IP in UMTS Networks

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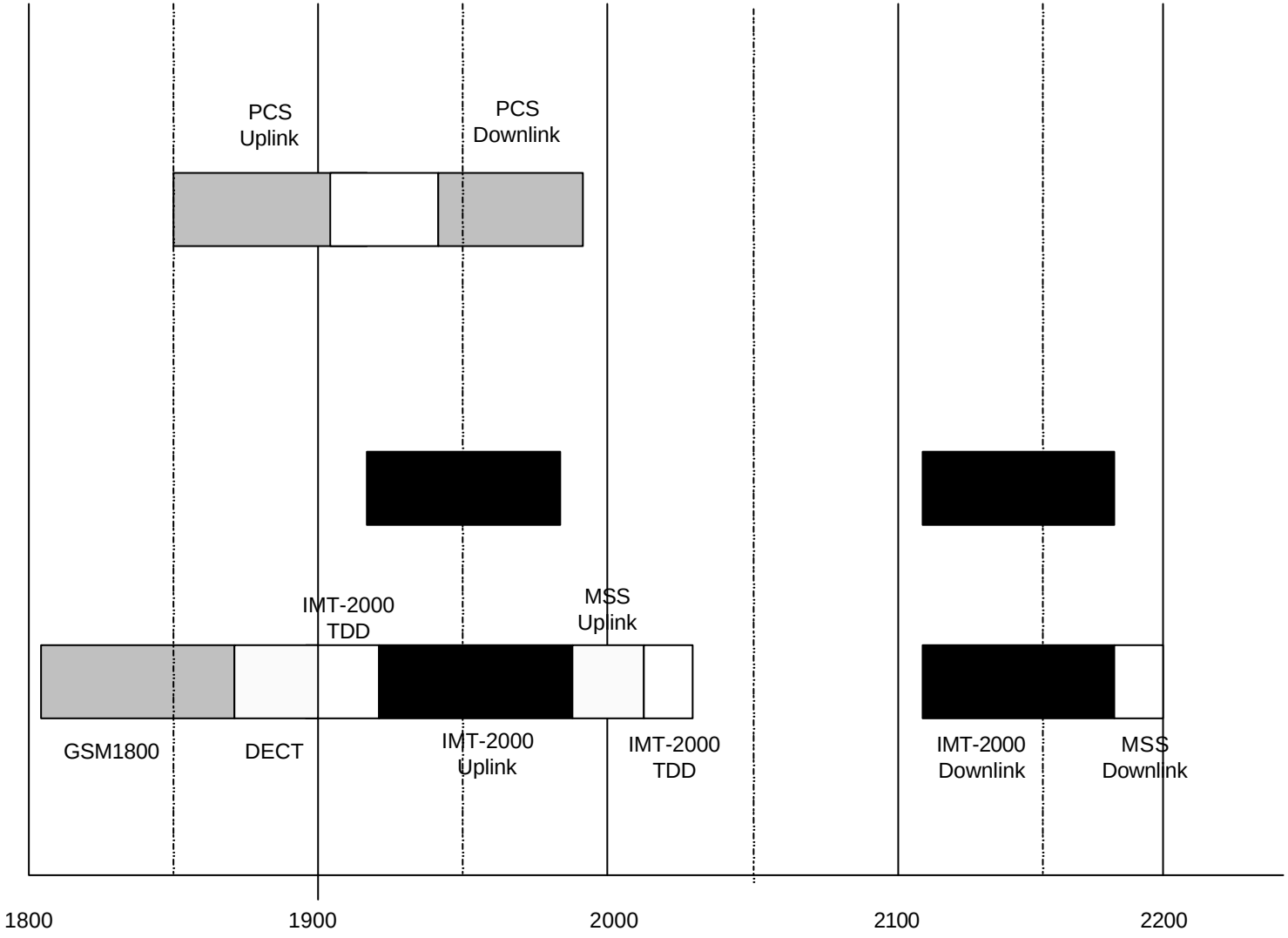
Content:

- UMTS vision
- UMTS requirements and features
- UMTS architecture
  - Radio access networks (UTRAN,GERAN)
    - RNC
  - Core Network
    - SGSN,GGSN, Border gateway
  - Interfaces
    - Iu, Iub, Iur
- Protocol architecture
  - User Plane
  - Signaling Plane
  - GPRS tunneling
- Summary

History and Vision

- Vision
  - Build a mobile wireless system that is access independent and provide personalized services that are accessible from anywhere at any time via different devices.
  - Architecture allows clear separation of radio access networks.
  - Currently two types radio access networks
    - UTRAN which is based on WCDMA.
    - GERAN (GSM/EDGE) that is based on TDMA as evolution from GSM.
- Spectrum
  - WARC (World Administrative Radio Conference) specified two frequency bands for IMT-2000 applications in 1992.
    - 1885…2025Mhz
    - 2110..2200Mhz.
  - Further split up to support several different types of 3G services.
    - E.g. terrestrial paired band
      - Operators employ ground-based BS and will use FDD to separate the b-directional communications between MS and BS.

IMT-2000 Spectrum



UMTS requirements and features

Main categorizes:

- Access to information and content on the Internet
  - 3G enables creation of wireless internet.
- Global roaming
  - UMTS requires that a common core network be able to support different types of access network. Roaming across heterogonous network becomes easier.
- New services
  - UMTS network is expected to provide new services than traditional voice.
  - Multimedia services: Video streaming/telephony, integration of voice and data (e.g. voIP).
- Convergence of datacom and telecom
  - Wired/wireless networks are set to move in the direction of convergence and packet based data transfer.

- 3G features are rich: increased data rates (WCDMA - 2MB, HSDPA-10Mb), subscriber security, clarified separation of radio access networks.

IP networking perspective

- High access data rate alone, is huge improvement over GPRS.
  - Bandwidth enables new IP services in addition to old ones (GPRS).
  - Real time services (voIP) and streaming video as main driver applications.
  - Network must support QOS in order to provide real time services.

UMTS architecture

- 2 radio networks attached to CS and PS core networks.
  - Each able to carry subscriber IP traffic.
- UMTS packet core adopted many GPRS features
- WCDMA radio interface is main new item (R99)
- UTRAN enables new main IP services.

IP point of view:

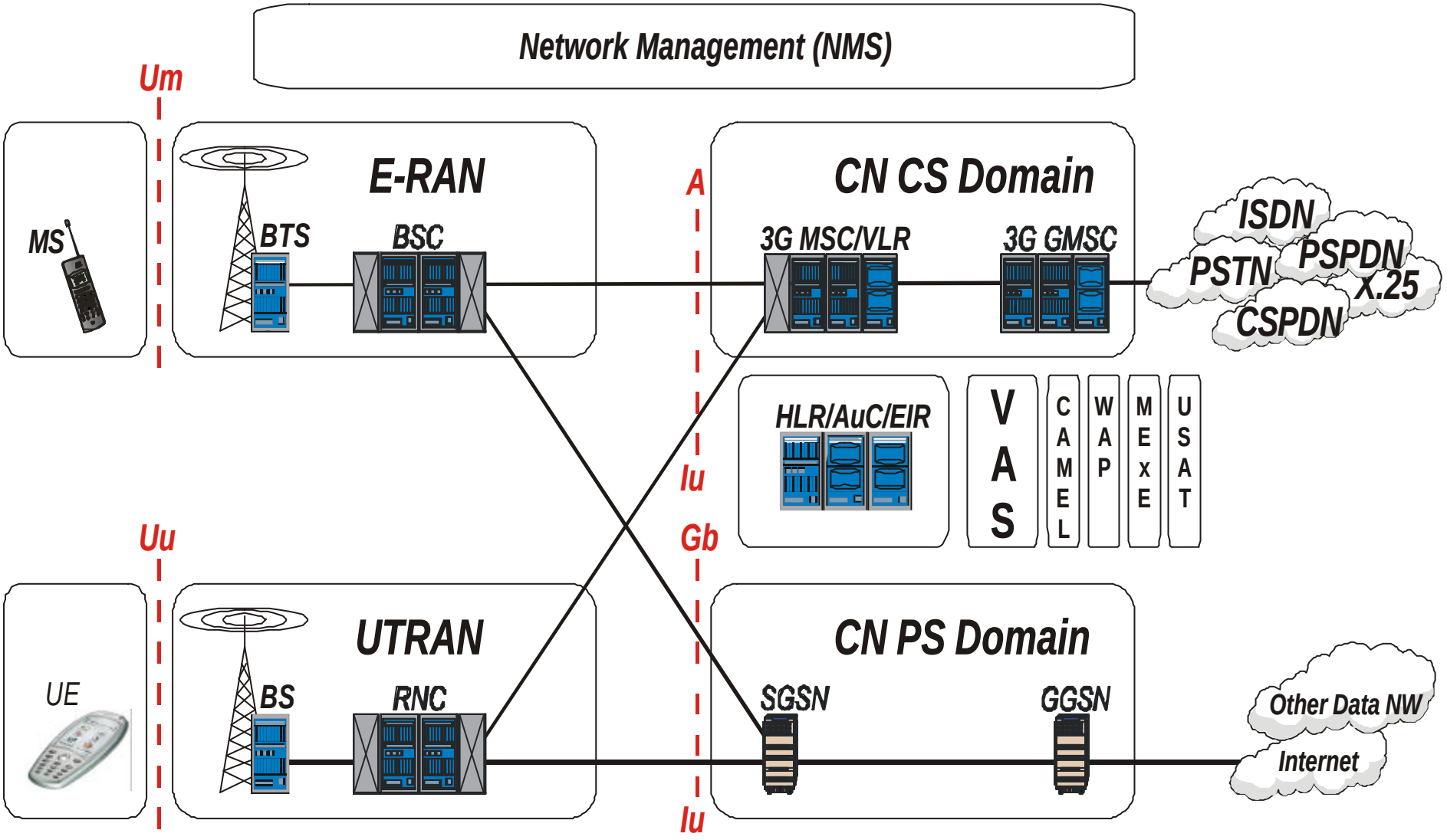
- Main change that Iu-ps interface replaces Gb between core and access network.
  - IP header compression is required to improve the bandwidth usage over the air interface.
  - Compression done in RNC (GPRS: SGSN), its invisible to UMTS network or like other access-specific optimizations.

R5:

- IMS (IP multimedia subsystem)
  - Radio network moves toward IP from current ATM infrastructure.
    - Offers more freedom to operators in network implementation.

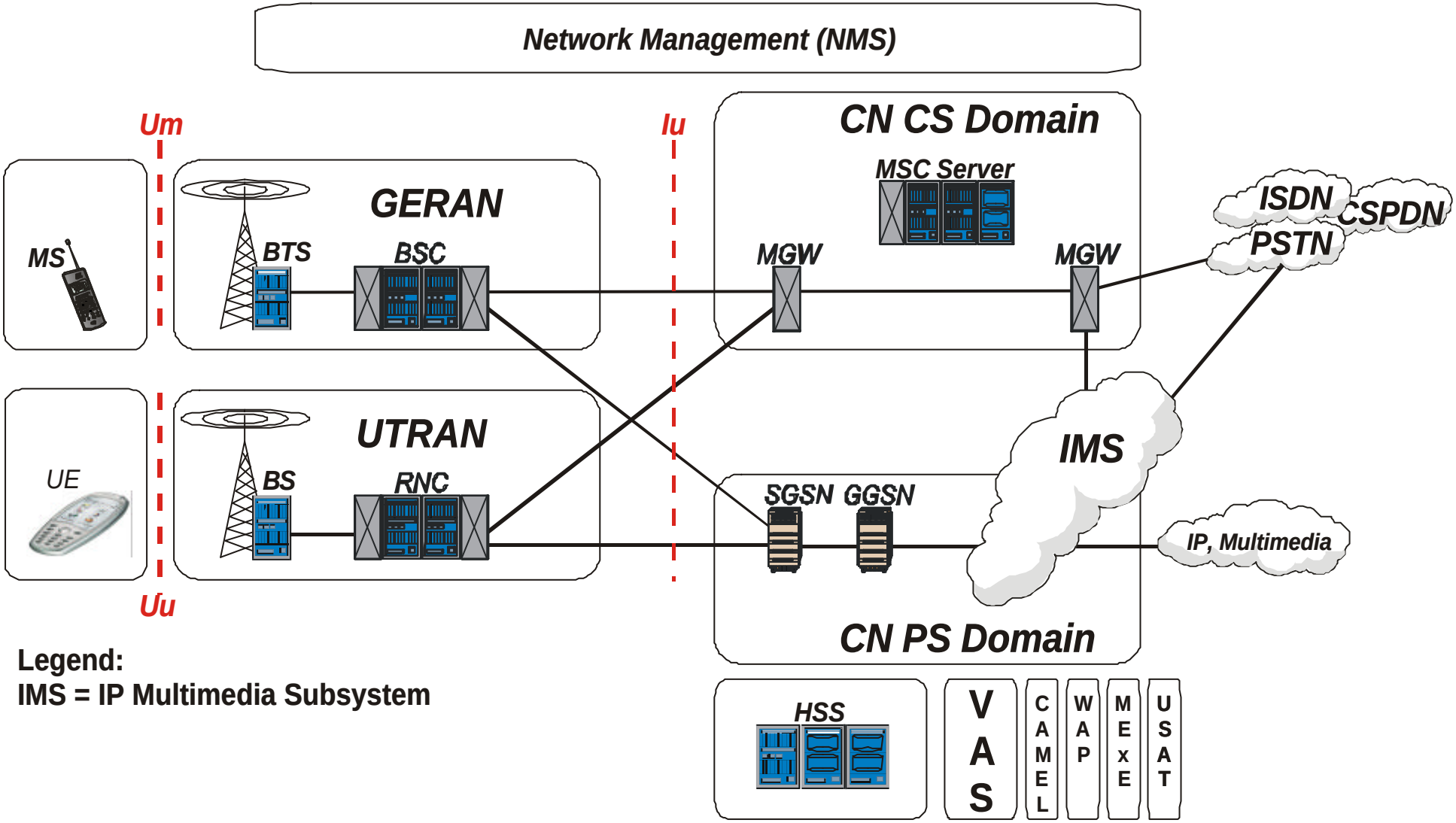
UMTS Network Architecture (3GPP R99)

(Figure from Ari Ahtiainen presentation 'From GSM to UMTS')



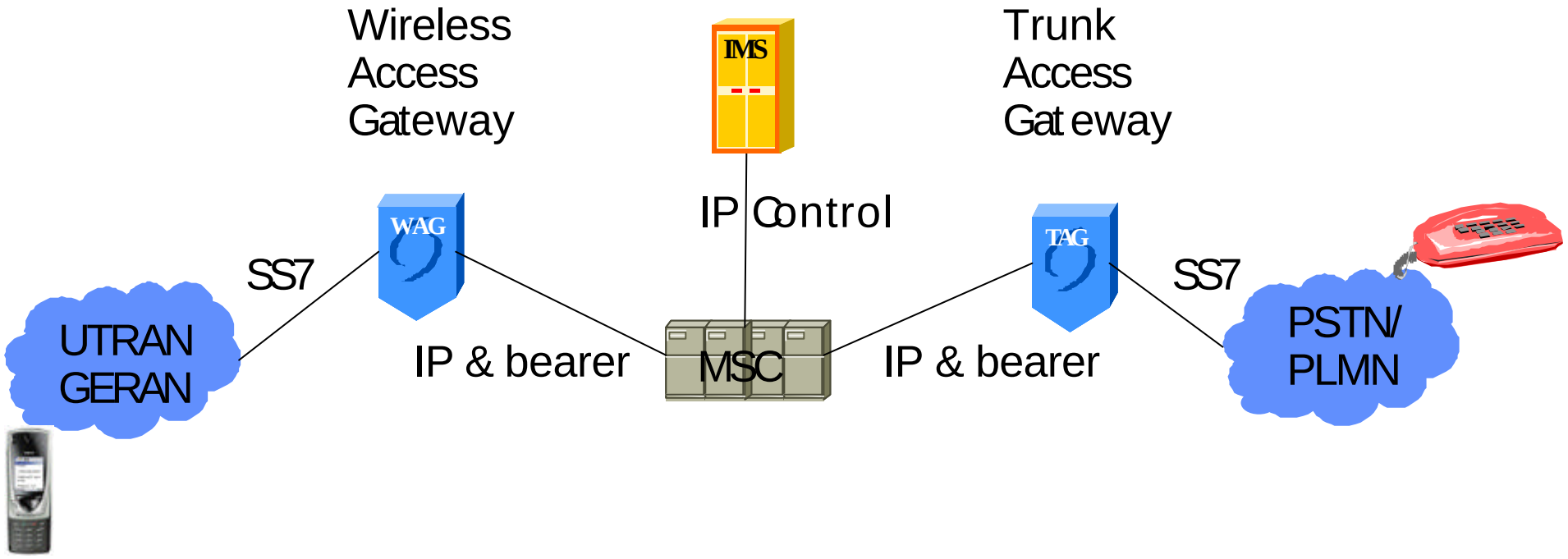
3GPP R4 Implementation Scenario

(Figure from Ari Ahtiainen presentation 'From GSM to UMTS')



Legend:
IMS = IP Multimedia Subsystem

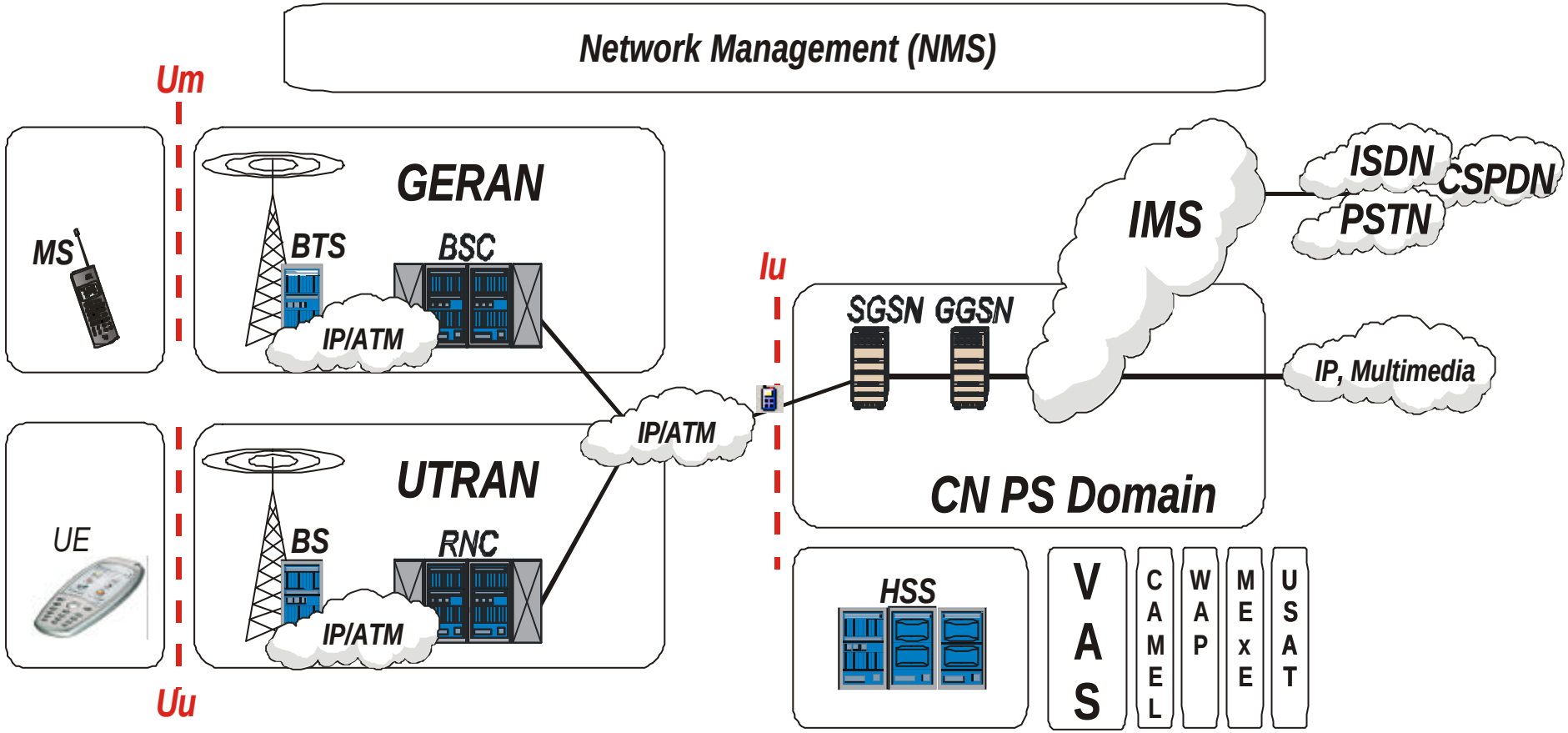
IP point of view



MSC = mobile switching center
IMS=IP Multimedia Subsystem

Vision of 3GPP R5 (All IP)

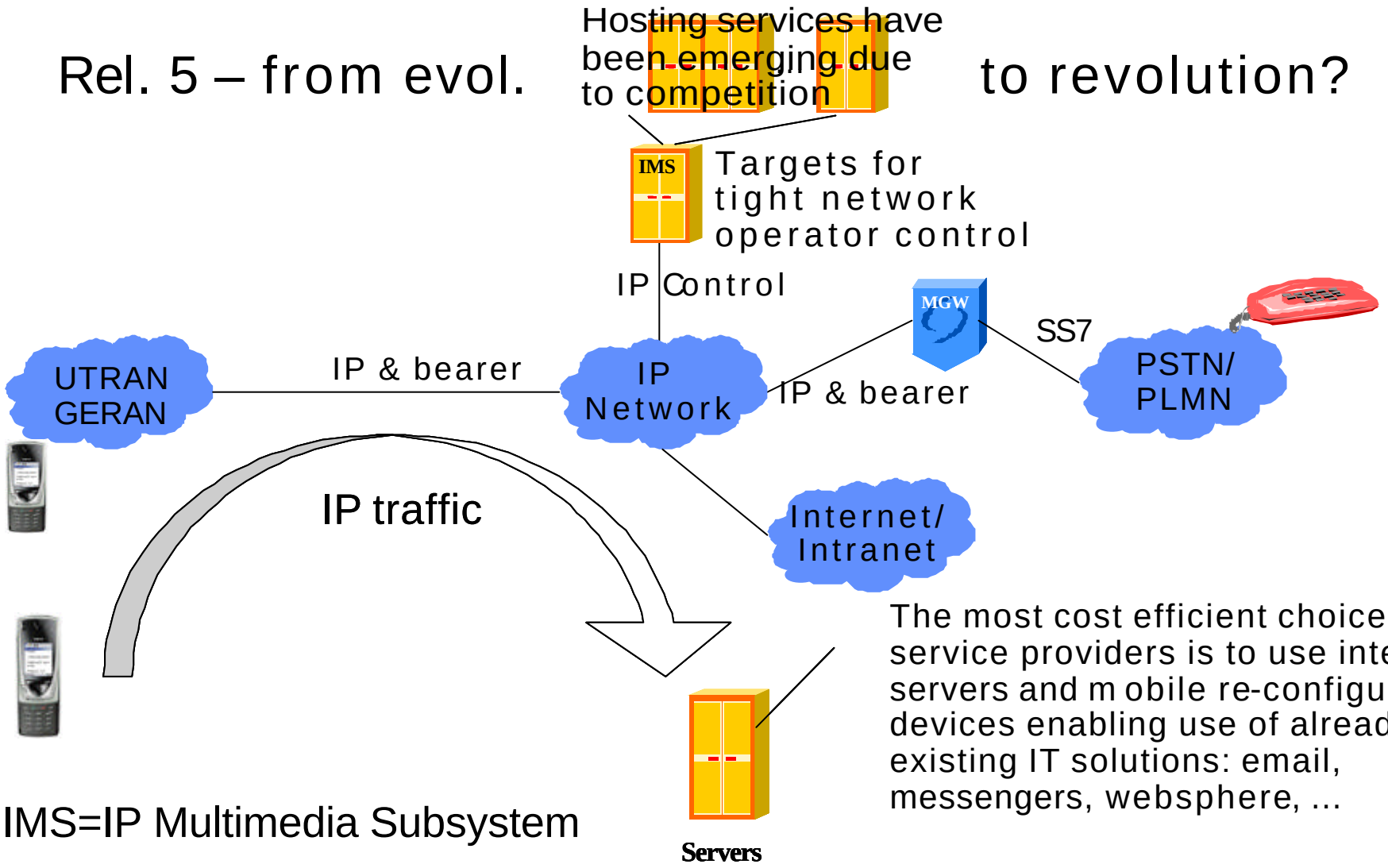
(Figure from Ari Ahtiainen presentation 'From GSM to UMTS')



Legend:
IMS = IP Multimedia Subsystem

IP point of view

Rel. 5 – from evol. to revolution?



IMS=IP Multimedia Subsystem

The most cost efficient choice for service providers is to use internet servers and m obile re-configurable devices enabling use of already existing IT solutions: email, messengers, websphere, ...

UMTS network architecture

- RNC
  - Is the controlling element of the UTRAN. It manages radio resources associated multiple Node Bs that are connected to it.
  - Interfaces the UTRAN or GERAN with core network via Iups Iucs interfaces.

Packet Switched Core Network

- UMTS inherits many of the GPRS packet core features.
- Difference: Air interface capacity allocation.
  - WCDMA allows much higher data rates, up to 2Mbps.
  - Flexibility
  - UMTS implements 2-way authentication
    - Security improves for user

Packet core functions are in high level as follows:

- Network access control
- Packet routing and transfer
- Mobility Management
- Logical link management
- Radio Resource management
- Network management

Packet switched core Network

- Packet switched core network: SGSN, GGSN, Border Gateway

- UMTS packet data access supports 4 different QOS classes:
  - Conversational (real time services, e.g. voice)
  - Streaming (Audio and Video)
  - Interactive (Applications, e.g. Web browsing)
  - Background (other services, e.g. email, file transfer etc.)

Packet switched core Network - components

- GGSN

  Is a gateway to the external packet data networks. It tunnels the PDUs to the MS's current point of attachment.

  - Anchor point for MS. Functions same than in GPRS network.
  - Default router
  - Selection depends on APN (Access Point Name)
    - APN is included as part of PDP context request.

  - Supports multiple PDP contexts requests (Difference to GPRS).
    - Capable of assigning multiple PDP context within a single IP address for MS.

Packet switched core Network - components

- SGSN

  Provides mobility management, performs authentication, and routes packet data. SGSN collects charging information related to the usage of the network.

  - Interface (Iups) that connects it to RNC is different than in GPRS.
    - Enhancement over Gb, that is the interface that connects BSS to the SGSN in GPRS.
  - IuPs interface supports real-time services.
  - Completely free from radio-related functions (unlike in 2G SGSN)
    - 2G SGSN optimizes radio link usage.
  - 2 GTP tunnels for carrying user plane datagrams.
    - Only one in 2G SGSN.
    - Tunnels (GTP-U) are between GGSN-SGSN and SGSN-RNC.

- Border Gateway

  Two intra-PLMN backbone networks can be connected via the Gb interface using BGs.

  - BG is a firewall that protects the packet core from security threats.
  - GGSN connects to packet networks e.g. Internet via BG.
  - BG is the same in GPRS and UMTS networks

Interfaces

Iu

Connects UTRAN/GERAN radio network to the core network.

Divedded in to 2:

- IuC
  - Connects radio network into circuit switched core network.
  - Includes MSC, HLR, VLR, AuC functions
- IuP
  - Connects radio network into packet switched core network that comprises SGSN and GGSN.

Iub

Connects Node Bs (also BTS) to the RNC.

- Consists user and control plane, NBAP (Node B application Part).
- ATM is used as the underlying protocol for Iub interface.

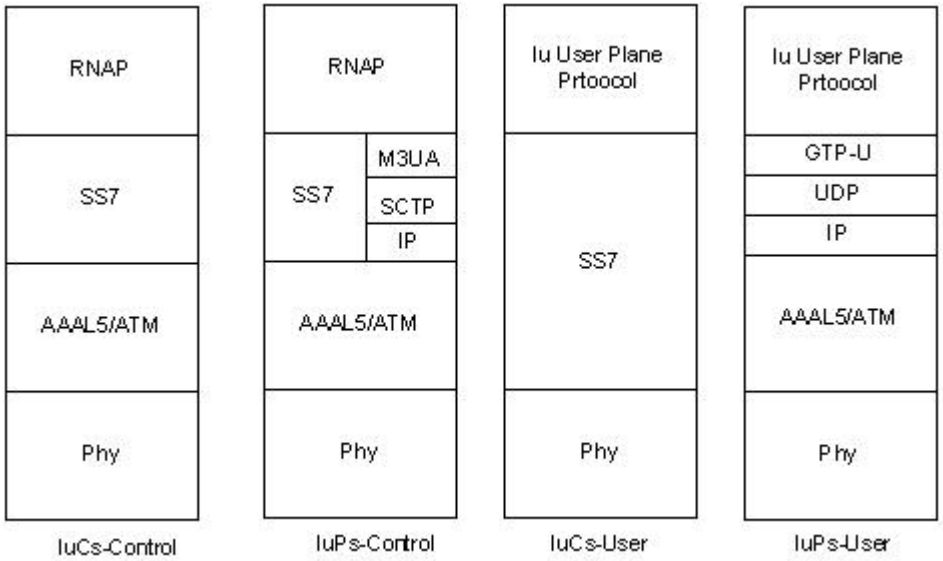
Interfaces

Iur

Defined for inter-RNC communication

- Consists user and control plane, RNSAP (Radio Network System Application Part).
- RNSAP operates over SS7 (Signaling system num. 7), that is carried over ATM (AAAL5) interface.
- Use plane consists 2 frame protocols
  - Dedicated channel frame
  - Common channel frame

Interfaces


RNAP
SS7
AAAL5/ATM
Phy
IuCs-Control
RNAP
SS7
M3UA
SCTP
IP
AAAL5/ATM
Phy
IuPs-Control
Iu User Plane Prtoocol
SS7
Phy
IuCs-User
Iu User Plane Prtoocol
GTP-U
UDP
IP
AAAL5/ATM
Phy
IuPs-User

Protocol architecture

UMTS splits the protocols into user and control plane for both UTRAN/GERAN and CN.

Architecture can be shared as 3 layers:

- Transport network
  - Provide general transport for all UMTS network elements.
- Radio Network
  - Allows inter-working between MS and CN in all aspects related to the radio access bearer.
- System Network
  - Enables setup of tunnels/PDP context and perform mobility management, authentication and data delivery.

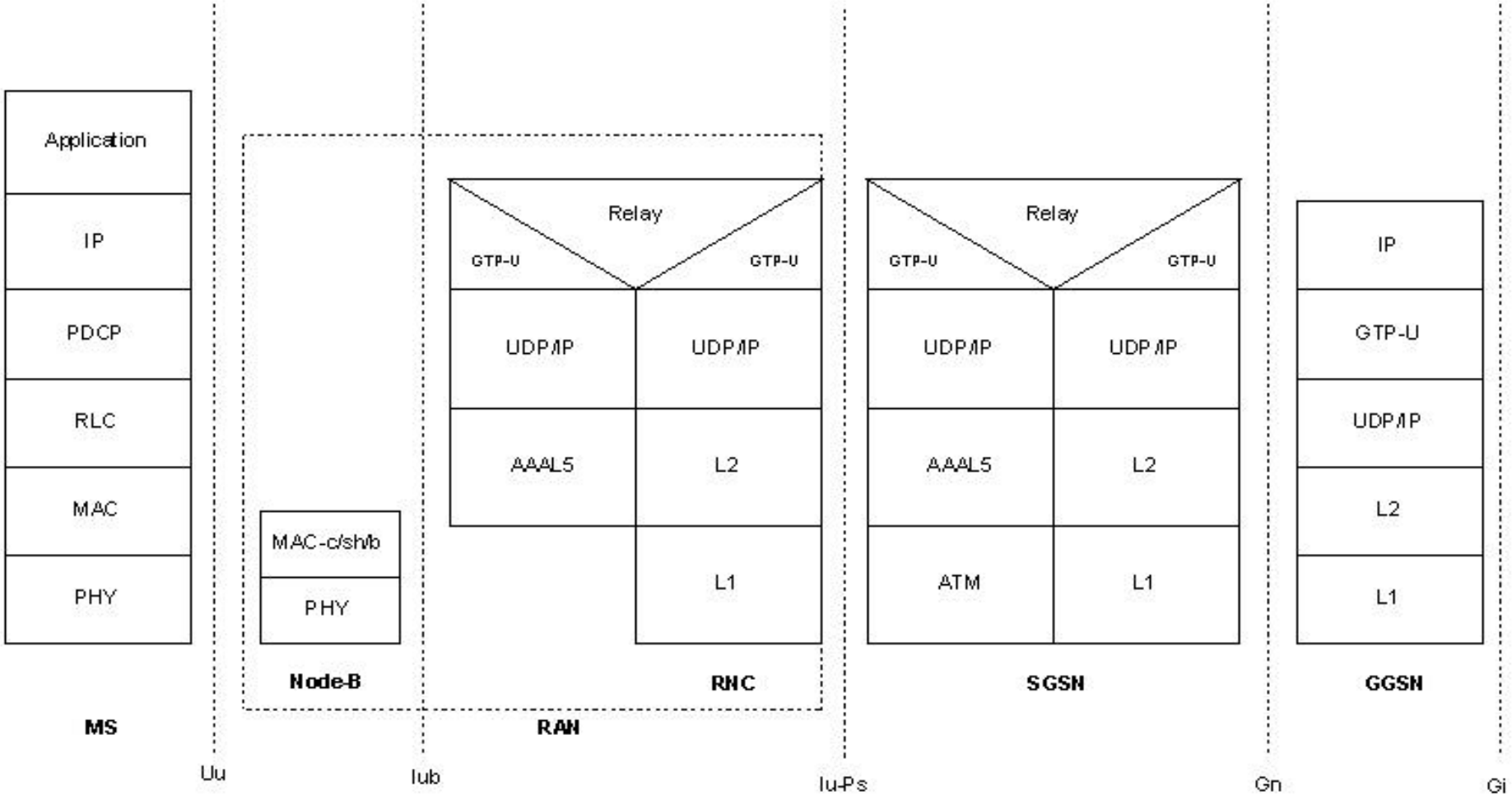
Protocol architecture

User plane

- UMTS user plane protocol stack offers few changes compared to R97 GPRS (2.5G).
- Its based on GSM infrastructure.
  - Protocol Control Unit introduced as logical element between SGSN and BSS.
  - Because of PCU , 2.5G SGSN performs link-layer functions of SNDCP and LLC.

- UMTS was designed without this consideration.
- User plane consists carefully designed layered structure providing user plane transfer along with control procedures – e.g. error handling and flow control.
- 3G SGSN doesn’t have radio protocol layers, e.g. SNDCP or LLC.

Protocol architecture – user plane

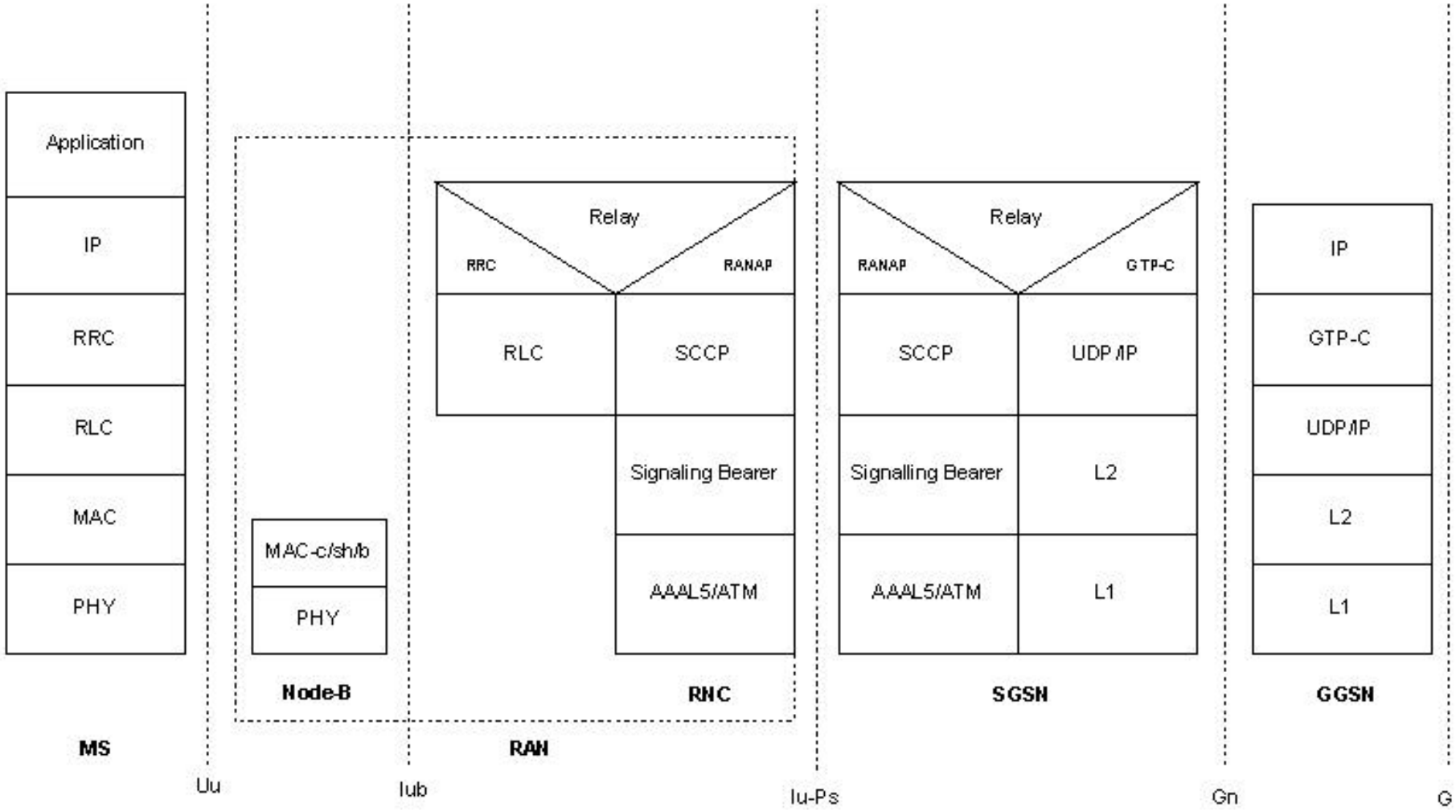


Protocol architecture

Signaling plane

- Consists of protocols for control and support of the user plane functions.
- Provides SM (Session Management), GMM (GPRS Mobility Management) for a user along with SMS.
- SM: PDP activation, modification, deactivation procedures.
- GMM: attach, detach,routing area update and security procedures.

Protocol architecture – signaling plane



GPRS Tunneling protocol

- GTP provides both signaling (GTP-c) and data transfer (GTP-u) procedures between GGSNs.
- It provides a header, which together with UDP/TCP and IP identifies the destination GGSN.
- GTP is also used for transporting charging information to the charging gateway function from GGSN.

Summary

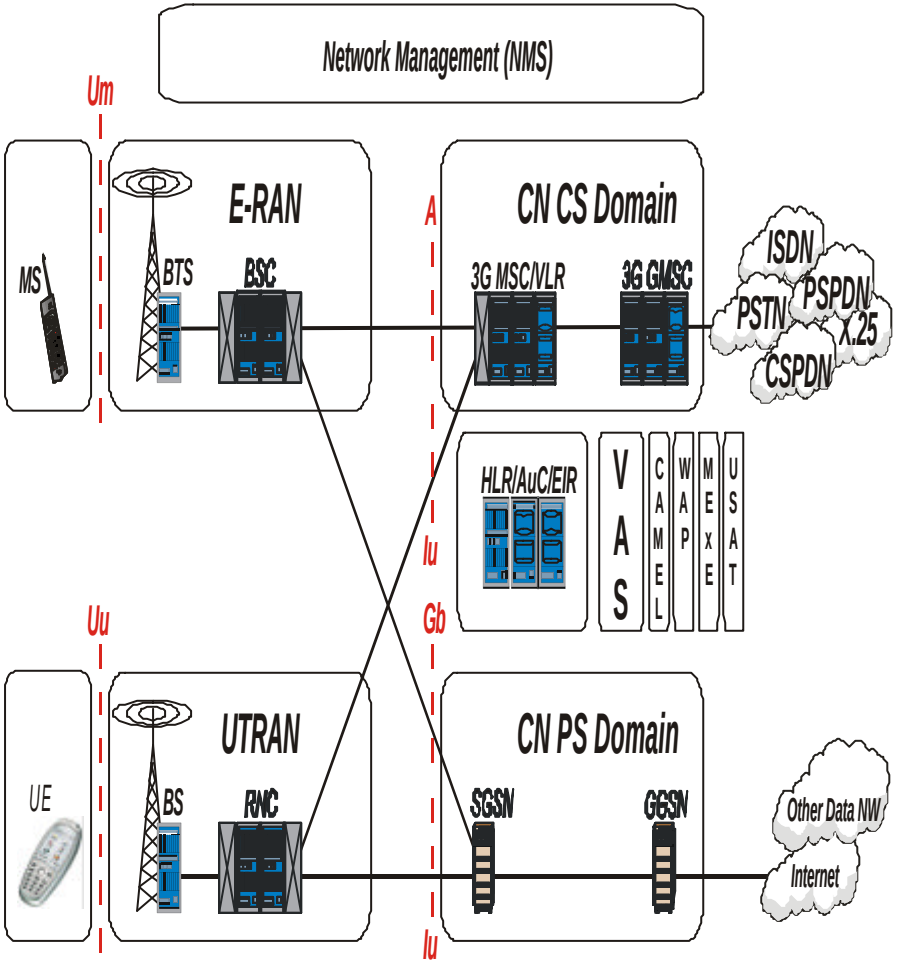
- Access independent, provides personalized services, accessible from anywhere.
- Architecture allows clear separation of radio access networks (Currently 2 GERAN/UTRAN)

IP point of view:

- Iu-Ps (Packet switched) interface replaces Gb between core and access Network.
- IP header compression is required to improve bandwidth usage over air interface.
  - GPRS -> SGSN
  - UMTS -> RNC
- R5: IMS (IP Multimedia Subsystem)
  - SIP (Session Initiation protocol) will be used for both user and network signaling.
  - Radio network moves toward IP from the current ATM infrastructure.

Summary: Replacement Gb/Iu-Ps

GPRS (R99)



UMTS (R4)