Global State of 5G Play and Expectations for the Next 24 Months

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Global launch overview at mid-3Q19

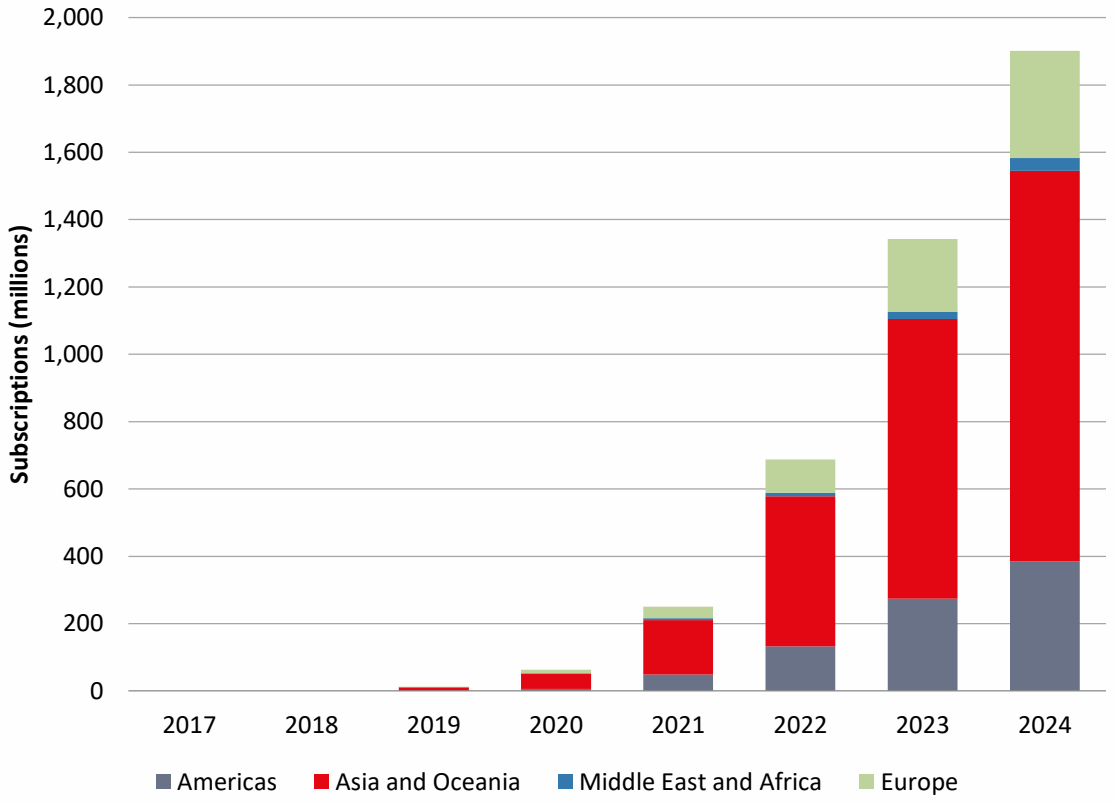
China:
3 service providers Launched 5G networks in 4Q19

GSA:
56 CSPs in 31 countries launched 5G networks

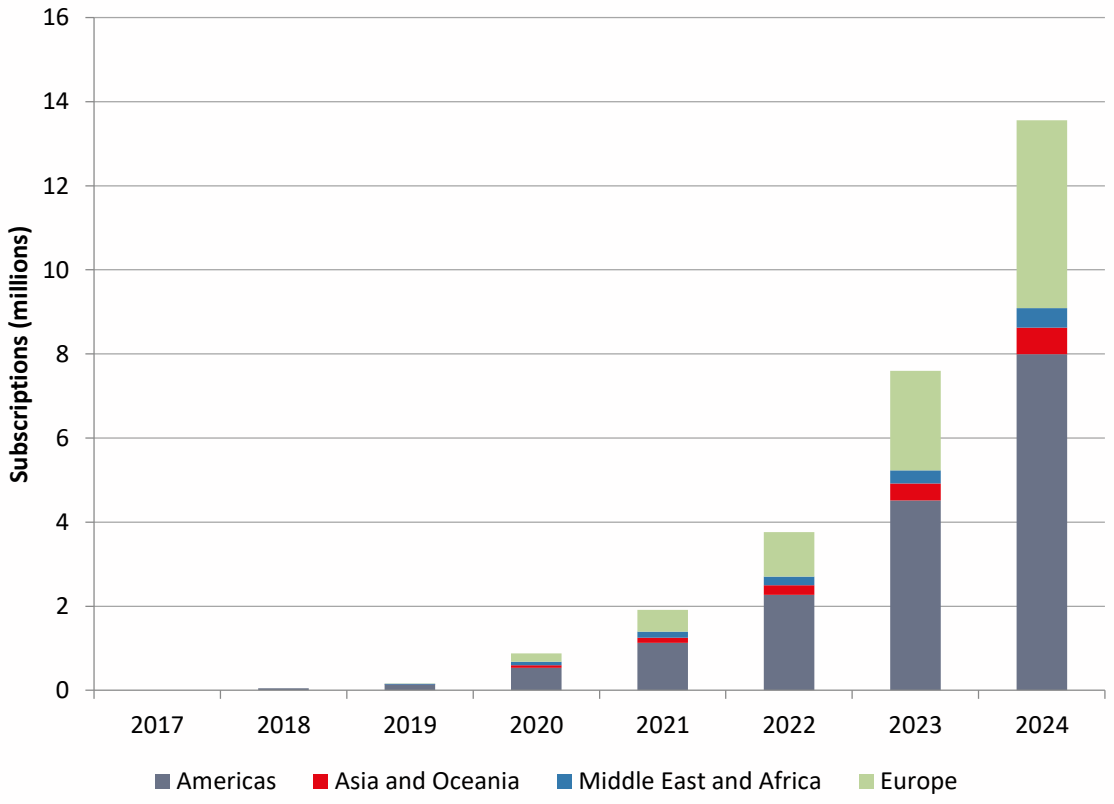
Global 5G subscriptions will start to accelerate when large operators in major developed mobile markets such as China, Japan, Germany, the US, and France to launch 5G commercially

5G mobile and fixed subscription forecasts

5G mobile subscriptions

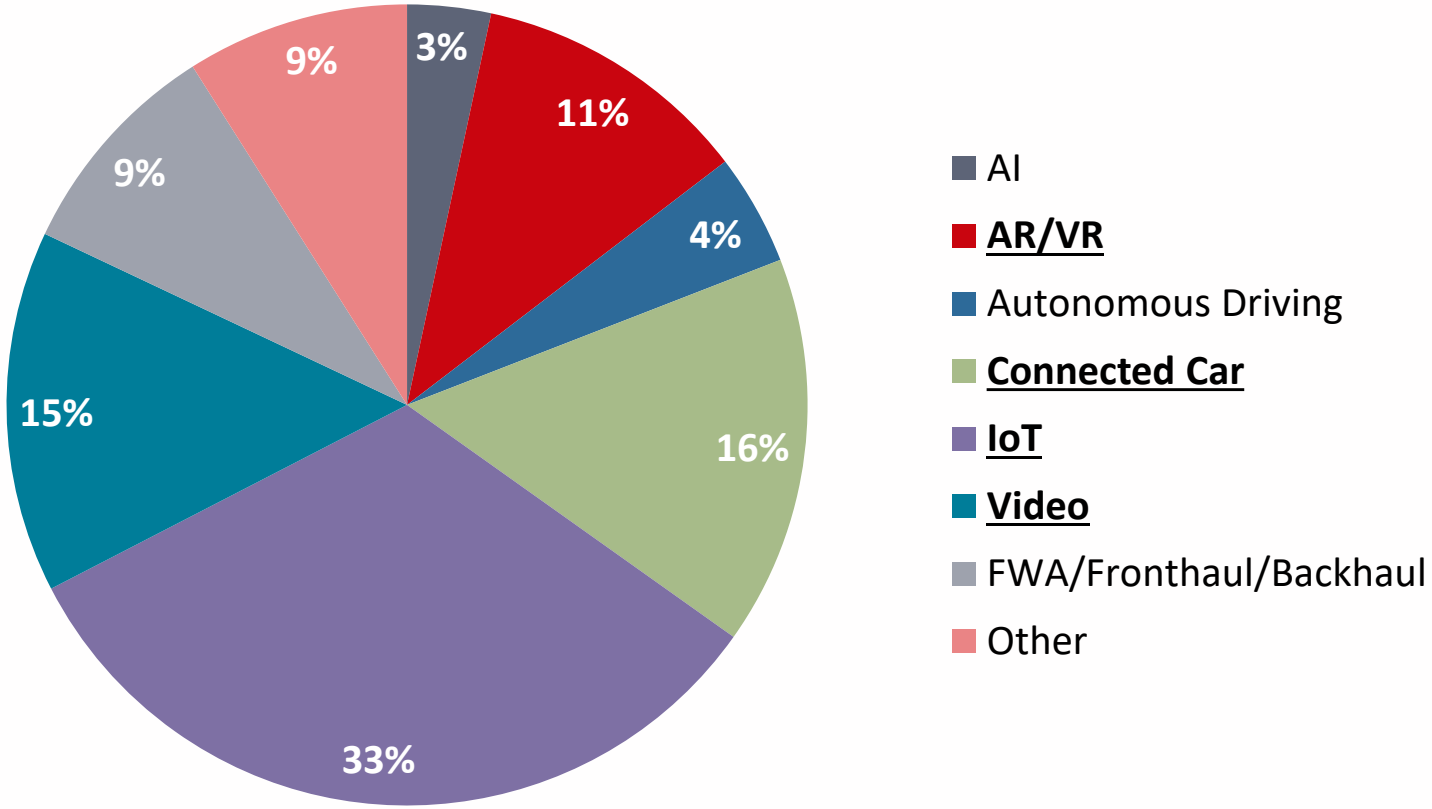


5G fixed subscriptions

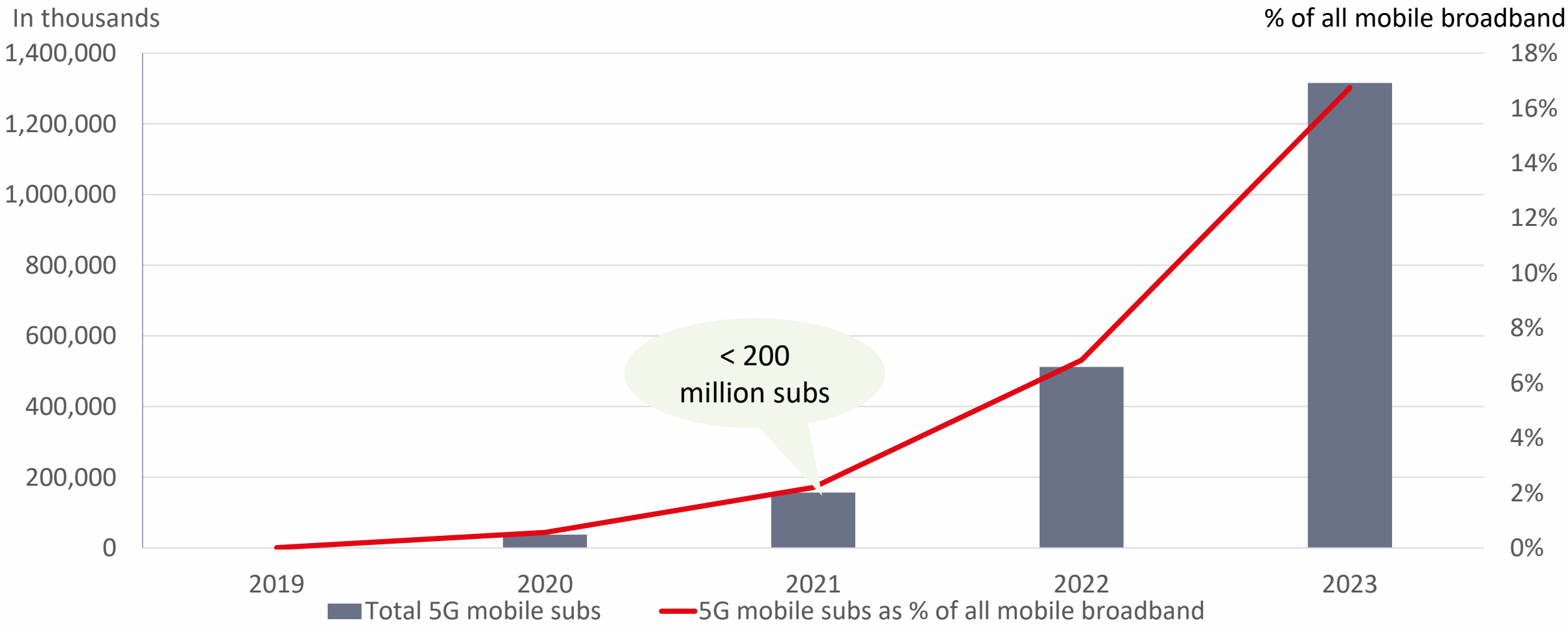


5G Services Statistics

Service statistics shows 49% as combined connected car and IoT

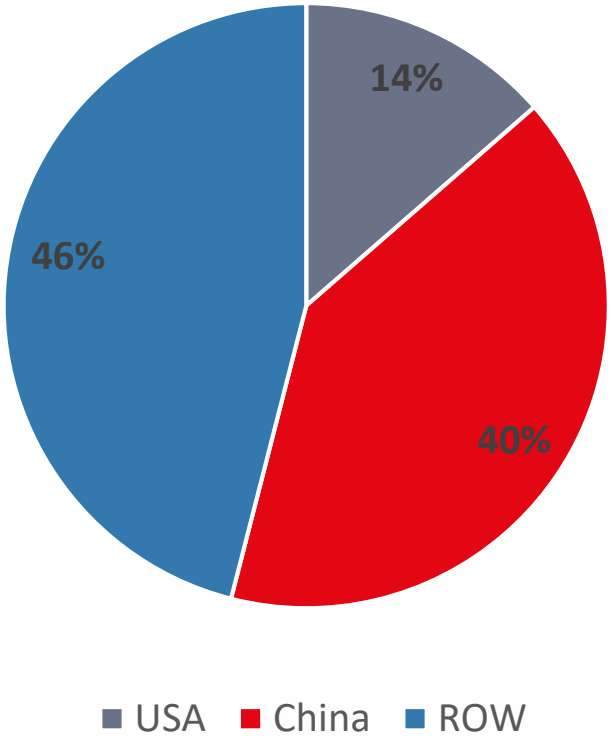


5G mobile subs will surpass a billion in 2023, but still remain a small percent of all mobile broadband subs



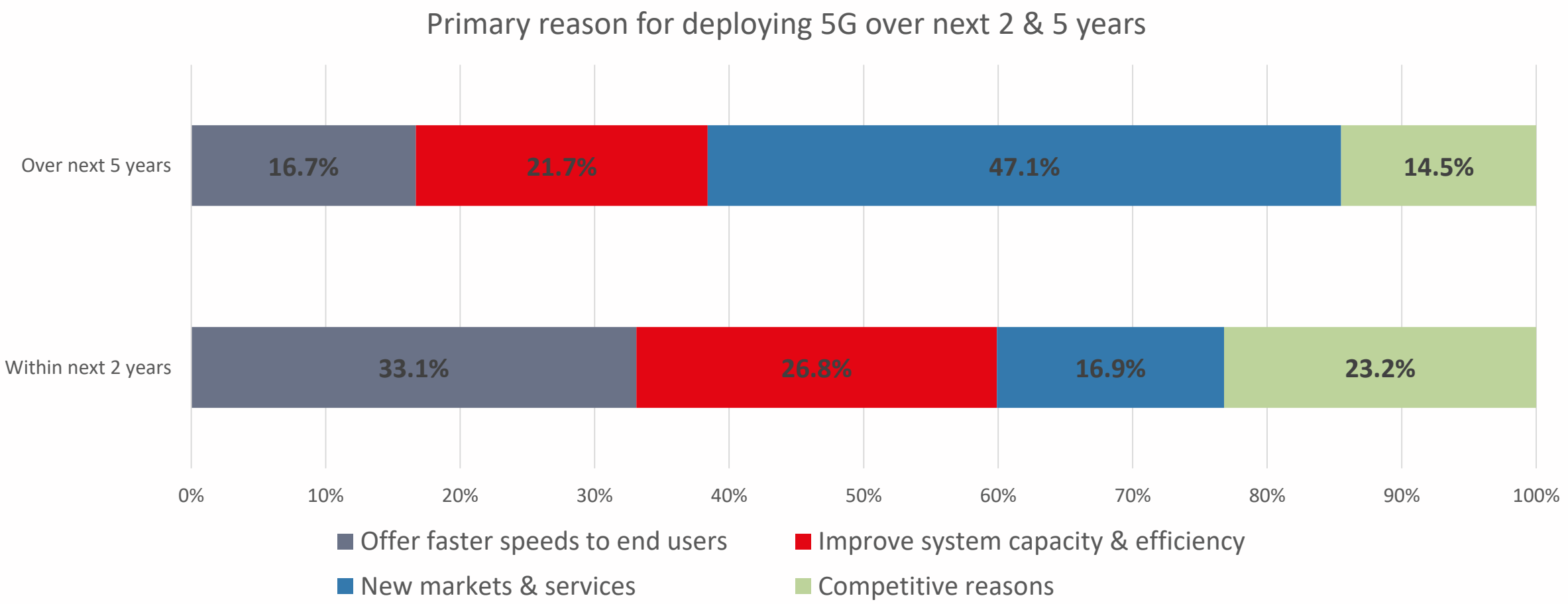
Source Ovum

In 2023 China and USA will have over 50% of all 5G mobile subscribers



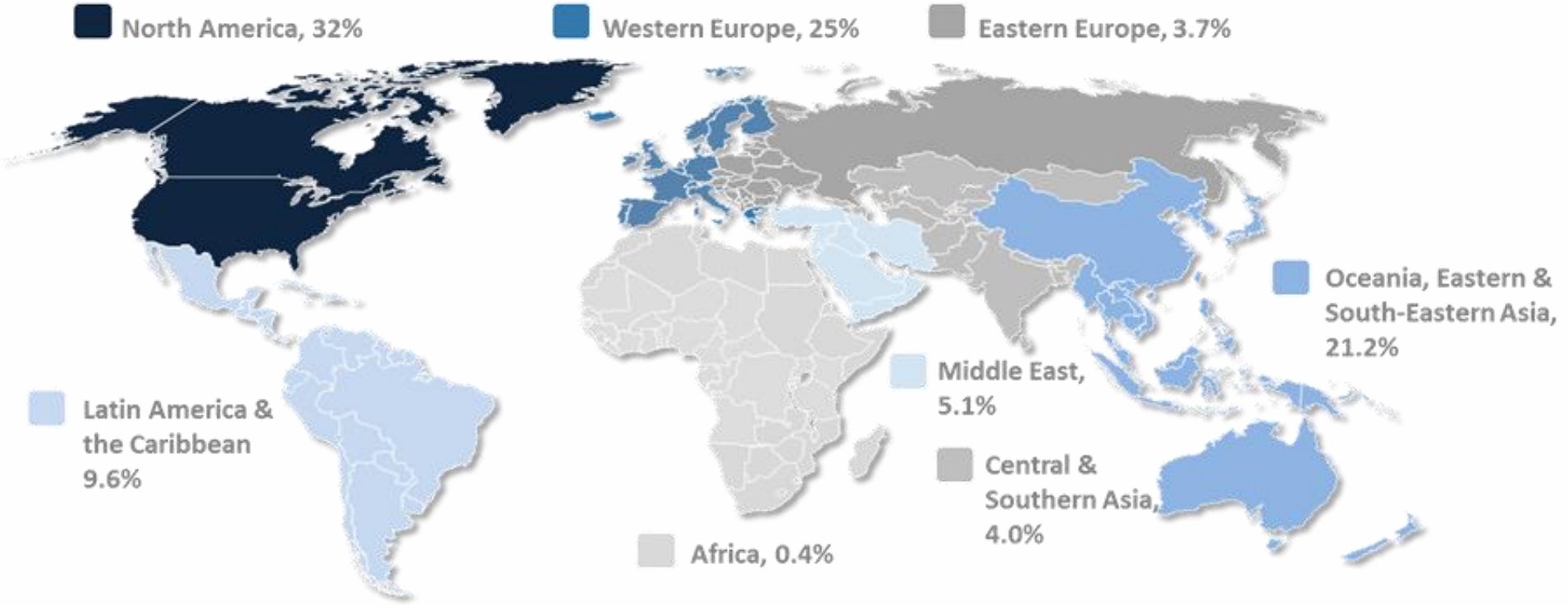
Source: Ovum

New services aren’t the driver for initial 5G deployments



Source: Heavy Reading

Global 5G launch expectation in 2023



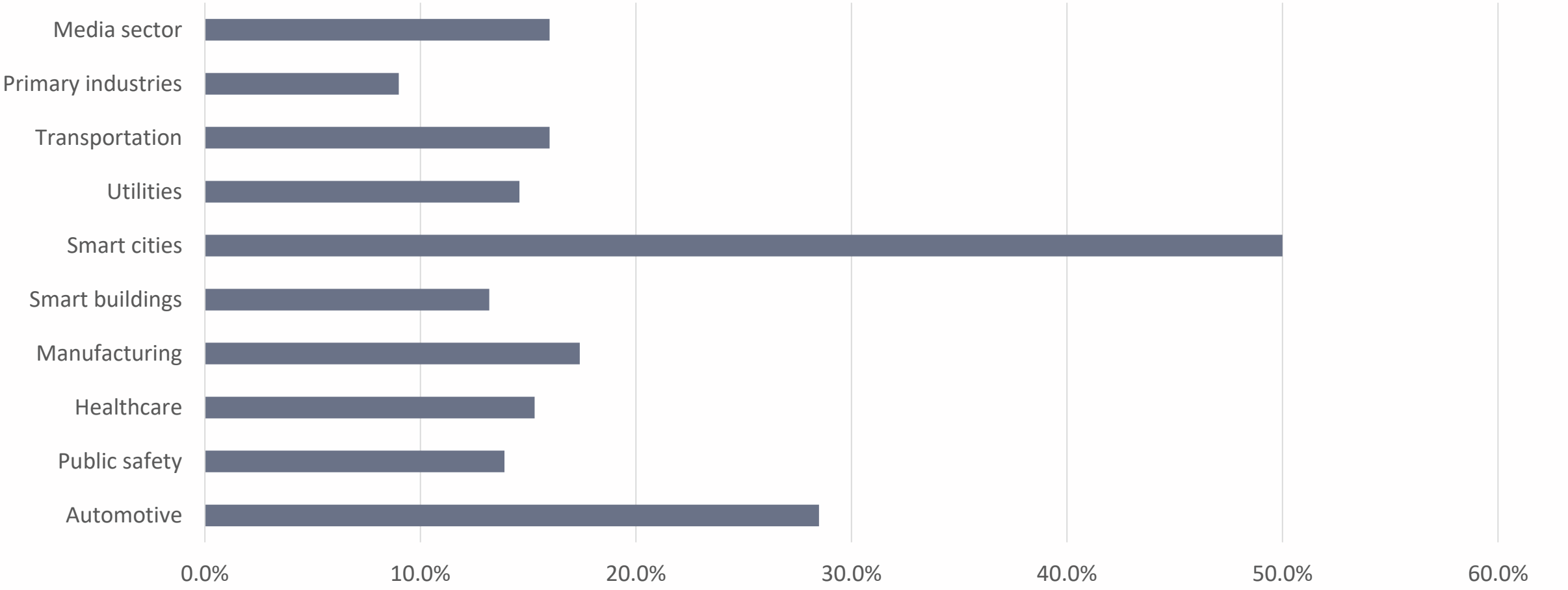
5G penetration rates by region, 2023

5G Customer growth will take longer time due to the complexity of application and market development

The Offering of 5G Technology and Service Challenges

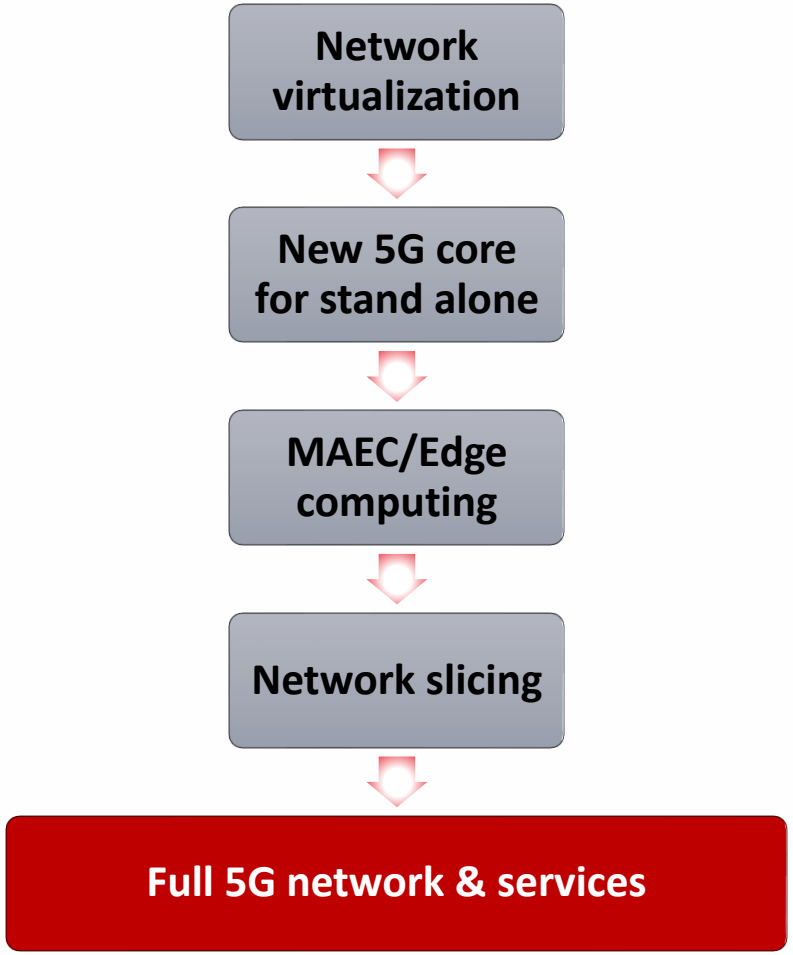
- eMBB – enhanced Mobile Broad Band
  - Newly added 3.5G – 6GHz and mmWave spectrum with large bandwidth and much higher deployment cost
  - Challenge on high order modulation and massive MIMO – limited channel condition
- mMTC – massive Machine Type Communication（massive IoT）
  - The concept exists in the industry for a long time, such as remote sensing, telemetry, remote control, SCADA and remote metering
  - Very diversified application requirements. It takes much longer time to nurture or cultivate the market
- URLLC – Ultra Reliable Low Latency Communication
  - Challenge on conflicted requirement
  - < 1 ms delay（limited to single radio hop）
- New 5G Core network (SA)
  - Separated control and data plane
  - End to end network resource slicing

Which industry segments do operators think are most attractive for 5G



Source: Heavy Reading

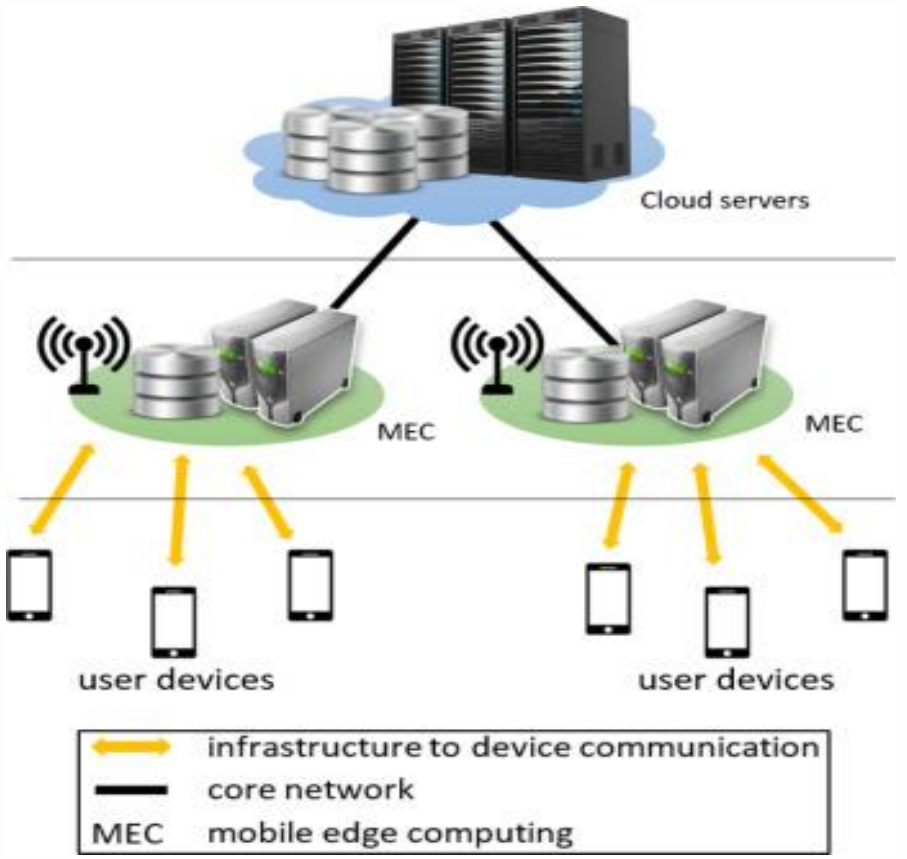
5G new radio just part of the 5G story



- The edge of the network can be in different places for different applications
  - Operators are experimenting with different technology solutions for edge networking
- Dynamic spectrum sharing is needed to get 5G into mobile bands to full footprint coverage and support IoT
  - Commercial solutions from vendors expected by end of 2019, but don't expect operator deployment until at least late 2020
- 5G in stand alone mode with new 5G cloud native core is needed to offer full range of services
- OSS/BSS will limit number of network slices operators can deploy
- Expect network performance variance depending on spectrum holdings and operator service strategies

MAEC & Applications in 5G Network

- ETSI renamed MEC to MAEC to align with the reality of fixed and mobile network consolidation and guide its development on a right track
- Push computing power to where it is required
- Diversified MAEC application requirements
- The importance is to find right application requirement and the best location in the network that EDGE server should be installed to meet the service needs
- CSP should provide with a platform that allows customer quickly and easily (SW/HW) integrate its the server installed and connected into the network platform

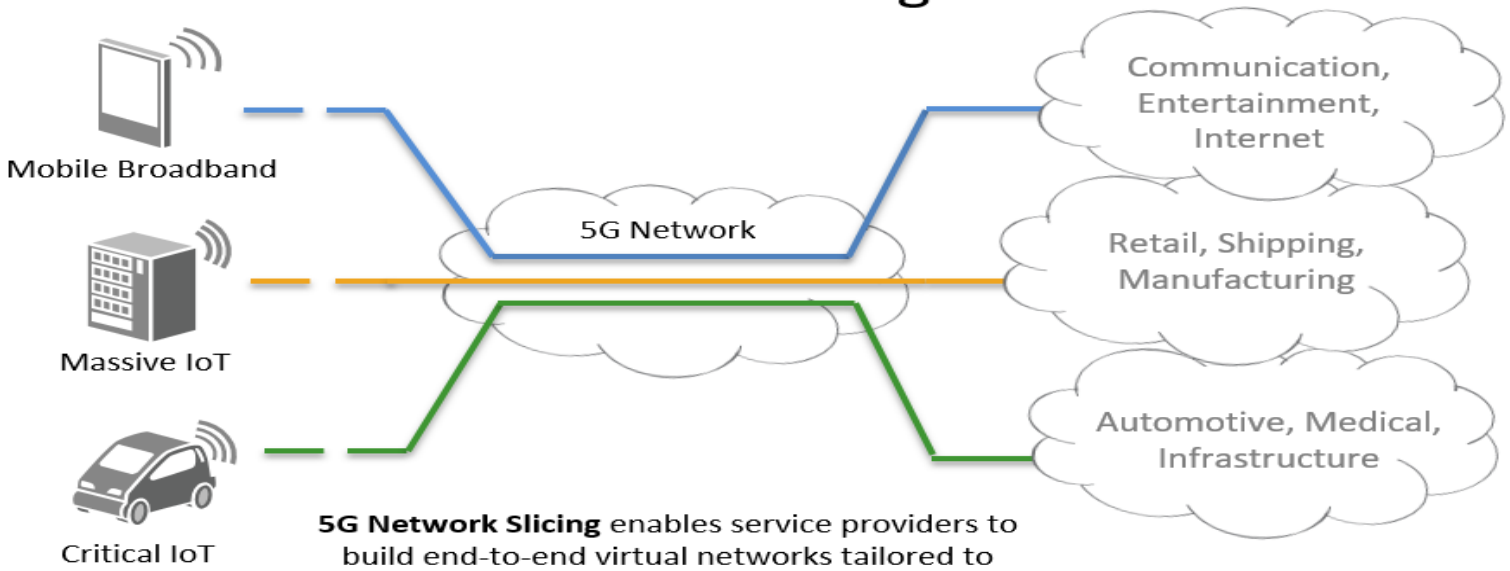


Concept of Network Slicing

The 4G Network

4G enables voice, text, and data services, but not the range of use cases that the future requires and 5G will enable. 5G will not only be faster, it will be more flexible.

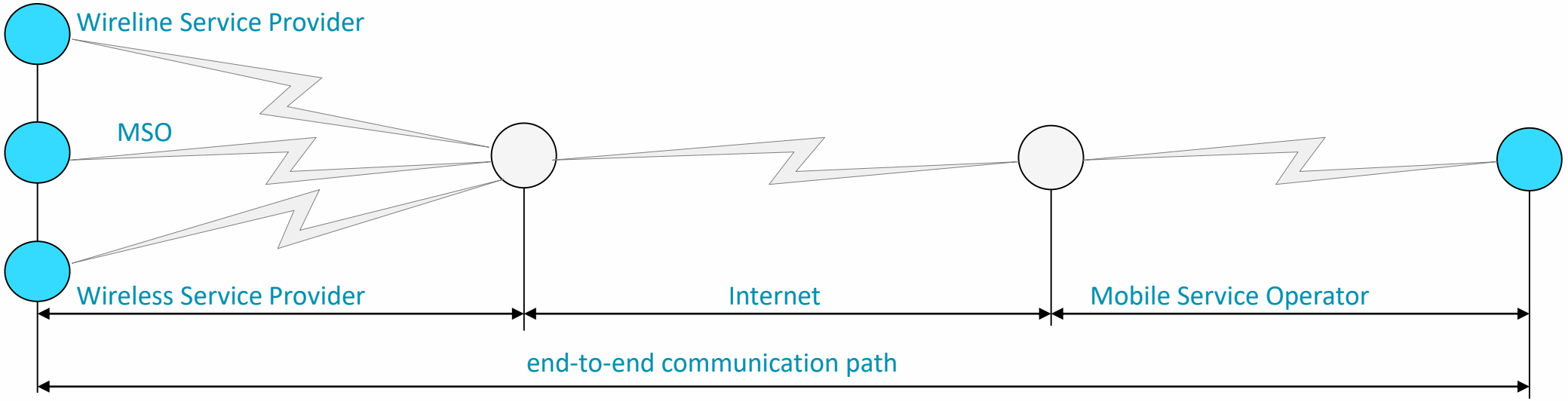
5G Network Slicing



5G Network Slicing enables service providers to build end-to-end virtual networks tailored to application requirements.

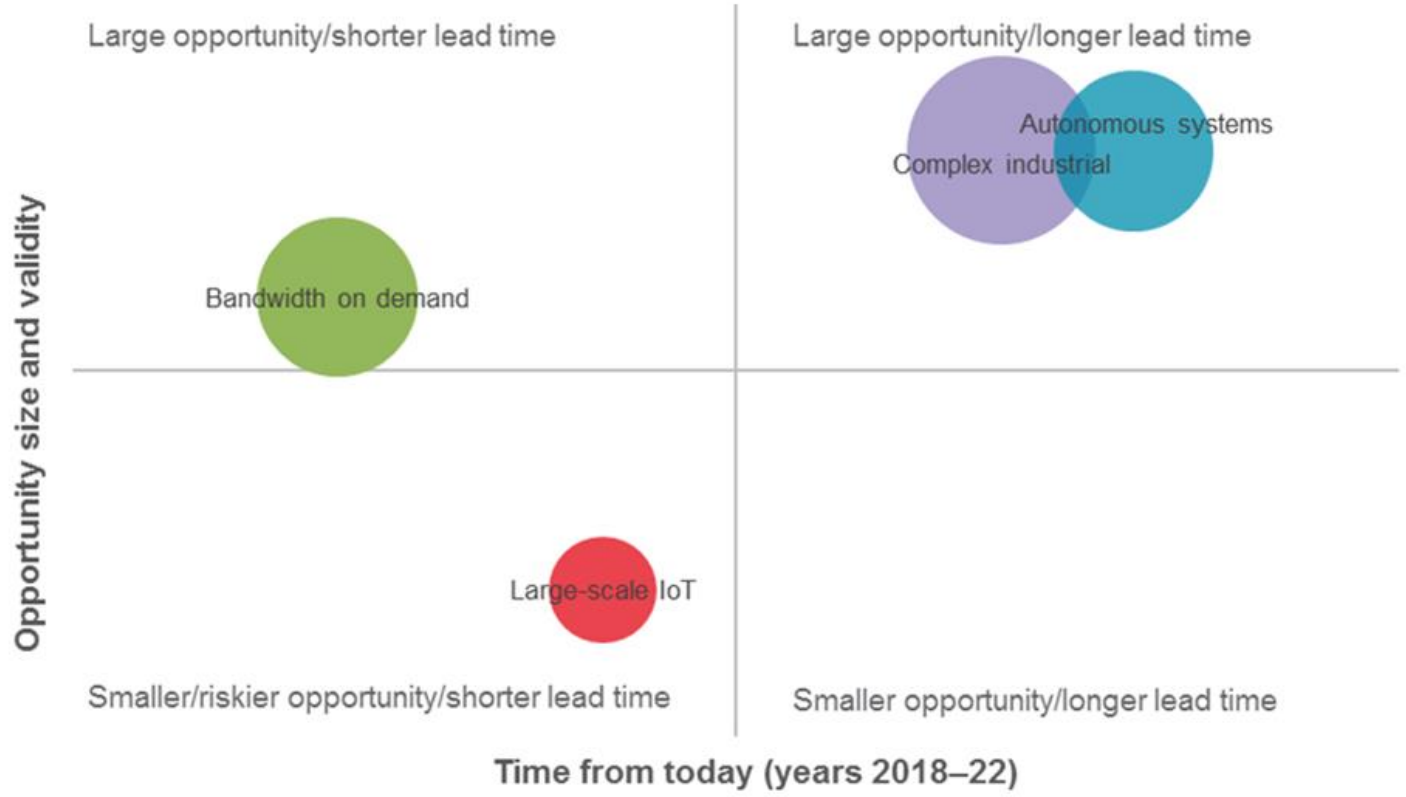
Slicing - End-to-End Resource Allocation

- Multiple network operators and resources coordination
- Standardized resource allocation protocol and procedures
- Multi-vendor Interoperability is critical for 5G network efficiency



Enterprise services hold best promise for new 5G generated services

But the bigger more complex opportunities will take more time to develop



Source: Ovum

5G Network - An Intelligent Information Service Platform

- Merge fixed and mobile network into **One Integrated Network** and service. **IT and telecom consolidation**.
- Support time critical applications with short latency and fast response (UrLLC)
- Support massive MTC (IoT) services connections with high reliability and efficiency
- **Ubiquitous service coverage** and pervasive information processing (data service and IoT)
- Effective, efficient and intelligent information delivery – Service enhancement and transformation
  - Traffic volume services
  - Information services
- Automated network complexity and security management
- Support **highly mixed traffic** with **very dynamic attributes**

Key messages on 5G services

- Obtaining significant service revenue uptick from 5G services will be difficult
  - 5G is important for consumer branding, defend customer base and to take subscribers from competitors
  - Operators can use 5G to turn back unlimited data services and sell larger data packages
  - Slowdown in smartphone sales is troubling and could negatively impact consumer adoption of 5G
- Enterprise and other B2B services hold the real promise for growing new revenues with 5G
  - Low-latency is a real differentiator
  - Operators need to build business practices as they build out 5G platform
  - LTE can be a proving ground for future 5G services
  - The business case for 5G services are far from defined or proven, we are just at the start of the process

Questions and Answers

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