LTE Advanced and the evolving telecom business models

ITU/BDT Arab Regional Forum for ARAB Region on "IMT Systems Technology, Evolution and Implementation

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Summary

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A. Evolving business models

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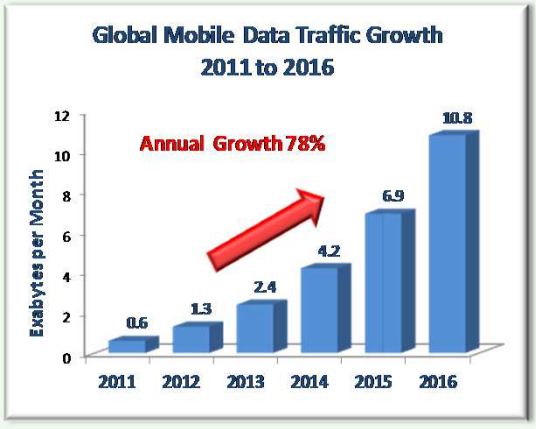
Mobile Data Tsunami

- Global growth of mobile data traffic: **18 times** from 2011 to 2016
- ***AT&T network***:
  - Over the past five years, wireless data traffic has grown **20,000%**
  - At least **doubling** every year since 2007
- Existing cellular technologies are **inadequate**
  - **Fundamental redesign of cellular networks** is needed

Japan's NTT DoCoMo predicts **12x** network traffic growth in the next 3 years.
Telefonica forecasts a requirement for up to **50x** capacity growth in cities (improved spectral efficiency of 3G/4G will only satisfy up to **8x**).



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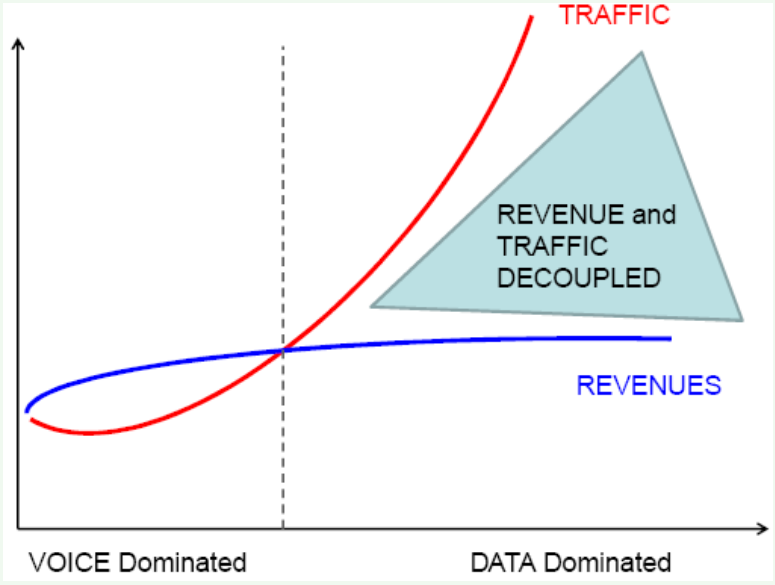
Source: CISCO Visual Networking Index (VNI) Global Mobil Data Traffic Forecast 2011 to 2016

Traffic and revenues decoupled



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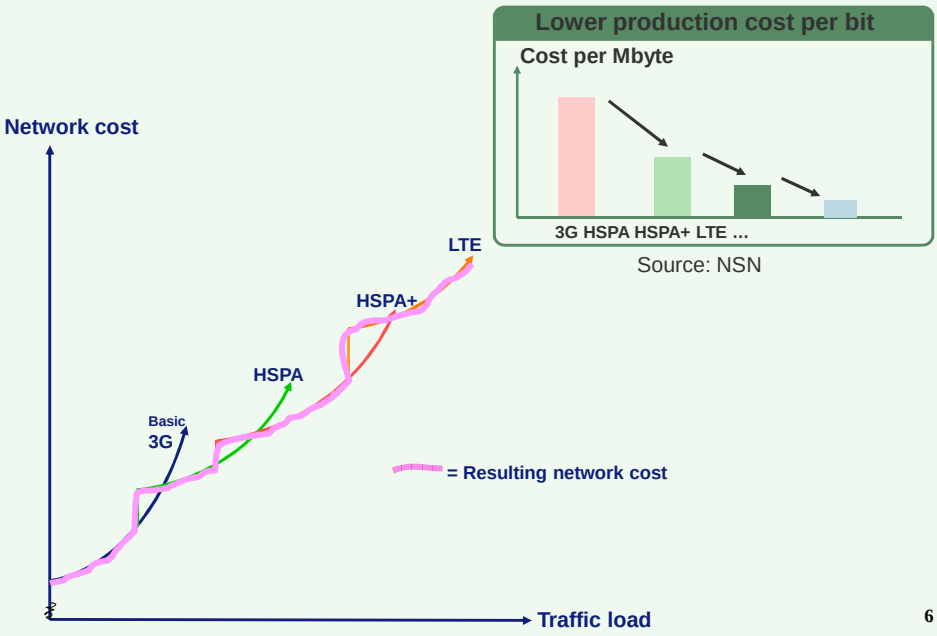
4G motivations



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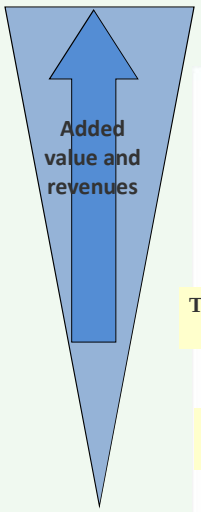
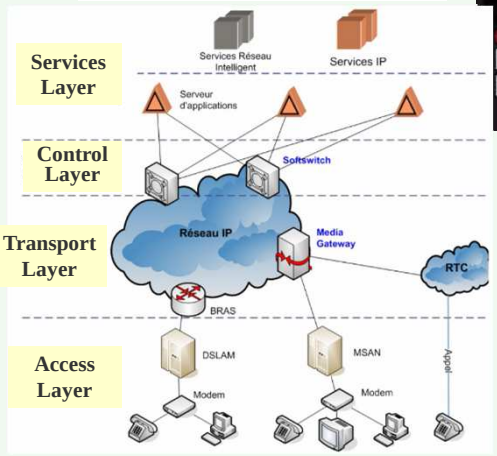
Business models changes

Revenues are taken by OTT players



Google amazon



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Current trends: OTT services migration

KPN (May 2011): first mobile operator to report that subscriber use of OTT voice and messaging applications – in particular, *WhatsApp* –caused a **decline in voice and messaging traffic and revenues**.
"***KPN effect***" was confined to KPN's "***Hi***" brand: 85 % subscribers were using WhatsApp ➔ Decline of 24 % in outgoing SMS traffic by 3Q 2011.

OTT players offering messaging:

KakaoTalk TALK

WhatsApp

BlackBerry RIM

Viber

iM

mxit JOIN THE EVOLUTION

Media-Line software services

***WhatsApp* daily traffic in** August 2012 reached a record of **10 billion messages.**

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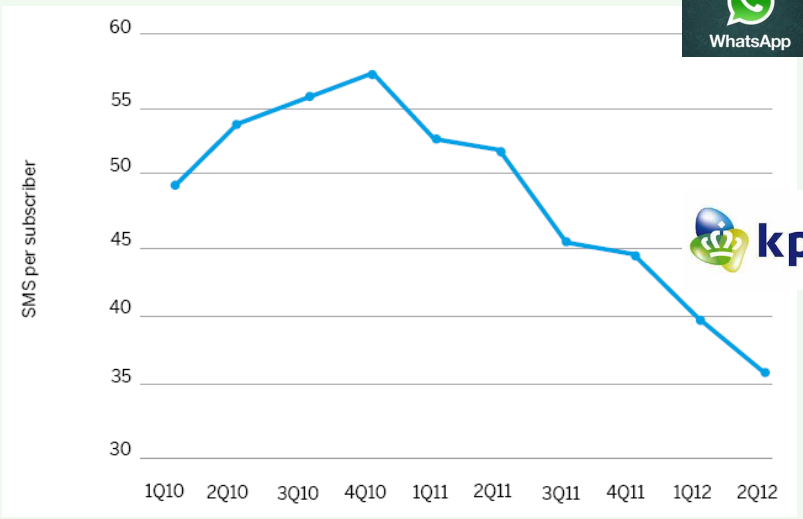
KPN Mobile SMS / subscriber decline



Source: KPN

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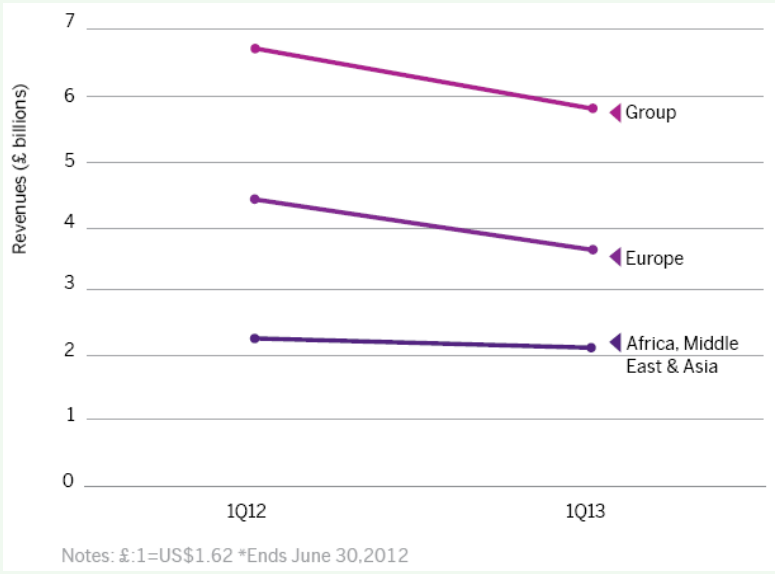
Vodafone Group, messaging revenues



Source: Vodafone.

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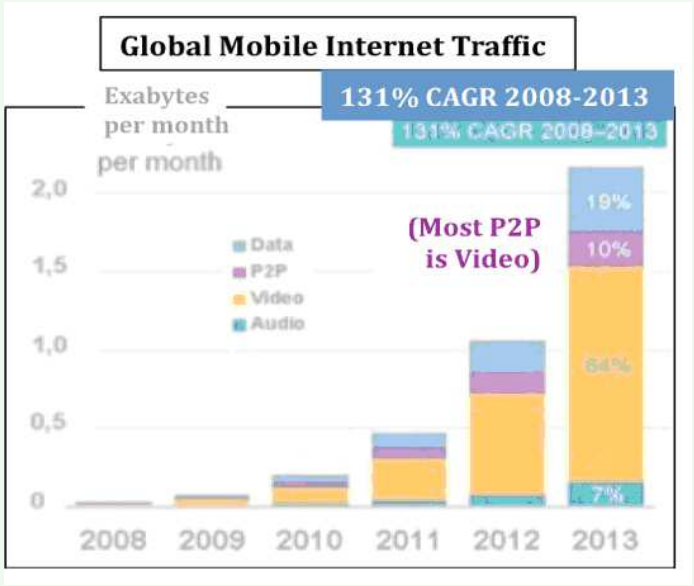
Mobile video

More than 50% of the mobile traffic and more 70% in some networks (85% of Voda Germany LTE traffic in 09/2012)



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Average mobile user, traffic per month

Nielsen: 78% of all smartphone data in UK is over WiFi (01/2013)

www.slideshare.net/CiscoSP360/cisco-visual-networking-index-vni-global-mobile-data-traffic-forecast-20112016

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Challenges of the "classical" stakeholders (vendors, operators, …)

- 4G infrastructure investments are expected to **exceed** those in 3G from 2013
- **4G Network sharing** will emerge as a strong differentiator to historic 3G deployment, less because of costs, but more to enable much **faster geographical coverage and enough spectrum**
- **Tele2 / Telenor** (Sweden): JV to ***share RANs and spectrum*** (900+2100 Mhz) ➔ MVNO's on the jointly owned network.
- **Orange Spain** CTO calls for active LTE network sharing.

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LTE Wholesale Operators

- LTE wholesale operator business model: one party gets spectrum, build, owns and operates the LTE access network and leases bandwidth to LTE Virtual operators. QoS controlled by dynamic SLA's.
- LTE wholesale operator has no end customers of his own.
- *Examples*: **Lightsquared (US), YOTA (Russia):** MegaFon, MTS, Rostelecom and VimpelCom to provide high-speed mobile broadband services across 180 cities by 2014.

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From operator role to Service and Content enabler

- New core asset of operators is **no longer access provisioning** (SIM, socket, cable), **no longer the customer database with telephone number** (after number portability and multiple identities), but the **information set** made of:
  - Customer profiles and preferences
  - Usage intelligence
  - Performance intelligence
  - Contextual and eventually location information
  - Service focus on user needs and capabilities
  - Capability to add value to over-the-top applications

Information exploited and updated to the fullest in policy and quota servers , identity management , open application and network interfaces , performance analytics, and fast connect/disconnect applications.

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B. 4G technologies and LTE-A

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Needs for IMT-Advanced systems

- Need for **higher data rates** and greater spectral efficiency
- Need for a **Packet Switched only** optimized system
- Use of **licensed frequencies** to guarantee quality of services
- **Always-on experience** (reduce control plane latency significantly and reduce round trip delay)
- Need for **cheaper infrastructure**
- **Simplify architecture** of all network elements

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Impact on LTE characteristics

- Architecture (flat)
- Frequencies (flexibility)
- Bitrates (higher)
- Latencies (lower)
- Cooperation with other technologies (all 3GPP and non-3GPP)
- Network sharing (part or full)
- Full-IP (QoS issues, protocols integration, lower costs)
- OFDMA
- Broadcast services
- Intelligent radio schemes

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Evolution to LTE-A

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3GPP Releases: Evolution from UMTS to LTE-A

- **Release '99**
  - –The basis for early 3G deployment
- **Release 4**
  - –First steps towards IP-based operation
  - –Also defines the low chip rate TDD mode (TD-SCDMA)
- **Release 5**
  - –IMS - IP-based Multimedia Services
  - –HSDPA - High Speed Downlink Packet Access
- **Release 6**
  - –2nd phase of IMS
  - –High Speed Uplink
- **Release 7**
  - –Enhanced uplink
  - –Other spectrum
  - –Multiple input multiple output antennas (MIMO)
- **Release 8**
  - –Long Term Evolution (LTE) and System Architecture Evolution (SAE)
- **Release 9**
  - –Enhancement of Release 8 features
  - –Refinement of LTE
  - –Preliminary studies into LTE Advanced
- **Release 10**
  - –LTE Advanced

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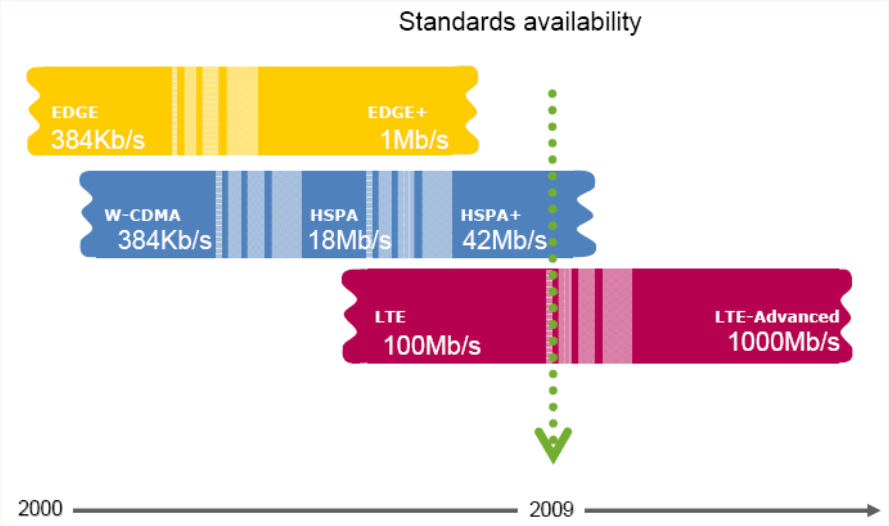
3GPP family standards evolution



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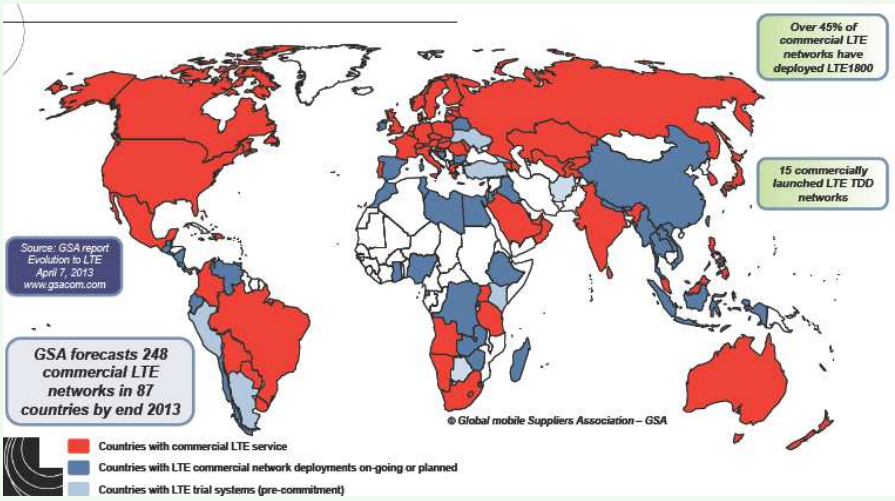
LTE networks in 2013



415 operators in 124 countries are investing in LTE

- 361 commercial LTE network commitments in 114 countries
- *54 pre-commitment trials in additional 10 countries*
- *163 commercially launched LTE networks in 67 countries*

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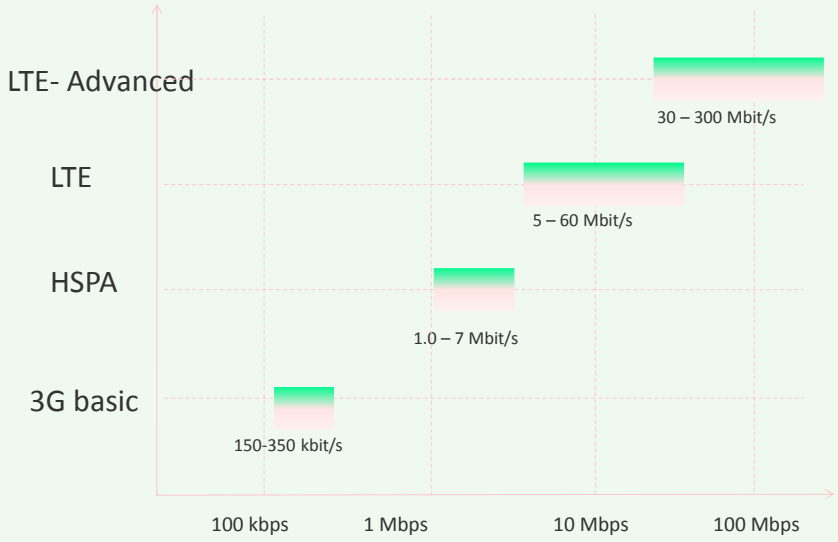
LTE and SAE and performance objectives

Practical **user** data rates



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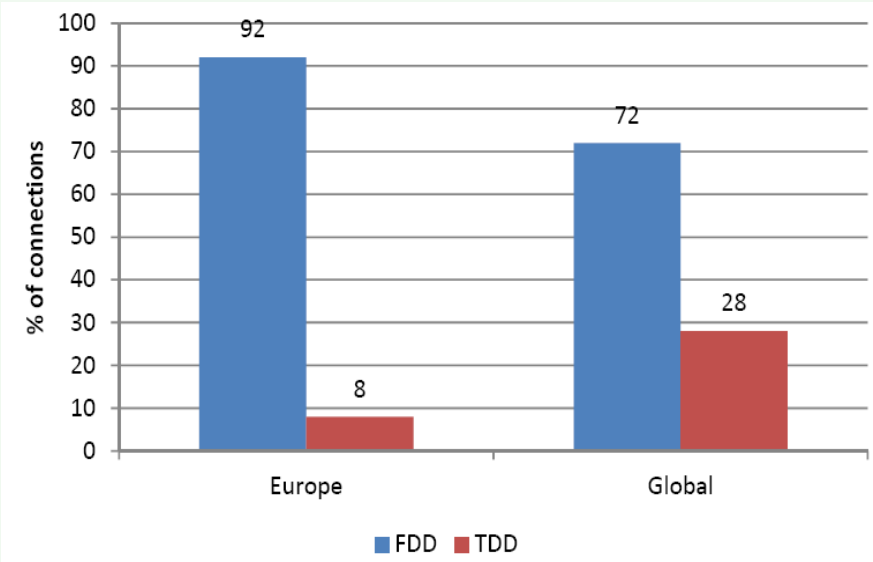
FDD/TDD support in Europe and Worldwide



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LTE Architecture to meet costs and flexibility challenges

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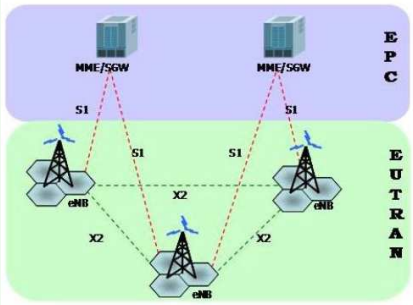
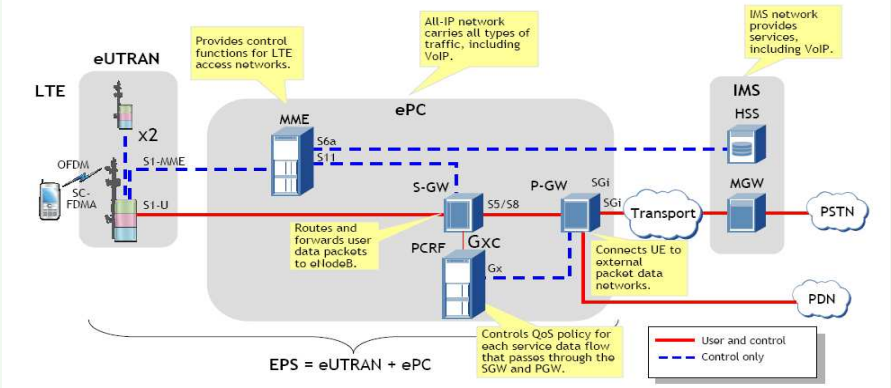
LTE architecture

- **EPC - Evolved Packet Core**
  - MME: Mobility Management Entity
  - S-GW: Serving Gateway
  - P-GW: Gateway for the Packet Data Network
- **E-UTRAN - Evolved UTRAN, known as LTE**
  - eNB - enhanced NodeB, base stations





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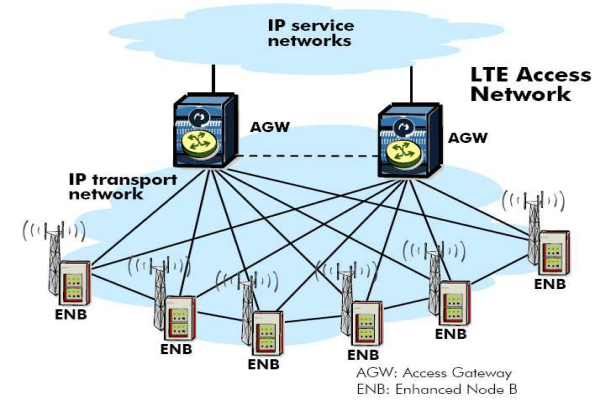
S1-Flex feature



- Allows:
  - Network redundancy,
  - Load sharing of traffic across network elements in the CN, the MME and the SGW,
- Creates **pools** of MMEs and SGWs,
- Each eNB connected to multiple MMEs and SGWs in a pool.

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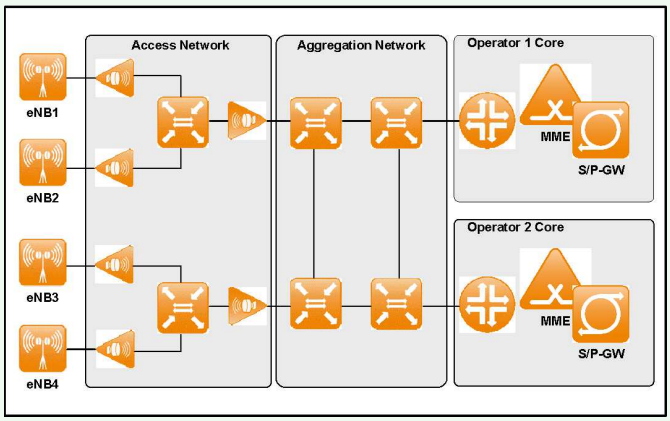
Multiple Operator Core Network



- **MOCN** → service providers can have **separate core networks** (MME, SGW, PDN GW) and **E-UTRAN (eNBs) jointly shared**.
- Enabled by the S1-flex mechanism (each eNB can be connected to multiple core networks entities).

Vodafone and Telefonica UK network sharing (O2: Northern Ireland, Scotland, East of England and North London. Vodafone: west of Englnd, South London and Wales. 18 500 sites locations shared.

LTE radio interface to meet traffic data volumes increase challenges

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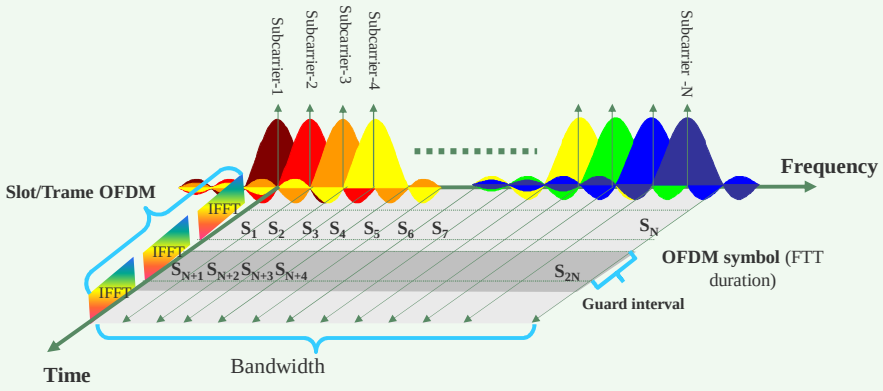
OFDM



Advantages of OFDM

- **Greater spectral efficiency for time dispersive channels**
- **Easy integration of MIMO**

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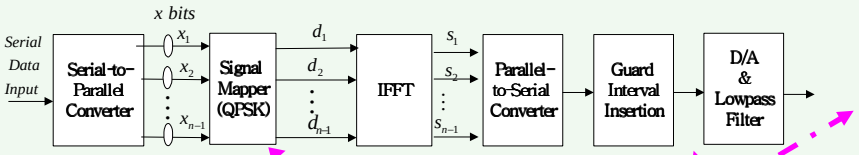
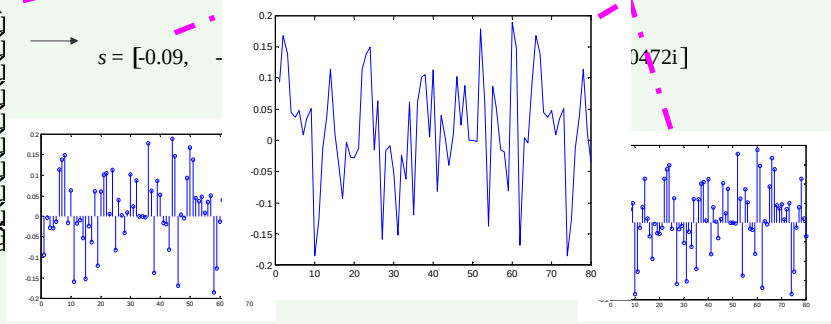
FFT-based OFDM System - OFDM Transmitter



$$d_i = \begin{bmatrix} 1 \\ i \\ M \\ 1 \\ 1 \end{bmatrix} \longrightarrow s = [-0.09, \; \ldots \; 0472i]$$



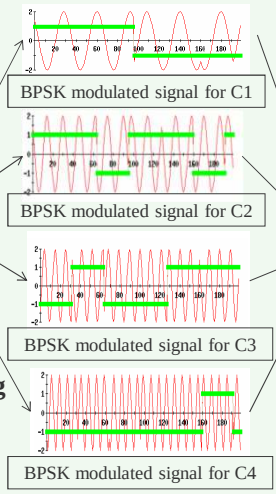
OFDM operation

Input data flow: **1, 1, -1, -1, 1, 1, 1, -1, 1, -1, -1, -1, -1, 1, -1, -1, …**

Serial to parallel

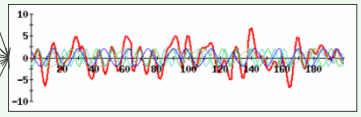
C1	1	1	1	-1
C2	1	1	-1	1
C3	-1	1	-1	-1
C4	-1	-1	-1	1

Mapping



IFFT

Final OFDM Signal = Sum of all signals



$$V(t) = \sum_{n=0}^{N-1} I_n(t) \sin(2\pi n t)$$

Inter-cell interference coordination (ICIC)

In Rel.-10 3GPP :

ICIC based on Carrier Aggregation: Also called ***spatial ICIC***. The macro layer uses only the PCC (*Primary Component Carriers*) frequency, while the pico layer schedules its UEs served in CRE mode on its PCC and its cell-center UEs on its SCC (*Secondary Component Carriers*), i.e. the macro layer's PCC.

Time Domain Multiplexing ICIC: Transmissions from eNodeBs causing severe interference to others (called *Almost Blank Subframes* (ABS)) are periodically muted for entire subframes, so that the victim eNodeBs have a chance to serve their UEs suffering from severe interference from the interfering eNodeB.

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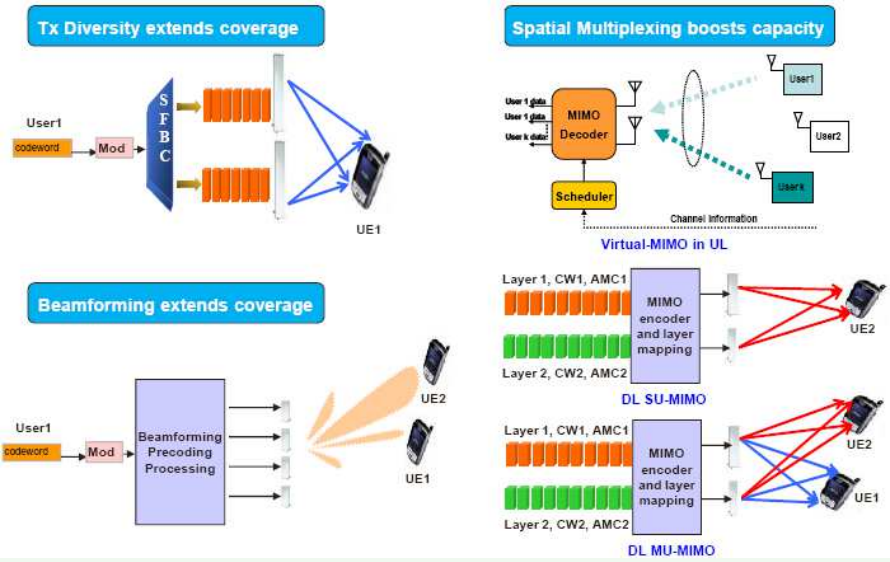
MIMO and Beamforming



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LTE Spectrum flexility to meet radio spectrum scarcity and bitrates challenges

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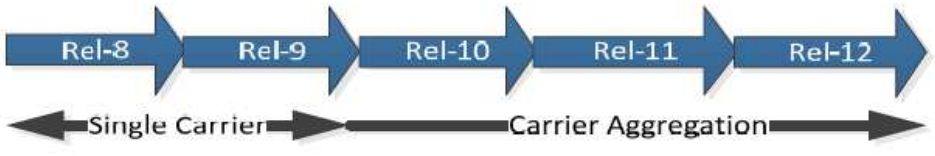
Carrier aggregation in LTE

Release-10 carrier aggregation supports the following features:

- Peak data rates of 1 Gbps on downlink and 500 Mbps on uplink.
- Up to **five carriers** ("*component carriers*") aggregated.
- Each component carrier can have any of the bandwidths supported in LTE Rel-8 (1.4, 3, 5, 10, 15 and 20 MHz). LTE carrier aggregation can support operation on transmission bandwidths of up to 100 MHz by aggregating five 20 MHz carriers.
- A carrier aggregation capable UE can simultaneously receive and transmit in one or multiple component carriers.



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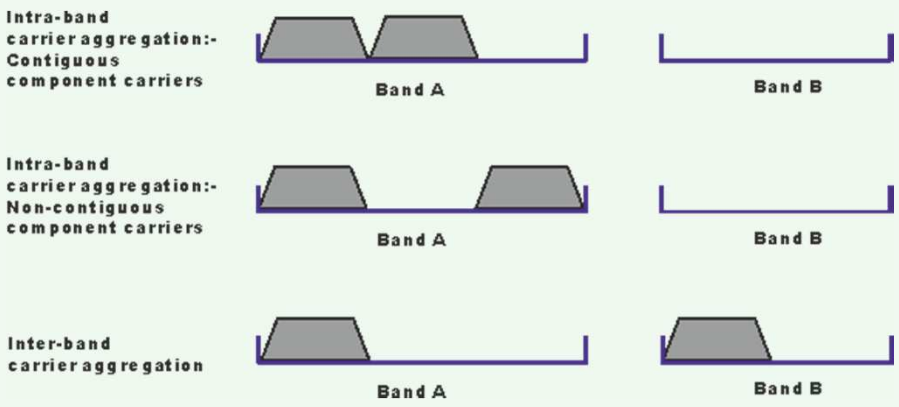
Types of LTE carrier aggregation



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Efficient spectrum usage

To get wider spectrum bandwidth up to 100MHz

- Aggregation of fragmented spectrums
- Sharing of fragmented spectrums among several systems
- Asymmetric UL and DL spectrum allocation

To attain another 'bit/Hz'

- SU-MIMO for UL (2x2 or 2x4)
- Further enhancement of the current MIMO scheme

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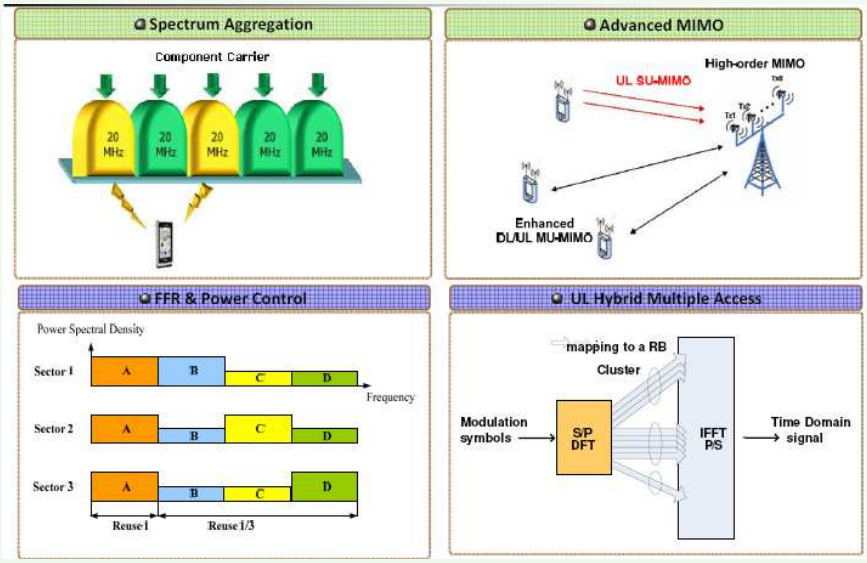
LTE-A improvements



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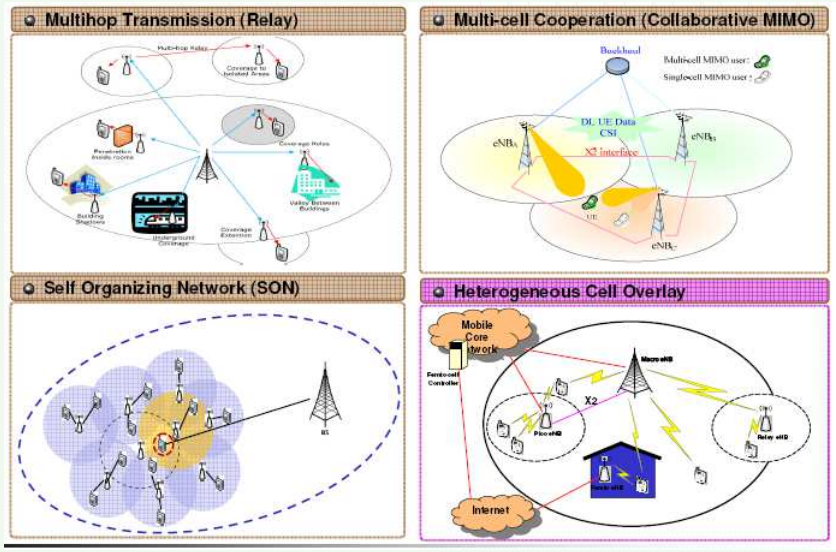
LTE-A improvements



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SAE nodes to meet QoS and revenue decrease challenges

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DPI (Deep Packet Inspection)

- DPI = HW and SW solution that:
  - Monitors a network's data stream,
  - Identifies protocols and applications, inappropriate URLs, intrusion attempts and malware
- DPI inspects, reassembles and decompresses incoming packets, analyzes the code and passes data to appropriate applications and services.
- If malicious URLs or code are detected, the system can block them entirely.
- DPI can also be used by service providers to offer subscribers **different levels of access** (such as type of usage, data limits or bandwidth level), comply with regulations, **prioritize traffic**, adjust loads and gather statistical information.
- **DPI can recognize applications as data passes through the system, allocating each the resources they need.**

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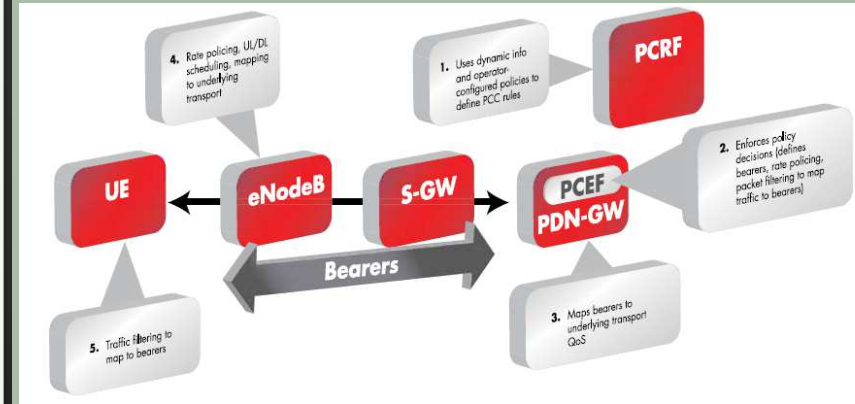
QoS management with the PCRF



Functional Elements in the 3GPP's Policy and Charging Control (PCC) Framework

Thank you for your attention

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