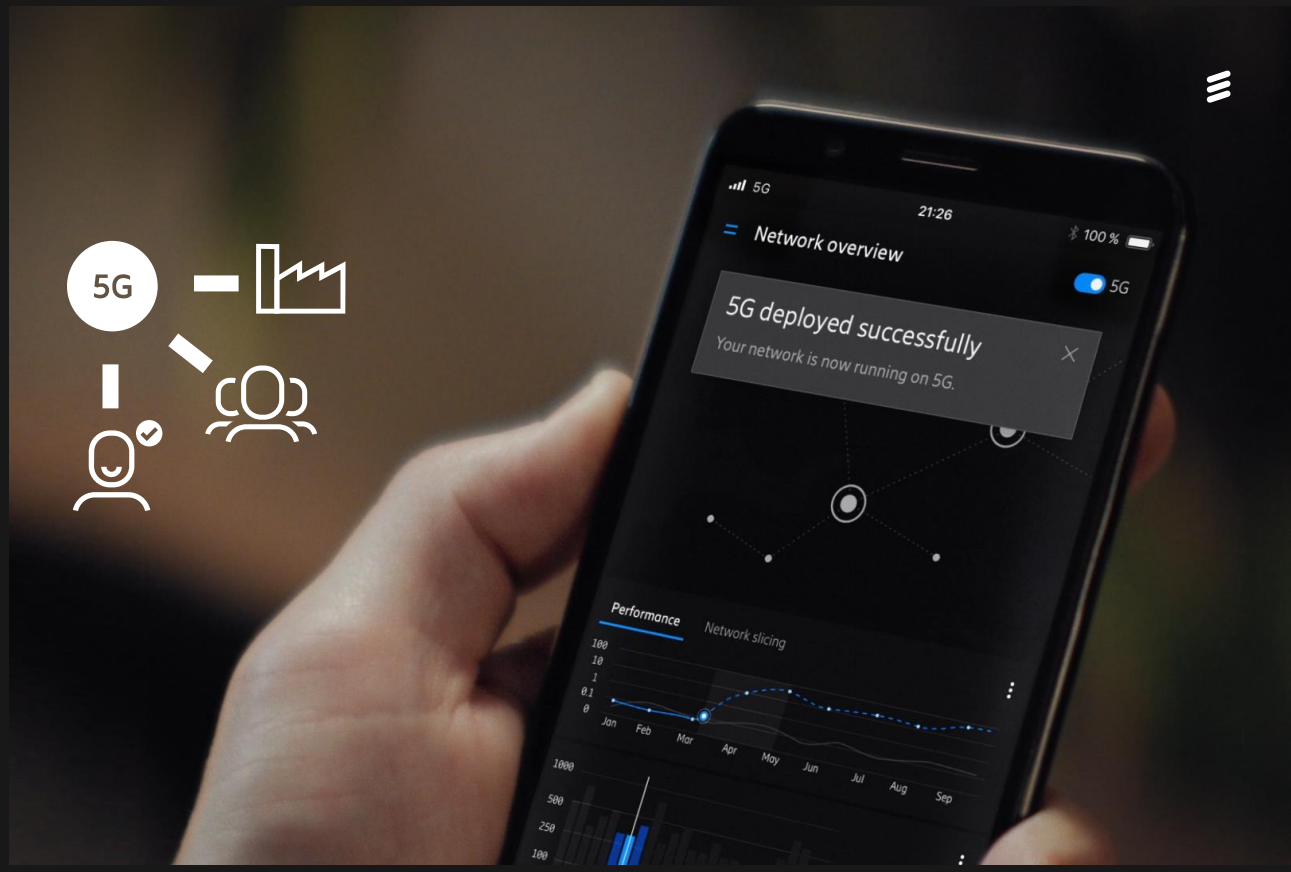
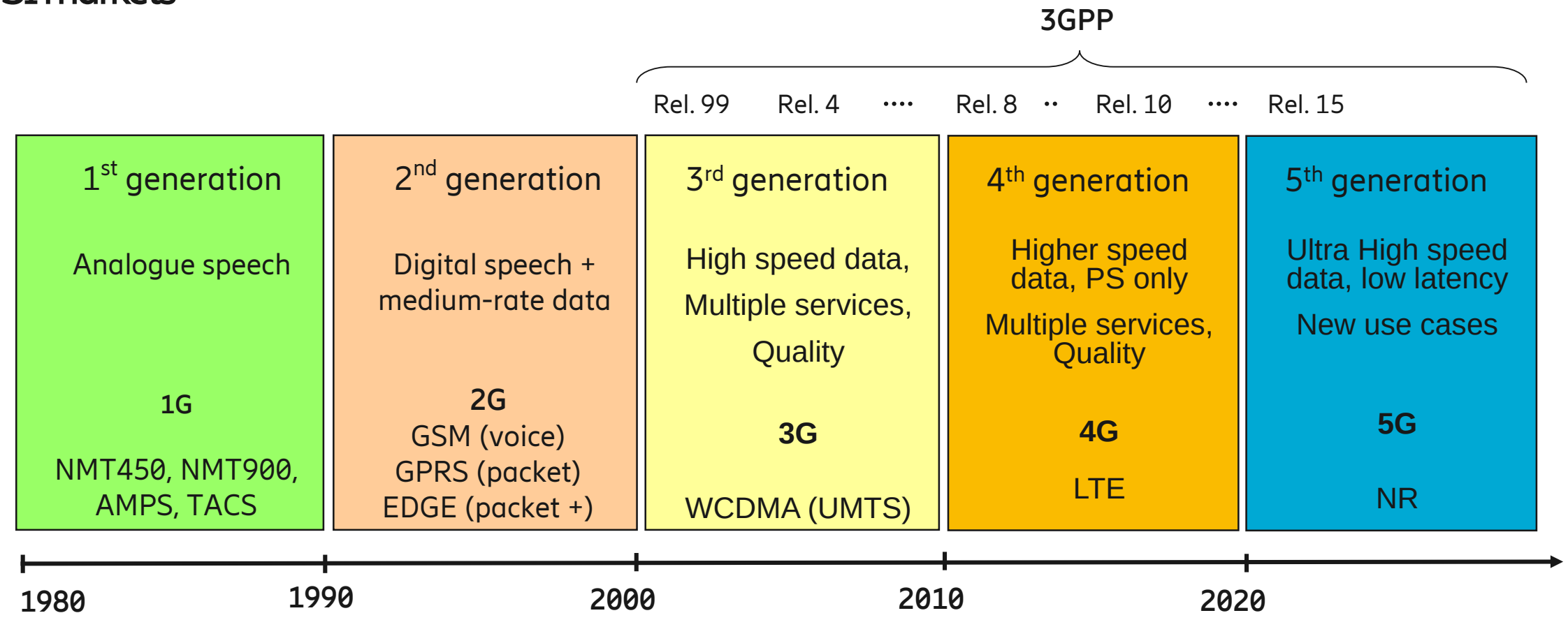
5G today: Trends and Insights



Vanesa Čačković - Ericsson Nikola Tesla d.d.

17. Međunarodna konferencija "Regulatorna djelatnost u sektoru elektronskih komunikacija“
Budva, 30.09.2019 – 01.10.2019.

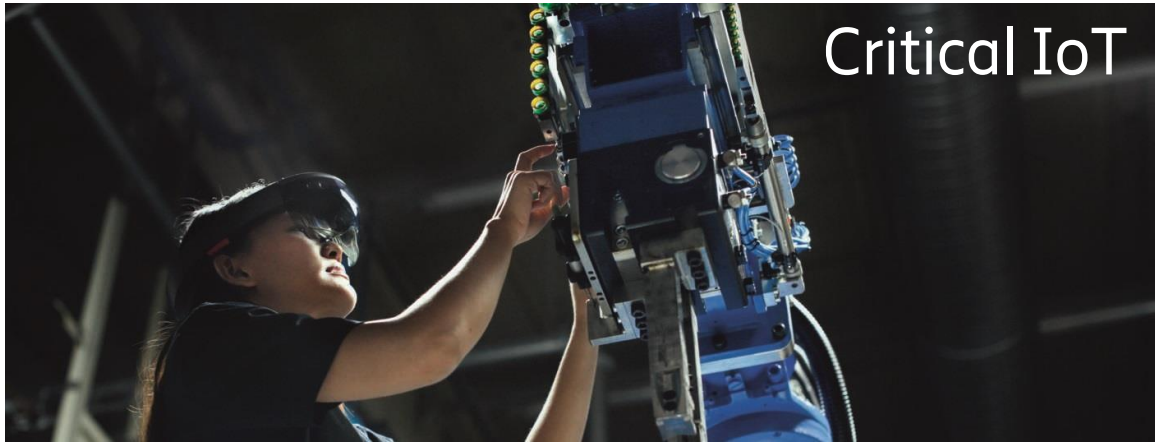
Mobile telephony evolution
- ETSI markets

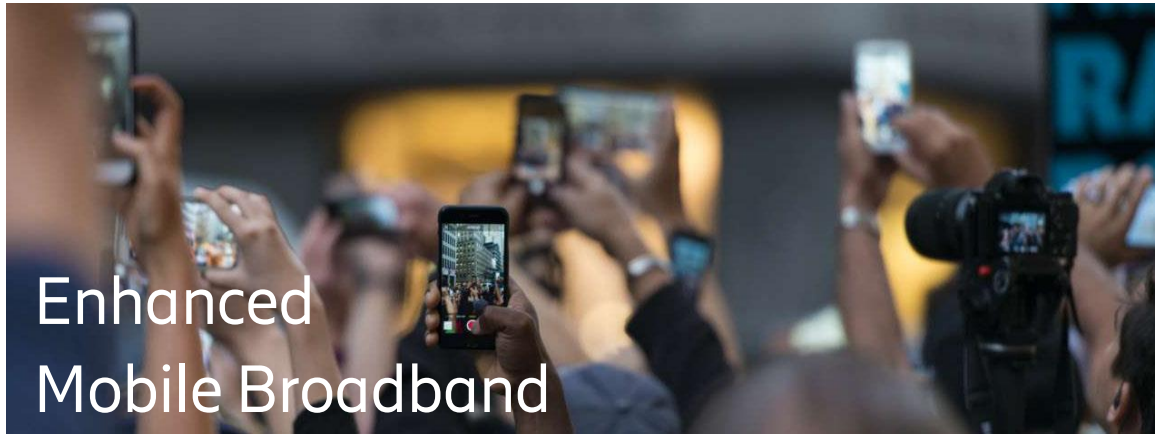


GSM – Global System for Mobile communication
GPRS – General Packet Radio Services
EDGE – Enhanced Data rates in GSM Evolution
3GPP – 3rd Generation Partnership Program
WCDMA – Wideband Code Division Multiple Access
UMTS – Universal Mobile Telephony System

LTE – Long Term Evolution
NR – New Radio

5G - A platform serving four major use case categories - and more...



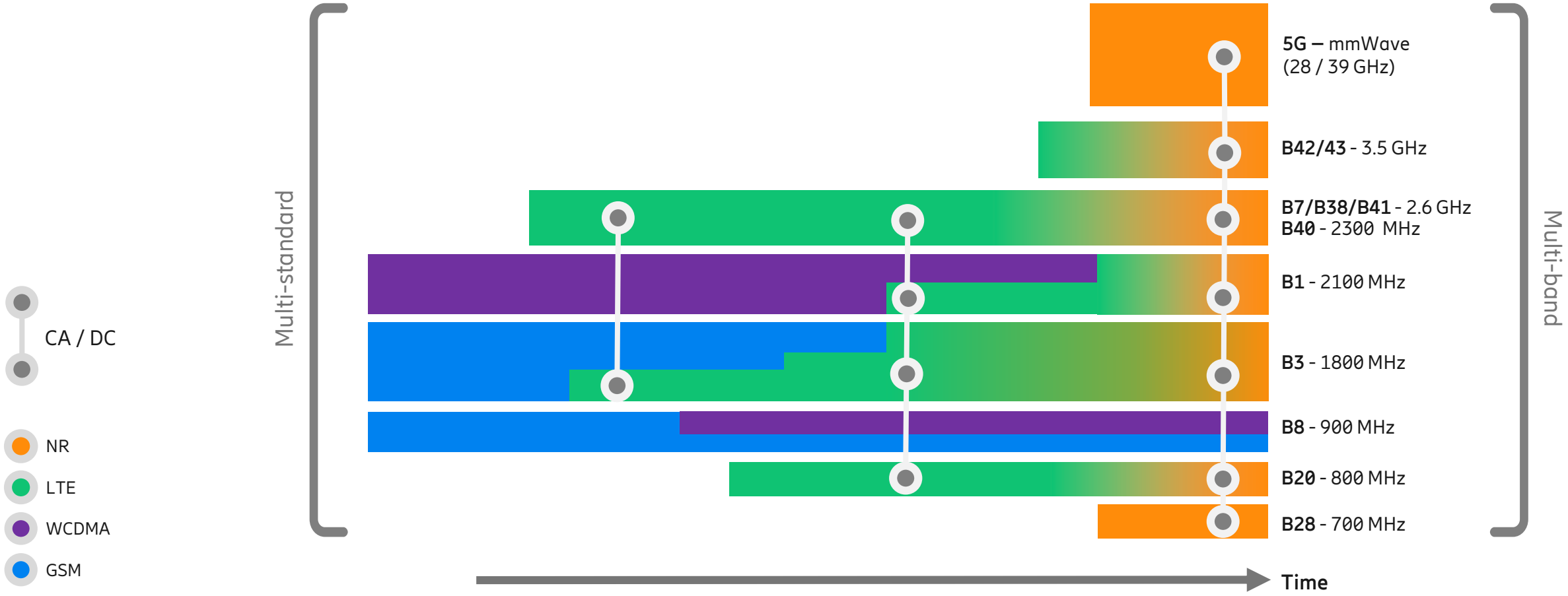


Performance boost in 8 dimensions

20 Gbps Peak rate downstream to users	**< 1 ms** Latency	**500 km/h** Mobility	**1 M/km²** Device connection density
10 Gbps Peak rate upstream from users	**1 m** Position accuracy	**99.999%** Availability and reliability	**>10 years** Battery life

Source: Ericsson This is 5G, February 2018

Multi-standard and multi-band sites
Example



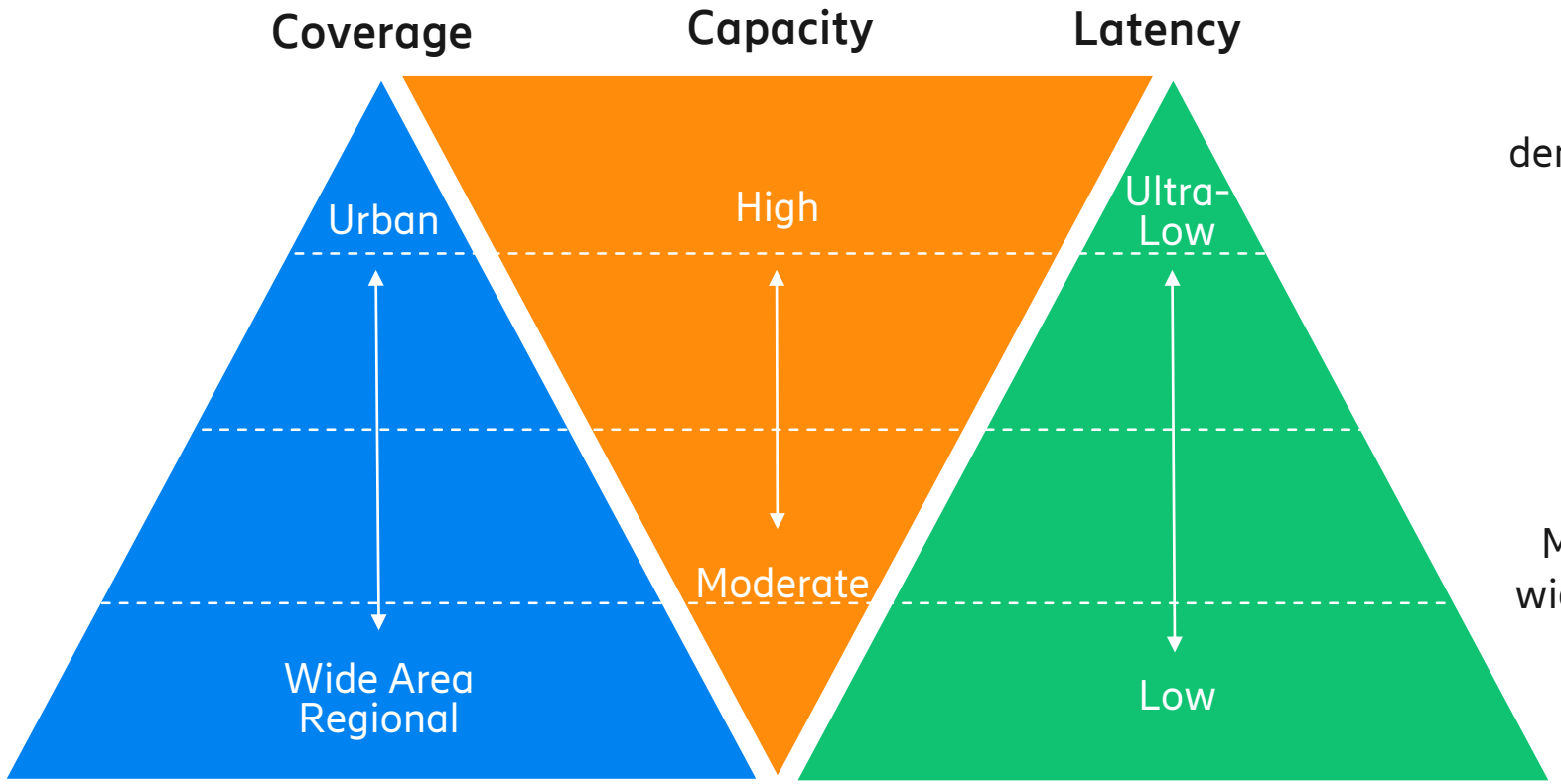
Spectrum trade-offs between capacity, coverage and latency

High bands
(24 GHz – 40 GHz)
New

Mid bands II
(3.5 GHz – 6 GHz)
New

Mid bands I
(1 GHz – 2.6 GHz)
Legacy

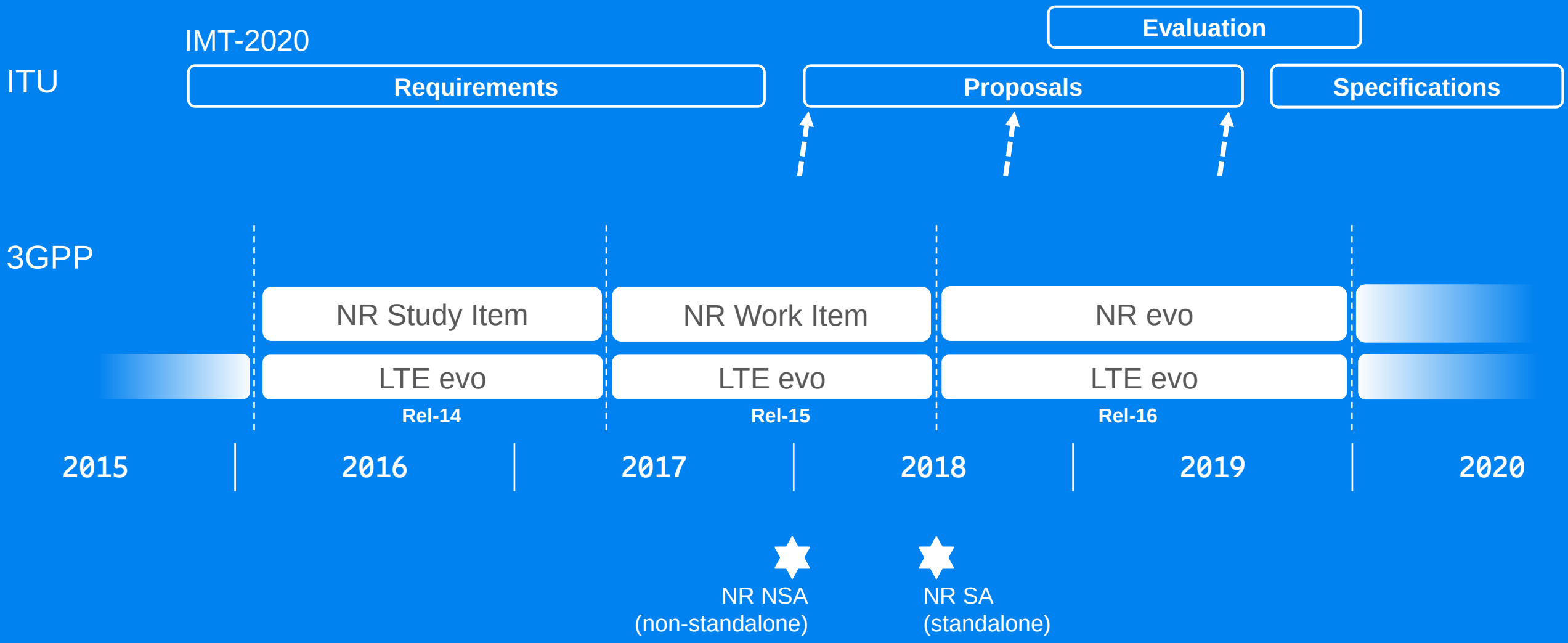
Low bands
(Sub – 1 GHz)
New/legacy



High capacity
dense urban / localized
deployments

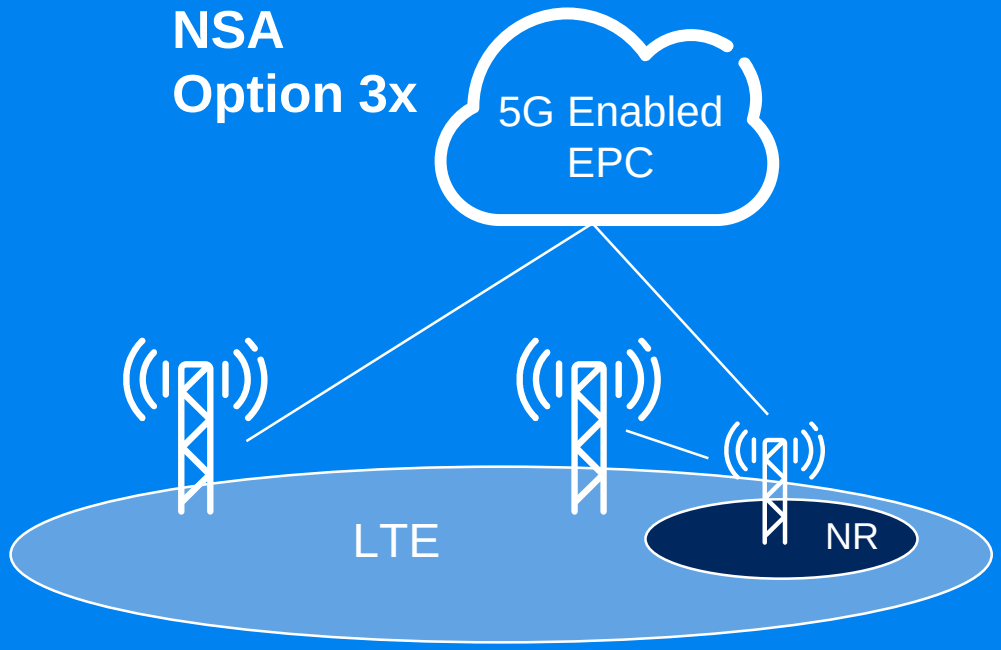
Moderate capacity
wide area/ outside-in
coverage

3GPP 5G timeplan



Initial 5G Architectures

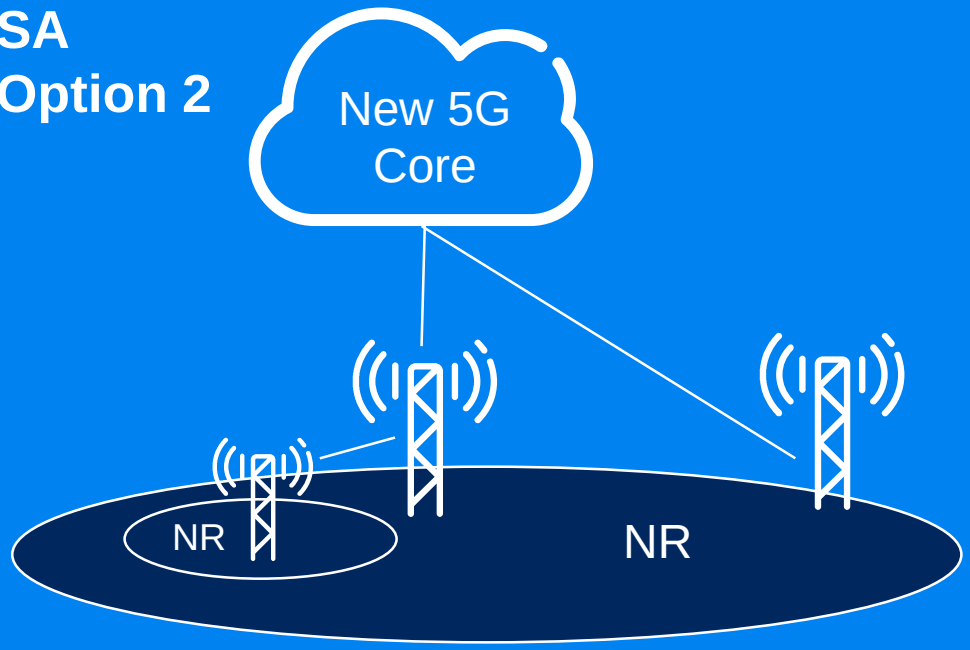
NSA
Option 3x



Tight interworking with LTE. Evolved EPC
→ Fastest TTM

- Standardization : Dec 2017
- Ericsson Support: LA Q4 2018, GA Q2 2019
- Supporting Use Case in 2019/2020:
  - eMBB + FWA

SA
Option 2

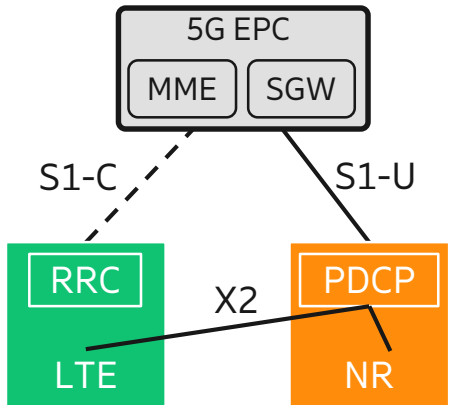


"Independent" overlay. New CN architecture
→ Highest potential for further evolution

- Standardization : Jun 2018
- Ericsson Support: LA Q2 2019, GA Q4 2019
- Supporting Use Case in 2019/2020:
  - eMBB + FWA

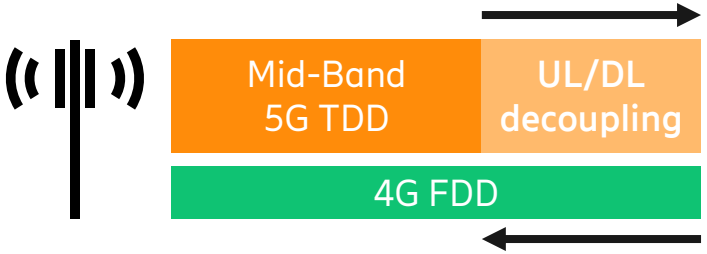
NSA (option 3x) connectivity

Dual connectivity



- Control plane through LTE
- S1-U terminates on NR
- UE attached to LTE and NR simultaneously
- X2 i/f between LTE and NR

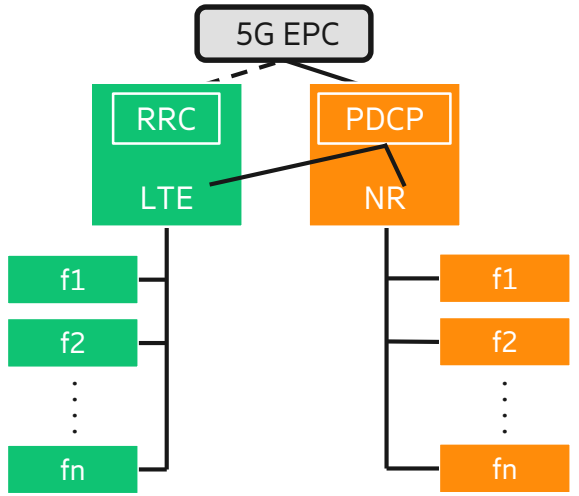
UL/DL decoupling



Extend 3.5GHz coverage

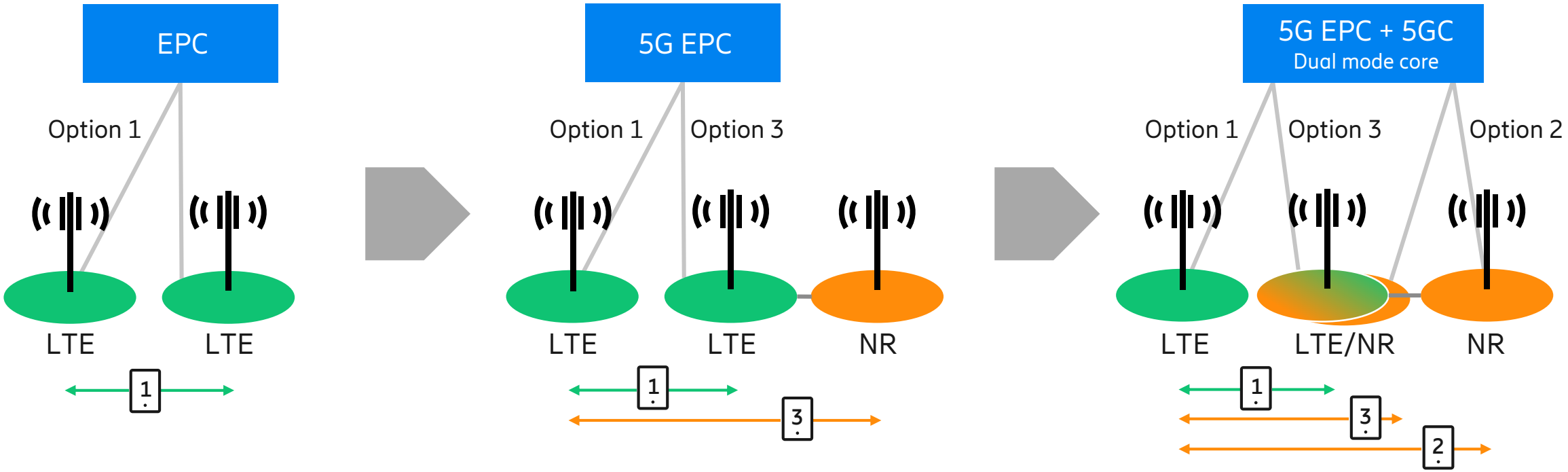
- Use Low-Band LTE spectrum for UL traffic and DL on NR spectrum
- Maximize usage of Mid-Band 5G
- Increase Network capacity

LTE + NR aggregation



- Aggregate all 4G and 5G spectrum
- NR L1 control on low NR band
- Maximize user experience
- Driver for same vendor on both 4G and 5G

5G architecture evolution

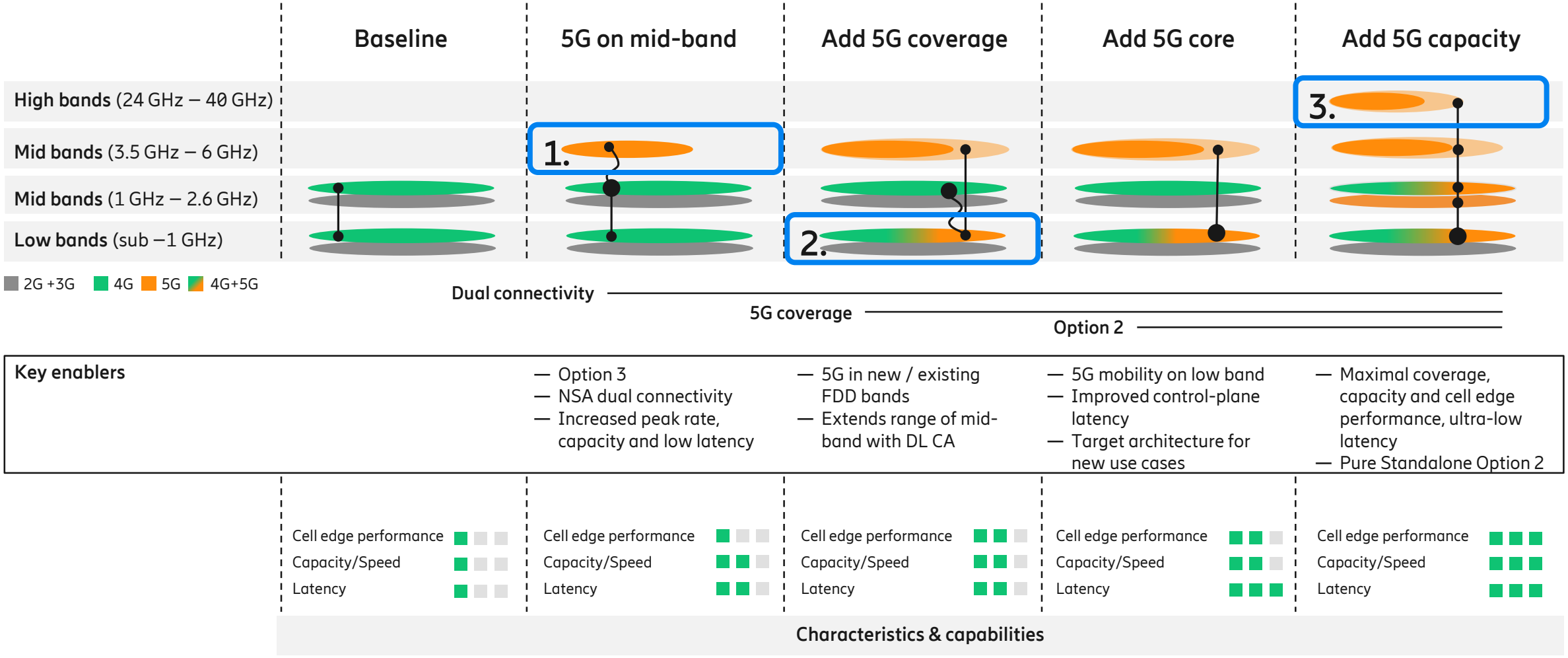


— Option 1 = LTE

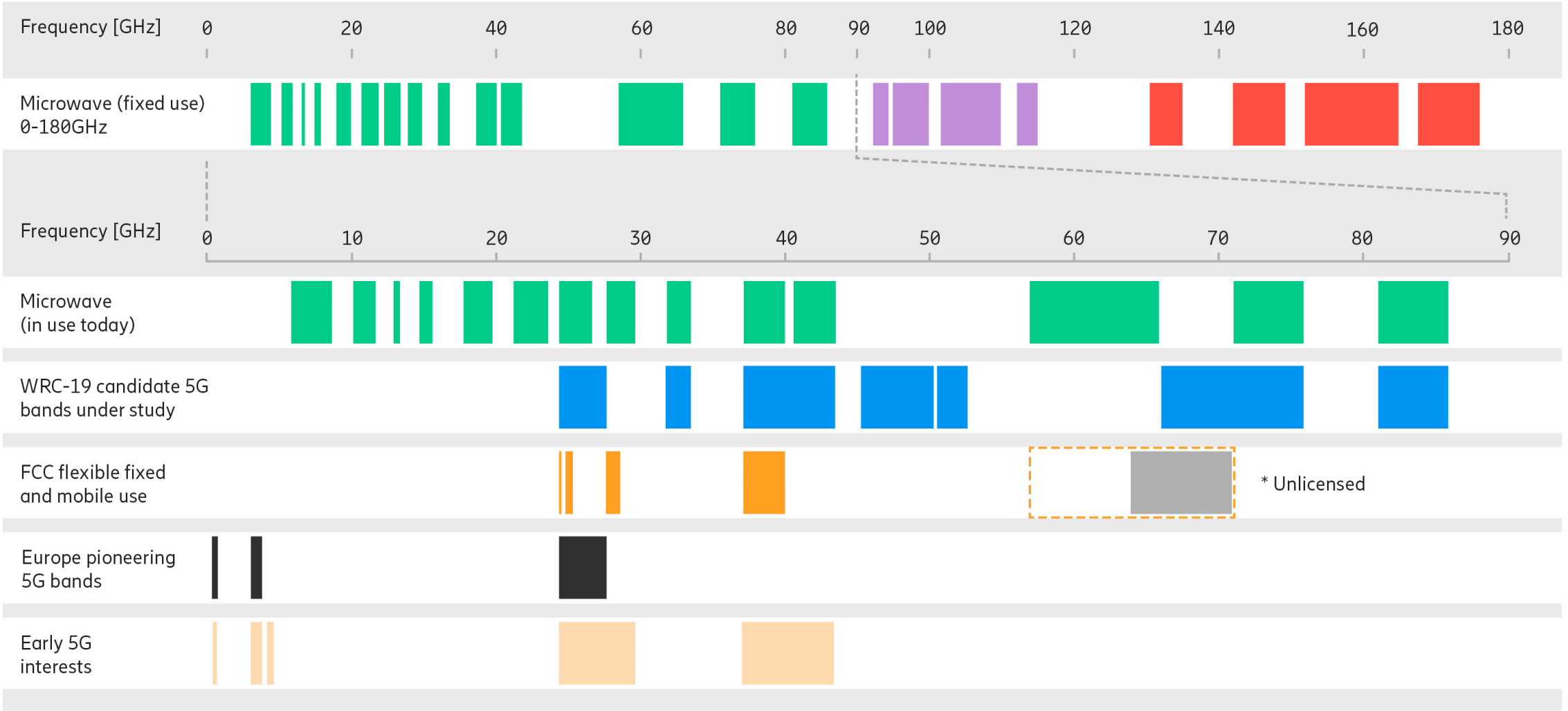
— Introduce NR air interface to offer peak data rates early (NR NSA/Option 3)
— Fully leverage VoLTE or CSFB for voice while NR matures

— Introduce 5GC and next generation services, without disturbing existing deployment (NR SA/Option 2)
— Fully leverage VoLTE for voice while NR/5GC matures
— EPC-5GC interworking supporting migration

5G network and spectrum evolution



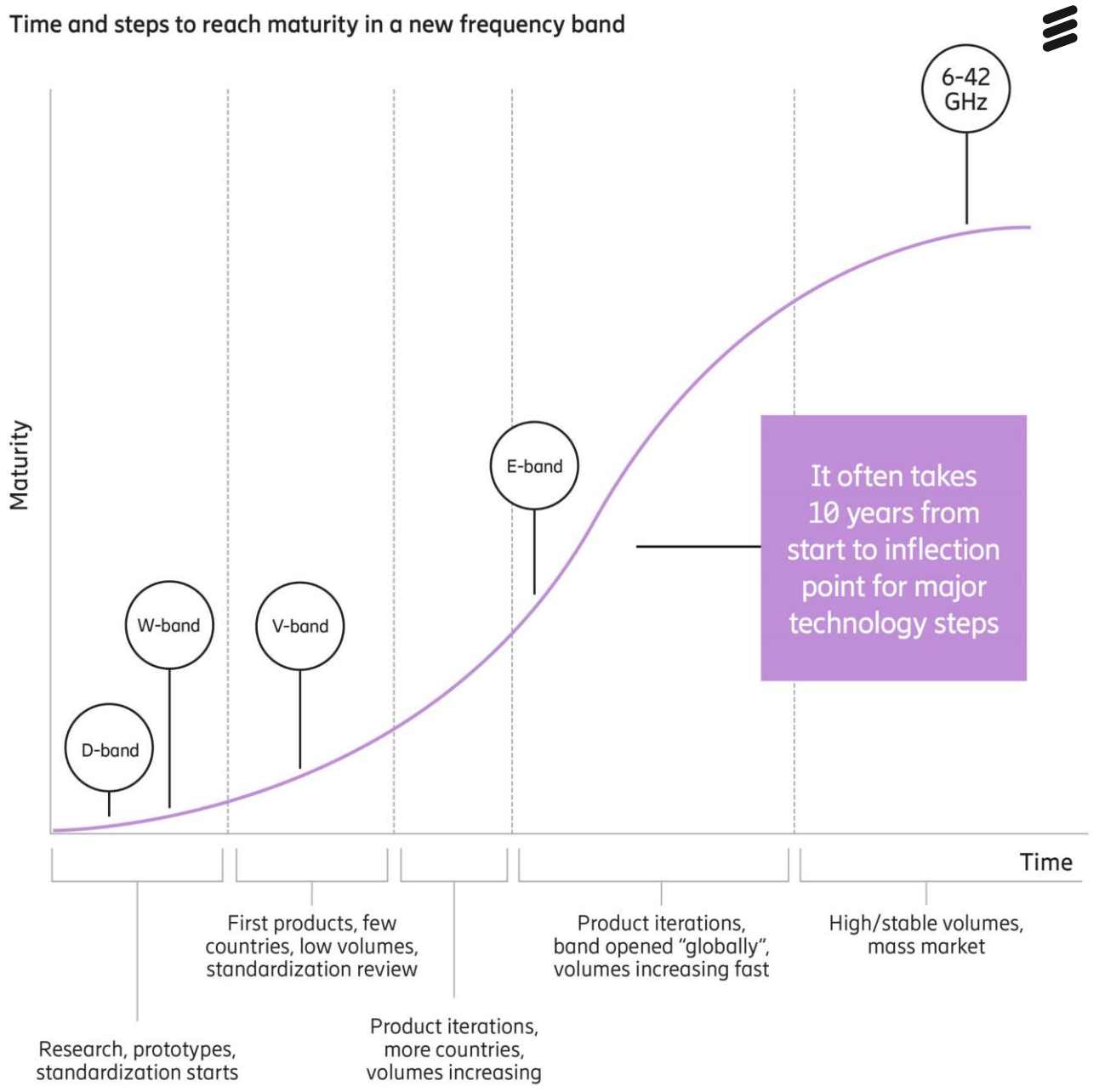
5G and backhaul spectrum



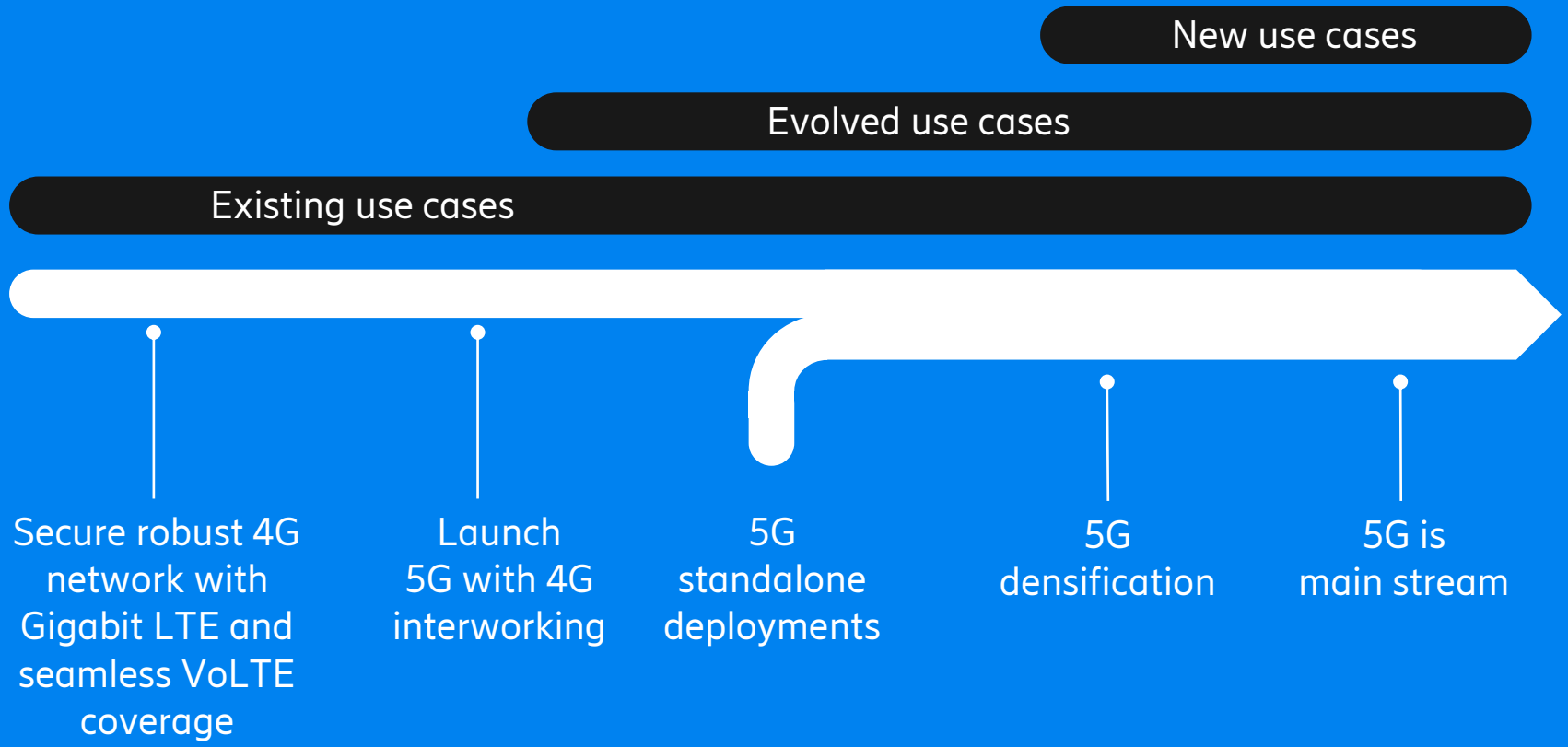
Source: Ericsson (2017)

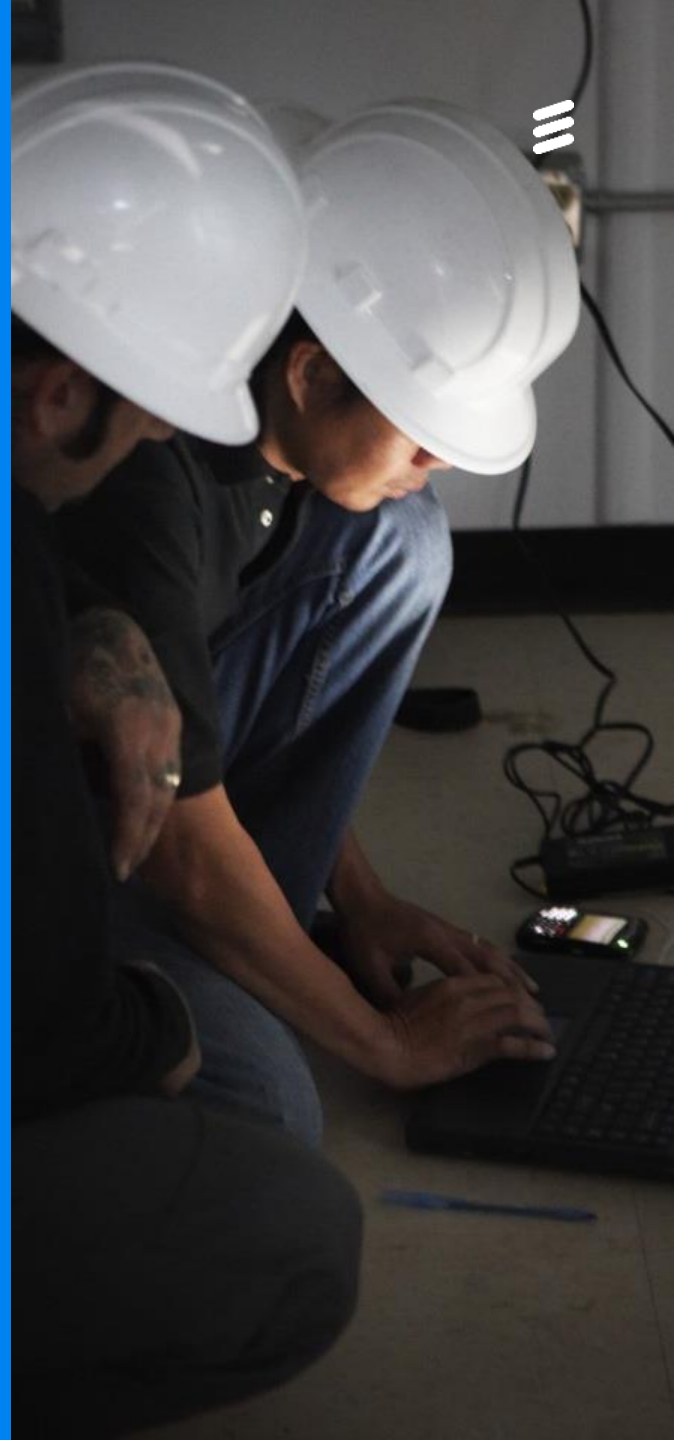
W- & D-band

- Total amount of spectrum for W- and D-band is ~50 GHz
  - 5x more spectrum than E-band
- No significant use until 2025
- Approx 10 years for D-band to mature
- W-band will have a shorter journey due to its closeness to E-band



The 5G journey





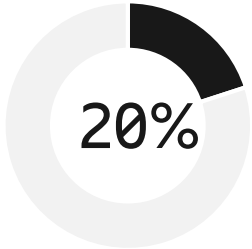
5G Deployment Experiences

July 2019

Global 5G market insights by 2024

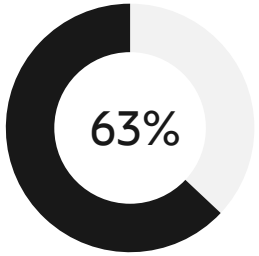
Almost **2 billion**

5G subscriptions for eMBB



20% mobile traffic via 5G networks

Up to **65%** of world's population covered by 5G



63% 5G mobile subscriptions in North America

Global Internet of Things (IoT) connections will be **more** than **22** billion

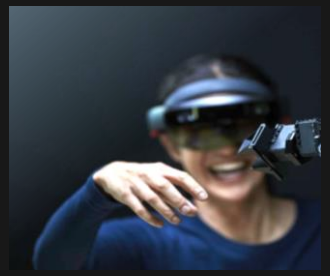
5G expected to contribute **$2.2** trillion to the global economy over the next 15 years

Ericsson Mobility Report; Mobile Economy report 2019, GSMA

The value of 5G for consumers and industry

Consumer

In the near term, consumers expect 5G will offer benefits



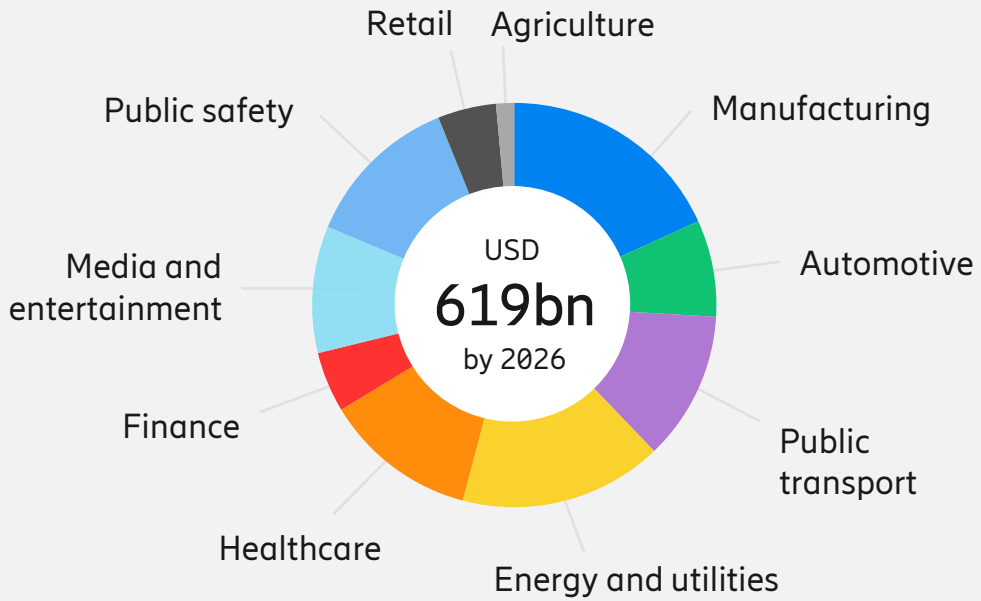
Consumers see value in 5G use cases and are willing to pay

Consumers predict 10x data usage increase on 5G by 2025

Source: Ericsson ConsumerLab report, 5G consumer potential , May 2019

Industry

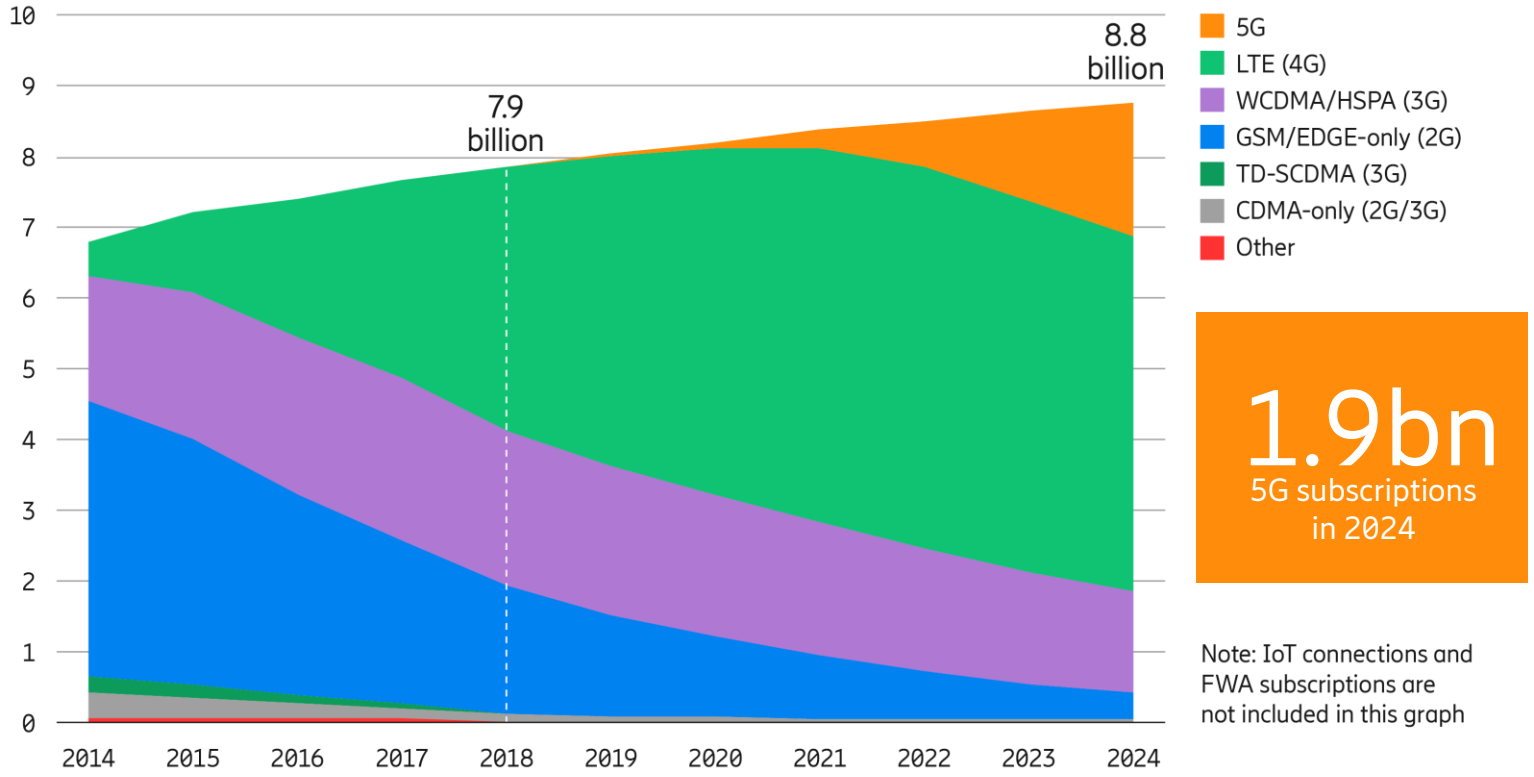
Industry digitalization potential
5G investment by 2026



Source: Ericsson and Arthur D. Little, The guide to capturing the 5G industry digitalization business potential, 2018

The strong momentum for 5G continues

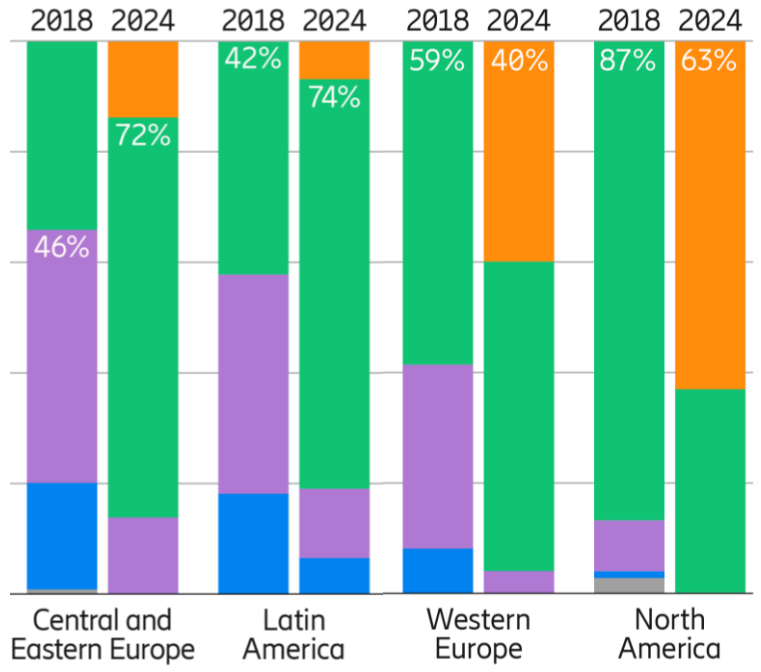
Mobile subscriptions by technology (billion)



1.9bn
5G subscriptions in 2024

Note: IoT connections and FWA subscriptions are not included in this graph

Mobile subscriptions (percent)



Note: Technologies with less than 1 percent of subscriptions are not shown in the graph

Source: Ericsson Mobility Report

Live 5G networks with smartphones

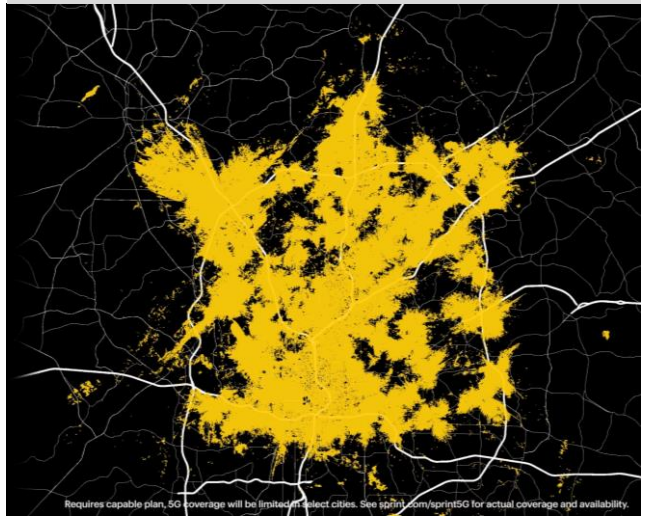
Both mmWave/mid-band spectrum

2 Gbps 5G, Denver June 27th

Verizon launches 5G in 2 markets

- Moto Z3, Z4 & S10 5G; LG V50 to follow
- Chicago , Minneapolis & Denver
- 19 more markets during 2019
- 450 Mbps DL typical

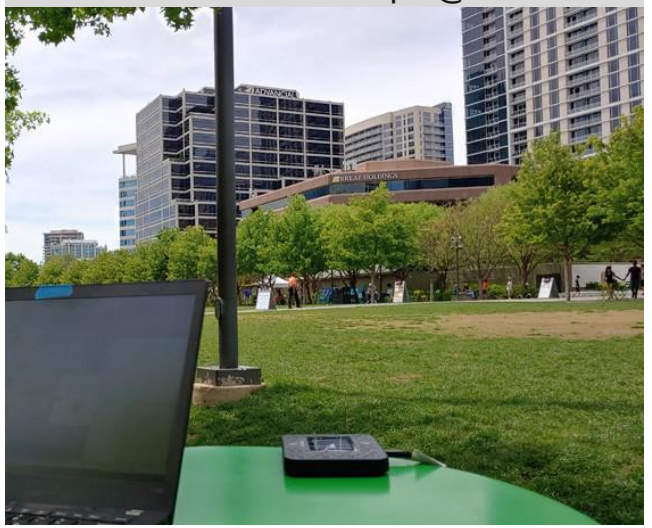
Sprint 5G coverage Atlanta May 30th



Sprint launches in 4 markets

- LG V50 & HTC 5G Hub
- Consistent 100Mbps with 700 Mbps peaks
- Covering more than 1,115 sq miles in 4 cities
- Using 2.5 GHz spectrum with 64T M-MIMO Ericsson radios

AT&T achieves 1.3 Gbps @ 600 feet



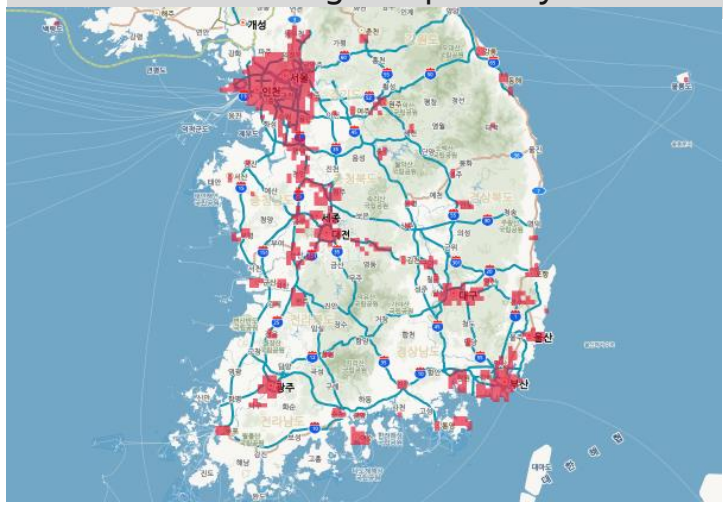
AT&T 5G Mobility live in 12 cities

- Launched Dec 2018 in 39 GHz
- Performance improved to 1 Gbps and then 2 Gbps
- Using NETGEAR® Nighthawk 5G Mobile Hotspot (pictured) & S10 5G

Live 5G networks with smartphones

Both mmWave/mid-band spectrum

SKT 5G coverage map – May 29th



All Korean operators launch 5G

- Samsung S10 5G & LG V50
- More than 1M subscribers
- Large scale mid-band launch with Nationwide by H2 2020
- 64T, 32T and classic 4T radios in mix
- 5G traffic per user 3x LTE

5G 1.2 Gbps, Bern – Jul 4th

Swisscom first 5G in Europe

- Oppo Reno 5G smartphone in Europe on 1st May
- Initial deployment of 100 sites in 54 cities
- Mid-band 3.5GHz band (100 MHz)
- Nationwide coverge H2 2019 enabled by Ericsson Spectrum Sharing

5G 1.9 Gbps, Sydney – May28th

Telstra launches in 10 cities

- Samsung S10 5G & HTC 5G Hub
- Using 3.5 GHz band
- 5G available in premium price plan

5G phones - First line-up

Mid-band/3.5GHz and/or High-band/28GHz support first out

Motorola MOTO X

- Launched in April 2019
- Clip-on with Qualcomm Snapdragon 855
- 5G: high-band module for Moto Z3 and Moto Z2 phones
- LTE: Cat 16 1Gbps
- U.S. markets

Oppo Reno 5G

- Launched in EU
- Qualcomm Snapdragon 855 chipset
- 5G: mid-band 3.5GHz

Samsung Galaxy S10

- Launched in Korea
- Qualcomm Snapdragon 855 chipset - USA/LATAM, China
- Exynos 9820 – EMEA
- 5G: mid-band 3.5GHz and high-band 28GHz depending on markets
- LTE-A: Cat 20 7CC

LG V50 ThinQ 5G

- Launched in Korea
- Qualcomm Snapdragon 855 chipset
- 5G: mid-band 3.5GHz
- LTE Advanced

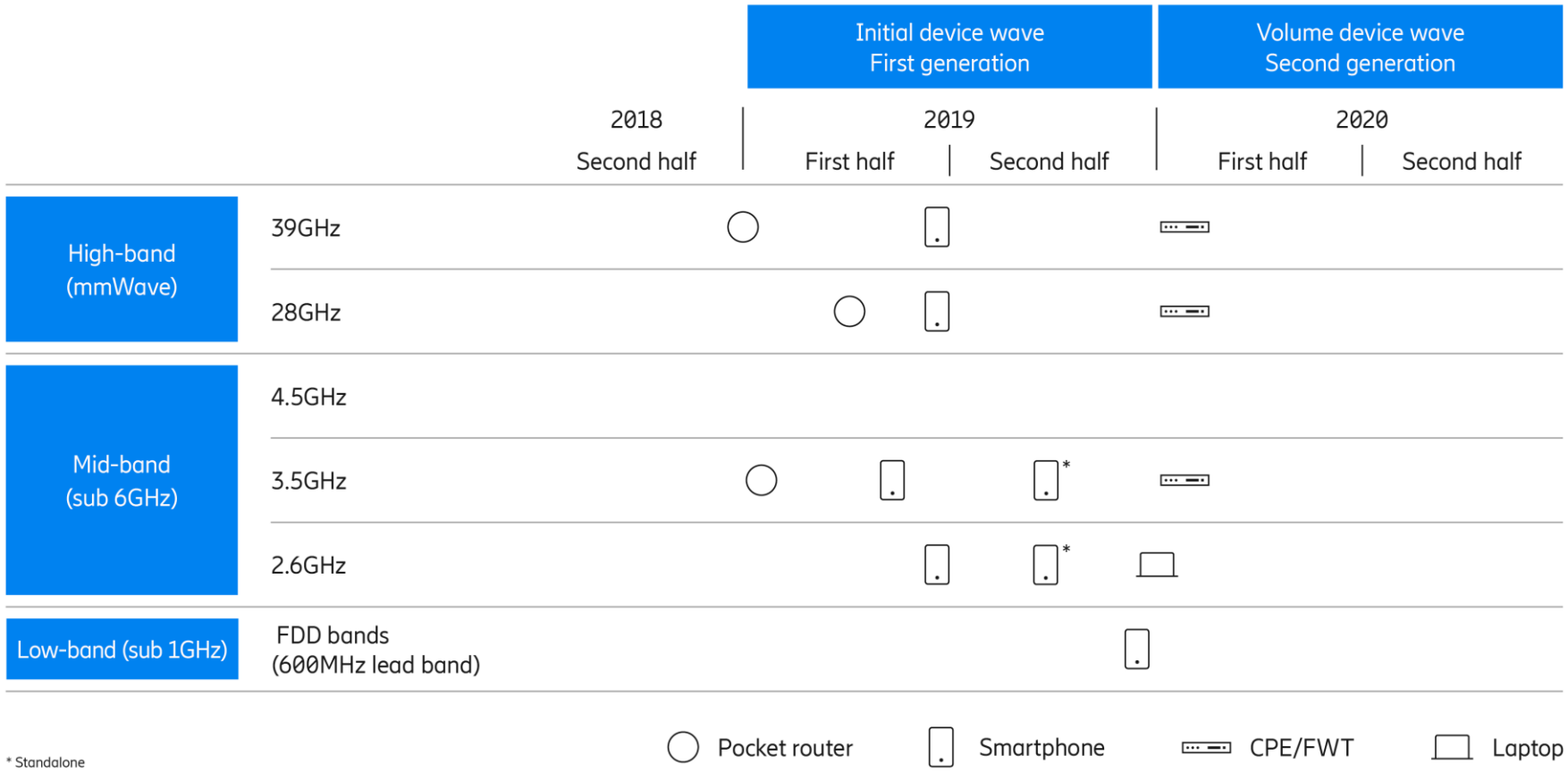
Xiaomi Mi Mix 3 5G

- Launched in EU
- Qualcomm Snapdragon 855 chipset
- 5G: mid-band 3.5GHz

Source: Phone finder GSMArena.com

5G smartphones are expected to be available in all three spectrum bands in 2019

5G device availability (3GPP)



Strong commitment and increasing 5G focus from chipset and device vendors

Chipsets for Standalone Architecture are expected in the second half of 2019

Market update

We were first with commercial 5G live networks in 4 continents: Americas, Europe, Asia and Oceania

15
live networks

We are supporting with our 5G network technology networks across 4 continents

21%
better DL speed

Ericsson is leading in performance on 5G live networks

3
million radios

We have shipped 3 million 5G HW prepared radios since 2015

5G in Asia

Telstra

Leading with 5G

5G in conjunction with software defined networking and machine learning will enable huge gains in spectral efficiency, new technologies like IoT and a range of new business opportunities

Phase 1

Fixed-wireless solutions – where mobile market develops and makes sense for customers

Phase 2

Lower cost per Gig network capacity and greater spectral efficiency

Phase 3

New use cases and emerging opportunities e.g. industrial IoT

Highlights

- Launch in key markets
  - Korea: April 2019!
  - China: CP0 (late19)/ CP1 2020 (massive)
  - Australia: 2019
  - Japan: 2020 (Olympics)
- China earlier on 5G than 4G
  - Scale to drive down handset prices faster
  - Broad set of use cases
- Spectrum
  - Mainly midbands
  - Few mmW (28 GHz)
- E/// contracts: SKT, KT, Telstra, Optus, Softbank

5G in Europe

1 WE WILL DEPLOY 5G SMARTLY

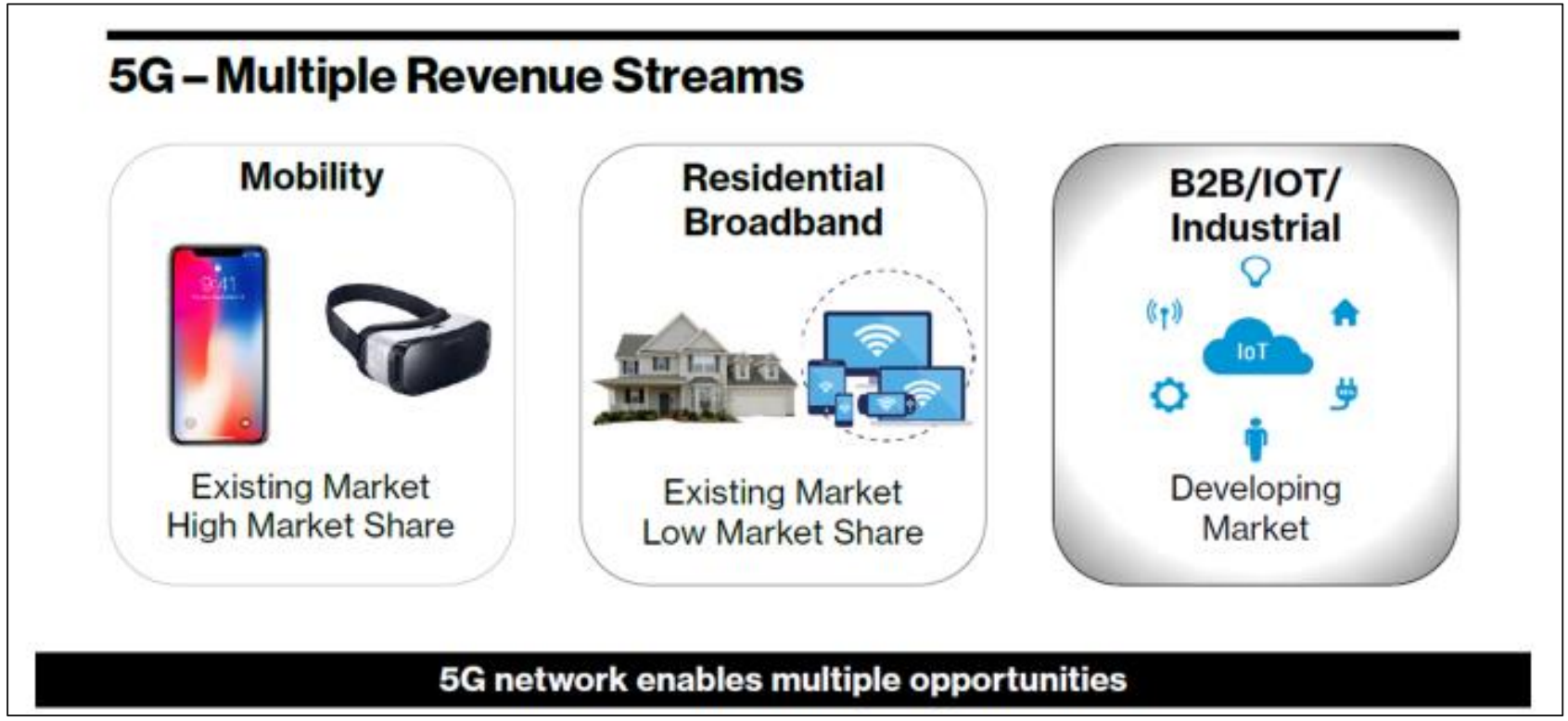
	1. Mobile Capacity/ Speed Upgrade	2. Fixed Wireless Access	3. Selected new products/solutions
CAPABILITY	▪ Enhanced mobile broadband	▪ Gigabit speed on higher frequencies/millimeter waves	▪ Massive IoT ▪ Low latency, QoS
APPLICATION AREA	▪ Starting with areas of interest (cities, campus networks; as overlay on 4G)	▪ Complement to FTTH/B in (sub-) urban areas	▪ In selected areas of interest
ECONOMIC RATIONALE	▪ More efficient than 4G from 2021 onwards	▪ Depending on topology, more cost-efficient than FTTH/B, faster time to market	▪ Enable new revenue streams

Highlights

- US and Asia developments accelerating 5G in Europe
- Spectrum auctions in few markets (mainly mid bands)
  - Ireland, UK, Czech, Italy, Spain, Finland, Sweden, Austria, Switzerland, Germany and Latvia
- Coverage from main cities (e.g., Swisscom and EE)
- Growing interest in private networks (Industry 4.0 driven)
- E/// contracts: Vodafone UK/SP, Telenor NO/SE/DE, Swisscom, Wind 3 Italy, TDC

5G in North America

verizon



Highlights

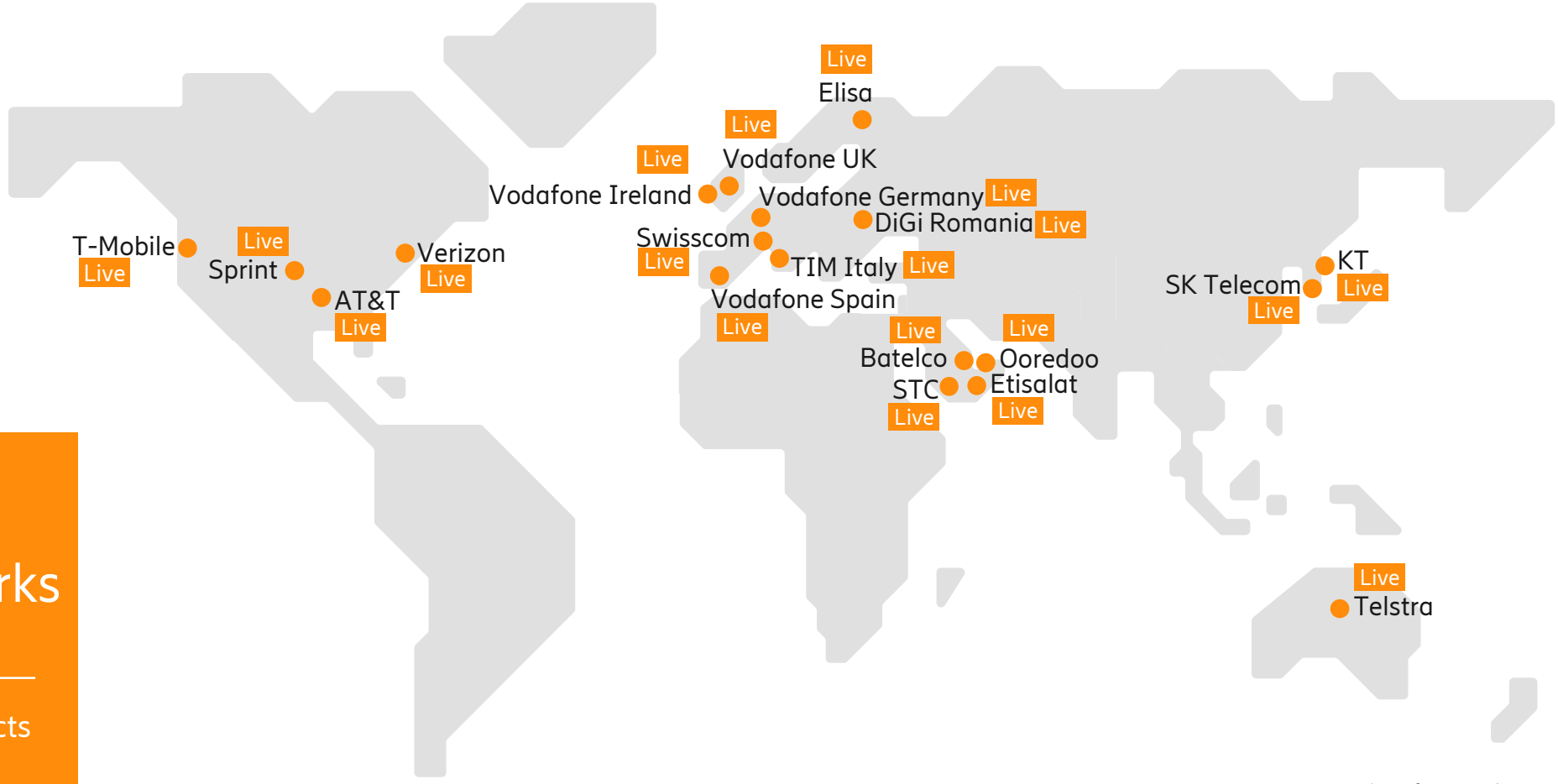
- Accelerated launches
  - 4G: 30 months
  - 5G: 9months
- Initial use cases
  - eMBB & FWA
- Coverage: ~30-50 cities by end of 2019
- Spectrum
  - Low band (600MHz)
  - Mid band: 2.5GHz
  - mmW (28/39GHz)
  - Later: 3.5GHz/24GHz
- E/// contract: Big 4 in US, US Cellular

5G in Middle East & Africa

Highlights

- Middle East MNOs positioning to be 5G leaders
- First "Launches" in 2018 but commercial service only from May/June 2019
- Lots of activity on how to go beyond mobile broadband and key flagship events, e.g. Expo 2020
- E/// contracts: Ooredoo, Etisalat, STC, Batelco

First with commercial 5G live networks in 4 continents

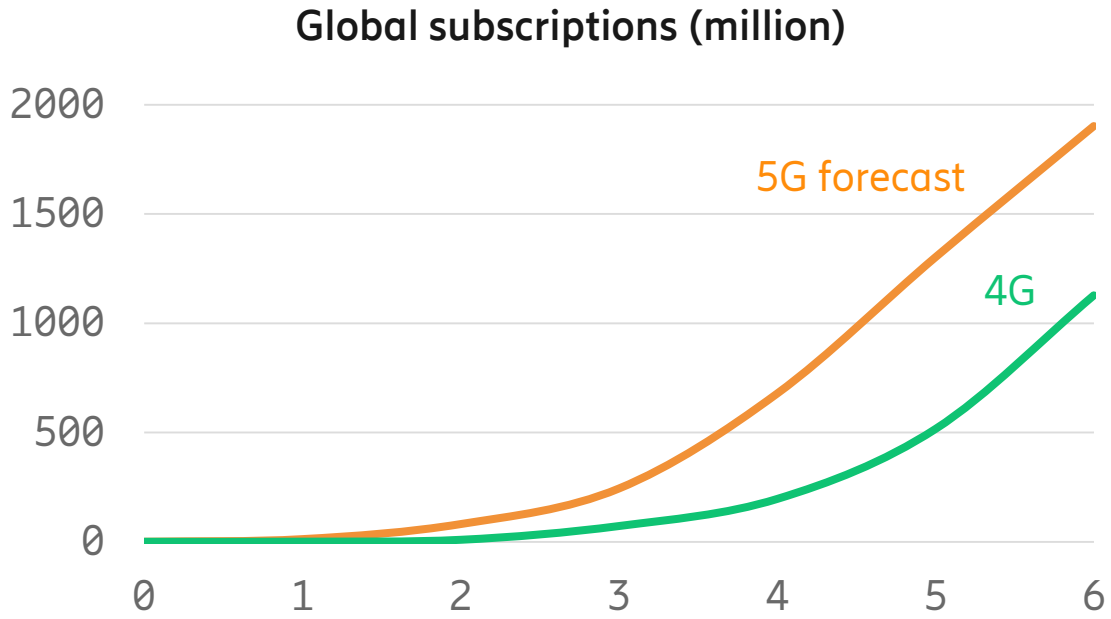


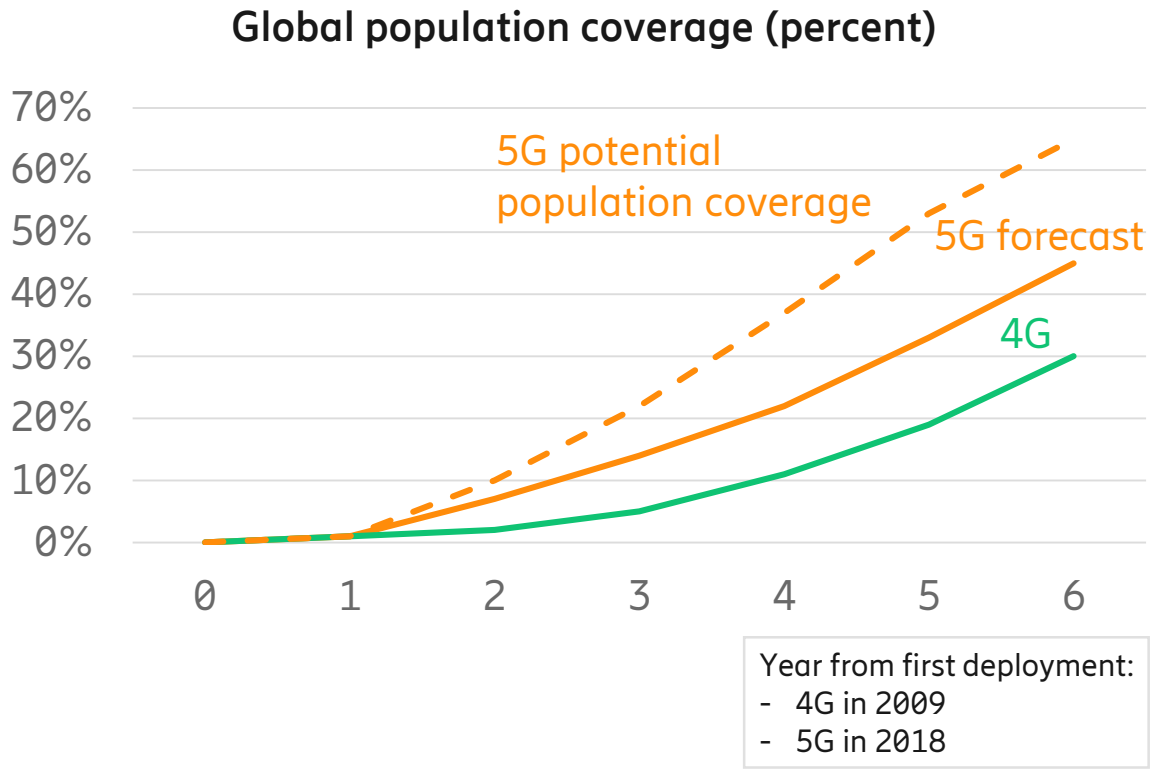
19 Live networks

25 Announced 5G contracts

*As of September 2019

5G uptake expected to be faster than 4G



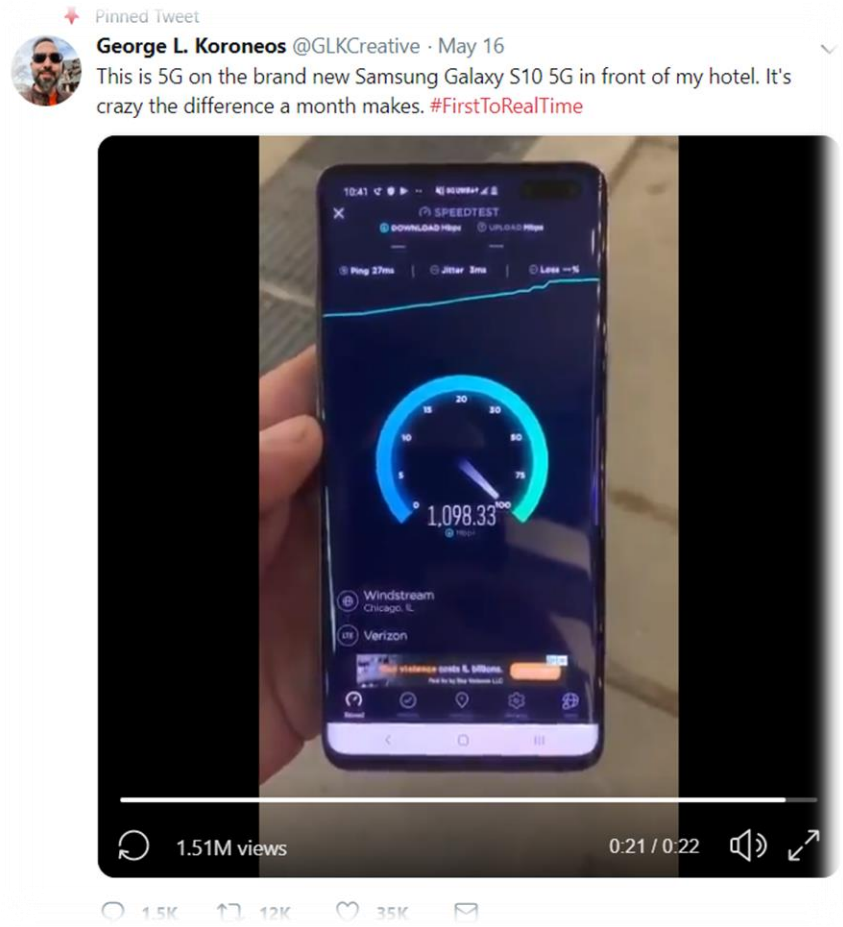


In 2024 , 5G subscriptions will have reached 1.9B subscriptions globally

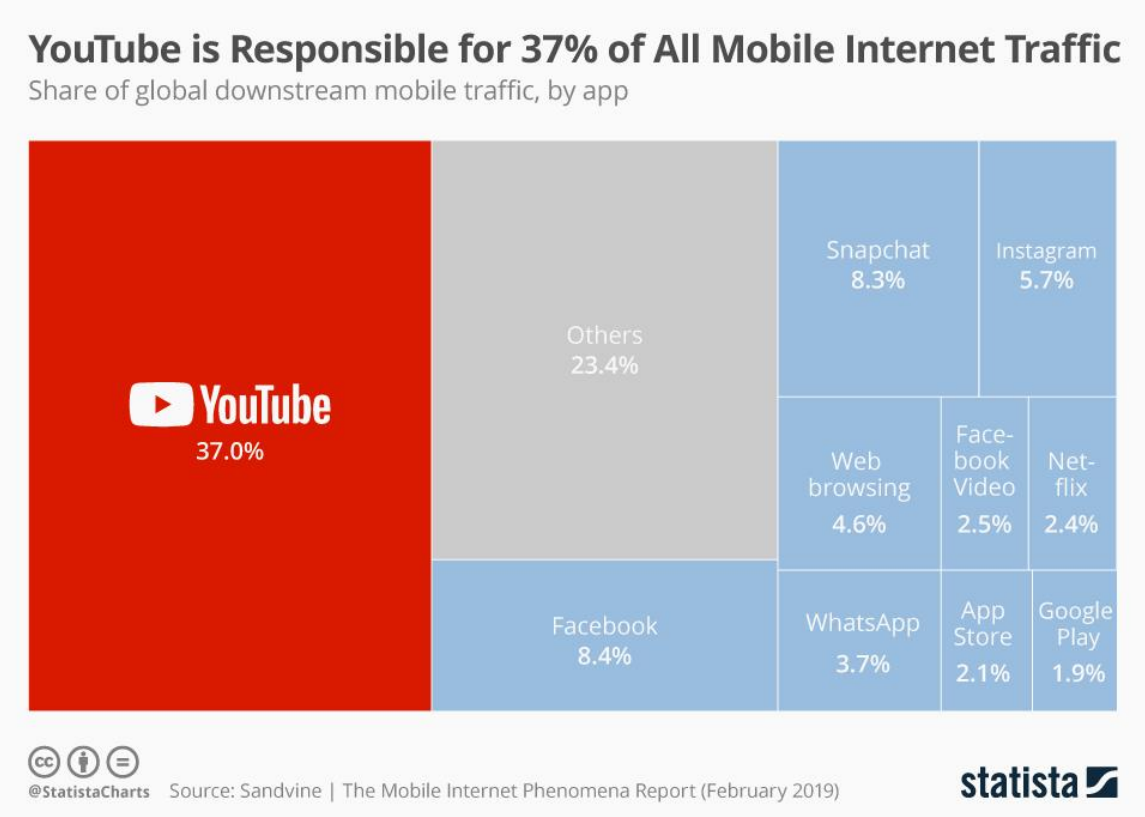
In 2024 , up to 65% of the world´s population may be covered by 5G by leveraging Ericsson Spectrum Sharing

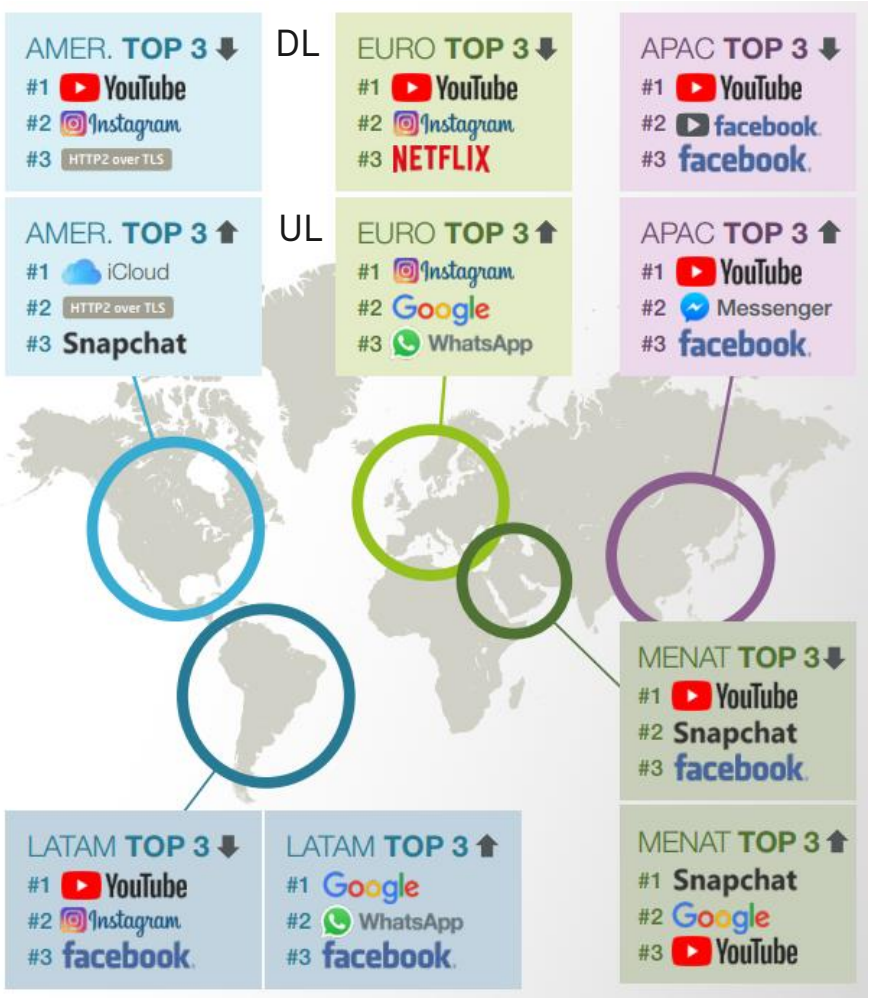
Verizon 5G Customer Experience

Gbit speeds, full 4K video downloaded in 90 seconds



YouTube dominates Mobile Traffic





SANDVINE

Cloud gaming drives streaming over cellular

— Gaming enhanced **smartphones**

Nokia 3310

to

One Plus with Snapdragon 845

— Games go **mobile…**

— **… with Cloud** providers

— Operators at the heart of technology & content providers

Performance key for gamers - bandwidth, latency, packet loss

5G first-mover advantage

Strengthen operator brand with 5G

Establish technology leadership

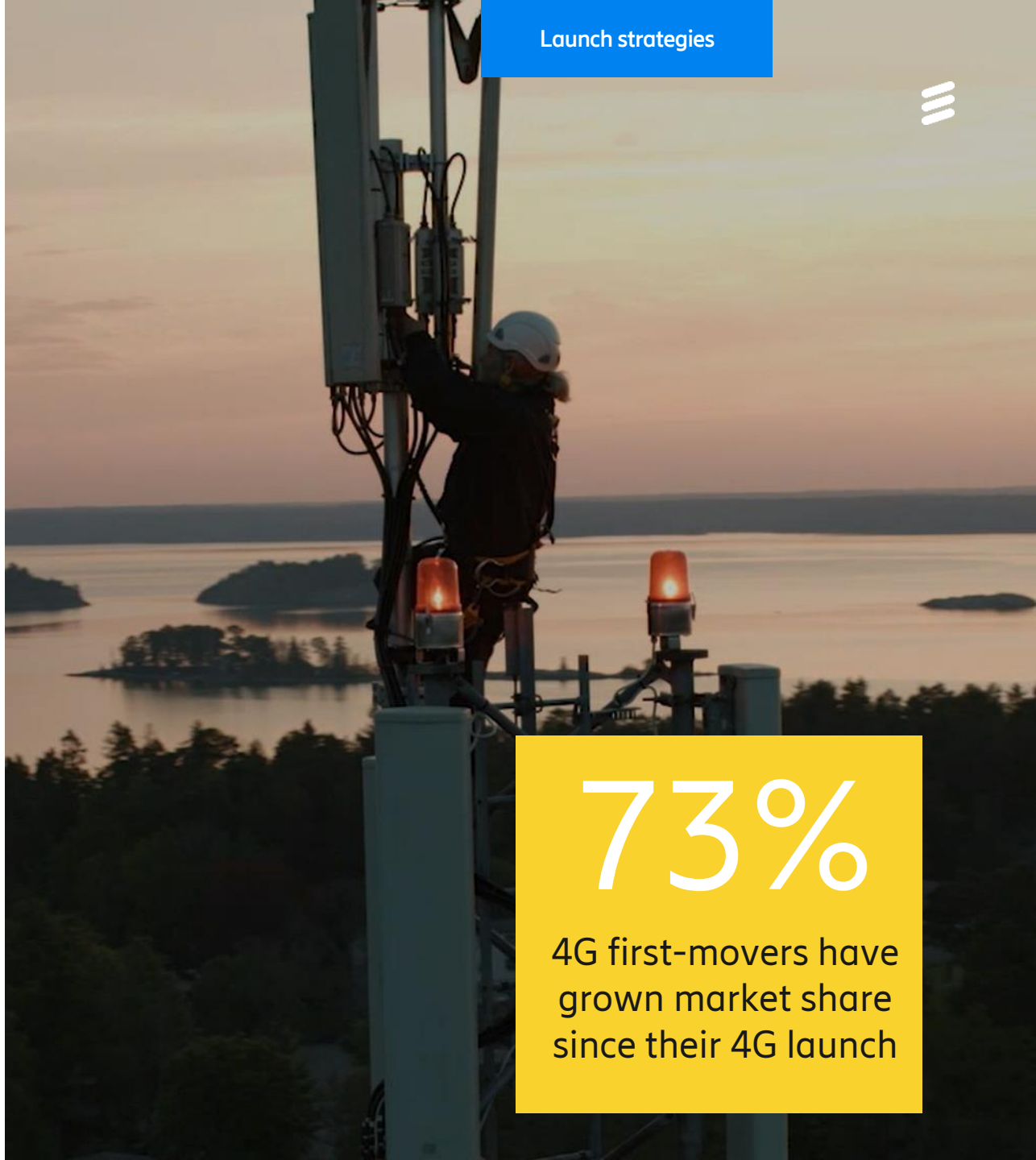
Lead the 5G market

Capture the lucrative early 5G adopters
Deliver enhanced Mobile Broadband
Explore new use cases and business models

Start offloading 4G network

Make use of new 5G spectrum
Move data-heavy consumers to 5G
Improve user experience also on 4G

Source: Ericsson study of 15 largest markets in the world that have 4G, based on number of subscriptions on all technologies. (Data from Ovum's WCIS database)



Thank you!