Latency

in

LTE Systems

Agenda

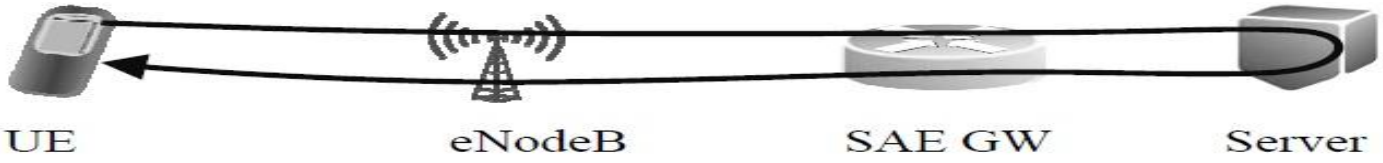
- Introduction
- Handover theory
- GSM Handover
- UMTS Handover
- Inter RAT Handover
- Handover and performance

Introduction

What is Latency ?

The time from a user sending a piece of data,req downlad or a webpage to load, to the time when the user gets a response, which is sometimes more important than the bit rate offered

The latency can be measured by the time it takes for a small IP packet to travel from the terminal through the network to the internet server, and back. That measure is called round trip time and is illustrated in Figure



Round trip time measurement

Why does latency matter?

- *System latency is more important than the actual peak data rates for many IP based applications.*
- *User are more dependent on applications the is reliable on low latency such as:*

1- Games

2-VOIP

3-Mail & file Sync

4-Application sharing

5-Video & voice conference over IP

Latency in numbers

Medium	Application	Degree of symmetry	Data rate	e2e one-way delay	Delay variation within a call	Information loss
Audio	Conversational voice	Two-way	4-25 kb/s	< 150 msec preferred < 400 msec limit	< 1 msec	< 3% FER
Video	Videophone	Two-way	32-384 kb/s	< 150 msec preferred < 400 msec limit Lip-synch < 100 msec		< 1% FER
Data	Telemetry	Two-way	<28.8 kb/s	< 250 msec	N.A	Zero
Data	Realtime games	Two-way	< 60 kb/s	< 75 msec preferred	N.A	< 3% FER preferred < 5% FER limit
Data	Telnet	Two-way (asymmetric)	< 1 KB	< 250 msec	N.A	Zero

- *http://www.ericsson.com/hr/about/events/archieve/2007/mipro_2007/mipro_1137.pdf*

RTT in different Tech.

LTE 750 const

120km

400ms 400E-6 410E-5 120E3m ~~120km~~ / 3E8 m s

- GSM/EDGE 150ms
  air delay
- HSPA 100ms
- HSPA+ 50ms
- LTE 20ms
- Target is to have it as low as 5ms

0.4ms 120km

X2

~1 ms for 120 km

c = 3E8 m/s

3E8 m/s · 20E-3 s

60 E5 m

60E2 km ~6000km

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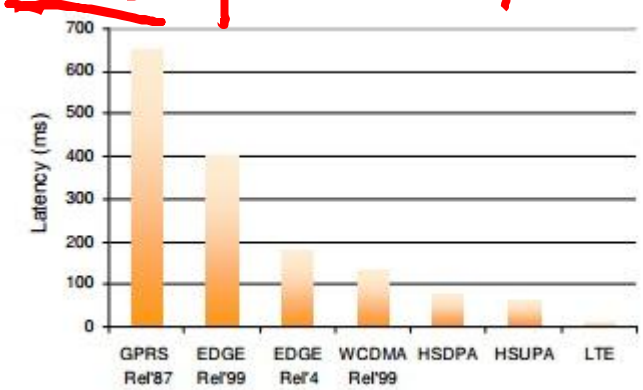

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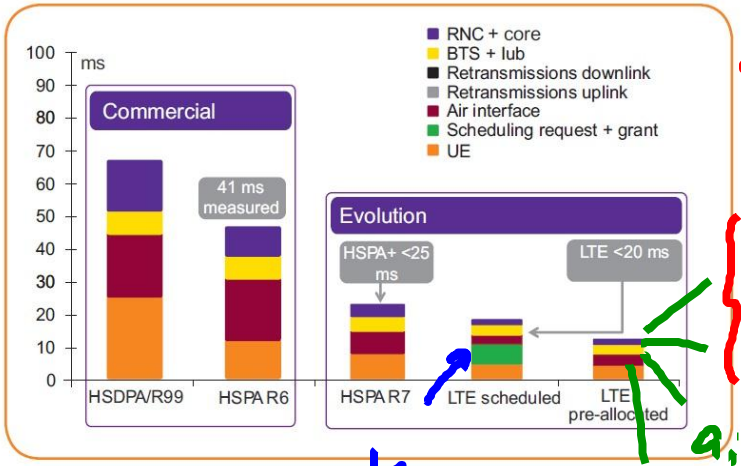

Figure 1: Expected latency evolution for HSPA and LTE

Latency improvments in LTE

- System Architecture
- Control plane
- User Plane

System Architecture Evolution (SAE)

LTE

- less equipment components
- integrated control in base station
- bypass controllers (RNC, SGSN)

LTE was designed with less NE, By integrating the Radio Network controller functionality in NodeB/eNodeB it enables data trafic to by-pass the RNC and SGSN and network elemnts to connect the Radio Access Network (RAN) to the core packet network directly.

The RTT will improve because there is no Iub related transport set-up delay. The transport connection is on all the time and the IP packets are sent immediately.

Ref

I-HSPA: Less nodes in the data path improves Latency

User Plane & Control Plane

User Plane Latency:

The latency can be measured by the time it takes for a small IP packet to travel from the terminal through the network to the internet server, and back. That measure is called round trip time. (LTE for UMTS)

U-Plane latency is defined as one-way transmit time between a packet being available at the IP layer in the UE/E-UTRAN (Evolved UMTS Terrestrial Radio Access Network) edge node and the availability of this packet at the IP layer in the EUTRAN/UE node. U-Plane latency is relevant for the performance of many applications.

Control Plane Latency:

Control plane deals with signaling and control functions, while user plane deals with actual user data transmission. C-Plane latency is measured as the time required for the UE (User Equipment) to transit from idle state to active state. In idle state, the UE does not have an RRC connection. Once the RRC is setup, the UE transitions to connected state and then to the active state when it enters the dedicated mode.

(http://www.techmahindra.com/Documents/WhitePaper/White_Paper_Latency_Analysis.pdf)

User Plane Latency

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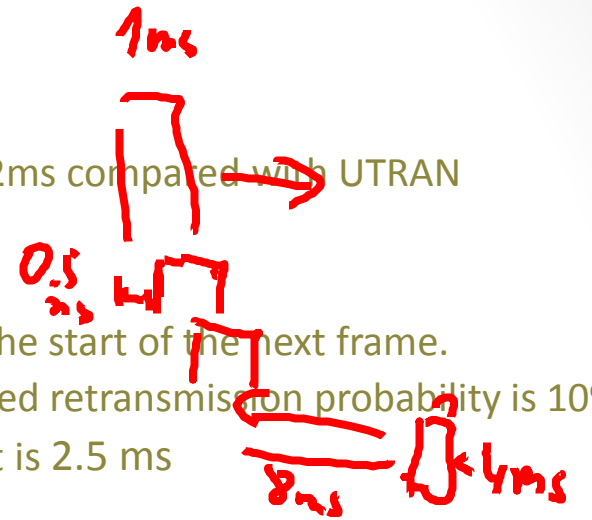
User Plane Latency



In E-UTRAN it was defined a subframe in 1ms instead of 2ms compared with UTRAN

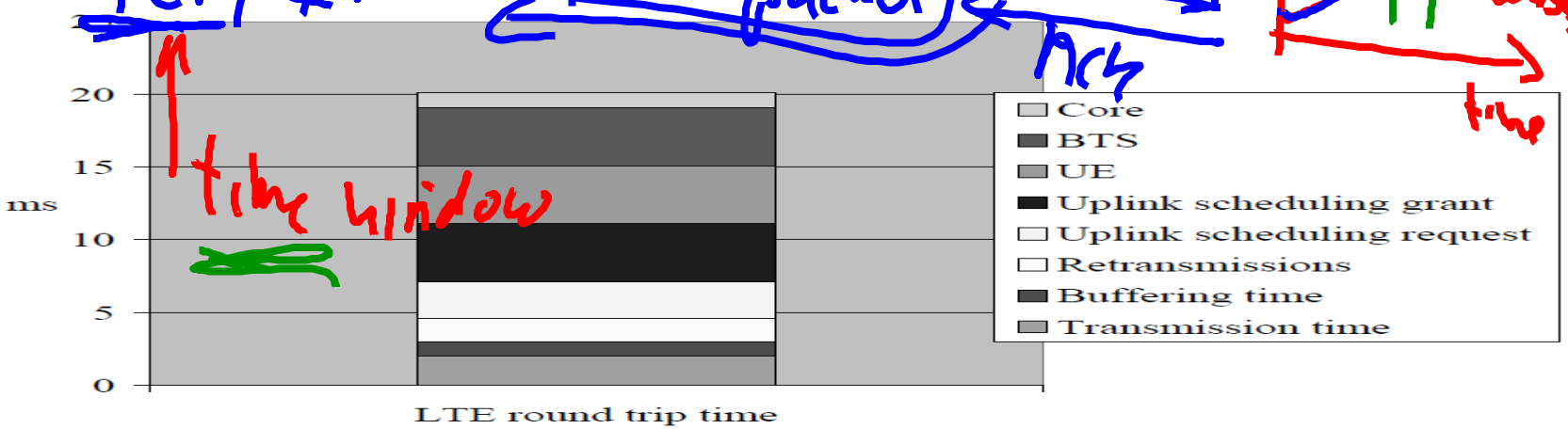
The 1-ms frame size allows a very low transmission time:

- On average, the packet needs to wait for 0.5 ms for the start of the next frame.
- The retransmissions take 8 ms at best and the assumed retransmission probability is 10%.
- The average delay for sending the scheduling request is 2.5 ms
- and the scheduling grant 4 ms.
- We further assume a UE processing delay of 4 ms, an eNodeB processing delay of 4 ms
- and a core network delay of 1 ms.
- The average round trip including retransmission can be clearly below 15 ms if there are pre-allocated resources. If the scheduling delay is included, the delay round trip time will be approximately 20 ms.
- The user plane latency in LTE can be as low as 10–20 ms. The low latency is relevant for improving the end user performance since many applications and protocols benefit from low latency. The low latency is enabled by the short sub-frame size of 1 ms.

IP (header | payload)

Latency components

Delay component	Delay value
Transmission time uplink + downlink	2 ms
Buffering time (0.5 × transmission time)	2 × 0.5 × 1 ms = 1 ms
Retransmissions 10%	2 × 0.1 × 8 ms = 1.6 ms
Uplink scheduling request	0.5 × 5 ms = 2.5 ms
Uplink scheduling grant	4 ms
UE delay estimated	4 ms
eNodeB delay estimated	4 ms
Core network	1 ms
Total delay with pre-allocated resources	13.6 ms
Total delay with scheduling	20.1 ms



End-to-end round trip time including scheduling latency

Control Plane

- Control plane deals with signaling and control functions.
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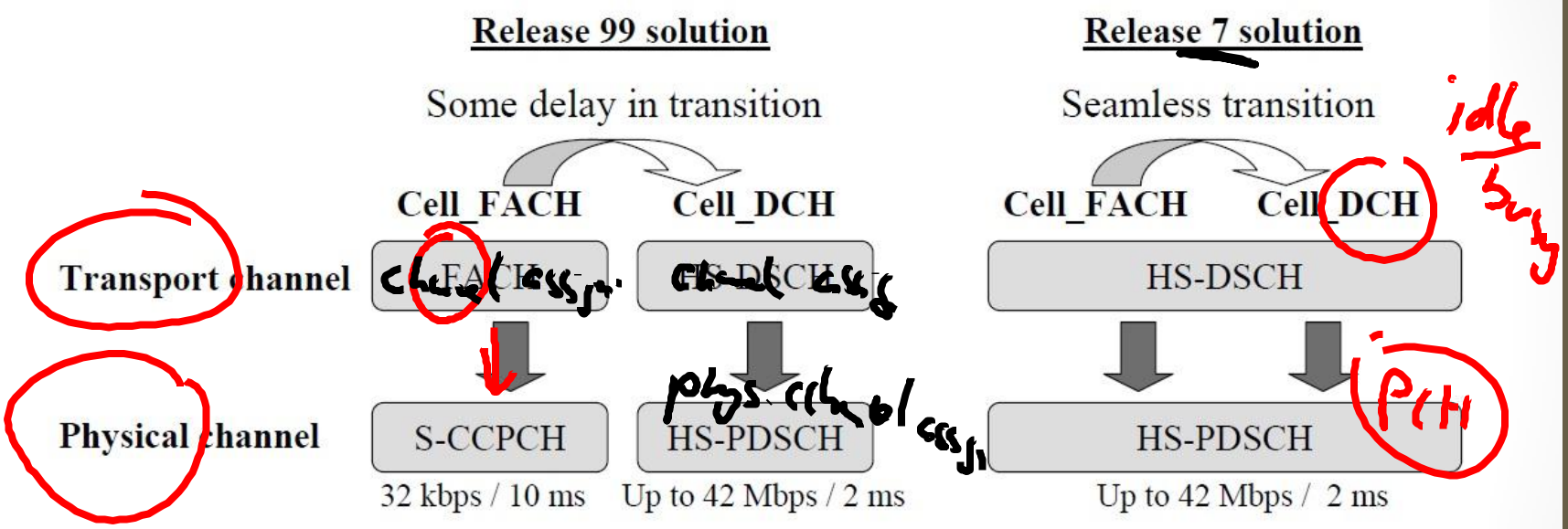
- (http://www.techmahindra.com/Documents/WhitePaper/White_Paper_Latency_Analysis.pdf)

Controll plane

- Enhanced FACH & RACH.
- The expected packet call setup time with Release 7 will be below 1 s.
- Once the packet call has been established, user data can flow on HSDPA/HSUPA in Cell_DCH state.
- The idea in Release 7 Enhanced FACH and Release 8 Enhanced RACH is to use the Release 5 and Release 6 HSPA transport and physical channels also in the Cell_FACH state for improving the end user performance and system effi ciency.

cell_DCH
stat
cell_FACH
cell_PCH
stat)



idle
busy

PCH

assign channel (phys)

(FACH
PCCH)

FACH = Forward Access Channel
S-CCPCH = Secondary Common Control Physical Channel
HS-DSCH = High Speed Downlink Shared Channel
HS-PDSCH = High Speed Downlink Physical Shared Channel

Enhanced FACH concept [4]

Q&A

Thank You