3GPP Systems Architecture and Core Network

Sungho Choi

Vice-Chairman of 3GPP TSG-SA

THE Mobile Broadband Standard

Outline

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- 3GPP in general
- Main technical areas
- Trends for System and Core Network Evolution
- Key features of recent Releases

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The Role of 3GPP

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- Partnership Consists of
  - **Regional standards organizations**

    (Asia, Europe & North America):

  - **Market partners representing the broader industry**:

    IMS Forum, GSA, GSMA, IPv6 Forum, UMTS Forum, 4G Americas, TD SCDMA Industry Alliance, InfoCommunication Union (ICU), Small Cell Forum, CDMA Development Group (CDG), Cellular Operators Association of India (COAI), NGMN Alliance

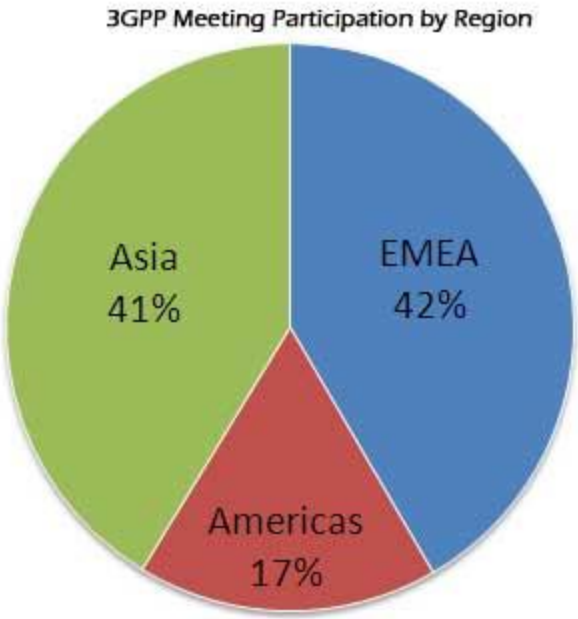
- Radio Technologies

  GSM/EDGE, GPRS/EGPRS, UMTS/W-CDMA/HSPA and LTE

- Systems Architecture, Core Network and Services

3GPP Participation

- Over 380 Companies participate through their membership of one of the 6 Partners
  - You have to be a member to contribute
  - Limited time guest memberships (~6 months) also available
- Over 150 meetings (including Working Groups) per year
- Decision process: consensus-based



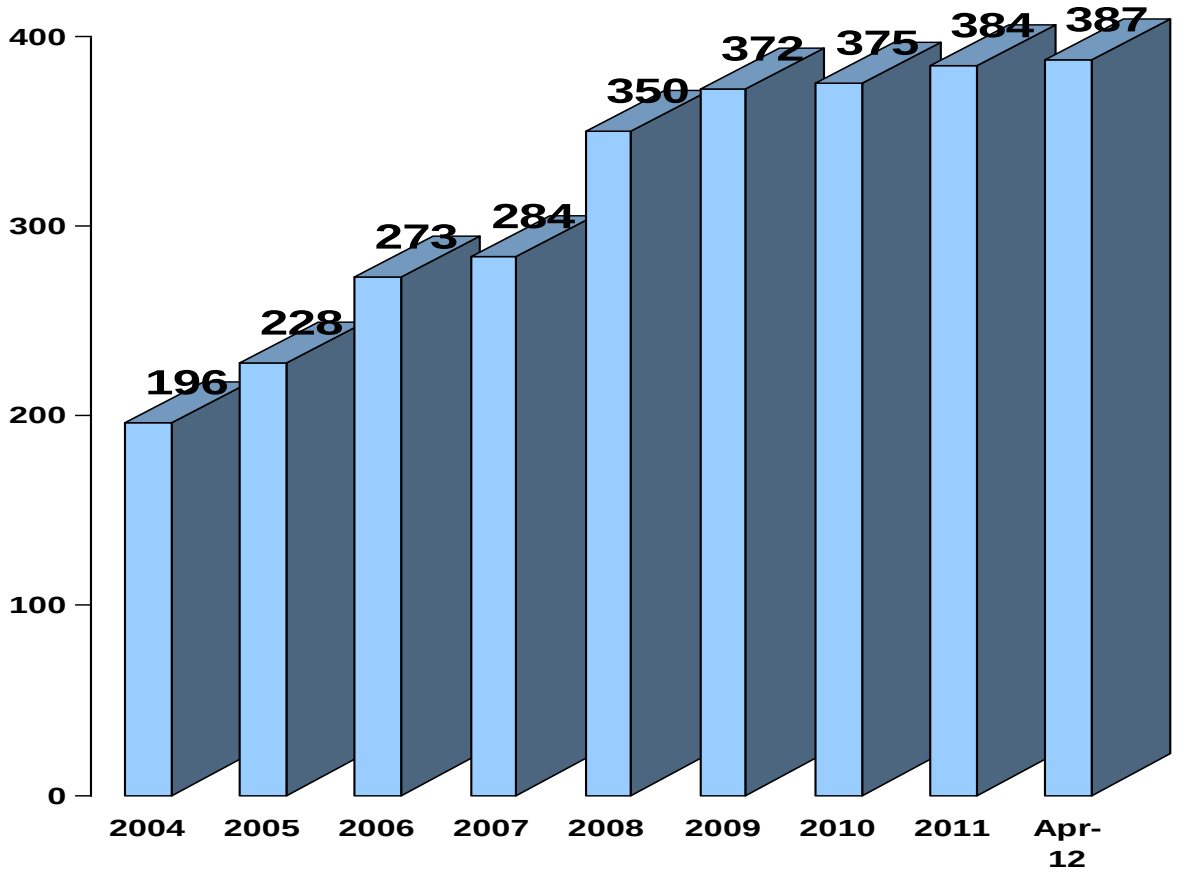
Source: 3GPP MCC (December 2010)

3GPP Membership

3GPP Membership is now at an all-time high, with 387 Individual members. In addition, there are 17 companies having Guest Status, which are potential IMs of the future.

Number of Individual Members in 3GPP

3GPP Individual Members come from 39 Countries worldwide



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3GPP Structure

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TSG Structure

Project Co-ordination Group (PCG)

TSG GERAN
GSM EDGE Radio Access Network

- **GERAN WG1** Radio Aspects
- **GERAN WG2** Protocol Aspects
- **GERAN WG3** Terminal Testing

TSG RAN
Radio Access Network

- **RAN WG1** Radio Layer 1 spec
- **RAN WG2** Radio Layer 2 spec Radio Layer 3 RR spec
- **RAN WG3** Iub spec, Iur spec, Iu spec UTRAN O&M requirements
- **RAN WG4** Radio Performance Protocol aspects
- **RAN WG5** Mobile Terminal Conformance Testing

TSG SA
Service & Systems Aspects

- **SA WG1** Services
- **SA WG2** Architecture
- **SA WG3** Security
- **SA WG4** Codec
- **SA WG5** Telecom Management

TSG CT
Core Network & Terminals

- **CT WG1** MM/CC/SM (Iu)
- **CT WG3** Interworking with external networks
- **CT WG4** MAP/GTP/BCH/SS
- **CT WG6** Smart Card Application Aspects

3GPP systems, Building on Releases

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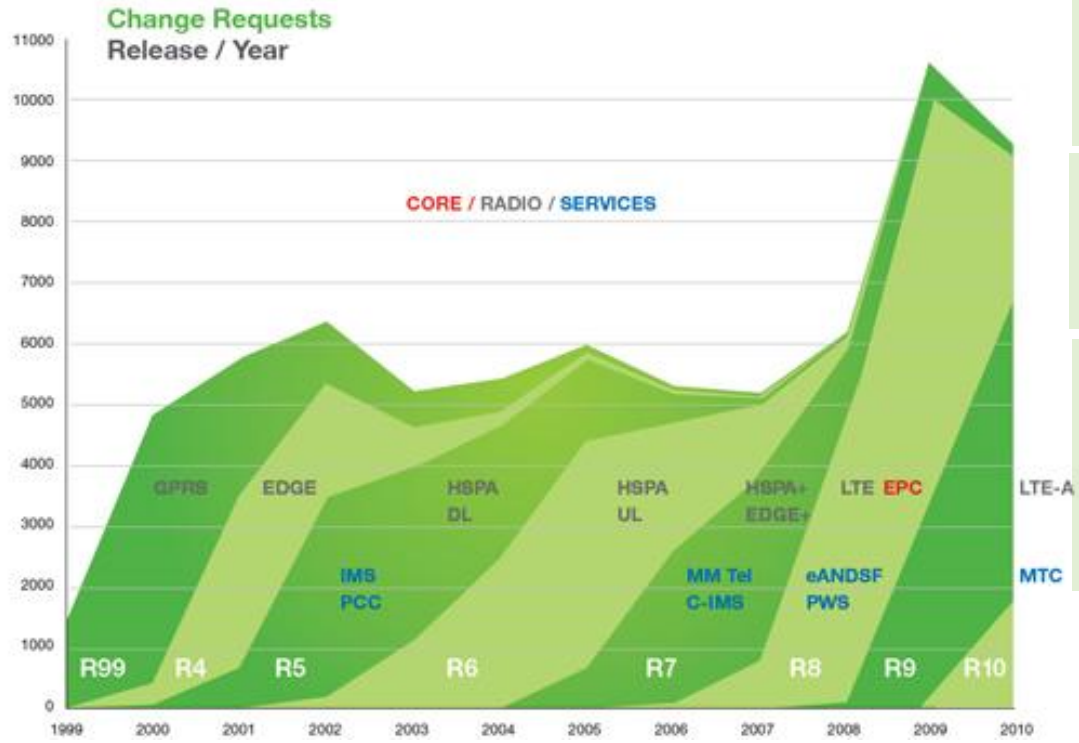
Release 99: Enhancements to GSM data (EDGE). Majority of deployments today are based on Release 99. Provides support for GSM/EDGE/GPRS/WCDMA radio-access networks.

Release 4: Multimedia messaging support. First steps toward using IP transport in the core network.

Release 5: HSDPA. First phase of Internet Protocol Multimedia Subsystem (IMS). Full ability to use IP-based transport instead of just Asynchronous Transfer Mode (ATM) in the core network.

Release 6: HSUPA. Enhanced multimedia support through Multimedia Broadcast/Multicast Services (MBMS). Performance specifications for advanced receivers. Wireless Local Area Network (WLAN) integration option. IMS enhancements. Initial VoIP capability.



Release 7: Evolved EDGE. Specifies HSPA+, higher order modulation and MIMO. Performance enhancements, improved spectral efficiency, increased capacity, and better resistance to interference. Continuous Packet Connectivity (CPC) enables efficient "always-on" service and enhanced uplink UL VoIP capacity, as well as reductions in call set-up delay for Push-to-Talk Over Cellular (PoC). Radio enhancements to HSPA include 64 Quadrature Amplitude Modulation (QAM) in the downlink DL and 16 QAM in the uplink. Also includes optimization of MBMS capabilities through the multicast/broadcast, single-frequency network (MBSFN) function.

Release 11
Interworking - 3GPP EPS and fixed BB accesses, M2M, Non voice emergency communications, 8 carrier HSDPA, Uplink MIMO study

Release 10 LTE-Advanced meeting the requirements set by ITU's IMT-Advanced project.

Also includes quad-carrier operation for HSPA+.

Release 9: HSPA and LTE enhancements including HSPA dual-carrier operation in combination with MIMO, EPC enhancements, femtocell support, support for regulatory features such as emergency user-equipment positioning and Commercial Mobile Alert System (CMAS), and evolution of IMS architecture.

Release 8: HSPA Evolution, simultaneous use of MIMO and 64 QAM. Includes dual-carrier HSPA (DC-HSPA) wherein two WCDMA radio channels can be combined for a doubling of throughput performance. Specifies OFDMA-based 3GPP LTE.

Defines EPC.

Text adapted from 3G Americas White Paper, September 2010

Technical areas

GSM 1G
Analog technology.
Deployed in the 1980s.

GSM 2G
Digital Technology.
First digital systems.
Deployed in the 1990s.
New services such as SMS and low-rate data.
Primary technologies include IS-95 CDMA and GSM.

3G ITU's IMT-2000 required 144 kbps mobile, 384 kbps pedestrian, 2 Mbps indoors
Primary technologies include CDMA2000 1X/EVDO, WiMAX, and UMTS-HSPA.

4G ITU's IMT-Advanced requirements include ability to operate in up to 40 MHz radio channels and with very high spectral efficiency.
No technology meets requirements today.
IEEE 802.16m and LTE Advanced designed to meet requirements.

Radio Technology

- Spectrum availability, efficiency, flexibility
- Higher Data Throughput, Lower Latency
- Improved CAPEX and OPEX

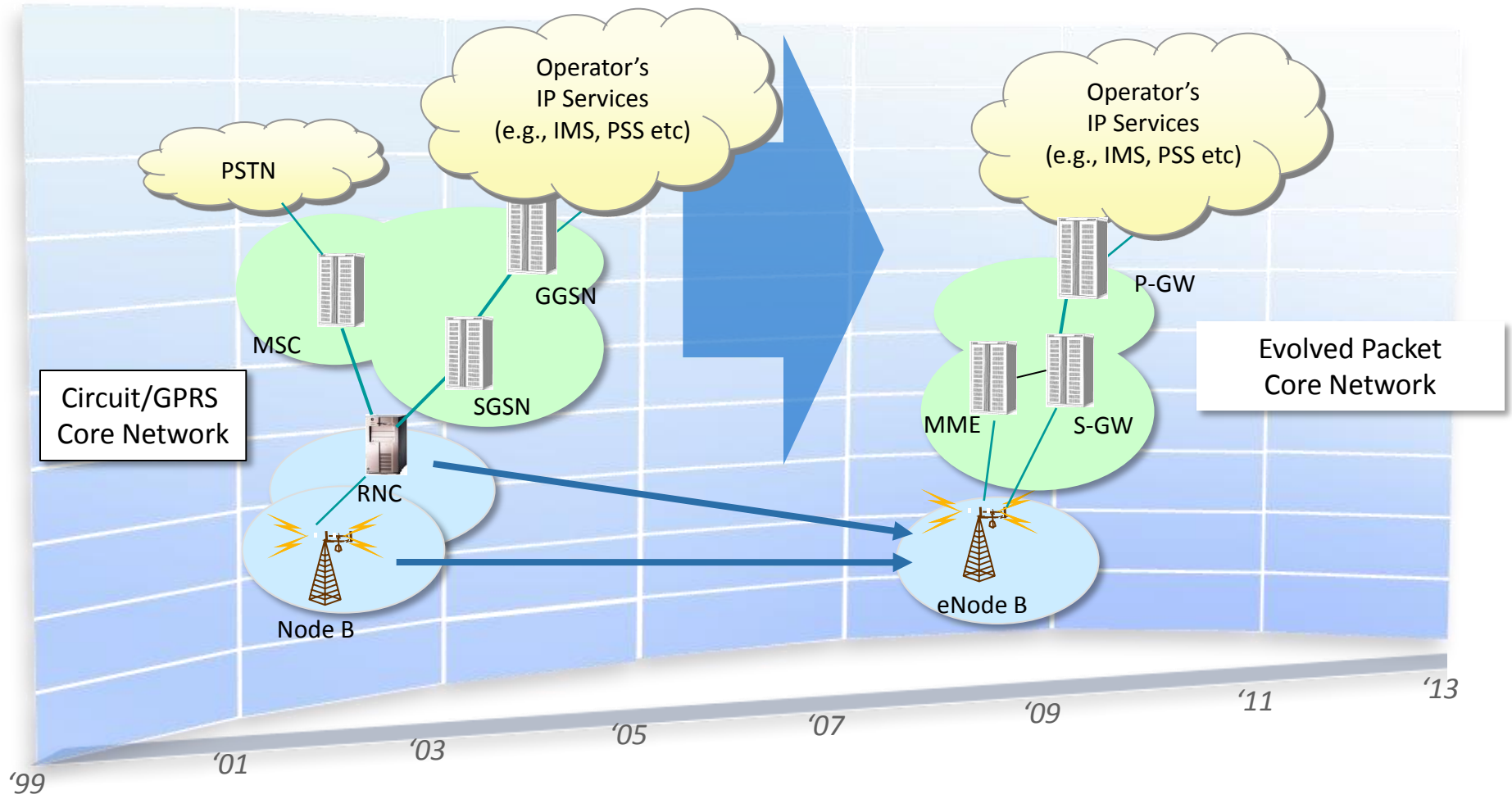
IP Core Network

- Support of non-3GPP Accesses (e.g. WiFi)
- Optimized Packet Only Support
- Enhanced QoS and Policy
- Support for M2M
- Greater Device Diversity

Service Layer

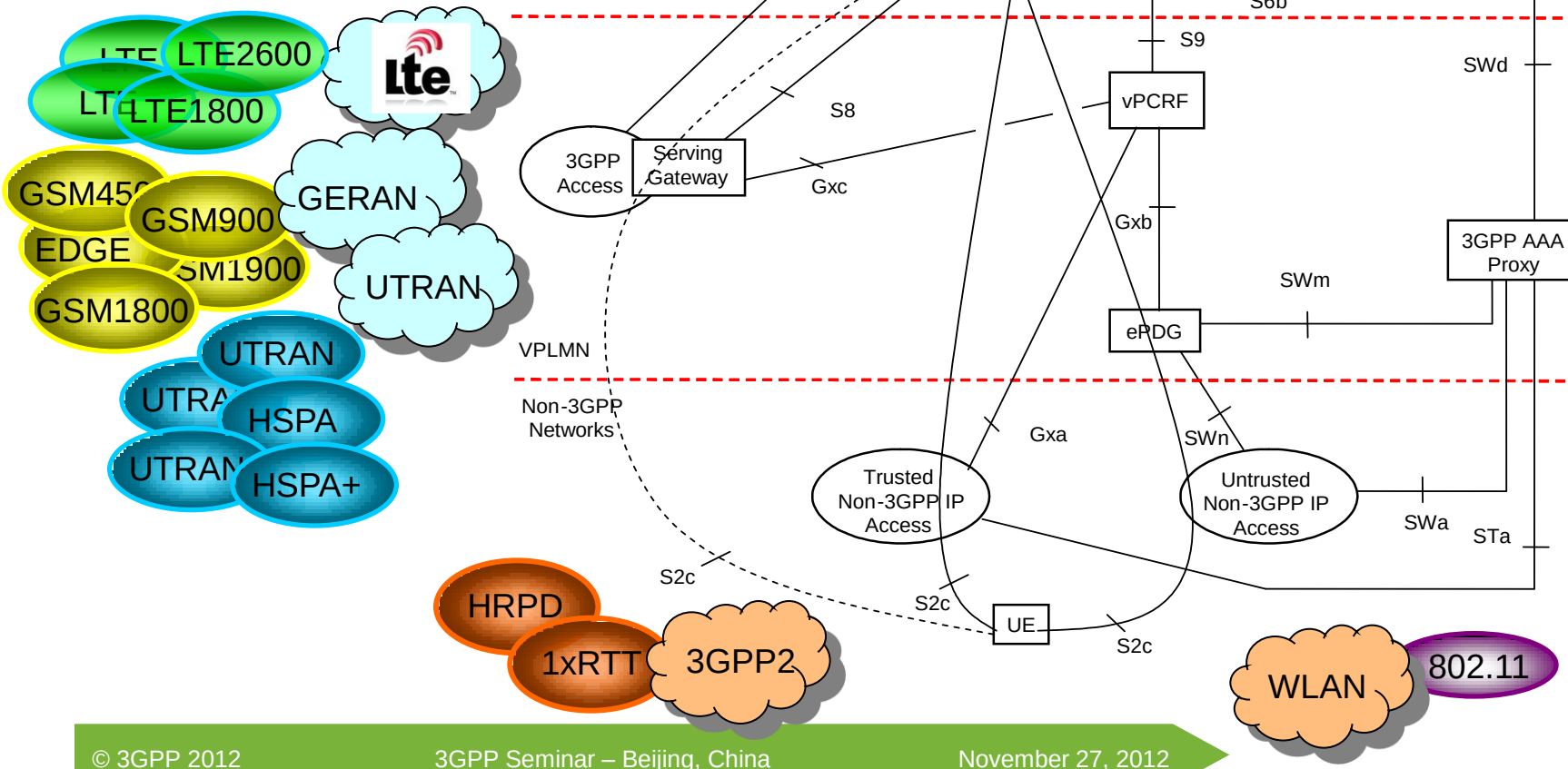
- IMS and Applications
- Session continuity

Core Network Evolution



EPS architecture

- Many 3GPP access technologies
- Mobility between access technologies
- Multiple roaming models
- Non-3GPP accesses



Key features of recent Releases

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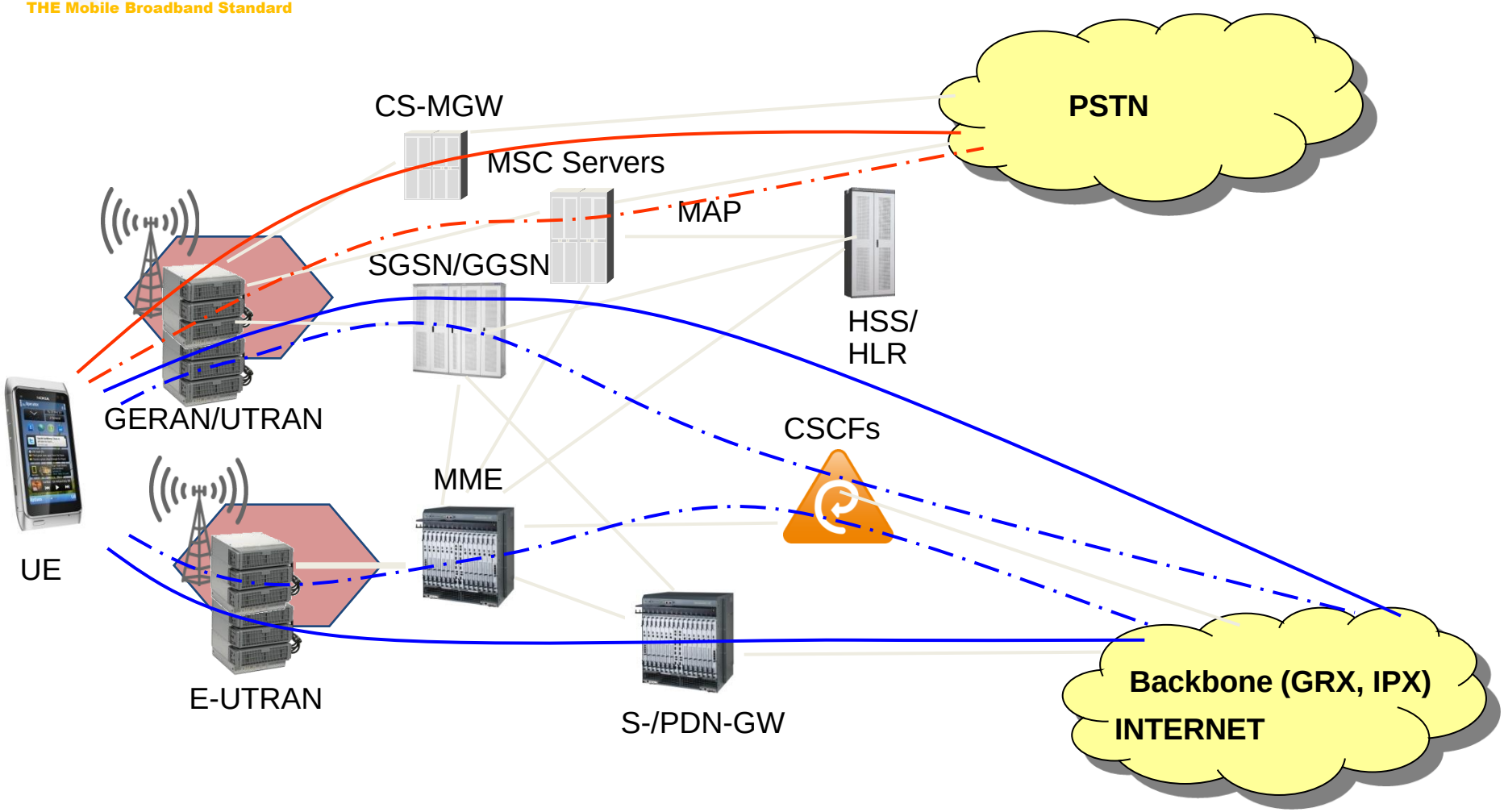
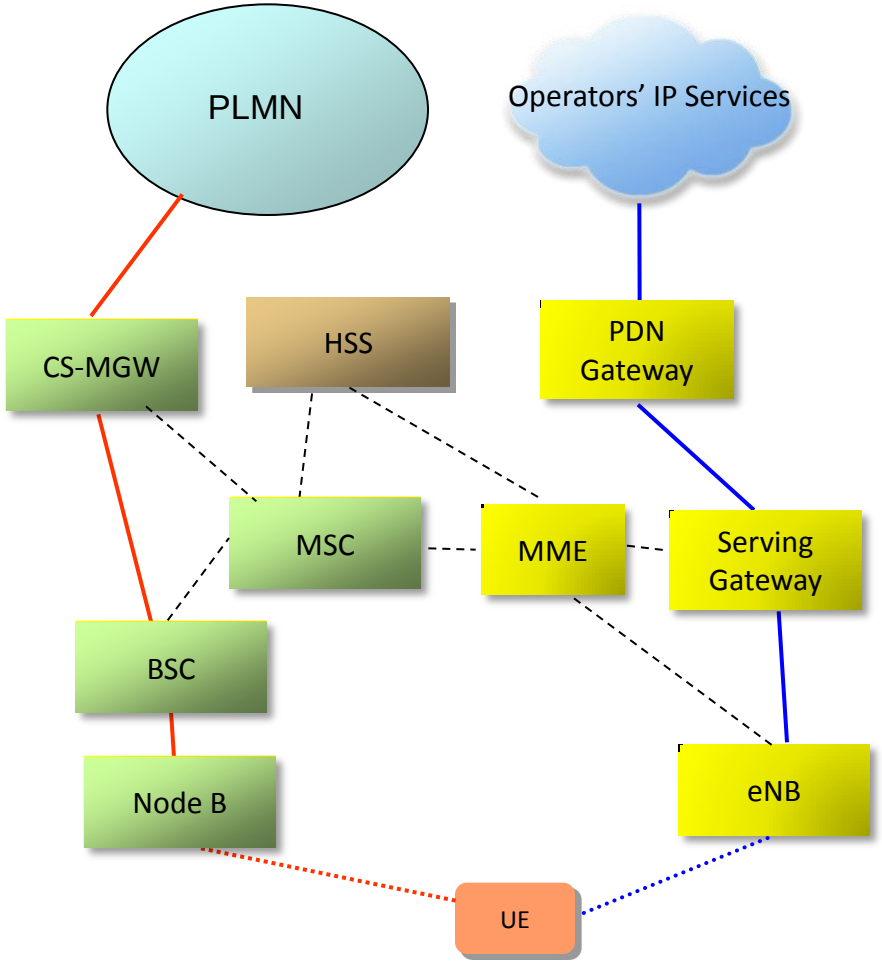
- Multimedia and carrier grade VoIP with IMS
- Multi-access, operators can influence the access selection
- Dual-stack IPv4/v6 connectivity to cater for IPv6 migration
- Various ways to combine or split traffic off inside the network
  - Local IP Access (LIPA)
  - Selective IP Traffic Offloading (SIPTO)
  - WLAN offloading
- Machine Type Communications (M2M)
- Regulatory features

CS and PS voice service architecture



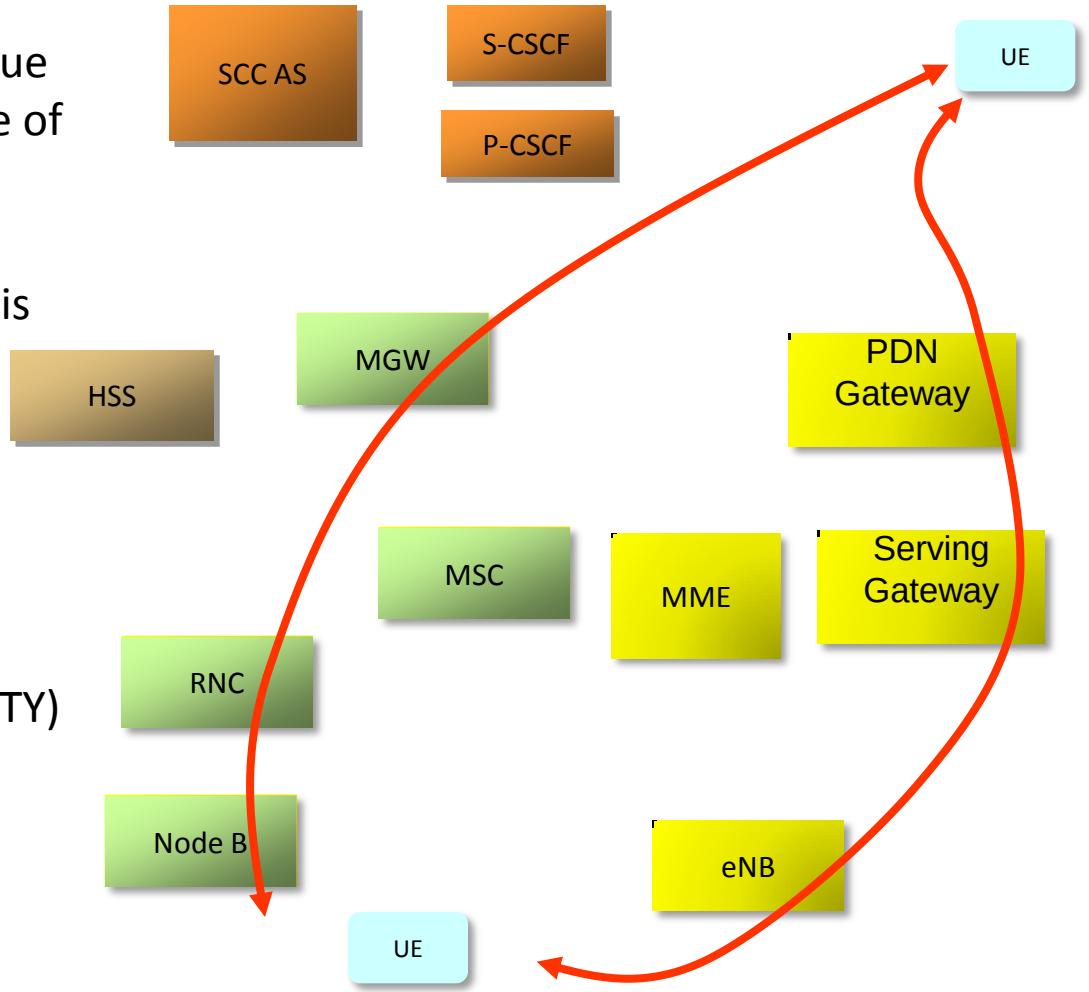
CS Fallback in EPS

- Application of CSFB:
  - CS capable device camping on LTE cell can establish/receive CS services
  - Reuse of existing CS infrastructure for voice service until IMS VoIP is deployed
  - Provide voice roaming support with LTE
  - Can support emergency calls using existing CS infrastructure
- SMS can be delivered to the UE without redirecting to CS Domain
- After CS service the UE returns to LTE, depending on coverage and policy



Single Radio Voice Call Continuity

- SRVCC use case:
  - IMS call initiated in LTE can continue in CS domain after moving outside of LTE coverage area
  - SRVCC is invoked if no other VoIP capable PS system (HSPA/eHRPD) is available for VoIP PS-PS HO
  - Requires overlapping with GSM/WCDMA/1xRTT coverage
- SRVCC improvements:
  - Mid-call services (like HOLD & MPTY)
  - emergency calls
  - video calls



Access Discovery and Selection (ANDSF)

- EPC is a multi-access IP core system supporting both native 3GPP cellular radio technologies and other IP access systems (802.x, etc…)
- Legacy selection mechanisms have been available to choose a 3GPP cellular radio and PLMN
- Additional standards were developed to take into account non-3GPP access technologies
  - Access technology policies are uploaded to the device using Device Management procedures
- Further work ongoing to fine-tune the granularity of the policies

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Improved Dual-Stack Support for IPv6 migration

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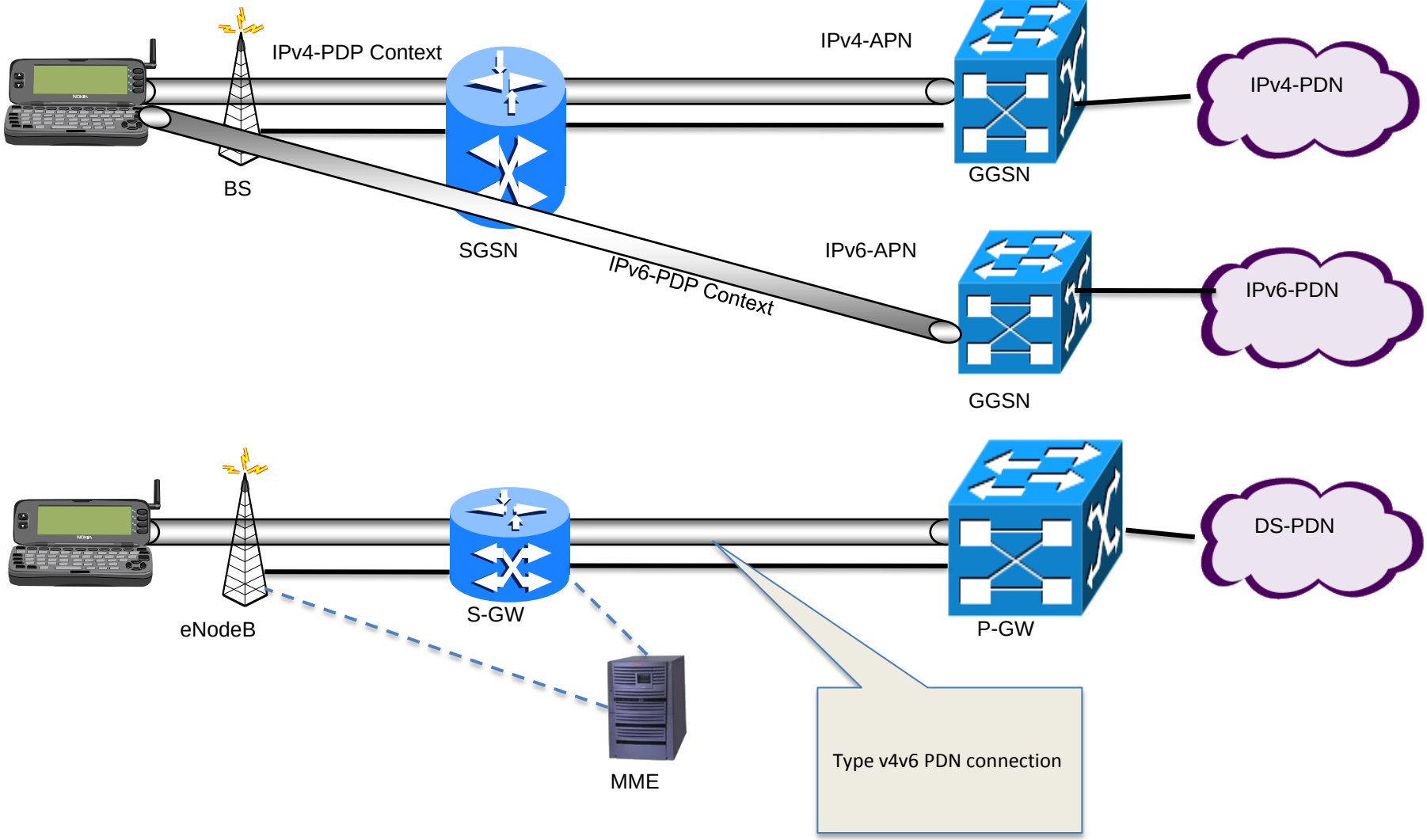
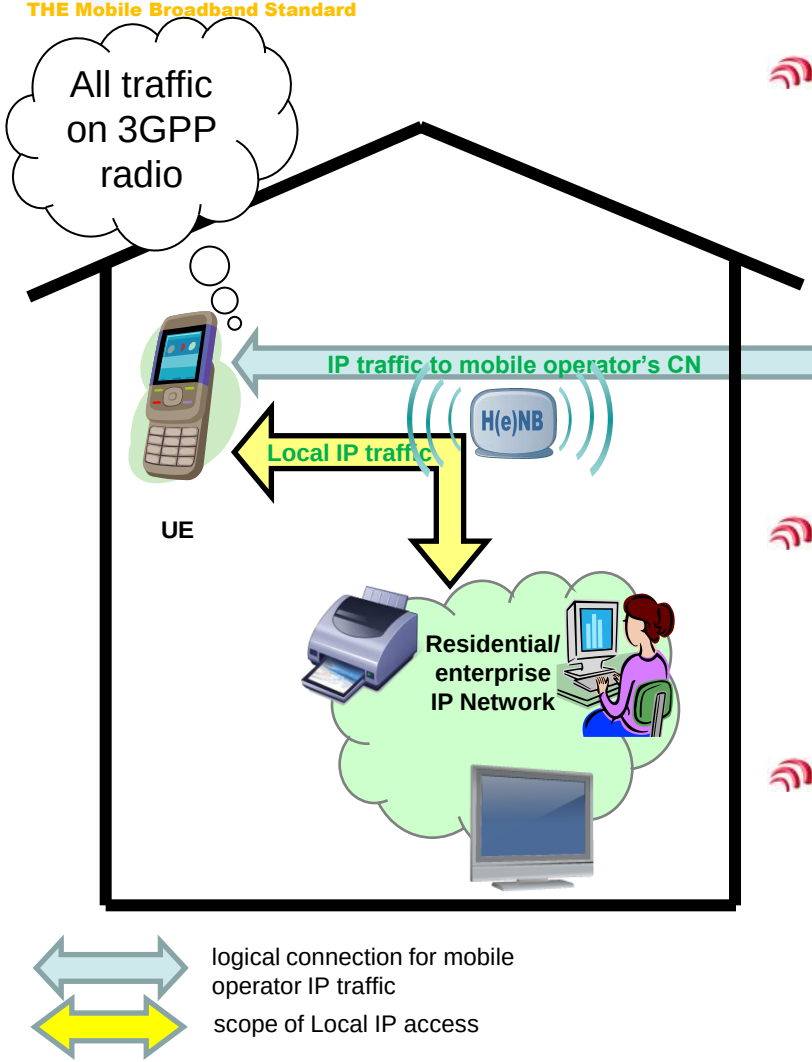
- Networks prior to Release-8 (Dec/2008)
  - Dual-stack connectivity only possible by opening two parallel Bearers: one of each for IPv4 and IPv6
  - Shows up as two separate interfaces to the IP stack
- Networks from Release-8 onwards with the addition of LTE
  - Always-on…
  - A single IPv4v6 PDN Connection
  - Shows up as one interface with both IPv4 and IPv6 addresses to the IP stack (with v4v6 type)
  - Does not lower the needed number of v4 addresses, but helps v6 uptake by optimizing resource usage

Improved Dual-Stack Support



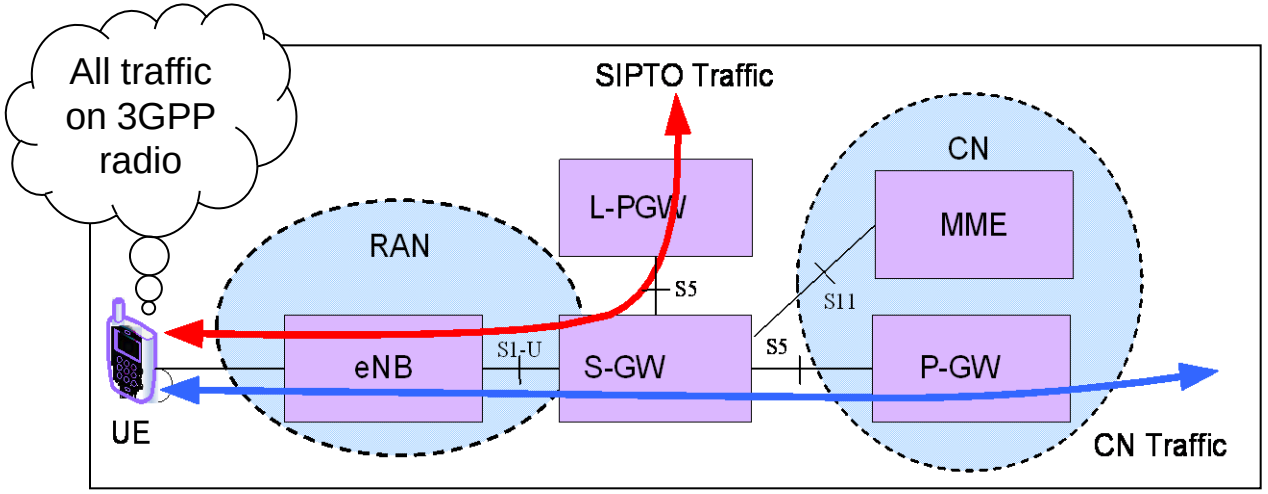
Local IP Access (LIPA)



- LIPA is primarily for end user's benefit, to allow access to local residential or corporate network through a 3GPP device
- LIPA provides access for IP capable UEs that are connected via a H(e)NB subsystem to other IP capable entities in the same residential/ enterprise IP network.
- Simultaneous access from a UE to the mobile operator's core network and Local IP Access to a residential/enterprise IP network will be supported.

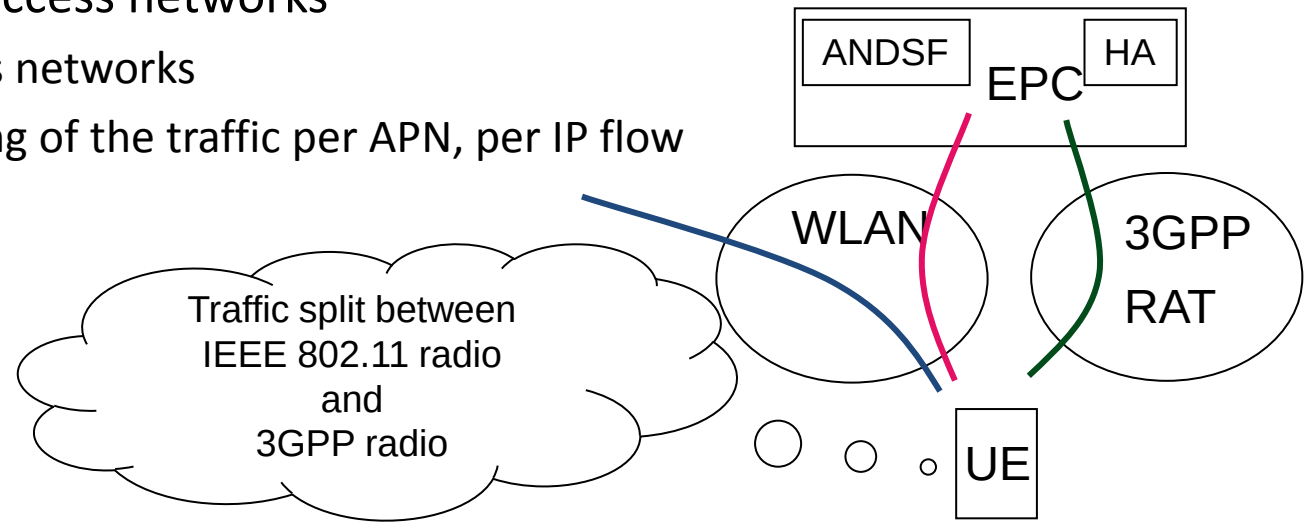
Selective IP Traffic Offloading (SIPTO)

- Optimizing “cost per bit” is becoming essential in the “flat rate” era
- SIPTO is a specific routing scenario within the operator’s network, allowing *selective* offloading of the traffic away from the Evolved Packet Core network
- SIPTO benefits the cellular operator and it is transparent for the end user
- SIPTO is intended for allowing cost optimized handling of the internet traffic that is not intended for the operator’s core network
- Local GW is selected for the traffic to be offloaded



WLAN Offloading

- WLAN offloading refers to the dual radio scenario where part of the traffic is routed via WLAN access and part via 3GPP access
- WLAN offloading covers both the scenario where the traffic via WLAN radio is anchored in the EPC (i.e., seamless offloading) and the scenario where it is not anchored (i.e., non-seamless offloading)
- Access Network Discovery and Selection Function (ANDSF) is there to provide the UE with the access network discovery information and the policy on how to use the available access networks
  - Available access networks
  - Preferred routing of the traffic per APN, per IP flow



Machine-to-Machine (M2M)

- M2M is recognized as a key segment in future packet networks
- Initial 3GPP efforts have focused on the ability to differentiate machine-type devices
  - This allows the operator to selectively handle such devices in overload situations
    - Low priority indicator has been added to the relevant UE-network procedures
    - Overload and Congestion control is done on both core network and radio access network based on this indicator
- Functions for device triggering and small data transmission have been added
- Still a lot to do…

Regulatory features – disaster response

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- Recent events have brought the different disaster response functions of the 3G/4G networks to the forefront
  - Public Warning System (PWS) provides a secure framework for delivering Warning Messages to the devices
    - The Japanese version of this system saved thousands of lives in last year's earthquake/tsunami disaster
  - Priority Services
    - Mechanisms have been standardized to allow priority access to the network services (voice calls, Internet, multimedia calls, etc…) for e.g. government officials in the event of a mass disaster

Summary

- As a global organization 3GPP is fully focused on
  - Providing the industry with timely technology evolution
    - Finding the right balance between evolution and revolution
  - Addressing the smartphone challenge with innovative features across radio and core
  - Optimizing the network for new business opportunities, e.g. machine-to-machine communications
  - Ensuring backwards compatibility to protect existing network investments

Thank You !!

Sungho Choi

3GPP TSG SA vice-chairman

schoi@samsung.com

More Information about 3GPP:

www.3gpp.org

contact@3gpp.org