Evolution for the Mobile BroadBand

WIND
Più vicini.

September, 9th 2014

Technology Architecture/ Mobile Access/ Alessandro Anania

AGENDA

- **Introduction**
- **Mobile Broadband definition**
- **MBB status in Italy**
- **MBB: traffic evolution**
- **LTE-Advanced and eMBMS**
- **MBB: mobile devices evolution**

Introduction

Wind:

WIND 2G commercial launch

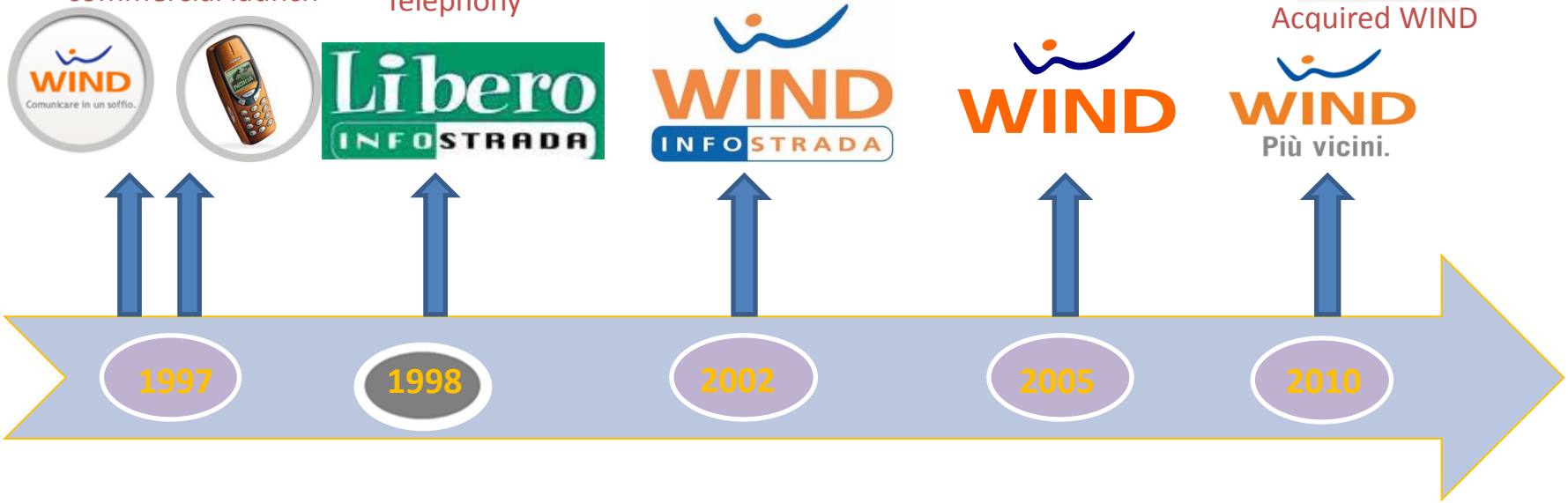
Start-up Fixed Telephony

WIND/Enel acquired Infostrada

Orascom acquired

VimpelCom

Acquired WIND

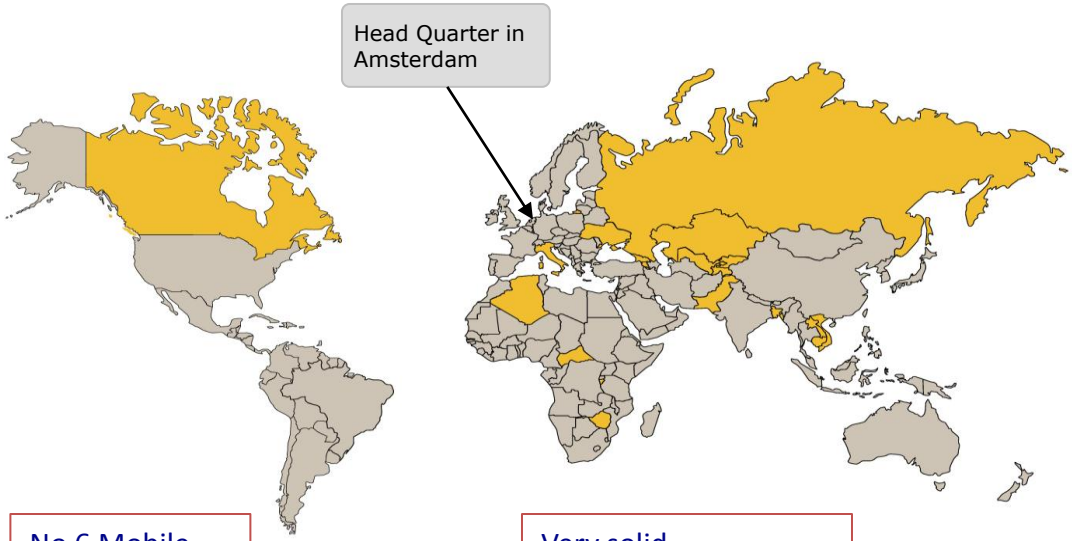


Alessandro Anania: Technology Architecture – Mobile Access

Laurea Telecommunication Eng.

Laurea Statistics

VimpelCom Group Presence



No 6 Mobile Operator in the world**

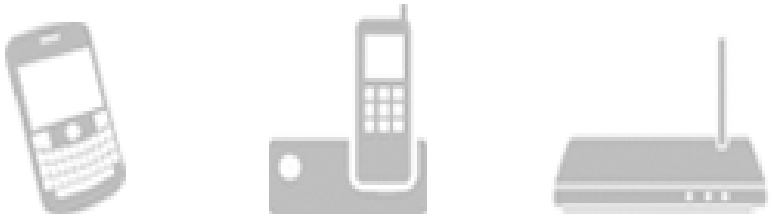
Very solid shareholders: Altimo and Telenor

Vimpelcom Main Figures

- Mobile subscribers: 214 Million
- Population covered: 767 Million***
- Countries : 18
- Number of Brands: 10
- Total Revenues: USD 23.1 billion*
- EBITDA: USD 9.8 billion*

* FY 2012
** Based on mobile subscribers
*** Population figures are provided by ©Informa Telecoms & Media – © Informa UK Ltd 2013 as per YE 2012

WIND: Mobile and Fixed services



6.952	22,3M	3M	4.983 M€
Employees (40% Technology)	Mobile CB	Fixed CB	Revenues 2013

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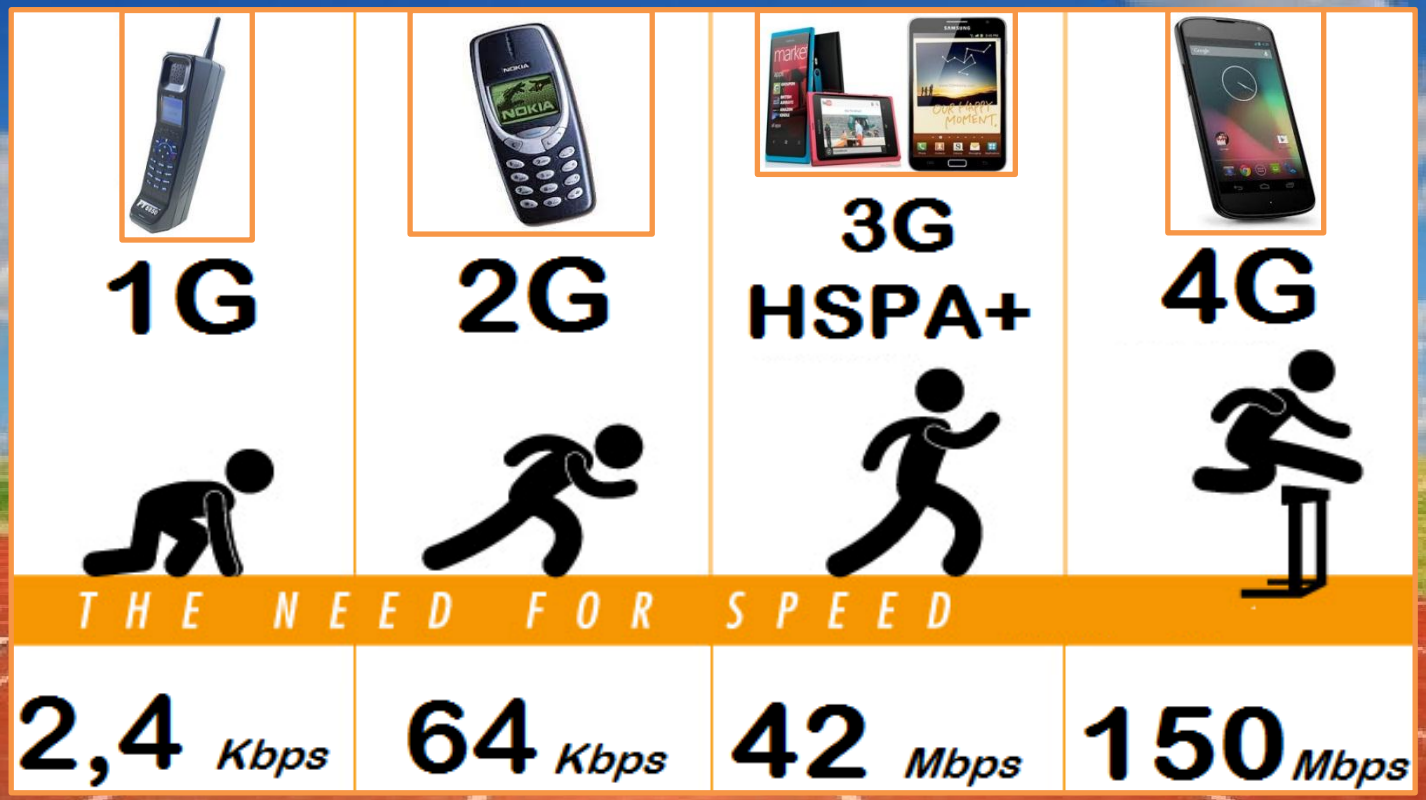
Mobile BroadBand Definition

“Mobile broadband is the marketing term for wireless Internet access through a portable modem, mobile phone, USB wireless modem, tablet or other mobile devices. The first wireless Internet access became available in 1991 as part of the second generation (2G) of mobile phone technology. Higher speeds became available in 2001 and 2006 as part of the third (3G) and fourth (4G) generations.” (by WIKIPEDIA)

Need for speed



Mobile Broadband: maximun throughput

	DL		UL
Bandwidth	2x2	4x4	1x2
5 MHz	37 Mbps	72 Mbps	18 Mbps
10 MHz	73 Mbps	147 Mbps	36 Mbps
20 MHz	150 Mbps	300 Mbps	75 Mbps

Down Link and UP Link speed

Current HSPA+ can achieve 21Mbps in 5MHz or 42Mbps in 10MHz

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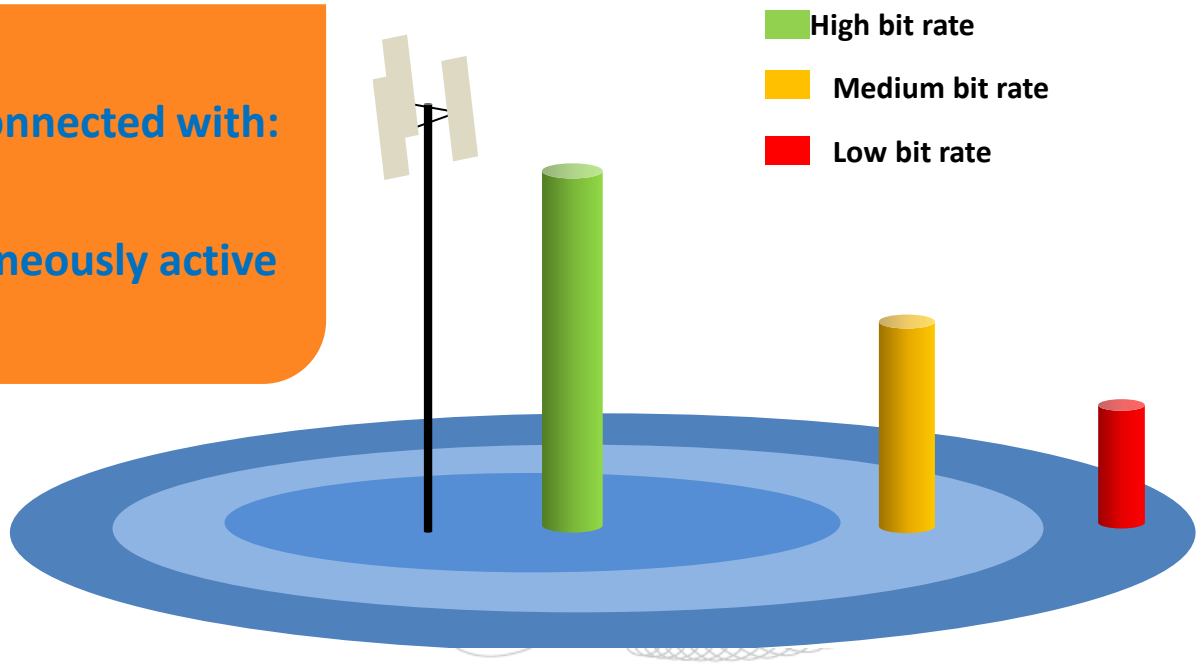
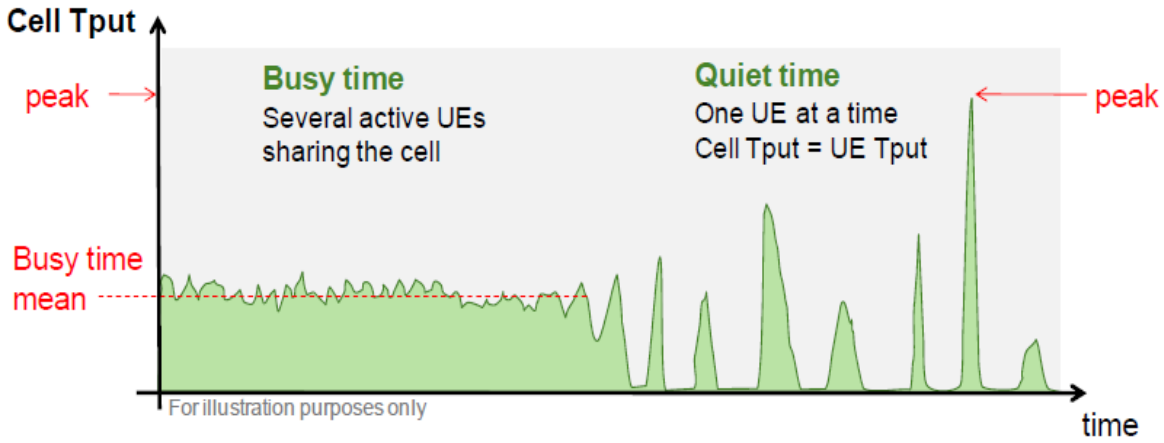
Mobile Broadband: user experience

Data speed available is strictly connected with:

- ❑ **Distance user-antennas**
- ❑ **Number of users simultaneously active**





Mobile Broadband: Caratteristiche frequenze

	Area [km2] coverage per site		
f [MHz]	**urban**	**sub urban**	**Remote/Rural Areas**
2600	1,0	5,8	34,7
2100	1,7	9,9	55,6
1800	2,1	12,3	76,9
900	4,8	29,4	125,9
800	5,6	34,7	147,6

LTE @800MHz: **Best coverage**

LTE @1800MHz: **Good Coverage/capacity**

LTE @2600MHz: **Best Capacity**

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Frequencies Allocation Strategy

Expand coverage

Higher capacity and speed

GSM/GPRS/EDGE @ 900 MHz

WCDMA/HSPA+ @ 2100 MHz

HSPA+ on third carrier
+ Dual Carrier 42Mbps

HSPA+ @ 900 MHz

LTE @ 800 MHz

LTE Speed Capacity booster and coverage acceleration @ 1800 MHz

LTE Speed Capacity booster @ 2600 MHz

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LTE in the world

318 LTE networks commercially launched in 111 countries

- 526 operator commitments in 155 countries (of which 318 networks are launched)
- *51 LTE networks commercially launched so far in 2014*
- *Latest nations to gain access to LTE service: Israel, Madagascar, Northern Mariana Islands*
- *245.4 million LTE subscriptions worldwide: Q1 2014*

(Source of data: GSA's Evolution to LTE report: 28 July 2014)

GSA

www.gsacom.com

Over 45% of LTE networks use 1800 MHz (band 3)
144 LTE1800 networks launched in 70 countries

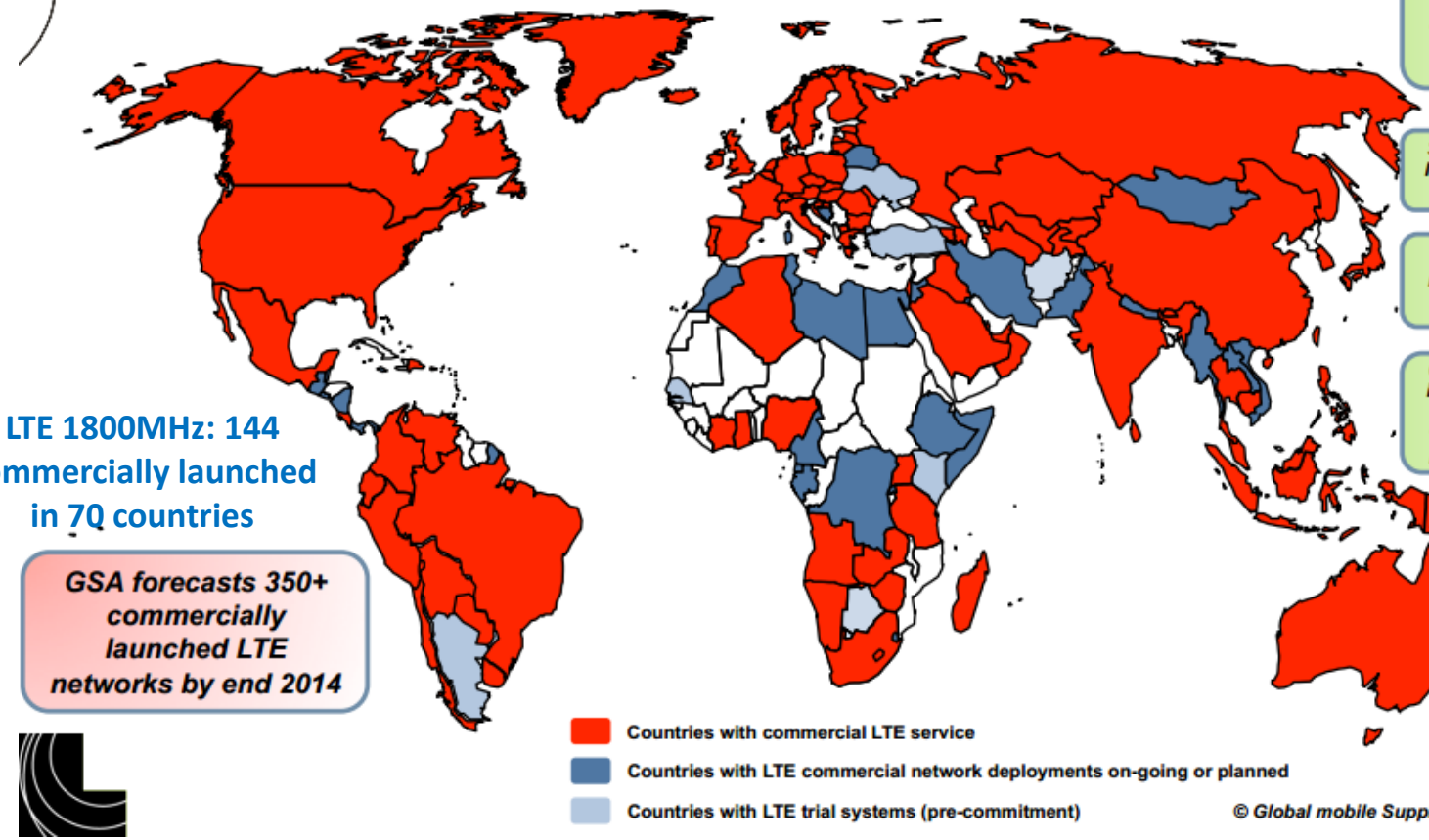
39 operators, i.e. 1 in 8 launched LTE TDD (TD-LTE) in 26 countries

16 LTE-Advanced networks using carrier aggregation launched

66 operators investing in VoLTE studies, trials or deployments
10 operators launched HD Voice using VoLTE

LTE 1800MHz: 144 commercially launched in 70 countries

GSA forecasts 350+ commercially launched LTE networks by end 2014



© Global mobile Suppliers Association – GSA

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Frequency spectrum allocation

	Telecom Italia	Vodafone	Wind	3 Italia
800 MHz	5 5	5 5	5 5	
900 MHz	5 5	5 5	5 5	5
1800 MHz	5 5 5 5	5 5 5 5	5 5 5	5 5 5
2100 MHz	5 5 5	5 5 5	5 5 5	5 5 5
2600 MHz	5 5 5	5 5 5	5 5 5 5	5 5

After the LTE Auction in 2011 WIND acquired 10MHz in 800MHz band and 20MHz in 2600MHz band.

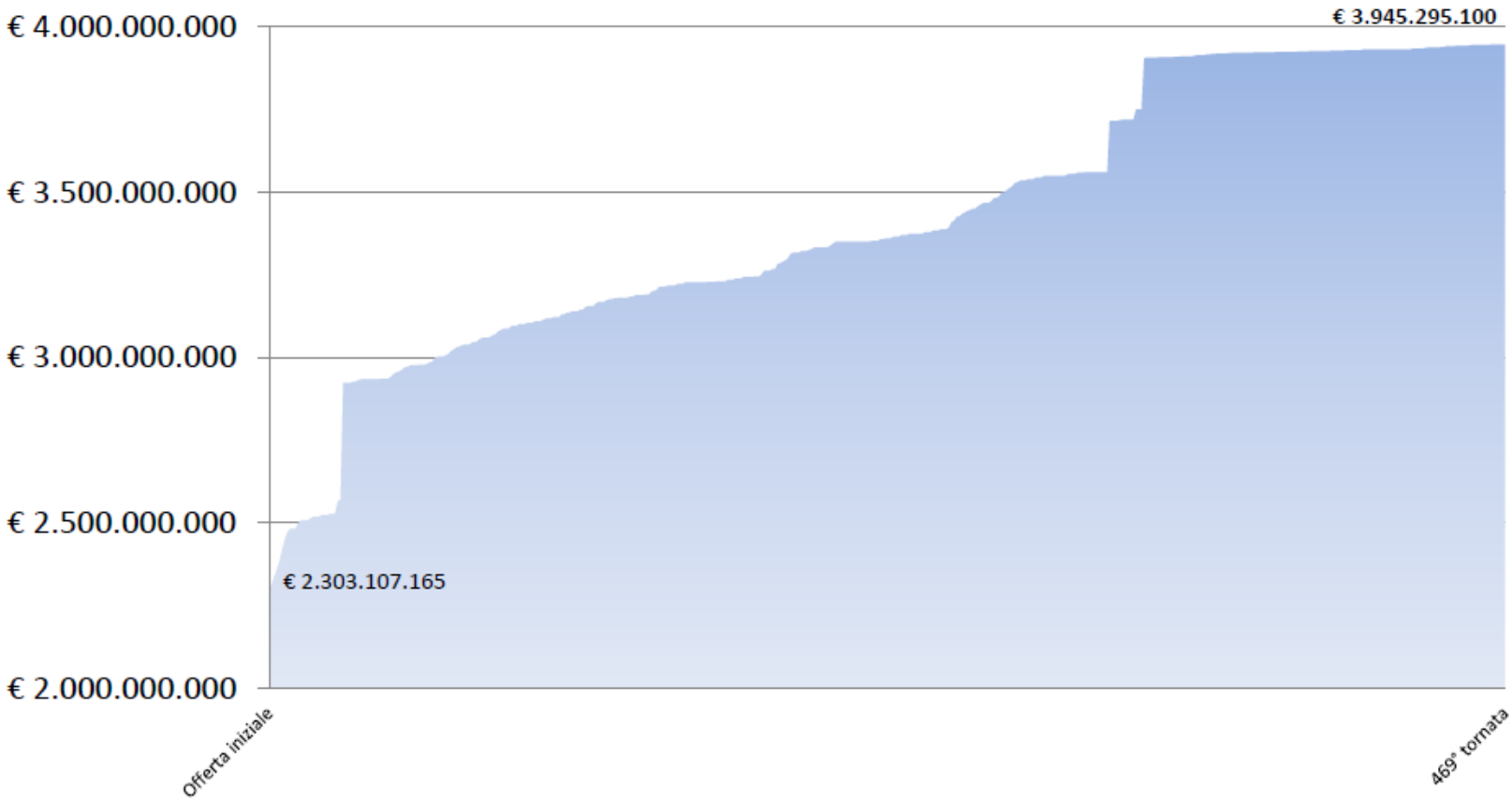
In terms of spectrum resources, WIND is at the same level as Vodafone and Telecom Italia

= Band acquired in LTE Auction

GARA FREQUENZE 4G

Assegnazione di diritti d'uso di frequenze nelle bande 800, 1800, 2000 e 2600 MHz

Andamento incasso totale Gara



Aggiornato al 29/09/11

Elaborazione dati a cura di FUB Fondazione Ugo Bordoni Ricerca e Innovazione

LTE status in Italy: August 2014

1800 cities
63% pop

803 cities
60% pop

280 cities
32% pop

Source: press release, official/unofficial web site (Aug 2014)

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MBB is a Reality

Part of daily life

Internet connection

Broadband becoming a necessity!

Everything is connected

Mobility

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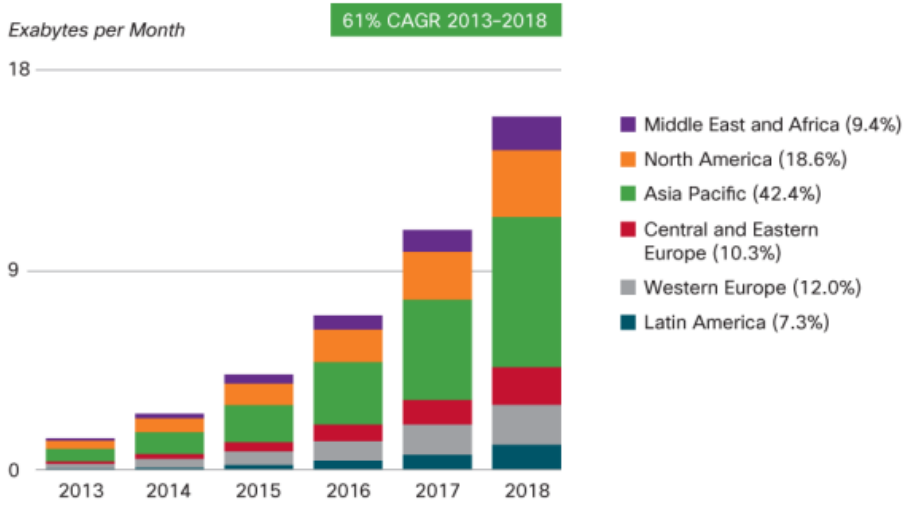
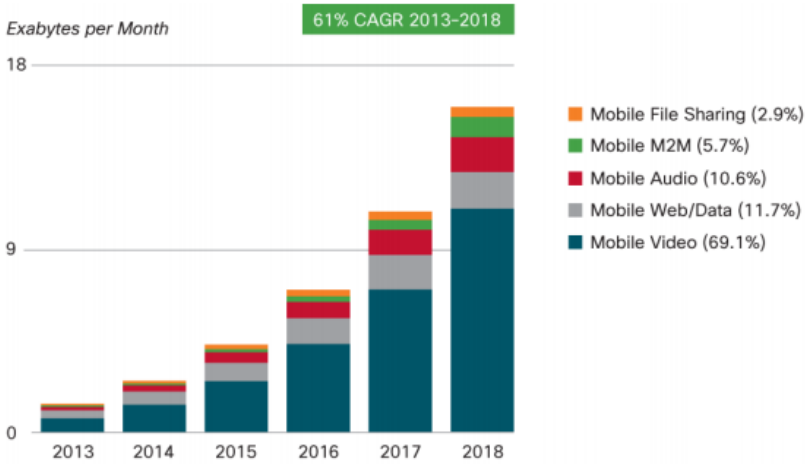
Global Mobile Data Traffic Forecast by Region



Figures in parentheses refer to regional share in 2018.
Source: Cisco VNI Mobile, 2014



Figures in parentheses refer to traffic share in 2018.
Source: Cisco VNI Mobile, 2014

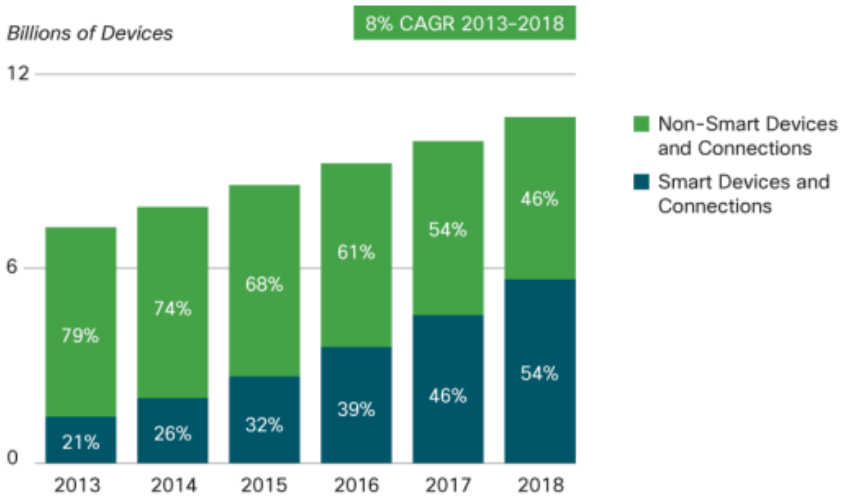
Global mobile data traffic grew 81 percent in 2013. Global mobile data traffic reached 1.5 exabytes per month at the end of 2013, up from 820 petabytes per month at the end of 2012.

Global mobile data traffic will increase nearly 11-fold between 2013 and 2018. Mobile data traffic will grow at a compound annual growth rate (CAGR) of 61 percent from 2013 to 2018, reaching 15.9 exabytes per month by 2018.

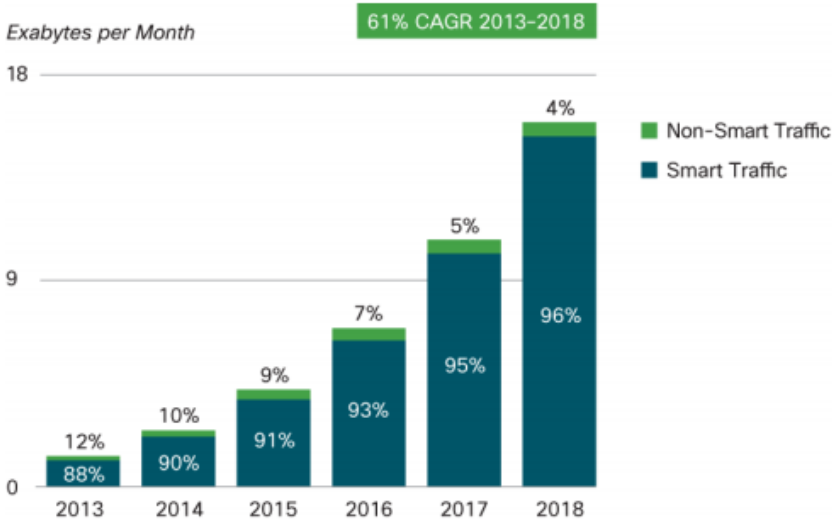
Last year's mobile data traffic was nearly 18 times the size of the entire global Internet in 2000. One exabyte of traffic traversed the global Internet in 2000, and in 2013 mobile networks carried nearly 18 exabytes of traffic.

Mobile video traffic exceeded 50 percent for the first time in 2012. Mobile video traffic was 53 percent of traffic by the end of 2013.

Effect of Smart Mobile Devices and Connections Growth on Traffic



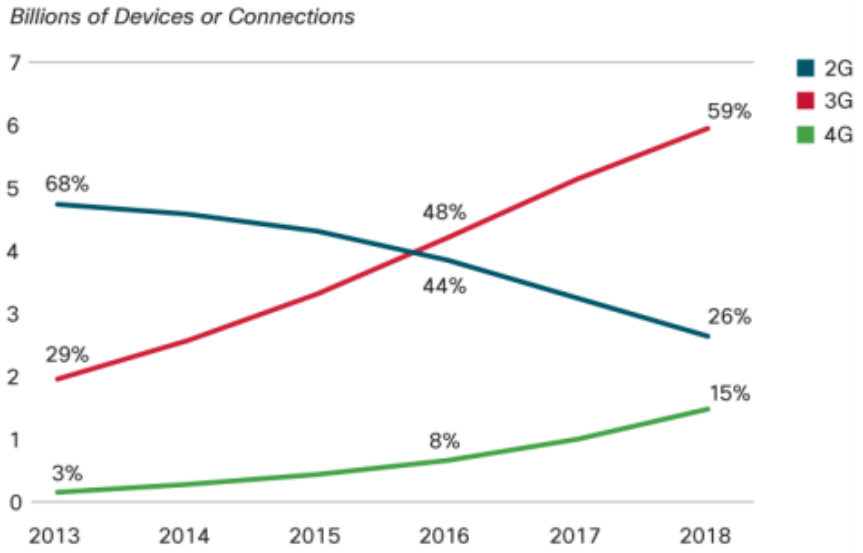
Percentages refer to device or connections share.
Source: Cisco VNI Mobile, 2014



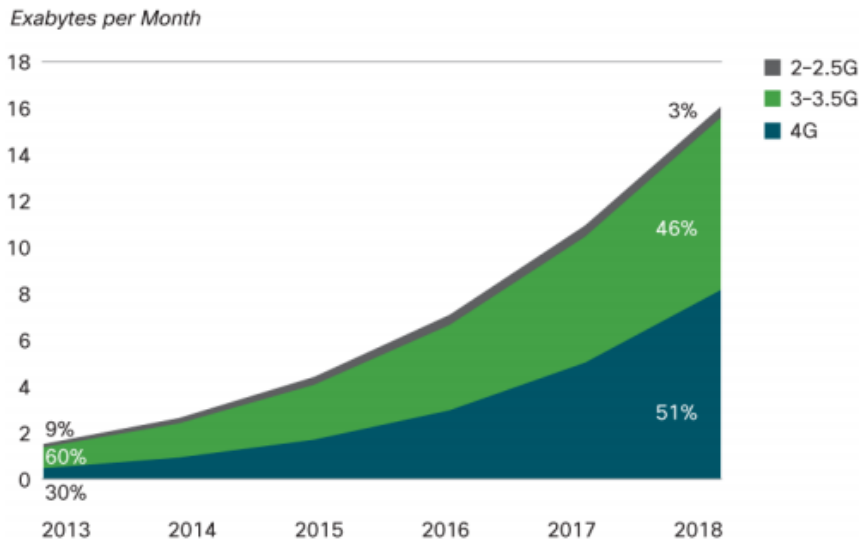
Percentages refer to device or connections share.
Source: Cisco VNI Mobile, 2014

Globally, smart devices represented 21 percent of the total mobile devices and connections in 2013, they accounted for 88 percent of the mobile data traffic. In 2013, on an average, a smart device generated 29 times more traffic than a non-smart device.

Global Mobile Devices, Connections and Traffic by 2G, 3G, and 4G



Source: Cisco VNI Mobile, 2014



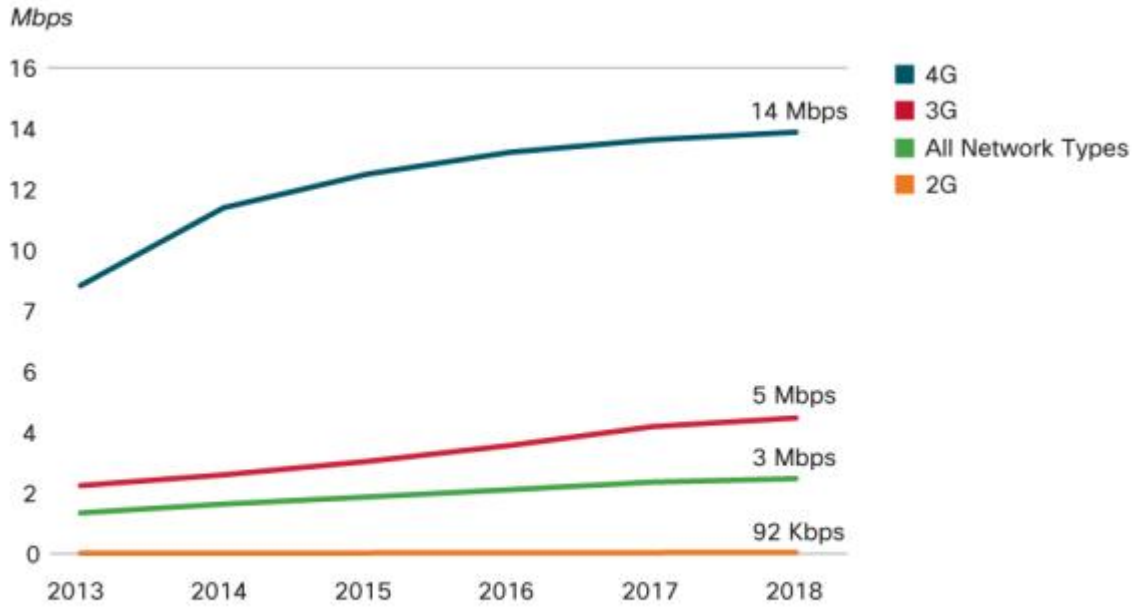
Source: Cisco VNI Mobile, 2014

Over half a billion (526 million) mobile devices and connections were added in 2013. Global mobile devices and connections in 2013 grew to 7 billion, up from 6.5 billion in 2012.

By 2018, 4G will be 15 percent of connections, but 51 percent of total traffic. By 2018, a 4G connection will generate 6 times more traffic on average than a non-4G connection.

In 2013, a fourth-generation (4G) connection generated 14.5 times more traffic on average than a non-4G connection. Although 4G connections represent only 2.9 percent of mobile connections today, they already account for 30 percent of mobile data traffic.

Mobile Speeds by Technology 2G vs. 3G vs. 4G



Source: Cisco VNI Mobile, 2014

Mobile network connection speeds more than doubled in 2013. Globally, the average mobile network downstream speed in 2013 was 1,387 kilobits per second (Kbps), up from 526 Kbps in 2012.

Mobile network connection speeds will increase two-fold by 2018. The average mobile network connection speed (1,387 Kbps in 2013) will exceed 2.5 megabits per second (Mbps) by 2018.

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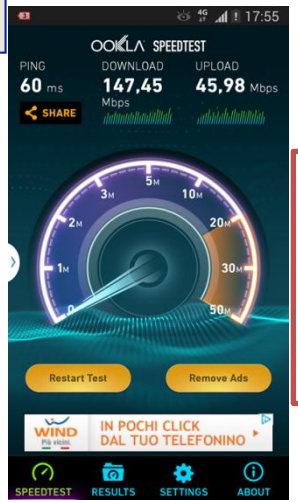
LTE Benefits

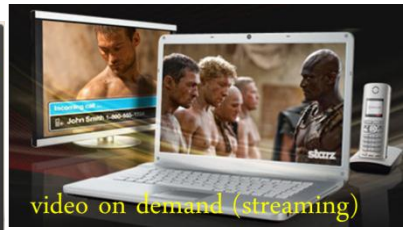
Faster Downloads



Higher Speed

Low Latency

More Services



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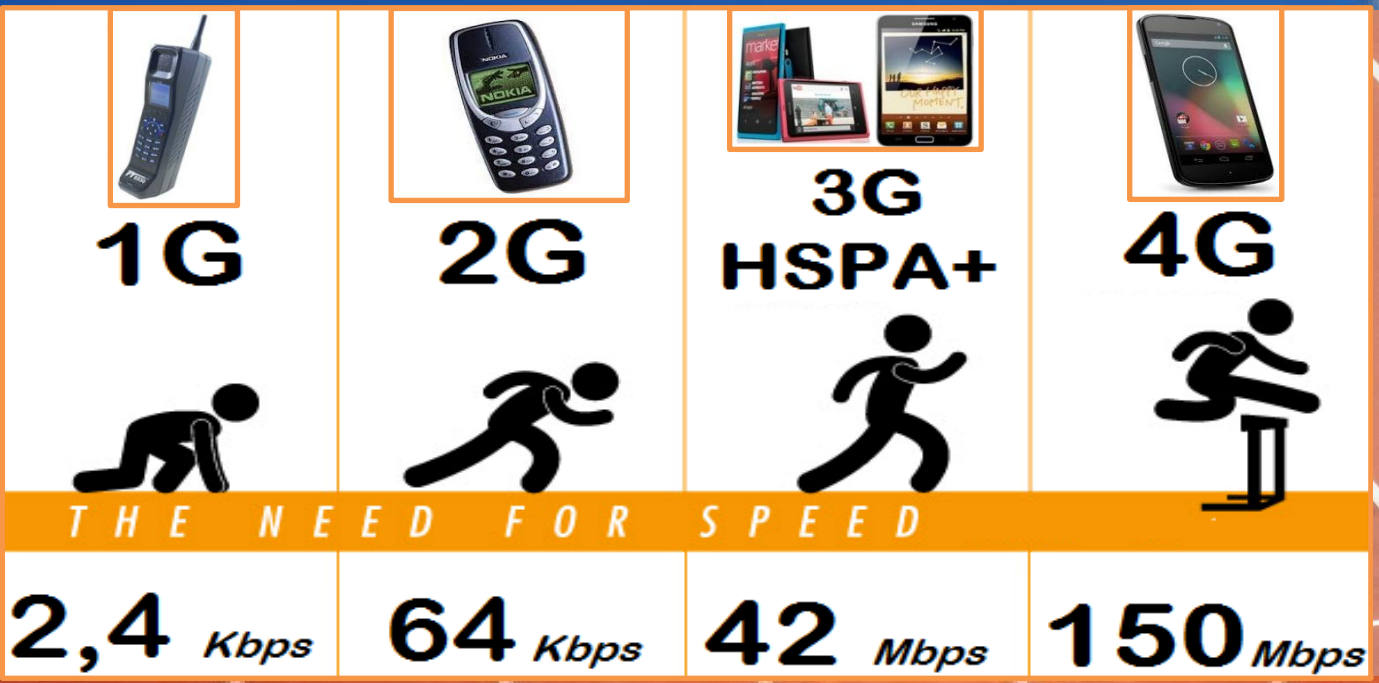
LTE Advanced

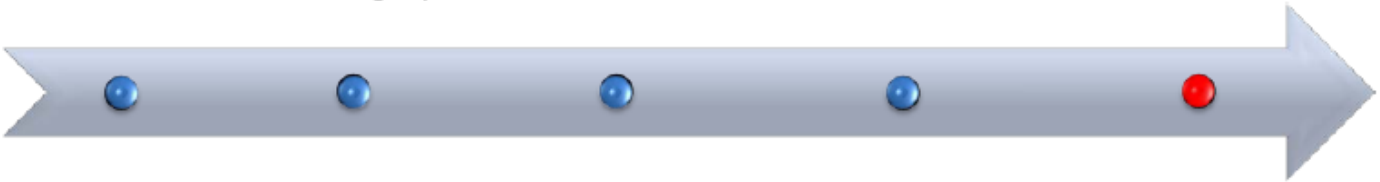


LTE Advanced Evolution

LTE: continual evolution

Rel-9 (Dec. '09)
- eMBMS
- Dual stream beamforming
- Positioning
- Enhanced HeNB/CSG support
- Emergency services

Rel-11 (Jun. '13)
- DL and UL CoMP
- In-device coexistence
- Enhanced Physical Downlink Control Channel (ePDCCH)
- Further eICIC



Rel-8 (Dec. '08)
- FDD and TDD mode
- Flexible bandwidth (1.4MHz to 20MHz)
- DL SU-MIMO (4 layers) and SDMA
- UL TX diversity and SDMA
- Inter-cell power control and interference management
- Inter-eNB and Inter-RAT mobility
- HeNB/CSG & SON support

Rel-10 (Jun. '11)
- CA (up to 5 CCs)
- Enhanced MIMO (8 DL and 4 UL layers)
- eICIC
- Relays
- Enhanced SON & MDT

Rel-12 (Dec. '14)

© 3GPP 2013 LTE Rel-12 and beyond

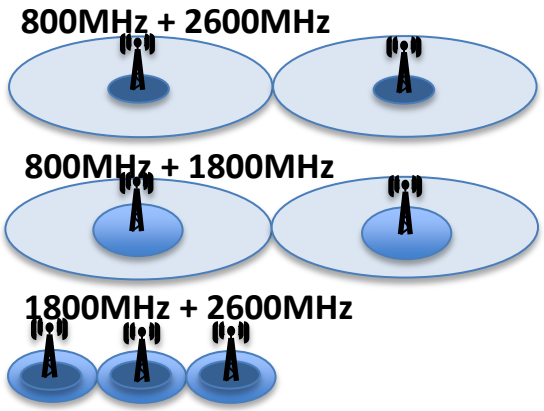
What is LTE-Advanced

LTE-Advanced is the evolution of LTE.

LTE-Advanced is based on the same LTE standard adding new radio functionality to fit the IMT- Advanced requirements for 4G generation services (1Gbps in 100MHz band)

The first available LTE-Adv functionality is the Carrier Aggregation (CA)

CA can provide higher bitrate in the overlapped coverage of different band



800MHz	1800MHz*	2600MHz	Peak data rate
5 MHz, 5 MHz		5 MHz, 5 MHz, 5 MHz, 5 MHz	225 Mbps (75+150)Mbps
5 MHz, 5 MHz	5 MHz, 5 MHz		150Mbps (75+ 75)
	5 MHz, 5 MHz	5 MHz, 5 MHz, 5 MHz, 5 MHz	225Mbps (75+150)

*assuming refarming of 10MHz in 1800MHz band;

CA require same Vendor environment. Low impact in Network.

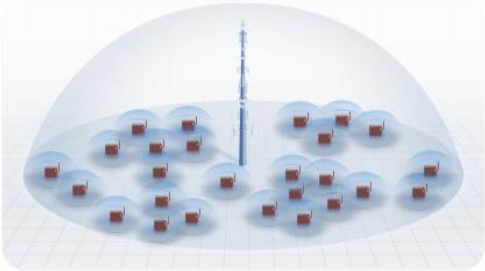
Commercial availability not before 4Q2014 with 20+20MHz device chipset availability. Current 10+10MHz chipset already on the market can only work if on network side 10+10MHz CA is implemented.

Trials have been performed. In Russia 5+10HMz. In Italy Vodafone 20+15MHz (1800+2600) and Telecom Italia 10+15 (800+1800)

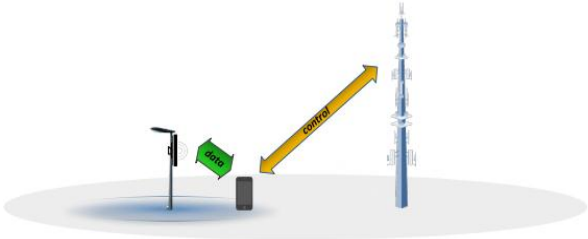
Technologies for MBB Capacity Improvements

Network hyper-densification

- ✓ Physical Layer enhancements for Small Cells
  - higher order modulation
  - small cell discovery mechanism
  - radio interface based inter-cell synchronization
- ✓ New protocol/architectural enhancements for Small Cells
  - dual connectivity
  - mobility and SON enhancements



Towards hyper-dense networks



Example of Dual Connectivity: *anchoring connections to macro cells while boosting datarate via small cells*

Multi-antenna technology advancements

- ✓ Terminal-specific elevation beamforming
- ✓ MIMO systems with large number of antennas

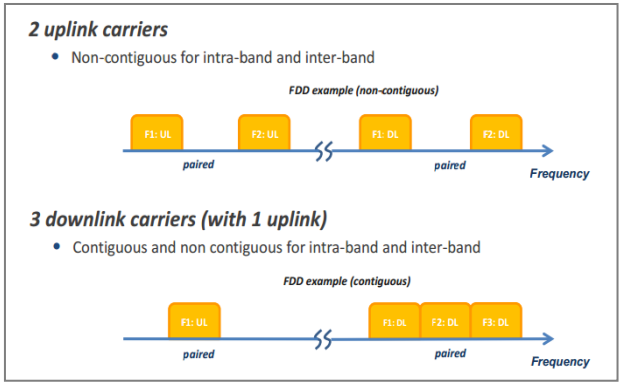
Coordinated Multi-Point (CoMP) operation with non ideal-backhauling

Advanced interference suppression at the terminal

Technologies for Spectrum availability at the terminal Improvements

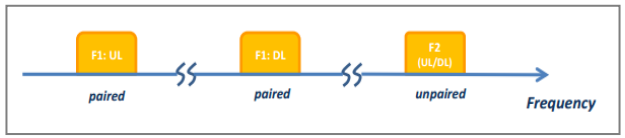
Carrier Aggregation advancements

- ✓ RF requirements definition for CA combinations with



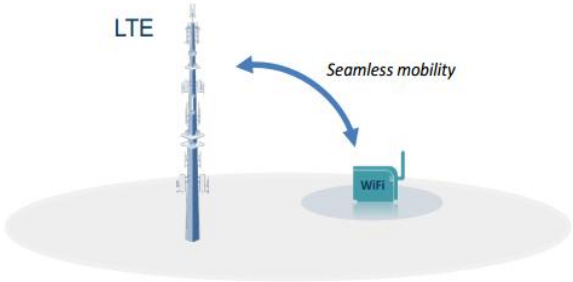
- ✓ FDD/TDD carrier aggregation framework allowing operators to fully utilize their spectrum

- ✓ RF requirements definition for actual CA band combinations



LTE-WiFi radio Interworking

Goal is to allow operators to steer traffic between their LTE and Wifi networks, based on radio or load conditions

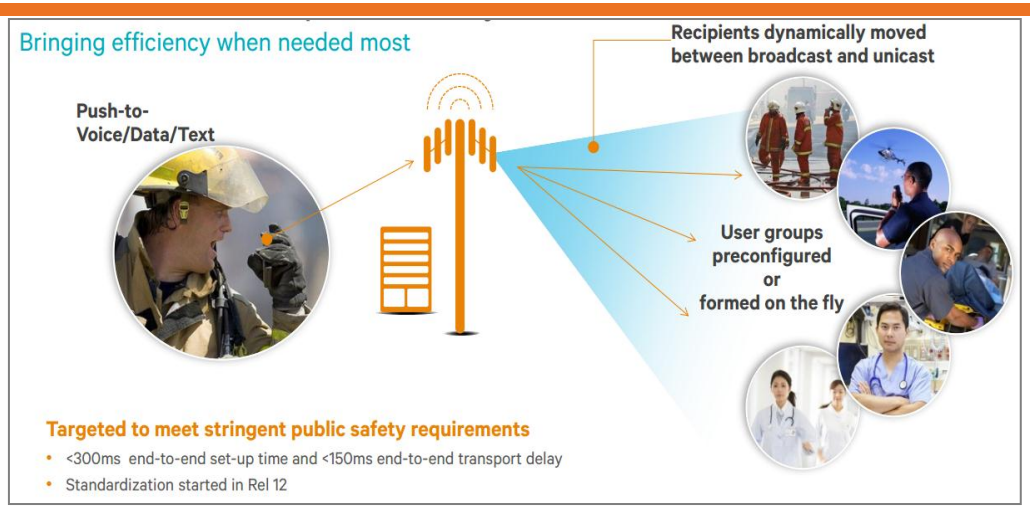


LTE in unlicensed spectrum

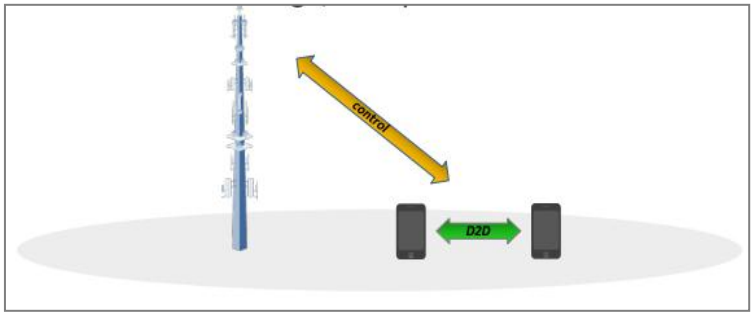
Goal is to offer operators the option to utilize unlicensed spectrum with a unified network, with potential operational cost saving, improved spectral efficiency and better user experience

Technologies for Services Improvements

Public Safety



Device-to-device (D2D):
solution for D2D discovery and communications under network coverage



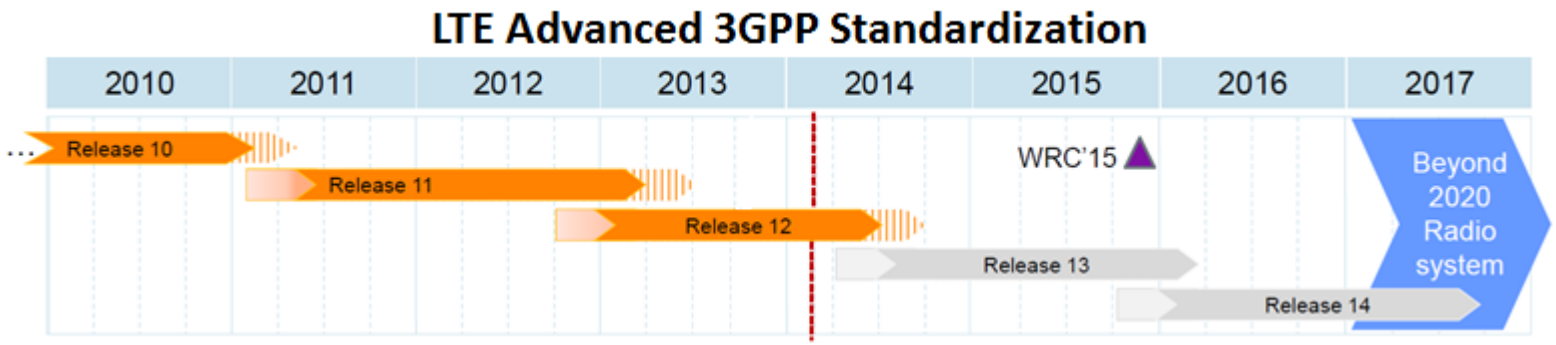
eMBMS measurements:
Definition of eMBMS-related measurements to be used for planning purposes e.g. to optimize the quality of MBMS services being delivered

LTE-Adv main features

LTE-Advanced is based on the same LTE radio interface technology but adds the following main new functionality:

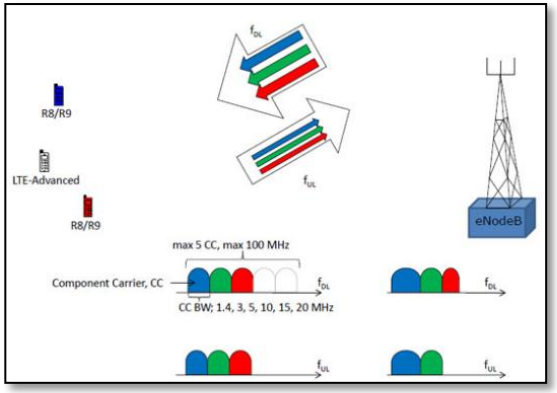
- Carrier Aggregation
- MIMO
- Relay Nodes
- CoMP

Item	IMT-Advanced Requirement	LTE-Advanced Projected Capability
Peak Data Rate Downlink		1 Gbps
Peak Data Rate Uplink		500 Mbps
Spectrum Allocation	Up to 40 MHz	Up to 100 MHz
Latency User Plane	10 msec	10 msec
Latency Control Plane	100 msec	50 msec
Peak Spectral Efficiency DL[133]	15 bps/Hz	30 bps/Hz
Peak Spectral Efficiency UL	6.75 bps/Hz	15 bps/Hz
Average Spectral Efficiency DL	2.2 bps/Hz	2.6 bps/Hz
Average Spectral Efficiency UL	1.4 bps/Hz	2.0 bps/Hz
Cell-Edge Spectral Efficiency DL	0.06 bps/Hz	0.09 bps/Hz
Cell-Edge Spectral Efficiency UL	0.03 bps/Hz	0.07 bps/Hz



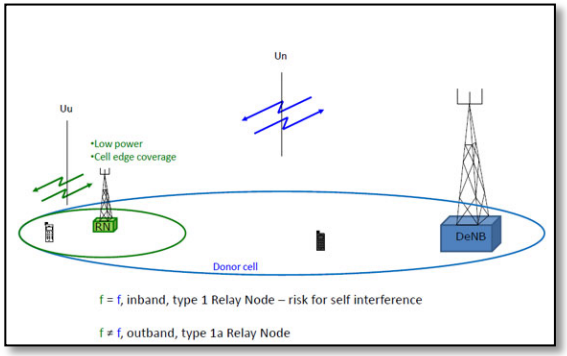
Main functionalities

The main new functionalities are:



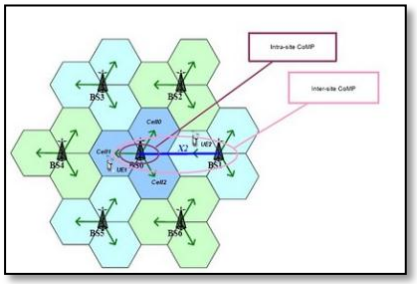
- **CARRIER AGGREGATION**: LTE-Adv uses carrier aggregation of multiple Components Carriers (CCs) to achieve high-bandwidth transmission. LTE-Adv can aggregate till 100MHz spectrum.

- **MIMO**: is used to increase the overall bitrate through transmission of two (or more) different data streams on two (or more) different antennas - using the same resources in both frequency and time, separated only through use of different reference signals - to be received by two or more antennas. LTE-Adv can support till 8+8 MIMO



- **RELAY NODES:** are low power base stations that will provide enhanced coverage and capacity at cell edges, and hot-spot areas and it can also be used to connect to remote areas without fiber connection.

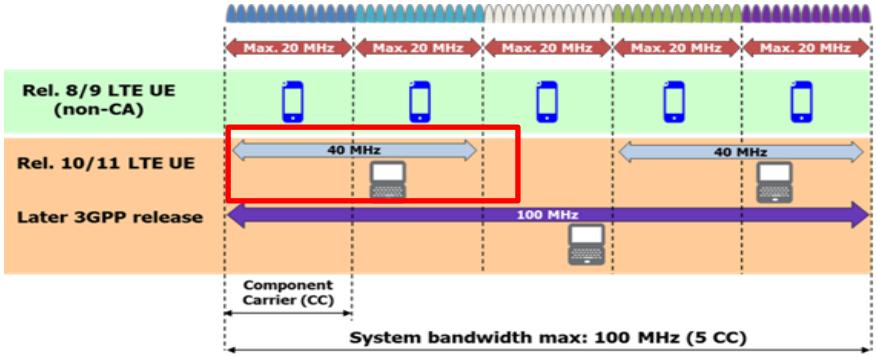
- **CoMP (Rel.11):** it is a technique involving the coordination of transmissions from multiple cells or transmission points, or the reception of transmissions from a single UE at multiple reception points.



CA: data rates

In LTE-Advanced Rel.10 standardization provide a downlink Carrier Aggregation for 2 component carriers and up to 20 MHz (10MHz + 10MHz) of combined bandwidth.

In Rel.11 it's possible to aggregate up to 40MHz (20MHz + 20MHz) of bandwidth.



The possibility to aggregate up to 40MHz of BW could be an opportunity to offer higher data rates to its customers.

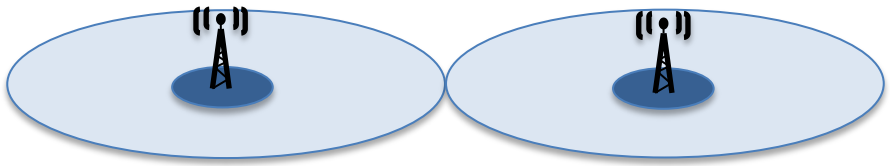
800MHz	1800MHz*	2600MHz	Peak data rate
5 MHz, 5 MHz		5 MHz, 5 MHz, 5 MHz, 5 MHz	225 Mbps
5 MHz, 5 MHz	5 MHz		110Mbps
	5 MHz	5 MHz, 5 MHz, 5 MHz, 5 MHz	187Mbps

*assuming refarming of 5MHz in 1800MHz band

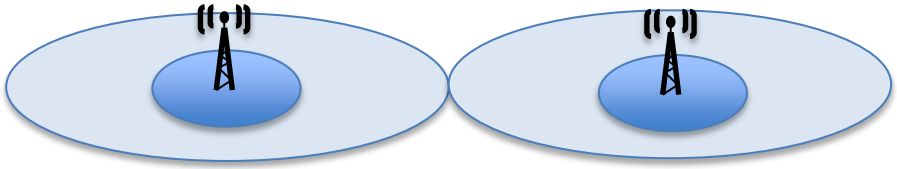
CA: possible band scenarios

CA is an opportunity for troughput boost in overlapped areas. The higher the overlapping the best the customer experience.

800MHz + 2600MHz



800MHz + 1800MHz



1800MHz + 2600MHz

Legend:
- 800MHz
- 1800MHz
- 2600MHz

Aggregation of these 2 bands can assure a better sites overlapping

CA is not standardized in a RAN multivendor environment (no LTE overlay scenario)

Devices

In June 2013 Qualcomm announced that enabled the world's first LTE-Advanced smartphone able to aggregate 10MHz + 10MHz: the Samsung Galaxy S4 LTE-A has been launched on all three mobile operators' LTE networks in Korea.

Based on Qualcomm information in Europe devices that support 10MHz + 10MHz CA cannot work if on network side it's implemented a different combination of CA (i.e. 20MHz + 10MHz). When new chipset's devices will support 20MHz + 20MHz CA it will be allowed any kind of combination up to 40MHz of BW (i.e 20MHz + 5MHz).

Qualcomm has announced that from 4Q2014 will be introduced in the market a new chipset for mobile devices able to aggregate up to 20MHz + 20MHz BW

WIND & Competitors

Last February **Vodafone** tested the new LTE-Adv network in **Napoli** using a prototype of Huawei router category 6; this device can reach a maximum downlink data rate of 300Mbps).

For this daily test Vodafone probably opened the own entire 1800MHz band to LTE-Adv and aggregated it with 15MHz in 2600MHz band, so it was possible to achieve a peak data rate of **253Mbps.**

800MHz	1800MHz	2600MHz	Peak data rates
	5 MHz, 5 MHz, 5 MHz, 5 MHz	5 MHz, 5 MHz, 5 MHz	262Mbps

On Last July **Telecom Italia** tested the new LTE-Adv network in **Torino** using a prototype of Samsung S5 Broadband LTE-A category 6; this device can reach a maximum downlink data rate of 300Mbps).

For this daily test Telecom Italia probably opened 10MHz of 1800MHz band to LTE-Adv (using 10 dedicated to GSM + 10MHz dedicated to LTE) and aggregated it with 15MHz in 2600MHz band, so it possible to achieve a peak data rate of **180Mbps**.

800MHz	1800MHz	2600MHz	Peak data rates
	5 MHz, 5 MHz	5 MHz, 5 MHz, 5 MHz	187Mbps

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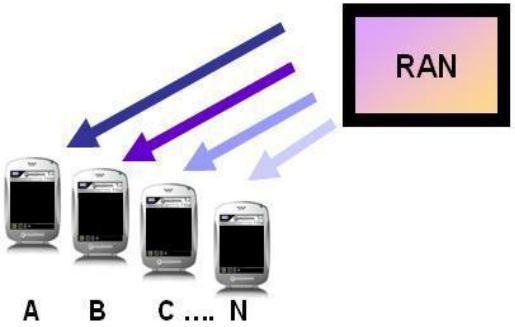
eMBMS : summary

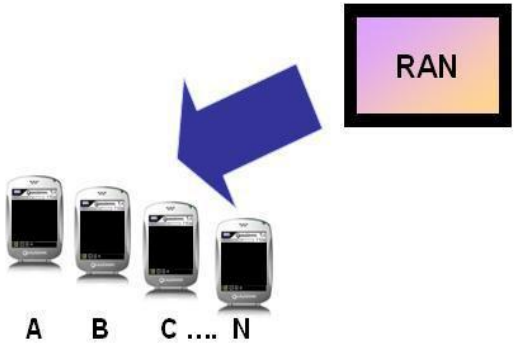
- eMBMS is a functionality available in LTE standard to implement the Broadcast service on mobile devices.
- Some trial have been announced (i.e. coverage of stadium to provide real time broadcast transmission during football match)
- Impact on Network is very high (radio resources; new entities to be added on Core Network MCE, MBMS-GW, BM SC; phase syncronization)
- Commercial device available since 2Q2014
- Verizon is the first operator to announce that it will launch eMBMS services, in 2014, over its LTE networks

Unicast VS Broadcast services

- Unicast
  - One to one transmission
  - Each user sends and receives data individually
  - Apps: E-mail, web-browsing, Media downloads
- Broadcast
  - One to many transmission
  - More efficiency and lower cost for common content using fewer network resources
  - Apps: Live Video/Audio streaming, OS updates



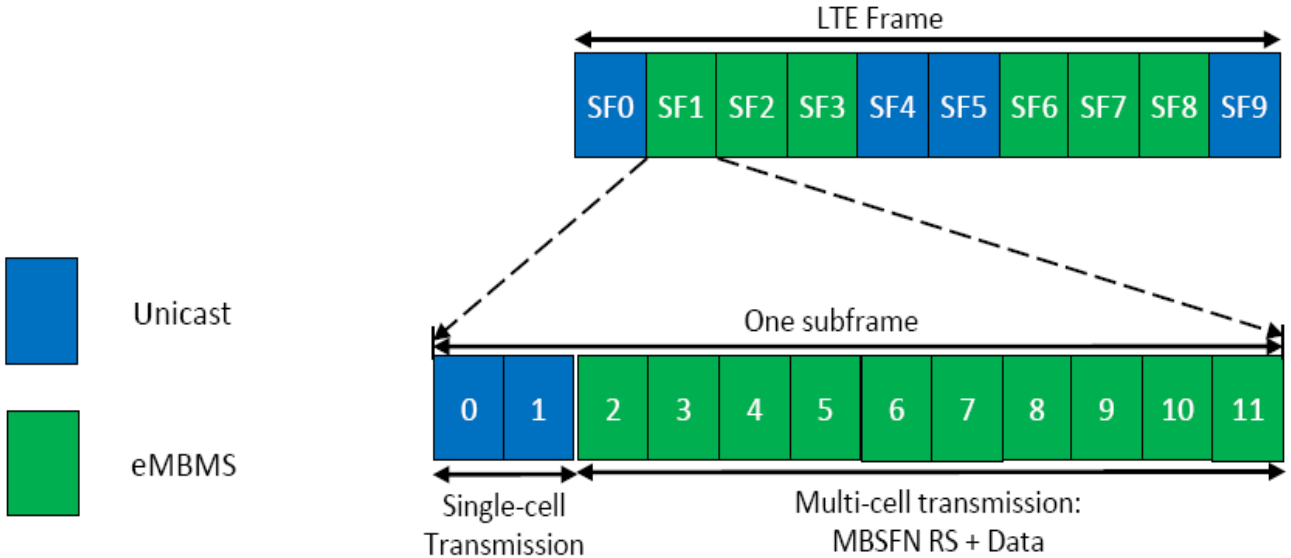
Unicast: users transmit and receive separately



Multicast: all users receive simultaneously

eMBMS: Feature Description

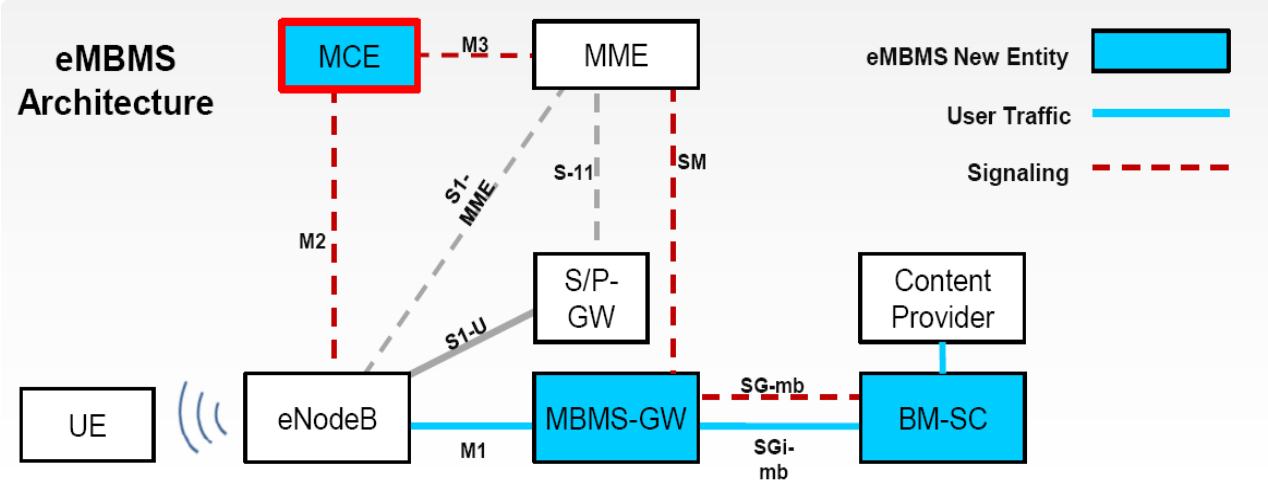
- eMBMS (enhanced **Multimedia Broadcast Multicast Services**) is an LTE-Adv functionality that provide a broadcast real time transmission (mobile TV)
- Broadcast and unicast transmissions are mixed by TDM in one common LTE carrier (similar to TDM ICIC functionality)
- LTE resources can be dynamically allocated to unicast or broadcast transmissions (reserved for eMBMS only when needed, i.e. in case of special events)
- LTE unicast capacity consequently is reduced only when eMBMS is active



eMBMS Requirements

- Transport Requirements
  - Phase synchronization (± 5 µs phase accuracy)
- Core Network Requirements
  - Additional Core Network Elements :MCE, MBMS-GW, BM SC
- Access Network Requirements
  - Huawei SW Rel. eRAN 7.0 : 2Q14
  - User Terminals compatible with MBMS : 2Q14

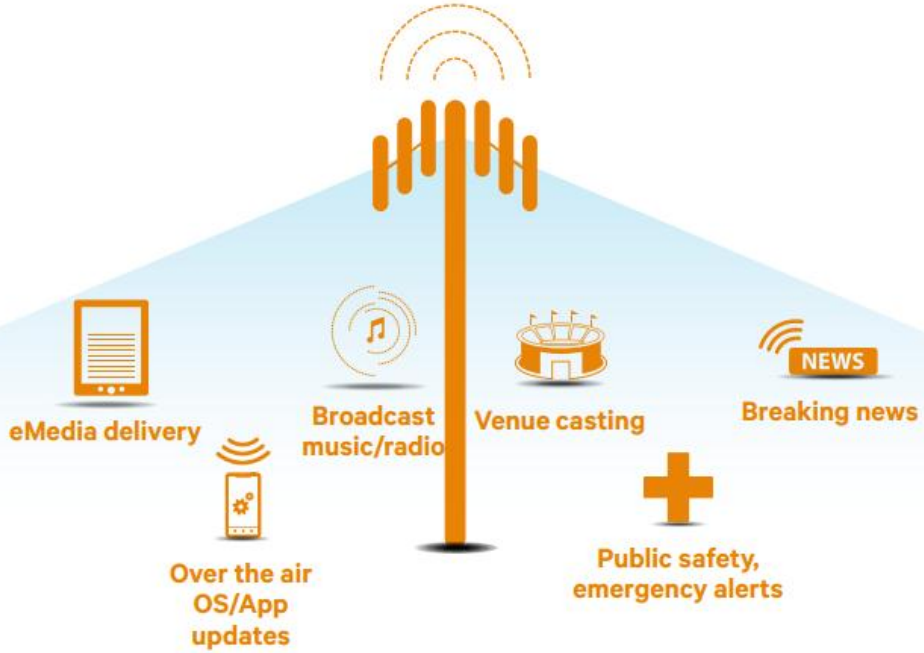
eMBMS Architecture



Huawei MCE (eRAN 7.0)

- BM-SC (Broadcast Multicast Service Center)
  - Provides membership, session and transmission, proxy and transport, service announcement, security, and content synchronization
- MBMS GW (eMBMS Gateway)
  - Distribute MBMS user plane data to eNBs using IP Multicast
  - Perform MBMS Session Control Signaling towards the E-UTRAN via MME
- MCE (Multi-cell/multicast Coordination Entity)
  - The MCE can be a separate entity or as part of eNB
  - Provides admission control

eMBMS Opportunities

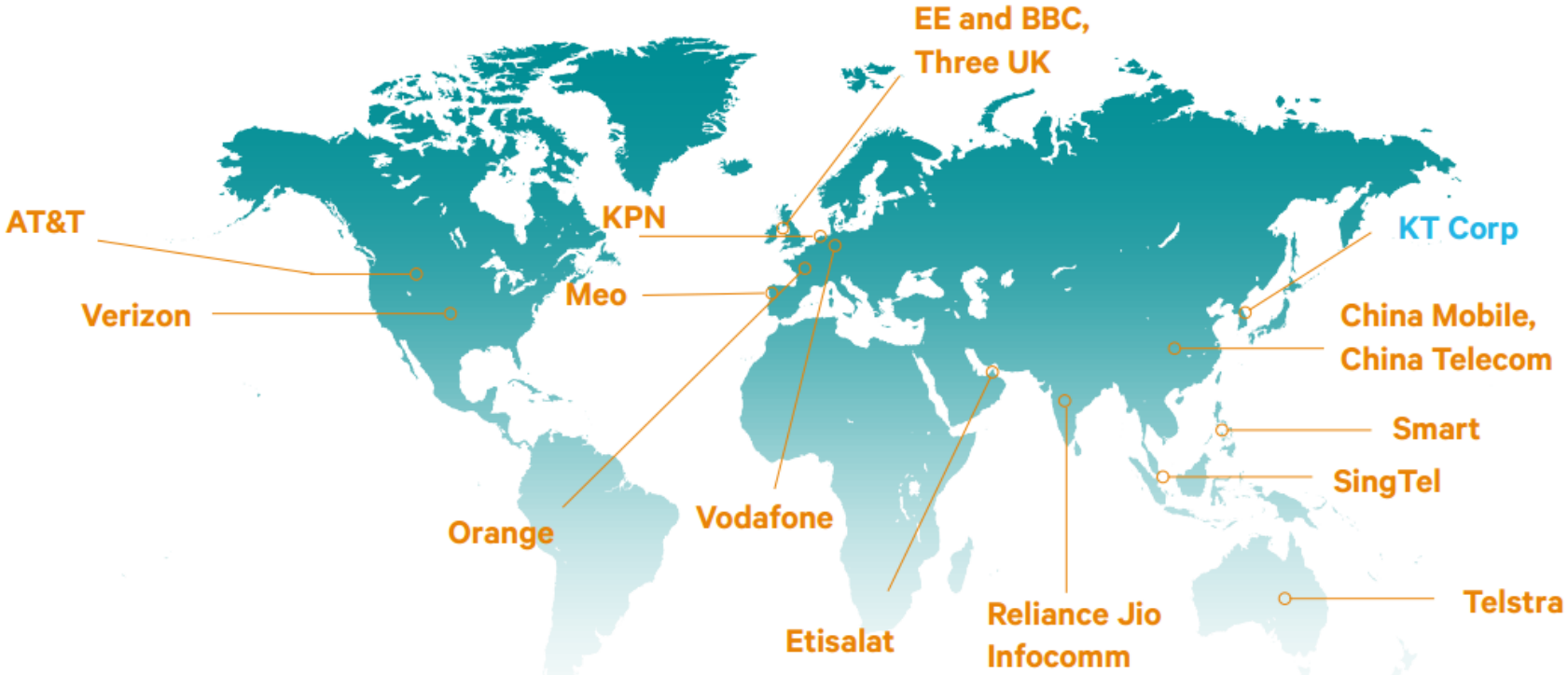


Significant data offload | **Enhanced user experience** | **More revenue opportunities**

Source: Qualcomm LTE broadcast and beyond

Leading Operators already embraced LTE MBMS

Commercial launch, launch plans, trails, demos, and commitments



Source: Operator press statements, news articles, and www.gsacom.com

Source: Qualcomm LTE broadcast and beyond

AGENDA

- Introduction
- Mobile Broadband definition
- MBB status in Italy
- MBB: traffic evolution
- LTE-Advanced and eMBMS
- **MBB: mobile devices evolution**

HSPA+/LTE main interesting features

	Possible application	Chipset	UE Availability
UMTS	42Mbps (1 carrier @900 MHz+ 1 carrier @2100 MHz)	Available now for trials using Qualcomm reference devices	TBD (*)
	63 Mbps (3 Carrier @2100 MHz)	H2 2014 available for Trials using Qualcomm reference devices	TBD (*)
	84 Mbps (3 carrier @ 2100 MHz + 1 Carrier @ 900 MHz)	Not planned	Not planned
LTE	2C interband CA (10+20)	NOW (SD805)	End of Q3 2014
	3C interband CA (10+20+5/10)	1Q15	H2 2015

- Even if chipset have been developed (trial) advanced CA features on 3G (21Mbps@2100MHz + 21Mbps@900MHz; intraband 63Mbps and 84Mbps) seems not pushed on devices'market
- **On the other hand LTE CA features (interband till 40MHz) should be available in in medium/short term (NTW and devices): end of 2014 for 2 band and 2Q2015 for 3band**

(*) Chipset manifacturing ready for production but no request is coming from Terminal market

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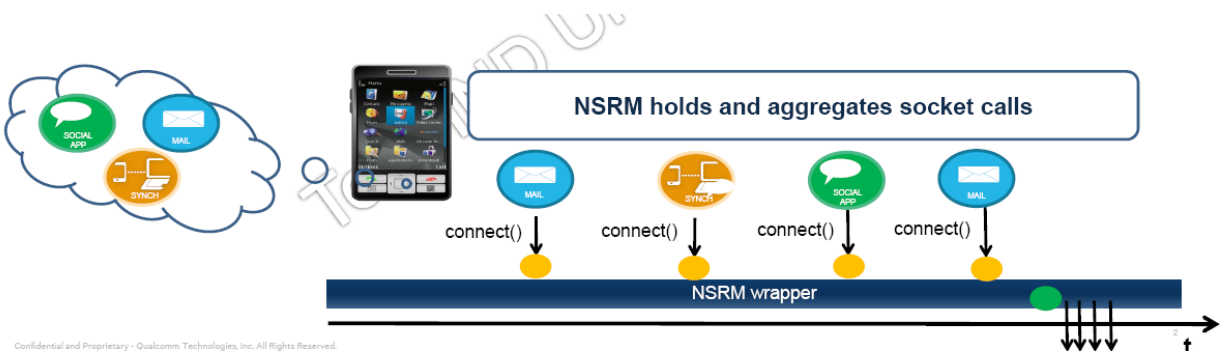
Chipset Optimization Features

The smartphone challenge are Signaling Congestion and Power Consumption.

There are some features/functionality embedded in the chipsets that should be taken into account as they do not require specific network features support and could help operators in Network Capex efficiency. The more interesting:

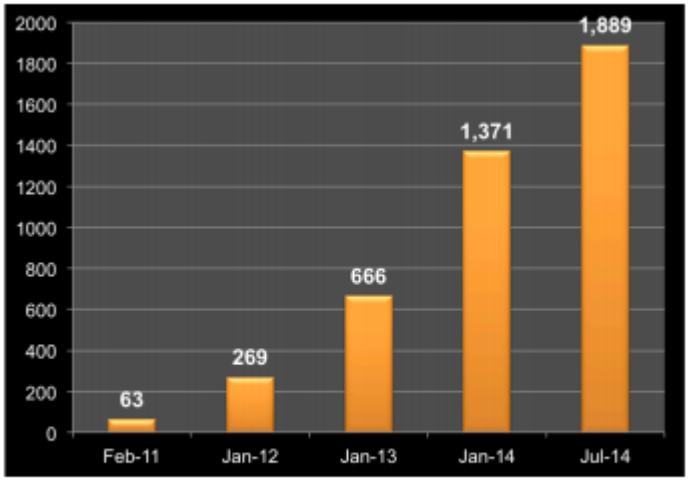
- **Network Socket Request Manager (NRSM):** This solution prevent network signaling congestion joining and holdings the connection requests of running apps instead of immediately sending them; moreover it postpones requests if the terminal is not in use. In particular in 3G technology this functionality seems reduce up to 50% of the RNC signaling processing load. Operator can manage the functionality. No impact on user experience → CAPEX Savings



- **RX Diversity MIMO2x4 with four Rx at UE side:** in field tests show that, at cell edge, MIMO 2x4 performances are comparable to MIMO 4x4. Main advantage of this solution is that no investments are requested on network side to improve cell edge performance (i.e. 4 TX on BS; FFR) → CAPEX Savings

UE Vendors could be not interested in activating these kind of features. Sometime they propose similar features developed at application level (less effective and without operator managing)

LTE devices ecosystem (1/2)



LTE user devices growth
© GSA – Global mobile Suppliers Association

LTE FDD	
1800 MHz band 3	769 devices
2600 MHz band 7	740 devices
2100 MHz band 1	544 devices
800 MHz band 20	467 devices
800/1800/2600 tri-band	413 devices
AWS band 4	405 devices
700 MHz bands 12 or 17	379 devices
850 MHz band 5	345 devices
900 MHz band 8	335 devices
700 MHz band 13	308 devices
1900 MHz band 2	220 devices
1900 MHz band 25	107 devices
APT700 band 28	33 devices

1,889 user devices by 168

LTE / 3G fallback support

- 1,354 LTE devices also operate on either HSPA, HSPA+ or DC-HSPA+ networks
- 691 LTE devices support DC-HSPA+
- 170 LTE devices also support TD-SCDMA

98.3% of LTE phones are multimode/3G capable
37.7% of LTE phones support DC-HSPA+
93.1% of LTE tablets are multimode/3G capable
30.2% of LTE tablets support DC-HSPA+

LTE devices ecosystem (2/2)

LTE UE device **Category 4** offers an enhanced user experience supporting a peak downlink data rate up to 150 Mbps and peak uplink up to 50 Mbps. Operators in several countries have commercially launched or are deploying networks that support Cat 4 devices. **373 devices** support Category 4, i.e. almost 20% of all LTE devices.

LTE-Advanced system operate in spectrum allocation wider than 2x20MHz used in most LTE Networks. LTE-A 300Mbps systems (with **Category 6** devices) represent a further gain by combining 40MHz of paired spectrum using carrier aggregation. **7 devices** already support category 6.

VoLTE (initially deployed to offer HD voice) requires an LTE core and radio network and user terminal that supports SIP-based voice service i.e. IP based communication services over IMS core network. **92 phones** (Asus, Fujitsu, Huawei, LG, Pantech, Samsung, Sharp and Sony Mobile) support VoLTE.

1800MHz is the most popular spectrum for LTE deployments and is used in 43% of commercially launched LTE networks globally. GSA believes that 1800 MHz (band 3) will continue as the prominent band for LTE network deployments for the foreseeable future and be the major enabling band for international LTE roaming. **769 LTE1800** (band 3) user devices are announced.

source GSA: Status of LTE ecosystem July 2014

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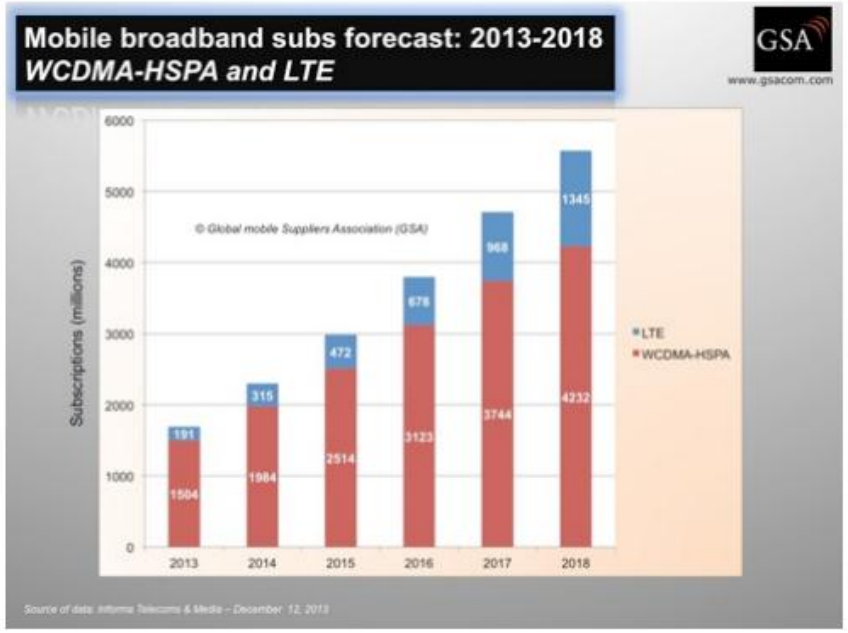
Macro trend coming from worldwide market

LTE is growing faster than 2G and 3G did.



MOREOVER… Qualcomm is announcing in 2015 a widespread availability of low cost LTE chipsets cat4 (150Mbps in DL, CA 10+10MHz) and cat6 (300Mbps in DL with CA20+20MHz).

The request come from some huge LTE operators in the East (TDD and FDD) interested in getting more spectrum efficiency freeing as soon as possible their 2G/3G bands.

The effects will reach Europe too, speeding up LTE network development and user device growth.

Handset Conclusion

- Customer experience of network performances strictly depend on chipset/device available/allowed functionalities.
- Operators in the next future should pay attention to UE chipsets technical characteristics and push Ues' Vendors to activate interesting features and functionality already embedded in the chipset.
- Worldwide trends seem to strongly push on LTE network development and on LTE advanced functionality implementation instead of going on with HSPA+ development (i.e. advanced CA features).
- The availability of low cost 3G/LTE chipset starting from 2015 can speed up device innovation freeing current 2G spectrum for more efficient technology deployment.

“Sometimes to really communicate, technology isn’t everything”

WIND
Più vicini.