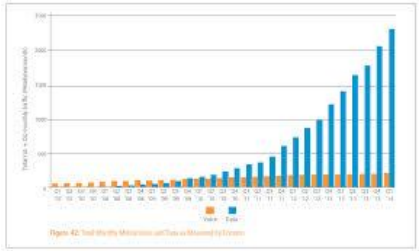
The future of Mobile: 4G evolution and 5G

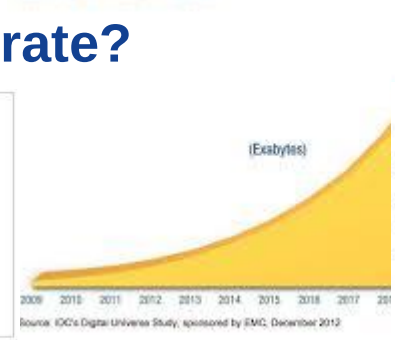
Telecom Infra, Rotterdam

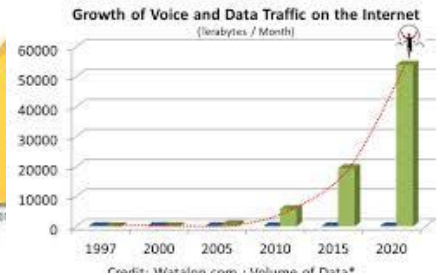
Anne van Otterlo

25-03-2015

Will data demand saturate?







Cisco VNI study, world average 2GB/month/human by 2018

➔ Cloud, Things & Video (79% of mobile traffic by 2018)

IP Traffic, 2013–2018							
	2013	2014	2015	2016	2017	2018	CAGR 2013–2018
By Type (Petabytes [PB] per Month)							
Fixed Internet	34,952	42,119	50,504	60,540	72,557	86,409	20%
Managed IP	14,736	17,774	20,898	23,738	26,361	29,305	15%
Mobile data	1,480	2,582	4,337	6,981	10,788	15,838	61%

Source: Cisco VNI study, June 2014

2005: Joseph Ratzinger election

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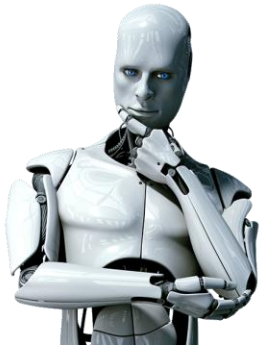
2013: Jorge Bergoglio election

Only 8 years, but a lot changed...
… so where will we be in 2020?

- Data Volume?
- Usage & Behavior?
- Machines?
- Devices?

Use case category	Connection Density	Traffic Density
Broadband access in dense areas	200-2500 /km^2	DL: 750 Gbps / km2 UL: 125 Gbps / km2
Indoor ultra-high broadband access	75,000 / km^2 (75/1000 m^2 office)	DL: 15 Tbps/ km2 (15 Gbps / 1000 m2) UL: 2 Tbps / km2 (2 Gbps / 1000 m2)
Broadband access in a crowd	150,000 / km^2 (30.000 / stadium)	DL: 3.75 Tbps / km2 (DL: 0.75 Tbps / stadium) UL: 7.5 Tbps / km2 (1.5 Tbps / stadium)

Source: NGMN 5G Whitepaper



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Nokia Technology Vision 2020

"1GB of personalized data per user per day profitably"

Key requirements for networks towards 2020

- Support up to 1000 times more capacity 
- Reduce latency to milliseconds 
- Teach networks to be self-aware 
- Flatten total energy consumption 
- Reinvent Telcos for the cloud 
- Personalize network experience 

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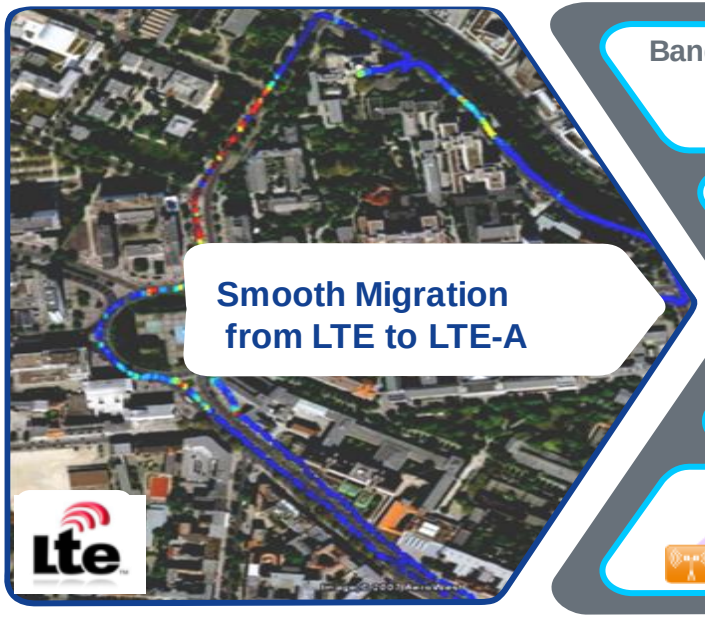
LTE-Advanced

Key Ingredients or Toolbox of Features



More bandwidth

Bandwidth Extension / CA

100 MHz

More antennas

MIMO

8x

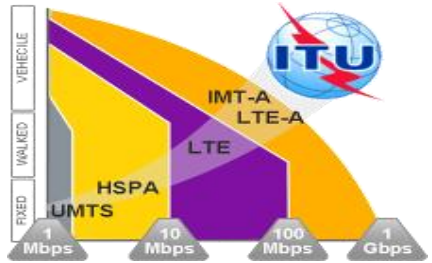
4x

Cooperative Systems

Cooperation

Relaying

Backward compatible to LTE



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Heterogeneous Networks

More sites

LTE: 3GPP Release 8, 9
LTE-A : 3GPP Release 10, 11, 12

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Carrier Aggregation Market Introduction in Korea

Since mid 2013

- Korea is the most advanced LTE market, LTE subs (23 Mio) passed 3G subs (22 Mio) in June 2013
- LTE-A Carrier Aggregation launched, and heavily promoted by the operators, few UEs (Samsung, LG) widely available
- CA data-rates can be frequently experienced in everyday use, ~40ms latency is the norm

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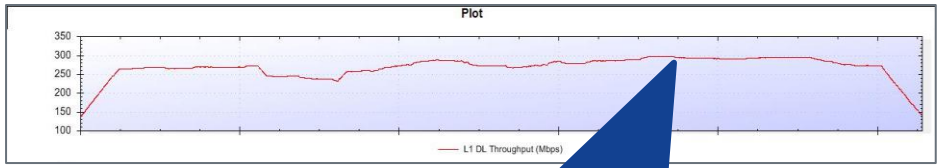
Further examples: 20+20 MHz, LTE TD & FDD Carrier Aggregation, …



Peak rate hitting 300 Mbps

elisa BROADCOM. Connecting everything® nsn

Press Release
Espoo, Finland – February 11, 2014

Broadcom and NSN demonstrate Category 6 LTE-Advanced 300 Mbps on live commercial network from Elisa
Milestone delivers 2X the speed of the fastest LTE generally deployed today

Broadcom Corporation, Nokia Solutions and Networks (NSN) and Finnish operator Elisa today announced the first ever demonstration of LTE Advanced (LTE-A) carrier aggregation Category 6 (Cat 6) data rates of 300 Mbps on a live commercial network in the Nordic Countries. The achievement represents an important milestone for all three companies with the goal of delivering a superior mobile experience to consumers.

Press Release, June 11th:

Nokia, SK Telecom achieve 3.78 Gbps throughput speed on converged TD and FD LTE spectrum

Nokia and SK Telecom have achieved a throughput speed of 3.78 Gbps on the converged TDD and FDD LTE spectrum. The trial used combined 10 spectrum frequencies allocated for both LTE variants for 200 MHz of bandwidth.

The throughput speed of 3.78 Gbps enables mobile broadband users to download a full-length 5 GB high-definition (HD) movie in 11 seconds.

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LTE Evolution: New Use Cases

New Application Areas

Internet of things	LTE-M = Machine-to-Machine
Proximity services	LTE-D = Device-to-Device
Replace terrestrial TV	LTE-B = Broadcast = eMBMS
Run public safety on your LTE	LTE-R and LTE for Public Safety
Move voice to IP in LTE network	LTE for Voice (VoLTE)
Connectivity for car entertainment	LTE for Connected Cars
Wi-Fi backhaul for airplanes	LTE for Airplane Connections

New Spectrum

500 MHz more spectrum at 5 GHz	LTE-U = Unlicensed Band
Sharing with incumbent user	Authorized shared access
LTE on 470 – 700 MHz	LTE on UHF Bands

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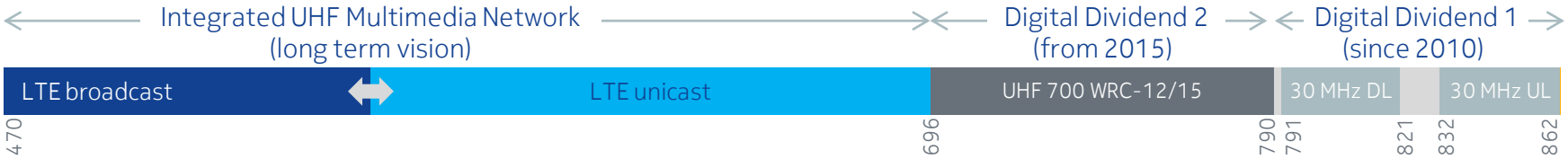
LTE makes best use of the valuable spectrum below 700 MHz



LTE broadcast for up to 25 TV channels covering the most popular programs including public service broadcast

Massive capacity for non-linear content (Video on-demand, niche channels and a multitude of MBB services)

Dynamic spectrum allocation between broadcast and unicast = full flexibility

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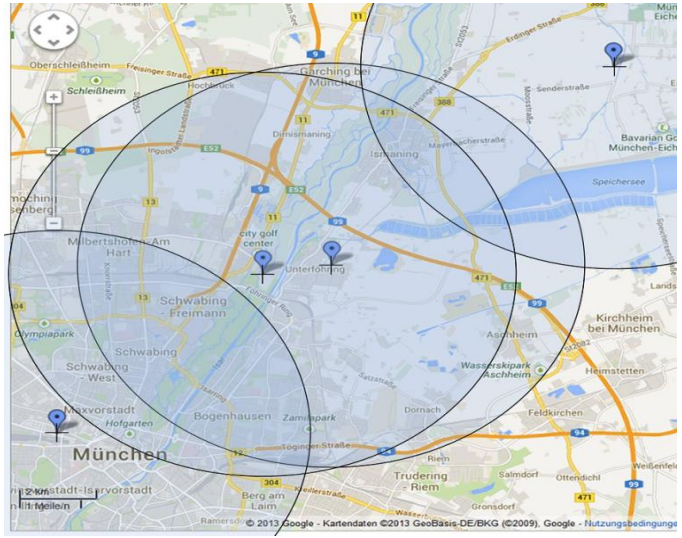
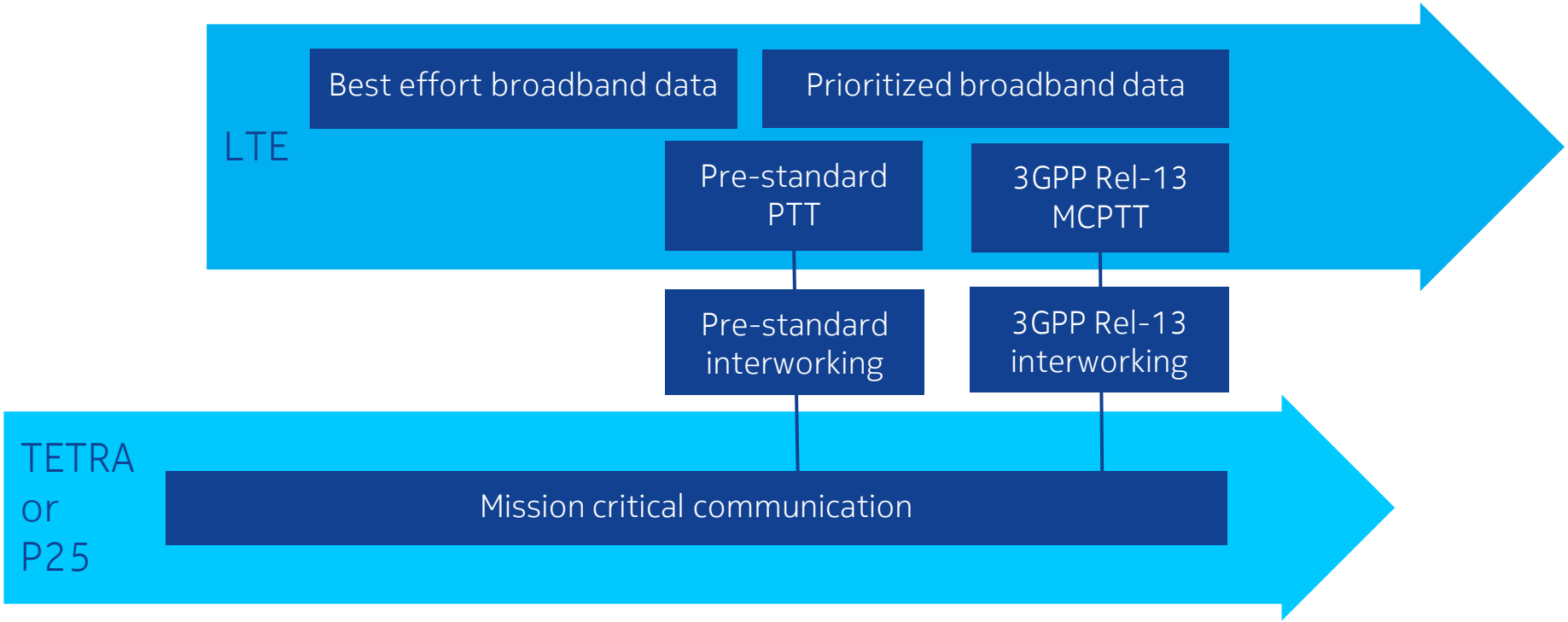
eMBMS live trial in Munich, Germany

- Evolved Multimedia Broadcast/Multicast Service (eMBMS) software running in Nokia Flexi Multiradio 10 Base Stations
- SFN with four sites of the Bavarian broadcast company, Bayerischer Rundfunk, covering over a 200 km2 area in Northern Munich.
- LTE broadcast trial began transmissions in early July 2014 in Munich, Germany
- The trial uses a test license in band 28 or “APT700”.
- 10 MHz (several SD channels, some HD channels)
- Qualcomm terminals



Public safety network evolution



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LTE-R: main drivers for a Next Gen Railway Communication System

Broadband Applications

How will railway systems be operated in 10 years?

- Increasing use of data apps and new operational services require efficient networks
- LTE offers more than changing the radio interface

Today

Data applications – from LOW to HIGH bandwidth

Security solutions	ETCS	Passenger counting	Passenger information	Video surveillance
Train positioning	Fleet management	Train diagnostic monitoring	Online ticket sales	Announcement updates

Low bandwidth (CSD, SMS, GPRS)

High bandwidth (LTE,...)

Next Generation Railway Mobile

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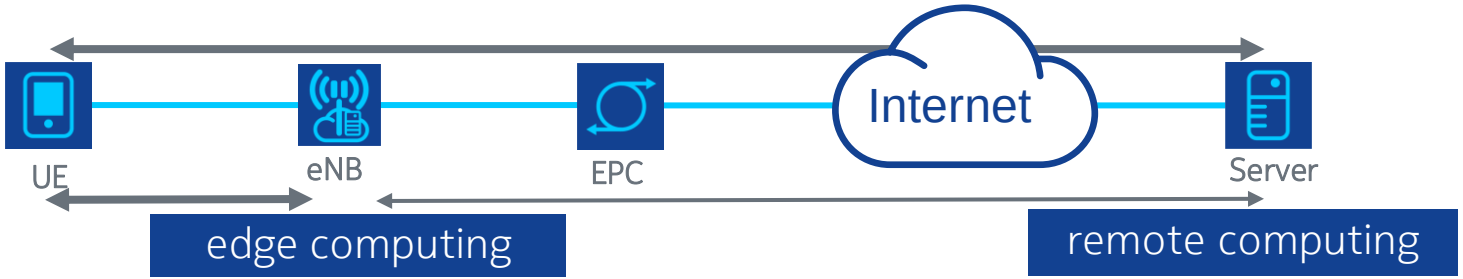
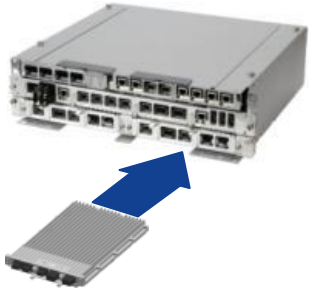
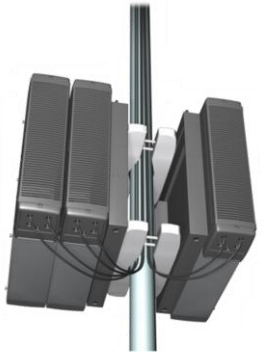
Mobile Edge Computing addresses the latency topic







What is it:
- Computing & Applications
- Storage & Content
- Open platform (App factory)

in the base station (eNodeB)

Use cases:
- Real time services
- Augmented Reality
- Caching and content
- …

Benefits:
- Low Latency
- Intelligence
- Innovation
- Efficiency

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Showcase: car-to-car and car-to-roadside communications

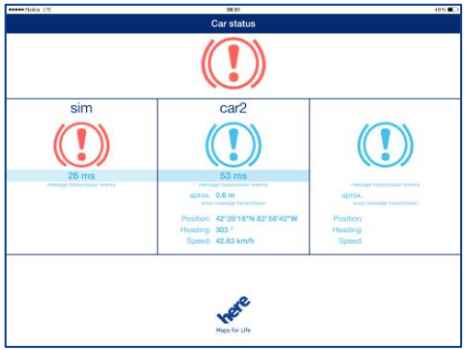
Mobile Edge Computing and LTE as basis for low latency reliable communication

20…50ms

delay between message generation by one car and message reception by other cars in the vicinity

0.5…1.5m

distance covered by other cars after message generation, e.g. a hard brake warning



Public technology showcase with

T-Mobile · here · HONDA

Notes

- This showcase was presented at ITS World Congress 2014 in Detroit, on the booth of HERE
- A T-Mobile US base station, equipped with RACS, was providing coverage at the event location
- Messages were generated by a simulator (hard brake, see picture) and real Honda cars driving on a nearby track

Public references

- Nokia blog
- HERE blog

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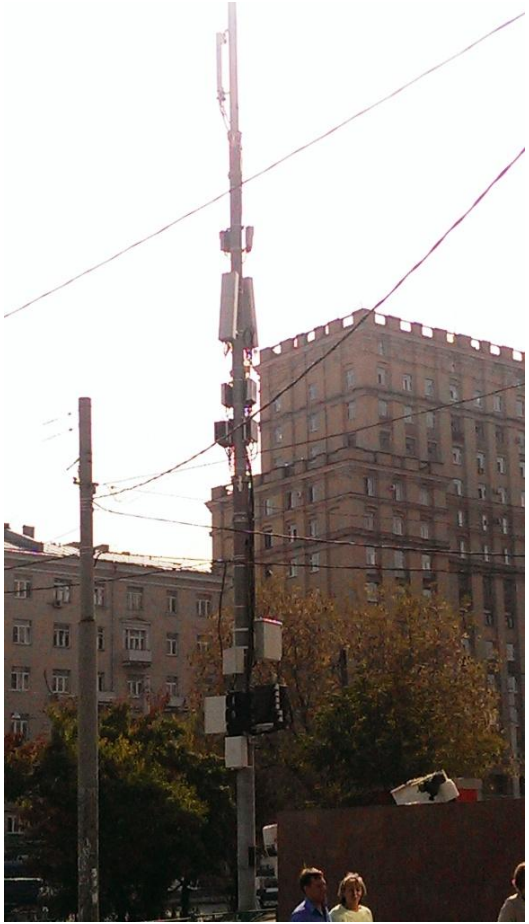
Site Challenges

Moscow examples



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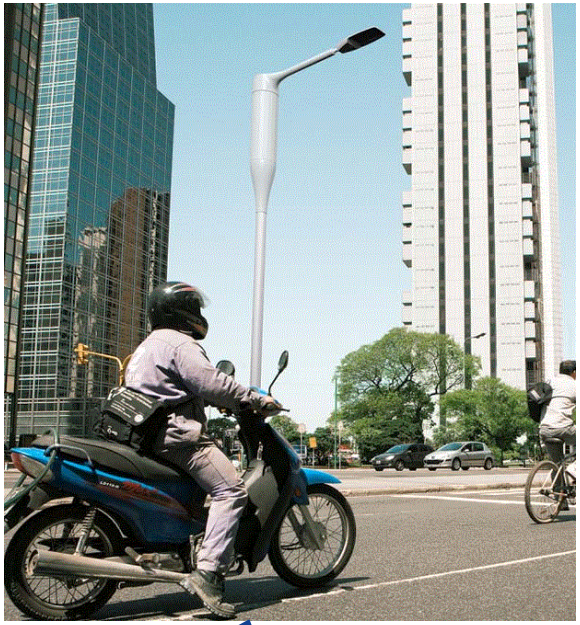
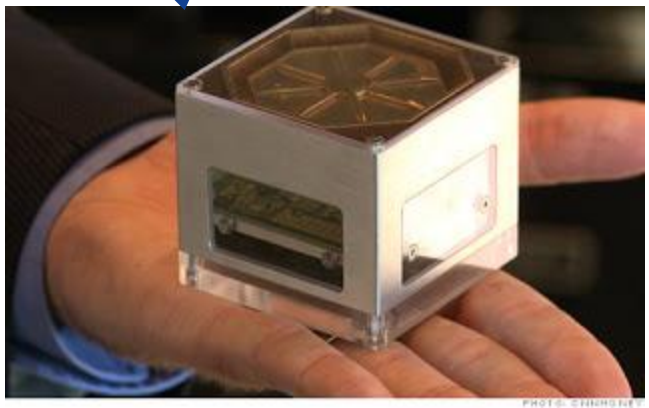
Denser networks, Small Cells, and HetNets …



Ericsson and Philips

Alcatel-Lucent Atom Cell



Nokia FlexiZone

… backhaul remains the challenge

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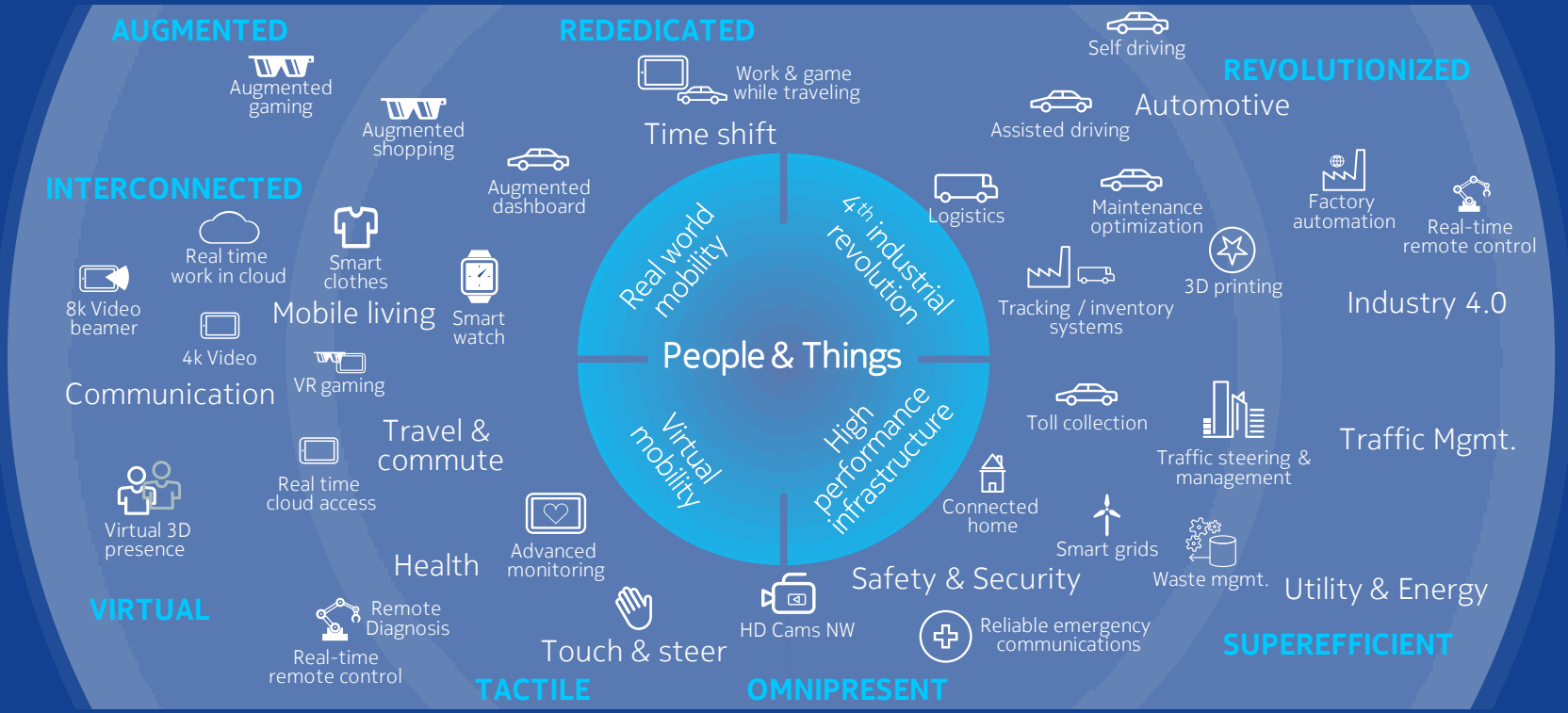
5G: designed to support an explosion of possibilities



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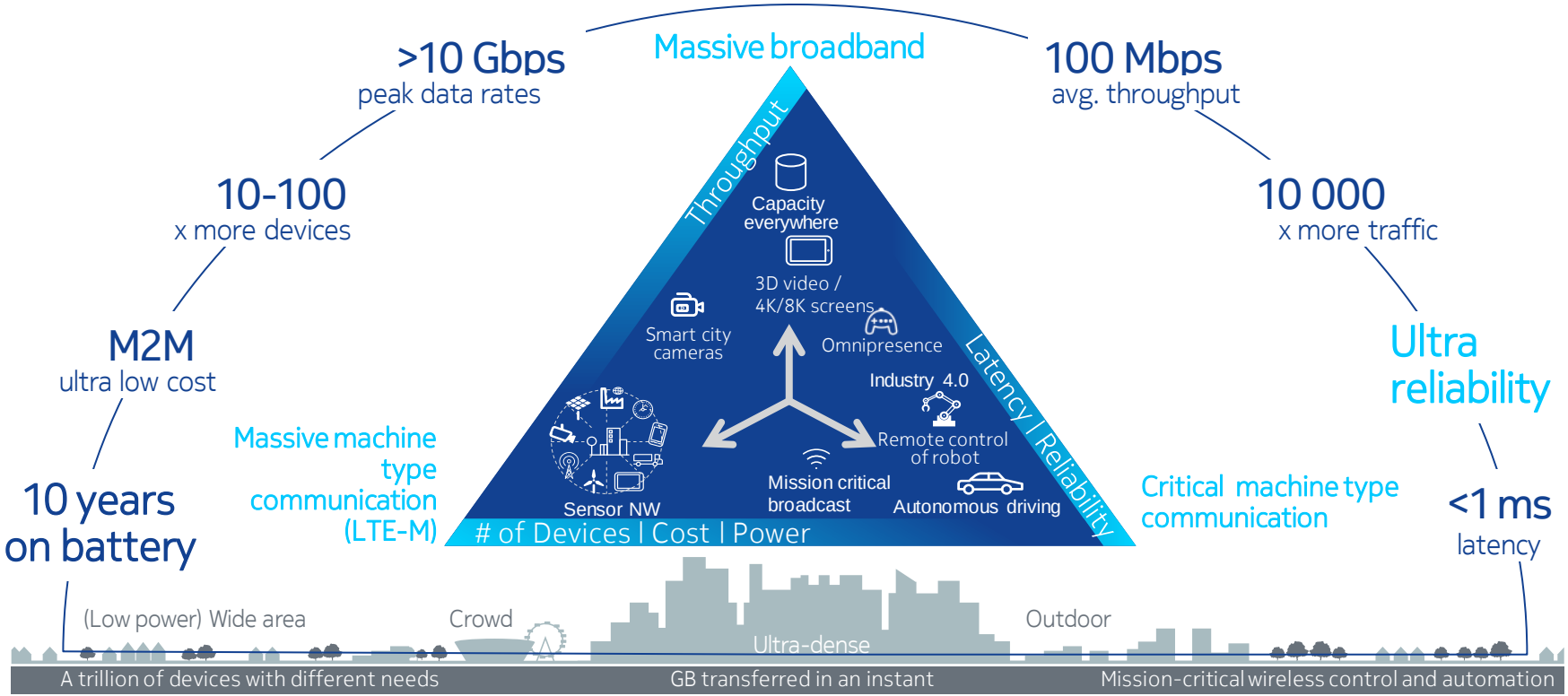
Meeting extreme requirements



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GSM-A report on 5G identifies latency and data speed as main drivers

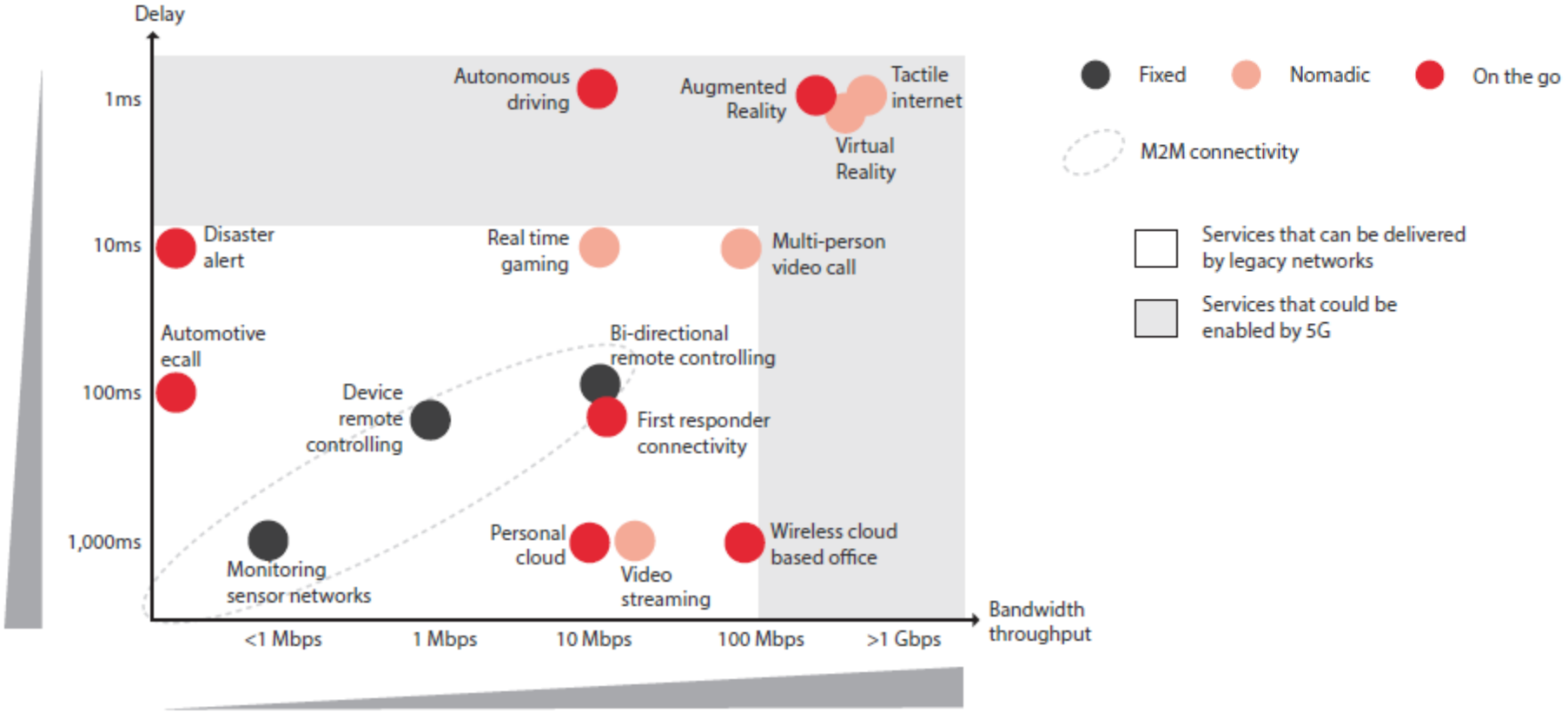
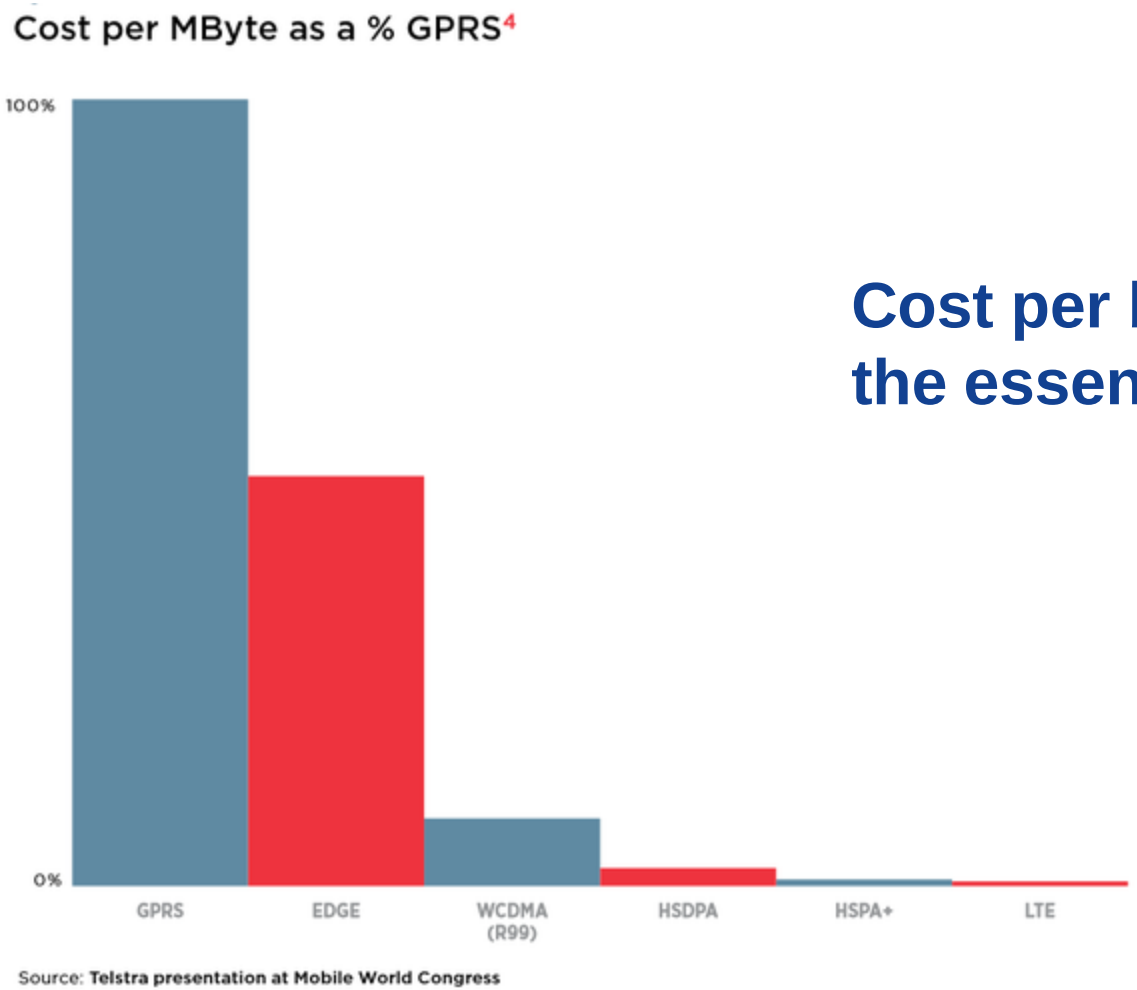


Figure 1: Bandwidth and latency requirements of potential 5G use cases

Source: GSMA Intelligence



Cost per bit is the essential KPI

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