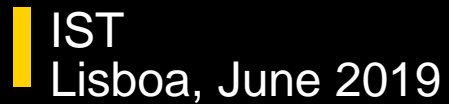# 5G, An Operator Perspective

Henrique Ribeiro
Radio Networks & Devices

IST
Lisboa, June 2019

5G

AGENDA

Trends & Society 5.0
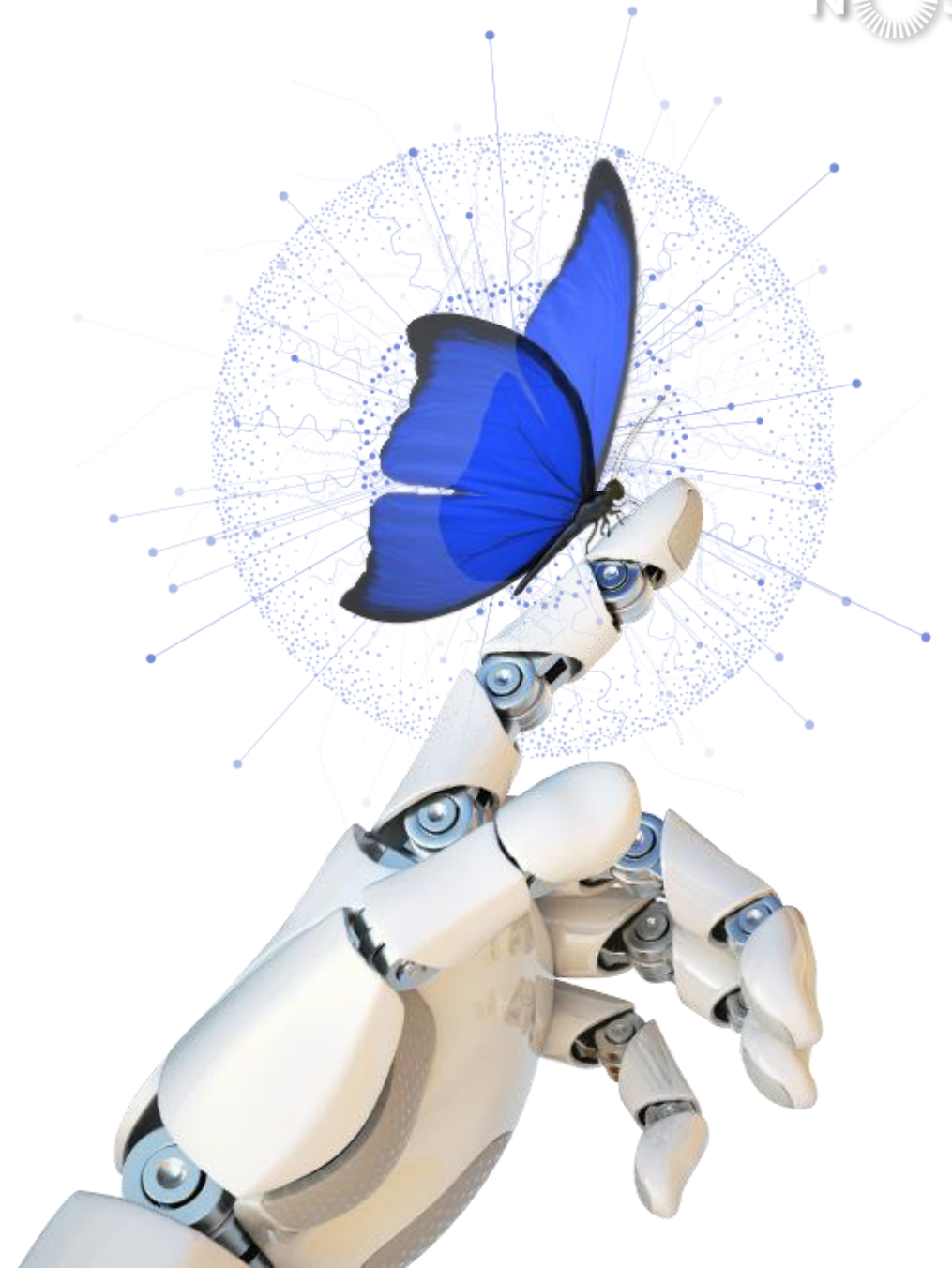
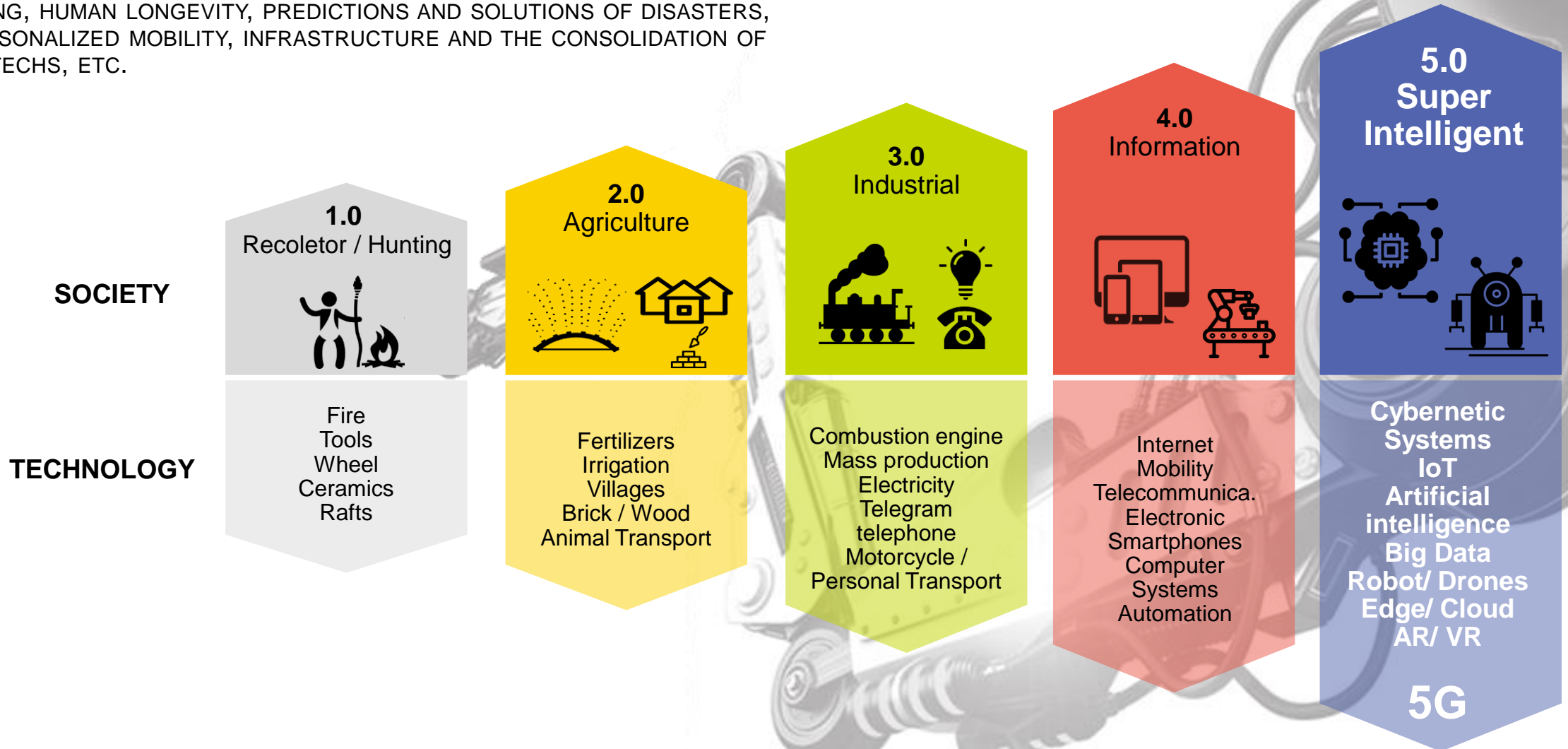**5G a New Generation**

Transforming the Future

Roadmap to 5G

CIVILIZATIONAL EVOLUTION AND TECHNOLOGY ARE SIDE-BY-SIDE

SOCIETY 5.0: TECHNOLOGY TO IMPROVE QUALITY OF LIFE; ACTIVE AGING, HUMAN LONGEVITY, PREDICTIONS AND SOLUTIONS OF DISASTERS, PERSONALIZED MOBILITY, INFRASTRUCTURE AND THE CONSOLIDATION OF FINTECHS, ETC.

SOCIETY

1.0 Recoletor / Hunting	2.0 Agriculture	3.0 Industrial	4.0 Information	5.0 Super Intelligent

TECHNOLOGY

Fire Tools Wheel Ceramics Rafts	Fertilizers Irrigation Villages Brick / Wood Animal Transport	Combustion engine Mass production Electricity Telegram telephone Motorcycle / Personal Transport	Internet Mobility Telecommunica. Electronic Smartphones Computer Systems Automation	Cybernetic Systems IoT Artificial intelligence Big Data Robot/ Drones Edge/ Cloud AR/ VR
				5G

SOCIETY 5.0 = SOCIETY 5G

5G: ONE OF THE TRANSVERSAL TECHNOLOGICAL ENABLERS TO ACHIEVE THE GLOBAL OBJECTIVES OF SUSTAINABLE DEVELOPMENT (ONU SDG)

From the Internet of Things, we have evolved into the Internet of People ...

TELCO TRENDS: CONSUMERS

Video represents 60% current traffic; > 75% by 2024

Monthly volume will grow 10-14x; 20% will consume 200 GB / month

50% consumers foresee new ways of using (VR glasses)

Higher speed, lower latency and new APPs are the expectations for 5G

IN SHORT, THE 5G WILL ACCELERATE

There is strong political *momentum* around
5G in Europe - a city by 2020

Spectrum allocations accelerate across Europe;
3500 MHz is the main band

5G seems to have greater potential in industries,
but consumers also recognize value

5G is an important technological enabler
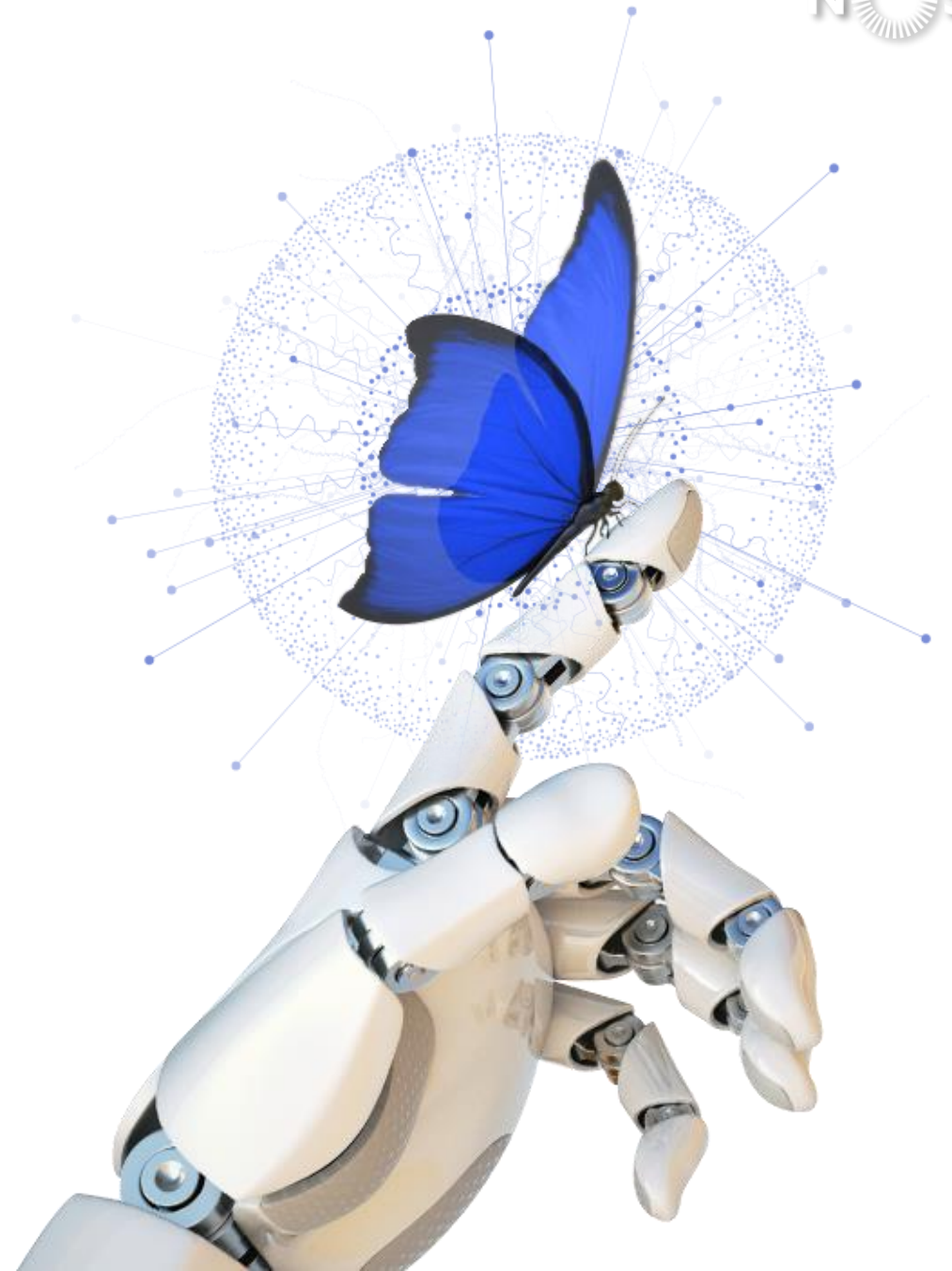of the Future Society (5.0) vision

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Trends & Society 5.0

5G a New Generation

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THE EVOLUTION OF MOBILE NETWORKS MAINTAINS A RENEWAL RATE FOR EVERY 10 YEARS

5G IS INTENDED TO START IN 2020.

5G INTRODUCES THREE MAJOR TYPES OF SERVICES

eMBB
**IMMERSIVE EXPERIENCE**
Enhanced Mobile Broadband

mMTC
FOR EVERYTHING
Massive Machine-Type Communications

uRLLC
INSTANT ACTION
Ultra-Reliable Low Latency Communications

Throughput X-Gigabit

Latency/Real Time

Reliability

Massive Simultaneous Connections

X10 – X100

Network Slicing / Virtualization: Ensuring The Simultaneous And Differentiated Treatment Of Every Application

Network Slicing

50%

40%

10%

Video/
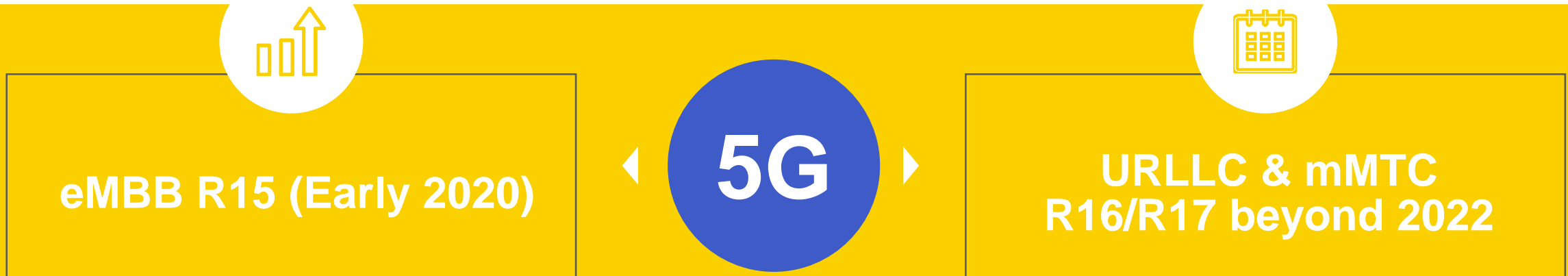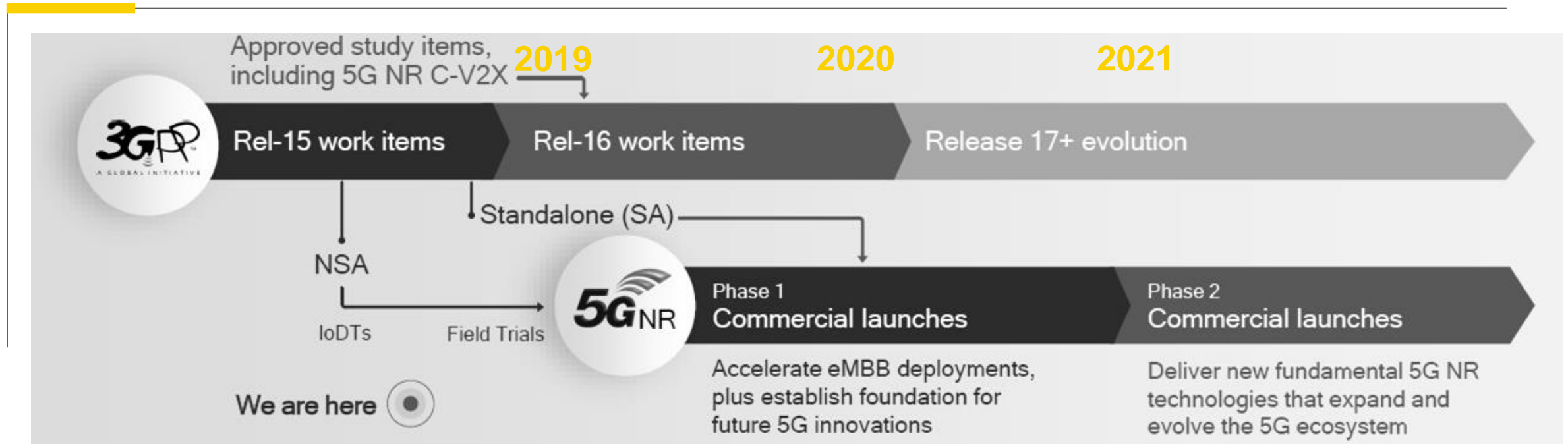Virtual Reality

Automation

IoT Devices
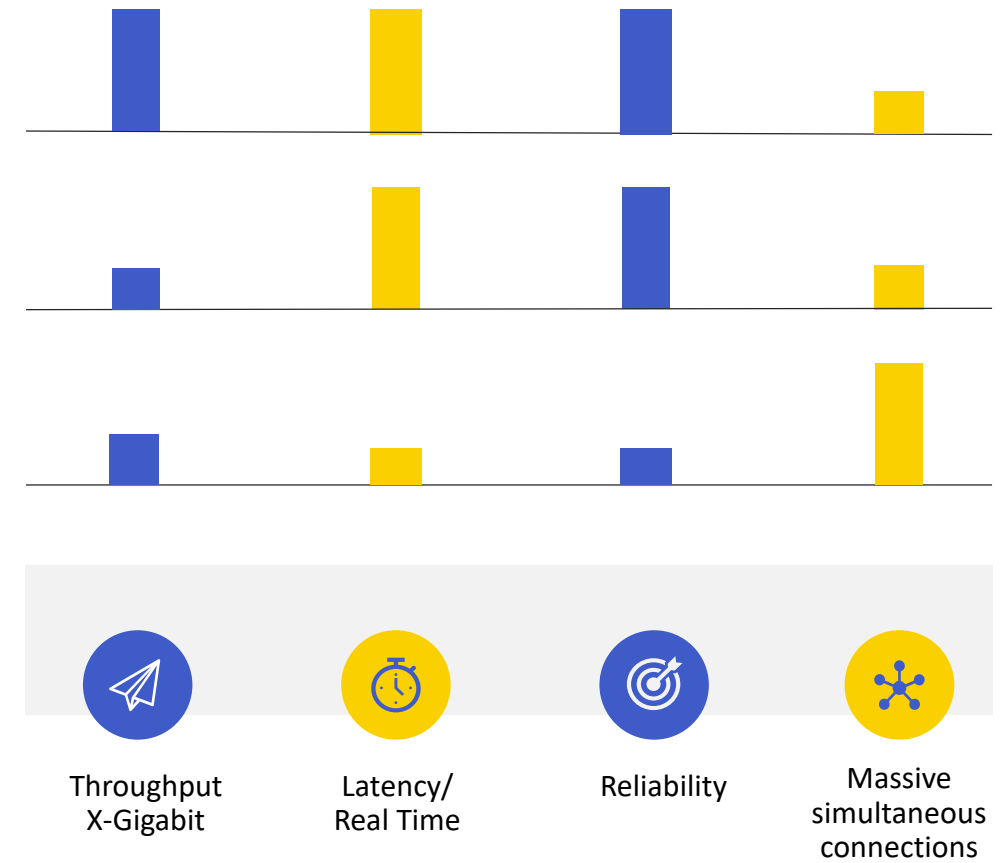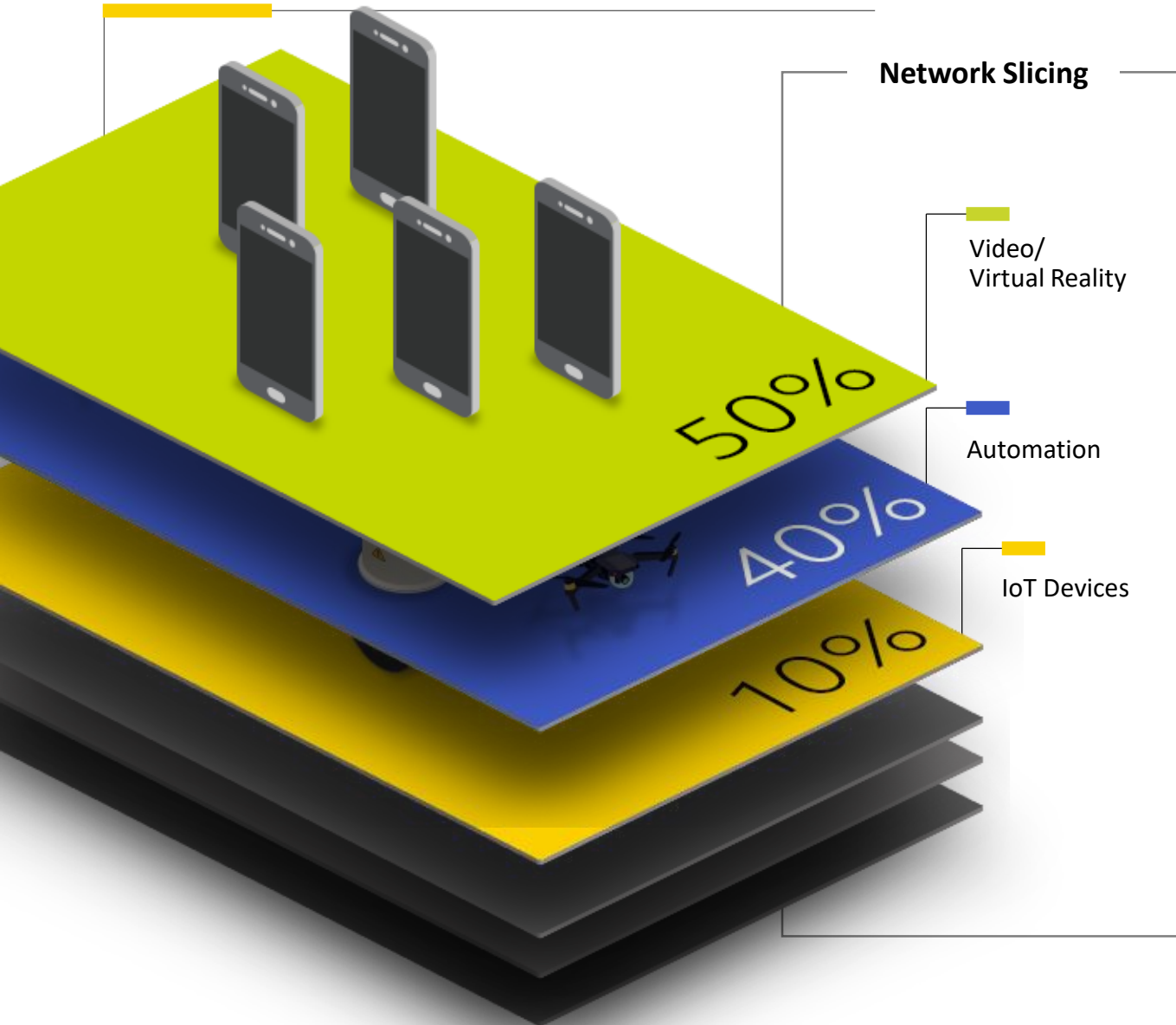
Throughput
X-Gigabit

Latency/
Real Time

Reliability

Massive
simultaneous
connections

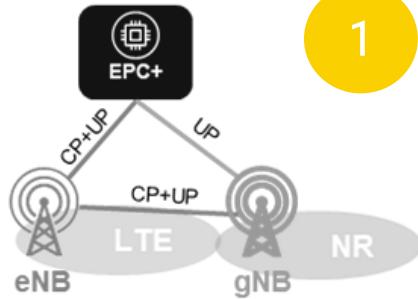# 5G WILL HAPPEN IN 2 WAVES; eMBB In 2020 And uRLCC / mMTC AFTER 2022

eMBB R15 (Early 2020)

5G

URLLC & mMTC R16/R17 beyond 2022

5G Will Require a New Core For uRLLC e mMTC
5G Will Start With Actual Core EPC + (NON STAND ALONE)

Path toward 5G

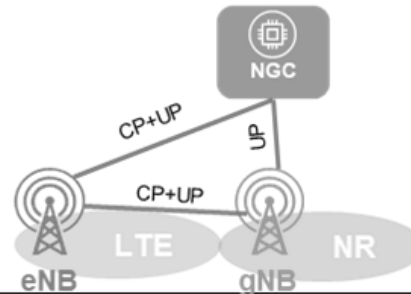### Option 3X

1

EPC+

CP+UP UP
CP+UP

eNB LTE NR gNB

✔ Benefits
- Core 4G
- UL/DL decoupling
- Extended 5G UL coverage thought 4G bands

✘ Drawback
- No 5G Low Latency Services (uRLLC, mMTC)

Option 2

EPC NGC

CP+UP CP+UP

eNB LTE NR gNB

✔ Benefits
- RAN 4G no changes

✘ Drawback
- 2 CORE PS
- **Cobertura (No UL/DL decoupling)**

Option 7/7A

NGC

CP+UP UP
CP+UP

eNB LTE NR gNB

✔ Benefits
- 1 Core
- Full 5G service ready
- UL/DL decoupling

✘ Drawback
- **No CSFB/SRVCC**
- 100% VoLTE
- RAN 4G must evolve
- **NGC Imaturity**

Option 3X + Option 2
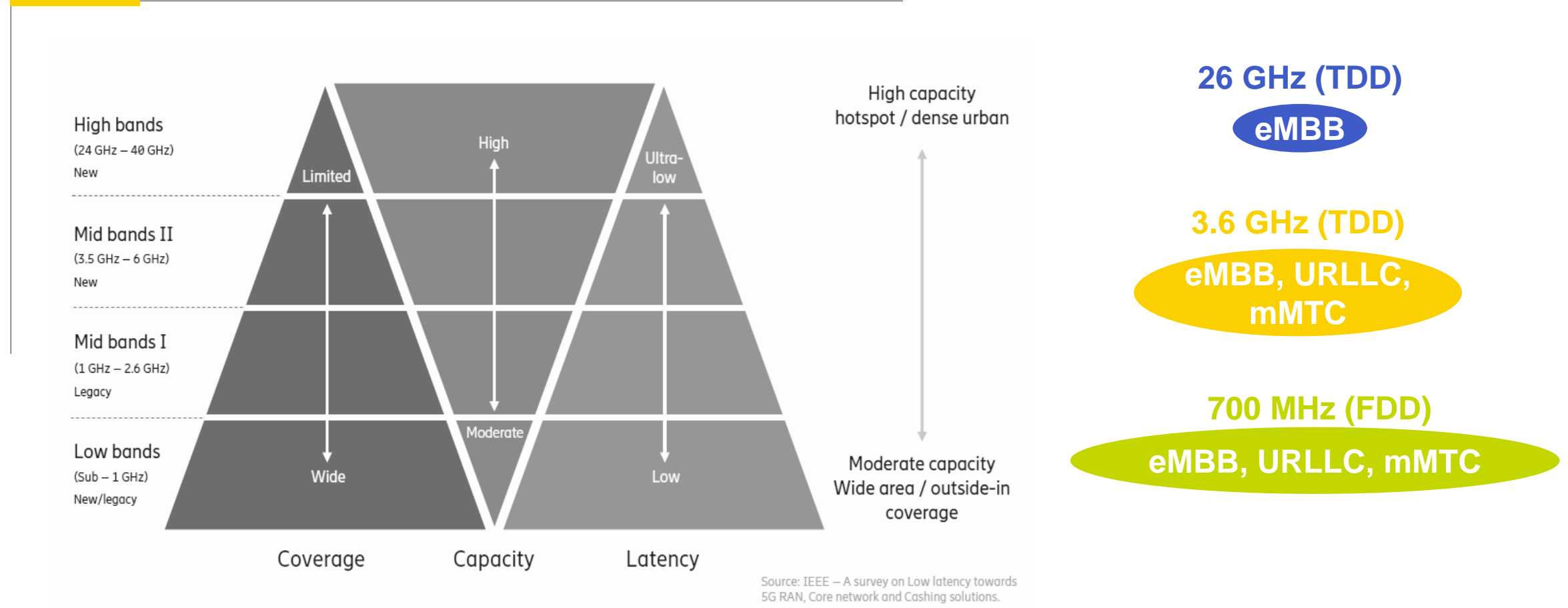
EPC+ NGC

CP+UP UP CP+UP
CP+UP

eNB LTE NR gNB
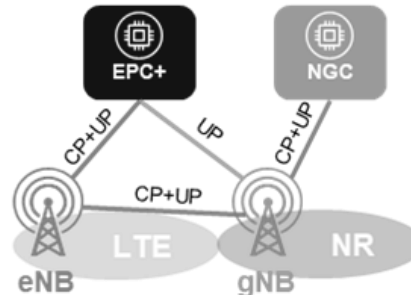
✔ Benefits
- UL/DL decoupling
- CSFB/SRVCC
- RAN 4G no Changes
- Full 5G service
- Full support of 5G terminal

✘ Drawback
- 2 CORE PS

2

3 FREQUENCY BANDS WILL ALLOW A NATIONAL COVERAGE AND SUPPORT TO USE DIFFERENT CASES

26 GHz (TDD)
eMBB

3.6 GHz (TDD)
eMBB, URLLC, mMTC

700 MHz (FDD)
eMBB, URLLC, mMTC

Source: IEEE – A survey on Low latency towards 5G RAN, Core network and Cashing solutions.

700 MHz will have a global coverage role, including the 3.6 GHz UL; 3.6 GHz will be the most balanced between coverage and capacity (up to 4 Gbps); 26 GHz has strict requirements (LoS required)
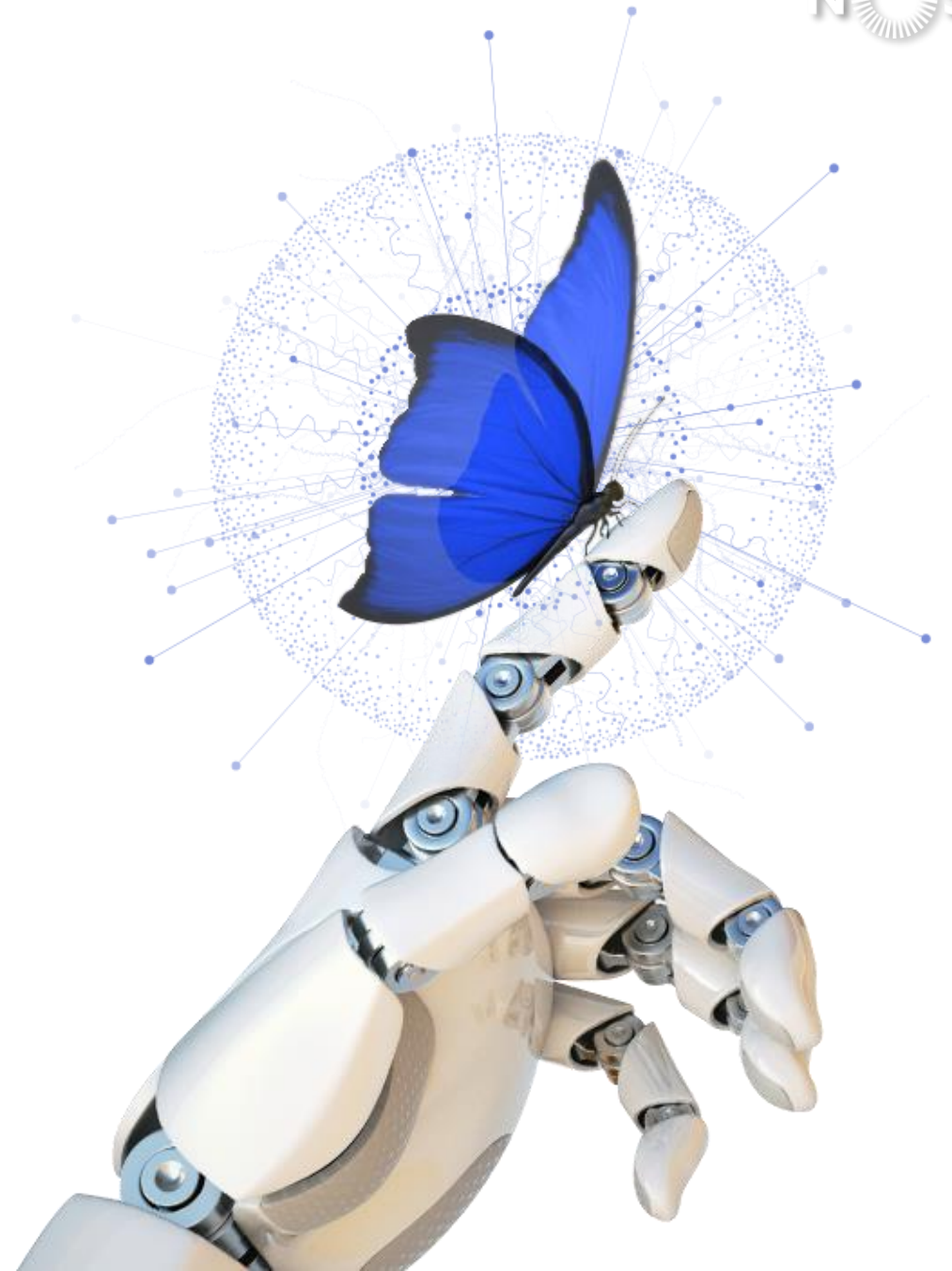
Spectrum Assignments: Europa

Legend:
- 🟧 Already assigned for 4G/BWA
- 🟩 Awarded for 5G
- 🟦 To be released as national licences
- 🟦 (light) To be released as regional licences
- ⬜ (grey) Currently not available

Frequency scale (MHz): 3400 · 3450 · 3500 · 3550 · 3600 · 3650 · 3700 · 3750

Country	Assignments
Czech Rep	Nordic Telecom / Defence / Vfe / Poda / O2 / Nordic Telecom / Nordic Telecom
Ireland	25 MHz / 40 MHz (state service) / Vodafone / Airspan / Meteor / Three
Spain	Masmovil / TEF / Orange / MoD / Masmovil / TEF / Orange / MoD / Orange / Vodafone / TEF
Italy	MoD (37 MHz) / 21 MHz / 21 MHz / 21 MHz / MoD (37 MHz) / 21 MHz / 21 MHz / 21 MHz / Liad / Wind3 / VDF / TIM
Finland	Telia Finland / Elisa / DNA
UK	Vodafone / H3G / H3G / Telefonica / EE / H3G / To be auctioned in 2019
Switzerland	Salt / Sunrise / Swisscom
Austria	Regional, A1TA, unawarded / A1 TA / H3A / Tmobile
Germany	To be released as national licences in 2019 / To be released for local licences in 2019
Sweden	To be released as national licences in 2019 / To be released for local licences in 2019
France	FWA in rural areas / Bolloré / Auction expected in 2019, for availability in 2020
Denmark	To be released in 2019/2020 - conditions TBD

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Fonte: GSA-Recommendations-C-Band-April-2019, GSAcom, abril 2019

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REMOTIZATION AND CONTROL

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Critical machine control
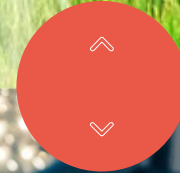
Specialized interventions

Remote Training

Immersive environment supported on AR and VR

Indoor or outdoor environment

DIGITALIZATION PRODUCTION AND SENSING

Connected sensors, cameras and systems

Autonomous robots and collaborative precision

Integrated, centralized view of production

Failure detection and instant decision

Layout Flexibility

MOBILITY, LOGISTICS AND TRANSPORTATION

All connected items

Production control for sale

Smart Analytics e Big Data

Operational model and business support

V2X Remote Driving

- Complex value chain; car manufacturers will take the lion's share
- V2X will generate economic value; less accidents, less pollution, higher productivity
- 5G will use URLLC services, requiring edge computing, with high costs
- Infrastructure owners should be initial promoters of V2X (IP/BRISA)

AR / VR Video, Surveillance and Analytics

Streaming content with 360º Video

Augmented Reality Enhanced Entertainment / Training

Virtual Reality Remote Entertainment

Gaming / Training with Augmented Virtual Reality

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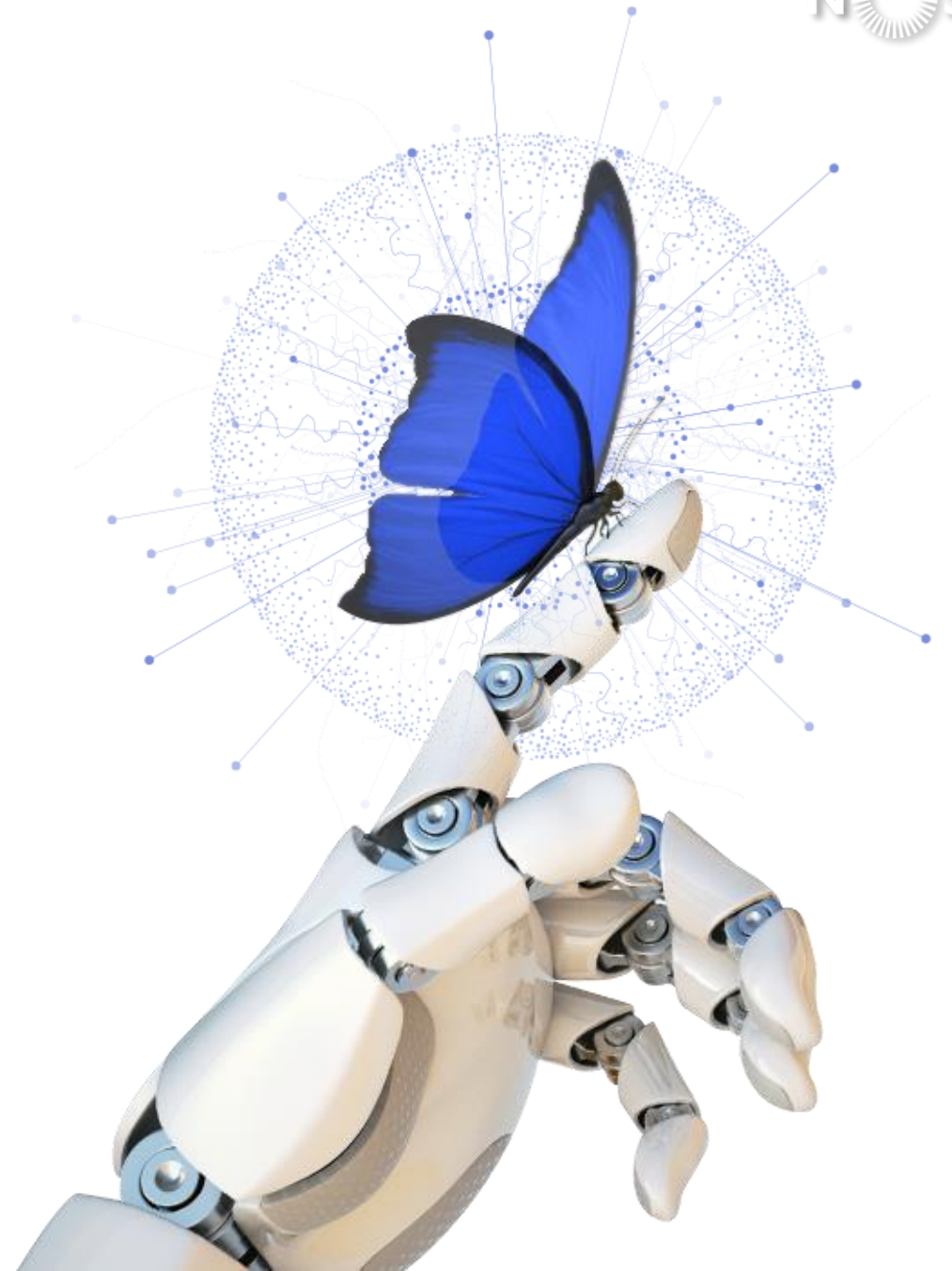
1ST LIVE 5G DEMO – REMOTE DRIVING (PORTUGAL SMARTCITIES)

SUMMARY

5G has the potential to change and transform many industries, whether in the production process or in another part of the value chain;

It will give consumers a better experience, especially in very high definition video APPs and access to higher speed, even at events;

eMBB will be the first services; very low latency and M2M will appear later (> 2021); it is estimated that in 2020 we will have the 1st 5G city (EU target);

5G applications are typically complex and require the creation of partnerships and ecosystems aggregated by verticals.

Thank You

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IST
Lisboa, June 2019