Harmonious development of the digital society in Portugal:

the right 5G auction structure is critical

Lisbon, October 13th, 2020

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A. Executive summary

Executive summary (1/3)

5G technology as the basis of the digital society

The digital society concept lays in a deep inter-connectivity platform system with consumers right at its center. Its success is enabled by the 5G paradigm, arising from a natural evolution of the telco sector. This new technology operates over a specific band of the electromagnetic spectrum, with 5G band levels unlocking different potential benefits enabled by new end-to-end network architecture and supported by stakeholders' cooperation

The implementation will keep pace with technological developments, while value generation gradually unfolds over the coming years, with all industrial sectors benefiting directly from its capabilities

The upcoming spectrum auction will be critical to the development of the 5G network that will support the digital society in Portugal. Notwithstanding, the existing auction rules call into question the feasibility of the deployment targets set by the government

Roland Berger has identified 5 critical requirements for the 5G spectrum auction structure to ensure the success of the digital society in Portugal

1) Recognize the focal role of telecom operators in the digital society

5G will be an enabler of 5% of the world´s economic value by 2035, with significant value creation across all industrial sectors (an estimated value of USD 35 bn just in Portugal), therefore it is important to recognize that operators continue to be pivotal to the functioning of the emerging digital value chain

Source: Roland Berger

Executive summary (2/3)

2) Consider the level of investment needed in the deployment of this technology falls on operators
Operators have not been able to monetize the increased data usage, facing a new round of heavy investment to enter the 5G paradigm. The diminishing returns on invested capital has put a strain on telco's ability to access the necessary funding to execute the investments required in 5G infrastructure. Hence, with one of the lowest revenue per capita and ROIC[1)] in Europe, introducing unfair competition in the Portuguese market would further undermine the overall goal

3) Maintain and promote the competitive fairness of the Portuguese telecom market
Market dynamics have allowed Portugal to reach a prominent place in the telecom sector, displaying supply indicators above the global average. The effect of a forced, new entrant might disrupt sector's economic sustainability and therefore jeopardize Portugal's global positioning concerning the hyperconnected society

4) Guarantee non-discriminatory access to potential new entrants
The quality of 5G infrastructure will be crucial to the success of the digital society – discriminatory auction rules have been proven to produce undesired outcomes, often leading to significant market deterioration (e.g. Germany, Netherlands)

5) Ensure the sustainable economic development of Portugal
The auction rules should be structured in a way to foster value and job creation. If the 5G spectrum auction is to be carried out in the foreseen manner, it could compromise the sector's worth to the overall economy (potential job loss estimations at +2 thousand)

1) Return on invested capital

Source: Roland Berger

Executive summary (3/3)

Moreover, Roland Berger has pinpointed 3 additional levers for stirring the Portuguese telecom sector

1) Facilitate network sharing among operators
Infrastructure sharing should be voluntary, and impositions should only be required in non-competitive areas

2) Promote the digital skills of the population
Digital skills training of the population should be a top priority in order to maximize the potential of the digital world

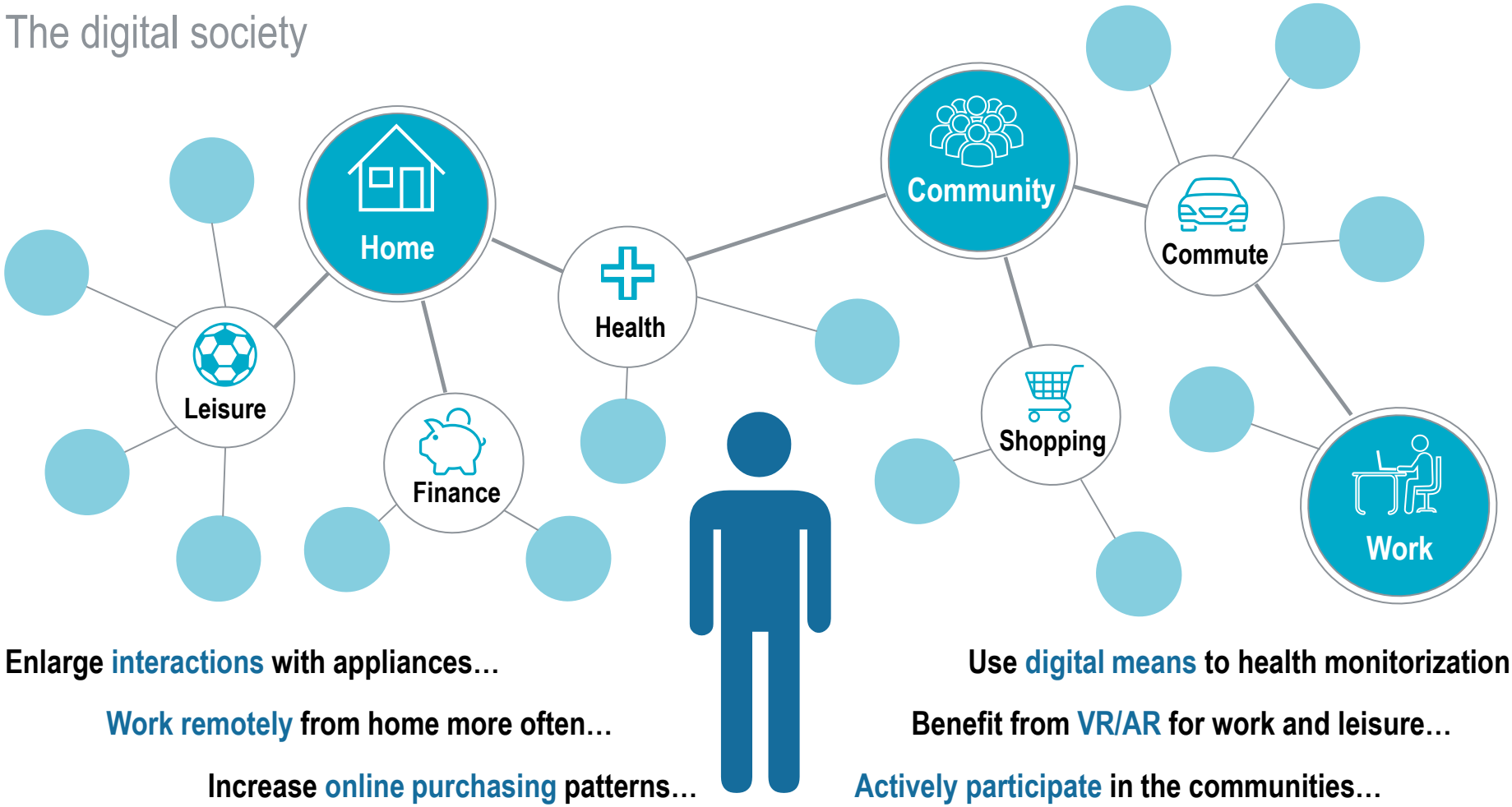
3) Adoption of convergence regulation
Once digital ecosystems cross industry, jurisdictional and geographical frontiers, regulators need to implement a collaborative regulatory approach to become the facilitators of the digital hyperconnected economy

Source: Roland Berger

B. 5G technology as the basis of the digital society

The digital society concept lays in a deep inter-connectivity platform system with consumers right at its center

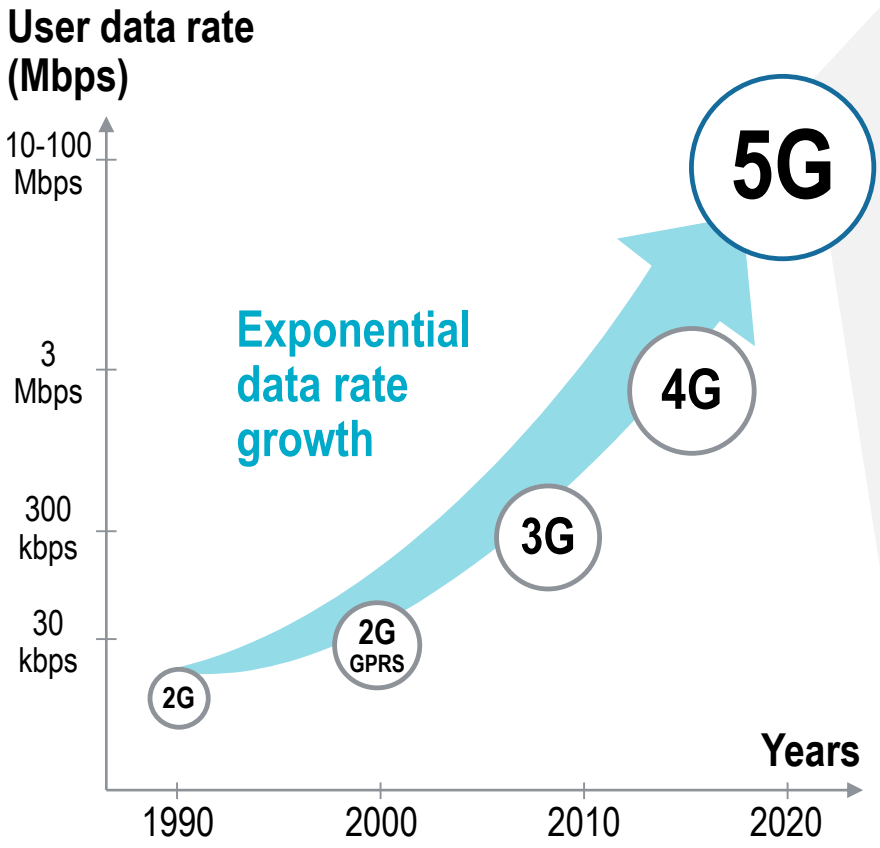
The digital society



Source: Roland Berger

5G arises from a natural evolution of the telco sector, presenting exponential growth to enable the success of the digital society concept

5G global context and defining features



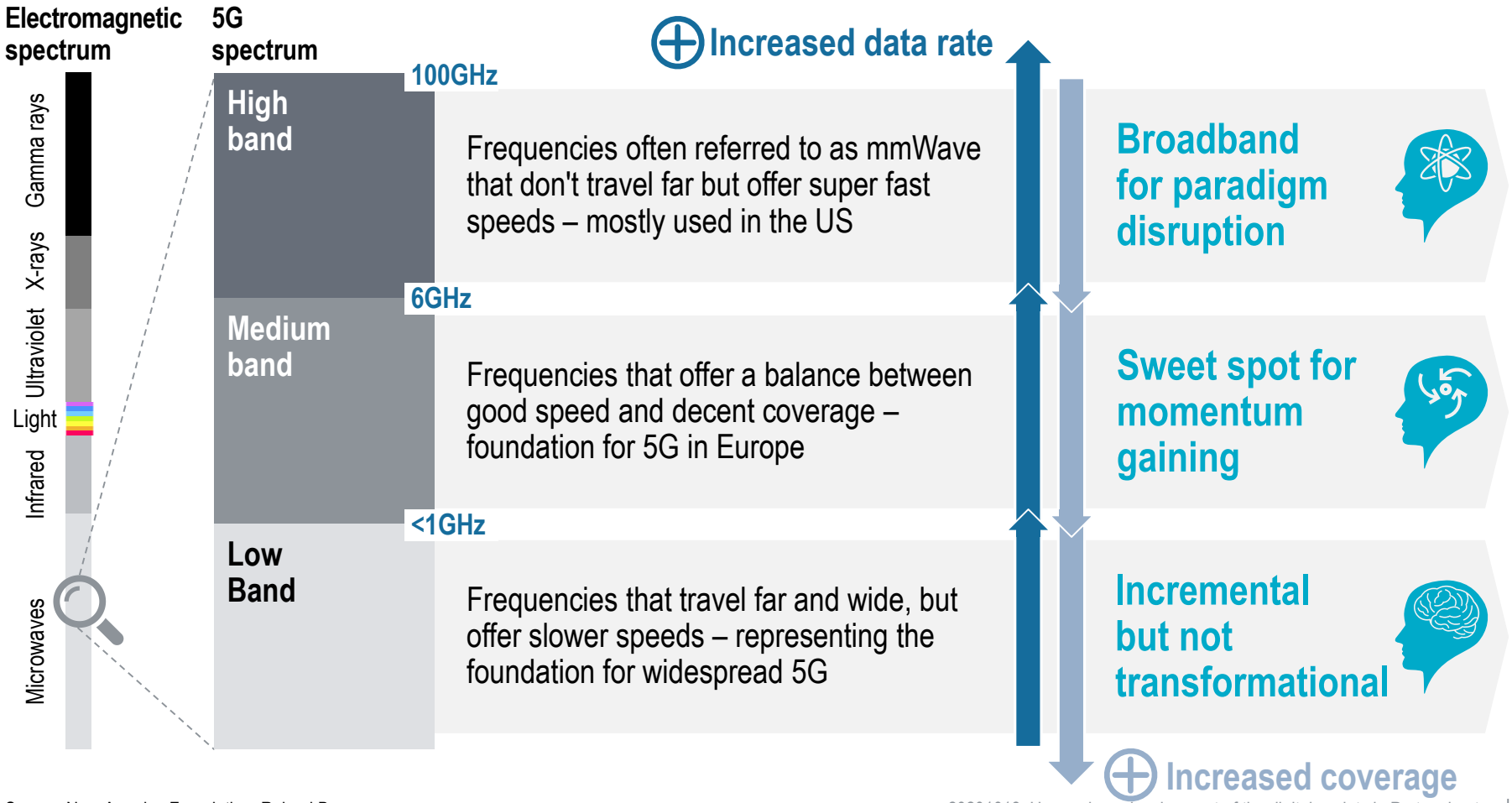
Transition to 5G involves new, end-to-end network architecture with several defining features

eMBB Enhanced mobile broadband	Faster connections, higher throughput and greater capacity (up to 10 Gbps)
uRLLC Ultra-reliable low latency communication	Reduced time for data from device to be uploaded and reach its target (1 ms compared to 50 ms for 4G)
Security	Robust security properties, leading to high reliability and availability to support future applications
mMTC Massive machine-type communications	Increased spectral efficiency plus small cell deployment, allowing large number of connections
Power efficiency	Efficient power requirements for massive multiple input/ output (MIMO), small cell implementation

Source: World Economic Forum, Roland Berger

The technology operates over a specific range of the electromagnetic spectrum, with 5G band levels unlocking different potential benefits

5G spectrum

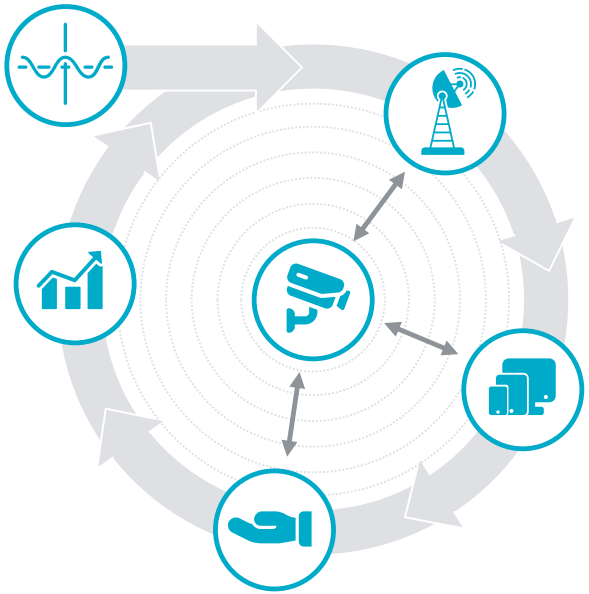


Source: New America Foundation, Roland Berger

The 5G ecosystem cycle allows the best use of the new, end-to-end network architecture, enabled by stakeholders' cooperation

5G ecosystem

5G ecosystem cycle



SPECTRUM

Base of the 5G ecosystem – combination of mainstream and alternative tech. and use both licensed and unlicensed spectrum across different bands

IMPACT

Economic impact: employment, profits, investment, etc.
Social impact: health, education, environment, etc.

SERVICES

Opportunity to deliver services across diverse industries and geographies, involving non-traditional stakeholders through transformed business models

INFRASTRUCTURE

Elements of the 5G network that provide coverage, bandwidth, latency and reliability for 5G devices

SECURITY

Actual and perceived end-to-end security of 5G infrastructure, devices and uses as key factor for enterprises and public institutions

DEVICES

Connected devices able to support much greater performances and need to exist in a variety of form factors to support the new 5G-enabled use cases and business models

Stakeholders

Regulators/ Policy-makers | Enterprises/ Associations | Service/ Tech. providers | Public-private organizations

Source: World Economic Forum, Roland Berger

5G will sustain global socio-economic growth, with all industrial sectors being directly impacted – COVID-19 crisis has accelerated the urgency

Expected economic impact of 5G technologies

$13tn

estimated global economic value reached by 2035, enabled by 5G as base for socio-economic growth

$35bn

expected impact[1] on the economy by 2035, securing 1% additional compound annual growth rate for the period

Post-COVID selected industries	How 5G can impact
Media and entertainment	Support massive increases in data rules and guarantee a good quality of service
Manufacturing	Provide the highly resilient, secure and low latency communication platform in the factory
Security	Support wireless security applications both for monitoring and detection
Agriculture	Remotely control farming equip. and provide bandwidth for advanced imagery and use of drones
Energy and utilities	Real-time control of grids and remote generators where fibre has not been rolled out
Healthcare	Enable mobile remote care solutions through guaranteed and secured connection
Automotive	Dynamically configure networks and resources to address different demands
Public transports	Provide coverage and bandwidth for infotainment and more efficient operations

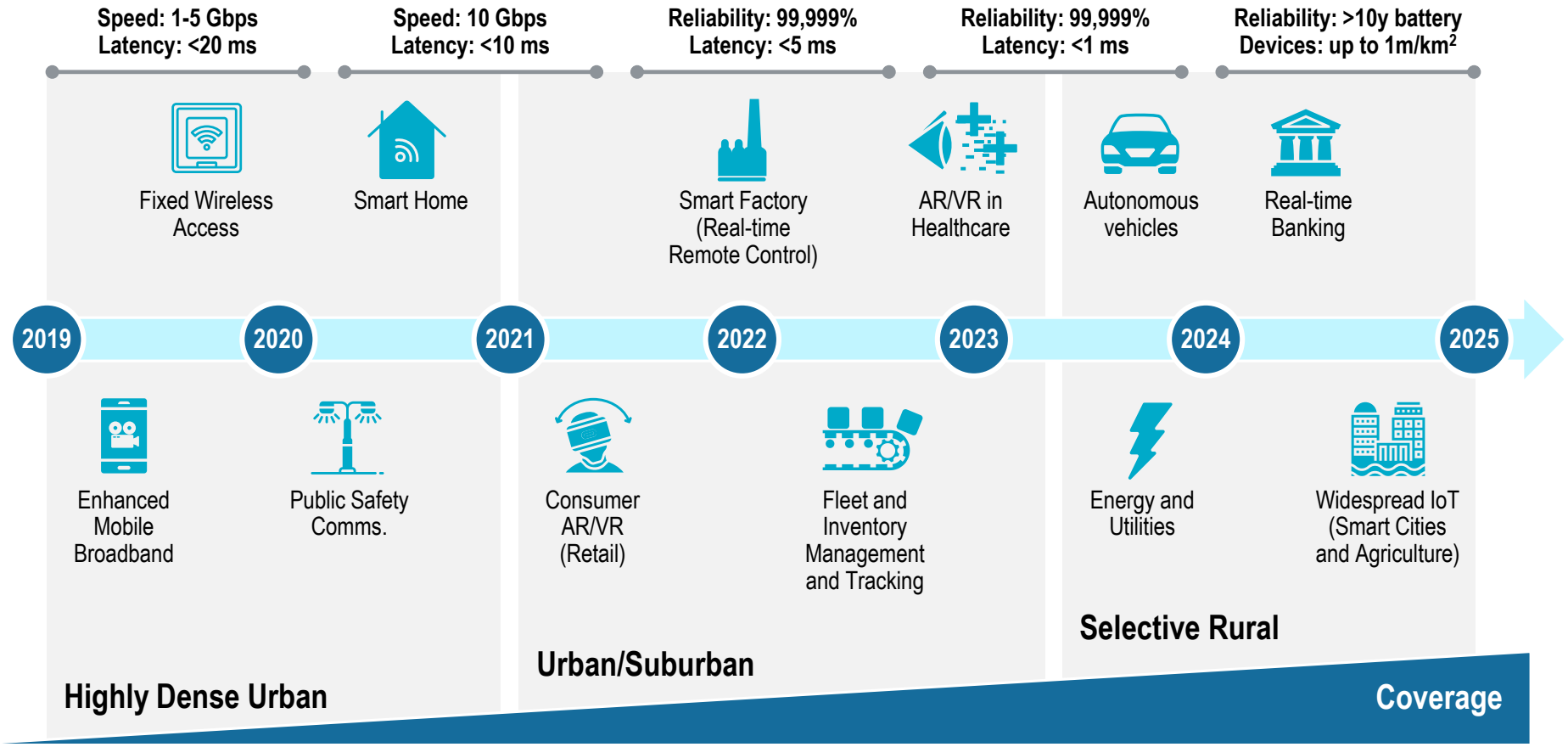
COVID-19 with key impact on societal indicators, relating to the digital development

- Platforms and apps to coordinate mass movement (e.g., StayAway Covid)
- Digital service infrastructures reinforcement to deal with higher demand
- Digitization of public administration (e.g., ePortugal portal)
- Platforms set to support SMEs during lockdowns
- Digital home solutions for home working/ schooling

1) Roland Berger estimates
Source: World Economic Forum, HIS Markit, Ericsson, Roland Berger

The implementation will keep pace with technological developments, while value generation gradually unfolds over the coming years

5G maturity implementation across industries



Source: World Economic Forum, Roland Berger

There have already been several moves in Portugal towards 5G deployment – upcoming spectrum auction as critical next step

5G deployment process in Portugal

Non-exhaustive

2017

ANACOM

Gave authorization to use radio spectrum for the performance of technical tests and scientific studies using various technologies

Vodafone; Altice

Developed 27.5-28.5 GHz trials to test and demonstrate the capabilities of new technologies in Lisbon (Vodafone) and Aveiro (Altice)

2018

ERICSSON

Installation of the first 5G antenna, making Massive MIMO and beam forming technologies available in Portugal for the first time

Vodafone; NOS; MEO

Conducted a series of tests in the context of practical use to new 5G technologies in order to test their potential and new features

2019

ANACOM

Approved on 23rd of October a draft decision on:

- A 700 MHz band for electronic communications services
- Limit on number of use rights of allocated frequencies in several bands[1)]
- Definition of the respective auction procedure

2020

- In February, ANACOM presented the draft regulation for the 5G spectrum auction
- 5G spectrum availability according to the principles of technology and service neutrality
- Objective to stimulate operations with different dimensions and efficient spectrum use
- Process suspend in wake of COVID-19 pandemic (March 2020)

5G as enabler of the digital society concept, depending on the way spectrum auction will be performed

1) 700 MHz, 900 MHz, 1800 MHz, 2.1 GHz, 2, 6 GHz and 3.6 GHz

Source: ANACOM, Press Clippings, Roland Berger

Current auction rules clash with Government set of very ambitious 5G deployment targets, raising important questions about its feasibility

Ensuring the 5G deployment targets

Non-exhaustive

The Government has set a number of very ambitious targets for the distribution of the 5th generation of mobile communications[1)]

2020 — At risk

Two Portuguese cities (one low density and another with +50k inhabitants)

2023

All municipalities with +75k inhabitants and 50% of all business areas, airports and main public hospitals

2024

All municipalities with +50k inhabitants

2025 – *Quasi* full coverage

… **90% of the population should have access to mobile broadband** services with a typical user experience of at least 100 Mbps

Key remarks

- **Is the implementation timetable feasible in light of the impacts of the pandemic crisis?**
- **Do the current auction rules promote the attractiveness of the future 5G infrastructure?**
- **What is the best way to ensure that operators are able to make the necessary investments?**

1) Council of Ministers Resolution 7-A/2020

Source: Portuguese Council of Ministers, Roland Berger

C. Critical requirements of the 5G spectrum auction structure

The structure of the 5G auction will be fundamental for the success of the digital society in Portugal – RB has identified 5 essential conditions

The right way to do things in the 5G auction

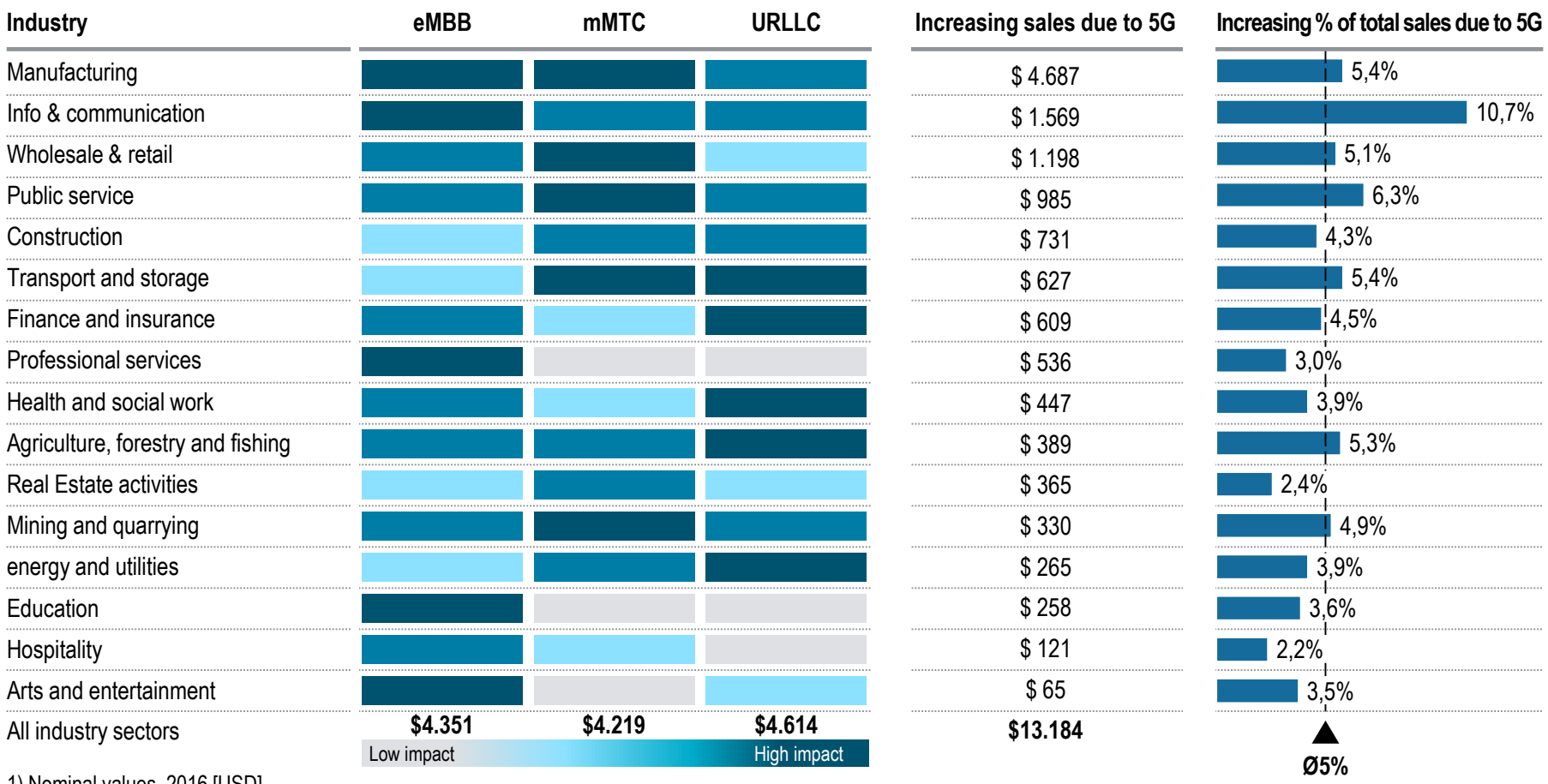
The upcoming 5G auction structure will set the **foundations for the success of the digital society**, therefore its rules should…

1. **… recognize the focal role of telecom operators in the digital society**, by understanding that the value created by 5G deployment will be distributed to the overall economy
2. **... consider the level of investment needed in the deployment of this technology falls on operators**, particularly when the sector's financial health is not keeping pace with investment requirements
3. **... maintain and promote the competitive fairness of the Portuguese telecom market** by avoiding artificially induced price reductions that ultimately will undermine Portugal's global connectivity positioning
4. **... guarantee non-discriminatory access to potential new entrants** by aligning incentives and requirements that ensure continuous and sustainable investment in the backbone infrastructure of the digital society
5. **.. ensure the sustainable economic development of Portugal** by stimulating the creation of value and jobs in the telecommunications sector

Source: Roland Berger

5G will be an enabler of 5% of world's economic value by 2035, with significant value creation across all industrial sectors

1 Impact of 5G defining features on increasing sales by industry, 2035 [USD[1)] bn]



1) Nominal values, 2016 [USD]

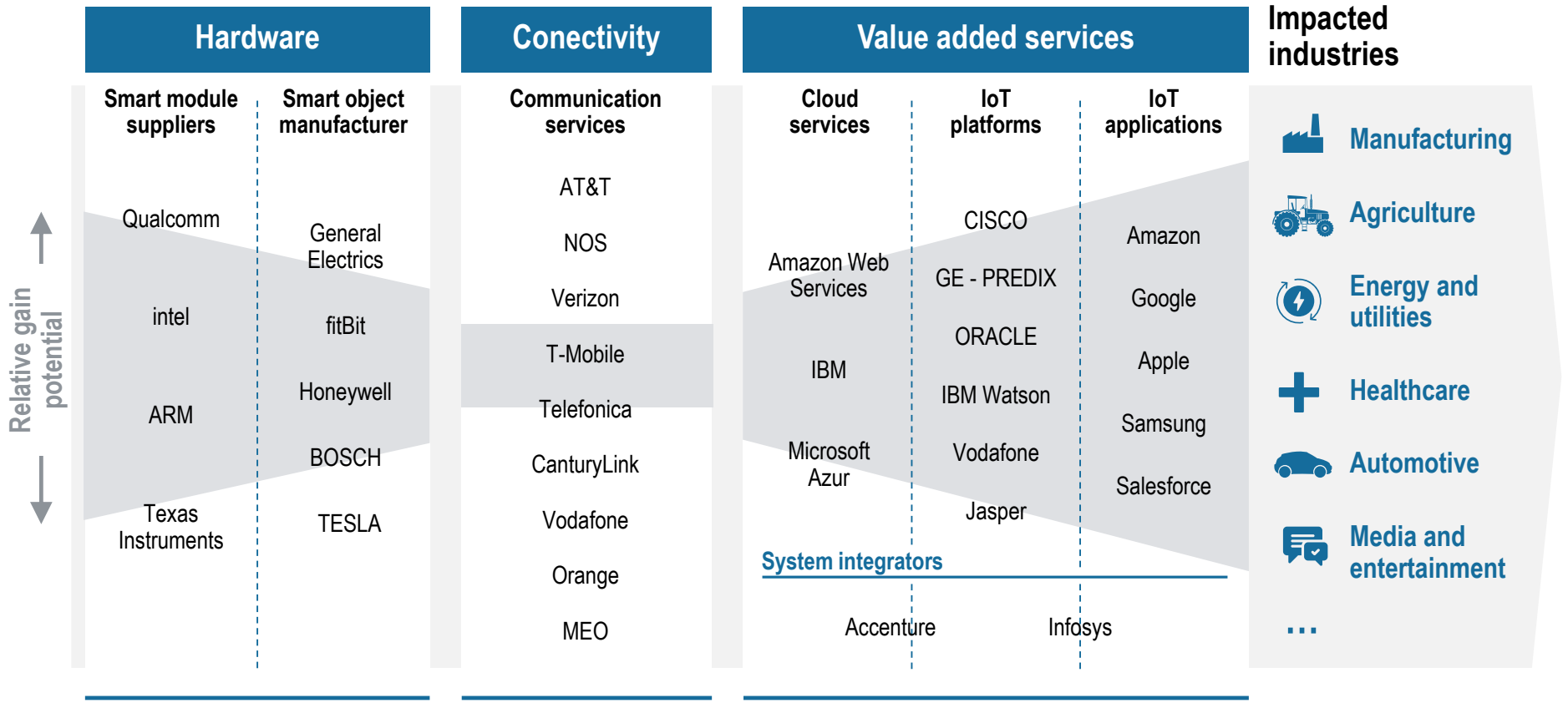
Note: *eMBB: Enhanced Mobile Broadband; URLCC: Ultra Reliable Low Latency Communication; mMTC: Massive Machine Type Communication*

Source: IHS Markit, Roland Berger

Despite lower potential gains, telecom operators continue to be pivotal to the functioning of the emerging digital value chain

1 Emerging digital value chain

Examples



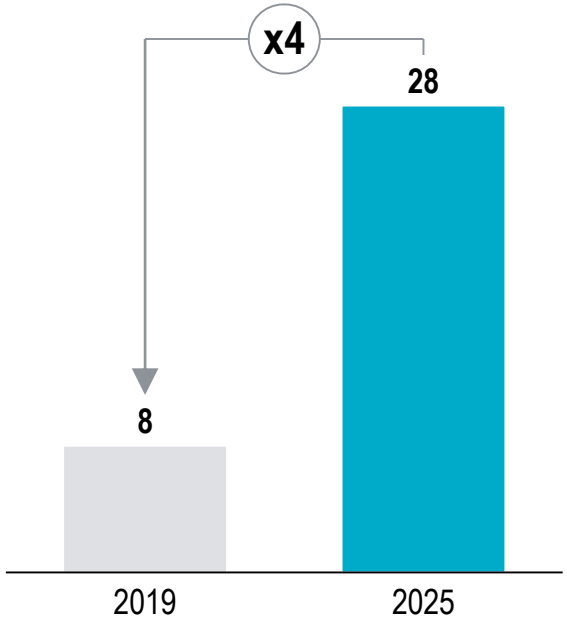
Source: Tieto, Telecomcircle, IoT Research EU

Operators have not been able to monetize the increased data usage, facing a new round of heavy investment to enter the new paradigm

2 CAPEX requirements

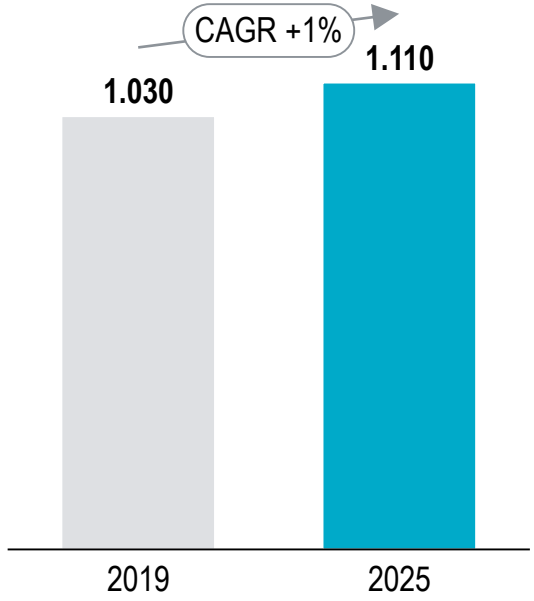
Global mobile data usage will grow almost fourfold by 2025…

Gb per subscriber per month



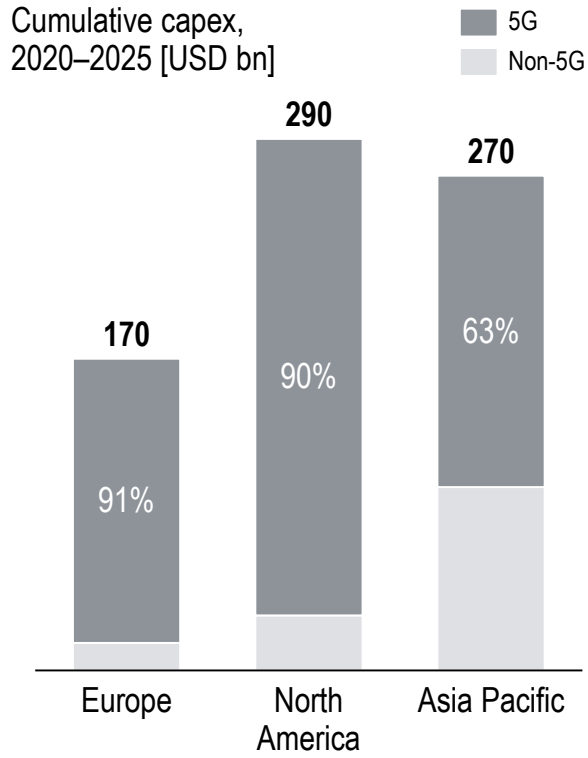
.. but total mobile revenues will only grow at 1.1%…

Mobile revenue [USD bn]



.. on top of that, operators will invest $1.1 trillion – 80% on 5G

Cumulative capex, 2020–2025 [USD bn]

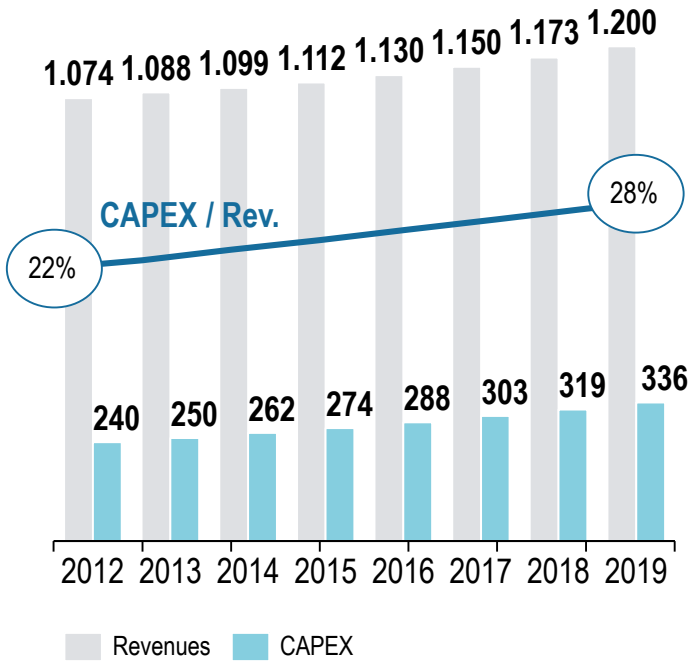


Source: GSMA, Roland Berger

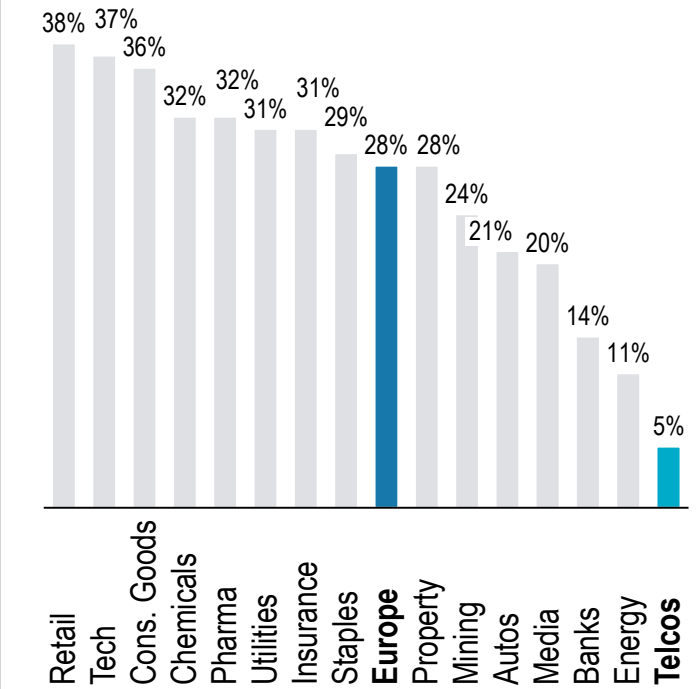
The diminishing returns on invested capital has put a strain on telco's funding ability – it's crucial to reflect on their ability to invest

2 Return on invested capital in the telecom sector

Global telecommunications sector revenues and investment effort [EUR bn]



Total shareholder return by sector, 2019



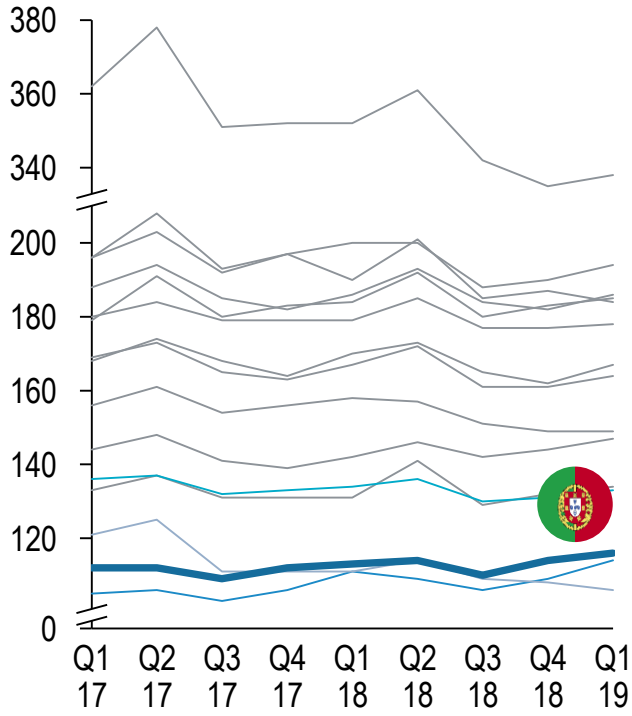
- The market **has strongly discounted investments in 5G** – particularly auctions above estimated outcome (e.g. Germany auction done at 2x the consensus estimate)
- Decrease in equity value has led to a **reduction in the financial capacity** of telecoms to fund their investments

Source: IDATE DigiWorld 2019, IDATE World CapEx Dynamics, ITU, Bloomberg, Roland Berger

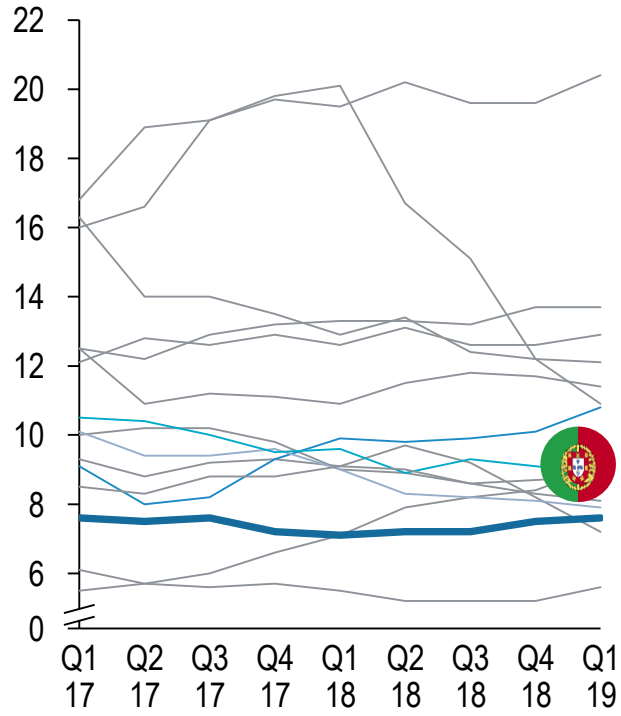
With one of the lowest revenue per capita and ROIC[1)] in Europe, forcing unfair competition in the market would undermine 5G roll-out

2 Benchmark of European telecom markets, 2017-2019

Revenue per capita [EUR]



ROIC[1)] [%]



Austria — Belgium — Denmark — Finland — France — Germany — Greece — Italy — Netherlands — Norway — Portugal — Spain — Sweden — Switzerland — UK

> The Portu**guese telecom sector** is already **one of the worst generating returns** on its assets in Europe, a situation that **could be aggravated by the conditions** of the **spectrum auction**

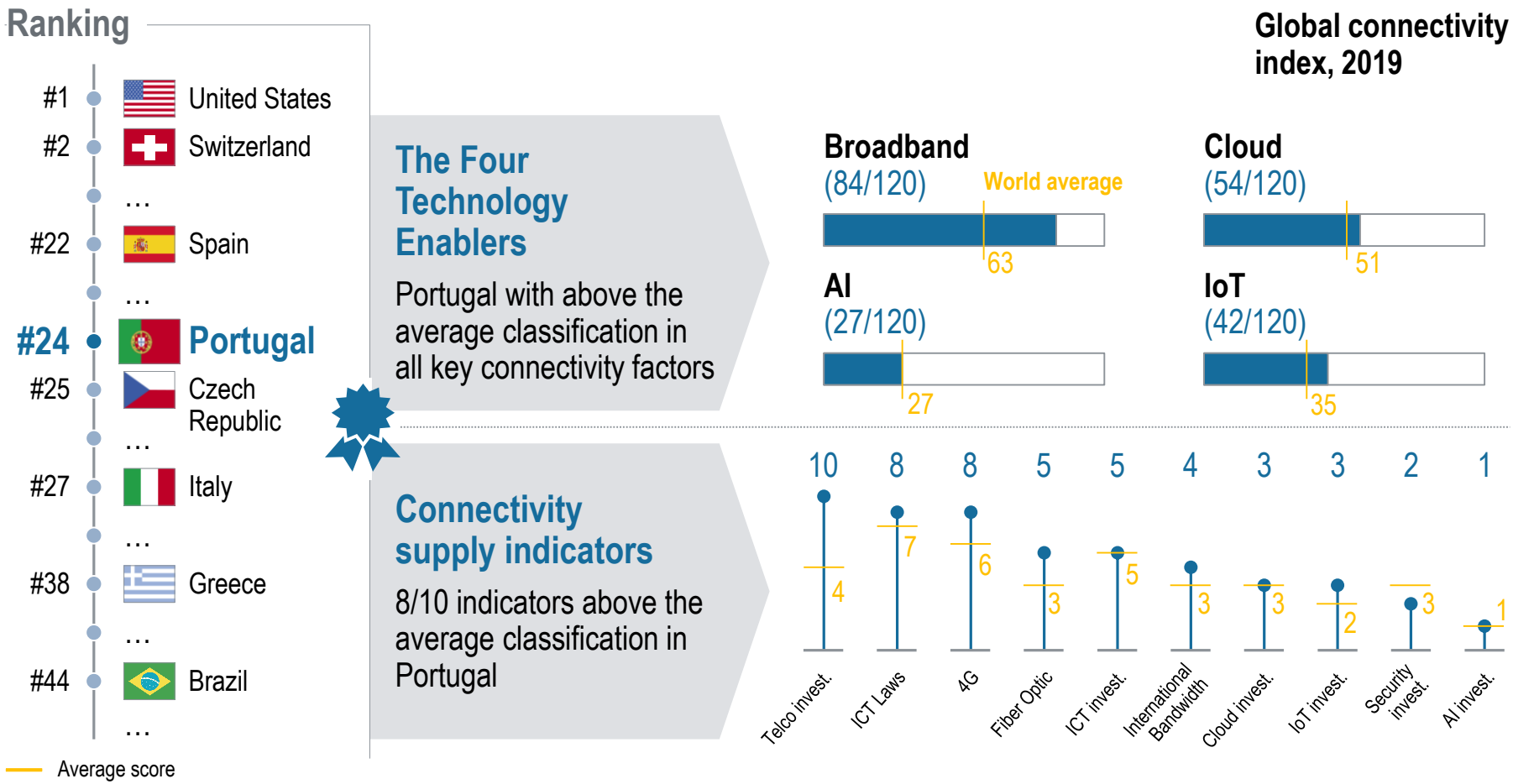
> The **terms of the PT auction should safeguard** the operators ability to execute necessary investments and **avoid unfair competition**

1) Return on invested capital

Source: New Street Research, Roland Berger

Market dynamics have allowed Portugal to reach a prominent place in the telecom sector – supply indicators above the global average

3 Global positioning of the Portuguese telecom sector



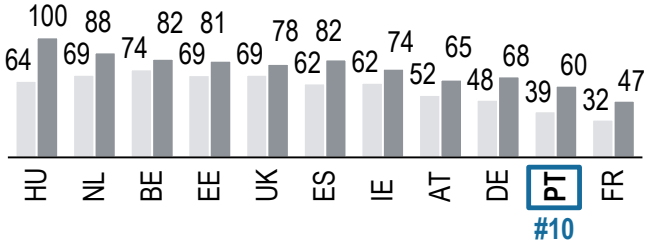
Source: Huawei Global Connectivity Index 2019, Roland Berger

Regardless of the methodologies evaluating price discrepancies, forced entrants effect may disrupt the sector and compromise service quality

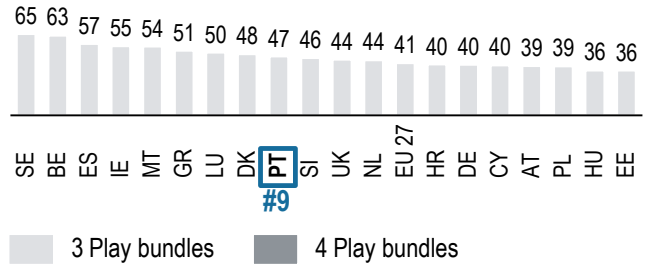
3 New entrants effect on the market

Despite observable discrepancies over the same price reality...

APRITEL – Electronic comm. price analysis in EU, 2019 [EUR]



European Commission – Fixed broadband prices in Europe, 2018 [EUR]



...the forced entry of new players has led to the diminishing of infrastructure investments and, ultimately, quality of service

TELE 2

Futility of forcing new entrants

> Tele2 NL's entry as a MNO was initially accompanied by **aggressive commercial offers**

> Despite lower network quality, NL market prices declined, **deteriorating competitiveness**

> Sector commission concluded that **quality gap was likely to increase** and market exit would occur if not for merging with T-Mobile

Airtel

How low can mobile prices go?

> Arrival of Bharti Airtel in Sri Lankan market plunged MNOs into an **aggressive price war**

> Tariffs were cut by 80% resulting in **financial distress in the industry and diminishing investments**

> In order to revert the situation, the regulator set floor tariffs, **stabilizing prices at the lowest levels worldwide**

Note: 3 Play and 4 Play bundles with 93,7% market penetration in Portugal

Source: Apritel, European Commission, ITU Publications, Press Clippings, Roland Berger

The current draft auction regulation provides an unprecedent set of incentives for new entrants

4 Rules of the spectrum auction

1. Spectrum reserve

Allocation of frequencies in categories B and D

2. Spectrum discounts

25% discount for new entrants in categories B, C and D

Encouraging new entrants with first stage benefits

Practice used when the regulator wants new *players* to enter the market

3. No investment obligations

No obligation to invest in the bands reserved for new entrants

4. Unlimited network access (roaming)[1)]

Right to use legacy and future infrastructure throughout the country

No barriers to operation if no investment initiative is taken

New measures in Europe - Portugal is the first to adopt

Potential risks of the current auction structure

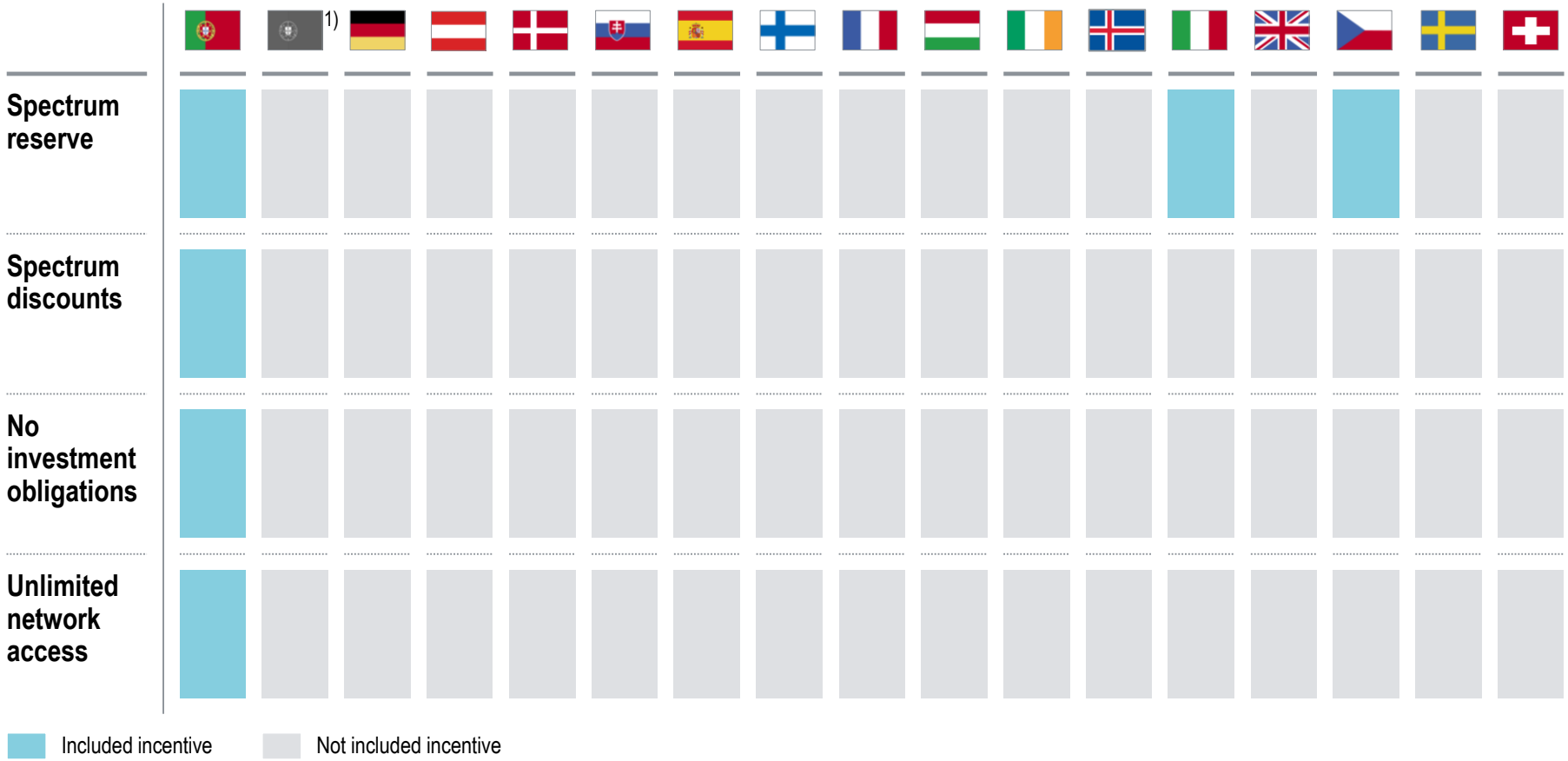
- **Encouraging the entry of operators backed by financial players with short-term objectives**
- **Misaligning incentives to invest in 5G network**
- **Possibility of litigation delaying the start of 5G deployment**
- **Destruction of value and jobs**

Source: ANACOM, Roland Berger

1) In the bands reserved for new entrants for a period of 10 years

There is no record of such strong incentives for new entrants at 5G auctions in Europe, as those we find in Portugal

4 Benchmark – Auction 5G incentives for new entrants



1) Previous spectrum auctions in Portugal

Source: European Commission, Countries' auction regulation, Roland Berger

In Europe, we have seen the consequences of auctions with discriminatory rules, often leading to significant market deterioration

4 Cases of discriminatory rules

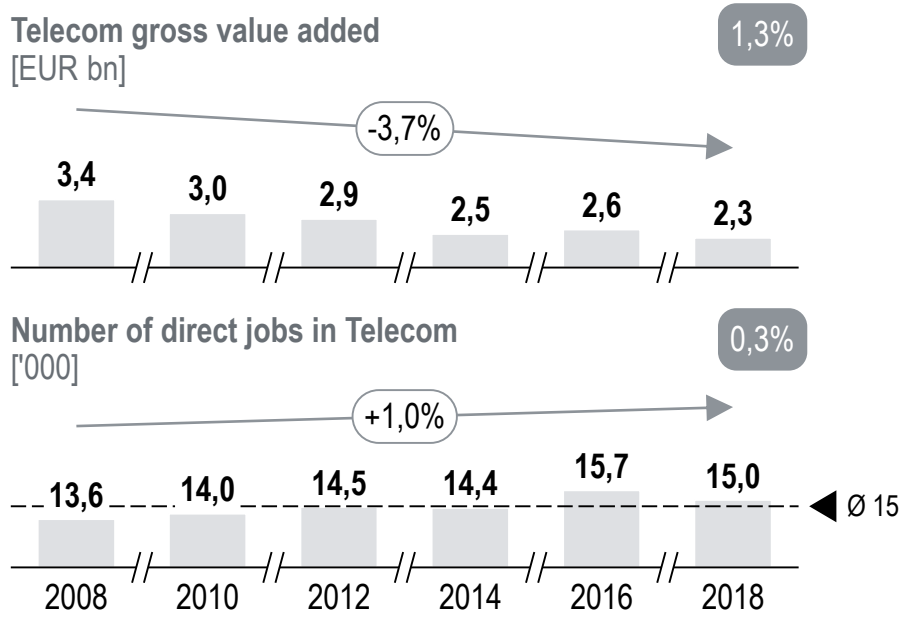
	Germany	Netherlands
Description	> German government reserved 100MHz spectrum for industrial use, as a means of ensuring national interest > The resulting spectrum scarcity led incumbent operators to entering a fierce price war > Auction had several rounds, generating more than 6.5 billion euros, against initial estimates of 3.0 billion euros	> Dutch government set aside spectrum for new entrants at the auction in a bid to boost mobile choice and lower prices in the country > At the beginning, the measure attracted competition which increased aside spectrum auction prices to levels that compromised new entrants viability – only one was able to go along > The auction for the remaining spectrum raised a much higher-than-expected 3.8 billion euros bid value, resulting in a fierce competition in one of Europe's most lucrative mobile phone markets
Outcome	> **100MHz spectrum** band for industrial use **remained idle** > Government eventually agreed to **give back the additional 2.0 billion euros** raised in the auction to the sector in the **form of regional deployment subsidies**	> Leading **operators to cut dividends to fund high prices** > **Market consolidation**, with small players being merged with incumbents > **New entrant later pulled out** and sold – market was down to 3 main incumbents after **less than 7 years**

Source: Press clippings, Reuters, Roland Berger

Auction rules' design should prevent the loss of the sector's worth to the overall economy (direct job loss est. at +2k), as occurred in Spain

5 Promote value as a mean to foster job creation

Value of the Telecom sector in Portugal



The deterioration of the Spanish telecom market has led to job cuts of up to 15% of total employment in the sector in last years

EL PAÍS

*Vodafone Spain announced **1,200 jobs** dismissal plan, justified by the obligation to reduce costs due to continuous reduction of market prices (2019)*

Bloomberg

*Telefónica Spain expects to cut about **5,000 jobs** to reduce costs, after seeing its share prices hit a 22-year low in August (2019)*

Adding telco incumbents' restructuring moves seen in recent years in Europe to a market disruption in Portugal as a consequence of unfair auction rules can **lead to a significant direct job loss of more than 2 thousand**

% Percentage of total industries in 2018

Source: INE, Roland Berger

If the 5G spectrum auction is to be carried out in the foreseen manner, it could compromise the digital society

5G spectrum auction potential risks

Hindered 5G network

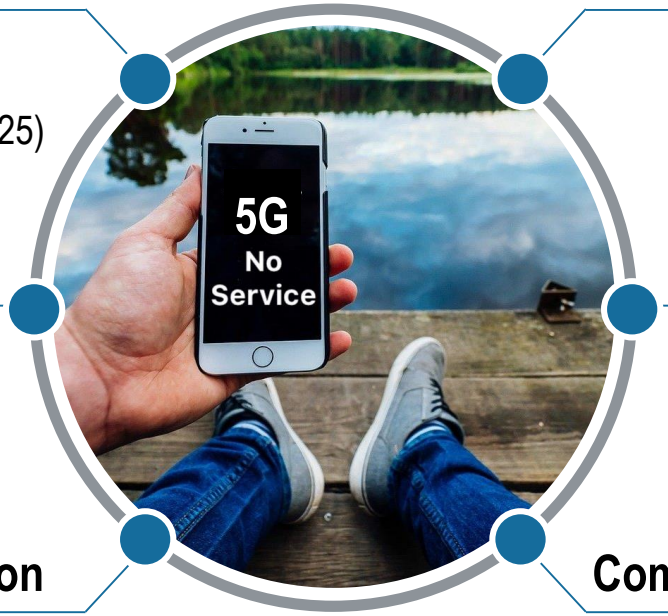
Insufficient financial capacity to comply with government's targets for 5G deployment (e.g., 90% coverage by 2025)

Value destruction

Portuguese telecom sector's already fragile performance deepen in a crisis of significant magnitude

Technological stagnation

Lack of incentives and ability may jeopardize the industry's innovation priorities (e.g., R&D in network architectures)



Potential risks for the success of the digital society

Quality deterioration

Price pressure and consequent financial instability may lead to lower standards of service

Job loss

Financial struggle and need for cost optimization leading to restructuring programs (potential for +2.000 jobs)

Compromised connectivity

Lack of investment jeopardizing Portugal's global connectivity positioning and its adoption of the digital society concept

Source: Roland Berger

To avoid those risks and achieve the 5G targets, auction rules should be reviewed to align incentives with investment requirements

Ensuring the 5G deployment targets

Starting point

> Very ambitious targets for 5G deployment

> Period of economic crisis (COVID-19)

> Portuguese telecom with the 3rd lowest ROIC[1] in Europe

> Unwillingness of the government to subsidize investment in non-competitive areas (e.g. rural)

Key requirements for the success of 5G deployment

Aligning incentives with responsibilities to invest in a network that has **heterogeneous rates of return – cross-subsidy effect** is key to guarantee coverage in non-competitive areas (e.g. rural)

Unbiassed auctioning by **avoiding artificially inflated prices through spectrum reserve** that **puts at risk the ability of remaining operators to invest** in the network by worsening the return/cost of capital dynamic

Promote healthy and fair competition by enabling **price discovery mechanisms to efficiently allocate capital** – preventing interventions that might cause the disruption of market equilibriums (e.g. Germany, Netherlands)

Fair competition & aligned incentives are paramount to guarantee the industry's ability to meet 5G targets and enable the digital society

1) Return on invested capital

Source: Council of Ministers, ANACOM, Roland Berger

D. Additional levers for stirring the Portuguese telecom sector

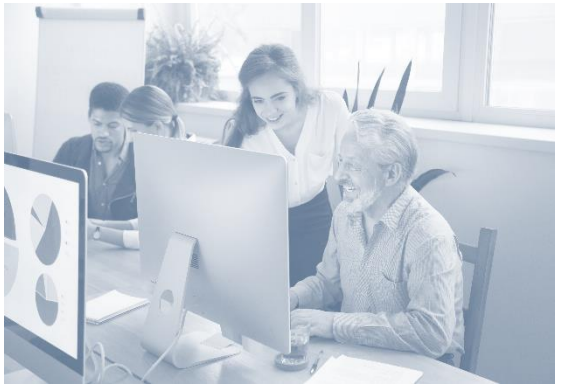
In addition to the auction structure, Roland Berger has identified a set of policies that should be considered to further enhance the sector

Additional levers for the telecom sector

1 Facilitate network sharing among operators

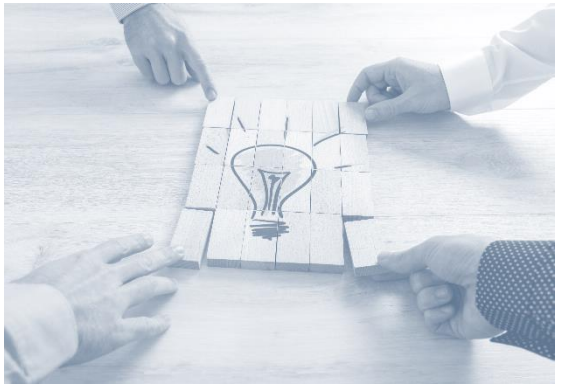
> Promotion of voluntary partnerships to share telecommunications infrastructure, freeing capital to gear investment towards innovation, service and unserved areas

2 Promote de digital skills of the population



> Increasing the digital skills of the population as a driver for increased value extraction from 5G technology and security in the their integration into the digital society

3 Adopt convergence regulation



> Evolution of the role of the regulator towards a collaborative framework, becoming the central promotor of the digital society

Source: Roland Berger

Infrastructure sharing should be voluntary, and impositions should only be required in non-competitive areas when arrangements fail

1 Best practice to network sharing

Despite conflicting views, regulators and operators have shown willingness to adopt telecom network sharing

ANACOM

> *The regulator says that conditions for infrastructure sharing or co-investment by operators may be considered in the 5G deployment*

Vodafone; NOS

> *Vodafone and NOS announced their intention to close an agreement on sharing mobile network infrastructure across the country, with 5G in mind*

Depending on the framework and conditions of the spectrum auction, network sharing should always be established on the following premises:

Competitive areas

Voluntary commercial agreements

Partnerships between operators with aligned incentives and serving the interests of those involved (e.g., investment sharing for coverage expansion)

Non-competitive areas

Mandatory sharing

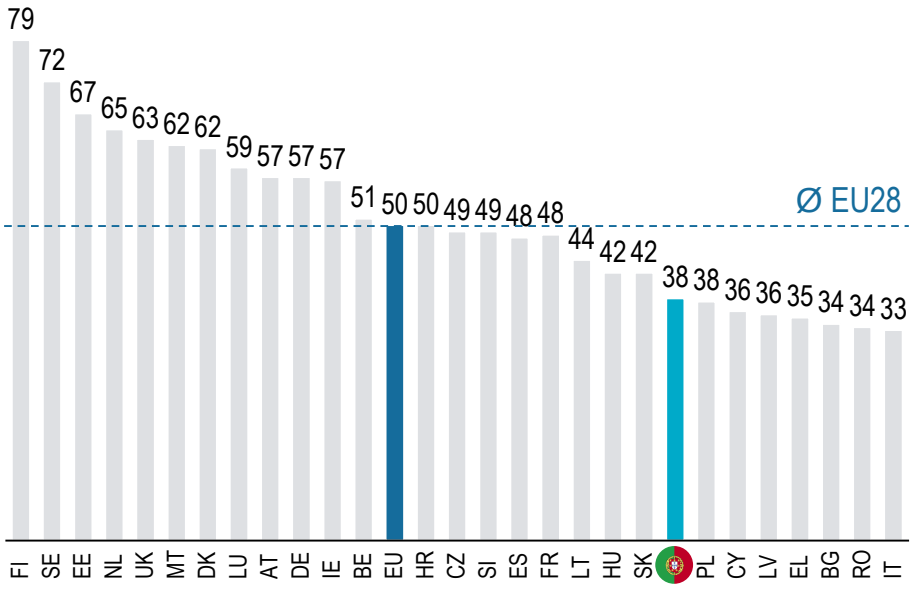
Lack of incentives for voluntary investments in non-competitive areas (e.g., rural) may require the regulator to impose network sharing to ensure service levels, but only after voluntary arrangements or negotiated outcome, including with use of subsidies, have failed

Source: Press Clippings, Roland Berger

Digital skills training of the population should be a top priority in order to maximize the potential of the hyperconnected society

2 Increase the population's digital skills

Human Capital[1] dimension score [0-100], 2019



The level of training in digital skills will be a ceiling to the growth of the ICT[2], therefore to harness the full potential of the technology, policymakers should maximize the population able to use it

Digital skills are fundamental to reduce potential harm associated with more negative aspects of digital engagement (e.g. data protection)

There is a significant risk that the lack of digital competences of a part of the population will be a factor of exclusion from a increasingly digitalized society

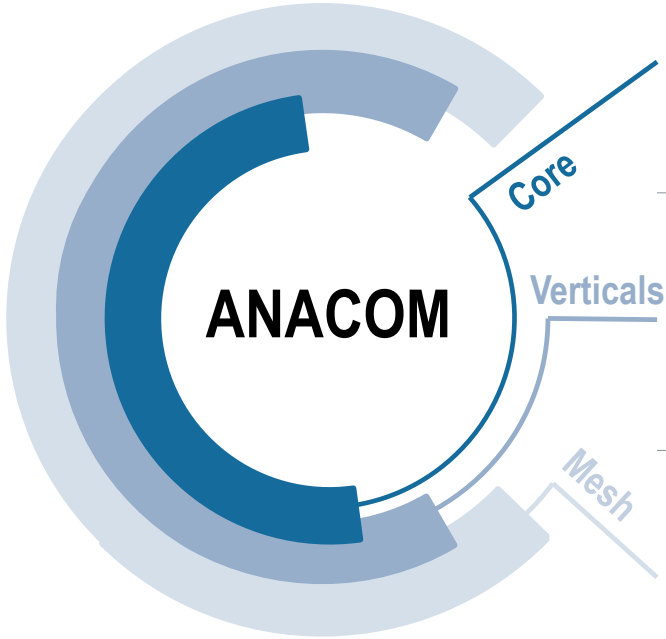
Regarding population's digital skills, Portugal ranks 21st out of 28 EU countries (below the EU av.), continuing to perform weakly by European standards in human capital and use of internet services

1) Considers access barriers, digital skills, software skills, and specialists 2) Information Communication Technology

Source: Digital Economy and Society Index (DESI) 2020, Roland Berger

To become promoters of the digital society and equalizers of all interests, regulators must implement a new collaborative framework

3 The three knots of collaborative regulation



> Competition authority > Consumer protection authority	> Data protection / Cybersecurity authority	> Media & broadcasting authority > Internet authority	> Radio spectrum agency > ICT regulator > ICT Ministry
> Energy regulator > Financial regulator	> Health authority > Education Ministry	> Trade bodies > Government Ministries	> Technical agencies
> Operators & service providers > Digital platforms	> Industries > Consumer associations	> Consumers at large, including unconnected / unserved	> Academia > The Judiciary > Municipalities

Once digital ecosystems cross industry, jurisdictional and geographical frontiers, regulators need to implement a **collaborative regulatory approach** to become the **facilitators of the digital hyperconnected economy**

Source: ITU, Roland Berger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