

Mobile Computing

Lecture 14

Digital Mobile Phone Systems 7



Contents



- Long Term Evolution (LTE)
- Features
- Frame Structure
- Architecture
- LTE Advanced

Long Term Evolution (LTE)

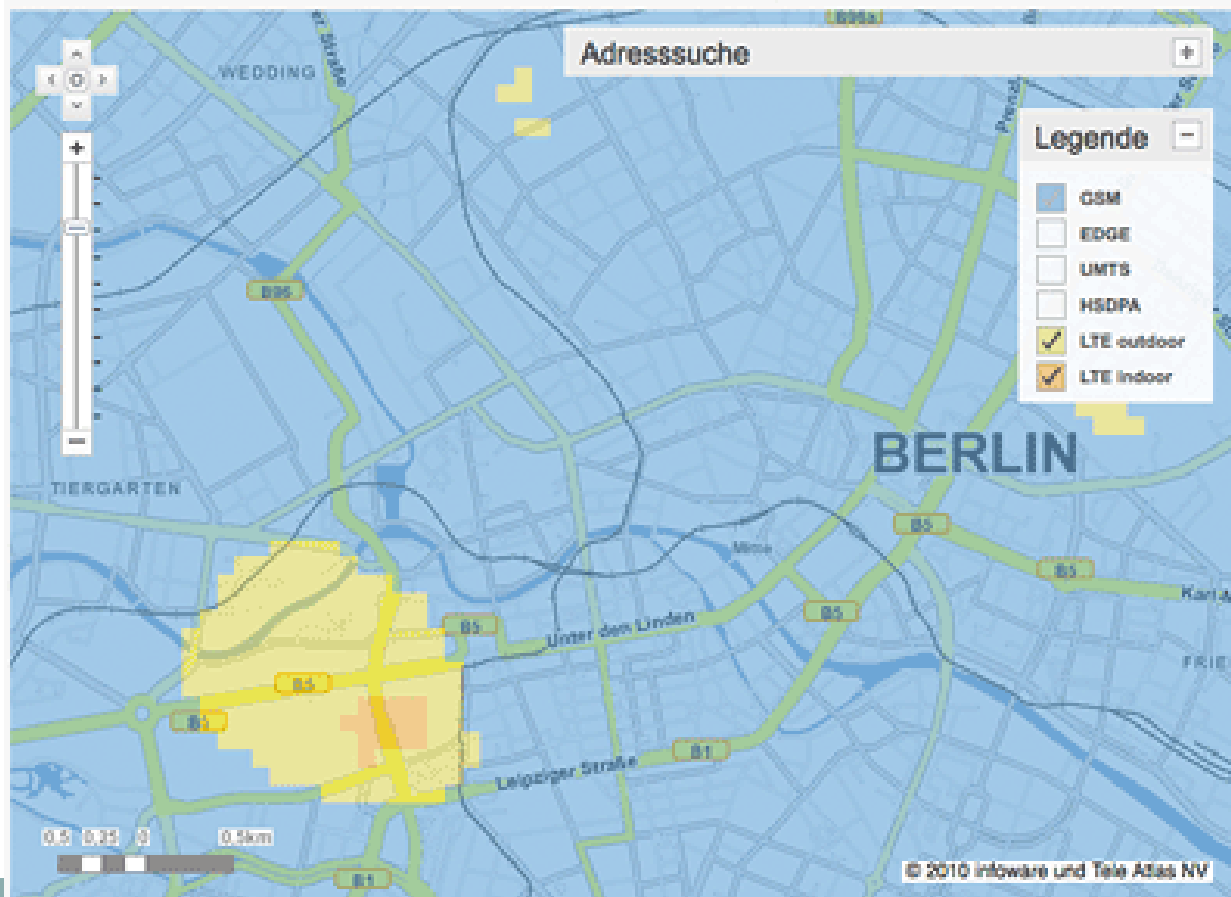


- Initiated in 2004 by NTT DoCoMo, focus on enhancing the Universal Terrestrial Radio Access (UTRA) and optimizing 3GPP's radio access architecture
- Targets: Downlink 100 Mbit/s, uplink 50 Mbit/s, RTT<10ms
- 2007: E UTRA progressed from the feasibility study stage to the first issue of approved Technical Specifications
- 2008: stable for commercial implementation
- 2009: first public LTE service available (Stockholm and Oslo)
- 2010: LTE starts in Germany
- LTE is not 4G – sometimes called 3.9G
 - Does not fulfill all requirements for IMT advanced

May 2011, Berlin gets LTE

Netzabdeckung

Lassen Sie sich hier die UMTS-Netzabdeckung und die Verfügbarkeit unseres Datennetzes anzeigen. Wenn Sie eine Adresse eingeben, können Sie sich auch den Zuhause-Bereich anzeigen lassen, in dem Sie besonders günstig zu Festnetzbedingungen telefonieren.



Key LTE features



- Simplified network architecture compared to GSM/UMTS
 - Flat IP-based network replacing the GPRS core, optimized for the IP-Multimedia Subsystem (IMS), no more circuit switching
- Network should be in parts self-organizing
- Scheme for soft frequency reuse between cells
 - Inner part uses all subbands with less power
 - Outer part uses pre-served subbands with higher power
- Much higher data throughput supported by multiple antennas
- Much higher flexibility in terms of spectrum, bandwidth, data rates
- Much lower RTT – good for interactive traffic and gaming
- Smooth transition from W-CDMA/HSPA, TD-SCDMA and cdma2000 1x EV-DO – but completely different radio!
- Large step towards 4G – IMT advanced

High flexibility

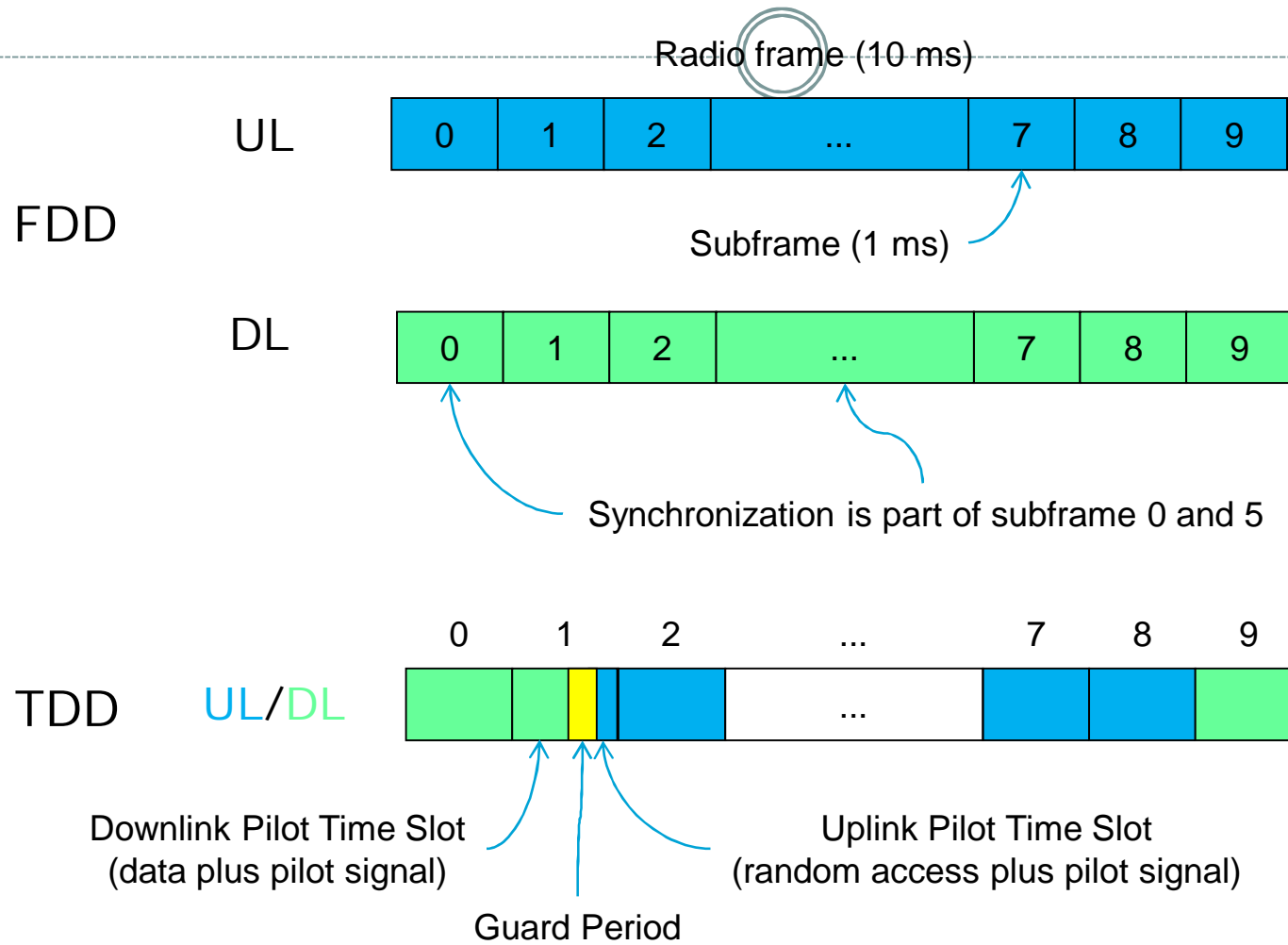


- E-UTRA (Evolved Universal Terrestrial Radio Access)
 - Operating bands 700-2700MHz
 - Channel bandwidth 1.4, 3, 5, 10, 15, or 20 MHz
 - TDD and FDD
- Modulation
 - QPSK, 16QAM, 64QAM
- Multiple Access
 - OFDMA (DL), SC-FDMA (UL)
- Peak data rates
 - 300 Mbit/s DL
 - 75 Mbit/s UL
 - Depends on UE category
- Cell radius
 - From <1km to 100km

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 ¹	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	699 MHz – 716 MHz	729 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 1: Band 6 is not applicable

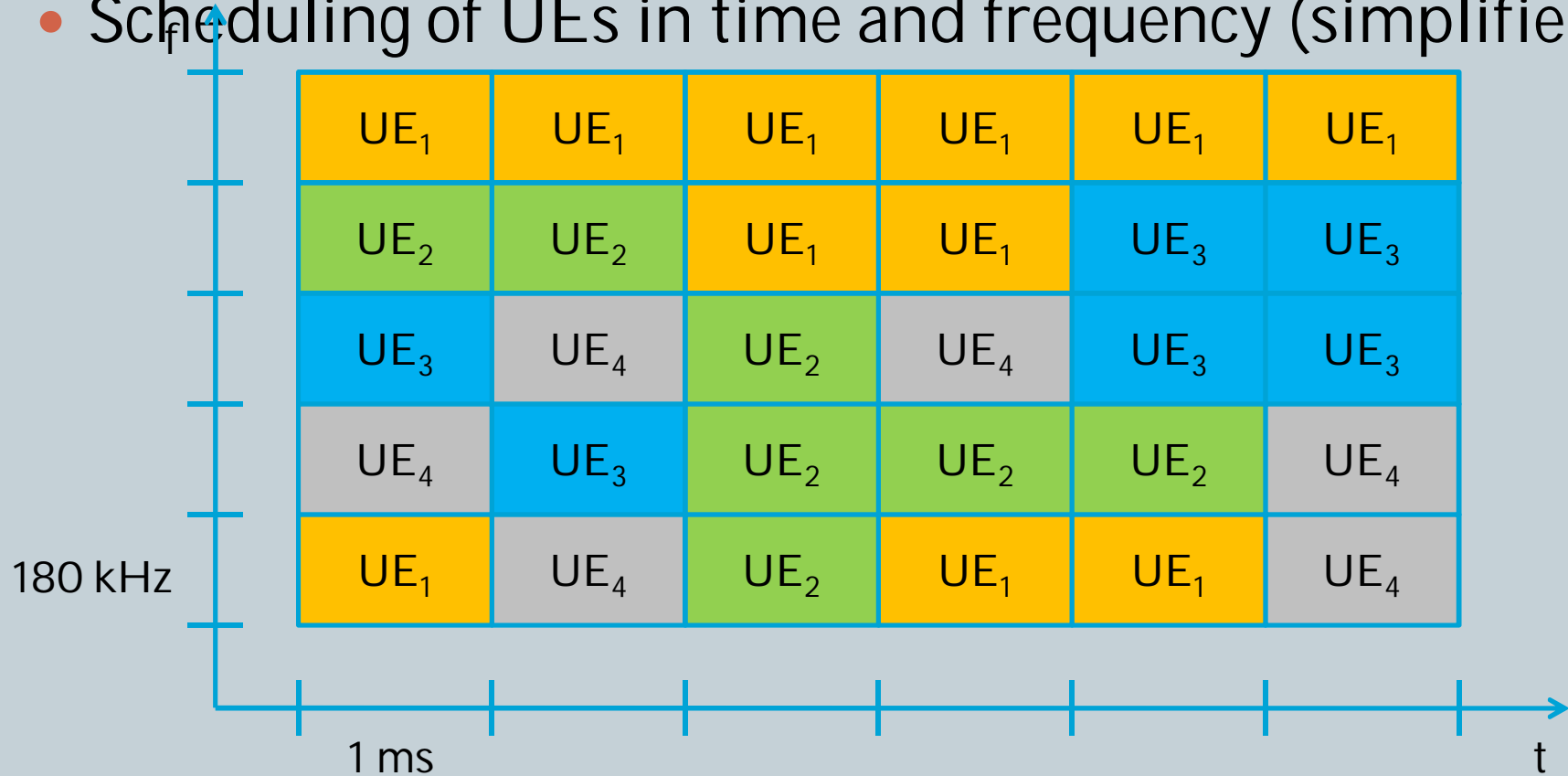
LTE frame structure



LTE multiple access



- Scheduling of UEs in time and frequency (simplified)

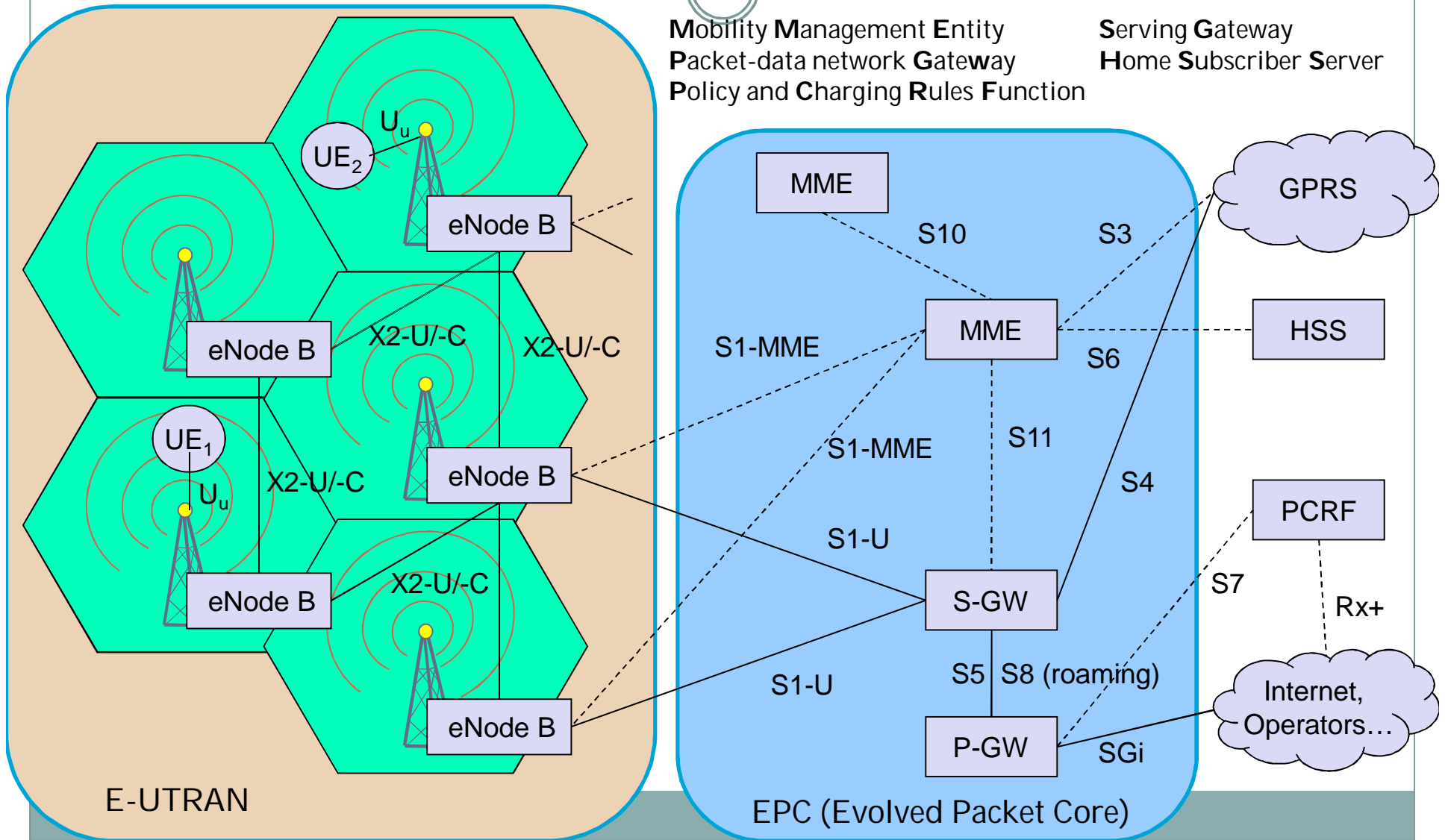


LTE architecture



Mobility **M**anagement **E**ntity
Packet-data network **G**ateway
Policy and **C**harging **R**ules **F**unction

Serving **G**ateway
Home **S**ubscriber **S**erver



IMT Advanced – from www.itu.int



- Key features of 'IMT-Advanced' a high degree of commonality of functionality worldwide while retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability; and,
- enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility were established as targets for research).
- These features enable IMT-Advanced to address evolving user needs and the capabilities of IMT-Advanced systems are being continuously enhanced in line with user trends and technology developments.



LTE advanced



- GSM – UMTS - LTE
 - LTE advanced as candidate for IMT-advanced
- Worldwide functionality & roaming
- Compatibility of services
- Interworking with other radio access systems
- Enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility)
- 3GPP will be contributing to the ITU-R towards the development of IMT-Advanced via its proposal for LTE-Advanced.
- Relay Nodes to increase coverage
- 100 MHz bandwidth (5x LTE with 20 MHz)