Seventh SG13 Regional Workshop on "Standardization of Future Networks towards Building a Better Connected Africa"

PROSPECTS OF IMT2030 IN AFRICA

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- Reports of FG-IMT2030 of SG13
- 5G Gap Analysis
- Emerging technologies
- Emerging needs, applications, services and use cases
- New researches and developments
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Preamble

- Our future society will be increasingly digitised, hyper-connected and globally data driven. Many widely anticipated future services, including eHealth and autonomous vehicles, will be critically dependent on instant, virtually unlimited wireless connectivity.
- Technology always pushes forward and standards take a long time to mature, so the idea of 6G this early in the development of 5G simply indicates how quickly this technology moves forward.
    - *Ref: 6G Flagship*

Background

- We’re already destined to have more powerful VR and AR systems with 5G, plus interconnected smart cities and farms, AI at our fingertips, intelligent robotics working in factories, car-to-car communication, and more.
- 6G will continue to support all of those areas while also providing even more bandwidth that will ultimately expand innovation even further, maybe even into fields that we haven’t tapped in to yet or even considered.

Release 16 progressing towards completion

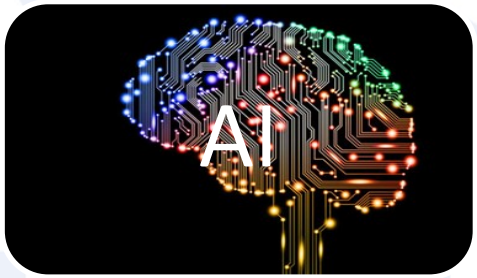
- 5G V2X
  - Targeting advanced use cases beyond LTE V2X
- Industrial IoT and URLLC enhancements
  - Adding 5G NR capabilities for full wired Ethernet replacement in factories: Time Sensitive networking, etc… with high reliability
- 5G NR operation in unlicensed bands
  - Includes both Licensed Assisted Access (LAA), as well as Standalone Unlicensed operation
- System improvements and enhancements
  - Positioning
  - MIMO enhancements
  - Power Consumption improvements

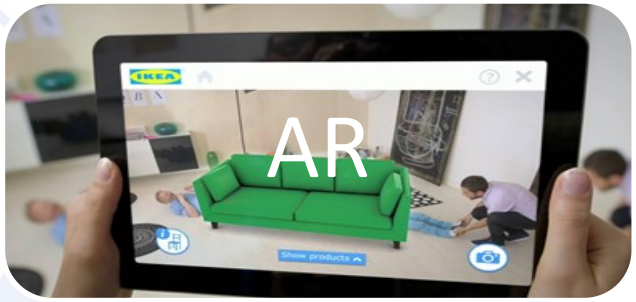
Release 17 - Key milestones

- RAN#84 (June/2019): One full day was set aside for initial presentations on Rel-17 proposals
  - Consolidation of multi-company proposals into Work Areas, start email discussion on these
- RAN#85 (September/2019): Review of email discussion progress on Work Areas, adjust where necessary
- RAN#86 (December/2019): Approval of Release 17 content

5G

Rel 16 and Rel 17

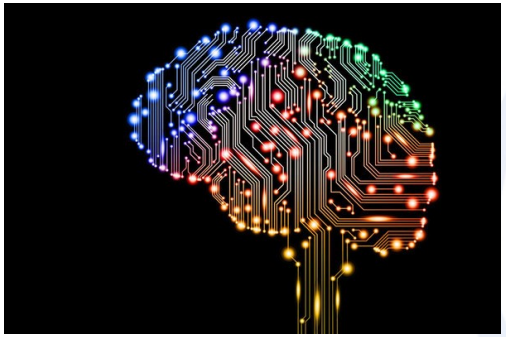




Car to Car

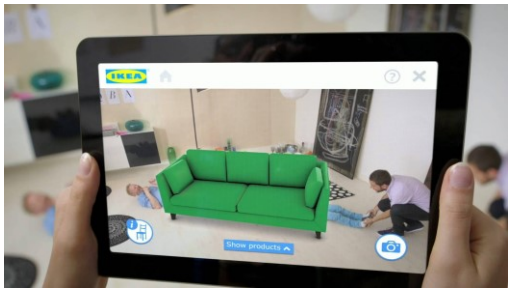
Standardising 6G

- ITU-T Focus Group Technologies for Network 2030 (FG NET-2030) was established by ITU-T Study Group 13 at its meeting in Geneva, 16-27 July 2018.
- The FG NET-2030, as a platform to study and advance international networking technologies, will investigate the future network architecture, requirements, use cases, and capabilities of the networks for the year 2030 and beyond.



AR

6GMOBILE



VR

Smart city

FORGET 5G, CHINA IS ALREADY WORKIN…
rotechnica.com

Huawei Is Working On A 6G Technology ...
digitalphablet.com

NTT DoCoMo declares what 6G should be ...
telecoms.com

Samsung opens research center to begin ...
techspot.com

We're only limited by our imagination ...
digitalnewsking.blogspot.com

6G: What It Is & When to Expect It
lifewire.com

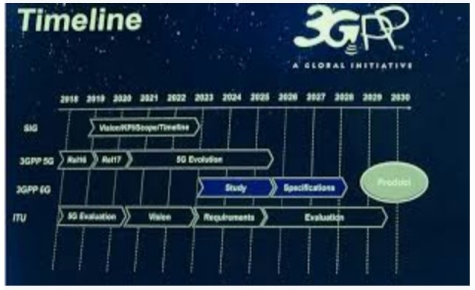
Finnish university sets out the drivers ...
smartcitiesworld.net

Huawei started research on 6G network ...
huaweicentral.com

With 5G Still in the Works, 6G Is ...
pcmag.com

Japan Starts Preparing For 6G Launch By ...
fossbytes.com

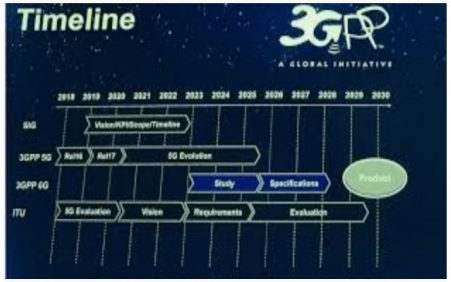
Chinese experts set foot in 6G research ...
dailytrust.com.ng



5G is old stuff, let's focus on ...
cmte.ieee.org

Japan Starts Preparing For 6G Launch ...
fossbytes.com

Chinese experts set foot in 6G resear...
dailytrust.com.ng

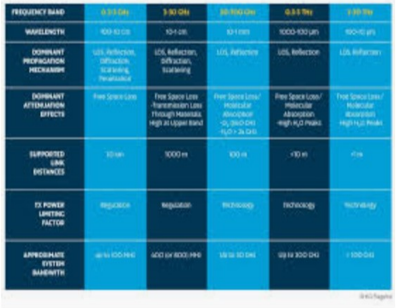


5G is old stuff, let's focus on ...
cmte.ieee.org

China looking to launch 6G by 2030 ...
techradar.com

6G Will Combine AI With Real-Time ...
technocracy.news

Samsung spurs R&D efforts for 6G mobil...
theinvestor.co.kr



6G preview: RF front-end is key to ...
rcrwireless.com

6G will achieve terabits-per-second ...
networkworld.com

What is The Difference between 5G ...
dficlub.org

If 5G is here, can 6G be far behind ...
chinadaily.com.cn

Chinese government kicks ...
rcrwireless.com

5G is only just arriving, but 6G plans ...
slashgear.com

6G Mobile Network after 5G hype ...
autoncell.com

5G is barely here and some people are ...
cnbc.com

6G Network trials ...
innov8tiv.com

FG NET-2030 Considerations

- This brings the fundamental **questions for study** as
- New Media
  - Holograms
  - Holosenses
  - Qualitative digitalization
- New Services
  - Latency-Guaranteed Services (in-time and on-time)
  - Throughput Guaranteed Services
  - Holographic Teleport
- New Architectures/Infrastructures
  - Convergence of Terrestrial and Space Networks
  - Trustable Infrastructure
  - Federated network architecture

- As in the past with 3G, 4G, and now 5G, as the capacity of a network increases, so too will its applications. This will cause an amazing effect where new products and services can be built to utilize 6G's bandwidth and other improved features to their fullest extents.

Introduction

- 6G research has begun from Virginia Tech and companies like Samsung and LG.
- Shortly after China launched 5G in 2019, the Ministry of Science and Technology announced that they'd be starting 6G research and development through the help of government departments, research institutes, universities, and enterprises.

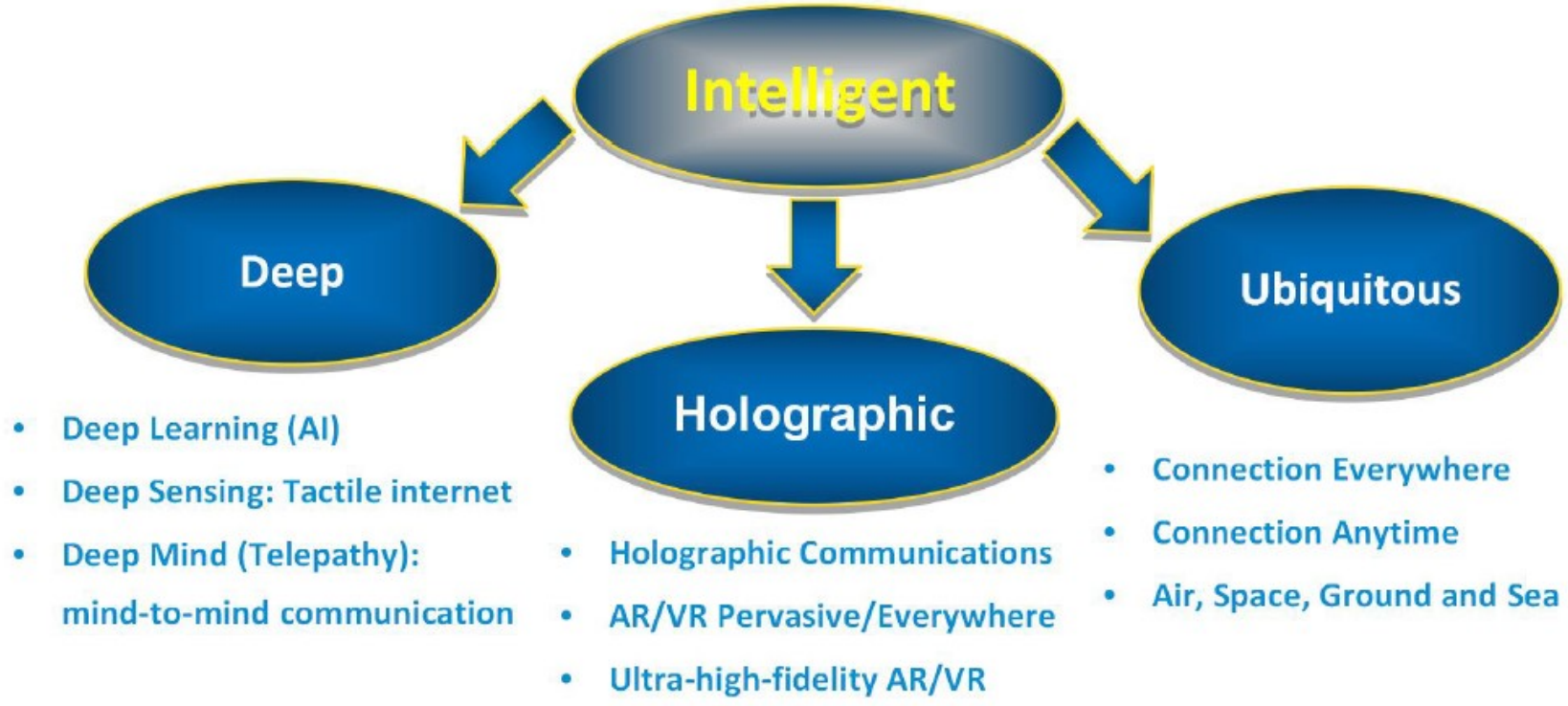
Progress in 6G Development

- Here are some clues that 6G development is already in its early stages:
- The FCC has taken the first steps of opening up terahertz wave spectrum (frequencies between 95 GHz and 3 THz), citing that it will "*expedite the deployment of new services in the spectrum above 95 GHz.*"
- In early 2018, the University of Oulu in Finland announced the funding of their 6G Flagship program to research materials, antennas, software, and more that will be required to launch 6G. The idea is to start developing the hardware needed to implement 6G and explore how the new technology might be used.

6G Expectations

- Marcus Weldon of Nokia Bell Labs, says that 6G will be a "*sixth sense experience for humans and machines*" where biology meets AI.
- Much of what makes 5G so great is its low latency of around 4 ms, but 6G networks might bring this down even further, maybe even to the point that we can safely say that there's **virtually *zero latency***. The start time for movies, TV, and games will be limited only by how long it takes the screen to power on, and video calls can be as crystal clear as standing in front of the other person.

6G Vision



Zhao, Yajun & Yu, Guanghui & Xu, Hanqing. 6G Mobile Communication Network: Vision, Challenges and Key Technologies. 05/2019. SCIENTIA SINICA Informationis 10.1360/N112019-00033.

6G Considerations

- Despite 6G being just a decade away, few telecom companies are actually looking into it seriously right now, but 6G experimentation is expected to really kick into high gear as we identify where 5G fails.
- 6G will improve on the inevitable weaknesses and limitations of 5G, so it won't take long for the powers that be to start deciding what to do next.

Report of FG NET-2030

- Published 2 Papers: White Paper and Deliverable
- **White Paper**: "Network 2030 - A Blueprint of Technology, Applications and Market Drivers Towards the Year 2030 and Beyond" (May 2019)
- **Deliverable**: “New Services and Capabilities for Network 2030: Description, Technical Gap and Performance Target Analysis” (October 2019)

1. *https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/White_Paper.pdf*
2. *https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/Deliverable_NET2030.pdf*

Reports of FG IMT-2030 on 5G Gaps

- From FG NET-2030
- From workshops
- From industry
- From 3GPP Rel 16 (in view) and Rel 17 (in plan)
- Technology lifespan

FG IMT-2030 – 5G Gaps

- The main gap concerns the ability of networks to support foundational services with sufficiently **low latency** and **sufficiently high bandwidth**.
- In addition, existing technology does not facilitate the notion of **aggregate bandwidth** shared across and dynamically reallocated among a set of flows.
- Statistical Multiplexing
- Some applicable technologies are not yet matured.
  - https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/Deliverable_NET2030.pdf

Motivation for Network 2030 Services FG NET-2030

- Future advances in networking technology will be driven by future networking applications.
- The following applications areas are seen among the primary drivers for new Network 2030 services:
  - *Industrial & Robotic automation*
  - *Emergence of holographic media and other advances in multimedia technology*
  - *Autonomic and critical infrastructures*

FG-NET2030
Motivation for Network 2030 Services

- *Diversity of applications and their needs*
- *Accountability for services delivered*
- *Expectations for varying degrees of distortion tolerance*

- Articulated Motivations from other sources:
  - Some un-matured and yet unknown technologies may find space in 6G applications
  - Speed and Bandwidth

Performance design targets

- 1. **Ultra-low latency**: Latency is most crucial for the future high precision networks. The maximum latency that goes unnoticed by the human eyes is 5 milliseconds [9]. For the operation to be smooth and immersive, the new paradigm even proposes sub-millisecond end-to-end latencies for tactile feedback.
- **2. Ultra-low packet loss**: In such critical applications loss of information means loss of reliability on the system. In addition, retransmission is generally not an option due to latency concerns. Hence loss should be as close to zero as is practical.
- **3. Ultra-high bandwidth**: the bandwidth requirement is especially important in case of remote monitoring as increasing the complexity of the visual feed (from 360 degrees video to holograms) makes the required bandwidth grow drastically as well. A bandwidth up to 5 Gbps is required for VR feeds [5] and it increases up to 1 Tbps for holograms [19]. The complexity increases with the numbers of streams.
- 4. **Strict synchronization**: The human brain has different reaction times to different sensory inputs (tactile (1ms), visual (10ms) or audio (100ms). By themselves, some streams (e.g. audio) might thus allow for slightly higher latency than others (e.g. tactile). Nonetheless, synchronization is important, even in the presence of ultra-low latency, as synchronization needs to be on time scales still significantly shorter than latency. This means that tolerable latency for e.g. video might be lower in scenarios when the visual information needs to be synchronized with tactile feedback than in other scenarios where no tactile feedback is involved.
  - https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/Deliverable_NET2030.pdf

Expectations

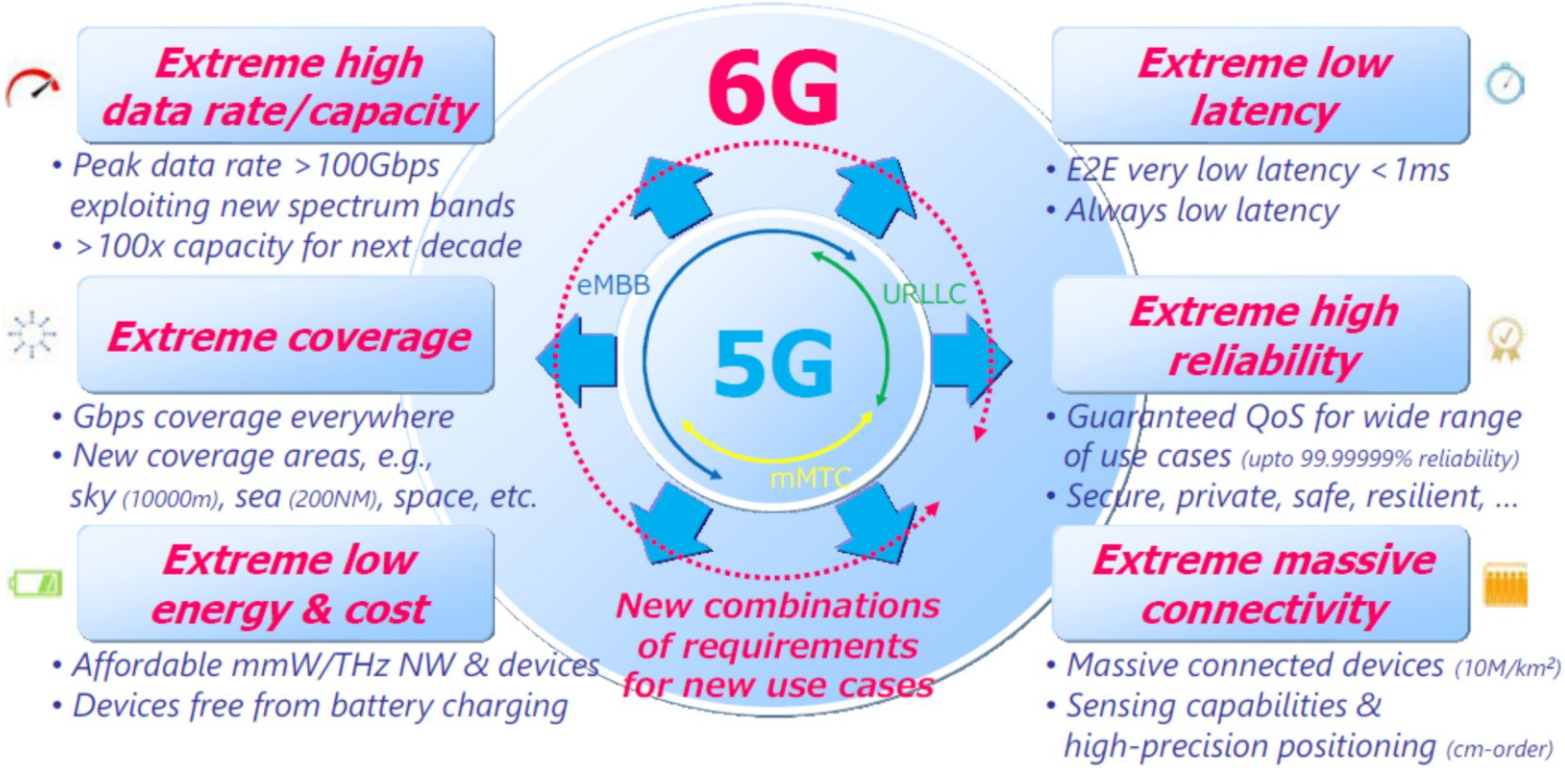
- Virtually zero latency or photon time
- for the **photon**, there's zero **time** elapsed between when it's emitted and when it's absorbed again. It doesn't experience distance either.
- Will current electronic materials cope with the frequency

- Totally new services such as telepresence and mixed reality will be made possible by high resolution imaging
- Sensing, accurate positioning, wearable displays, mobile robots and drones, specialized processors,
- In next-generation wireless networks, current smart phones are likely to be replaced by pervasive XR
- Experiences with lightweight glasses delivering unprecedented resolution, frame rates, and dynamic range.

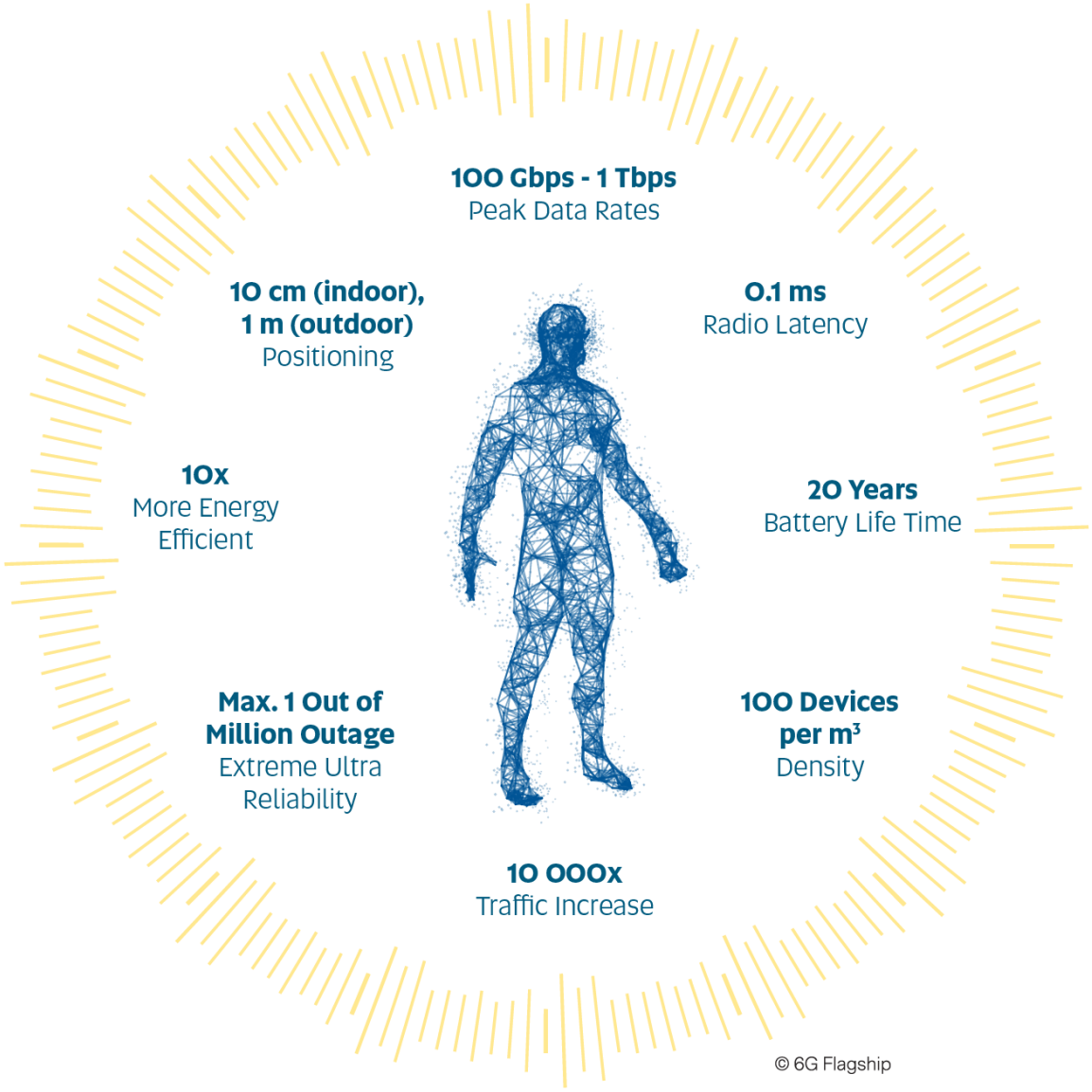
NTT DoCoMo whitepaper lists these six technology benchmarks for 6G to achieve

- Extremely high-speed and high-capacity communications, e.g. peak data rate to go >100Gbps;
- Extreme coverage extension, including coverage in high altitude, under sea, and in space;
- Extremely low power consumption and cost reduction, including alternative charging technologies;
- Extremely low latency, e.g. sub 1ms end-to-end latency;
- Extremely high reliability, e.g. availability to improve from “five-nine” to “seven-nine” (99.99999%)
- Extremely massive connectivity and sensing, e.g. handling 10 times as many connections as 5G does in comparable space

Requirements for 6G Wireless Technology Source: NTT DoCoMo



Generic 6G targets presented by academia and industry in different fora.



NTT DoCoMo believes the following should be the R&D focus areas in the years to come:

- New network topology
- Coverage extension including non-terrestrial network
- Frequency extension and improved spectrum utilization
- Further advancement of wireless transmission technologies
- Enhancement for URLLC and industrial IoT networks
- Expanded integration of variable wireless technologies
- Multi-functionalization and AI for everywhere in mobile network

6G in Japan

- What NTT DoCoMo has laid out, despite with more details, is not too different from what the Finnish 6Genesis programme announced at last year's Mobile World Congress, including the expected timing of 6G rollout.
- The industry conversation has since picked up speed, with the first 6G Wireless Summit held in the Finnish Lapland in March.
  - https://telecoms.com/495860/president-trumps-unexpected-ally-finland-kick-starts-6g/

6G in China

- While China has also thrown its weight behind 6G, we can expect to hear more about this topic at the upcoming Mobile World Congress 2020, MWC 2020.
  - https://telecoms.com/500768/china-joins-the-race-to-6g/
  - https://www.nordicsemi.com/Events/2020/MWC-2020
- Where is Africa?

Emerging Technologies

- Digital Scent technology
- Immersive virtual reality – haptic application
- Biometric
- Electronic nose
- Amorphous metal
- Energy, American Battery
- Aerogel - insulation

Emerging Technologies

- Conductive polymers – solar cells
- Screenless display (Virtual retinal display, Bionic contact lens, Augmented reality, virtual reality
- High-temperature superconductivity
- Concentrated solar power

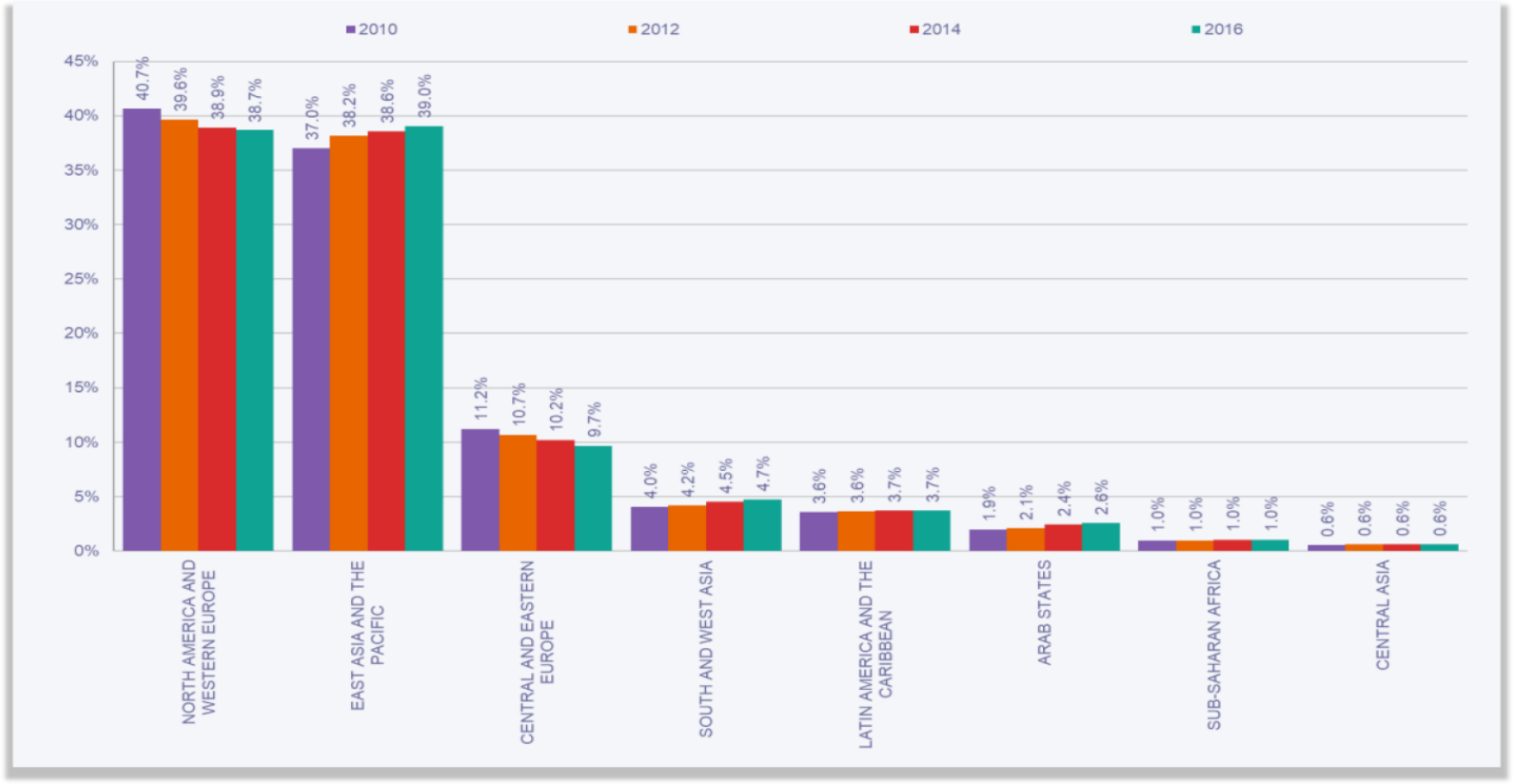
Prospects of 6G in Africa

- Smart Africa Initiative
- Motivation towards digital economy, digital inclusion
- Emerging needs and Use Cases
- One Net-Africa
- Sustainable Development Goals
- Africa has the number to achieve economies of scale in any industrial sector.

Prospects in Africa:

Research and Development

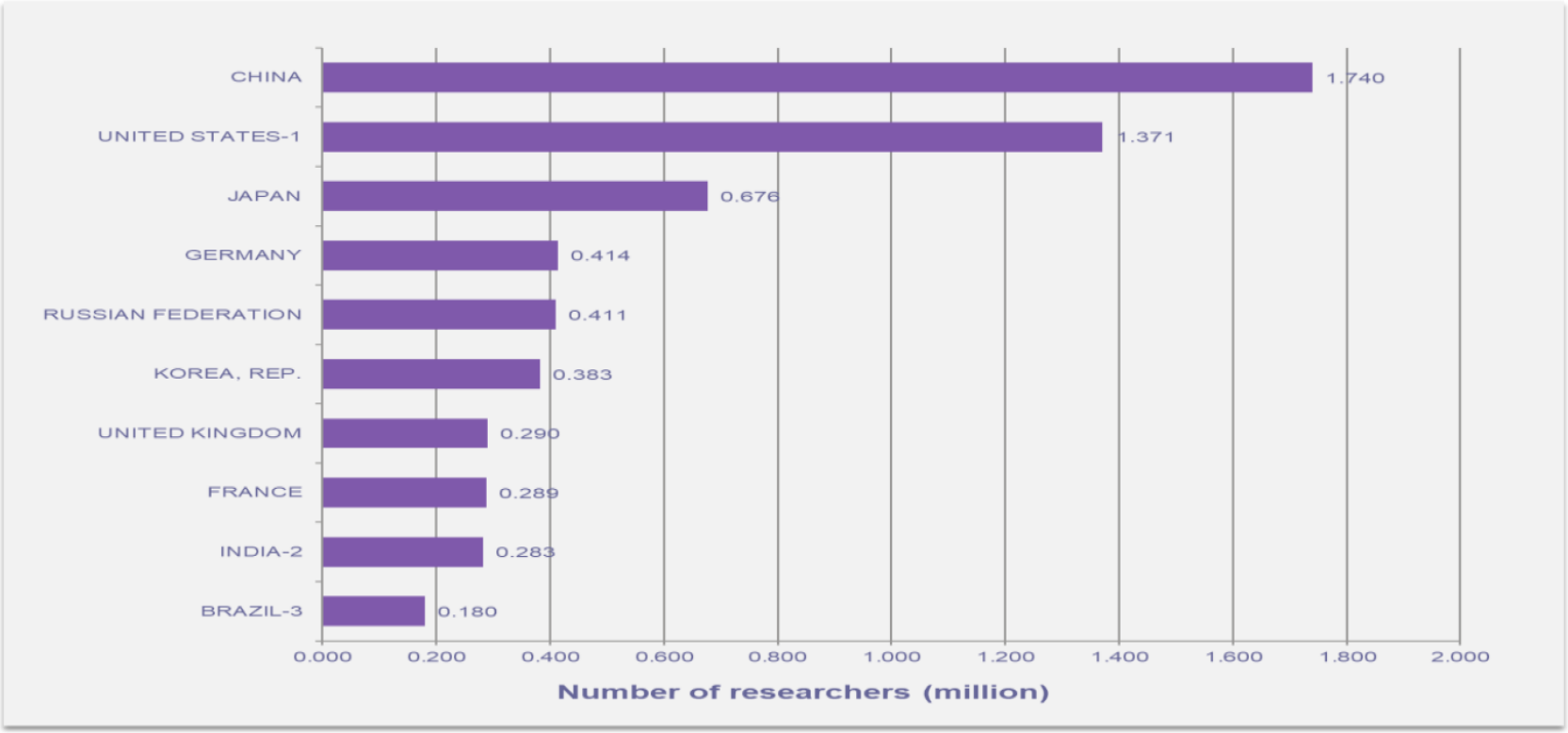
Shares of world researchers by principal regions, 2010, 2012, 2014 and 2016



Source: UNESCO Institute for Statistics estimates, February 2019.

Which countries host the greatest number of researchers?

Number of researchers, 2017 or latest year available

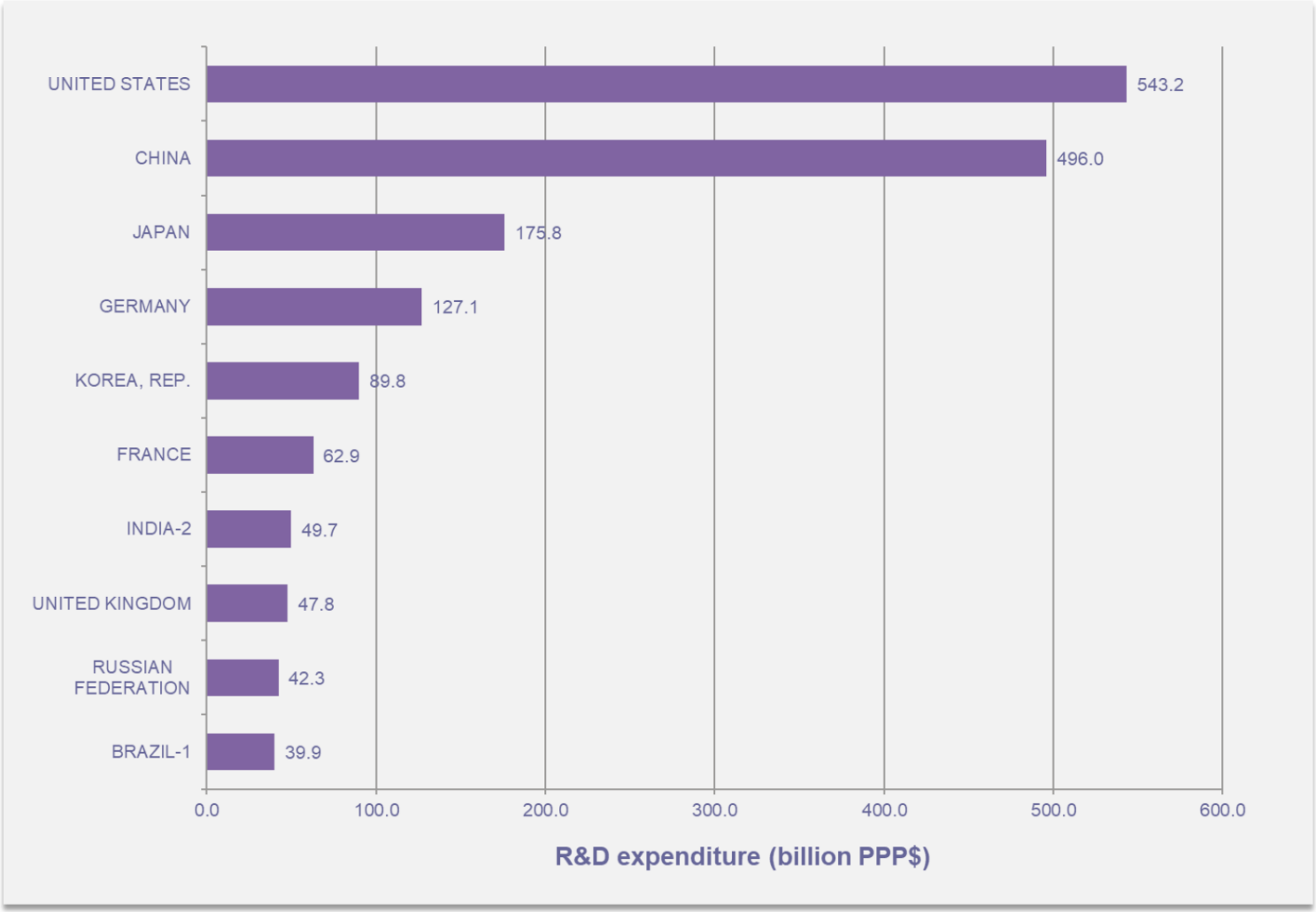


Notes:-1 = 2016, -2 = 2015, -3 = 2014; Data are based on FTE.

Source: UNESCO Institute for Statistics, June 2019.

World's top 10 leaders in R&D investment

GERD (billion PPP$), 2017 or latest year available

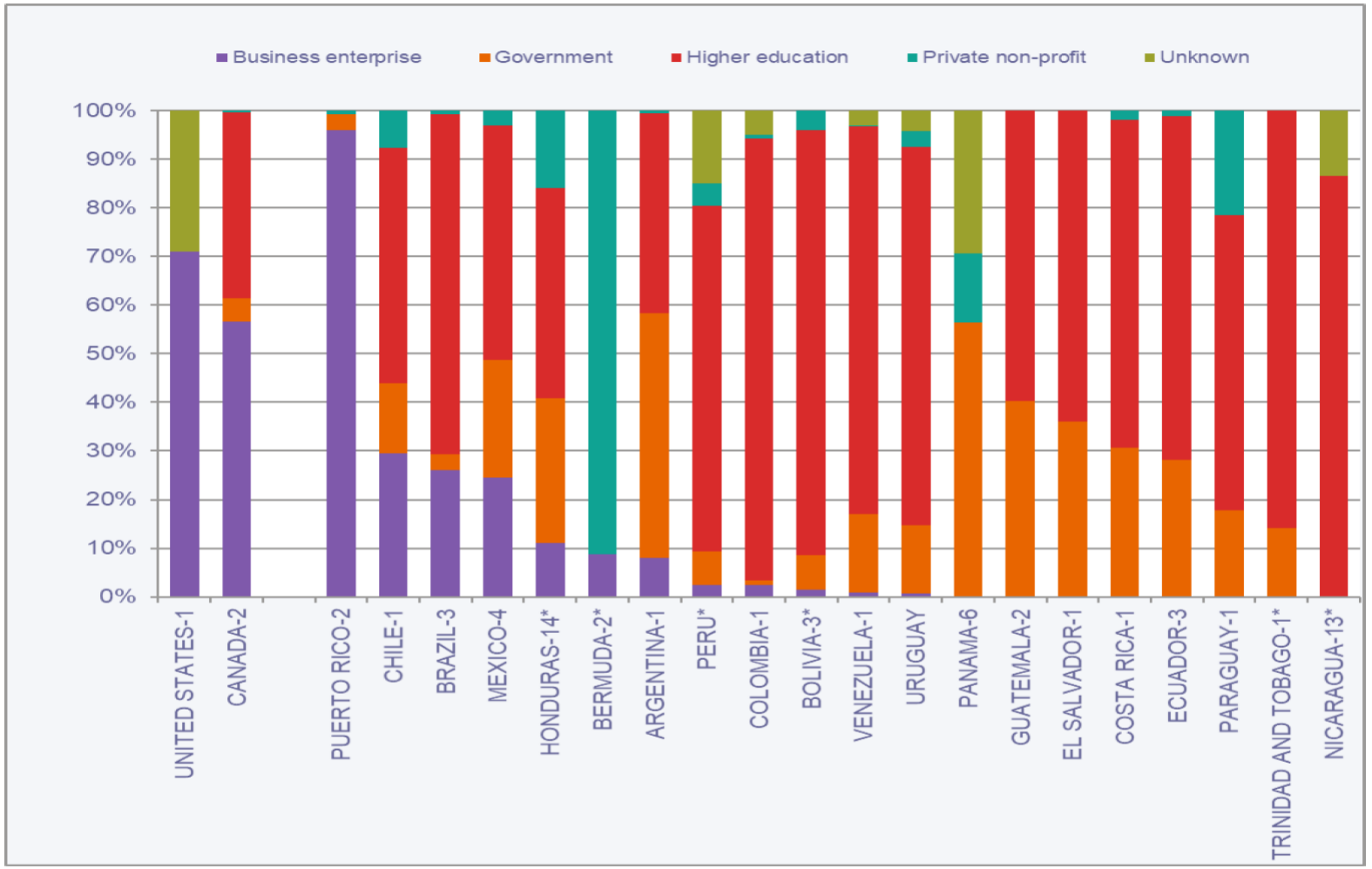


Notes: -1 = 2016, -2 = 2015.

Source: UNESCO Institute for Statistics, June 2019.

A breakdown of researchers in the Americas

Percentage of researchers by sector of employment (FTE), 2017 or latest year available



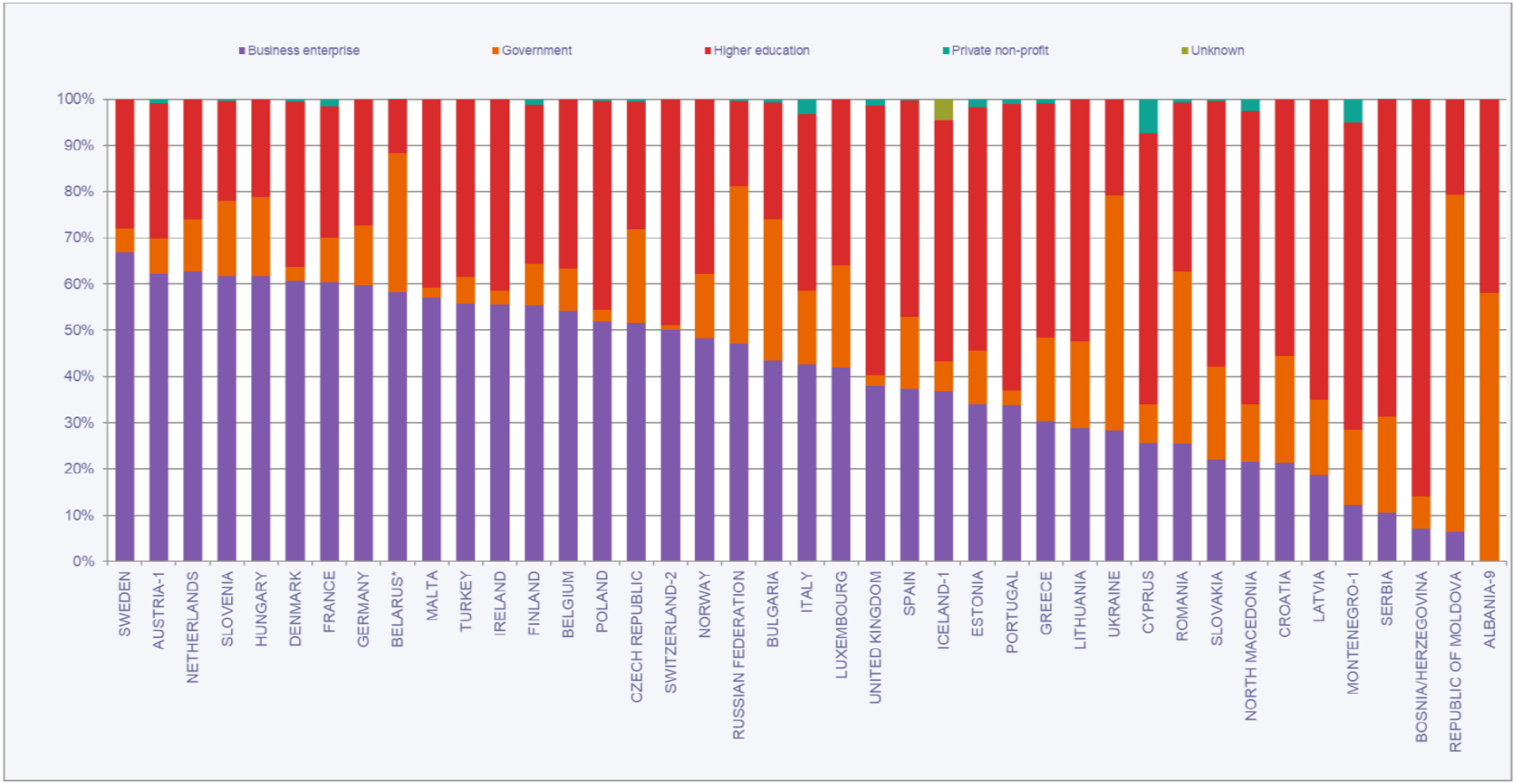
Notes:-1 = 2016, -2= 2015, -3 = 2014, -4 = 2013, -6= 2011, -13 = 2004, -14 = 2003.

* = based on HC data.

Source: UNESCO Institute for Statistics, June 2019.

A breakdown of researchers in the Europe

Percentage of researchers by sector of employment (FTE), 2017 or latest year available



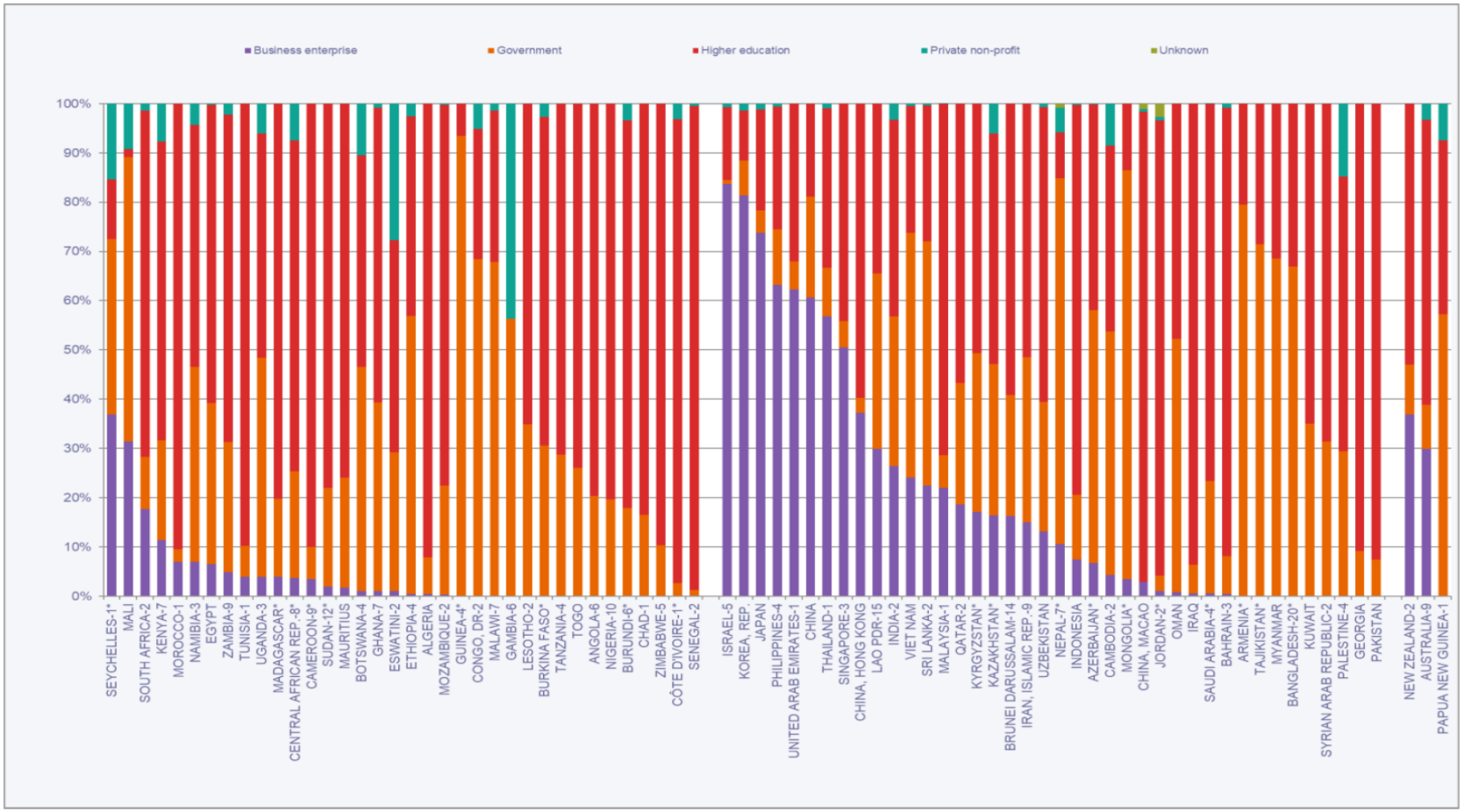
Notes:-1 = 2016, -2 = 2015, -9 = 2008.

* = based on HC data.

Source: UNESCO Institute for Statistics, June 2019.

A breakdown of researchers in Africa, Asia and the Pacific

Percentage of researchers by sector of employment (FTE), 2017 or latest year available



Notes:-1= 2016, -2= 2015, -3 = 2014, -4 = 2013, -5 = 2012, -6 = 2011, -7 = 2010, -8 = 2009, -9= 2008, -10 = 2007, -11 = 2006, -12 = 2005, -14 = 2003, -15 = 2012, -20 = 1997.

* = based on HC data.

Source: UNESCO Institute for Statistics, June 2019.

Emerging Needs, Applications, Services and Use Cases

- Teleporting/Telepresence
- Machine Type Communications
- Internet of Things
- Driverless cars
- Active tracking module in phones

Emerging Needs and Use Cases

- Microchip implant in man
- Personalising phones and embedded tracking systems in phone devices or others
- Phones to have capability of recording all phones or active devices around it.
- Definition of Broadband
- Efficient Solar Energy and other sources

Steps towards 6G in Africa

- Public Private Partnership engagement
- Massive research works and development
- Adaptation of Local Content -
- Collaboration with other Standards bodies and countries

ITU-T Conferences and Study Groups

- Attend the WTSA-2020
  - Next Study Period: Need to introduce appropriate Questions and Work Items
  - Full participation in ITU Studies
  - Contributions to the Work Items and Questions

Capacity Building

- Government policies on education
- Skills acquisition and expertise (Schools and Research Institutes
- Partnership with foreign Educational Institutions and with Industry Research Institutes
- Trainings – human capital development
- Acquiring equipment and material resources for research

Sourcing of Funding

- Foreign partnership funding
- Encourage foreign investments
- Implement Strategies from the Alliance
- Resource mobilisation

Government support

- Enabling laws, policies and regulatory framework
- Collaboration with foreign governments and development partners

Infrastructural Needs

- Capacity building
- Pervasive fibre penetration
- Continental Gateways
- Continental roaming, which some sub-regions have implemented

conclusion

- The future will be a completely data-driven society in which people and things are connected universally, almost instantaneously (milliseconds) to form an incredibly fully connected utopian world.
- Now is the perfect time to identify future communication needs, performance requirements, system and radio challenges, and major technical options for 6G to establish the research goals towards the 2030s.

Thank you

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