The Network of the Future
(The All-IP Network)

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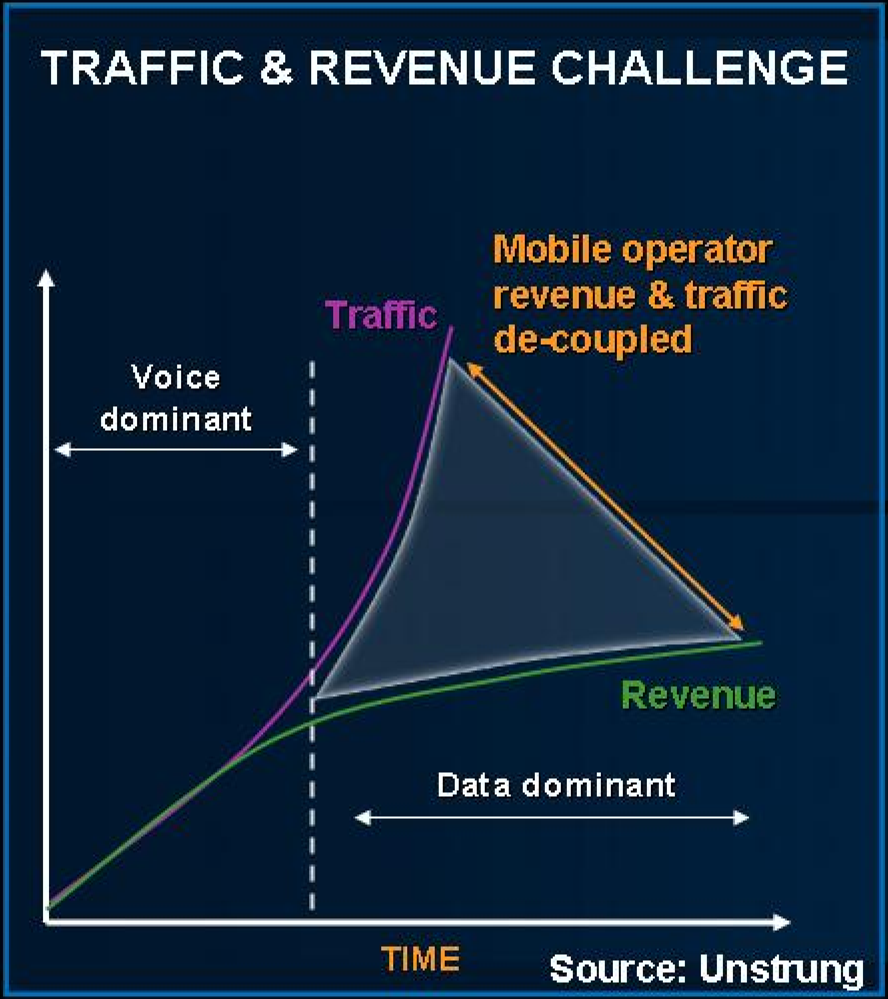
Mobile operators business drivers

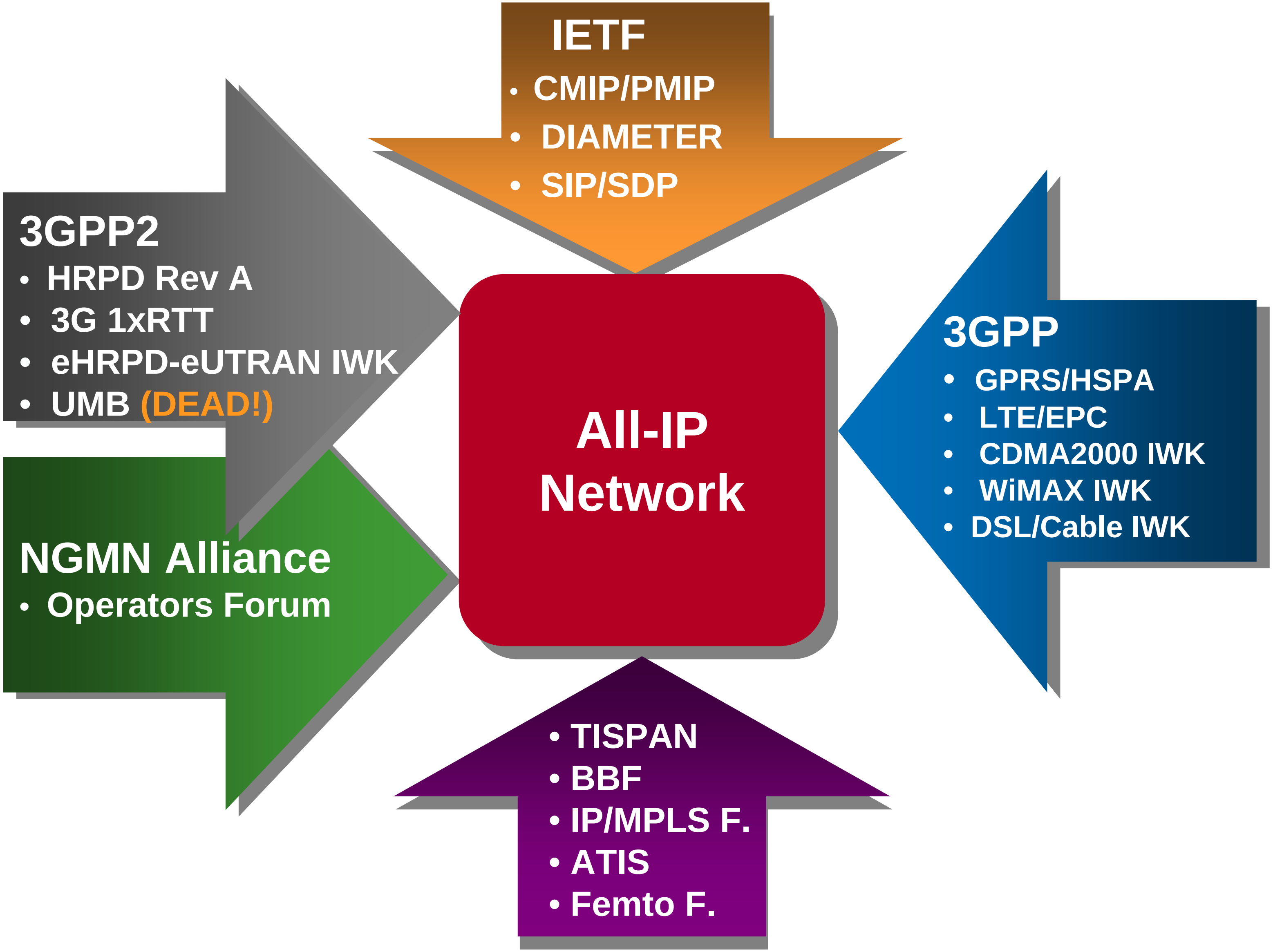


- Revenue per bit is dropping
  - Traffic: 360%+ per year
  - Revenue: 11%+ per year
- Data volume and value to the subscriber not necessarily proportional
- Must reduce *cost per bit*
  - Operational efficiency and cost control
- Must add *value per bit*
  - ARPU
- Must add *value to customer*
  - Customer loyalty

Evolution Story

- **Technology Evolution**
  - **3GPP**
  - **3GPP2**
  - **WiMAX**
- **Service Evolution**
  - **Voice, SMS**
  - **IMS**
  - **MBMS, …**
- **Network Evolution towards All-IP Architecture**
  - **3GPP All-IP Architecture**
    - ✓ **QoS in 3GPP EPS**
  - **WiMAX All-IP Architecture**
  - **Comparison of 3GPP and WiMAX Architectures**

All-IP Standards Initiatives

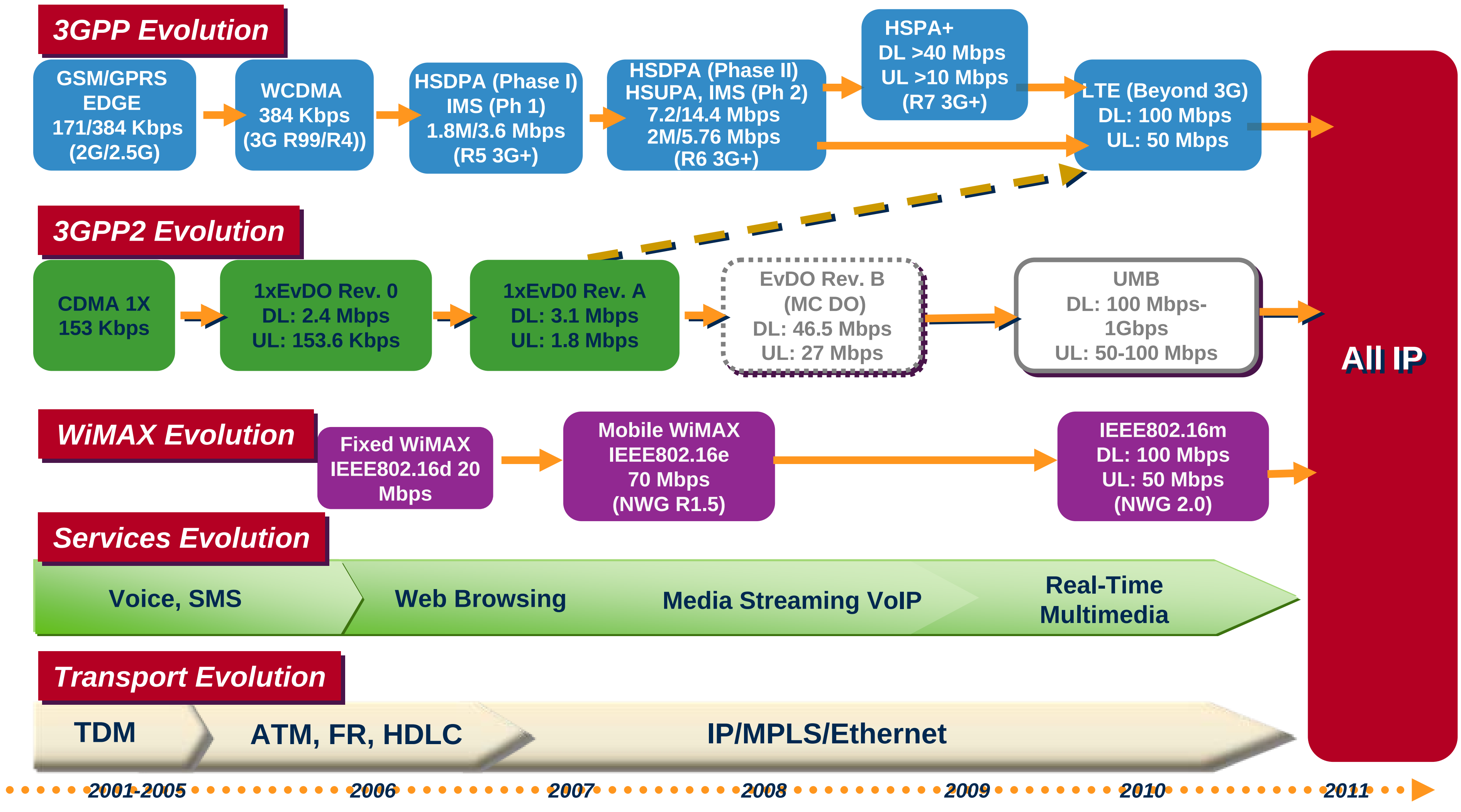


Mobile Broadband (up to 100 Mbps)

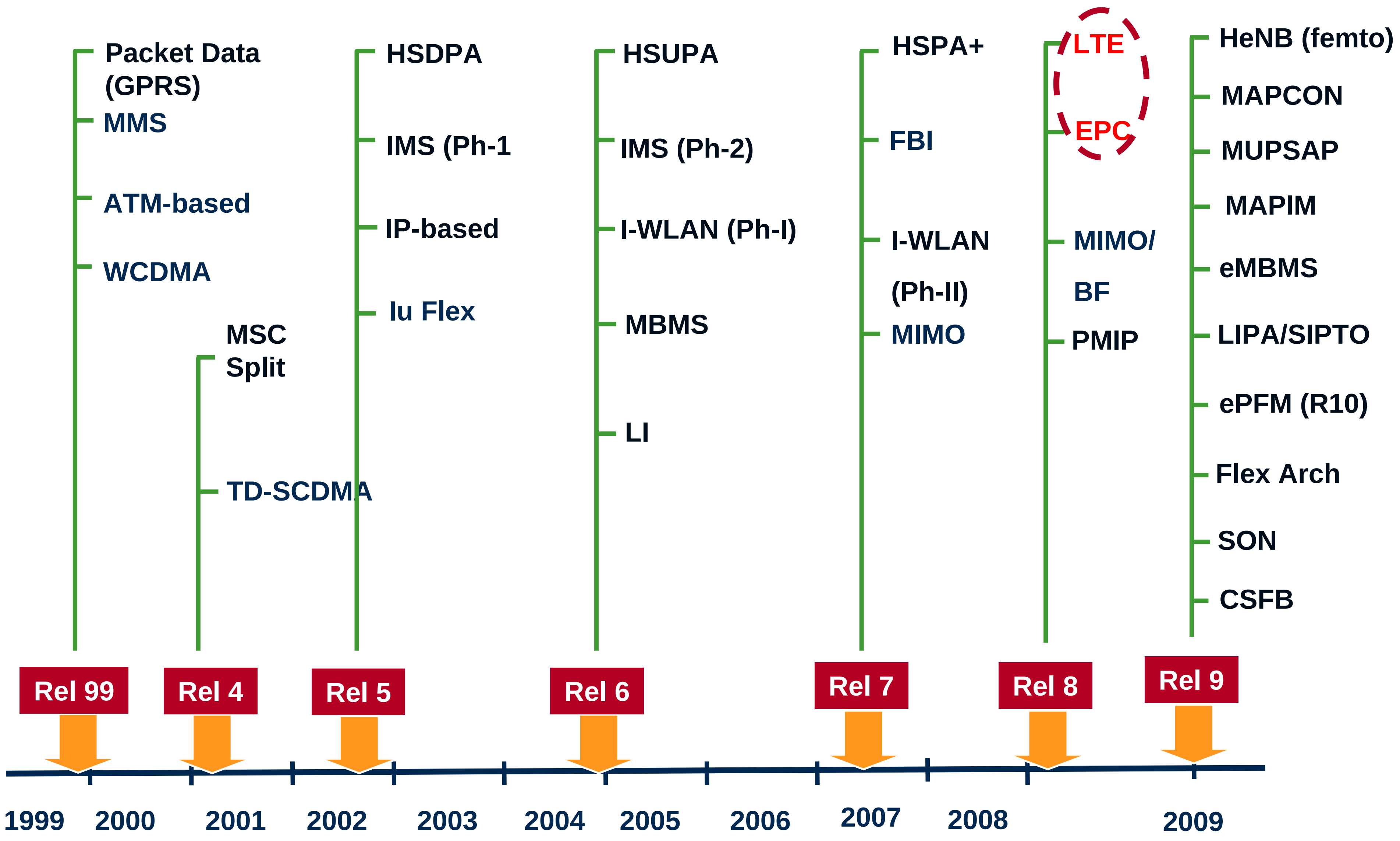
- **Demand for higher data rates => significantly increased peak data rates**
  - **Targets:**
    - ✓ **Instantaneous DL peak data rate of 100 Mbps in a 20MHz DL spectrum (i.e., 5 bps/Hz)**
    - ✓ **Instantaneous UL peak data rate of 50 Mbps in a 20MHz UL spectrum (i.e. 2.5 bps/Hz).**
- **Expectations of additional 3G spectrum allocations**
- **Greater flexibility in frequency allocations**

LTE offers 2-4 times better spectral efficiency than HSPA

Technology Evolution



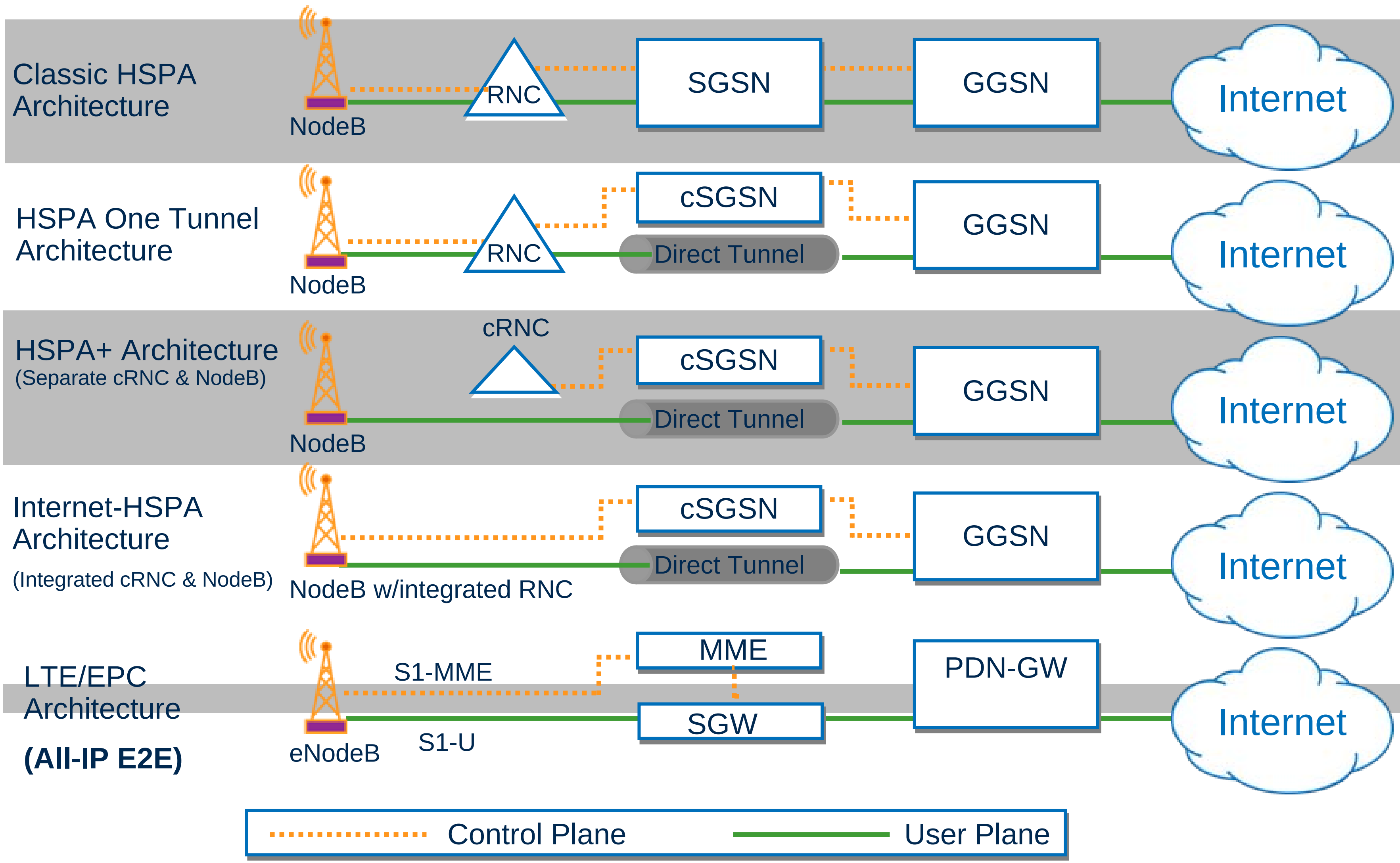
3GPP Migration towards All-IP Network



Service Evolution

- **Service evolution bring significant benefits to both providers and users**
- **Key services/service enabling technologies:**
  - **FMC (UMA, Femto, IMS)**
  - **IMS (VoIP, Video Telephony, ..)**
  - **Multicast/Broadcast Services (MBMS, Mobile TV)**
- **FMC benefits:**
  - **Ease of communication for end users**
    - ✓ **One device, one number, one mailbox**
  - **Consolidation of core network services for operators**
- **IMS advantages:**
  - **Adopted by all mobile SDOs (under *Common IMS* umbrella)**
  - **A key platform for HSPA and LTE**
  - **Allows service blending (Voice, Video, Presence, IM, Location)**
  - **Allows a unique service creation environment for application developers**

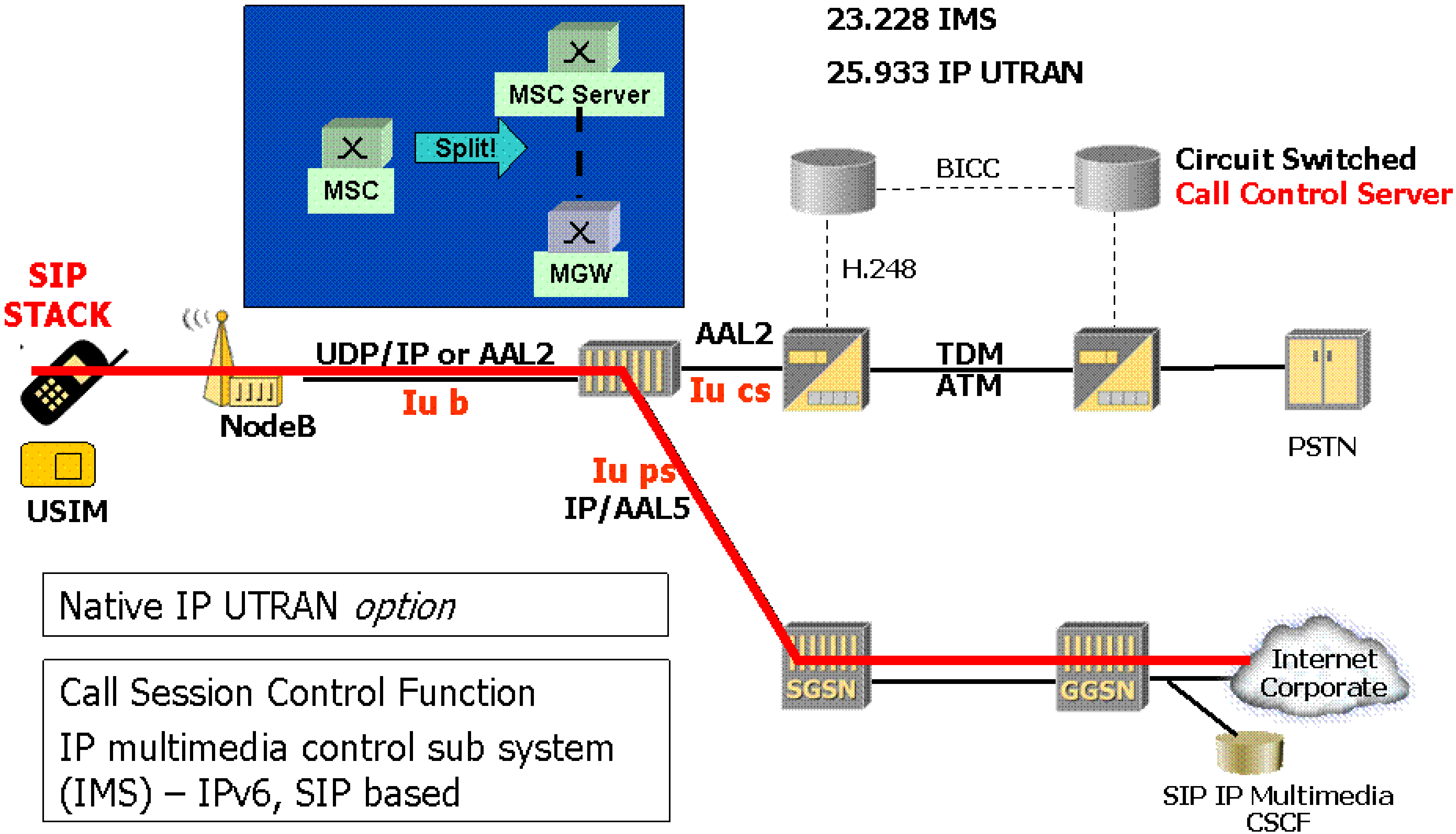
Network Architecture Evolution



Migration from 2G to 3G

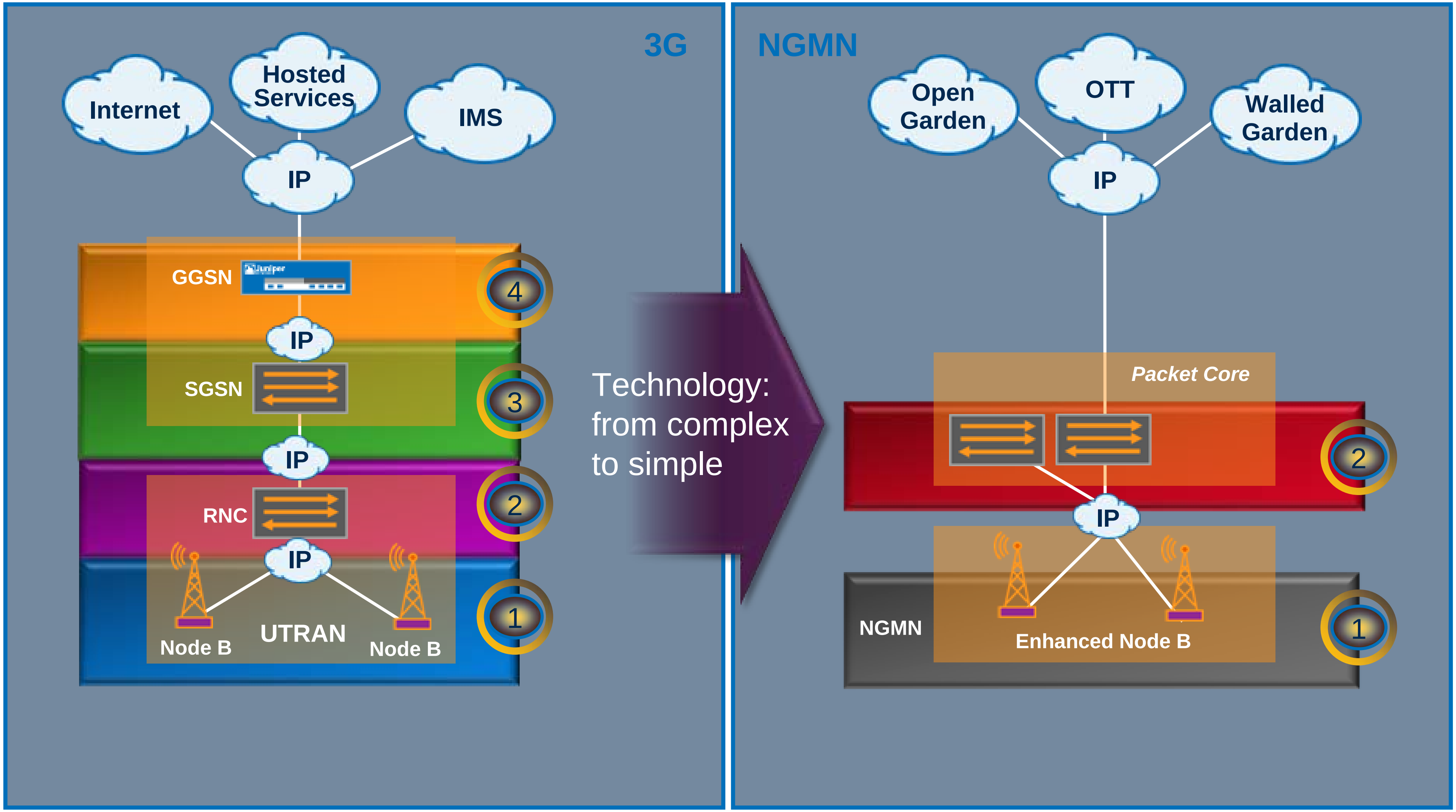
- **Evolution of GSM network to GPRS/EDGE allows *reuse of existing equipment (*Cell sites, Transceivers/ Interconnection facilities)**
- **3G operators have deployed HSPA/UMTS worldwide**
  - **UMTS involves a new RAN but most cell sites are collocated with GSM cell sites (i.e., much of the GSM network can be reused)**
  - **GGSN, HLR/HSS, Billing System will need *software upgrade*!**
- **Backward/Forward Compatibility**
  - **Upgraded UMTS radio channels can support any mix of R99, R5, R6 terminals**
  - **UMTS terminals can support GSM (i.e., larger coverage and network capabilities)**
- **Cost reduction by using a common**
  - **Packet data architecture, QoS architecture**
  - **Accounting/Billing system, Service platforms**
- **Handoff between access networks (service continuity)**

3G Reference Architecture

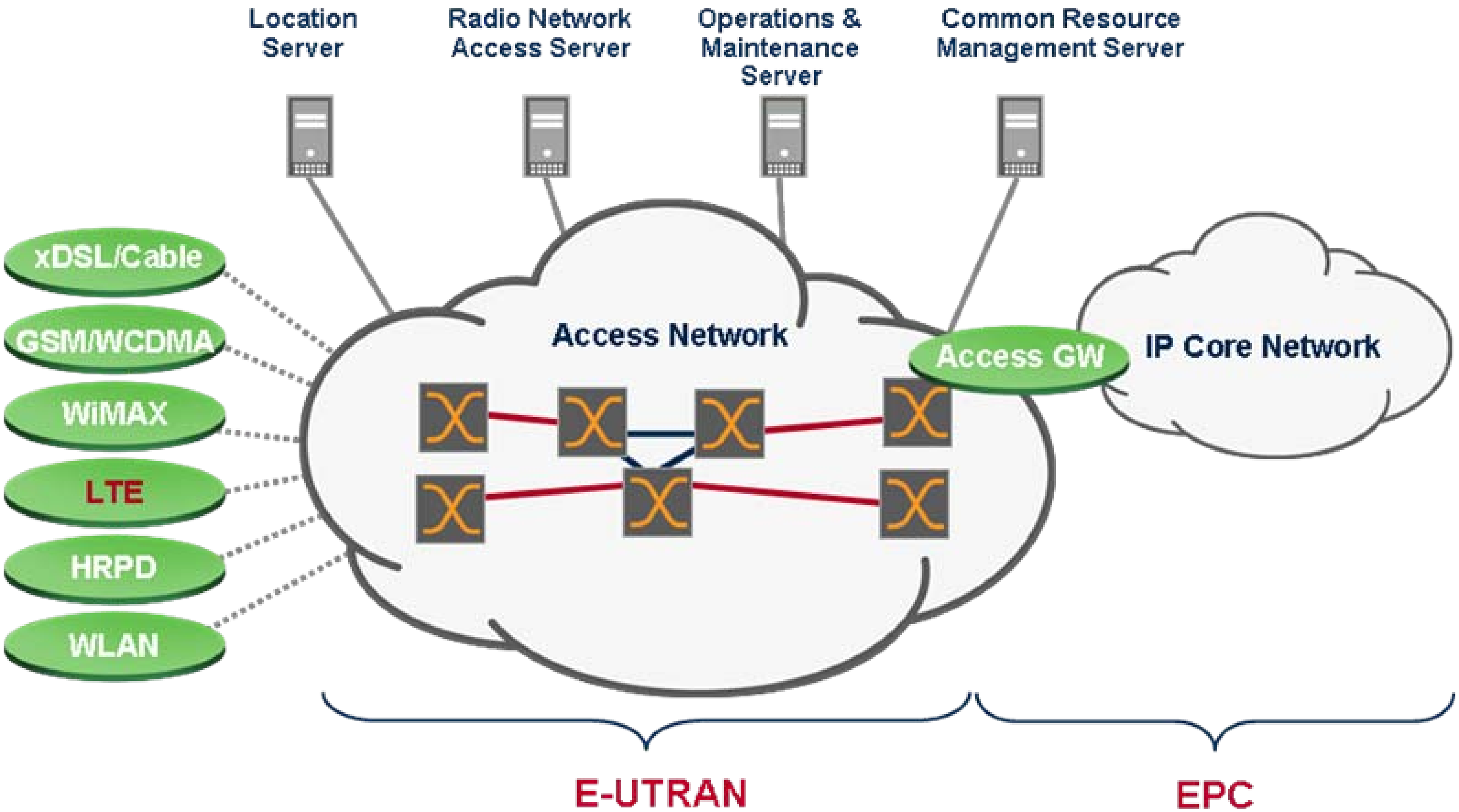


- Native IP UTRAN *option*
- Call Session Control Function
  IP multimedia control sub system (IMS) – IPv6, SIP based
- QoS enhancements (end-to-end)

Migration from 3G to All-IP Flat Architecture



All-IP Network Architecture



- **Access agnostic core network**
- **Interworking with Legacy Networks**
- **Standardized open interfaces**
- **Fully IPv4/IPv6 integration**

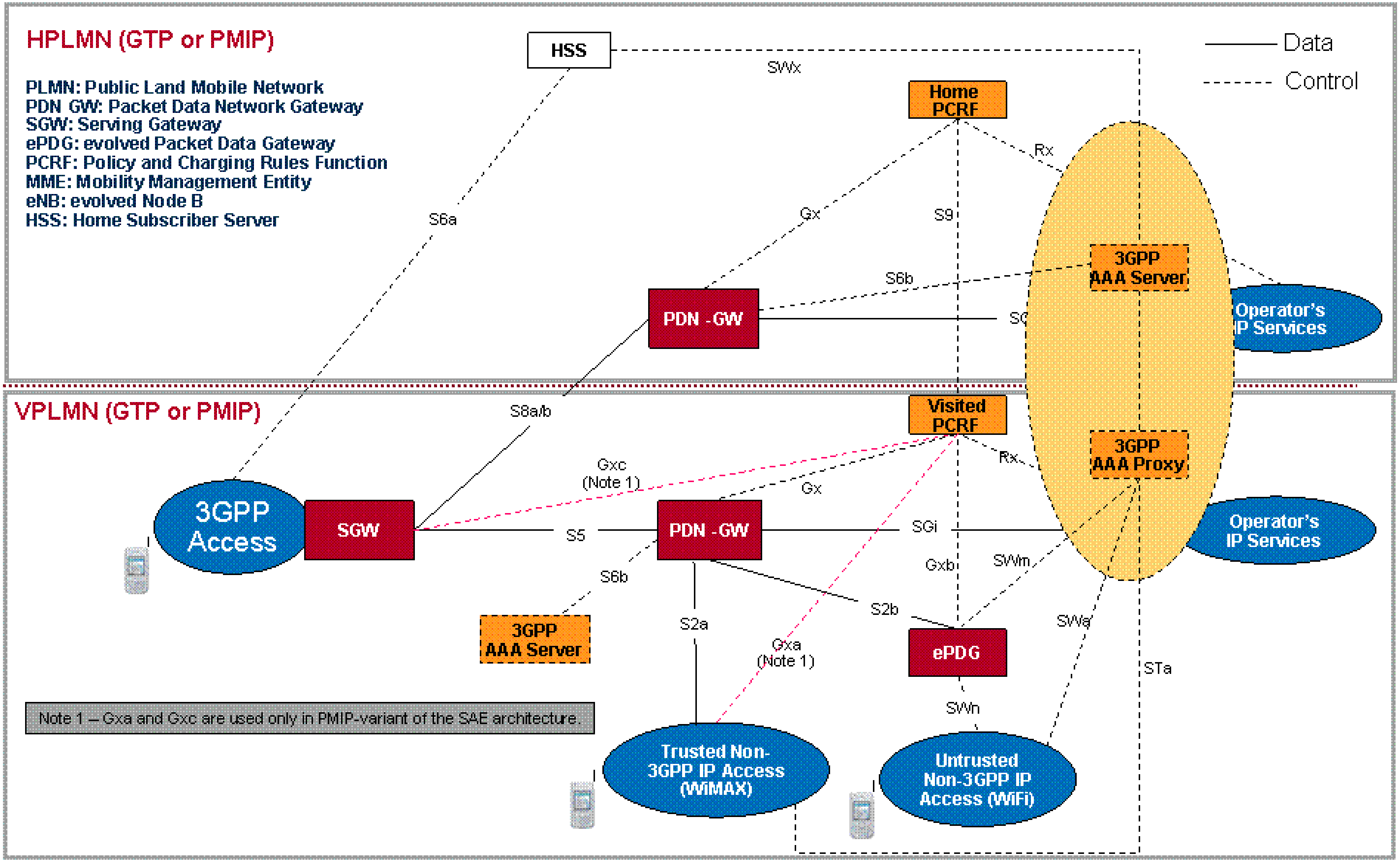
All-IP Network Objectives

- **Universal seamless access**
  - **Allows users to connect to any access system using any device**
  - **Uses common protocols, addressing and mobility management mechanisms**
  - **Access systems are selected according to service needs and availability**
- **Improved User Experience**
  - **Provides users with better quality via rapid network selection, rapid call or session setup times, low voice call delay and fast data transmission**
- **Reduction of cost**
  - **Reduces cost (both CAPEX/OPEX) for mobile operators**
- **Flexibility of deployment**
  - **Enables operators to scale their network according to needs of their users**
  - **Network Should interwork with legacy network/devices and**
  - **Should provide an evolution path from 2G/3G systems.**

All-IP Architecture Capabilities

- Design a global All-IP architecture for the Next Generation Mobile Networks
- Enable new services on top of IP
- IP-based infrastructure
- Integrated capabilities for E2E seamless operation (e.g., MPLS, integrated policy, security, identity, ..)
- Maximize synergy and compatibility with existing standards (3GPP, BBF, IP/MPLS)
- Unified architectural framework for Wireless and Wireline
- Common service exchange framework
- Service enabling technologies (IMS, UMA, Femto)
- Access technology agnostic

Roaming Architecture (3GPP Release 8)



Home Routed vs Local Breakout

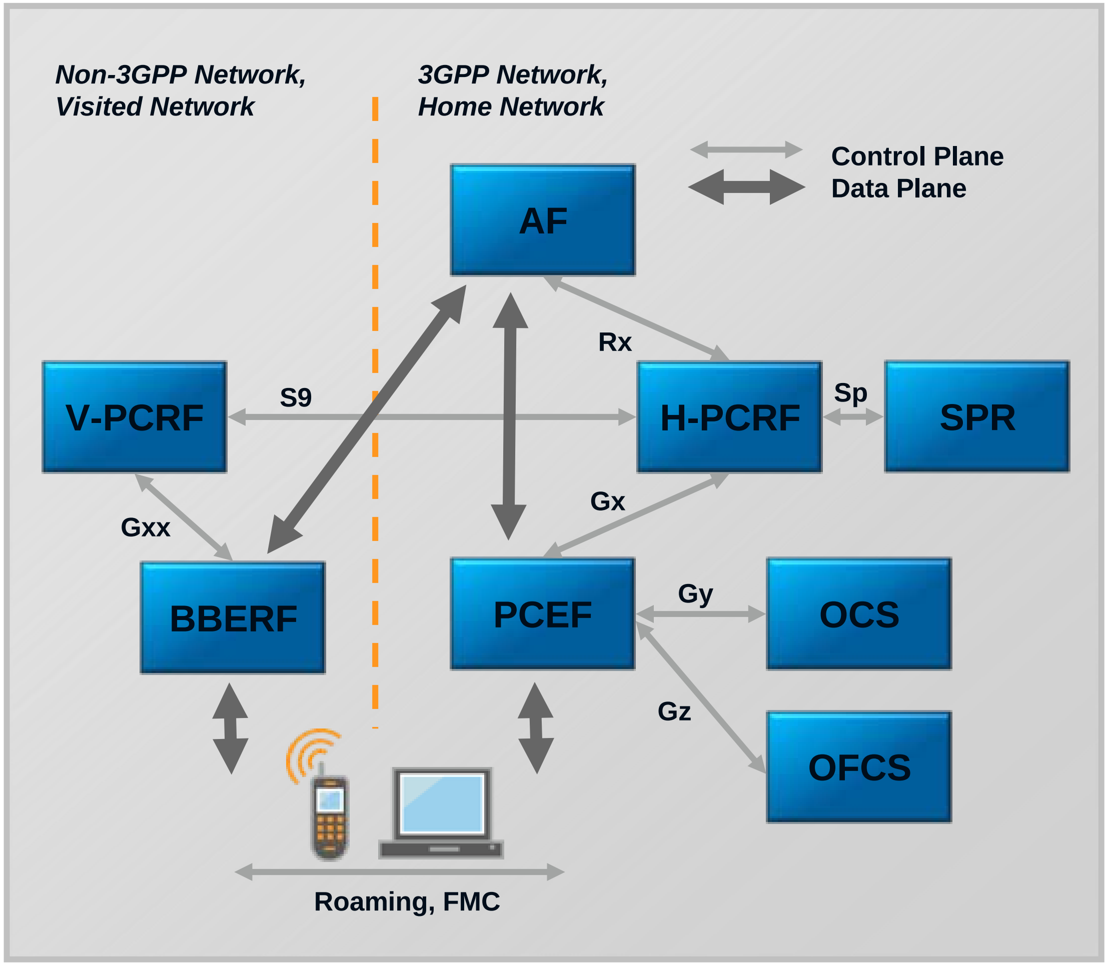
- **Home Routed traffic and Local Breakout**
  - **supported at the same time for a given UE**
  - **however, for a given application, only one of them can be used at a given point in time.**
- **GTP/PMIP Interworking**
  - **If visited network is PMIP-based, and home network is GTP-based, then SGW in visited (PMIP) network must offer a GTP-based interface to the home network.**
  - **If visited network is GTP-based, and home network is PMIP-based, then PDN-GW in the home (PMIP) network must offer a GTP-based interface to the visited network.**
  - **Differences in PCC infrastructure (Gxc interface to SGW) is expected to be handled by PMIP-based network as well**

IP Mobility Architecture in EPS

- 3GPP IP mobility in pre Rel-8 systems is based on GTP
- However, other networks (e.g., CDMA) had IP mobility based on Mobile IP
- In Rel-8 some vendors and operators preferred to use GTP, others preferred to use Mobile IP
- Consequently, both options were allowed and specified
  - TS 23.401 defines a GTP-based EPS
  - TS 23.402 defines a (Proxy) Mobile IP-based EPS
- Both Roaming and non-Roaming scenarios are considered
- For roaming between GTP-based and Mobile IP-based networks, the baseline interworking is GTP.

PCC Architecture (Roaming)
(3GPP Release 8)

- **H-PCRF & V-PCRF**
  - ✓ Allow control of resources in visited or not-3GPP networks
  - ✓ Controlled by S9 interface
- **Bearer Binding and Event Reporting Function (BBERF)**
  - ✓ Non-3GPP access gateway (PDSN, B-RAS, CMTS, etc)
  - ✓ Controlled by Gxx interface
  - ✓ Multiple variants of Gxx depending on access network type



QoS Framework in Evolved Packet System (EPS)

QoS

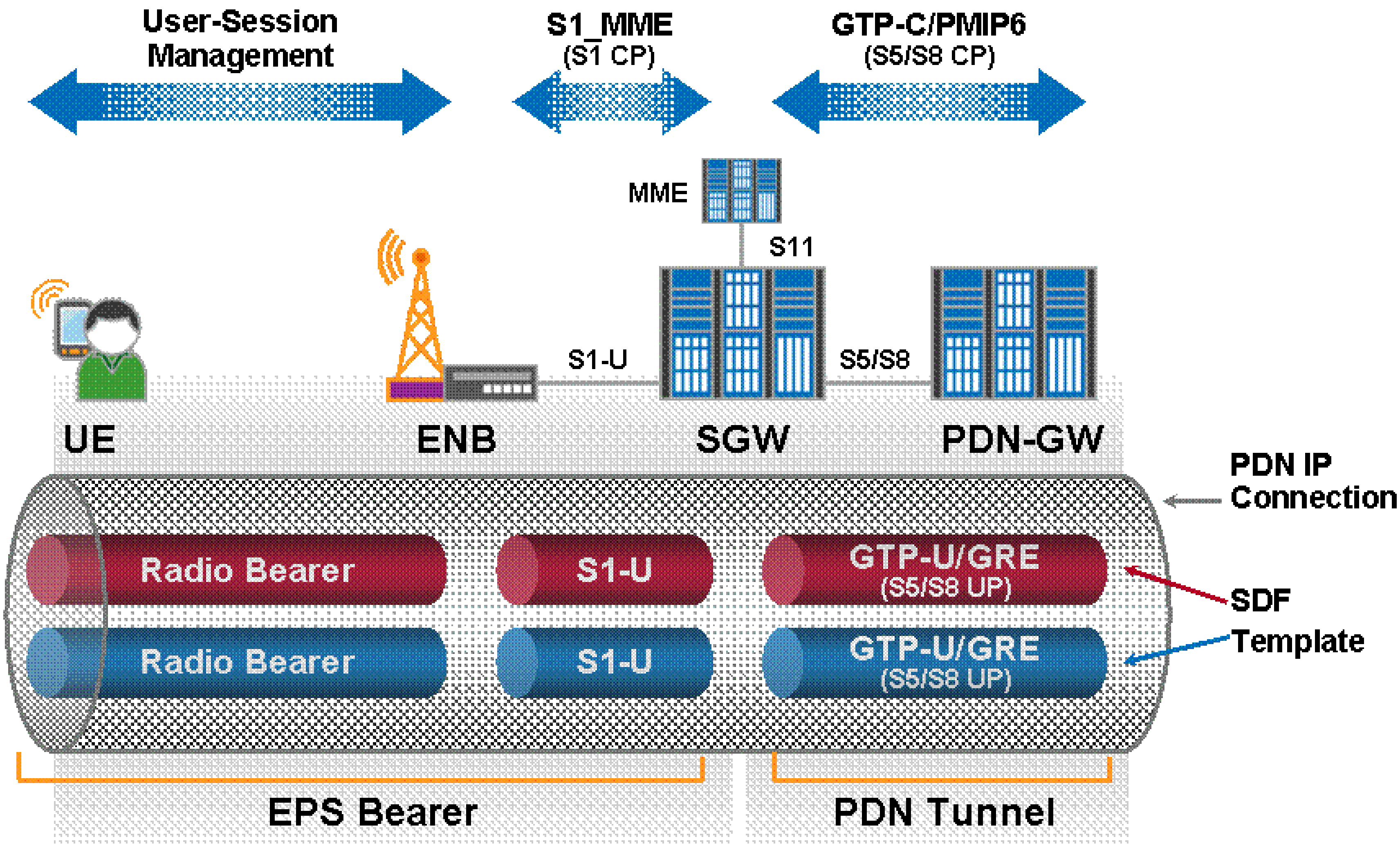
- Higher data rates
- Low latency
  (UP<20 ms, CP<80 ms)
- High cell edge throughput
- Spectrum flexibility
- Improved system capacity
- Improved system coverage

QoE

- Flat All-IP architecture
- Access independence
- Standardized MM services
- Seamless mobility
- Optimized HO
  (low latency,
  zero packet loss)

Radio Network | **Core Network**

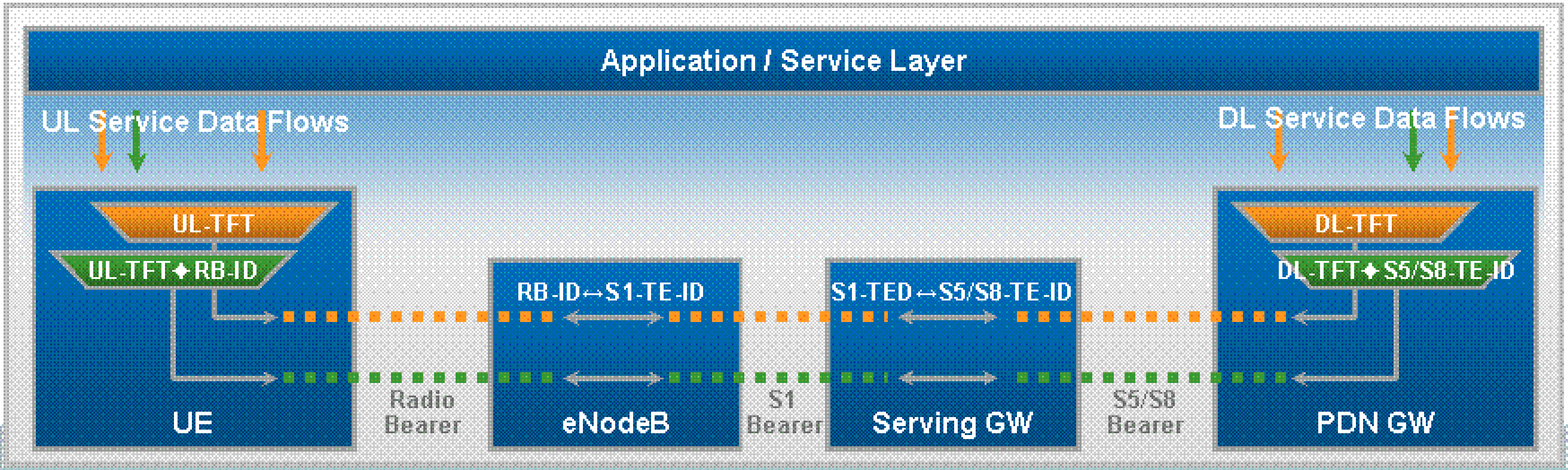
3GPP QoS model



Standardized QCI characteristics

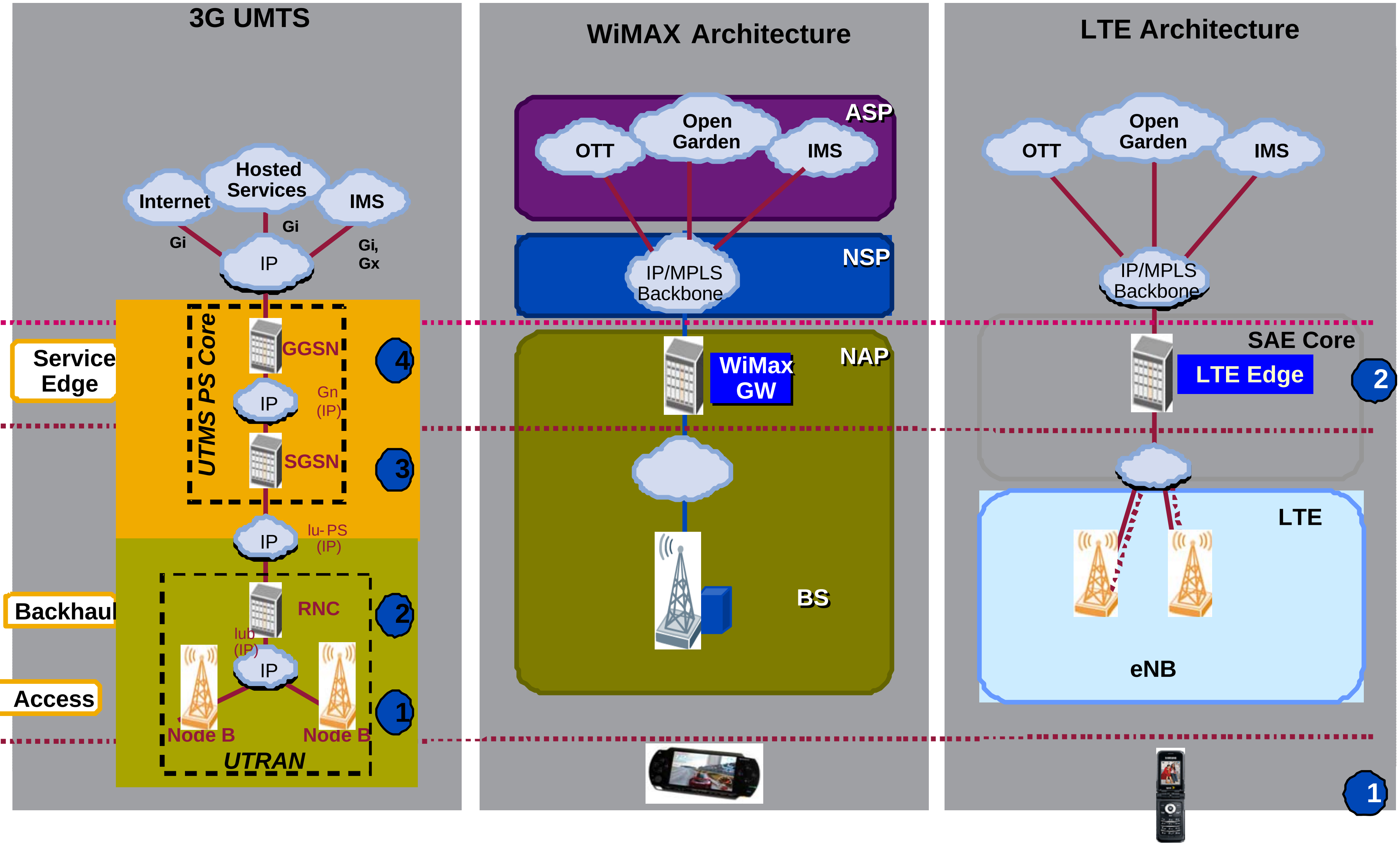
QCI	Resource Type	Priority	Packet Delay Budget (Note 1)	Packet Loss Rate (Note 2)	Example Services
1	GBR	2	100 ms	10^{-2}	Conversational Voice
2		4	150 ms	10^{-3}	Conversational Video (Live Streaming)
3		5	300 ms	10^{-6}	Non-conversational Video (Buffered Streaming)
4		3	50 ms	10^{-3}	Real-time Gaming
5	Non-GBR	1	100 ms	10^{-6}	IMS Signaling
6		7	100 ms	10^{-3}	Voice, Video (Live Streaming), Interactive Gaming
7		6	300 ms	10^{-6}	Video (Buffered Streaming), TCP-based (i.e., www, e-mail, chat, ftp, p2p file sharing, progressive video…)
8		8			
9		9			

EPS bearer setup (GTP-based)

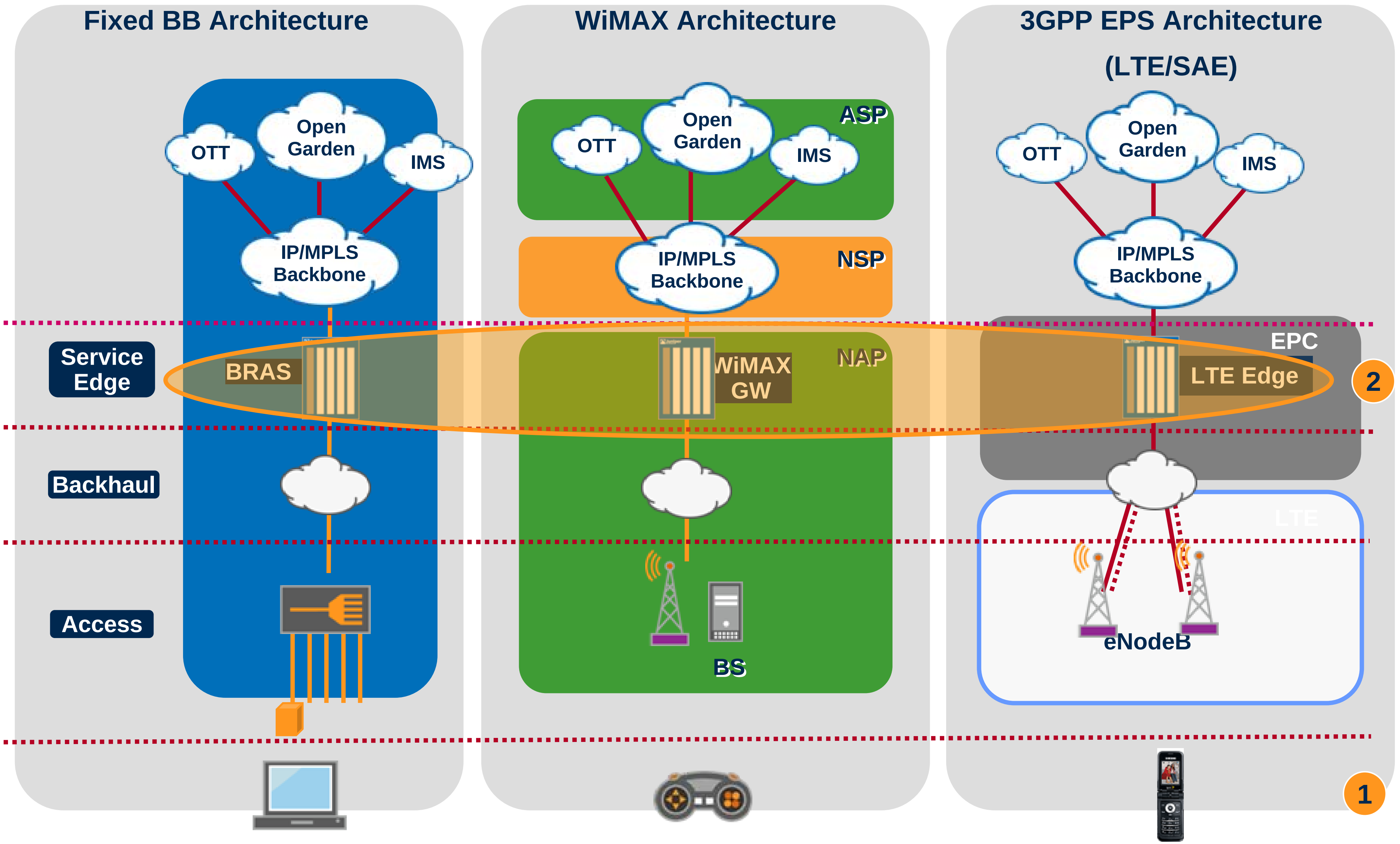


- **UE routes uplink packets to the different EPS bearers based on uplink packet filters in the TFTs assigned to these EPS bearers.**
- **UE evaluates for a match, first the uplink packet filter amongst all TFTs that has the lowest evaluation precedence index and, if no match is found, proceeds with the evaluation of uplink packet filters in increasing order of their evaluation precedence index.**
- **This procedure must be executed until a match is found or all uplink packet filters have been evaluated. If a match is found, Uplink data packet is transmitted on the EPS bearer that is associated with the TFT of the matching uplink packet filter.**
- **If no match is found, the uplink data packet must be sent via the EPS bearer that has not been assigned any uplink packet filter.**
- **If all EPS bearers (including the default EPS bearer for that PDN) have been assigned one or more uplink packet filters, the UE must discard the uplink data packet.**

Comparison of UMTS, LTE and WiMAX architectures

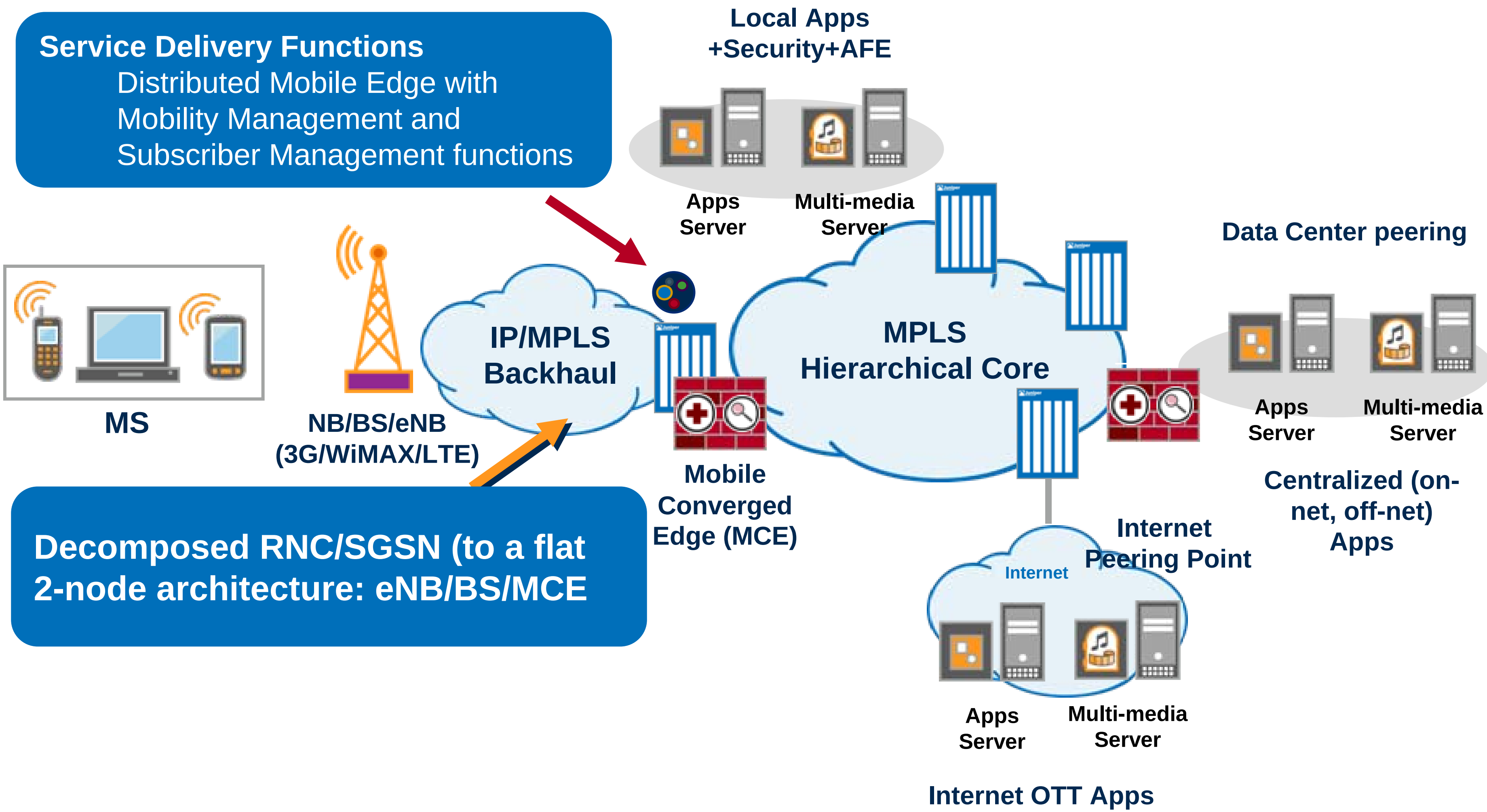


Architectural Harmonization between DSL, WiMAX and 3GPP



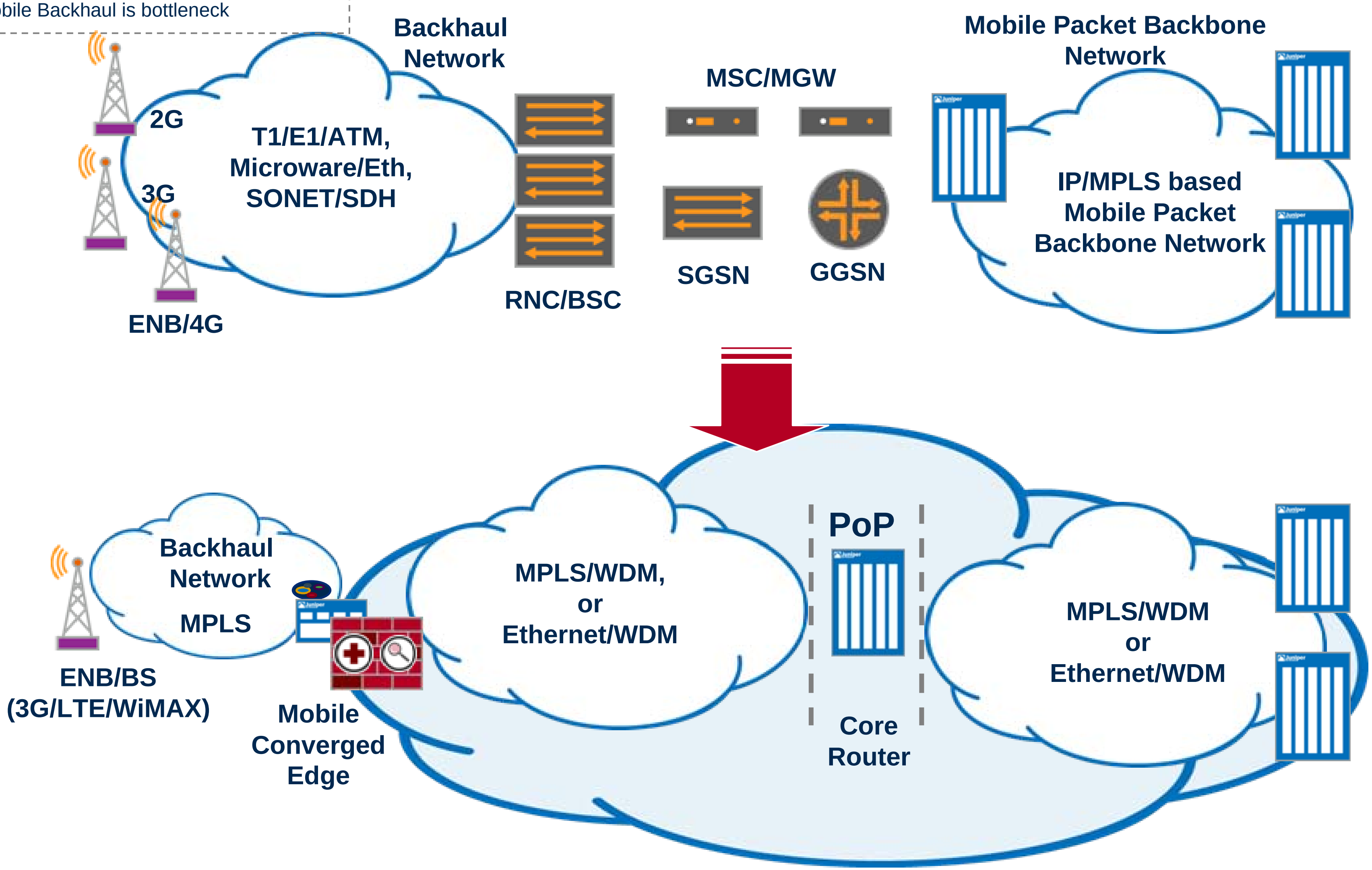
All-IP Architecture

- Mobile Edge gets more distributed
- BSC/RNC/SGSN functions are decomposed
- Fewer nodes to reduce, latency, OPEX/CAPEX



Seamless MPLS

=> Closed architecture; too many nodes
=> Radio/Transport layers tightly coupled
=> Not optimized for RT services
=> Mobile Backhaul is bottleneck



Summary

- Access technologies (wireless and wireline) and their interworking with all-IP architecture was presented
- An overview of service, network and technology evolution was presented
- QoS framework for the All-IP network of the future was discussed
- The differences between 3G/LTE, WiMAX and Wireline All-IP Architecture were examined
- Finally guidelines on how the harmonized All-IP architecture should be implemented was outlined.

THANK YOU