End-to-end IP Service Quality and Mobility

- Lecture #6 -

Special Course in Networking Technology

S-38.215

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Planned contents & draft schedule

1.	Introduction	Jan 13th
2.	Characteristics of mobile applications	Jan 20th
3.	Service quality requirement characterizations	Jan 27th
4.	Challenges of mobile environment	Feb 3rd
5.	Mobility and QoS in GPRS	Feb 10th
6.	**Mobility and QoS in 3GPP systems**	Feb 17th
7.	Mobility and QoS with Mobile IP	Feb 24th
8.	Mobile IP QoS enhancements	(Mar 3rd)
9.	Edge mobility	(Mar 10th)
10.	Inter-system mobility	(Mar 17th)
11.	End-to-end QoS management	(Mar 31st)
12.	Summary	(Apr 7th)

Dates in parentheses to be confirmed

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Agenda

- Taxonomy of 3rd generation systems
- Design principles of 3GPP systems
- WCDMA RAN
- 3GPP QoS model
- IMS QoS
- Summary

Goals of this lecture

- Types of 3rd generation systems
- Understanding of 3GPP 3rd generation systems
  - Design principles
  - Architecture
  - WCDMA RAN (UTRAN)
- 3GPP QoS model
- IMS

Taxonomy of 3rd generation systems

- ITU-R 3rd generation radio interfaces: IMT 2000
  - WCDMA
  - EDGE
  - } 3GPP
  - cdma2000
- 3GPP systems use WCDMA and EDGE
  - ETSI, ANSI-TI, ARIB, TTC, TTA, CWTS
- 3GPP2 systems use cdma2000
  - ARIB, TTC, TR.45, TTA
- Other fora:
  - 3G.IP: core network IP focus
  - MWIF: functional architecture studies

[Holma, Toskala]

3GPP releases

- R99
  - UTRAN: WCDMA
- R4
  - IP transport extension
- R5:
  - GERAN Iu mode
  - IMS support
- R6:
  - WLAN interworking

3GPP design philosophy

- Targets:
  - Multi-service support also for RT services
    - Delay
    - Reliability
  - High spectral efficiency
- UTRA: UE and RAN redesigned
  - Can interface both to “GSM-like” CS and PS core networks.
- End user services are supported using bearers, the properties of which are negotiated with the network.
  - Connection set-up
  - During connection
- Hide as much of mobility from CN as possible.

[Holma, Toskala / Wisely *et al*.]

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User perspective

- Envisioned end user service types on 3rd generation schedule:
  - Conferencing (includes telephony)
    - Voice conferencing
    - Video conferencing
  - Streamed content
    - Audio
    - Video
  - Interactive applications
    - Web browsing
    - Network games
  - Background
    - Background downloading

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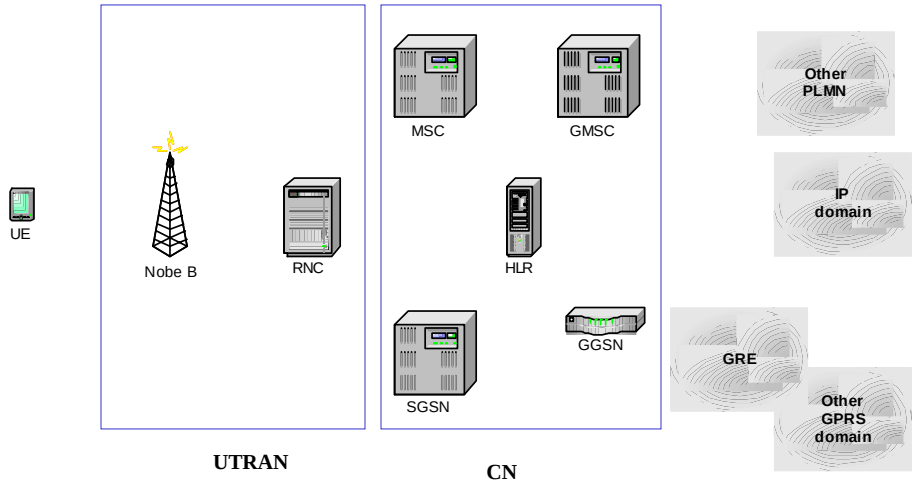
UMTS network architecture



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Rôles of network elements in UMTS

- **UE**: capable of managing PDP contexts.
- **Node B**: convert data between radio interface (Uu) and UTRAN (Iub); participate to radio resource management.
- **RNC**: manage radio resources and handovers, act as a service access point towards CN for all UTRAN services, QoS.
- **SGSN**: handles terminal mobility and authentication, radio and GPRS QoS, temporary storage of subscription data.
- **GGSN**: "edge router" for GPRS, IP address allocation, GPRS QoS.
- **HLR**: stores subscriber data, including QoS profile.

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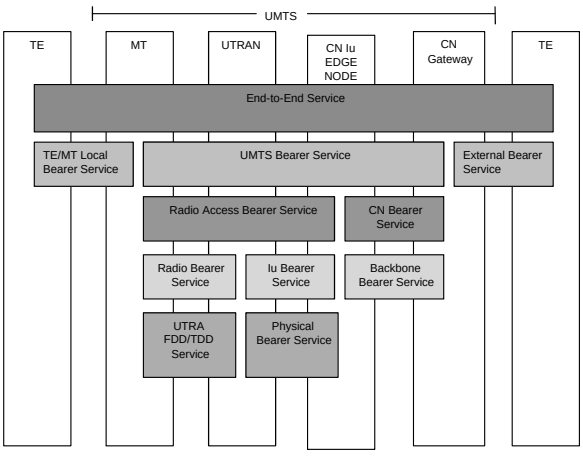
Mobility management in UMTS

- **UE states**
  - Detached
  - PMM-connected
  - PMM-idle
- Soft handover possible – mobiles communicating via multiple Node B's simultaneously.
- RNC manages topological diversity under Node B's belonging to it.
  - RNC can directly communicate with another RNC (serving / drift RNC).
- SGSN tracks mobility of UE at the granularity of RNC.
  - RNC relocation message to SGSN (or MSC).

UMTS bearers

- UMTS bearer service defines service performance between UE and GGSN.
- UMTS bearer is requested by UE.
- UMTS bearer makes use of bearers beneath it.
- Bearer mapping is not standardized.

[23.107]



Design principles of 3GPP QoS

- Derivation of QoS attributes from application requirements shall be simple.
- QoS definitions shall be future proof.
- QoS has to be provided end-to-end.
- QoS mechanism have to allow efficient use of radio capacity.
- Allow evolution of UMTS network.
  - Allow for independent evolution of core and access networks.
- UMTS shall provide for session-based QoS with possibility for asymmetric bearers on peer-to-peer basis between UE and gateway node.

[23.107]

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3GPP QoS profile

- Traffic class (**'conversational', 'streaming'**, 'interactive', 'background')
- Maximum bit rate (kbps)
- **Guaranteed bit rate (kbps)**
- Delivery order (y/n)
- Maximum SDU size (octets)
- SDU format information (bits)
- SDU error ratio
- Residual bit error ratio
- Delivery of erroneous SDUs (y/n/-)
- Transfer delay (ms)
- Traffic handling priority
- Allocation/Retention Priority
- Source statistics descriptor (‘speech’/’unknown’)

[23.107]

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Value ranges for UMTS bearer

Traffic class	Conversational class	Streaming class	Interactive class	Background class
Maximum bitrate (kbps)	< 2 048 (1) (2)	< 2 048 (1) (2)	< 2 048 - overhead (2) (3)	< 2 048 - overhead (2) (3)
Delivery order	Yes/No	Yes/No	Yes/No	Yes/No
Maximum SDU size (octets)	<=1 500 or 1 502 (4)	<=1 500 or 1 502 (4)	<=1 500 or 1 502 (4)	<=1 500 or 1 502 (4)
SDU format information	(5)	(5)		
Delivery of erroneous SDUs	Yes/No/- (6)	Yes/No/- (6)	Yes/No/- (6)	Yes/No/- (6)
Residual BER	$5*10^{-2}$, 10^{-2}, $5*10^{-3}$, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}	$5*10^{-2}$, 10^{-2}, $5*10^{-3}$, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}	$4*10^{-3}$, 10^{-5}, $6*10^{-8}$ (7)	$4*10^{-3}$, 10^{-5}, $6*10^{-8}$ (7)
SDU error ratio	10^{-2}, $7*10^{-3}$, 10^{-3}, 10^{-4}, 10^{-5}	10^{-1}, 10^{-2}, $7*10^{-3}$, 10^{-3}, 10^{-4}, 10^{-5}	10^{-3}, 10^{-4}, 10^{-6}	10^{-3}, 10^{-4}, 10^{-6}
Transfer delay (ms)	100 – maximum value	250 – maximum value		
Guaranteed bit rate (kbps)	< 2 048 (1) (2)	< 2 048 (1) (2)		
Traffic handling priority			1,2,3	
Allocation/Retention priority	1,2,3	1,2,3	1,2,3	1,2,3
Source statistic descriptor	Speech/unknown	Speech/unknown		

[23.107]

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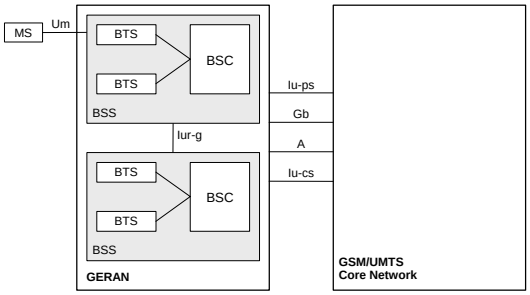
GERAN

- GERAN can interface both to GPRS and UMTS core networks.
- Terminal must operate either in “GPRS mode” (A/Gb mode) or “UMTS mode” (Iu mode).



[43.051]

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Secondary PDP context

- In GPRS R97/98, simultaneous use of applications with different QoS requirements requires
  - two different PDP contexts
  - two different PDP addresses (APNs)
- 3GPP R99 secondary PDP context allows differentiated QoS under one APN.
- **Traffic Flow Template (TFT)** controls which traffic is mapped to secondary PDP context

	Valid combination types		
Packet filter attribute	**I**	**II**	**III**
Source address	X	X	X
Protocol number (IPv4) / Next header (IPv6)	X	X	
Single destination port (or port range)	X		
Single source port (or port range)	X		
IPsec Security Parameter Index (SPI)		X	
Type Of Service (TOS) in IPv4 / Traffic Class in IPv6	X	X	X
Flow Label (IPv6)			X

[Wisely *et al.***]**

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Secondary PDP context example

- Britney wants to browse the home page of Trio Niskalaukaus.
- Terminal opens a (primary) PDP context to an APN for WAP browsing.
  - Interactive traffic class.
- Britney clicks a link for watching an advertisement for Trio's new song.
- UE activates a secondary PDP context.
  - Streaming traffic class.
- Media stream of streamed video is mapped to the secondary PDP context using TFT.
- Same APN can be used for both browsing and streaming.

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UMTS QoS details

- Air interface QoS controlled by Radio Resource Management
  - Admission control
  - Power control
  - Code management
  - Packet scheduling
  - Handover control
- In 3GPP R4, IP transport can extend up to RNC.
- IP transport bearers can be managed with same principles as in GPRS.
- Interworking towards external networks as with GPRS.
- R5: linking of SIP session QoS to 3GPP QoS possible.

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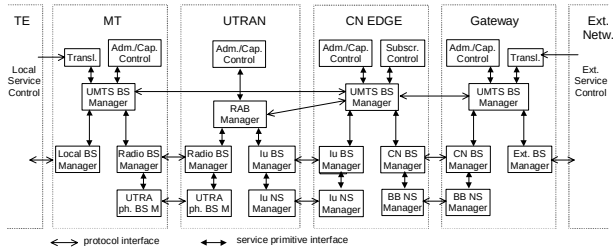
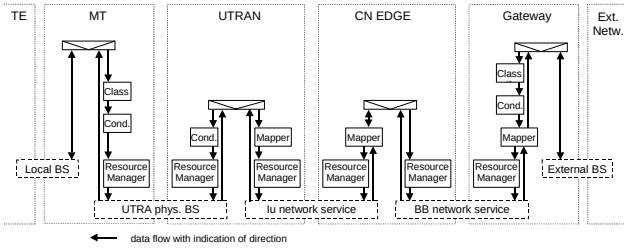
3GPP QoS management functions

Control layer



User layer



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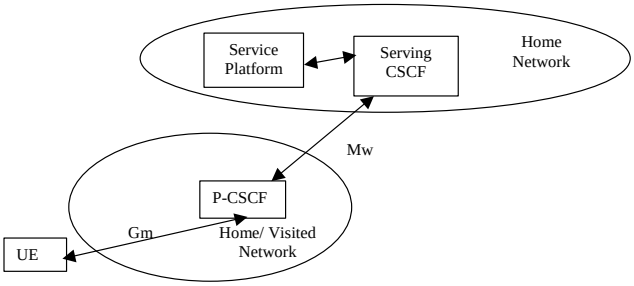
IP Multimedia Subsystem

- 3GPP R5 brings with it support for SIP services in IP Multimedia Subsystem (IMS).
- Call State Control Function (CSCF) = SIP proxy.
- Service signalling between CSCF and UE takes place using SIP.
- UE activates a suitable bearer for the SIP session.



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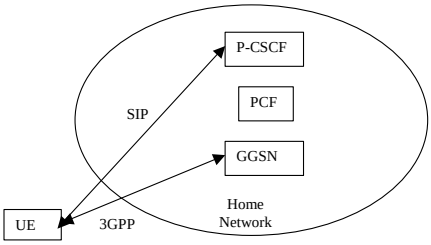
IMS QoS authorization

- GGSN does not participate to SIP signalling.
- GGSN authorizes QoS for SIP session from Policy Control Function (PCF).
- PCF has received SDP session parameters from P-CSCF, creates authorization token.
- UE uses token in opening PDP context.



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R5 example: SIP telephone call

- Terminal contacts P-CSCF with the SIP identifier of the remote end (B subscriber).
- Terminals and SIP proxies negotiate codec parameters (SDP).
- P-CSCF sends SDP information to PCF and gets back authorization token.
- P-CSCF sends authorization token to UE.
- UE sends authorization token to GGSN when activating PDP context.
- GGSN checks PDP contexts from PCF using authorization token.
- PCF authorizes QoS parameters.

Summary

- 3G R99 is based on GPRS core network.
- Radio interfaces: WCDMA, EDGE.
- WCDMA Radio Access Network (RAN) handles more of the mobility than in GPRS radio access network.
- Enhanced service quality support for packet traffic compared to GPRS.
  - Conversational class
  - Streaming class
- Secondary PDP context for better QoS differentiation.
- R5 brings support for SIP services for IMS.