Evolution of the 3GPP System

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3GPP – the Partnership

- 3GPP Stands for 3rd Generation Partnership Project*
- The Partners are Standards Developing Organizations:

ARIB (Japan)

CCSA (China)

TTA (Korea)

atis (USA)

ETSI World Class Standards (Europe)

TTC Telecommunication Technology Committee (Japan)

- Contribution driven …companies participate in 3GPP through their membership of one of these "Organizational Partners"
- Currently over 350 Individual Members (Operators, Vendors, Regulators)
- 13 Market Representation Partners (giving perspectives on market needs and drivers)

*3GPP is not constrained to 3rd Generation. It includes work on both 2nd and 4th generation technologies.

3GPP – the Work

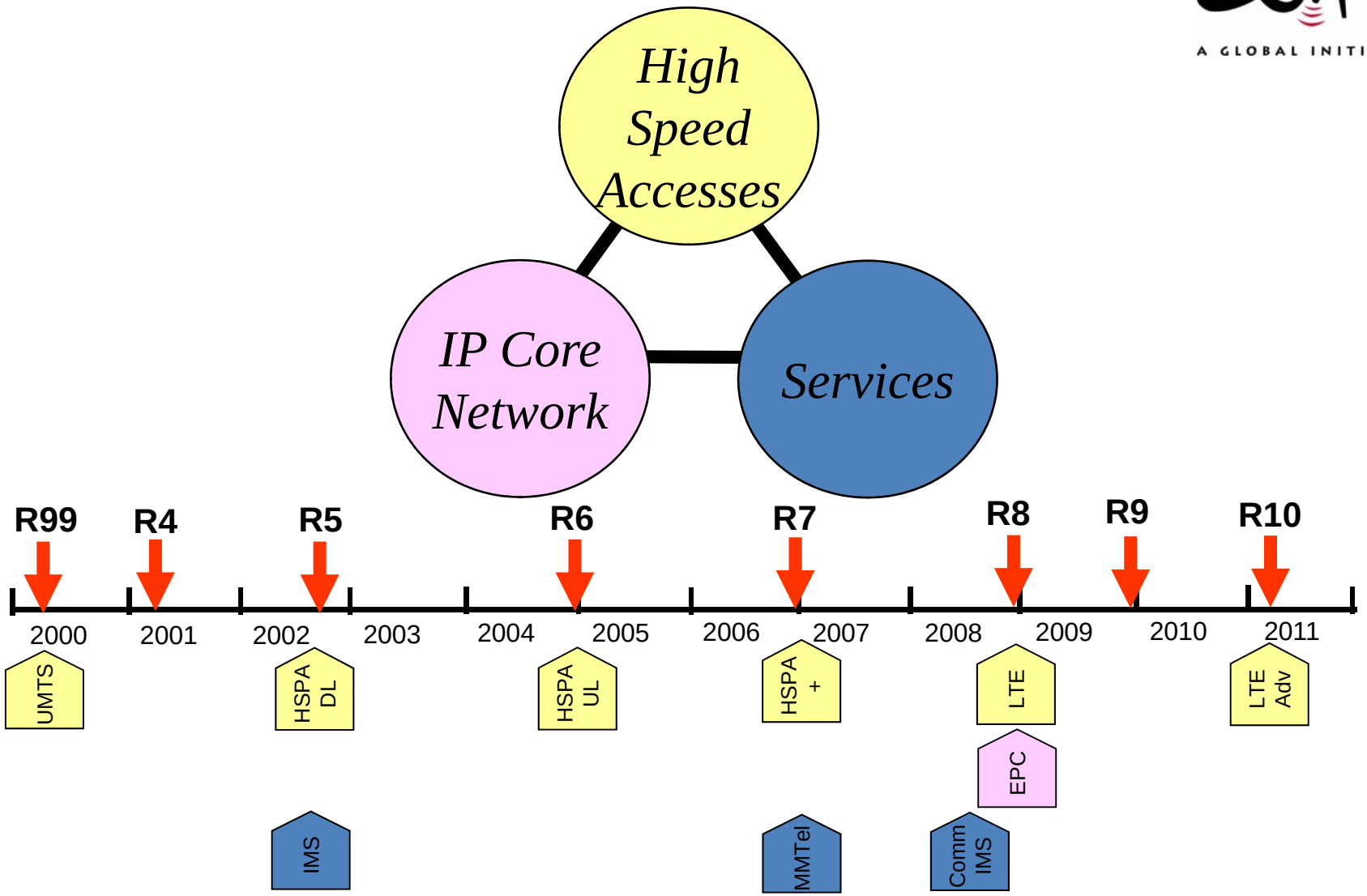
- Approximately *185 meetings* per year
- Many co-located meetings, totalling around 600 delegates
- Some meetings receive *1000 documents*

TSG Structure

What does 3GPP Specify?

- 3GPP Specified Radio Interfaces
  - 2G radio: GSM, GPRS, EDGE
  - 3G radio: WCDMA, HSPA, LTE
  - 4G radio: LTE Advanced
- 3GPP Core Network
  - 2G/3G: GSM core network
  - 3G/4G: Evolved Packet Core (EPC)
- 3GPP Service Layer
  - GSM services
  - IP Multimedia Subsystem (IMS)
  - Multimedia Telephony (MMTEL)
  - Support of Messaging and other OMA functionality
  - Emergency services and public warning
  - Etc.

3GPP Release Concept

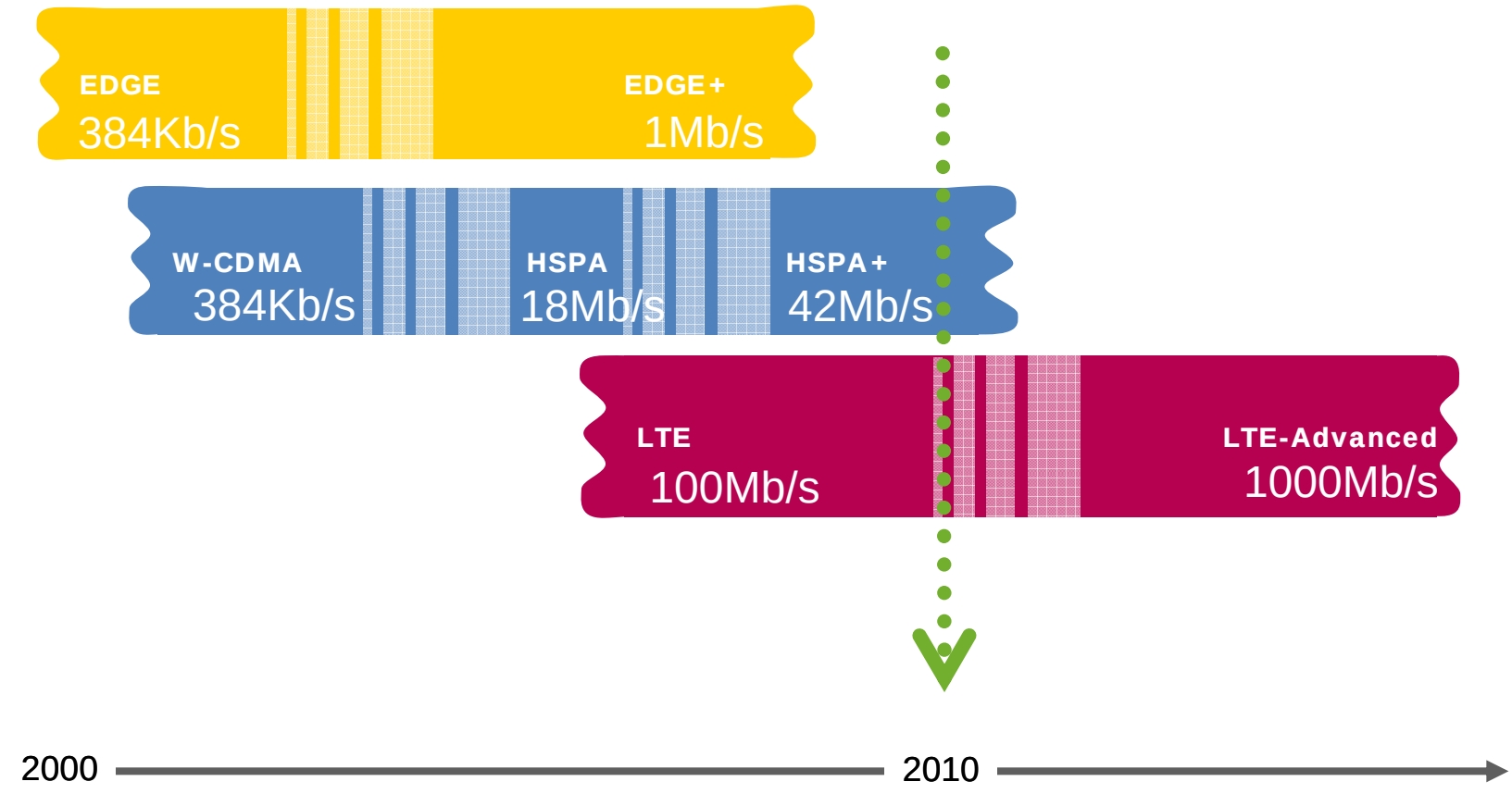


General Directions of 3GPP Evolution

- Radio Interfaces
  - Higher Data Throughput
  - Lower Latency
  - More Spectrum Flexibility
  - Improved CAPEX and OPEX
- IP Core Network
  - Support of non-3GPP Accesses
  - Packet Only Support
  - Improved Security
  - Greater Device Diversity
- Service Layer
  - More IMS Applications (MBMS, PSS, mobile TV now IMS enabled)
  - Greater session continuity

Evolution of the Radio Interface

Standards availability



GPRS/EDGE Evolution

- Release 8 and earlier
  - GERAN/LTE Interworking
  - General corrections
  - Multicarrier BTS
  - A-GNSS (Global Navigation Satellite Systems)
- Release 9
  - Hybrid Location
  - Multi Standard Radio (MSR)
- Release 10
  - Local Call Local Switch

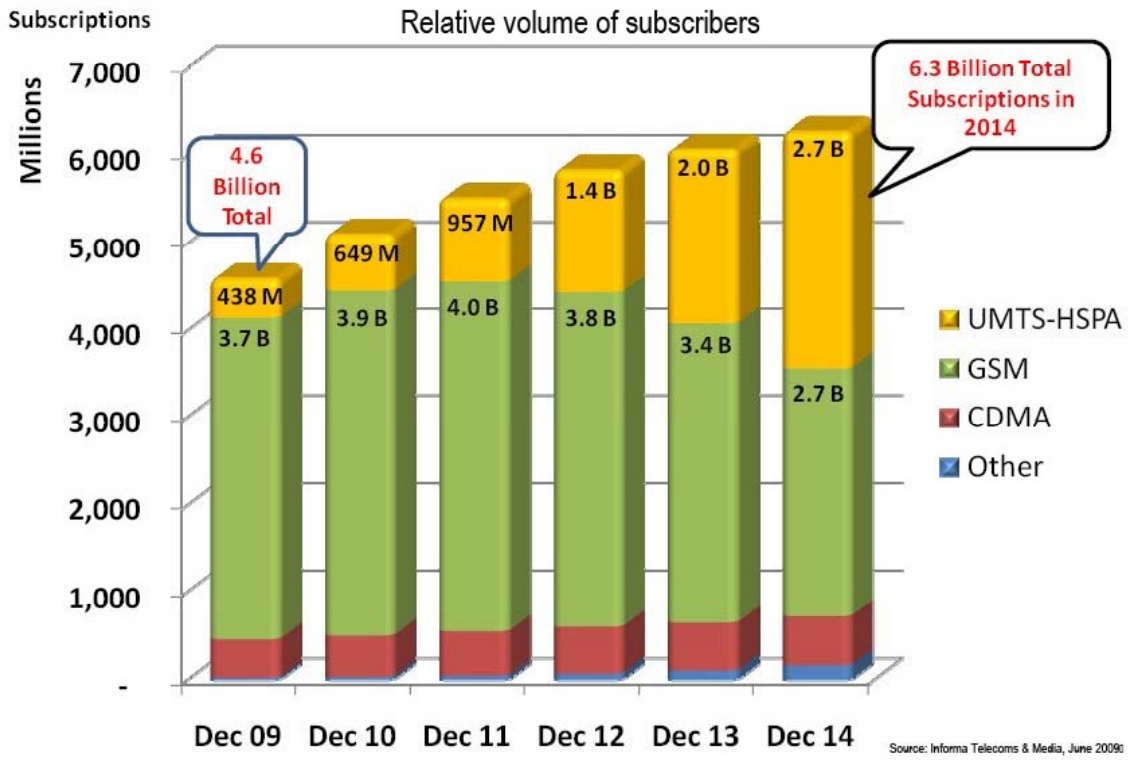
> “TSG GERAN has been continuing to evolve GSM EDGE technology towards services that approach UMTS and LTE levels”
>
> GERAN Chairman

Andrew Howell, 3GPP

UMTS Evolution (HSPA)

- 240 Operators in > 100 countries…Forecast 1 billion subscriptions by 2011
- 3GPP R5 & R7 added MIMO antenna and 16QAM (Uplink)/ 64QAM (Downlink) modulation

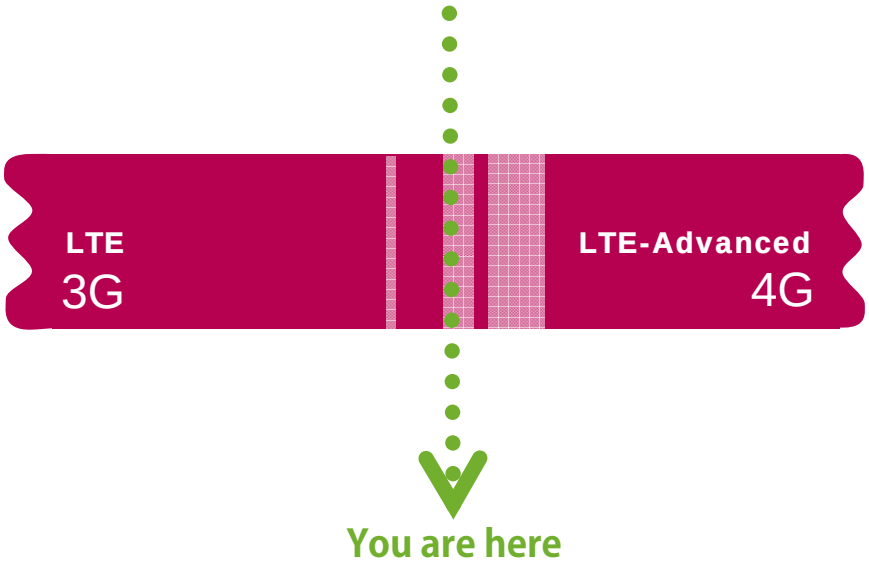
- Improved spectrum efficiency (modulation 16QAM, Reduced radio frame lengths
- New functionalities within radio networks (incl.re-transmissions between NodeB and the Radio Network Controller)
- Latency reduced (100ms for HSDPA and 50ms for HSUPA)



LTE characteristics

- LTE introduced in Rel 8
  - Minor improvements in Rel 9 and Rel 10
- Significantly increased data throughput
  - Downlink target 3-4 times greater than HSDPA Release 6
  - Uplink target 2-3 times greater than HSUPA Release 6
- Increased cell edge bit rates
  - Downlink: 70% of the values at 5% of the Cumulative Distribution Function (CDF)
  - Uplink: same values at 5% of the Cumulative Distribution Function (CDF)
- Significantly reduced latency
- High mobility
- Cell ranges up to 5 km; with best throughput, spectrum efficiency and mobility. Cell ranges up to 30 km; Mobility with some degradation in throughput and spectrum efficiency permitted. Cell ranges up to 100 km; Supported; degradations accepted

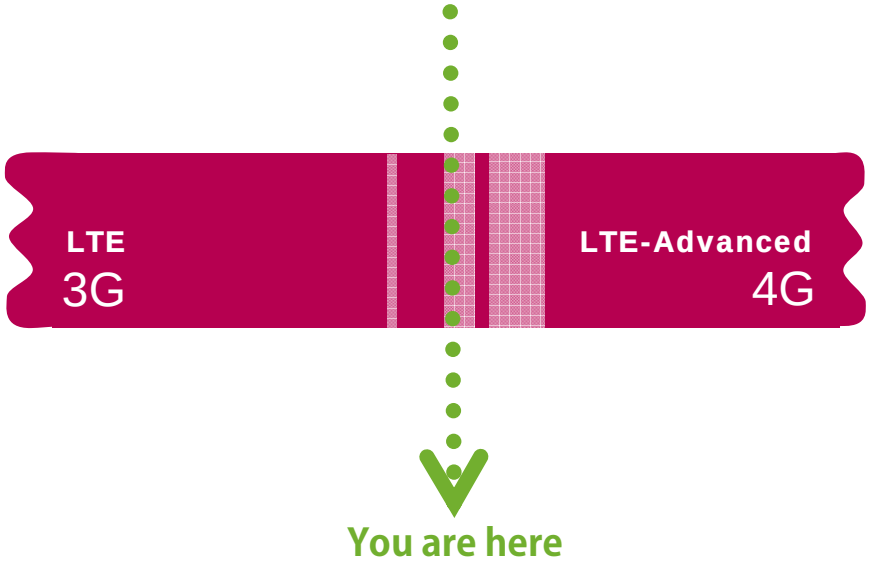
LTE-Advanced (R10)



- Smooth transition from 3G to 4G
- LTE-Advanced to be the main feature of 3GPP Release 10

What will LTE-Advanced deliver?

- Support for wider Bandwidth (Up to 100MHz)
- Downlink transmission scheme
  - Improvements to LTE by using 8x8 MIMO
  - Data rates of 100Mb/s with high mobility and 1Gb/s with low mobility



- Up link transmission scheme
  - Improvements to LTE
  - Data rates up to 500Mb/s
- Relay functionality
  - Improving cell edge coverage
  - More efficient coverage in rural areas
- CoMP (coordinated multiple point transmission and reception)
  - Downlink coordinated multi-point transmission
  - Uplink coordinated multi-point reception
- Local IP Access (LIPA) & Enhanced HNB to allow traffic off-load

Spectrum Issues

- LTE Bands:

- Re-farming

900/1800MHz GSM bands are attracting a lot of attention, as “spectrum re-farming” in those bands is seen as one way to allow the roll out of mobile broadband services.

Additional spectrum can be added to the specifications as required.

(eg. 3500MHz currently being added)

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit			Downlink (DL) operating band BS transmit UE receive			Duplex Mode
	$F_{UL\ low}$ – $F_{UL\ high}$			$F_{DL\ low}$ – $F_{DL\ high}$			
1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
2	1850 MHz	–	1910 MHz	1930 MHz	–	1990 MHz	FDD
3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz	FDD
4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz	FDD
5	824 MHz	–	849 MHz	869 MHz	–	894MHz	FDD
6+	830 MHz	–	840 MHz	875 MHz	–	885 MHz	FDD
7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz	FDD
8	880 MHz	–	915 MHz	925 MHz	–	960 MHz	FDD
9	1749.9 MHz	–	1784.9 MHz	1844.9 MHz	–	1879.9 MHz	FDD
10	1710 MHz	–	1770 MHz	2110 MHz	–	2170 MHz	FDD
11	1427.9 MHz	–	1447.9 MHz	1475.9 MHz	–	1495.9 MHz	FDD
12	698 MHz	–	716 MHz	728 MHz	–	746 MHz	FDD
13	777 MHz	–	787 MHz	746 MHz	–	756 MHz	FDD
14	788 MHz	–	798 MHz	758 MHz	–	768 MHz	FDD
15	Reserved			Reserved			FDD
16	Reserved			Reserved			FDD
17	704 MHz	–	716 MHz	734 MHz	–	746 MHz	FDD
18	815 MHz	–	830 MHz	860 MHz	–	875 MHz	FDD
19	830 MHz	–	845 MHz	875 MHz	–	890 MHz	FDD
20	832 MHz	–	862 MHz	791 MHz	–	821 MHz	FDD
21	1447.9 MHz	–	1462.9 MHz	1495.9 MHz	–	1510.9 MHz	FDD
...							
33	1900 MHz	–	1920 MHz	1900 MHz	–	1920 MHz	TDD
34	2010 MHz	–	2025 MHz	2010 MHz	–	2025 MHz	TDD
35	1850 MHz	–	1910 MHz	1850 MHz	–	1910 MHz	TDD
36	1930 MHz	–	1990 MHz	1930 MHz	–	1990 MHz	TDD
37	1910 MHz	–	1930 MHz	1910 MHz	–	1930 MHz	TDD
38	2570 MHz	–	2620 MHz	2570 MHz	–	2620 MHz	TDD
39	1880 MHz	–	1920 MHz	1880 MHz	–	1920 MHz	TDD
40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD
Note +: Band 6 is not applicable			TS 36,101 Version 9.2.0				

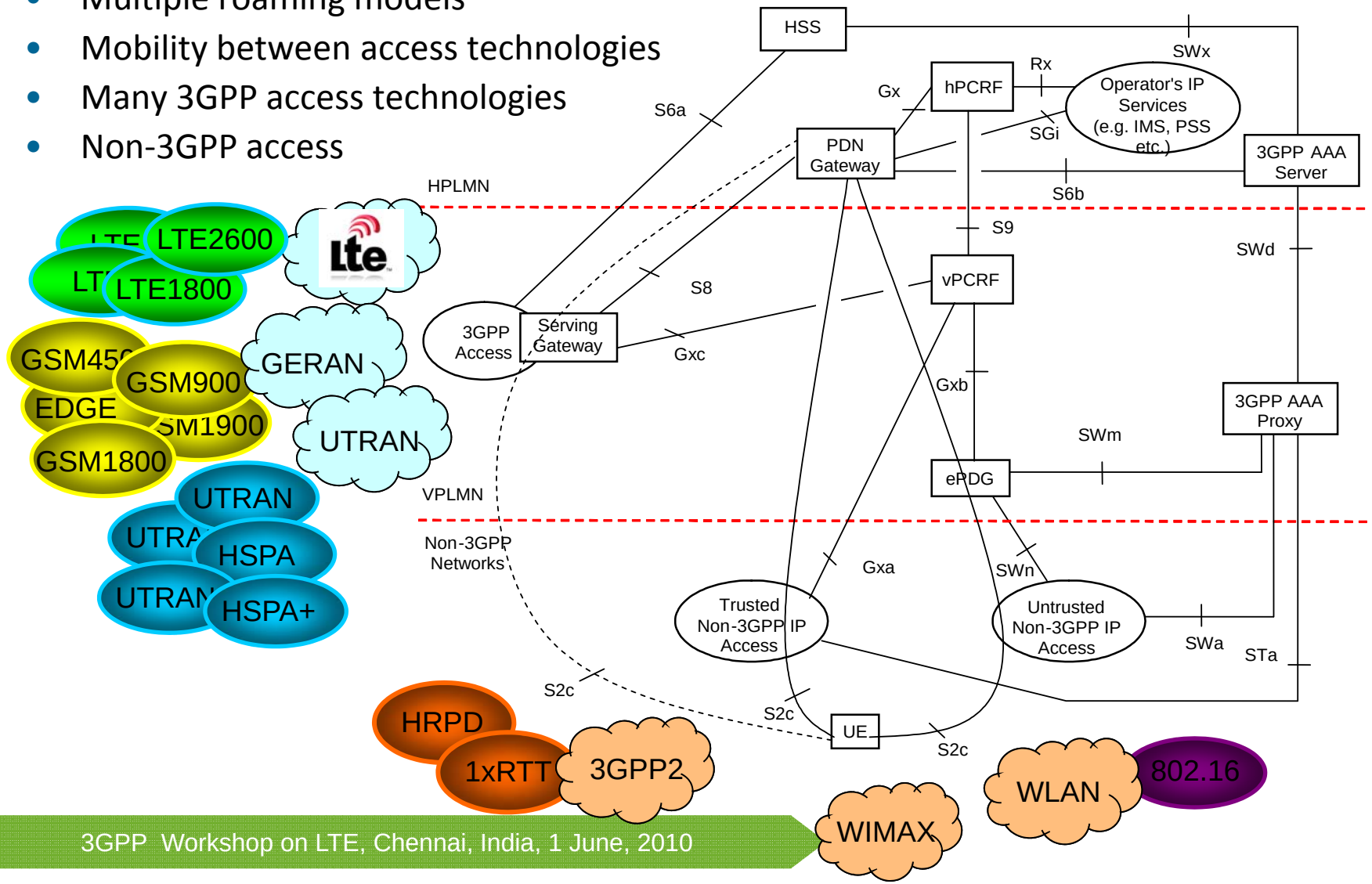
TS 36.101 v9.2.0

Evolution of the Core Network

- New Core Network defined in conjunction with LTE
- Characteristics of EPC (Evolved Packet Network)
  - IP Based Core Network
  - Flat structure
  - PMIP and GTP based mobility
  - Supports both 3GPP and non-3GPP Accesses
  - Policy Control
  - Optimized for packet based multimedia

EPS (EPS = LTE + EPC) Architecture

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



EPC Core Network

- Flat EPC architecture with only two network nodes for EPC control plane
  - PS-only architecture
- Interoperability
  - GTP and PMIP roaming interface (S5/S8)
  - Multiple security mechanisms
  - Optimised interworking with legacy cellular systems, incl. CDMA
  - Interworking with non-3GPP access technologies
- Access networks supported by 3GPP Core Network (EPC)
  - 3GPP and non-3GPP
  - Trusted and untrusted
  - Mobile and fixed
  - Different security, QoS, mobility
  - GERAN frequency bands: 13 bands
  - LTE frequency bands: 19 FDD and 8 TDD bands
  - UTRAN frequency bands: 17 bands
  - IMT-A in Rel-10 is expected to be connected to the same Rel-9 EPC

Additional EPC Characteristics

- Multi-mode Terminal Support
  - Access Network Discovery and Selection Function (ANDSF)
- Home Node B (and Home e Node B) – No new services, but support of closed subscriber groups and provisioning
- Traffic offload – As internet traffic grows, there is a need to offload the radio accesses and the core network
  - Local IP Access (LIPA) is used from a Home Node B to access local network resources (such as a printer)
  - IP Flow Mobility and Seamless Offload (IFOM) is used to carry some of a UE's traffic over wifi to offload Home Node B access.
  - Selected IP Traffic Offload (SIPTO) is used to offload the mobile core network by breaking traffic out of the network early.
    - SIPTO for Home Node B may be deferred to a later release
- Dual-stack IPv4/6 connectivity
- Currently working with BBF to integrate BBF accesses
- Policy Control integrated with the core network

Services Evolution in 3GPP

- IMS
  - IMS is the goal for voice over LTE
    - voLTE
  - IMS allows a transition to Multimedia
    - Multimedia Telephony
  - Transition capabilities developed to allow transition to IMS
    - CS Fallback
    - SRVCC
    - IMS Centralized Services
- Non-IMS
  - Regulatory Services
  - Machine Type Communications

Multimedia Telephony Services

- Telephony Services Defined for Multimedia
  - Originating Identification Presentation (OIP)
  - Originating Identification Restriction (OIR)
  - Terminating Identification Presentation (TIP)
  - Terminating Identification Restriction (TIR)
  - Communication Diversion (CDIV)
  - Communication Hold (HOLD)
  - Communication Barring (CB)
  - Message Waiting Indication (MWI)
  - Conference (CONF)
  - Explicit Communication Transfer (ECT)
  - Communication Waiting (CW)
  - Completion of Communications to Busy Subscriber (CCBS)
  - Completion of Communications on No Reply (CCNR)
  - Customized Alerting Tone (CAT)
  - Customized Ringing Signal (CRS)
  - Personal Network Management (PNM)
  - Malicious Communication IDentification (MCID)
  - Anonymous Communication Rejection (ACR)
  - Advice Of Charge (AOC)
  - Reverse charging
  - Closed User Group (CUG)
  - Three-Party (3PTY)
  - Flexible Alerting (FA)

BLUE = Applicable to mobile only

RED = Applicable to fixed only

Multimedia Telephony Services are defined in 3GPP TS 22.173

EPS Migration Mechanisms

- Voice
  - Voice Call Continuity (VCC) – Allows a basic voice call to be handed over from IMS to circuit switched and vice-versa (Rel 7) – Primarily focused on WiFi-GSM handover
  - CS Fallback – CS Voice provided over GSM or UMTS if no LTE IMS voice available (Rel 8)
  - SRVCC – Provides voice continuity with only a single radio (Rel 8)
  - IMS Centralized Services – Your services also work seamlessly between CS and IMS (Rel 8)
- Messaging
  - CS Fallback – SMS carried over LTE signalling – no need to switch radio I/F (Rel 8 – improvements ongoing)
  - SMS over IP – Enhancements to the gateway to integrate with OMA CPM (being defined in Rel 10)
- Video
  - SRVCC for video being defined in Rel 10

Dispelling some Myths about LTE and IMS

- Myth 1: LTE is Data only

  Reality: Support of voice was one of the key considerations in designing LTE. The voice solution for LTE is IMS VoIP and it is fully specified.

- Myth 2: SMS isn't supported over LTE

  Reality: LTE and EPS will support a rich variety of messaging applications - including SMS. The solution is twofold, covering both the full IMS case and a transition solution for those networks that do not support IMS.

- Myth 3: IMS isn't ready for prime time

  Reality: IMS was first developed as part of Rel 5 in 2002. It is based on IETF protocols such as SIP and SDP that are very mature. These technologies have been embraced by the industry as the signalling mechanism for multimedia applications.

- Myth 4: LTE doesn't support emergency calls

  Reality: VoIP support for emergency calls (incl. location) in Rel 9. A transition solution fall back to 3G/2G - has existed since IMS was introduced (Rel 5).

Other IMS related work ongoing

- Enhancements to Inter-Device Transfer
- IMS based Home Node B
- Non-voice Emergency Services
- Enhancements for supporting Streaming and MBMS using IMS
- Enhancements to IMS to support video

Non-IMS Services

- Regulatory
  - E-Call (completed in Rel 8)
  - Public Warning System (completed in Rel 9)
    - Extensible, but currently only Japan and US supported
  - Prioritized packet communications
- Enhancements to the Codec
  - Rate adaptation for LTE allowed in Rel 9
  - Enhanced Voice Codec in Rel 10
- MTC – Machine Type Communication
  - Focusing on network optimizations
  - 14 Features identified
  - Rel 10 work will focus on general functionality to allow priorities for features to stabilize

Machine Type Communications

- Work started on this in Rel 10
- 14 MTC Features identified
  - Low Mobility
  - Time Controlled
  - Time Tolerant
  - Packet Switched (PS) Only
  - Small Data Transmissions
  - Mobile Originated Only
  - Infrequent Mobile Terminated
  - MTC Monitoring
  - Priority Alarm Message (PAM)
  - Secure Connection
  - Location Specific Trigger
  - Network Provided Destination for Uplink Data
  - Infrequent Transmission
  - Group Based MTC Features
- In Rel 10, 3GPP will focus on the general functionality required to support these features
  - Overload control (Radio Network Congestion use case, Signalling Network Congestion use case and Core Network Congestion use case)
  - Addressing
  - Identifiers
  - Subscription control
  - Security

Conclusions

- 3GPP LTE is set to be *the* major enabler for mobile broadband
- LTE is being evolved into LTE-Advanced
- 3GPP is progressing work on all radio interface generations
- 3GPP is also addressing a variety of key areas
  - Femtocells
  - Traffic Offload
  - Machine 2 machine communications
  - Fixed Mobile Convergence

More Information

- All 3GPP specifications, documents, meeting reports, etc. can be freely downloaded from www.3gpp.org
- Or can be obtained from the 3GPP Organisational Partners (ARIB, ATIS, CCSA, ETSI, TTA, TTC)
- A DVD of the full set of 3GPP specifications is available