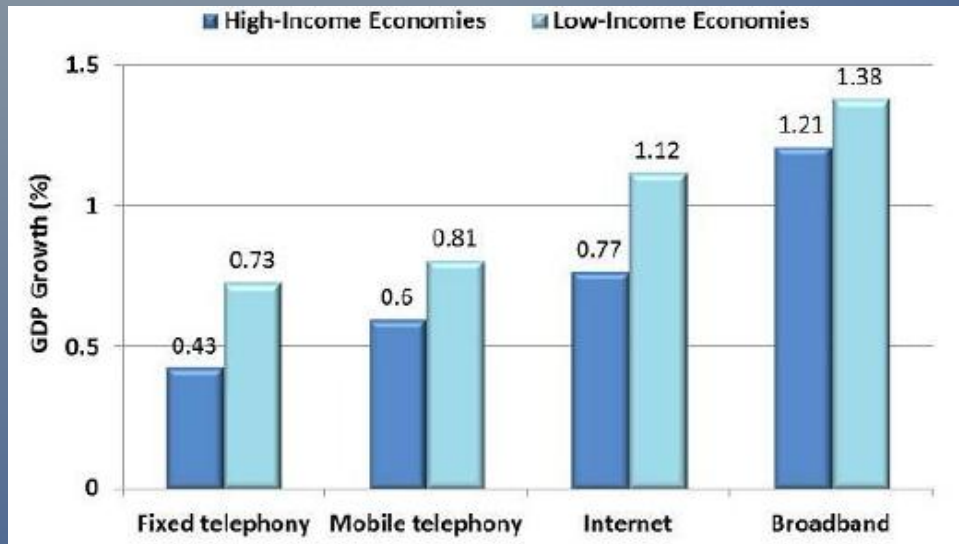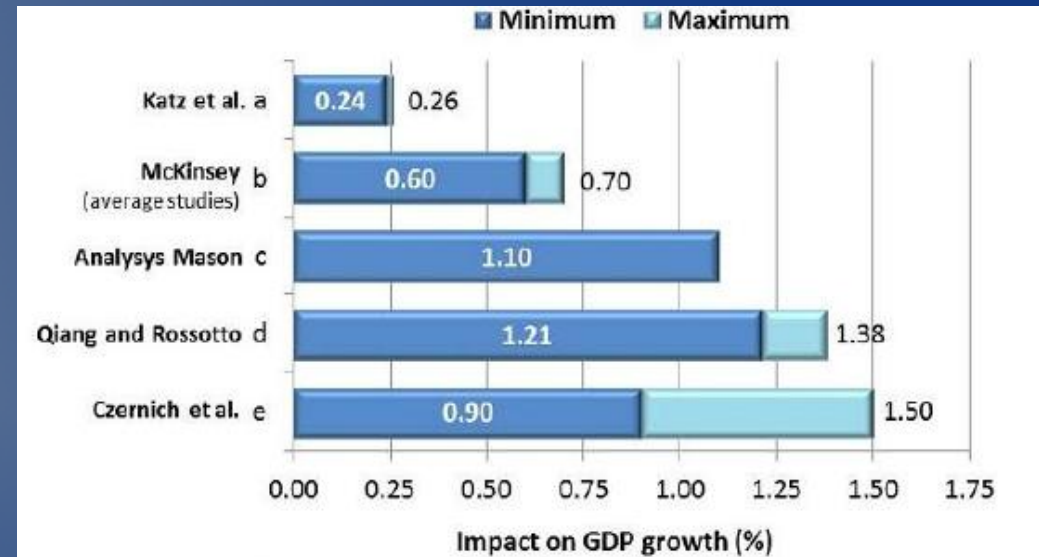# TIES410 "Future Internet"

Lecture Block I

Social and economical aspects of the mobile Internet

Source: World Bank Broadband Strategies Workbook

Source: Czernich et al, Qiang and Risotto,Analysys Mason, Beardsley et al, Katz et al.

Communication and wireless technologies promote job creation through three major channels:

- Direct jobs in the areas of installation, operation and maintenance of broadband infrastructure

- Indirect jobs in the manufacturing of materials and goods used in infrastructure deployment

- Jobs created as a result of external broadband network effects, such as the jobs created by the new applications and services industry as a result of the broadband infrastructure.

Overview

- Challenges and trends in wireless communication
- State-of-art in mobile broadband
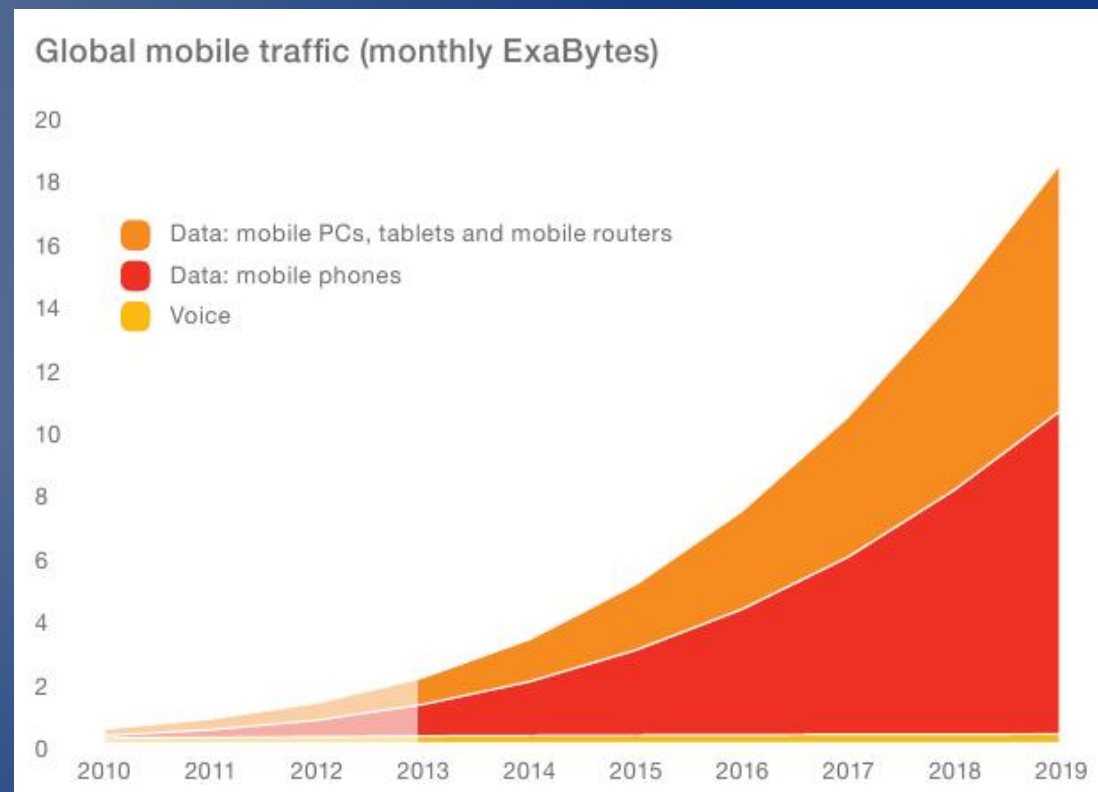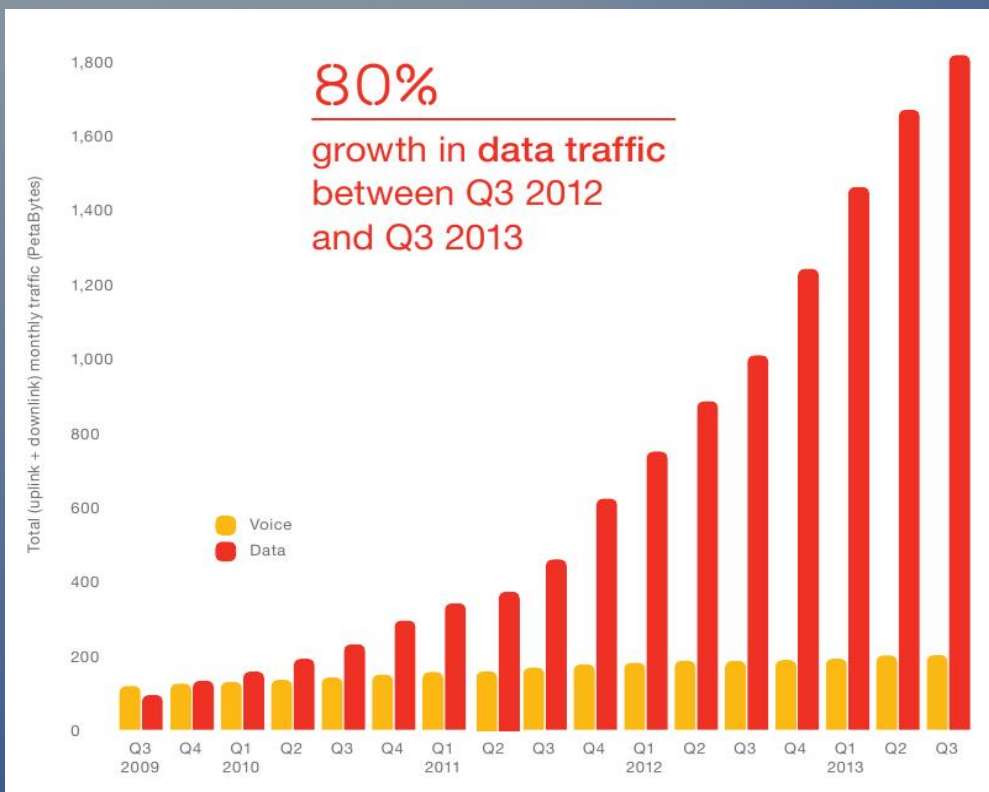- Development of wireless systems
- Mobile ecosystem

Challenges and trends

Biggest challenges

- Increased mobile data growth

- Increased customer demands

- "Always-on" connectivity and presence

- Flat-lining average revenue per user/unit (ARPU)

- Increased competition and new players

- Multi-layer/multi-RAT

Mobile data growth

- The amount of voice and data traffic varies a lot depending on region, market and operator.

- However, around 2011-2013 the amount of data traffic has exceeded voice

- The amount of data traffic has been increasing on average 10% every month is predicted to grow exponentially further

Mobile data growth per region

- Estimated mobile data growth per region (2013-2019)

  - North America   x7
  - Western Europe   x9
  - Central Europe and Middle East   x11
  - Latin America   x11
  - Asia Pacific   x11

Mobile data by device type & OS
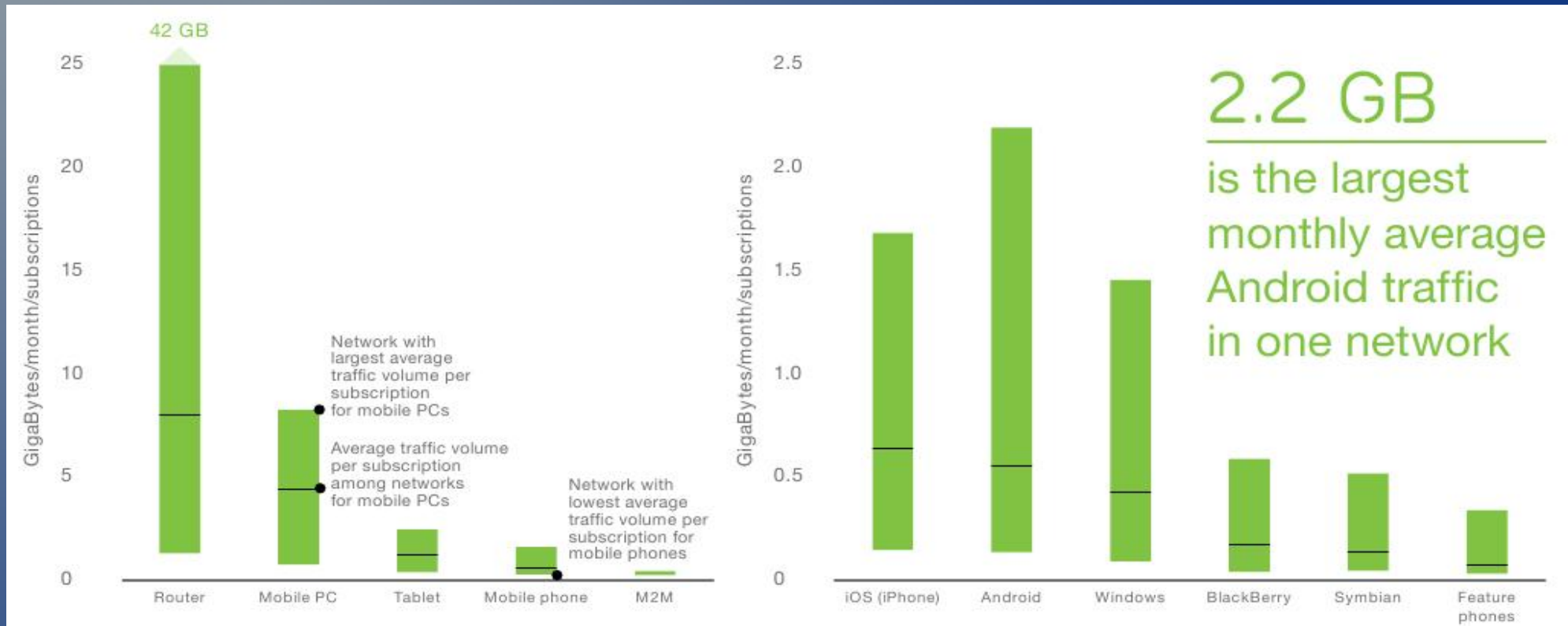
- The amount of data generated by mobile phones is noticeably less when compared to tablets, mobile PCs, and routers

- At the same time, since the number of mobile subscriptions is much larger, they create a much larger impact to the network load

DoCoMo and KDDI to enable mobile video on TV
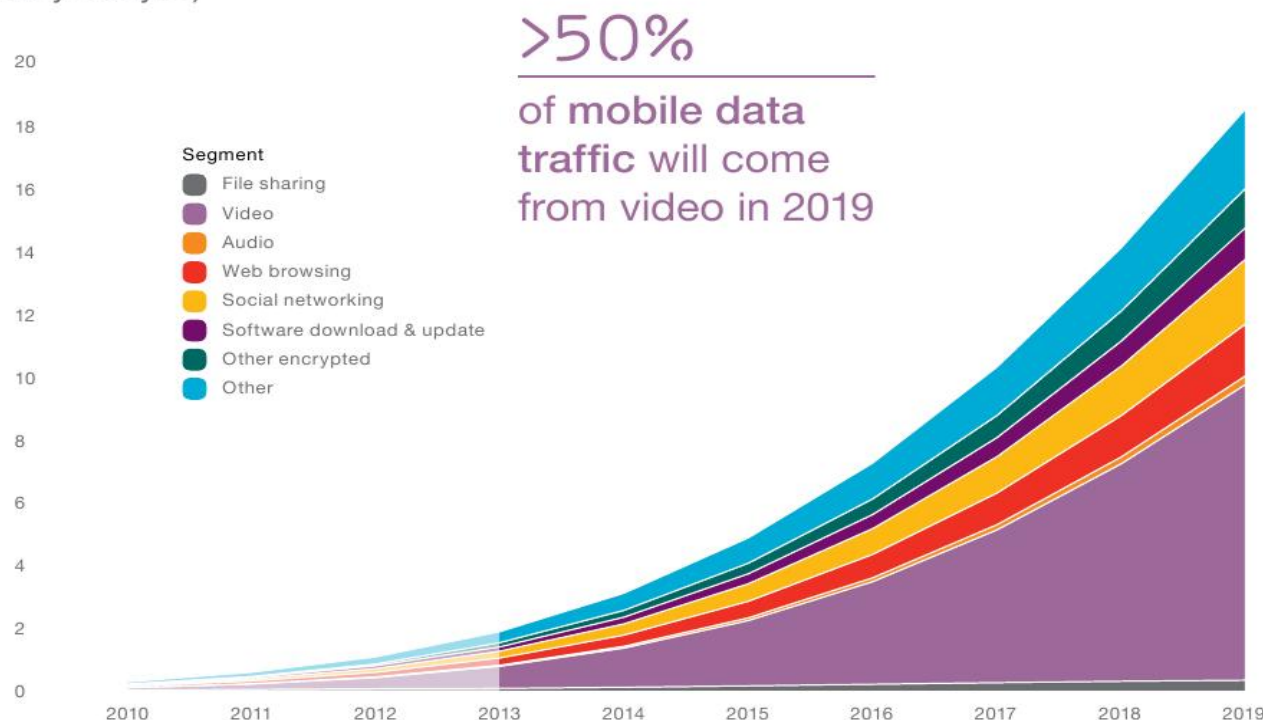
Source: Telegeography

8 Jan 2013

The Japanese wireless operators NTT DoCoMo and KDDI have both unveiled new services which will allow subscribers to their respective mobile TV services to watch video and listen to music on conventional TV sets. Both firms plan to introduce a dongle which will enable wireless streaming from a smartphone to a TV via the home Wi-Fi network.

(partially omitted)

Separately, DoCoMo has also revealed plans to introduce a new dual-screen smartphone device from April, which will run on Android and feature two individual four-inch screens which can be viewed separately for multi-tasking applications or combined into a single six-inch display. The new device will be manufactured by NEC Casio Mobile Communications, The Nikkei writes.

Insight on mobile data

Mobile data traffic by application type (monthly ExaBytes)

>50% of mobile data traffic will come from video in 2019

Segment
- File sharing
- Video
- Audio
- Web browsing
- Social networking
- Software download & update
- Other encrypted
- Other

- Video is the largest contributor of the mobile data volumes, varying from 30% to 50%

- In case of smartphones, the second largest contributor is social networking

- On mobile PC, file sharing still plays a noticeable role
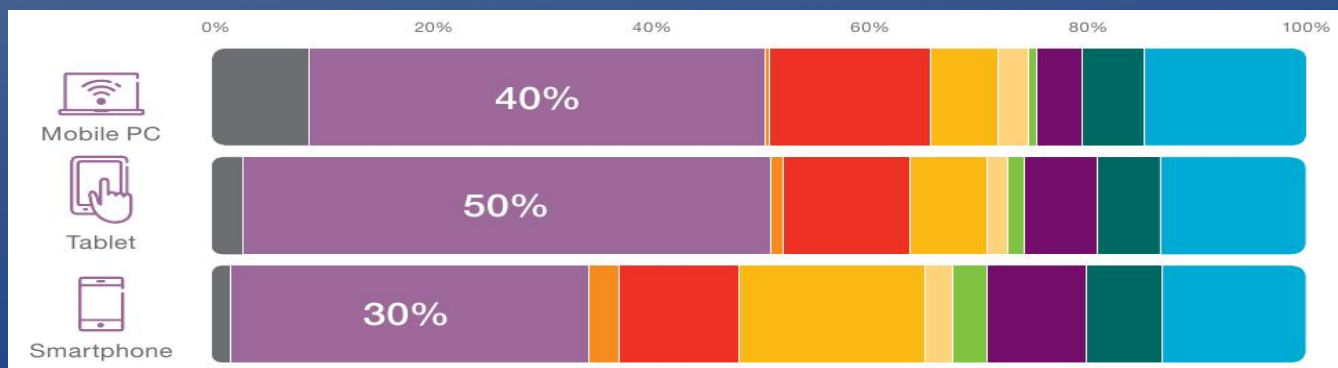
Key observations

- Mobile industry has crossed the point when the mobile data volumes start to exceed voice data

- Already now mobile data volumes have been increasing exponentially and this trends will continue

- Most of mobile data is generated by smartphones

- Even though amount of data generated by a smartphone is less when compared to a router, the overall number of mobile phone subscriptions create a larger impact

- Mobile applications represent a typical set of services usually used at mobile platforms

- Already now video take the largest share of mobile data and it is expected to grow to 50%

# State-of-art in wireless broadband

HSPA / LTE evolution

Higher-oder modulation & MIMO

Dual-carrier

Four-carrier & MIMO
Dual-band & MIMO
UL dual-carrier

Eight-carrier
4x4 MIMO
Multiflow

HetNet

Rel-7	Rel-8	Rel-9	Rel-10	Rel-11	Rel-12 & Beyond

HSPA
DL: 14.4 Mbps
UL: 5.7 Mbps

HSPA+
DL: 28 Mbps
UL: 11 Mbps
DL: 42 Mbps[1]
UL: 11 Mbps

HSPA+
DL: 84 -168 Mbps[2]
UL: 23 Mbps[2]

HSPA+ Advanced
DL: 336+ Mbps[4]
UL: 69+ Mbps[4]

FDD & TDD

CSFB

Carrier aggregation
VoLTE
HetNet

Rel-8	Rel-9	Rel-10	Rel-11	Rel-12 & Beyond

LTE
DL: 73 – 150 Mbps[1]
UL: 36 – 75 Mbps[1]
(10 MHz – 20 MHz)

LTE Advanced
DL: 1+ Gbps[2]
UL: 375+ Mbps[2]
(Up to 100 MHz)

Source: Qualcomm Incorporated

Global deployment status

Source: 4G Americas
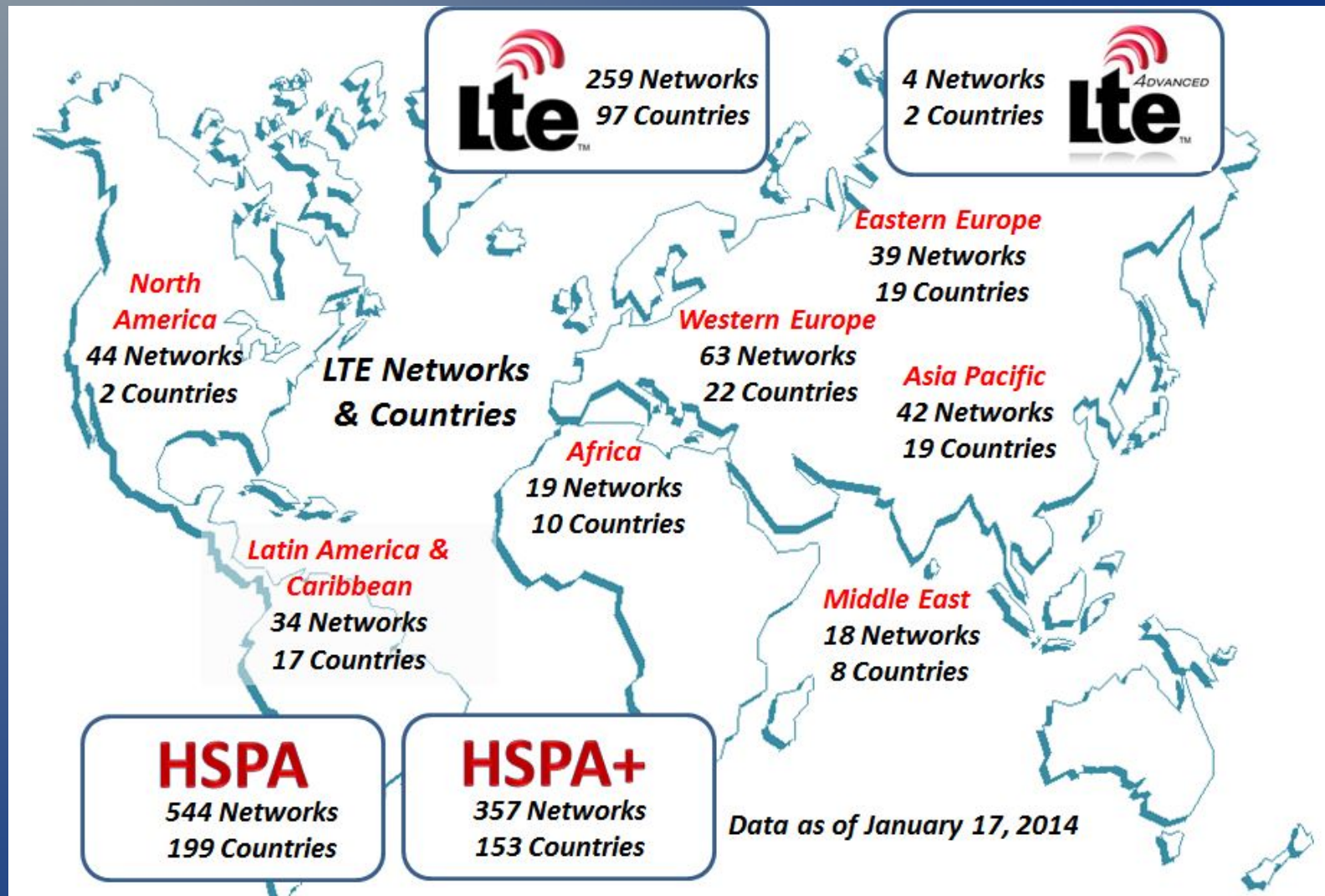
Mobile equipment investment

Global mobile equipment investment
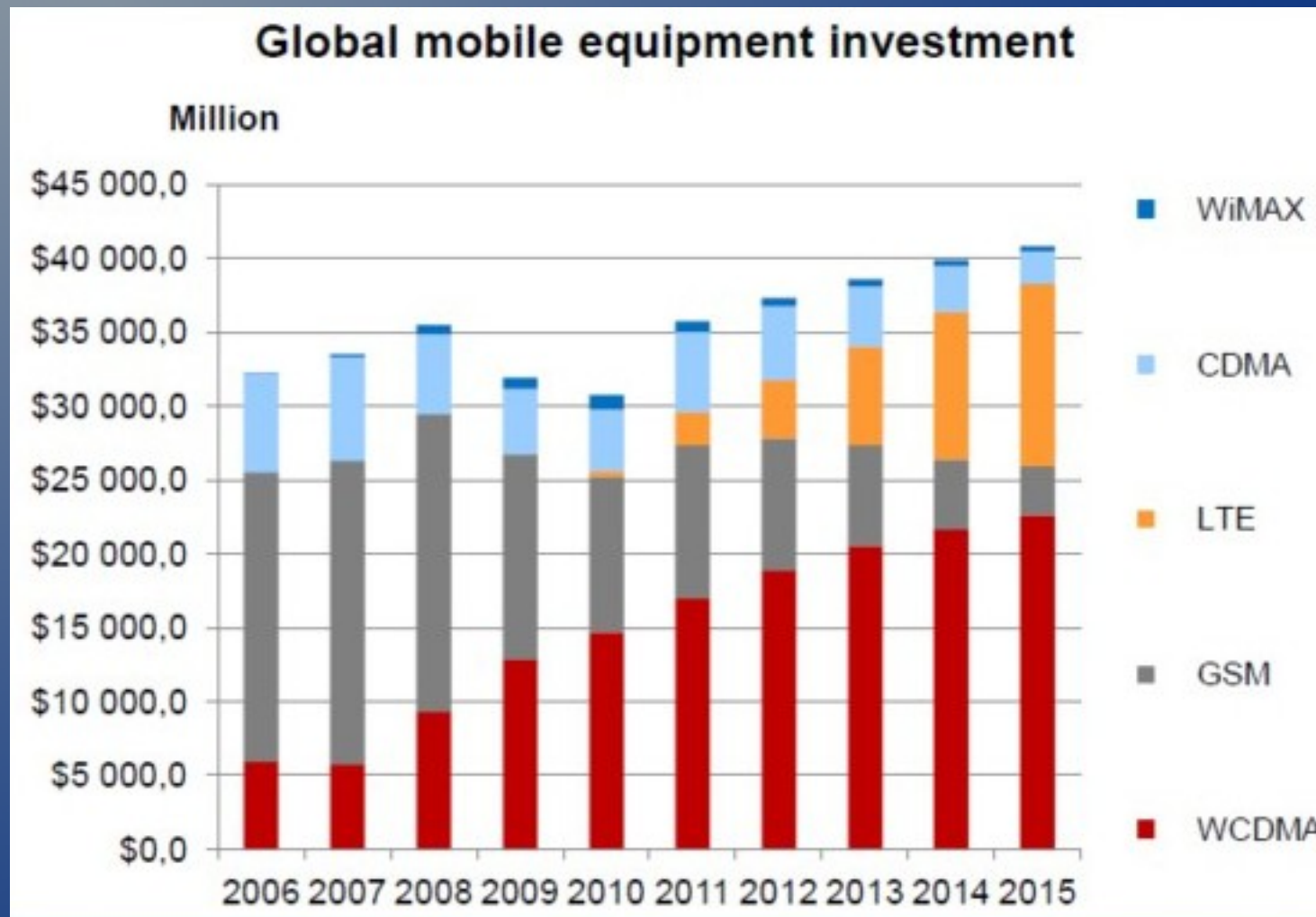
MTS reveals 2012 rollout achievements

Source Telegeography

2 Jan 2013

Russian telecom giant Mobile TeleSystems (MTS) has confirmed that during the twelve months ended 31 December 2012 it deployed a total of 6,000 GSM base transceiver stations (BTS) and 5,000 3G cell towers nationwide. In addition, the cellco rolled out some 2,000 LTE base stations in and around Moscow.
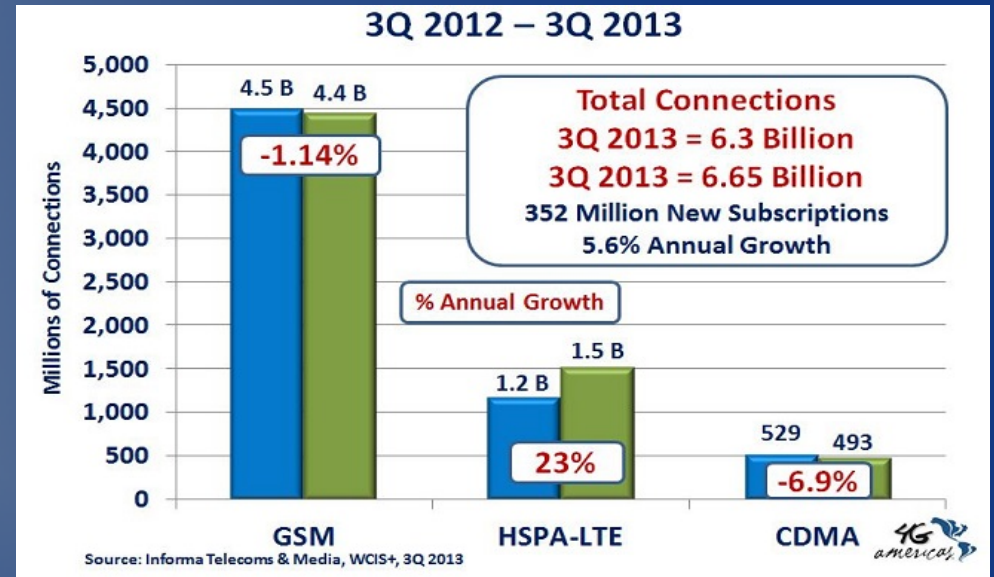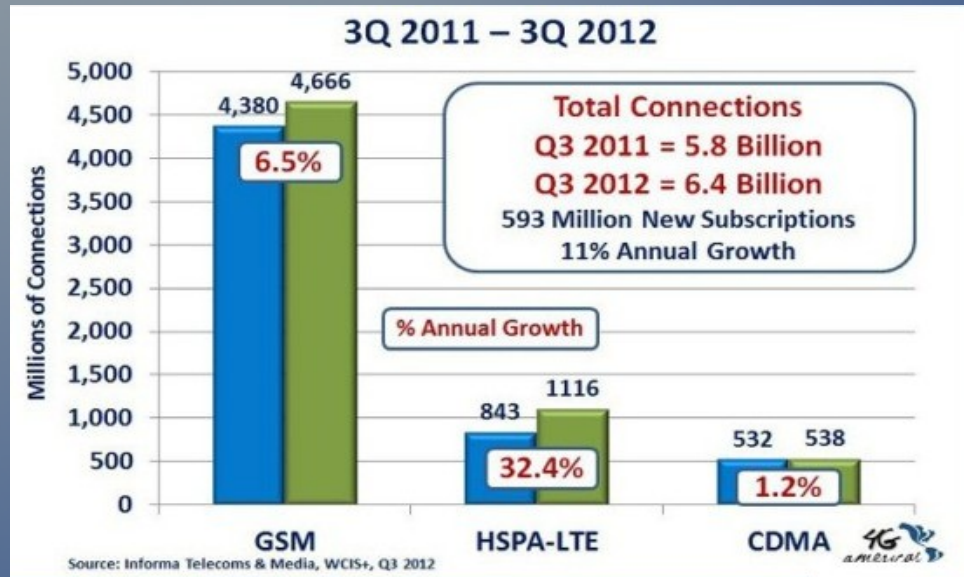
Technology share
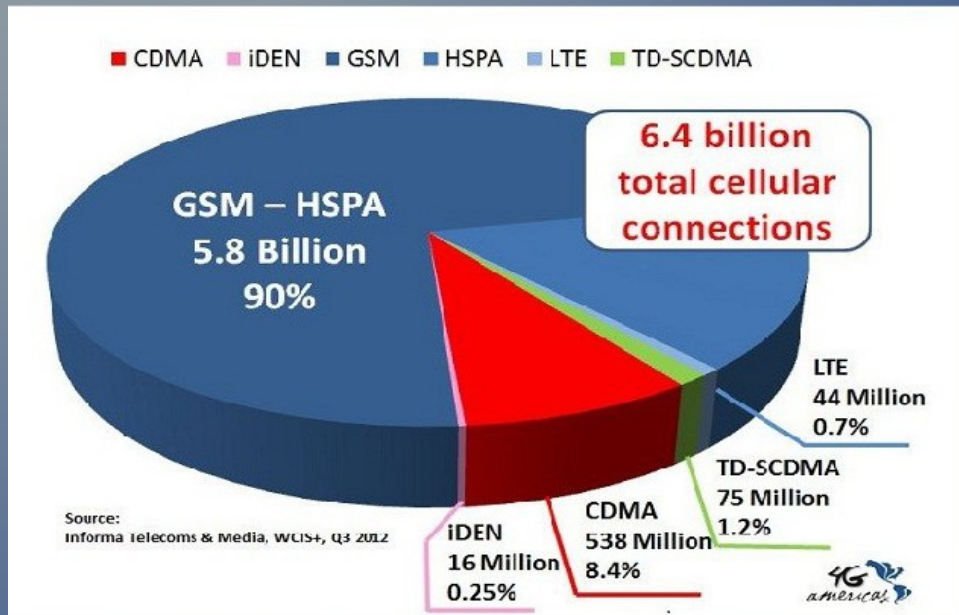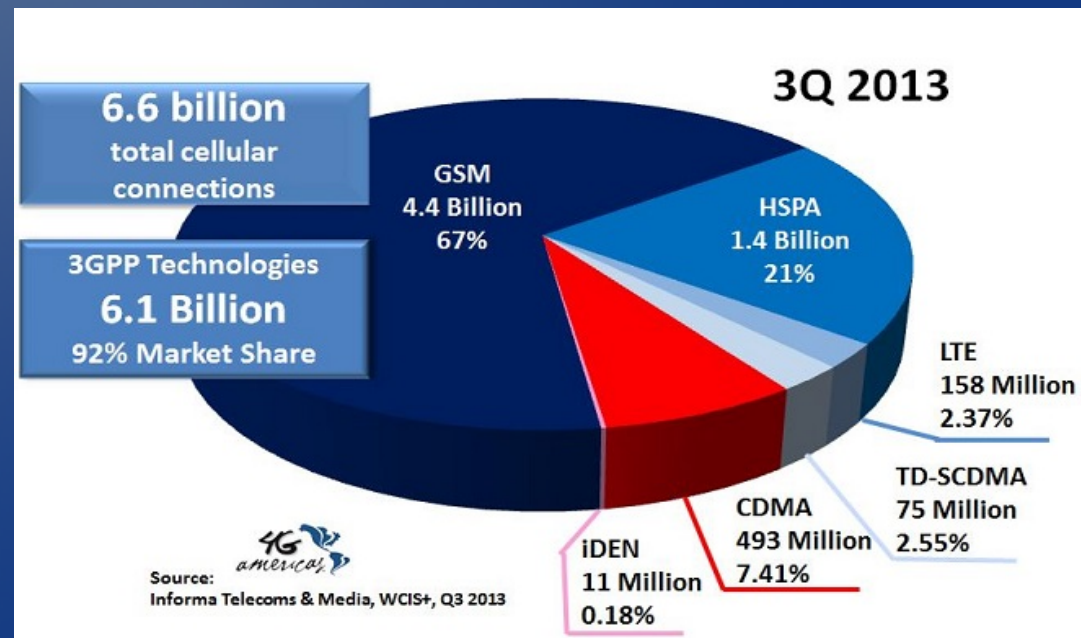
Technology trends

HSPA / LTE forecast

Source: 4G Americas
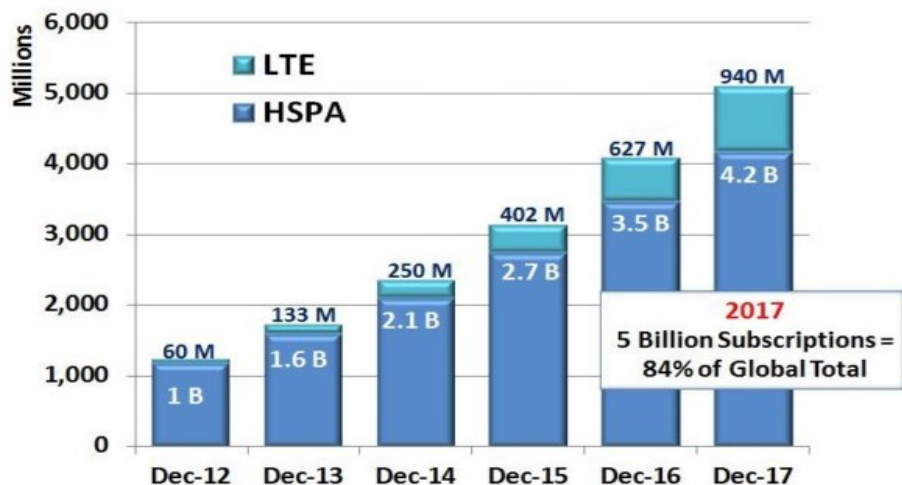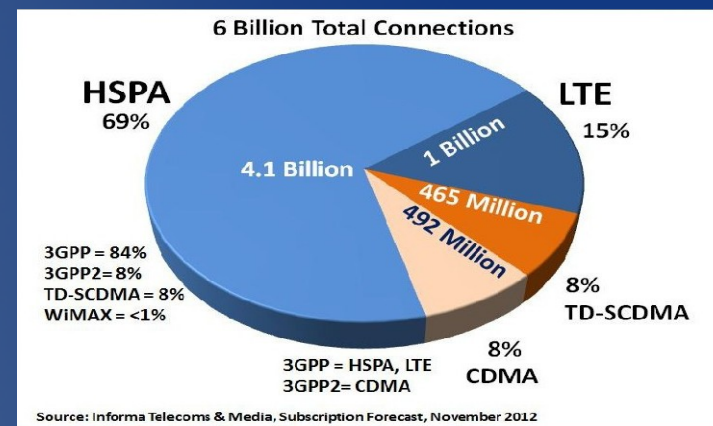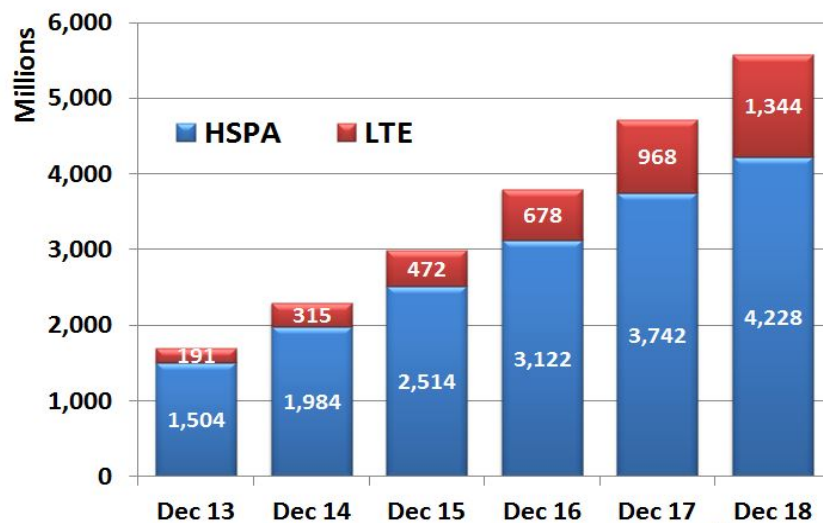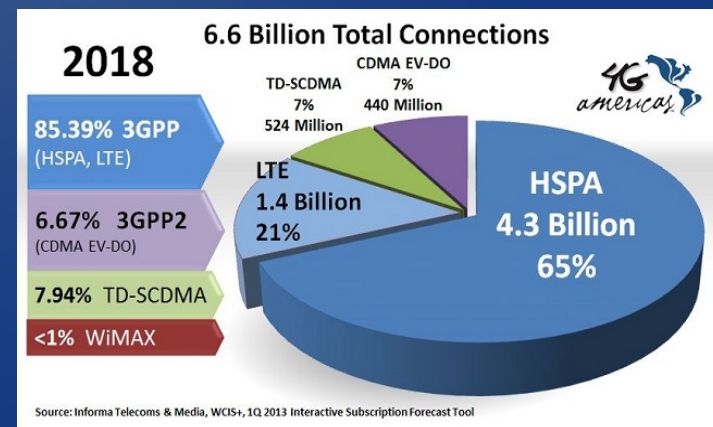
Subscription distribution

LTE subscription distribution

Source: 4G Americas

Source: Ericsson Mobile Report
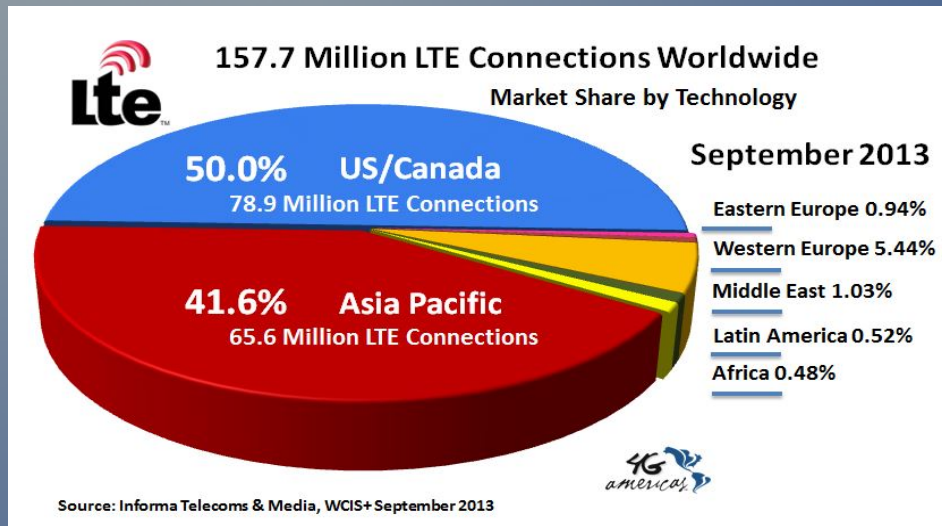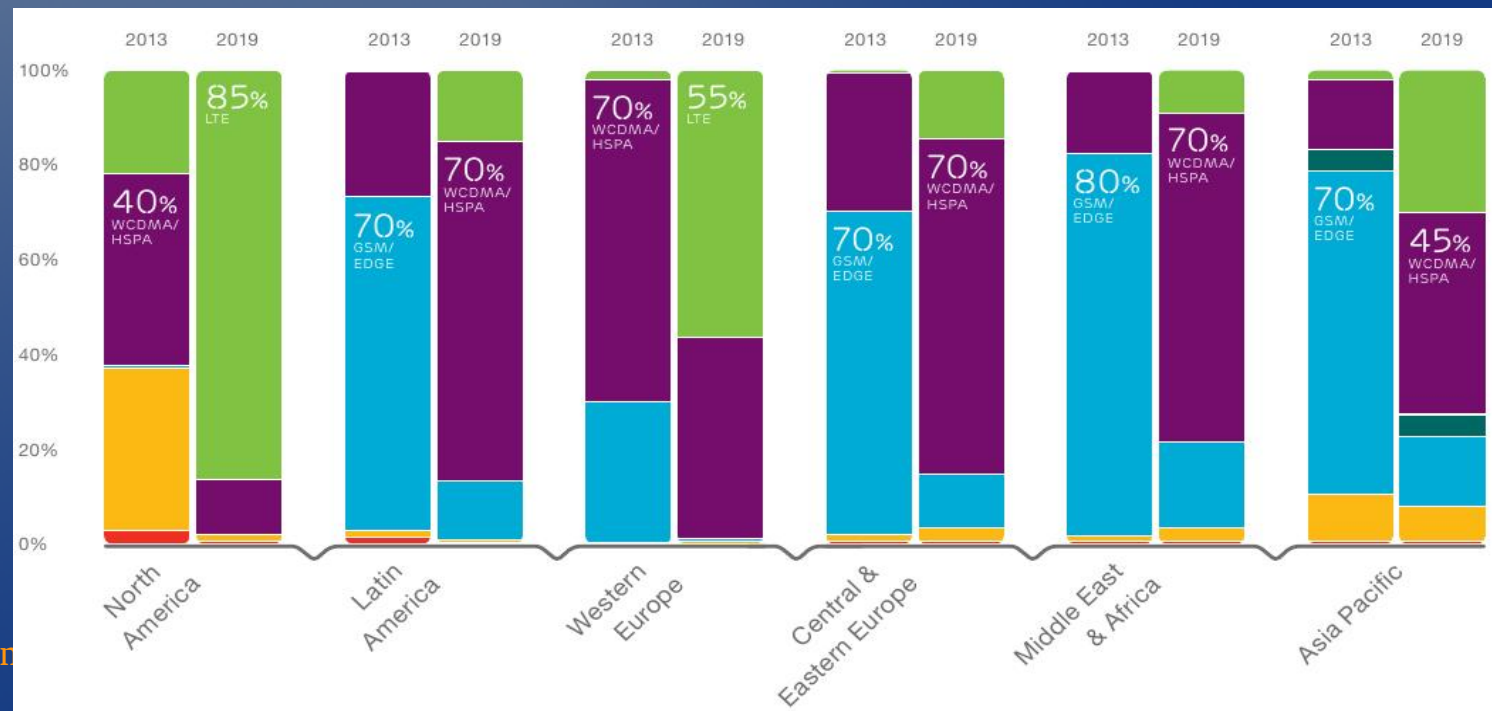
HSPA / LTE modems

TeleWell TW-LTE 4G USB

- LTE DL/UL: 100/50 Mbps
- HSPA DL/UL: 42/5.76 Mbps

- LTE: 1800/2100/2600 MHz
- HSPA: 900/1900/2100 MHz
- GSM: 850/900/1800/1900 MHz

Sierra Wireless AirCard

- LTE DL/UL: 100/50 Mbps
- HSPA DL/UL: 42/5.76 Mbps

- LTE: 800/1800/2100/2600 MHz
- HSPA: 900/1900/2100 MHz
- GSM: 850/900/1800/1900 MHz

HSPA / LTE terminals

Apple iPhone 5

- LTE DL/UL: 100/50 Mbps
- HSPA DL/UL: 42/5.76 Mbps

- LTE: 2100/1900/1800/850/750 MHz
- HSPA: 2100/1900/850 MHz
- GSM: 850/900/1800/1900 MHz

Samsung Galaxy SIII

- LTE DL/UL: 100/50 Mbps
- HSPA DL/UL: 21/5.76 Mbps

- LTE: 2100/750 MHz
- HSPA: 2100/1900/850 MHz
- GSM: 850/900/1800/1900 MHz

HSPA and LTE rates of commercially deployed networks

HSPA / HSPA+

600
500
400
300
200
100
0

HSPA   7.2 Mbps and   HSPA+   42 Mbps
            above
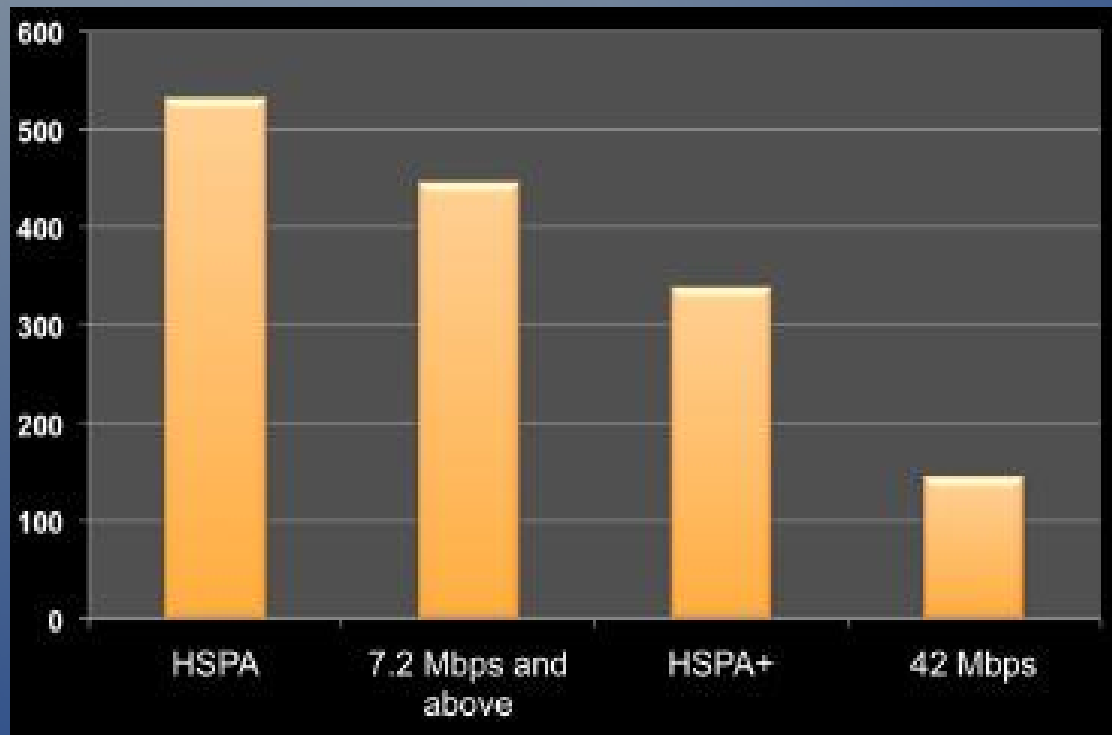
LTE

- Most LTE networks have a 10MHz bandwidth, thus capable of providing around 75Mbps

- Some operators have 20MHz spectrum, thus allowing for around 150Mbps

- Some operators have a few chunks of spectrum, so with carrier aggregation they can provide even more

- At the same time, some LTE operators have only 5MHz spectrum, resulting in around 35Mbps

Source: GSA

Vodafone achieves 73Mbps/35Mbps DL/DL speeds

Source Telegeography

5 Feb 2013

According to a report by business journal Ziarul Financiar, Vodafone Romania has successfully demonstrated Long Term Evolution (LTE) transmission speeds of 73Mbps (downlink) and 35Mbps (uplink) during a trial conducted using two different smartphones ... The trial has seen Vodafone achieve the aforementioned transmission speeds using the Samsung Galaxy S3 and the HTC SV One handsets...

Vodafone boosts 4G speeds to 150Mbps with Cat 4 modems

Source: Telegeography

17 Jan 2014

Vodafone Australia has announced the launch of two new 4G mobile broadband devices that are capable of delivering theoretical data speeds of up to 150Mbps. The Vodafone Mobile Broadband USB Stick and the Vodafone Pocket WiFi device are both 'Category 4' ('Cat 4') enabled, and are available for use on the operator's 4G network which is built on Vodafone's contiguous 20MHz spectrum holdings in Sydney, Melbourne, Brisbane, Perth and Adelaide. 'We are seeing a strong demand for mobile broadband products, especially from people who don't want a permanent fixed broadband connection, students, those living in share accommodation and people who simply don't want to be locked into a contract,' commented Vodafone's General Manager of Devices, Katie Turkal, adding: 'Increasingly, Australians are ditching fixed internet connections in favour of the convenience and portability of mobile data. What's more Vodafone 4G can offer speeds up to two and a half times faster than standard ADSL connection.' Until 2 April 2014 Vodafone is offering a 15% discount for customers purchasing the devices on their existing post-paid account.

Achievable downlink rates
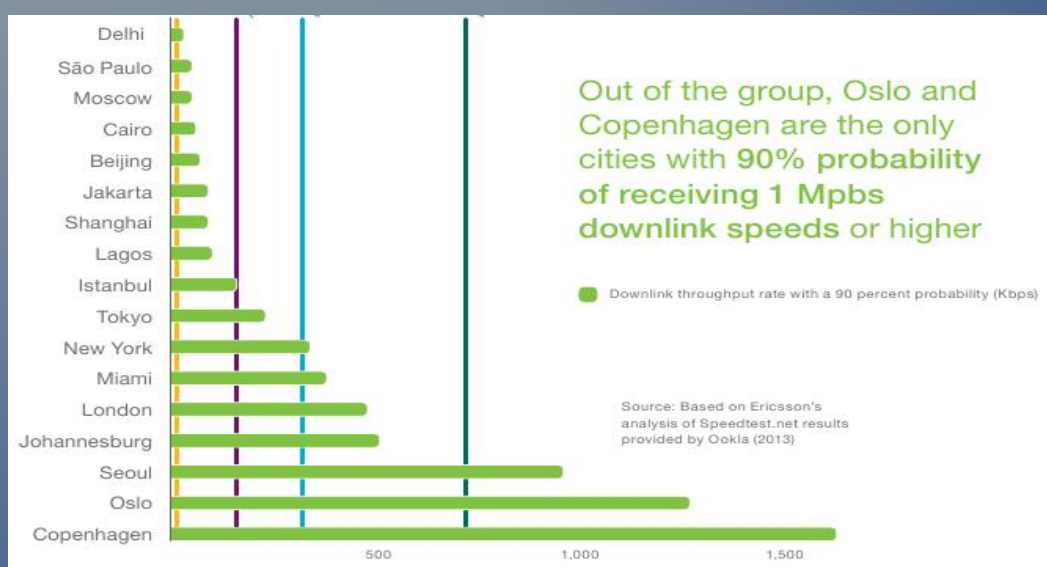
Source: Ericsson Mobile Report
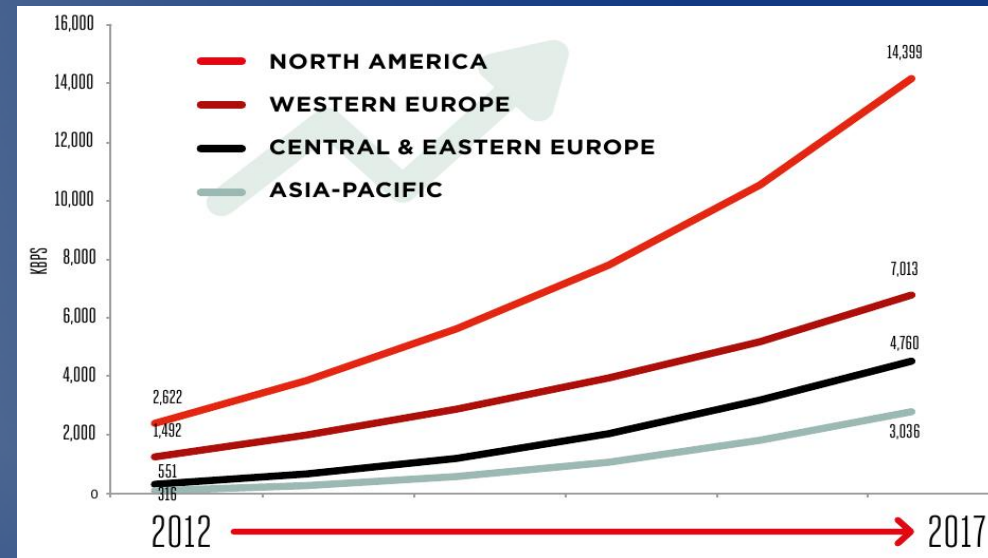
Source: Cisco VNI Mobile Report

- Despite all the advances, there are still many places, even in large cities, where the connection rate is low

- It does not explain only to the technology, but also how a network is deployed

- The overall number of active connections vs. base station densities is another important factor

- As can be seen, even in Western Europe and North America cities average rates are far from what the technology can theoretically provide

Key observations

- At the moment, mobile broadband is dominated by GSM/HSPA connections

- LTE technology has been growing, eating the market share of GSM, CDMA, and to some extent even HSPA, with a market share estimate of around 20% in 4-5 years

- HSPA share has been growing as well, and in 4-5 years it is estimated to be around 65% of the world market

- HSPA might remain a dominating technology of developing markets and rural areas, and LTE will occupy a segment of developed countries and dense urban areas

- Is GSM going to disappear? Most likely no – we still need a way to make reliably voice calls

Key observations

- Both LTE/LTE-A and HSPA/HSPA+ can theoretically provide high peak rates reaching correspondingly 1Gbps and 336Mbps

- Deployed LTE and HSPA+ systems are much modest in provided peak rates, 150Mbps and 42Mbps

- Mobile subscription plans, pricing, and the overall number of connections lower further achievable bit rates

- LTE carrier aggregation and HSPA+ multi-carrier should increase peak rates of deployed systems in a few years

- Nevertheless, there has been and will be a strong demand for higher rates

Development of wireless technologies

Mobile broadband evolution

- 2G – GSM

- 2.5G – GSM/GPRS/EDGE

- 3G – WCDMA

- 3.5G – HSPA

- 4G – LTE

- 5G –
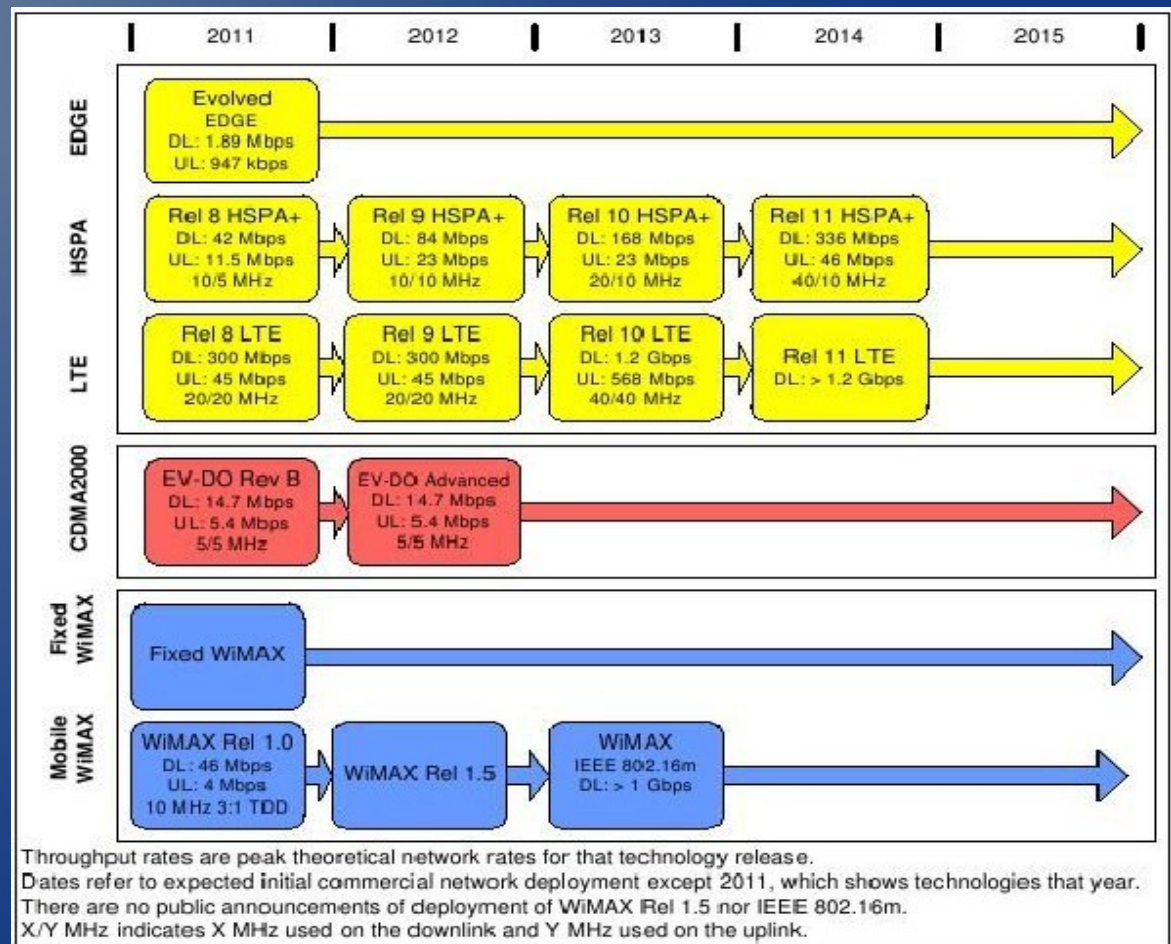
3G and 4G (as per ITU-R)

- ITU-R has specified a set of requirements which a particular technology should meet to be claimed as 3/4G

- Requirements are captured in a number of documents

- Formally speaking, there are several technologies which can be referred to as "3/4G"

    - 3G or "IMT-2000"
        - ITU-R M.1457 describes technologies meeting "3G" requirements
        - EDGE and EDGE evolution, CDMA2000 with EV-DO, WCDMA
    - 4G or "IMT-Advanced"
        - Requirements are defined in ITU-R M.2133 and ITU-R M.2133
        - ITU-R M.2012 provides an overview of 4G radio interfaces meeting 4G requirements

Some 4G requirements

- A nominal data rate of 100 Mbit/s while the client physically moves at high speeds relative to the station, and 1 Gbit/s while client and station are in relatively fixed positions

- Scalable channel bandwidth 5-20 MHz, optionally up to 40 MHz

- Peak link spectral efficiency of 15 bit/s/Hz in the downlink, and 6.75 bit/s/Hz in the uplink

- System spectral efficiency of up to 3 bit/s/Hz/cell in the downlink and 2.25 bit/s/Hz/cell for indoor usage

- Seamless connectivity and global roaming across multiple networks with smooth handover

Peru bans use of '4G' in marketing

Source Telegeography

28 Nov 2012

Peruvian telecoms regulator Osiptel has forbidden providers of mobile and fixed wireless services from using the terms '4G' or 'Fourth Generation' to market their products. The watchdog said its decision was based on the need to ensure accuracy and clarity of information that operators provide to users with regard to the qualities, properties and characteristics of products and plans – a requirement under Peru's telecoms regulations.

Osiptel noted that the term '4G', according to the International Telecommunication Union (ITU), denoted technologies with speeds 'substantially higher' than those currently available in Peru. The regulator added that services currently offered under the name '4G' were not materially different from those offered as '3G'.
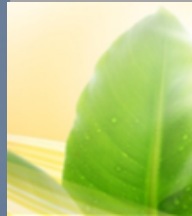
5G
A hot topic in 2013

There will be a 5th Generation (it's just not clear what, when or how!)

5G
Outlook beyond 2020

Broadband Internet connectivity widely available

Need for a strong limit on energy dissipation and CO2 footprint per capita

More context-related information (e.g. augmented reality)

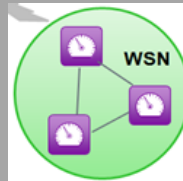**Increased extent of remote virtual collaboration**

Increasing average age and higher importance of health care

Need for more efficient and safer transportation means

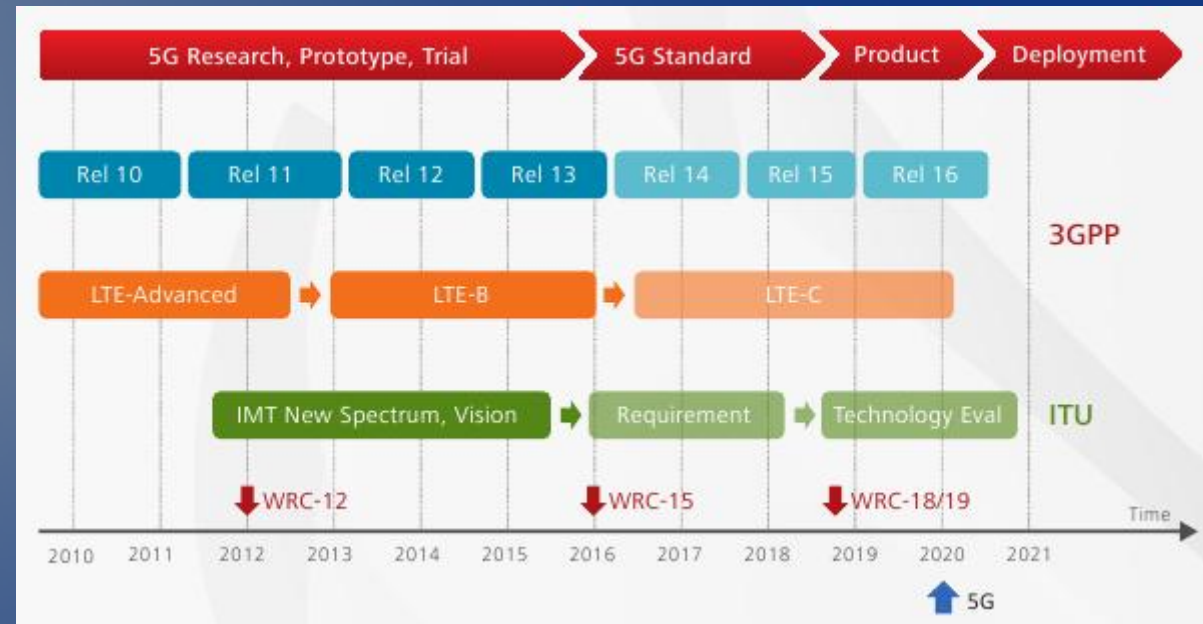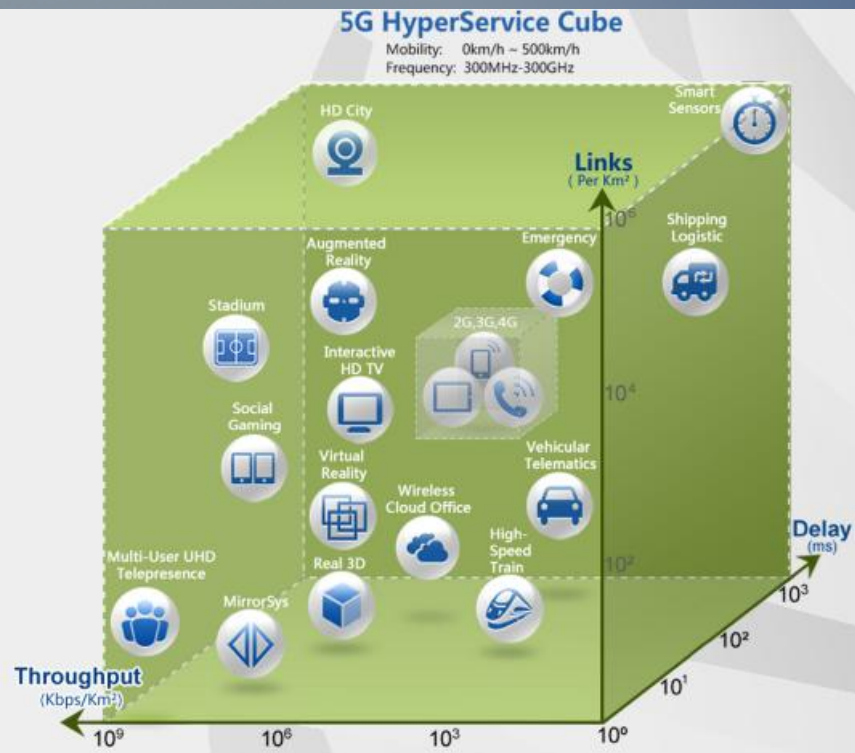**Personal data stored in the cloud and transmitted over wireless channels**

'Internet of things': Smart Homes, Smart Cites, Smart Society

Source: NSN

5G
Outlook beyond 2020

Source: Huawei

Factors driving development of mobile technologies

- Achievable spectrum efficiency and maximum bit rates

- Available spectrum

- Install base

- Compliance

- Non-technical, business and marketing aspects

Mobile ecosystem

Players and their roles

- **Mobile terminal vendor**

  - Brings the final product to end customer

  - Not always the same company who ships wireless modem and/or application processor

- **Chipset vendor**

  - Usually, it is not visible to end customer, but it plays a crucial role in what customer receives at the performance level

  - Depending on a case, it provides either only specific components or whole blocks such wireless modem and an application level processor

- **Network vendor**

  - Provides base stations, radio network controllers, and other core network equipment

  - Network equipment may come from different vendors

- **Operator / service operator**

Mobile ecosystem - big picture