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IEEE

IEEE COMMUNICATIONS SOCIETY

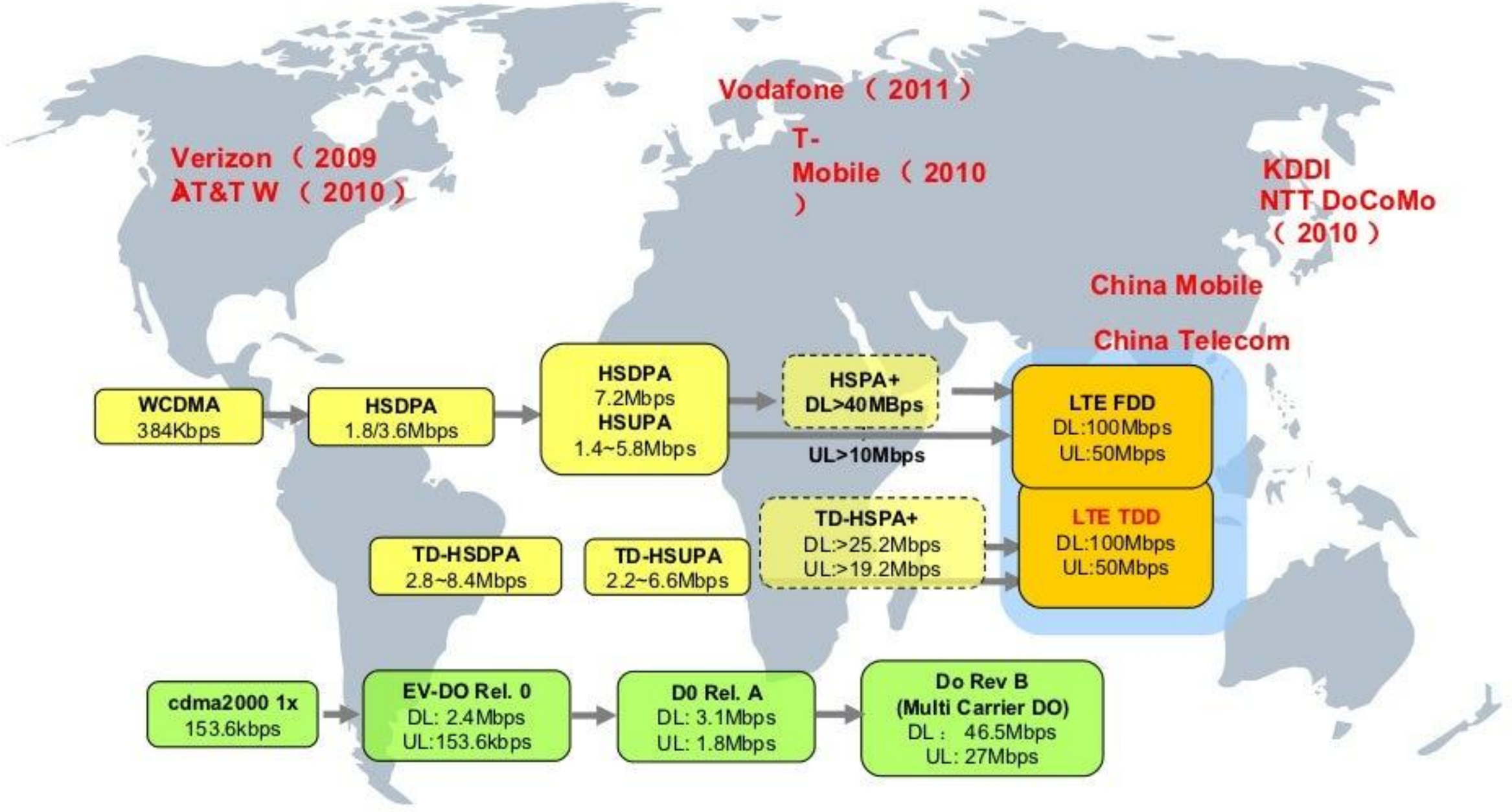
Main Topics

- Introduction
- Network Architecture
- System Architecture Evolution
- Channels
- Downlink Transmission Scheme
- Uplink Transmission Scheme
- MIMO
- LTE-Advanced
- Conclusion

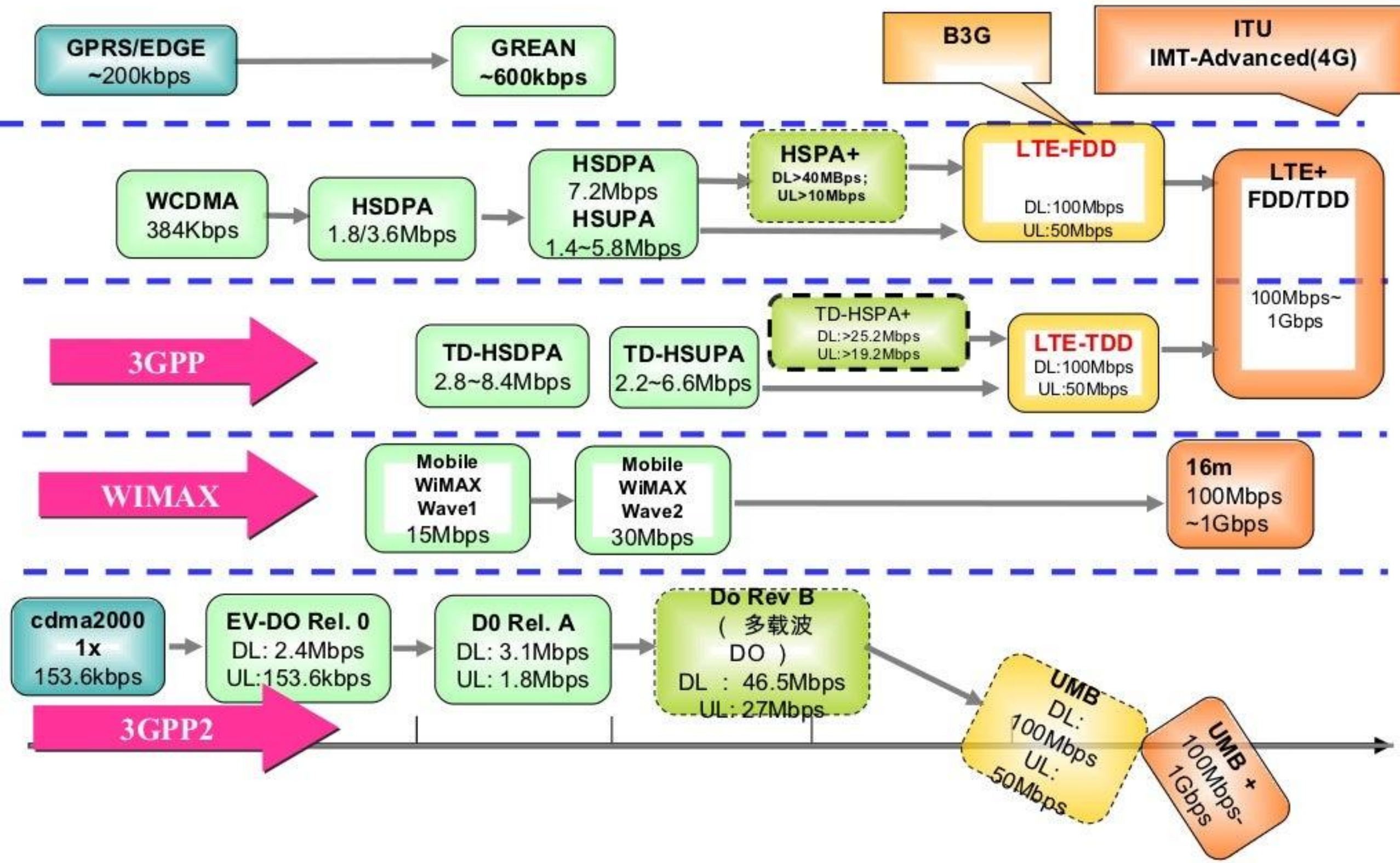
Introduction to LTE

- 3GPP Long Term Evolution - the next generation of wireless cellular technology beyond 3G
- Initiative taken by the 3rd Generation Partnership Project in 2004
- Introduced in Release 8 of 3GPP
- Mobile systems likely to be deployed by 2010

3G deployment in the world



Trend of B3G


GPRS/EDGE
~200kbps
GREAN
~600kbps
B3G
ITU
IMT-Advanced(4G)
WCDMA
384Kbps
HSDPA
1.8/3.6Mbps
HSDPA
7.2Mbps
HSUPA
1.4~5.8Mbps
HSPA+
DL>40MBps;
UL>10Mbps
LTE-FDD
DL:100Mbps
UL:50Mbps
LTE+
FDD/TDD
100Mbps~
1Gbps
3GPP
TD-HSDPA
2.8~8.4Mbps
TD-HSUPA
2.2~6.6Mbps
TD-HSPA+
DL:>25.2Mbps
UL:>19.2Mbps
LTE-TDD
DL:100Mbps
UL:50Mbps
WIMAX
Mobile
WiMAX
Wave1
15Mbps
Mobile
WiMAX
Wave2
30Mbps
16m
100Mbps
~1Gbps
cdma2000
1x
153.6kbps
EV-DO Rel. 0
DL: 2.4Mbps
UL:153.6kbps
D0 Rel. A
DL: 3.1Mbps
UL: 1.8Mbps
Do Rev B
（ 多载波
DO ）
DL ： 46.5Mbps
UL: 27Mbps
3GPP2
UMB
DL:
100Mbps
UL:
50Mbps
UMB +
100Mbps~
1Gbps

4G Technologies

Mobile WiMAX

Rel 1.0 802.16e-2005 | Rel 1.5 802.16e-2005 | Rel 2.0 802.16m

IP E2E Network

3GPP

HSPA Rel-6 | HSPA+ Rel-7 &Rel-8

CKT Switched Network

LTE & LTE Advanced

IP E2E Network

IMT-Advanced

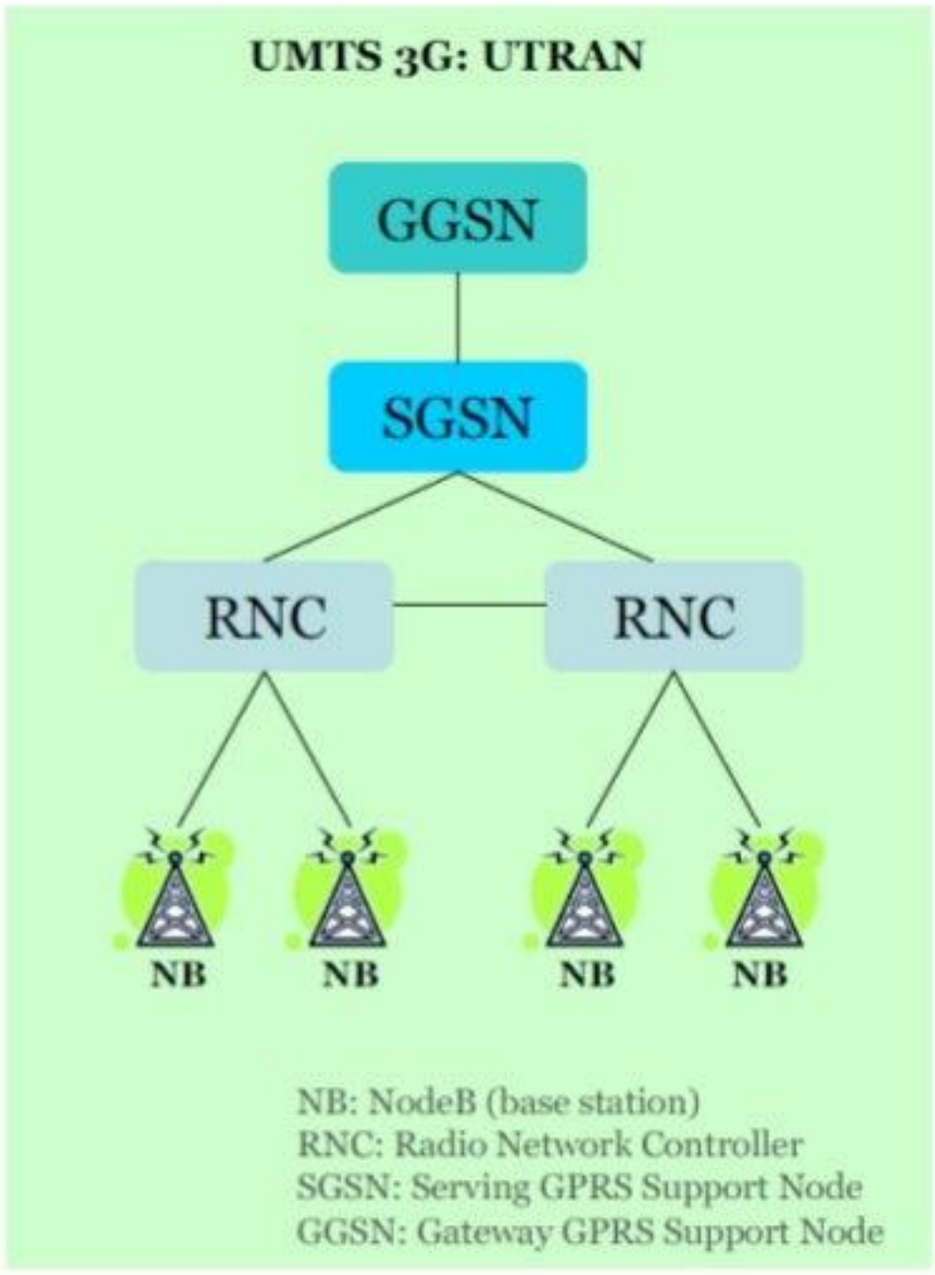
2008	2009	2010	2011	2012

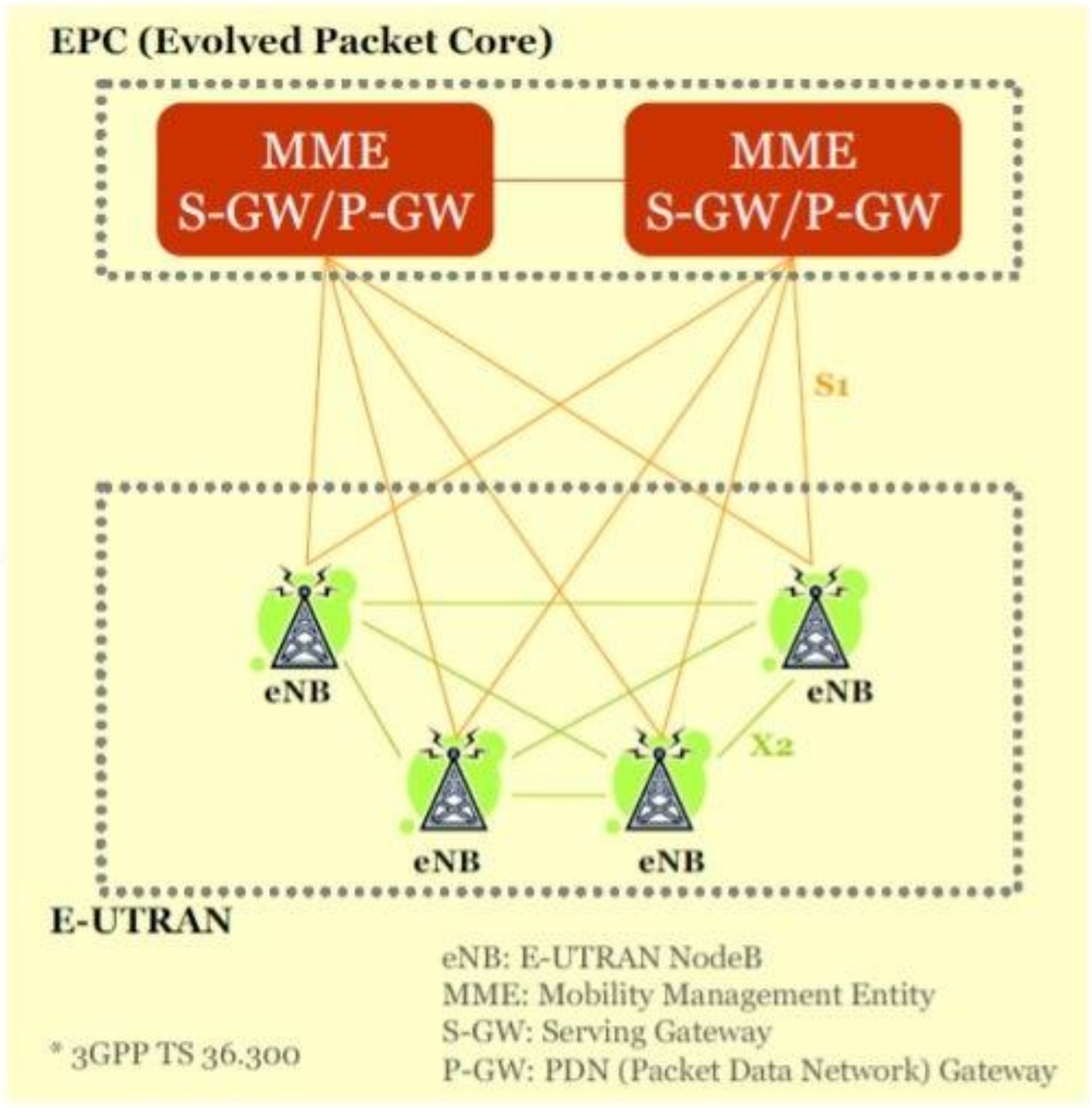
CDMA - Based

OFDMA - Based

LTE Network Architecture

- E-UTRAN (Evolved Universal Terrestrial Radio Access Network)





LTE Will Ensure the Success of Mobile Internet

Meeting Higher Demand for Data Speed

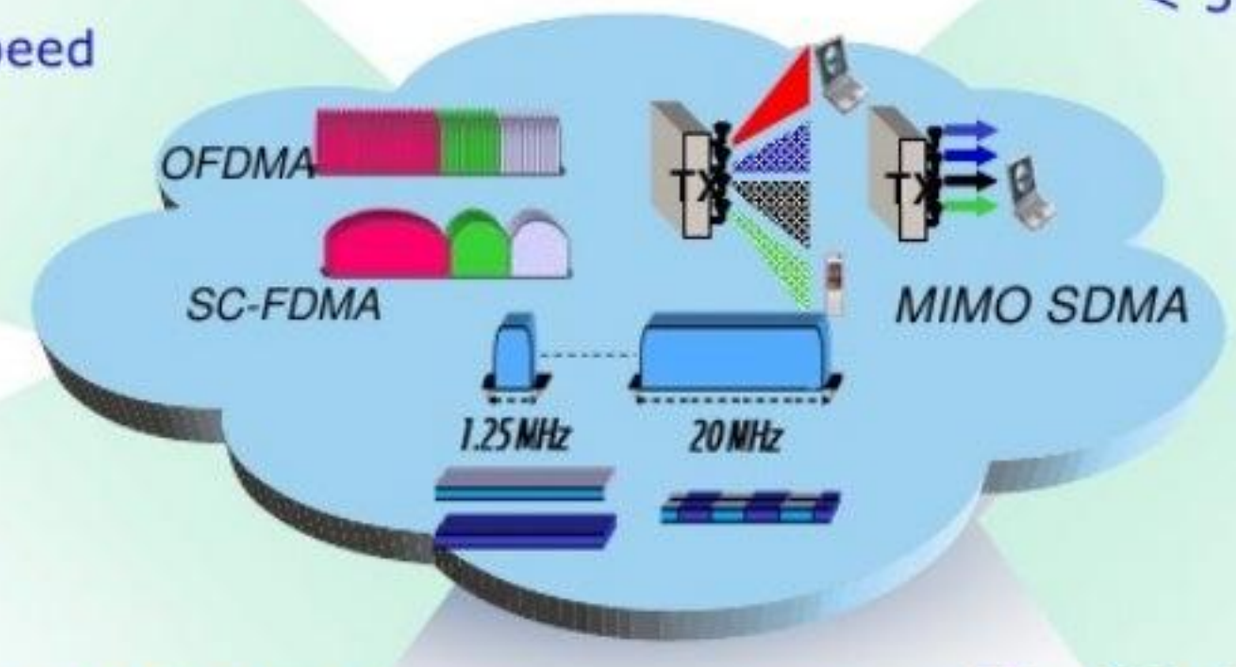
-Peak Data Rate: Downlink > 100Mbps / Uplink > 50Mbps

-Newest Standard Peak Downlink: 326Mbps /Uplink: 86Mbps

-Increased Data Speed at Cell Edge

Lowering Packet Delay

- Wireless User Data Packet Delay < 10 ms
- Control Plane Wake-up Delay < 50 ms



Increasing Spectral Efficiency

- Is 2 – 4 Times of 3GPP release 6 HSPA

Flexible Spectrum Allocation

- Can Be Deployed on Different Band Sizes
- Can Support Both FDD or TDD

LTE Offers 10-30x Improvement on cost/performance ratio vs. existing technologies

Significant improvement of spectral efficiency and higher bearing data rate with shorter latency

Irresistible attraction on value to mobile internet users at premium pricing

User Experience

Peak rate > 50 Mbps + Mean data rate per user > 10 Mbps + E2E latency < 30ms + Always on connection and Full mobility + Diversity of mobile devices

Same level Flat Data Charging Rate for Mobile internet access + Incremental ARPU from Mobile Internet Service

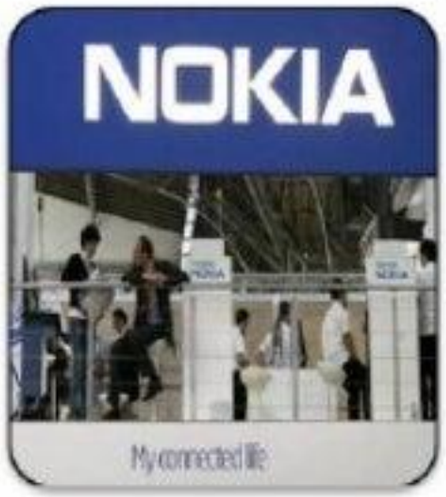
= **LTE significant improvement on cost/performance make new Mobile internet business model feasible**

Business Model

LTE - The Right Solution for Mobile internet

Issues	LTE Offers
Always On	▪ Multi-connection radio ▪ Ad Hoc networking ▪ Large-scale mobile IP access
Bursty Traffic	
QoS Cost / MB	▪ All-IP distributed network architecture ▪ Distributed radio architecture ▪ P2P cloud based core network design ▪ Macro-MIMO collaborative basestation technology
CAPEX & OPEX	

What's Happening in Mobile Internet World --Device Providers



To Be a digital content & service provider

- Purchased the global leading mobile ad company--Enpocket in Sept. 2007
- Purchased digital map giant--Navteq in Oct. 2007
- Carried out OVI program in 4th Quarter 2007, providing comprehensive services to subscribers

Terminal innovation & Totally new business model

- Launched iTunes digital music channel in 2003
- First iPhone become available in 2007
- 3G version iPhone is ready to market in 2008

LTE Key Parameters

Frequency Range	UMTS FDD bands and UMTS TDD bands					
Channel bandwidth, 1 Resource Block=180 kHz	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
	6 Resource Blocks	15 Resource Blocks	25 Resource Blocks	50 Resource Blocks	75 Resource Blocks	100 Resource Blocks
Modulation Schemes	**Downlink:** QPSK, 16QAM, 64QAM **Uplink:** QPSK, 16QAM, 64QAM (optional for handset)					
Multiple Access	**Downlink:** OFDMA (Orthogonal Frequency Division Multiple Access) **Uplink:** SC-FDMA (Single Carrier Frequency Division Multiple Access)					
MIMO technology	**Downlink:** Wide choice of MIMO configuration options for transmit diversity, spatial multiplexing, and cyclic delay diversity (max. 4 antennas at base station and handset) **Uplink:** Multi user collaborative MIMO					
Peak Data Rate	**Downlink:** 150 Mbps (UE category 4, 2x2 MIMO, 20 MHz) 300 Mbps (UE category 5, 4x4 MIMO, 20 MHz) **Uplink:** 75 Mbps (20 MHz)					

Modulation

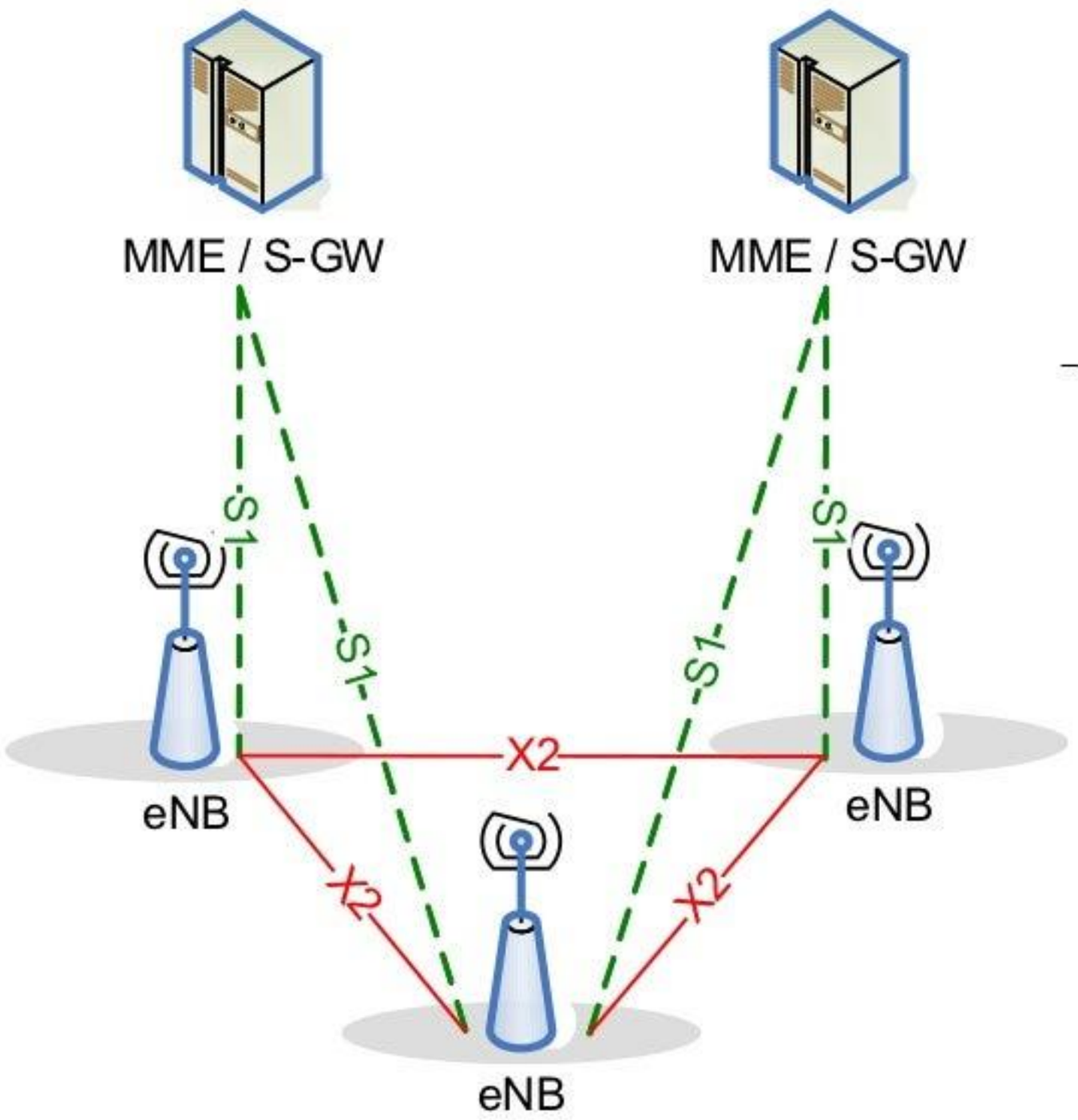
- QPSK, 16 QAM and 64 QAM used for the payload channels (spectrally efficient)
- BPSK and QPSK used for the control channels (Reliability and coverage)
- Adaptive modulation and coding

Requirements to be met by LTE
Fast, Efficient, Cheap, Simple

- Peak Data Rates
- Spectrum efficiency
- Reduced Latency
- Mobility
- Spectrum flexibility
- Coverage
- Low complexity and cost
- Interoperability
- Simple packet-oriented E-UTRAN architecture

Simplified LTE network elements and interfaces

3GPP TS 36.300 Figure 4: Overall Architecture



eNB = **E-UTRAN Node B**
All radio interface-related functions

MME = **Mobile Management entity**
– Manages mobility, UE identity, and security parameters.

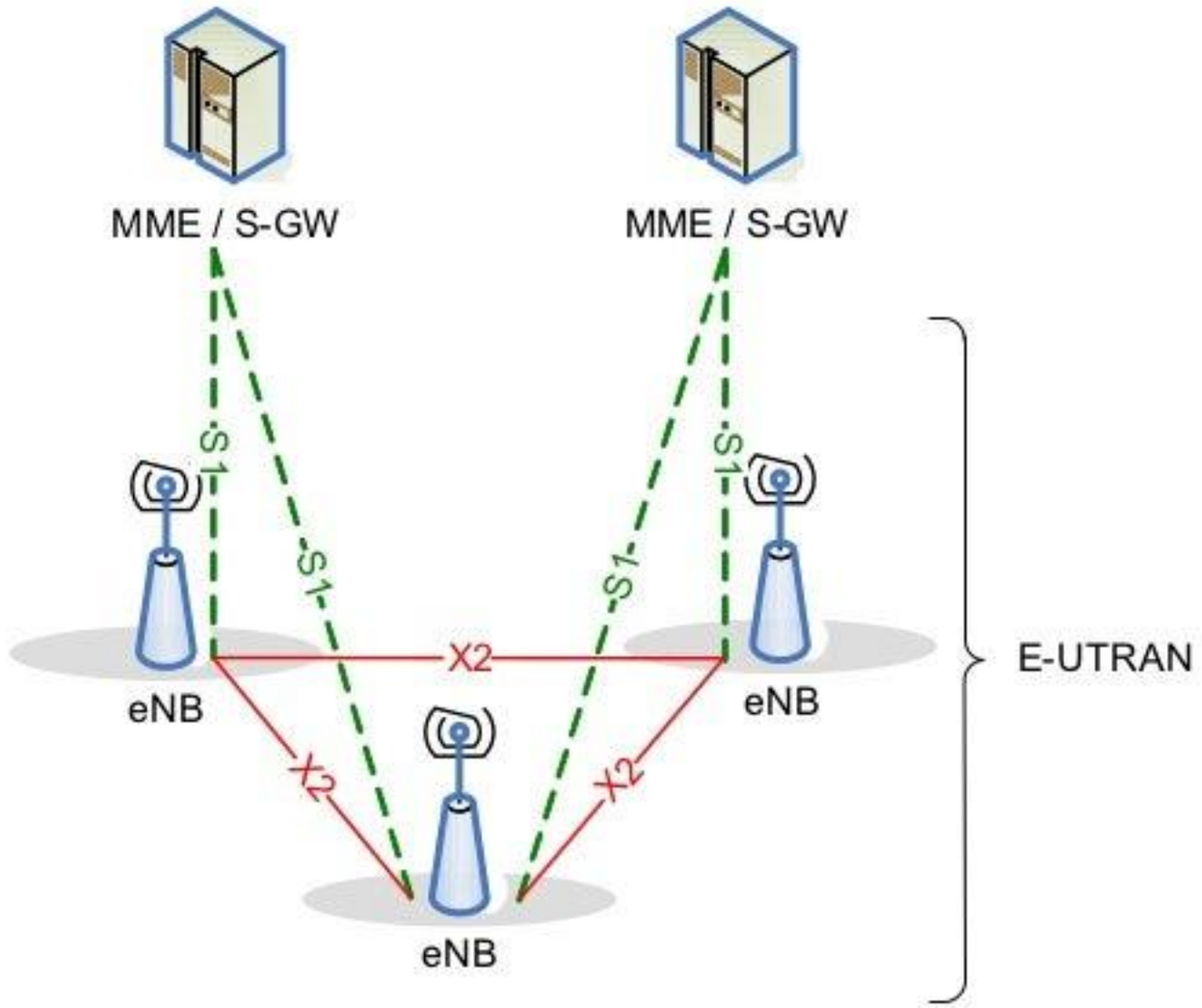
S-GW = **Serving Gateway**
– Node that terminates the interface towards E-UTRAN.

P-GW = PDN (Packet Data Network) Gateway
– Node that terminates the interface towards PDN.

E-UTRAN

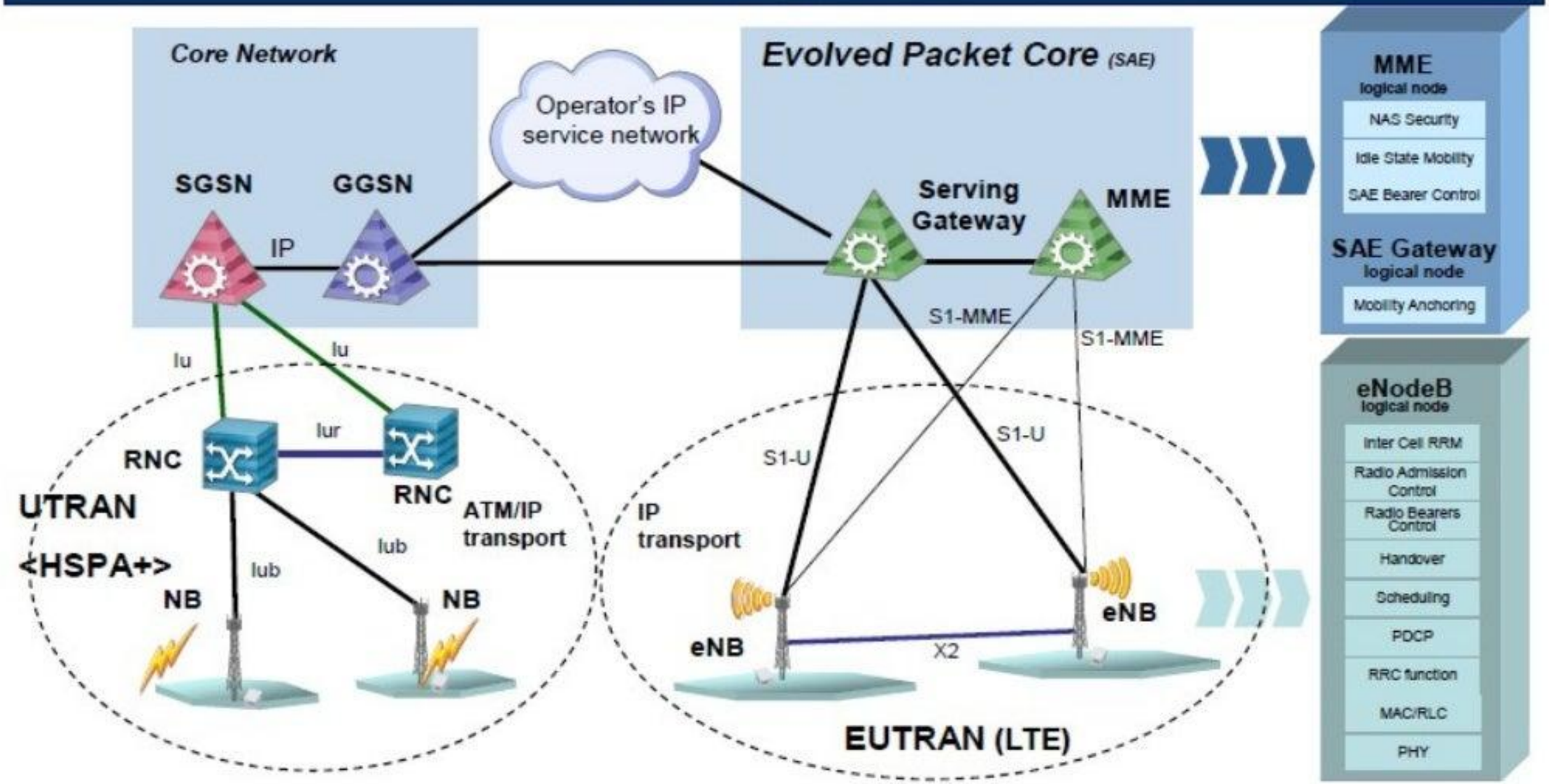
LTE Network Architecture

- Simple Architecture
- Flat IP-Based Architecture
- Reduction in latency and cost
- Split between EPC and E-UTRAN
- Compatibility with 3GPP and non-3GPP technologies
- eNB-radio interface-related functions
- MME-manages mobility, UE identity and security parameters
- S-GW-node that terminates the interface towards E-UTRAN



•EPC = Evolved Packet Core
•E-UTRAN = Evolved Universal Radio Access Network
•MME = Mobile Management entity
•S-GW = Serving Gateway
•SAE = System Architecture Evolution
•eNB = E-UTRAN Node B

One RAN node: eNB



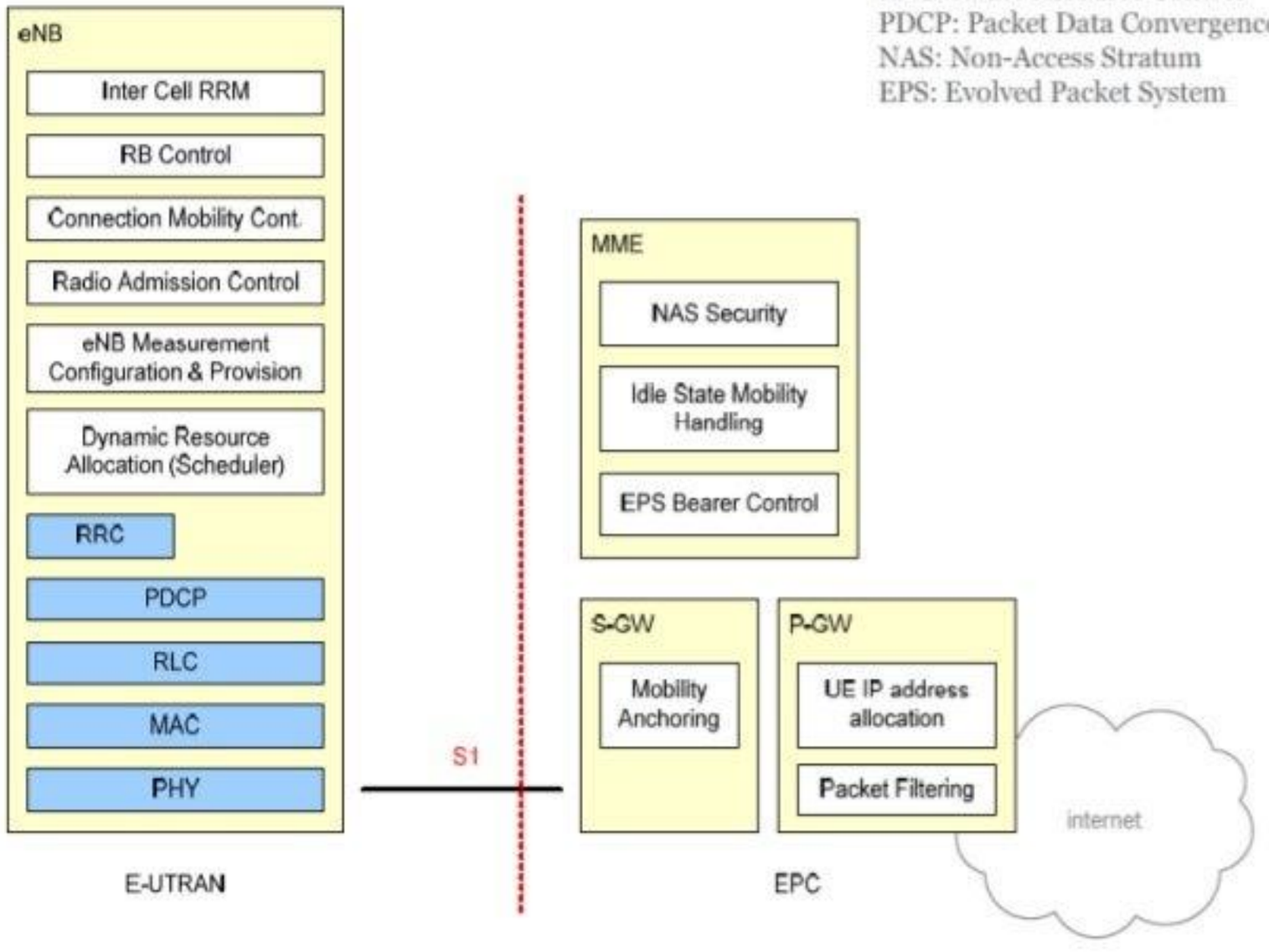
PDCP = Packet Data Convergence Protocol

RRC = Radio Resource Control

RLC = Radio Link Control

Protocol

RRM: Radio Resource Management
RB: Radio Bearer
RRC: Radio Resource Control
PDCP: Packet Data Convergence Protocol
NAS: Non-Access Stratum
EPS: Evolved Packet System



System Architecture Evolution

- SAE is a study within 3GPP targeting at the evolution of the overall system architecture.
- Objective is “to develop a framework for an evolution or migration of the 3GPP system to a higher-data-rate, lower-latency, packet optimized system that supports multiple radio access technologies.
- The focus of this work is on the PS domain with the assumption that voice services are supported in this domain". This study includes the vision of an all-IP network.

Why LTE/SAE?

- Packet Switched data is becoming more and more dominant
- VoIP is the most efficient method to transfer voice data

→ Need for PS optimised system

- Amount of data is continuously growing

→ Need for higher data rates at lower cost

- Users demand better quality to accept new services

→ High quality needs to be quaranteed

> Alternative solution for non-3GPP technologies (WiMAX) needed

- LTE will enhance the system to satisfy these requirements.