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5G for the Fourth Industrial Revolution

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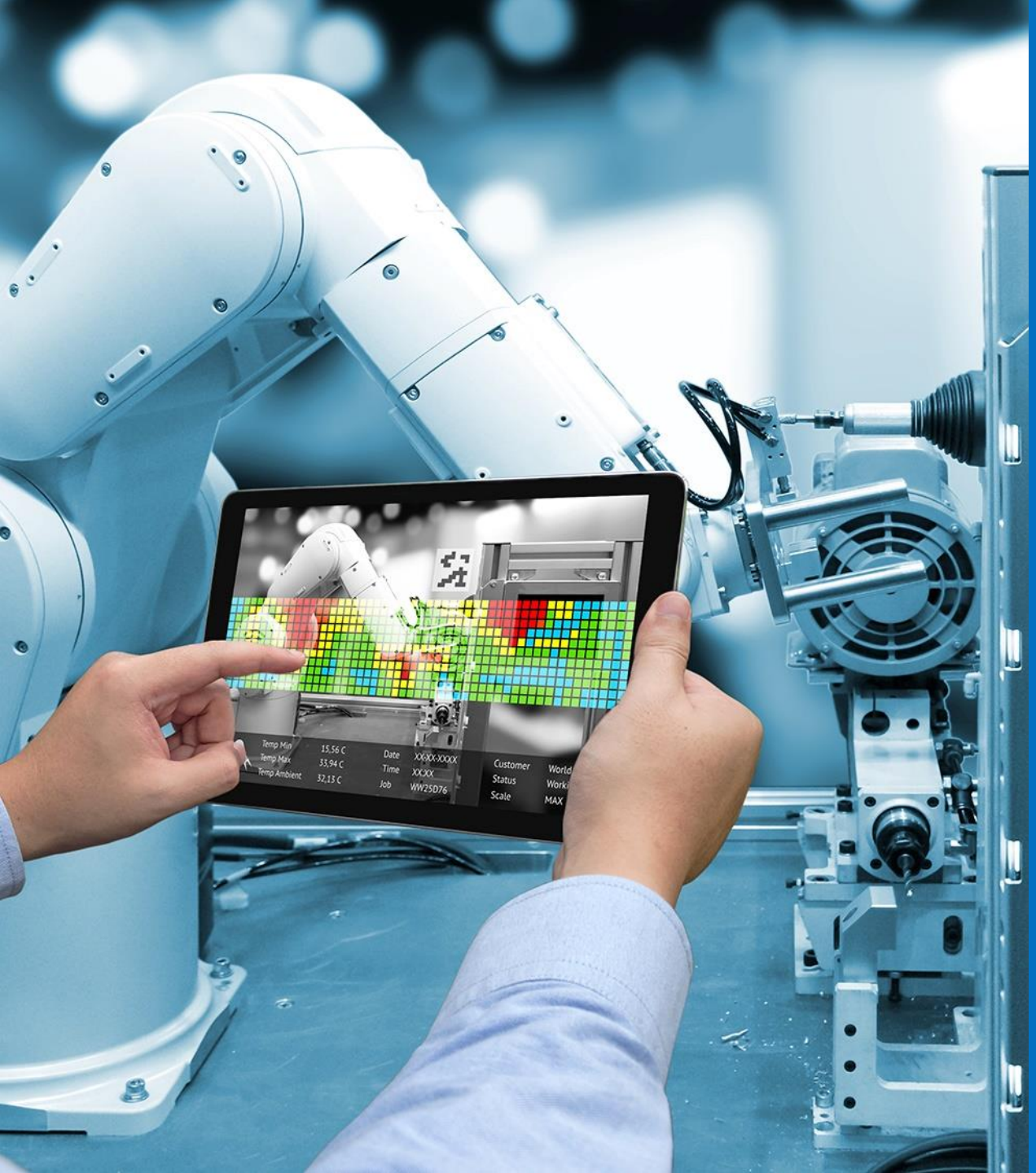

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Why is 5G important for the fourth Industrial Revolution (4IR)?

Intelligent connectivity, enabled by 5G, will be the catalyst for the socio-economic growth that the 4IR could bring

Global 5G impact assessed by international studies

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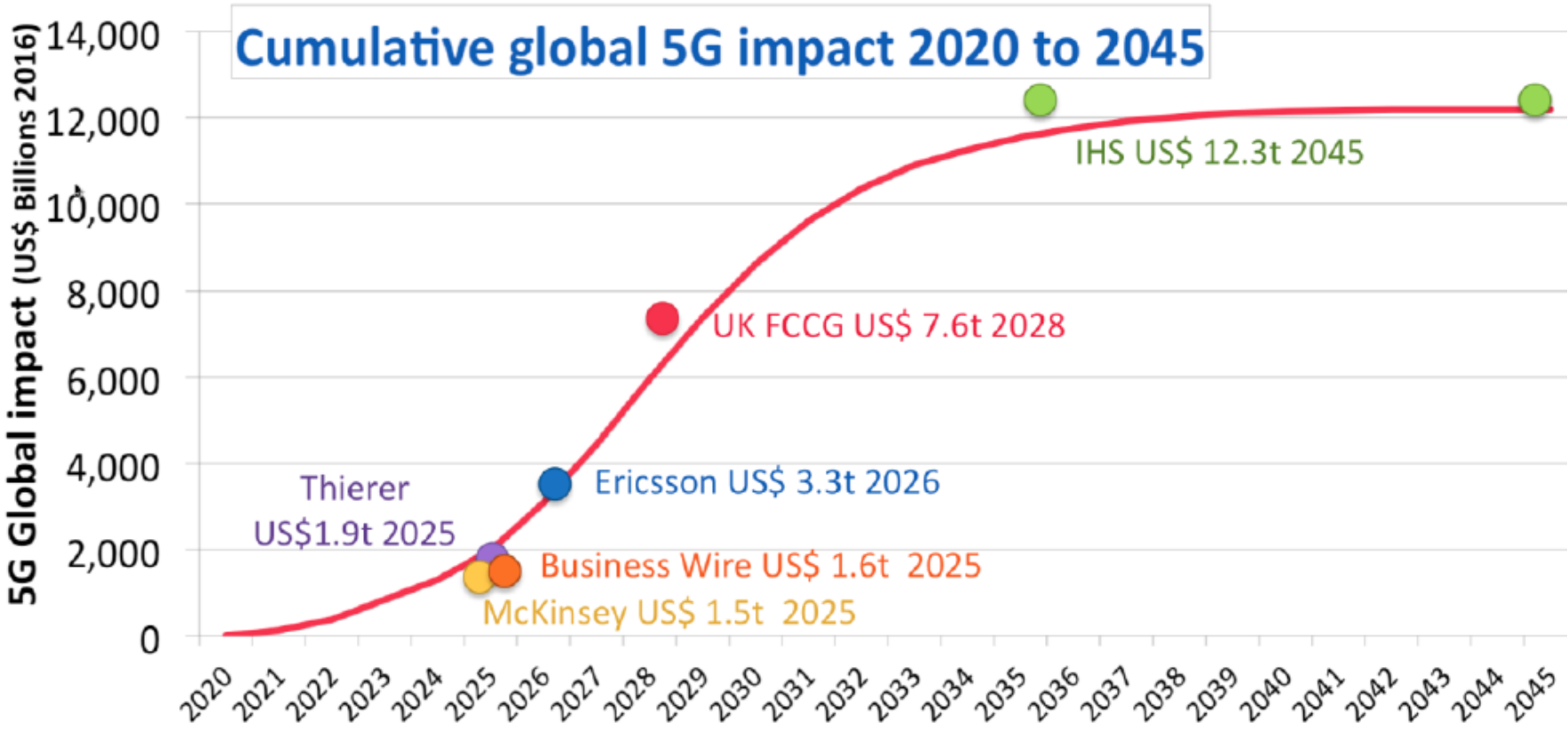
Multi-trillion dollar socio-economic impact confirmed by various industry sources

IHS Economics 2017: US$12.3 trillion and 5G global value chain supporting 22 million jobs by 2035

European Commission 2016: €141 billion with 2.3 million jobs in EU28 member states

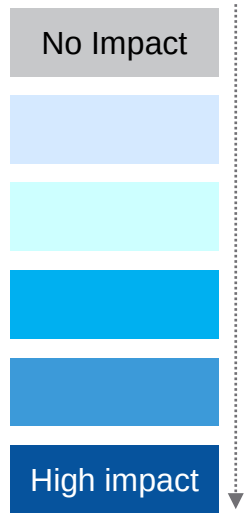


Source: IHS Markit, European Commission

Industry wide impact assessment

Multi-trillion dollar socio-economic impact confirmed by various industry sources

Industry	Enhanced Mobile broadband	Massive Internet of Things	Mission Critical Services	5G Enabled output (2016$, M)	Percent of industry output
Manufacturing				$3,364	4.2%
Info. & Communications				$1,421	11.5%
Wholesale & Retail				$1,295	3.4%
Public services				$1,066	6.5%
Construction				$742	4.7%
Financial & insurance				$676	4.6%
Transportation & storage				$659	5.6%
Professional services				$623	3.7%
Hospitality				$562	4.8%
Agriculture, Forestry & fishing				$510	6.4%
Real estate activities				$400	2.4%
Education				$277	3.5%
Utilities				$273	4.5%
Mining & quarrying				$249	4.1%
Health & social work				$119	2.3%
Arts and entertainment				$65	3.5%
All industry sectors	$4,400	$3,600	$4,300	$12,300	Average: 4.5%



Source: IHS Economics and IIHSS Technology, 2017

Types of impacts

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Socio- Economic Impact analysis

IMPACT CATEGORIES AND KEY IMPACT INDICATORS

ECONOMIC IMPACT

- Employment (Payroll)
- Economic Output
- Profits
- Investment

1

SOCIETAL IMPACT

- Health
- Education
- Livelihood
- Air Pollution
- Greenhouse gases
- Land Use and Biodiversity
- Waste
- Water Consumption
- Water Pollution

2

The business models will play an important role in coordinating efforts of the key stakeholders towards realizing the maximum socio-economic impact potential of the new vertical 5G use cases.

Factors promoting the need of socio-economic impact assessment

- **Potential of 5G networks in early achievement of the SDG targets**
- **Goal to reduce the digital divide by connecting the unconnected**
- **Need of education and open communication with citizens**
- **Lack of knowledge about Health and electromagnetic compatibility**
- **Multi-stakeholder ecosystem trying to rapidly scale the deployments**

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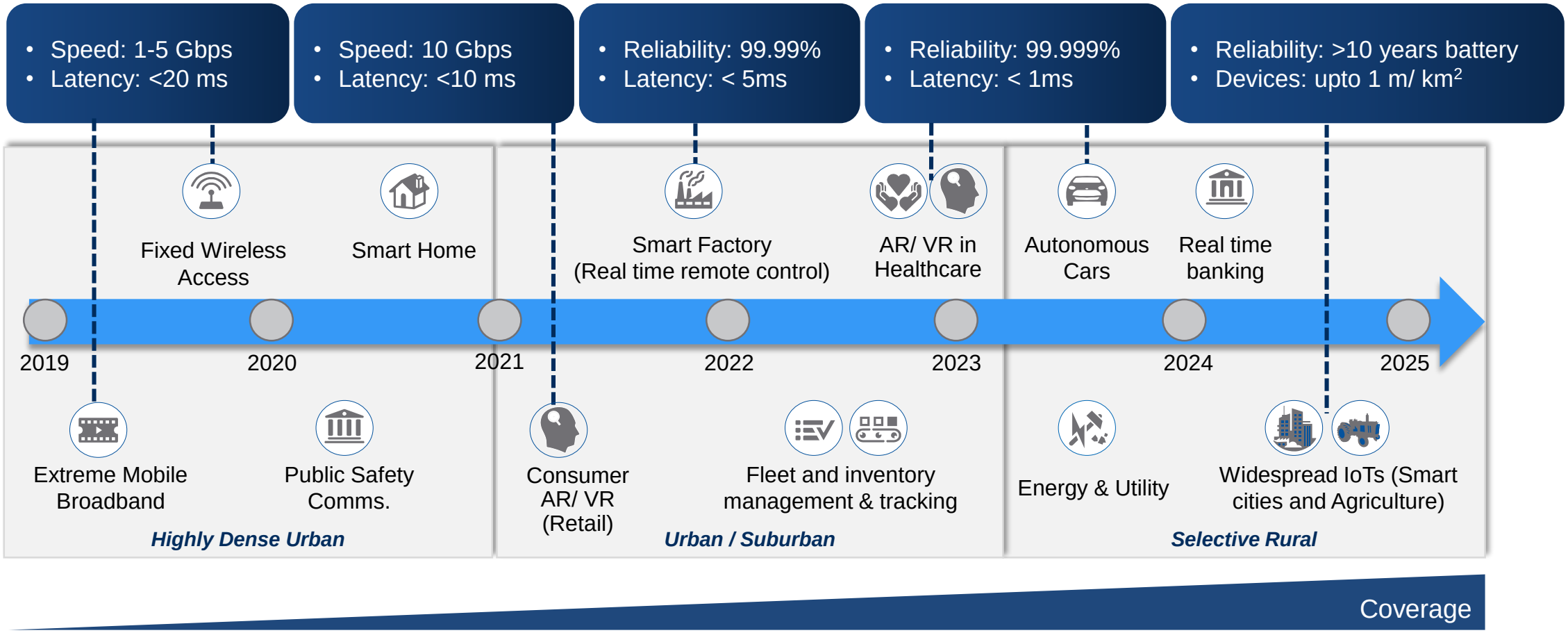
What is the role of telecom operators?

The transformation of network technologies in terms of higher speed, lower latency or reliability will create unique opportunities for enterprises across mobility, manufacturing, healthcare, entertainment, energy and other sectors

Enabling opportunities for other industries

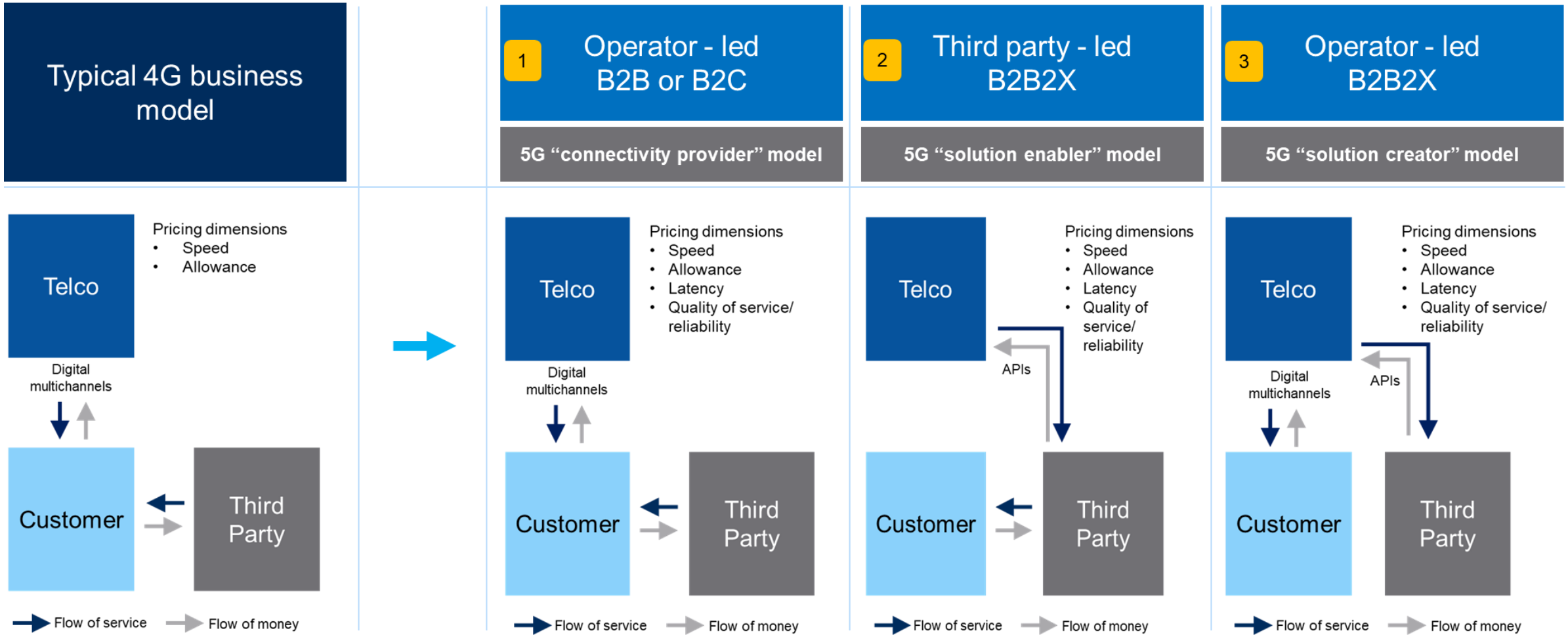
Maturity of use cases enabled across industry verticals by evolving features of 5G



Source: PwC Strategy& analysis

Emerging strategies for monetization

Ways to play: Emerging strategies for monetization



Source: PwC Making 5G pay

5G Flywheel with core elements and key actors

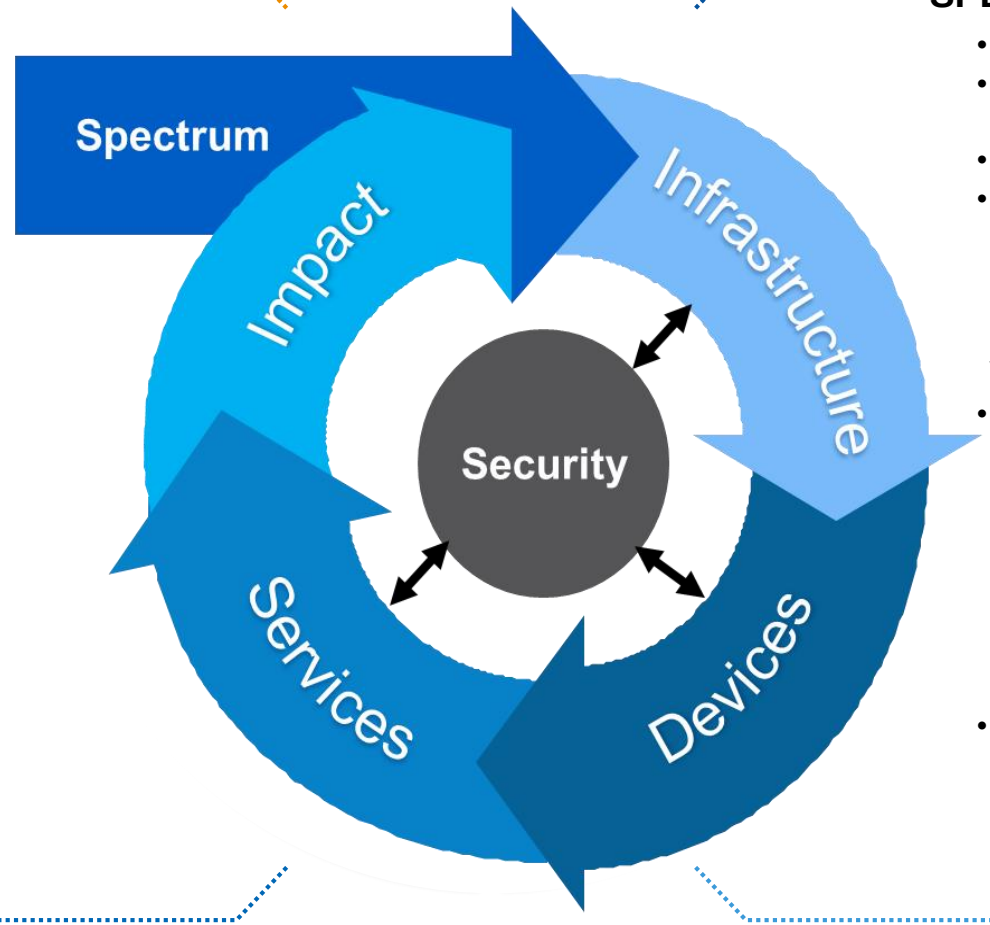
5G Flywheel: Propeller for sustainable transformation of industry verticals and society

IMPACT: Key actors/ stakeholders

- Data providers on 5G traffic/usage (GSMA, industry analysts)
- Economic impact (World Bank, IMF, OECD, industry analysts)
- Data providers on Social/ Environmental impact (United Nations, UNFCCC, ACE, WHO, Our World in Data, etc.)

SERVICES: Key actors/ stakeholders

- Network operators
- Software service providers
- Operational technology providers
- Public service providers
- Governments/ Regulators
- Enterprises and End-users
- Industry associations (5G-ACIA, 5GAA, etc.)
- Public-Private partnership organizations (WEF, 5G PPP, etc.)



5G Flywheel

SPECTRUM: Key actors/ stakeholders

- ITU, GSMA, 3GPP
- Governmental regulators (e.g. FCC: US, European Commission: EU, MIIT: China, etc.)
- Network operators
- Enterprises considering acquisition of 5G spectrum licenses or using unlicensed 5G

SECURITY: Key actors/ stakeholders

- SIA, 3GPP, IEEE, Governments/ Regulators, Industry Associations (5G-ACIA, 5GAA, etc.), Public-Private Partnership organizations (WEF, 5G PPP, etc.), enterprises, end-users

INFRASTRUCTURE & DEVICES: Key actors/ stakeholders

- Network operators, GSMA, 3GPP, Network equipment providers, Tower companies, Enterprises considering the deployment of private 5G networks, Device and chip manufacturers

Source: World Economic Forum

Whether spectrum should be set aside for private vertical 5G networks?

Impact on the 5G flywheel components if the spectrum is set aside for the private verticals:

Spectrum:

- "Ringfencing" spectrum for industrial use cases would be inefficient
- Monitoring implementation of spectrum policy guidelines/ standards

Business models:

- Challenge for telecos business models especially in the area of providing services to the enterprise market

Infrastructure and Devices:

- Different use cases to have very specific device and service requirements but may initially come at a rather small scale
- Manufacturers want to ensure SLAs and control of data
- MNOs may be dependent on one stakeholder in one location

Security:

- Need of highly customized security solutions
- Less risk as deployments by enterprises could be controlled and secured

Examples of enterprises procuring own local 5G networks

Volkswagen | BASF | Google Fi, an MVNO | Siemens

Top German industrial companies are looking to acquire regional licenses to run 5G mobile networks, as they plan futuristic networked factories that could help Europe's largest economy keep its export edge in the digital era.

Future networks will rely on a combination of mainstream and alternative technologies, and use both licensed and unlicensed spectrum, across different spectrum bands.

KEY DESIGN PRINCIPLES

Allocation: standard for licensed and unlicensed spectrum
Harmonization
Exclusive, shared and unlicensed models
Pricing favouring investments
Sharing to ensure maximum geographical coverage

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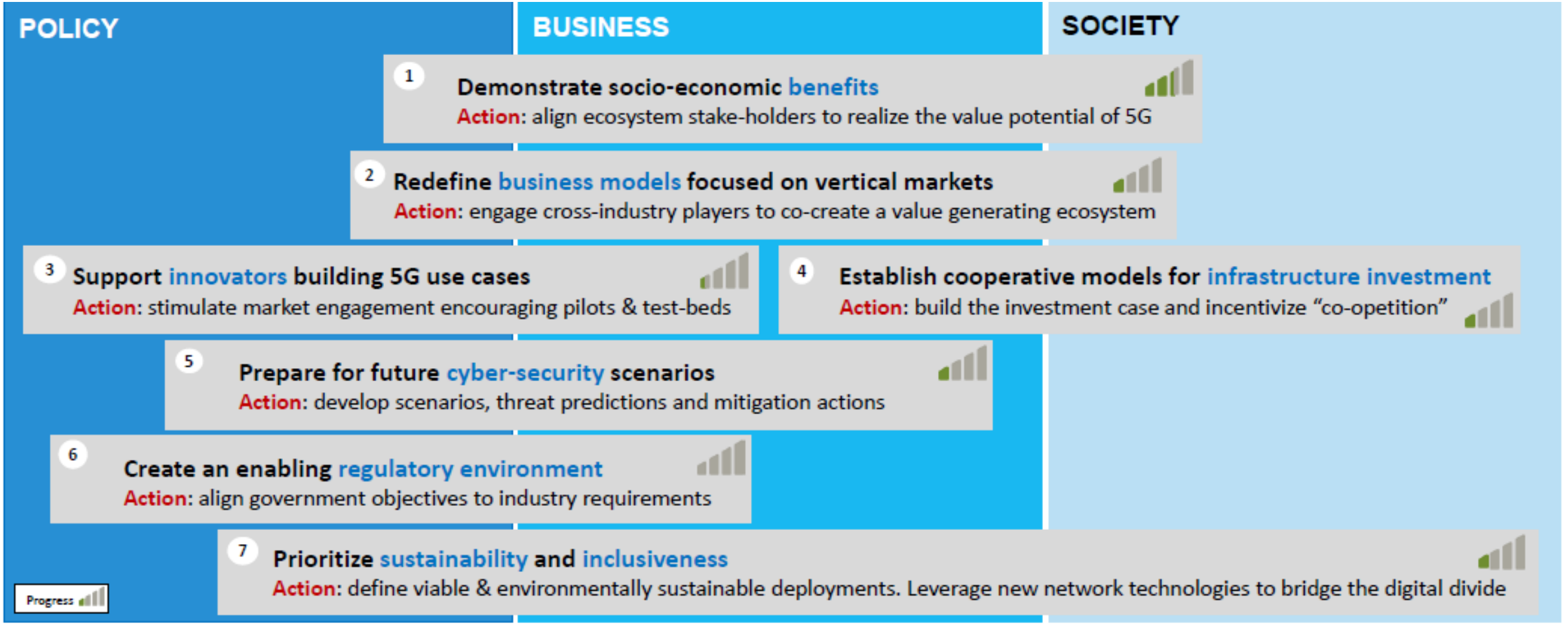
What role can the World Economic Forum Play?

The Forum is best suited to bring all stakeholders of the 5G ecosystem together, including the industry verticals, governments, telcos, academics. Objective is to advance on seven strategic objectives across *Policy, Business and Society* for the successful deployment of next generation networks

5G-Next Generation Networks Programme

Programme overview: seven strategic objectives

The Forum aims to advance on these objectives for the successful deployment of next generation networks



SUMMARY

Conclusions

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1. 4IR is expected to create enormous economic and societal value underpinned by ultrafast and ultra reliable 5G

2. A switch to 5G promises to catalyst various benefits, involving job creation, income growth/ disparity, consumer cost/time savings, pollution/greenhouse gas reduction and quality-adjusted life years gained

3. By cementing strong relationships between vendors, operators and verticals, 5G will open the field to new business models and offerings

4. 5G Flywheel will propel sustainable transformation of industry verticals and society and hence there's need to overcome blocking points

5. Collaborative proposition around 'How to support regulators and other stakeholders to communicate on new technology impacts to broader society'

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