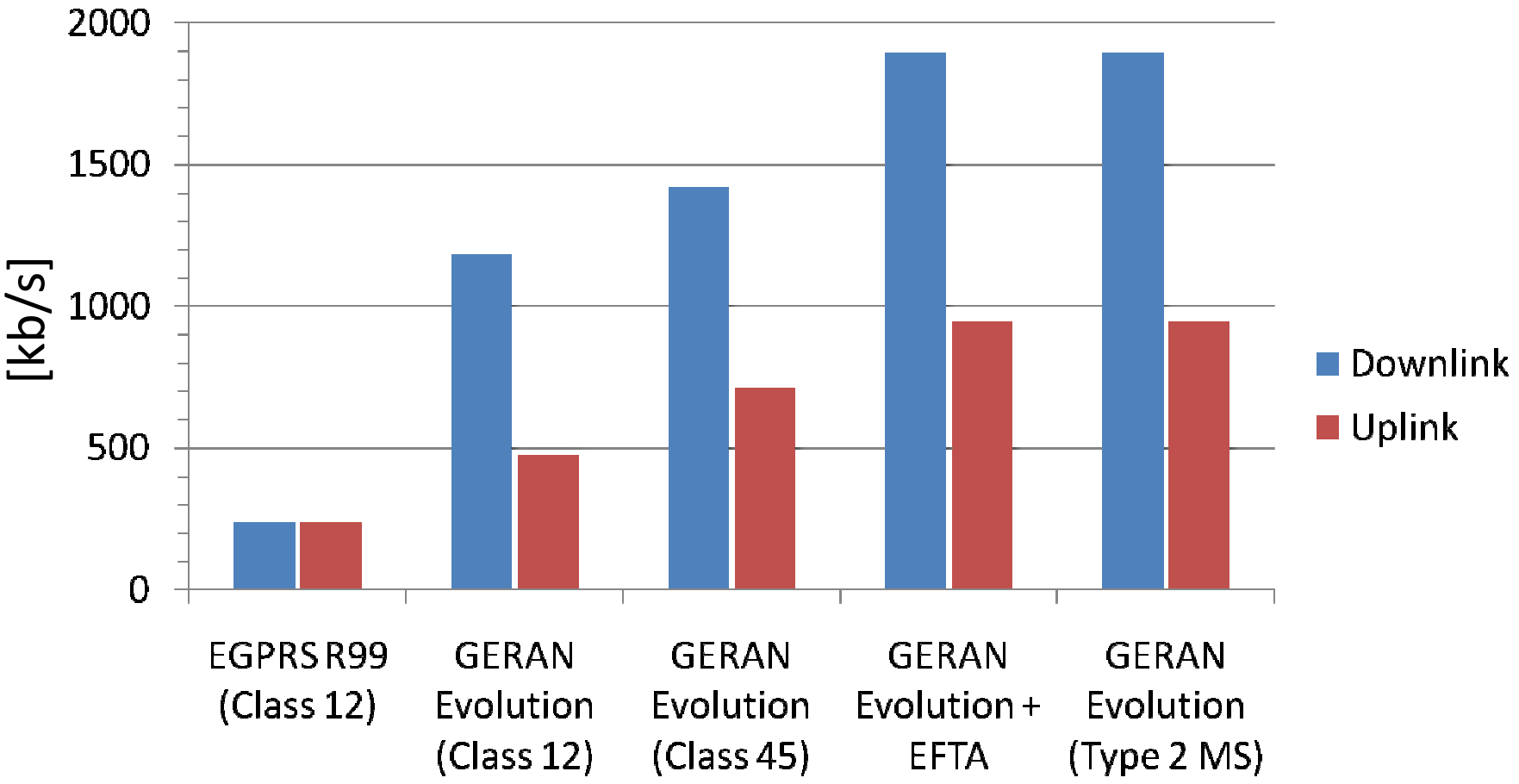
Peak Data Rates



Enhanced Flexible Time Slot Allocation

- EFTA – Gives the network the possibility to allocate one and the same mobile station uplink and downlink resources that overlap in time.
- The mobile station prioritizes uplink transmission over attempting to read downlink radio blocks.
- If the mobile station has nothing to transmit then downlink radio blocks are always read.
- A mobile station is able to receive on 8 time slots most of the time without full-duplex capabilities.

Peak Data Rates



Interworking and Support for Service Continuity

- GERAN – LTE interworking
  - defines cell reselection and CS/PS handover between GERAN and LTE.
- Home NB and Home eNB enhancements
  - Framework for reporting and mobility between GERAN and CSG cells.
- Improvements for CS fall back procedure under discussion.

There is Still Room for Improvement!

- Study Item on an optimized transmit pulse shape for downlink EGPRS2-B close to completion.
- New Study Item on enhancements for EGPRS2 – Significant increase to both data capacity and spectral efficiency expected.
- New Work Item to tighten single antenna link level performance requirements for the mobile station.

Summary

- How close can we get to an “LTE like” experience with GERAN?
- Support of interworking functionality.
- Reduced latency through fast acknowledgement reporting and reduced transmission time interval.
- Peak data rates: 1.9 Mb/s downlink, 950 kb/s uplink. Further improvements just started!