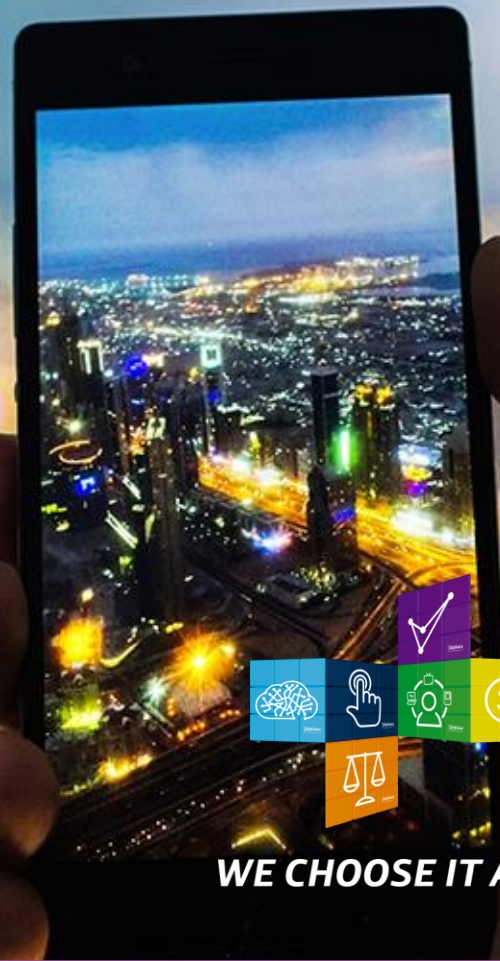# The Journey to 5G

A path to excellent connectivity

Global CTO - Telefónica

Mobile World Congress
Feb 2017

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Network Evolution has to cope with several critical points

Current deployment model (add spectrum, add infrastructure) does not scale well when confronted with the new challenges ahead:

- **Traffic growth**
- **New traffic patterns**
- Ever **growing number of connected devices**, some with unprecedented coverage requirements
- **Spectrum and technology decisions** take much longer than the lifecycles of most new services
- **New business opportunities** not addressable by current technologies
- Current network **upgrade model** does not scale well with the foreseen **data explosion**

5G can represent an excellent opportunity to foster a new network revolution
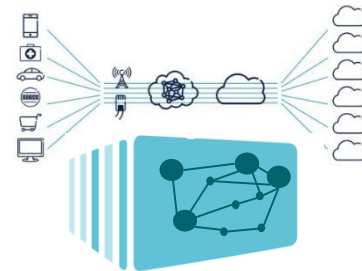
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5G should be able to take cost and economic sustainability into account

INDUSTRIES

Open the door to **vertical industries**

5G

Introduce **new services** in an economically **sustainable way**

Deliver **diverse services over a single network infrastructure** through **network slicing**
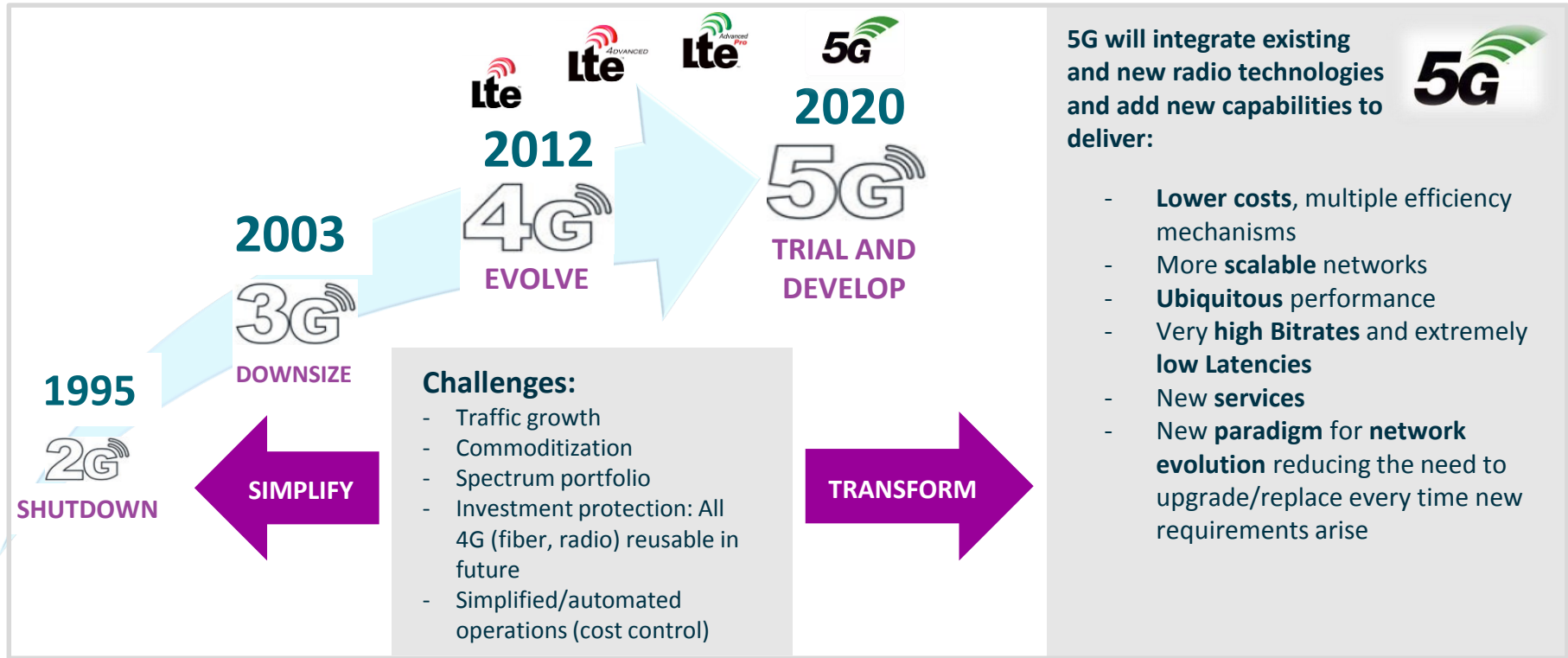
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5G brings new technological innovations

Network **capabilities will be increased** through the use of **advanced innovations**, like the following ones:

- **New radios** operating at **ultra-high frequencies** (up to 100 GHz), with **huge bandwidths** (hundreds of MHz) for unprecedented immersive video experience
- A new and flexible **Transport Architecture** capable to leverage existing transport means
- A new **Network Architecture** supporting **network slicing on the basis of NFV, SDN and MEC**
- Flexible assignment of **centralized/distributed network functions** for multiple scenarios
- Increased capacity per surface area by using **massive numbers of antennas** at the BS side
- A new **mobility paradigm**, less dependent on the device under full control of the network
- Advanced support of **machine-type traffic** (both for ultra-reliable needs and for sensor-like massive connections)
- **Ultra-low latency and ultra-high reliability** for critical applications
- Fixed/mobile convergence

5G is another step in the development cycle of our Wireless Technologies

1995

2G

SHUTDOWN

2003

3G

DOWNSIZE

2012

4G

EVOLVE

Lte
Lte Advanced
Lte Advanced Pro

2020

5G

TRIAL AND DEVELOP

5G

← SIMPLIFY

Challenges:
- Traffic growth
- Commoditization
- Spectrum portfolio
- Investment protection: All 4G (fiber, radio) reusable in future
- Simplified/automated operations (cost control)

TRANSFORM →

5G will integrate existing and new radio technologies and add new capabilities to deliver:

5G

- Lower costs, multiple efficiency mechanisms
- More scalable networks
- Ubiquitous performance
- Very high Bitrates and extremely low Latencies
- New services
- New paradigm for network evolution reducing the need to upgrade/replace every time new requirements arise

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Business case for 5G is the key question

Vertical industries may bring new businesses

Challenge

| Ultra-low latency, ultra-high reliability |
| 5G-IoT services are largely undefined |
| Acceleration of 3GPP standards |
| Economics of enhanced FWA to be proved |

3GPP use case

URLLC

mMTC

eMBB

eFWA

More feedback from industries is required for 5G to be able to address the needs from verticals

- The different use cases to be supported in 5G have **different requirements**, not only in terms of **performance** (latency, throughput and availability), but also in terms of **functionality**

- New **business models** will be mainly enabled by the **network slicing** in the 5G network, thus providing the flexibility required for the **customization of the network**

- Up to now only the automotive industry is steering the definition of 5G requirements and standards through the **5G Automotive Alliance**
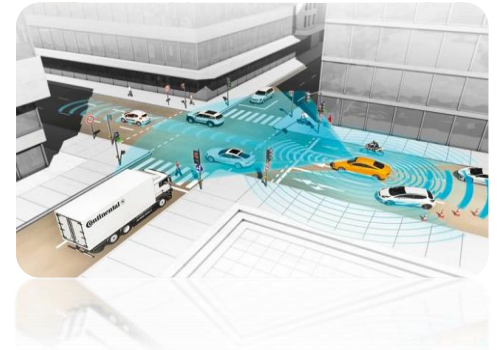
5GAA
Automotive Association

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We are actively contributing to the development of 5G

Cooperating for global adoption (Standards)

- Participating in **standardization bodies** (GSMA, 3GPP, ONF, ETSI NFV and MEC ISGs, ITU-R), as well as other forums that influence the standardization process, like NGMN or 5G Americas.

Participating in the Technology development

- Working actively in **EU research programs** (Horizon 2020 program, 5G PPP), both in Phase I and in the upcoming Phase II (more than 20 proposals submitted).
- Contributing to, and supporting, the 5G Manifesto.

Collaborating with the Industry players

- Bilateral **cooperation agreements** (MoUs) with some of the main players in the ecosystem (Ericsson, Huawei, Intel, ZTE, and more to come), in order to have access to confidential developments.

Setting up spaces for In-house R&D, Innovation

- Creating an **open 5G lab, 5TONIC**, for open experimentation and co-creation of new 5G services and products involving technology providers, operators and final users (including verticals).

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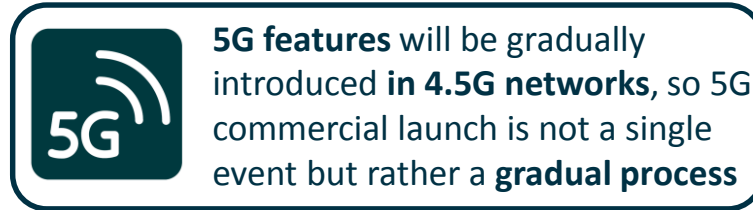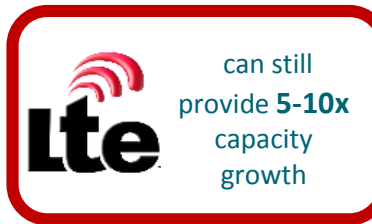# LTE keeps playing an essential role in our strategy

4G networks will be progressively evolving towards 5G

There are thee fundamental reasons for keeping **LTE** as an **essential asset**:

1. **Investments** and rollouts are still ongoing

2. Evolved LTE will be an integrating part of **non-standalone 5G systems**

3. LTE can serve for the **early introduction** of new 5G capabilities (e.g. Cloud RAN, massive MIMO…)

Some LTE advanced features can be gradually introduced:

- New **radio capabilities** (shorter TTIs, massive MIMO…)

- New **services** (FWA, CIoT, vehicular…)

- New **network capabilities** (CloudRAN, SDN/NFV…)

- New **frequency bands** (3.5 G, unlicensed bands…)

can still provide **5-10x** capacity growth

is one of the future pillars of our **Excellent Connectivity**

5G features will be gradually introduced **in 4.5G networks**, so 5G commercial launch is not a single event but rather a **gradual process**

Next 5G deployments will require:

- **New** network capabilities

- **Pervasive use of fiber** for the backhaul (alternatives also required, like mmwaves)

- Reliance on **Evolved LTE**

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NB-IoT and LTE-M solve the most important connectivity hurdles of present IoT communications

Applications **better suited for LTE-M** if they require

- Mobility
- Voice
- Less tolerance to latency (10-15 ms)
- Higher throughput class
- Bigger messages

Applications **better suited for NB-IoT** if they require

- No mobility
- No voice
- Latency (1-4 s)
- Ultra low data
- Small messages

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Currently, we are getting our networks ready for IoT explosion

Analyzing HW installed

- Analyzing in depth HW installed based in our networks and its readiness for NB-IoT/LTE-M

Preparing our Networks

- Preparing our networks with the SW versions that makes NB-IoT and LTE-M available
- Completing LTE nationwide coverage in low bands

Assuring **interoperability**

- Assuring interoperability among different vendors

Pre-commercial trials

- Starting pre-commercial trials to push the ecosystem

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# First 5G remote driving concept

Telefónica & Ericsson joint demo

THE
NEXT
ELEMENT

#MWC17

Telefonica and Ericsson demonstrate the first 5G remote driving concept

Showcasing 5G´s features through a immersive perception of reality demo

- The demo **showcases 5G's reliability**, **high speed and low latency** – key elements for remotely-driven cars

- The demo **uses Telefonica's trial 5G network to drive a car (provided by KTH, the Royal Institute of Technology in Stockholm) at a race track in Tarragona**, Spain, from remote locations at La Fira (Telefonica and Ericsson's booth)

- The **demo leverages on high-frequency spectrum** (at 15 GHz), with **ultra-narrow beams continuously tracking the cars** from a 5G base station, located at 70 km track race, **to ensure reliability, and ultra-low latency transport** network to connect the cars with Fira

- Driver in remote location gets "**in car" experience thanks to 4K video streams and sensors** transmitting from the car to the seat, and **haptic control/feedback** on the steering wheel. All of them **provide fully-detailed sensory perception to the remote driver**, that is "haptic communications" (also known as "tactile Internet")
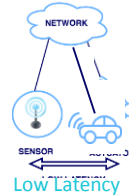
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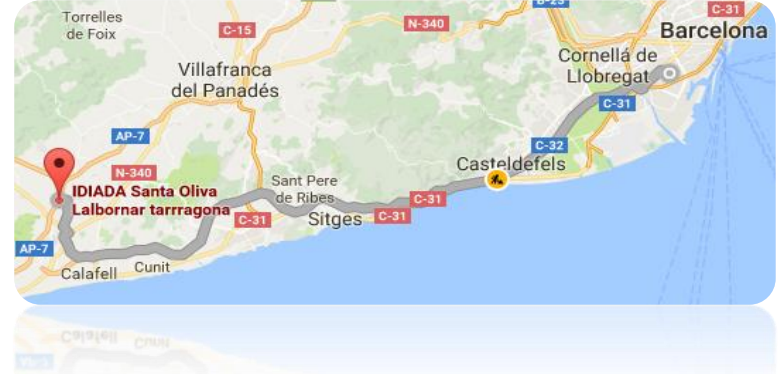
5G Demo characteristics

Ultra-low latency

Haptic control / feedback by feeling the bumps in the roads

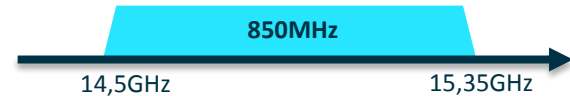**Three 4K video streams** plus numerous sensors transmitted form the car to the seat

(5G Radio) 2ms + (Transport) 2ms + video encoders < 30 ms

NETWORK
SENSOR   ACTUATOR
Low Latency

High data capacity

With just 1 5G node B we can manage **up to 50 cars like this**

Wide-Spectrum

TDD
850MHz BW
14.5-15.35 GHz Frequency band

850MHz
14,5GHz   15,35GHz

Massive number of antennas

MU-MIMO: Live visualization of beam-forming / beam-tracking
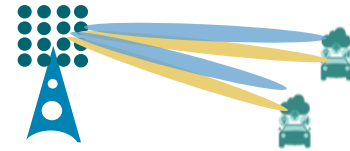
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