Mobile next generation network, Evolution towards 4G

ITU-D/ITU-T Seminar on Standardization and Development of Next Generation Networks for the Arab Region

Manama (Bahrain) 29 April - 2 May 2007

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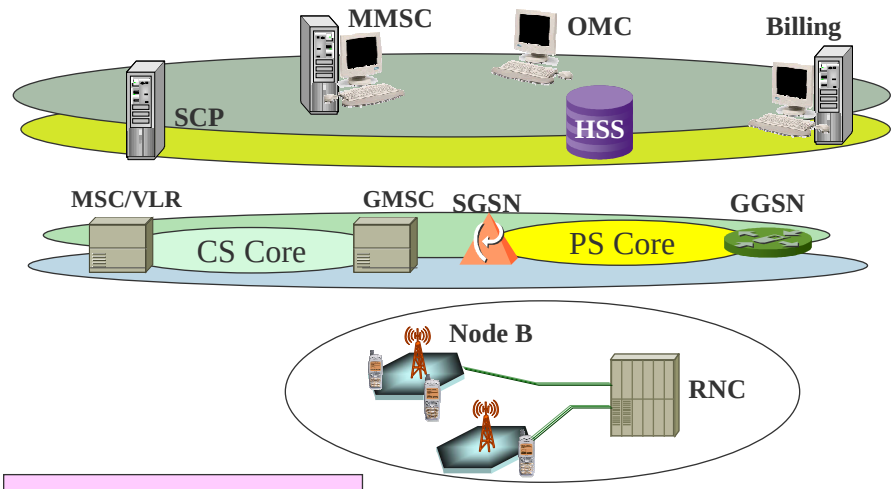
Summary

I. UMTS releases evolution

3

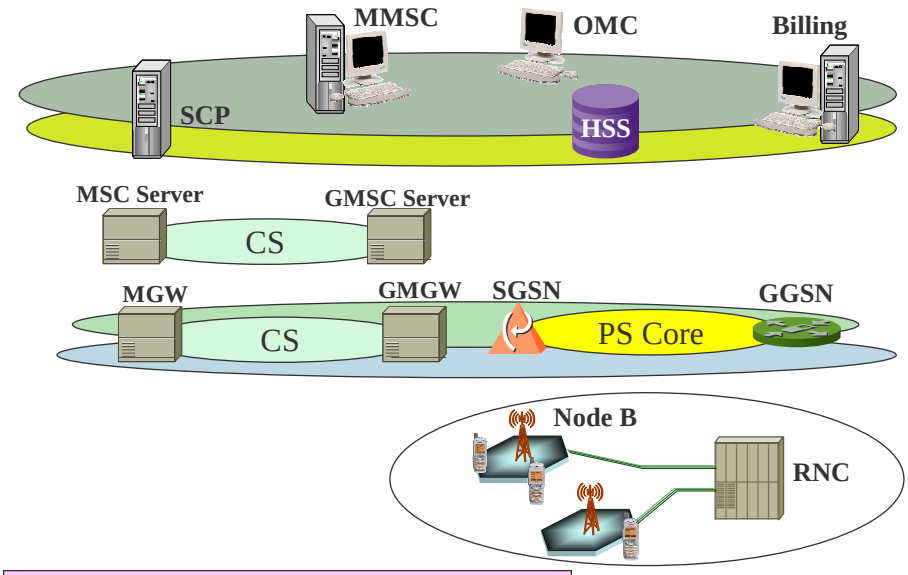
UMTS Release 99



Based on GSM and GPRS

4

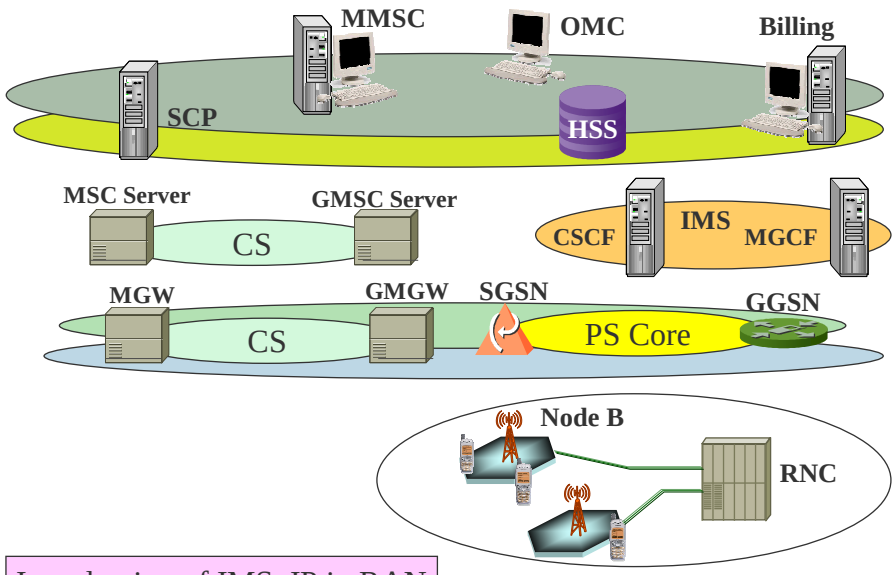
UMTS Release 99



Control and bearer plans separation for CS

5

UMTS Release 5



Introduction of IMS, IP in RAN

6

Core network evolution

2 main features

Gateway

- Border network
- Features:
  - ➢ Media resources,
  - ➢ Switching/Routing,
  - ➢ Media conversion,
  - ➢ Option: signaling.
- Examples: *Wireless Gateway, Fixed Gateway, IP Gateway*

Server

- Layer control
- Features:
  - ➢ Mobility management,
  - ➢ Call control,
  - ➢ Security,
  - ➢ Billing.
- Examples: *MSC Server, SGSN Server, CSCF (Call State Control Function), Media Gateway Control Function (MGCF).*

7

UMTS services

Classes	Types of services	Constraints
Conversational	Voice, video	Real time
Streaming	File transfer (video sequence downloading)	Synchronism between entities
Interactive	Sessions (Web, databases access, …)	Low BER
Background	SMS, e-mail, FTP	Low BER and low delay constraints

	Picocells	Microcells	Macrocells	Satellite coverage
Area	**Buildings**	**Urban**	**Rural and suburban**	**Rural and suburban**
Bitrates	**2 Mb/s**	**512 kb/s**	**144 – 384 kb/s**	**9,6 kb/s**
Speed	**Low**	**120 km/h**	**500 km/h**	**120 km/h**

8

UMTS Release 5 features

- HSDPA (1 - 5 Mb/s mean throughput)
- CAMEL 4
- IMS (VoIP, chatt, games, *white shared board*, flexible billing, …)
- *Wideband AMR* (larger band for voice)
- SIP (*call control*)
- Smart antennas
- OSA improvements (VAS offers from third parties, VHE eased)
- GTT (*Global Text Telephony*, real time conversation)
- *Extended streaming* (optimisation, 2 and 3D graphics, MIDI, …)
- LCS improvements with A-GPS
- IP transport in UTRAN (IP-RAN) with DiffServ introduction
- End to end QoS enhancements
- MMS/EMS enhanced
- IuFlex (load sharing among core network nodes).

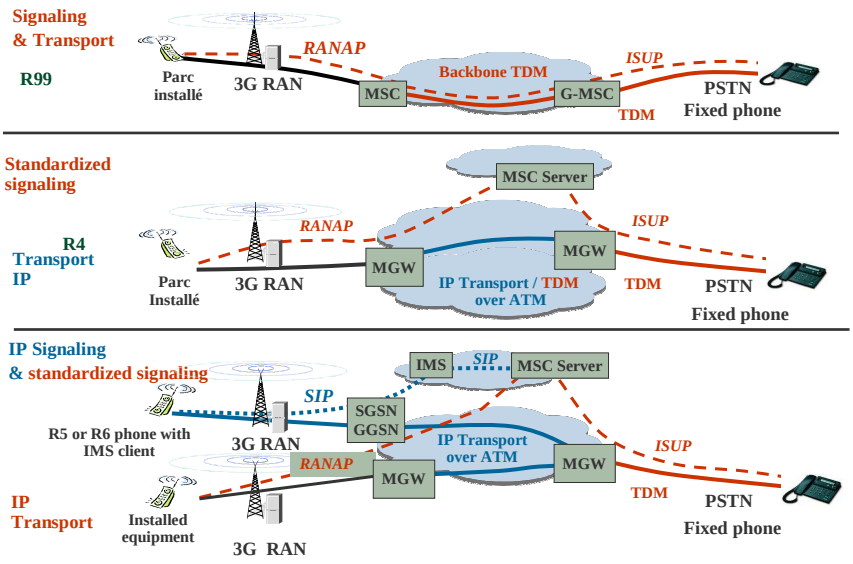
9

Release 6 features

- MBMS
- IMS phase 2 (access independant from access network UMTS, GERAN, WLAN)
- SES (*Speech Enhanced Services*): distributed speech recognition
- MIMO
- WLAN (*loose coupling*) with AAA features reuse, access with USIM
- Terminal management (configuration, performances, downloading)
- Presence and *Instant Messaging*

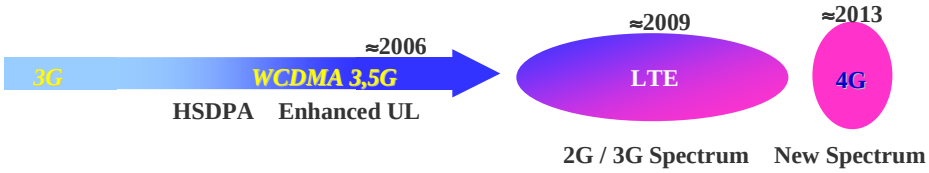
10

Core network evolution



11

3G LTE (Long Term Evolution)

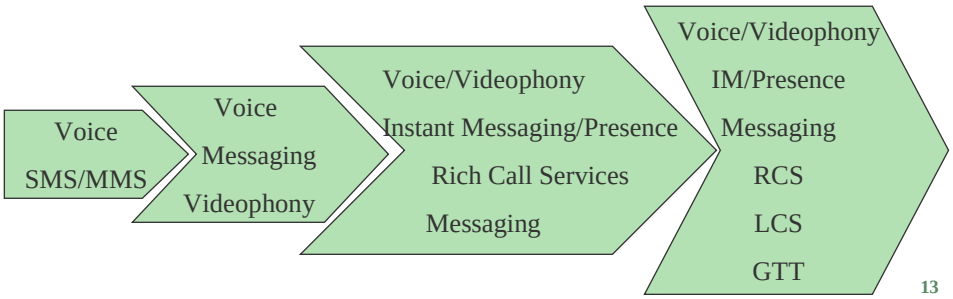


- **Performance and capabilities**
  - Data rates: up to 100 Mbps in local area
  - Latency: less than 10 ms
  - Improved spectrum efficiency
  - IP optimized
  - Broadcasting
  - Spectrum flexibility
- **Wider carrier bandwidth based on AML-OFDM** (up to 20 MHz, scalable downwards)

12

Services evolution in UMTS R99/R4/R5/R6 networks

Release	*Services*
R99	MMS, streaming, LCS (cell), MExE, SAT, VHE,
R4	TrFO, VHE, OSA, LCS in PS and CS,
R5	VoD, IMS, HSDPA, Wideband AMR, GTT
R6	MBMS, IMS phase 2



13

III. IMS and NGN

14

NGN definition ITU

Rec. Y.2001 "**General overview of NGN**" (Dec 2004):

An NGN is a packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which ***service-related functions are independent from underlying transport-related technologies***. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

15

NGN definition

Separation of:

- *Access Layer*
- *Transport Layer*
- *Control Layer*
- *Service Layer*

with Control & Transport Layers being shared by:

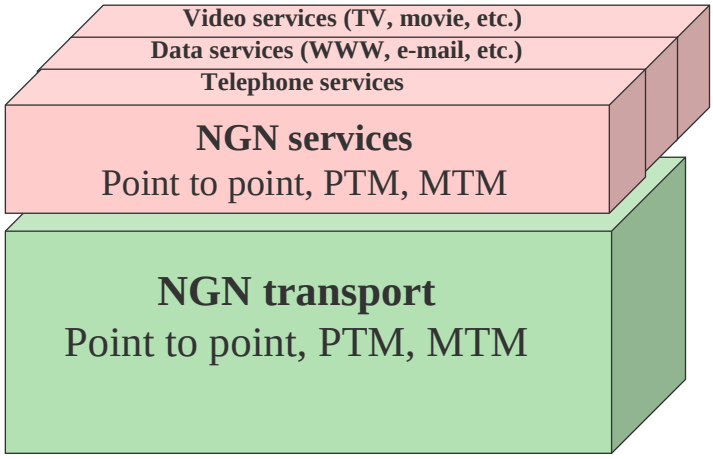
- different access types (RAN, Fixed…)
- service layers

with Packet (ATM, IP) Transport converging toward IP transport

for provision of Multimedia Services (Real Time, Presence, Messaging, Voice, Video, Data...)

16

NGN convergence model



17

IMS characteristics

Principles

- **QoS characteristics differentiation**: voice calls, videophony, associated to a multimedia session (streaming, IM, etc.)
- **Separation of the planes**: IP data and session control (SIP)
- **Independancy** from access network

R5

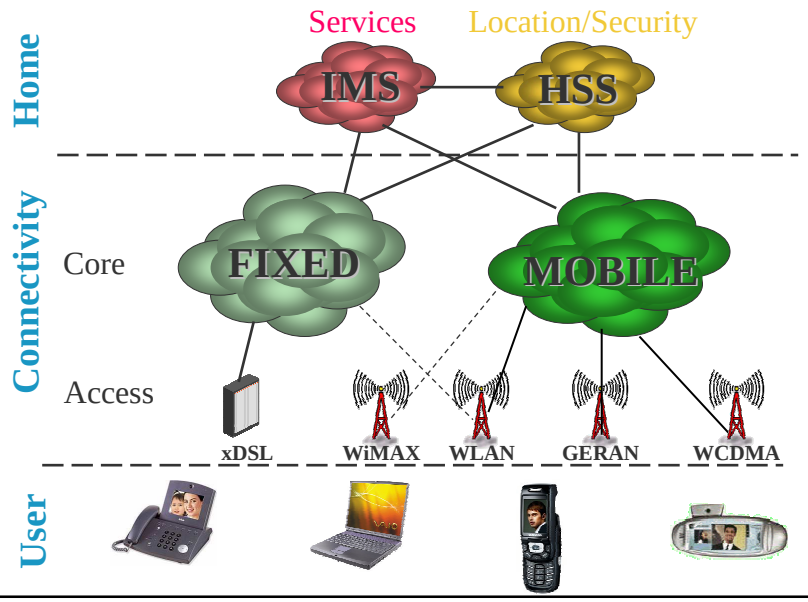
IMS for mobile networks
Packet GPRS, EDGE, UMTS & CDMA2000
Non real time services
Plate-forme for **multimedia IP applications**
Based on **IETF specifications**

R6

IMS extended to fixed networks (xDSL, WLAN, cable, …) with media gateway
Support of **services convergence** on fixed and mobile networks (conversion CS voice traffic into IP)

18

IMS Architecture (1)



19

IMS Architecture (2)

Layering structuring:

• ***Access:*** all broadband access such as UTRAN, CDMA2000, xDSL, cable, WiFi, …

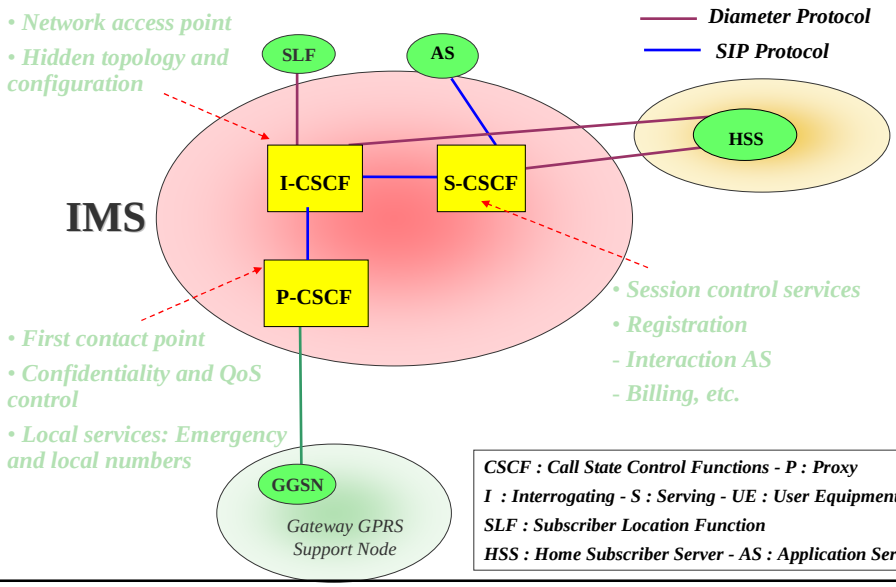
• ***Transport***: IP network or variants with QoS mechanisms (MPLS, Diffserv, RSVP, …). Switches/routers interconnected. Various stacks for IP network (IP/ATM/SDH, IP/Ethernet, IP/SDH, …)

• ***Control***: session controllers for signaling routing between users and services invocation. CSCF nodes (*Call State Control Function*).

• ***Application***: applications (VAS) with *Application Servers* (AS) and *IP Media Server* (IP).

20

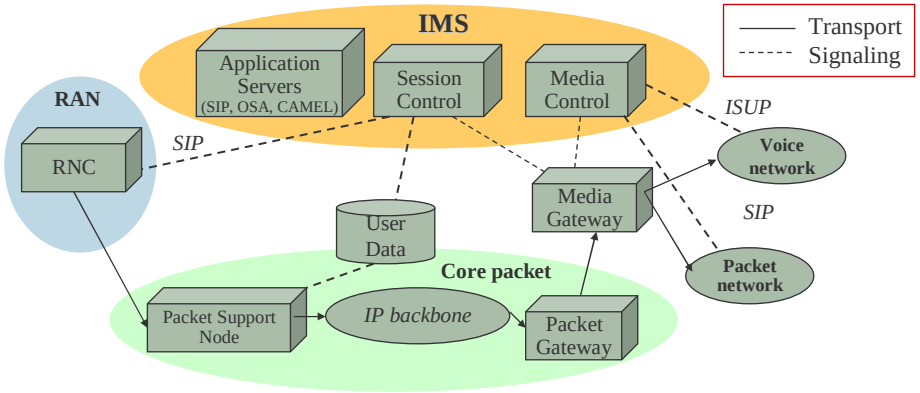
IMS basic componants



CSCF : Call State Control Functions - P : Proxy
I : Interrogating - S : Serving - UE : User Equipment
SLF : Subscriber Location Function
HSS : Home Subscriber Server - AS : Application Server

21

Componants and interactions between IMS and other networks



S-CSCF (*Call Status Control Function*): central IMS component;
SIP AS (*SIP Application Server*): provision of the logic associated with the VAS;
OSA SCS (*Service Capability Server*) gathers one or several features;
IM-SSF (*Inter-working Module*) : SIP-CAMEL interworking;
CSE (*Camel Service Environment*): SCP using CAMEL and GSM (GSM SCF) features;
HSS *(Home Subscriber Server)*: same as HLR for IMS

22

Définition and principles

Principle

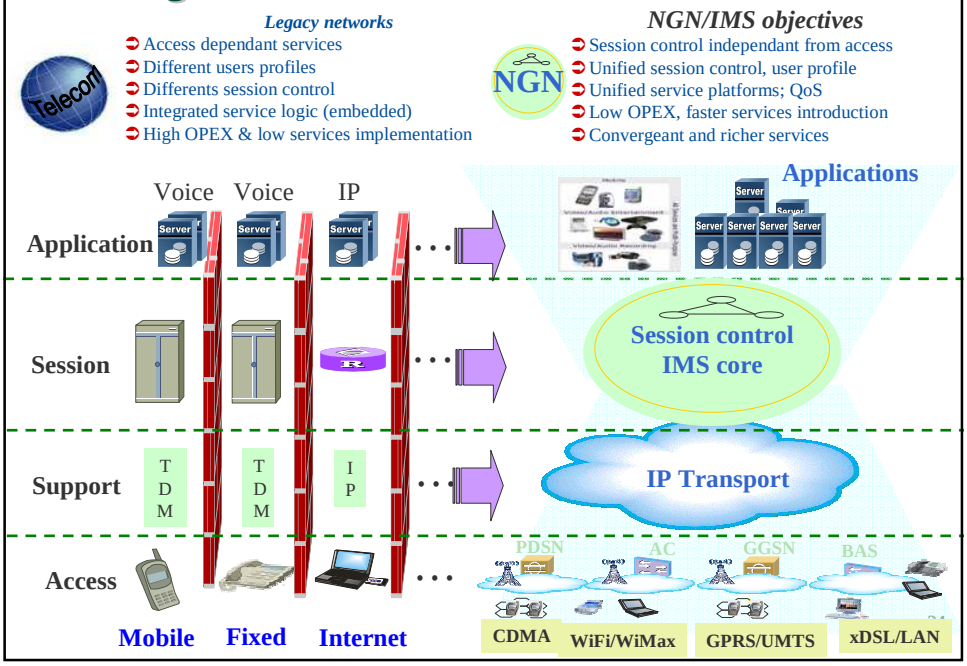
IMS architecture proposed as answer to the convergence needs of multimedia services between mobile and fixed networks. IMS is part of NGN implementation.

Definition

- Structured part of NGN architecture allowing progressive introduction of multimedia voice and data applications in mobile and fixed networks.
- IMS is based on IP and SIP (*Session Initiation Protocol*) specified by IETF with extensions introduced by 3GPP and TISPAN (ETSI).
- IMS involves standardization entities such as ATIS, 3GPP2, OASIS, FMCA, OMA/Parlay and UIT-T.
- IMS = compatibility between 3G mobile networks, circuit switched networks POST/ISDN and Internet for voice and multimedia services.

23

Convergence towards an all-IP NGN architecture



IMS development environment

IMS (*IP Multimedia Subsystem*)

1. New architecture based on new:
   - concepts,
   - technologies,
   - partners,
   - ecosystem.
2. IMS allows on an all-IP network: *real time* application sessions (voice, video, conferencing) and *non real time* (PtP, Presence, IM, …).
3. Concept of ***services convergence*** supported by different networks (fixed, mobile, Internet).
4. IMS = NGN Multimedia.

25

IMS in UMTS

Allows operators to have more control on the service level than with GPRS only:

- Service level awareness
- Correlation between the SIP application layer and the transport in PS domain
- Access to services in correlation with a subscription
- profile (e.g. basic, silver, gold…)
- Better control on the packet resources used
- **3GPP IMS Releases:**
- Release 5: frozen since March 2003
- Release 6: frozen since December 2004
- Release 7: target to freeze end 2005

26

IMS R5 features

Allows the differentiation of QoS characteristics associated to a multimedia, voice call, or videophone session: conference calls, access to *streaming* contents, presence, video messaging, *Instant Messaging*, push services, content sharing, web browsing, file download,

- *Flexible billing*: billing per service, connectivity, QoS, duration, destination – volume; billing per content, images, news, books.
- *Example*: add/suppress componants such as video, audio, whiteboard on-line sharing.

27

IMS R6 enhancements

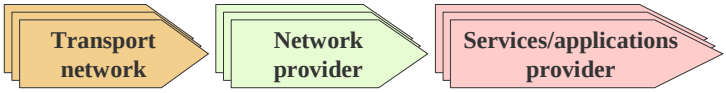
- *Identity portability*: Portability of the identities when changing operator
- *VoIP over HSDPA* (allows the use of IP for voice transportation during a handover with a better QoS during HO).

28

Impacts on the value-chain

Non-IMS networks

• Vertical and tight integration between network and services
Limited access to third parties (MVNO, service providers).



IMS networks

• Vertical and loose integration of networks, services and applications
Standardized interfaces allowing easy integration of third parties.
Focused on core network skills and scale savings
Enriched service offers for target markets.

29

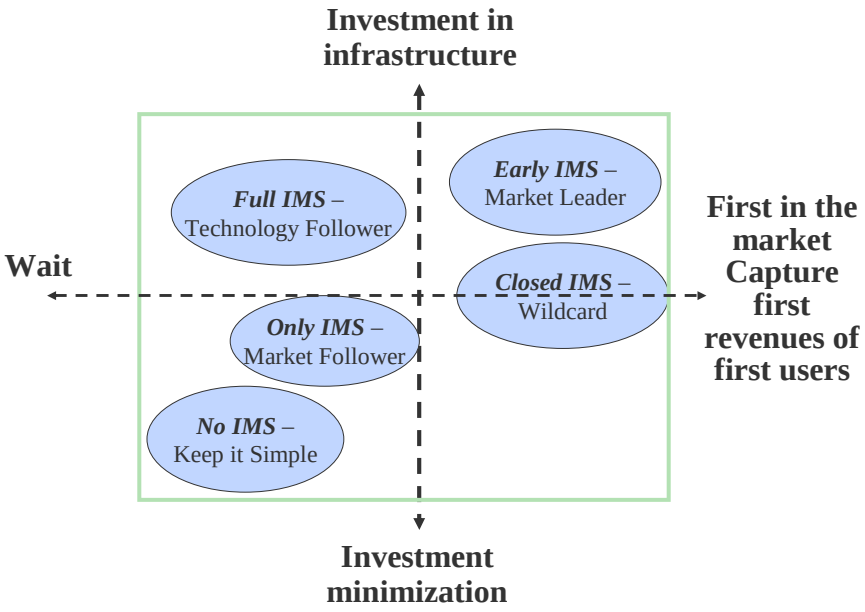
IMS scenarios introduction (1)

5 scenarios

- ***No IMS***: no IMS deployment, focus on classic services.
- ***Full IMS***: deployment in compliance with 3GPP standards.
- ***Closed IMS***: objective is to know the market and maximise IMS revenues.
- ***Only IMS***: most conservative investment strategy minimising the investments of mobile operator until 3GPP standard stabilization and demand development.
- ***Early IMS***: adoption of market solutions.

30

IMS scenarios introduction (2)

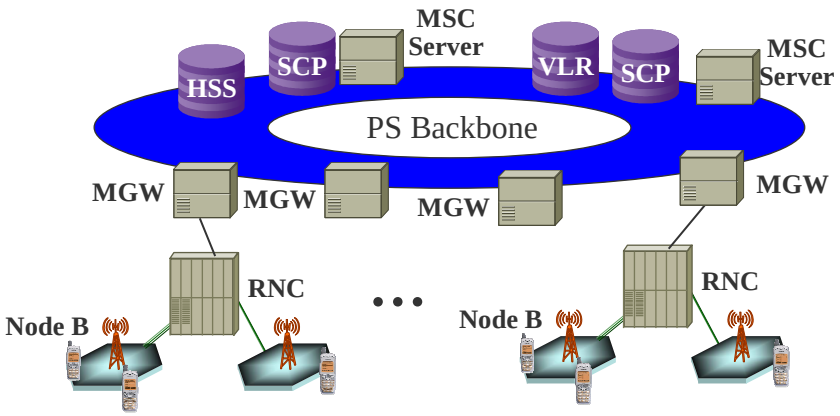


31

Transition to NGN (1)

NGN advantages:

- Transport network simplification (common CS/PS backbone),
- No transit layer,
- Common signaling (signaling over IP, SIGTRAN),

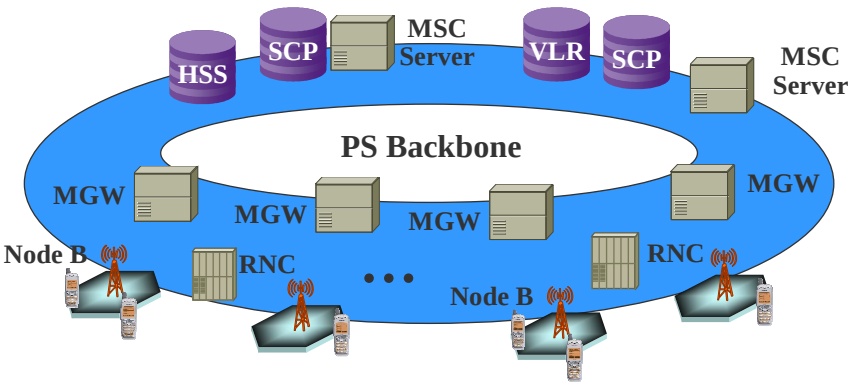


32

Transition to NGN (2)

NGN advantages:

- Transport network simplification: R5 common CN/RAN backbone,



33

IV. Evolution towards 4G

34

Migration between generations

1G → 2G

➢ 1G environment = little capacity, *telephony for everyone* as objective.

↳**Easy** introduction as voice is a service natural for everybody (killer application?)

2G → 3G

➢ 2G environment = large capacity: almost everybody has access to the technology, wideband multimedia for everyone as objective. WLANs are almost everywhere at cheap costs.

↳ **Difficult** introduction as data services on mobile is not natural (no killer application so far).

3G → 4G

➢ 2G + 3G + WLANs + … environment = huge capacity, many radio standards (GERAN, UTRAN, WiFi, WiMAX, WPANs, …): most people has access to multimedia services, broadband wireless access for everyone as objective. WLANs, cellular systems are almost everywhere at cheap costs and with high bit rates.

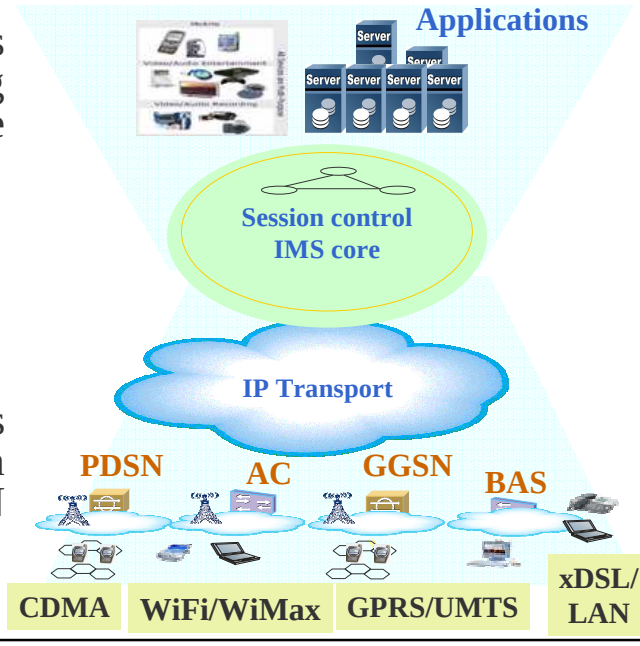
↳**Very difficult** introduction as users are accustomed to access data services at almost no cost (niche applications?).

35

Advantages of NGN in 4G

Many RANs for accessing to the core network: GERAN, UTRAN, WLANs, WPANs, …

⇒ Service ubiquity is natural with IMS in a NGN architecture



4G - What is it?

- 4G = 4th Generation mobile communications
- 4G = B3G = Beyond 3rd Generation (UMTS, IMT-2000) mobile communications
- Foreseen to become available *after 2010*.
- ITU Recommendation ITU-R M.1645:

Systems beyond IMT-2000 will be realized by functional fusion of existing, enhanced, and newly developed elements of IMT-2000, nomadic wireless access systems and other wireless systems, with high commonality and seamless interworking.

= *mix of many interacting systems* is foreseen - not one standard.

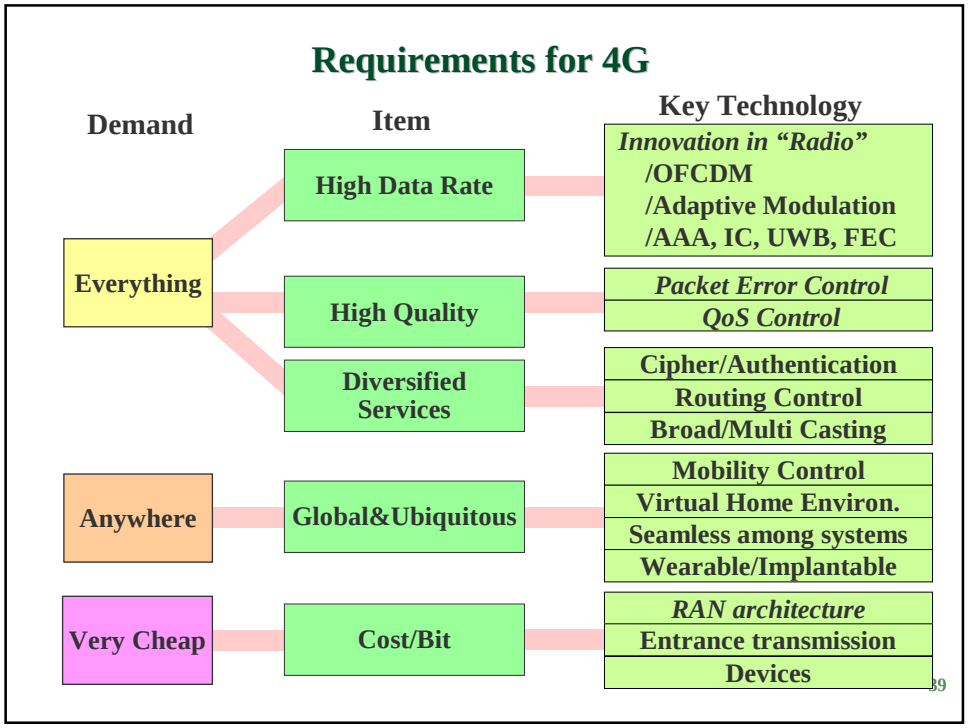
- Targeted data rates (with wide area coverage and significant mobility) are in the area of *50 to 100 Mbits/s*.

37

4G Requirements

- **Requirements for the Beyond IMT-2000 system**
  - High data rate transmission: e.g., DL:100Mbps / UL:20Mbps.
  - Larger system capacity: e.g., ***3G***:1.2Mbps/1MHz and 6-sector-BTS, ***4G***: 5-10 Times to 3G.
  - Lower cost/bit,
  - Wireless QoS control: NRT Service, RT Service, Multi-Cast Service.

38



Motivations

- Wider Bandwidth
- Global mobility and service portability difficult due to different standards hampering
- Primarily Cellular (WAN) with distinct LANs'; need a new integrated network
- Apply recent advances with spectrally more efficient modulation schemes
- Need all all digital network to fully utilize IP and converged video and data

40

Key 3G and 4G Parameters

Attribute	*3G*	*4G*
Major Characteristic	Predominantly voice- data	Converged data and VoIP
Network Architecture	Wide area cell based	Hybrid – integration of Wireless Lan (WiFi), Blue Tooth, Wide Area
Frequency Band	1.6 - 2.5 GHz	2 – 8 GHz
Component Design	Optimized antenna; multi-band adapters	Smart antennas; SW multi-band; wideband radios
Bandwidth	5 – 20 MHz	100+ MHz
Data Rate	385 Kbps - 2 Mbps	20 – 100 Mbps
Access	WCDMA/CDMA2000	MC-CDMA or OFDM
Forward Error Correction	Convolution code 1/2, 1/3; turbo	Concatenated Coding
Switching	Circuit/Packet	Packet
Mobile top Speed	200 kmph	200 kmph
IP	Multiple versions	All IP (IPv6.0)
Operational	~2003	~2010

41

Definition

- Completely **new fully IP-based** integrated **system of systems** and **network of networks** achieved after **convergence of wired and wireless networks** as well as **computers, consumer electronics, and communication technology** and several other convergences that will be **capable to provide 100 Mbps and 1 Gbps**, respectively in **outdoor and indoor** environments, with **end-to-end QoS** and high **security**, offering **any kind of services** at **any time** as per user requirements, **anywhere** with **seamless interoperability**, always on, **affordable cost**, one **billing** and fully **personalized**.

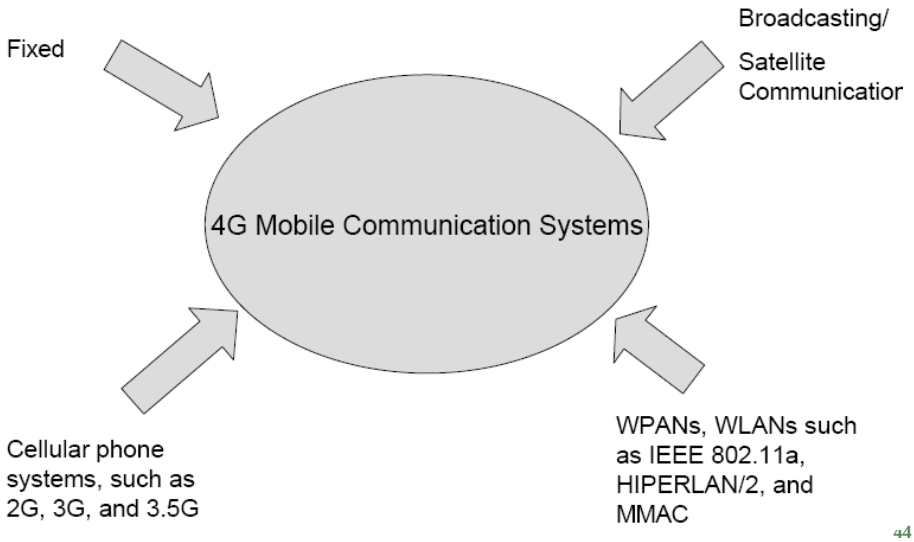
42

Radio technologies for B3G systems

- MIMO (*Multiple-Input Multiple Output*) technology
- Link adaptation techniques
- Multi-carrier based modulation and access (OFDM/OFDMA)
- Iterative (multi-user) processing
- "Cross-layer" optimization and design principles
- Ultra-WideBand (UWB)...?

43

Convergence is what 4G is about



44

Concluding remarks

- **4G, convergence**: networks, technologies, applications and services,
- Personalized and pervasive network to the users.
- Full IP and one unique core network.
- Services, applications, transport, access separation (NGN) approach.
- **Convergence** is the disruptive concept of 4th generation mobile networks.

45