Mobile market update and wholesale implications

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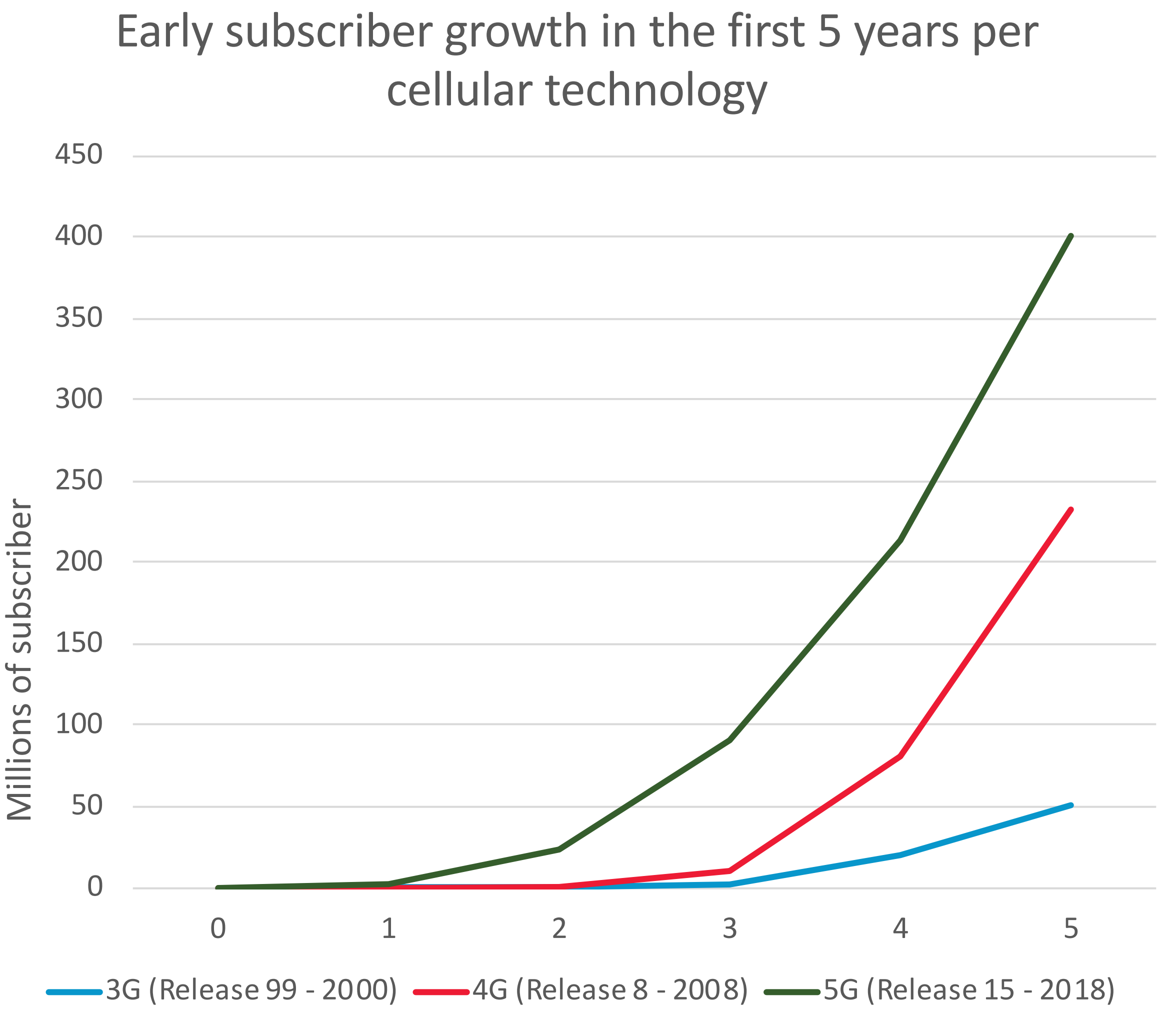
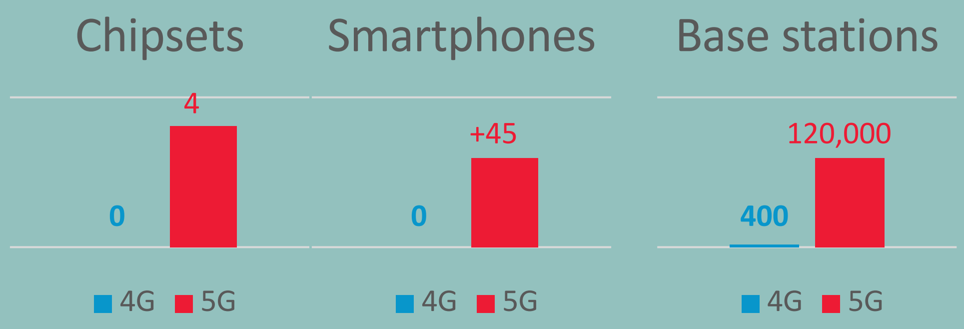
A look into the future of telecoms

Mobile market trends

Cellular generations spurring growth



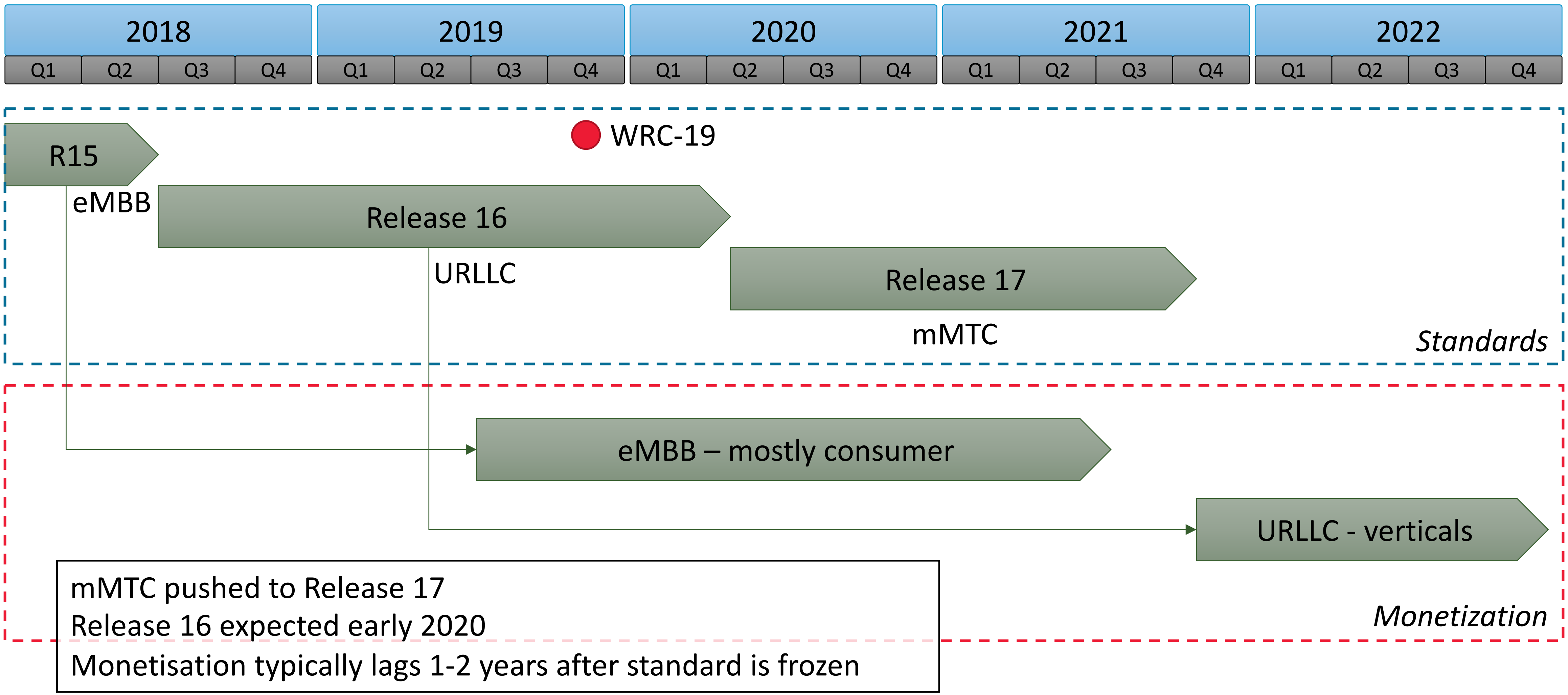
4G vs 5G



Each generation's magnitude is larger, however **5G came much faster than we expected.**

5G will need just **4 years to achieve 500 million** subscriber, while it took 5 years for 4G and 10 years for 3G

5G development timeline



What's next for 5G?

Traffic patterns

Devices

Network deployments

South Korea:

5G average daily use has increased to 4GB - Capacity constraints in sight with AR/VR, ultra HD video

➢ Further densification and extended coverage are necessary

Traffic patterns

- 5G will affect user behavior for all technologies, incl. 4G
- New innovation will spur, for consumer and B2B markets
- Video traffic is growing 50-60% per year and new apps will drive further growth

Devices

- Foldable 5G devices will enter the market in 2019
- 5G-capable devices were available from Day 1
- B2B devices will likely create significant higher traffic demands

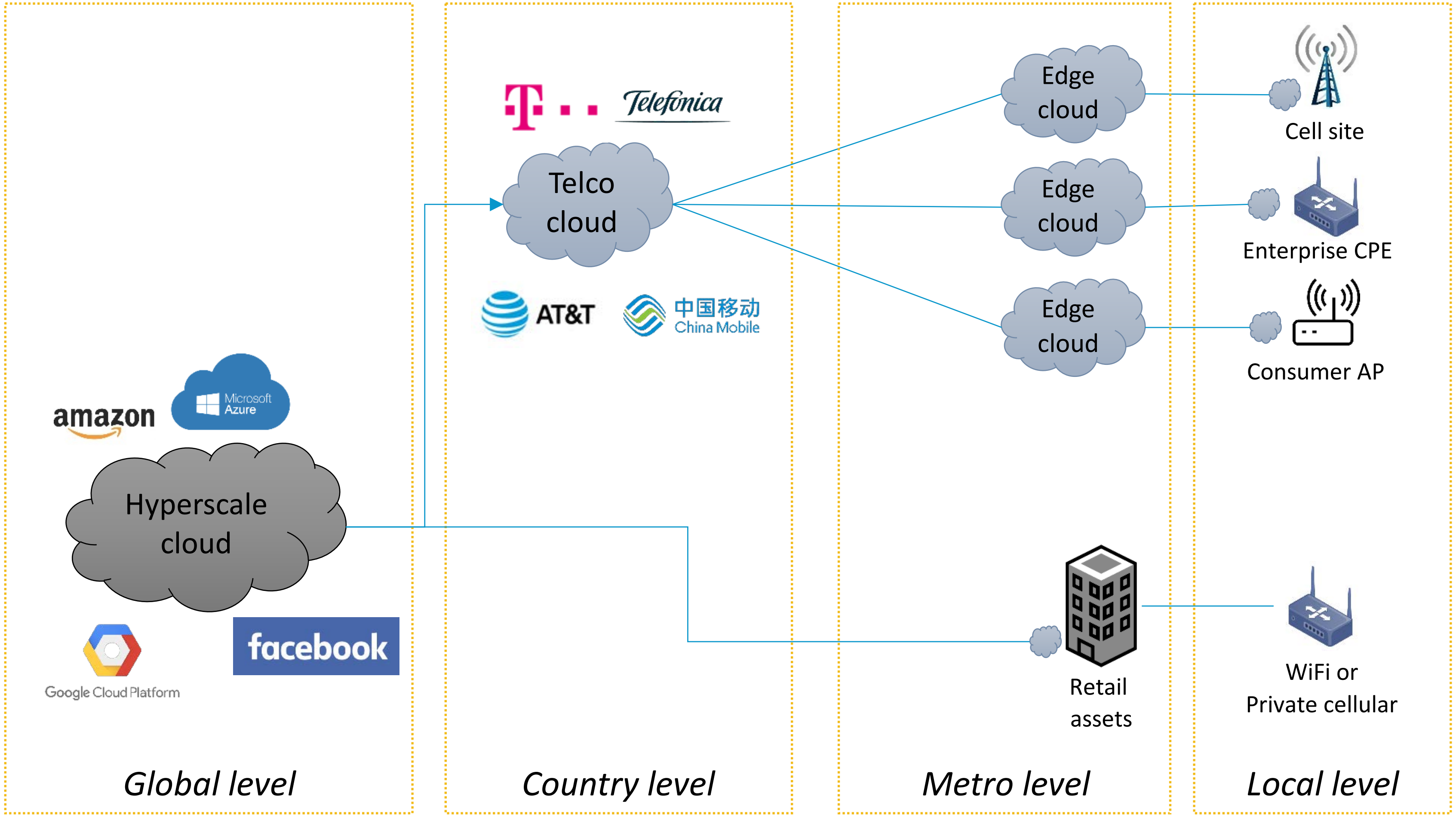
Network deployments

- Early 5G deployments are patchy, but demand will force operators to speed up
- Densification is inevitable with >C-band
- Massive MIMO imposes new challenges on cell sites

Implication

5G is here, and growing much faster than previous generations.
Same as 4G, it will change user behavior
B2B apps = new network requirements

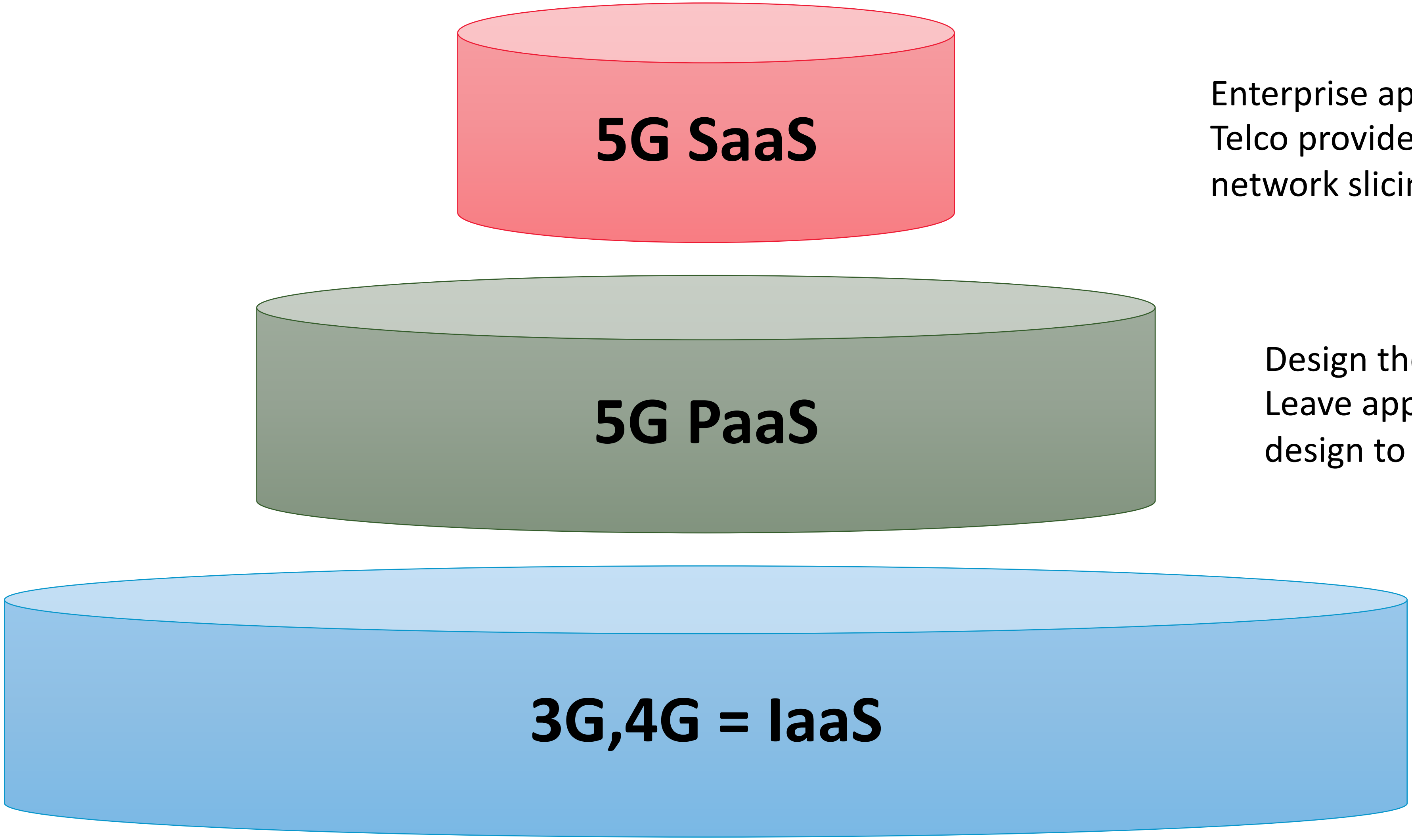
5G = B2B app platform



Market implications

Products and services that span across several operators
(e.g. MobileEdgeX, vapor.io)

How will this be implemented?

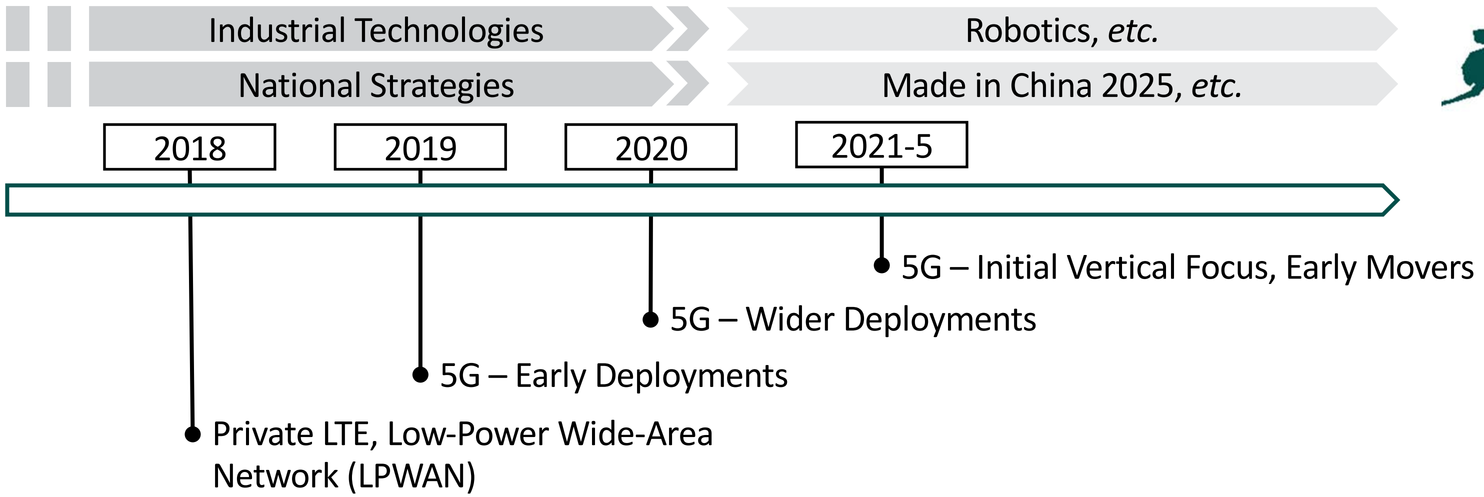


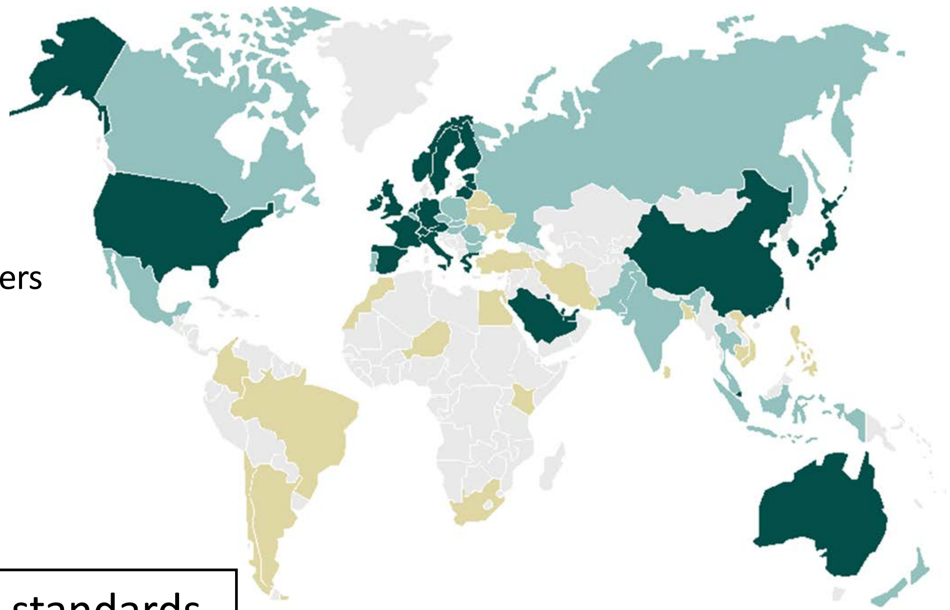
Enterprise applications
Telco provides services and apps:
network slicing, service chaining etc

Design the network as a platform
Leave application and service
design to experts

Current mode of operations
Buy network capacity and DIY

Alignment Between Industrial Technology Cycle and 5G





5G Launch By 2020

5G Launch Between 2020 and 2023

5G Launch Between 2023 and 2026

- Potential alignment between manufacturing requirements and cellular standards
- Private LTE is creating opportunities in the vertical currently now
- Role of mobile service provider and infrastructure vendor still not clear
- End-to-end solutions will be necessary to address this market
- Partnerships will be critical to enter this domain

Why is Network Slicing different?

Can the telco value chain overcome its connectivity legacy?

Changing telco value chain

- Deploy new services with little or no disruption to existing services
- Support a wide range of services with different SLAs in new value chains
- Network efficiency – pursue new growth in a cost-efficient fashion
- Ownership makes way for access

Changing demand & challenges

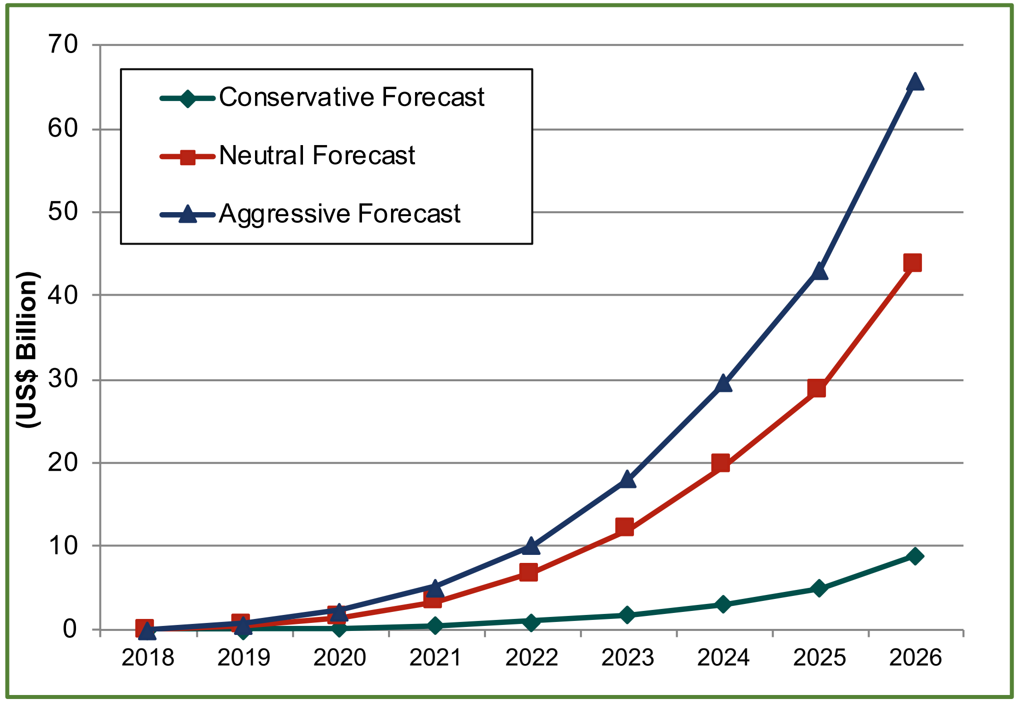
- Mirror webscale nimbleness and commercial "flatness"
- The right level of human capital
- Heterogeneous & convoluted technology ecosystem
- Functional requirements pose soft & hard conflicts

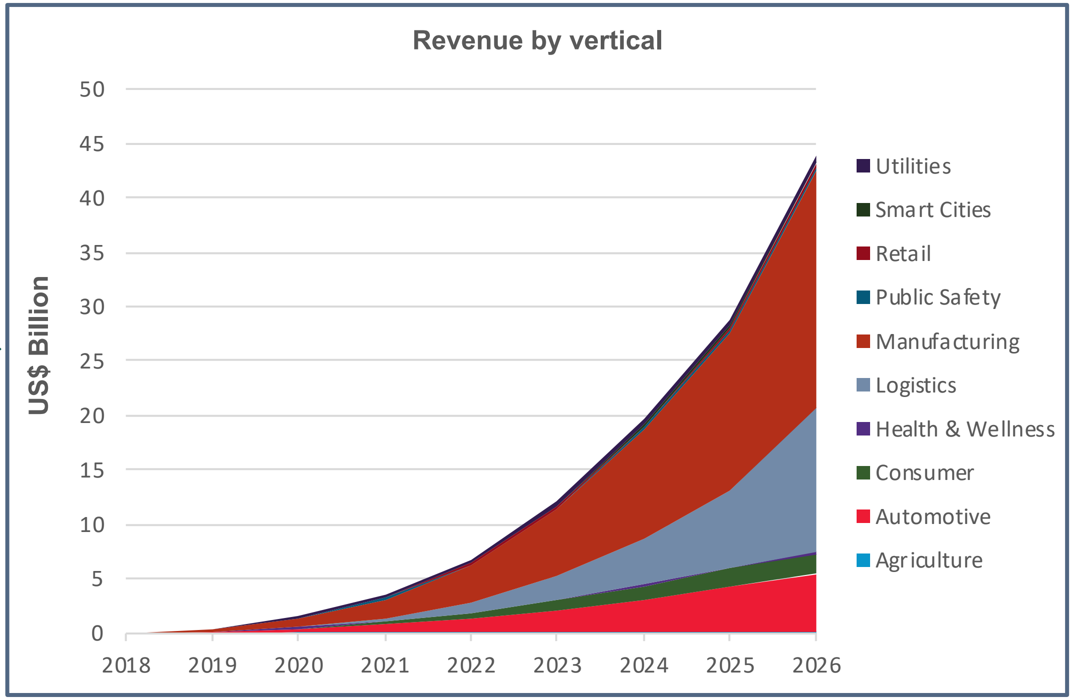
5G Network Slicing

NSaaS	Connectivity as a service supplants the increasingly redundant connectivity as a 'product'
TOC	Lower TOC by streamlining operations and processes
New Services	Services with different functional requirements and SLAs, but E2E orchestration & automation required
Platforms	Deploy new platforms without the financial burden, risk of ownership, and sunk costs
IT + Telecoms	Commercialize an ecosystem that extends the utility of IT-designed solutions to the telecom domain

Network Slicing as a Growth Opportunity

Over US$40 billion in value from the trio of manufacturing, logistics and automotive



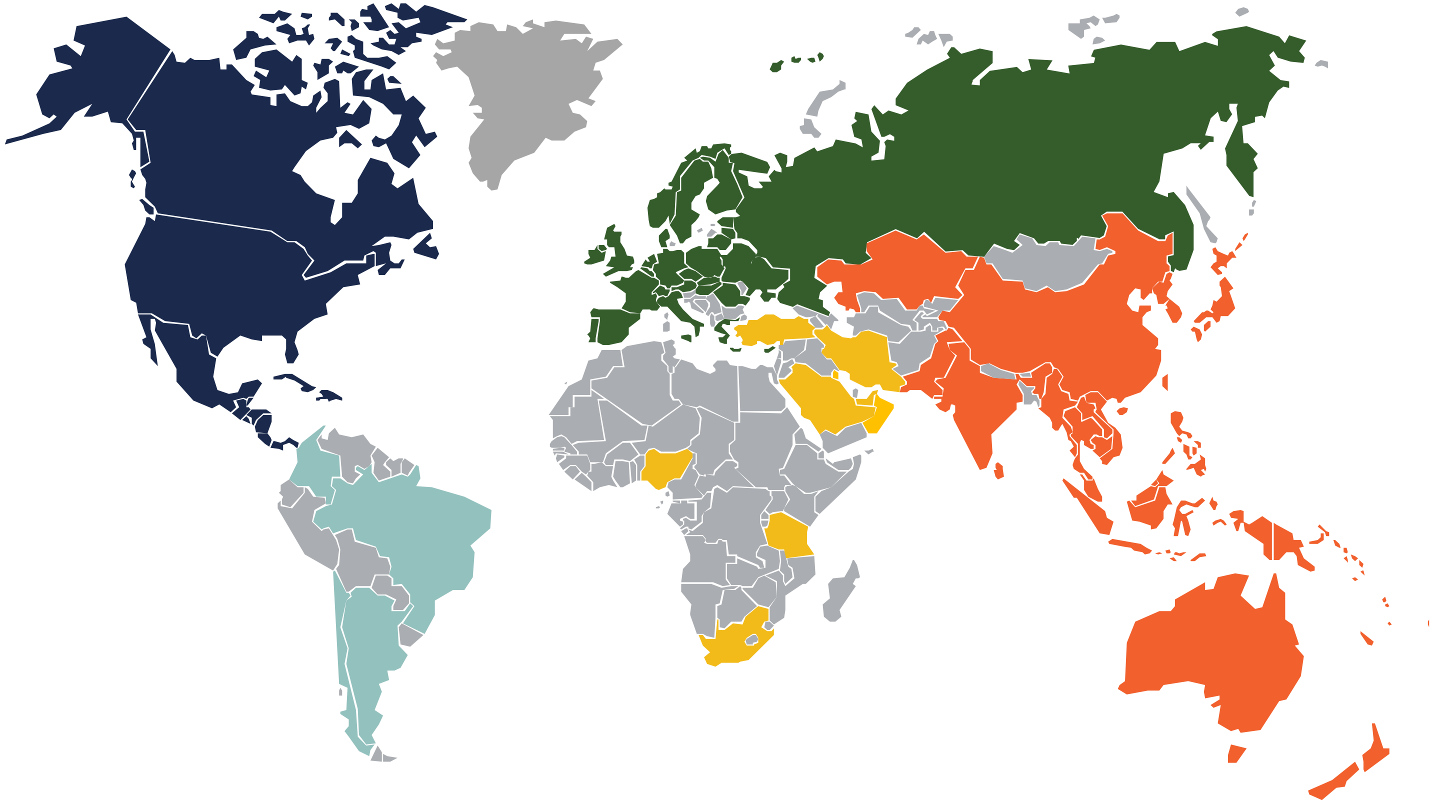


- Total opportunity is $43bn by 2026; manufacturing, logistics and automotive are the biggest opportunities
- Dependent on automation & orchestration across multiple domains and different vertical industry applications
- 5G core provides new slicing features and enables E2E slicing capability on as-a-service basis

Implication These estimates may not justify a large scale 5G network deployment, new deployment models and additional flexibility are necessary

Public LPWA Network Availability

Networks Deployed or Commercially Launched: May 2019



1 Based on Global Mobile Supplier Association (GSA) report published in 1Q 2019
2 Based on certified devices listed on the LoRa Alliance website.
3. Based on certified devices listed on the Sigfox website
** IC's, modules, routers and CPEs not considered in the end-device ecosystem analysis.

Cellular LPWA Networks

126 networks deployed in 53 countries[1]

- NB-IoT- 92 networks
- LTE-M- 34 networks

Cellular LPWA End-Devices[1]

- Asset trackers- 94%
- Wearables- 3%
- Condition-Based monitoring devices- 3%

LoRaWAN

113 Networks in 55 Countries

LoRaWAN End-Devices[2]

- Environmental sensors- 36%
- Condition-based monitoring devices- 25%
- Asset tracker- 20%
- Smart meters including Retrofit devices- 13%
- Others- 5%

SIGFOX

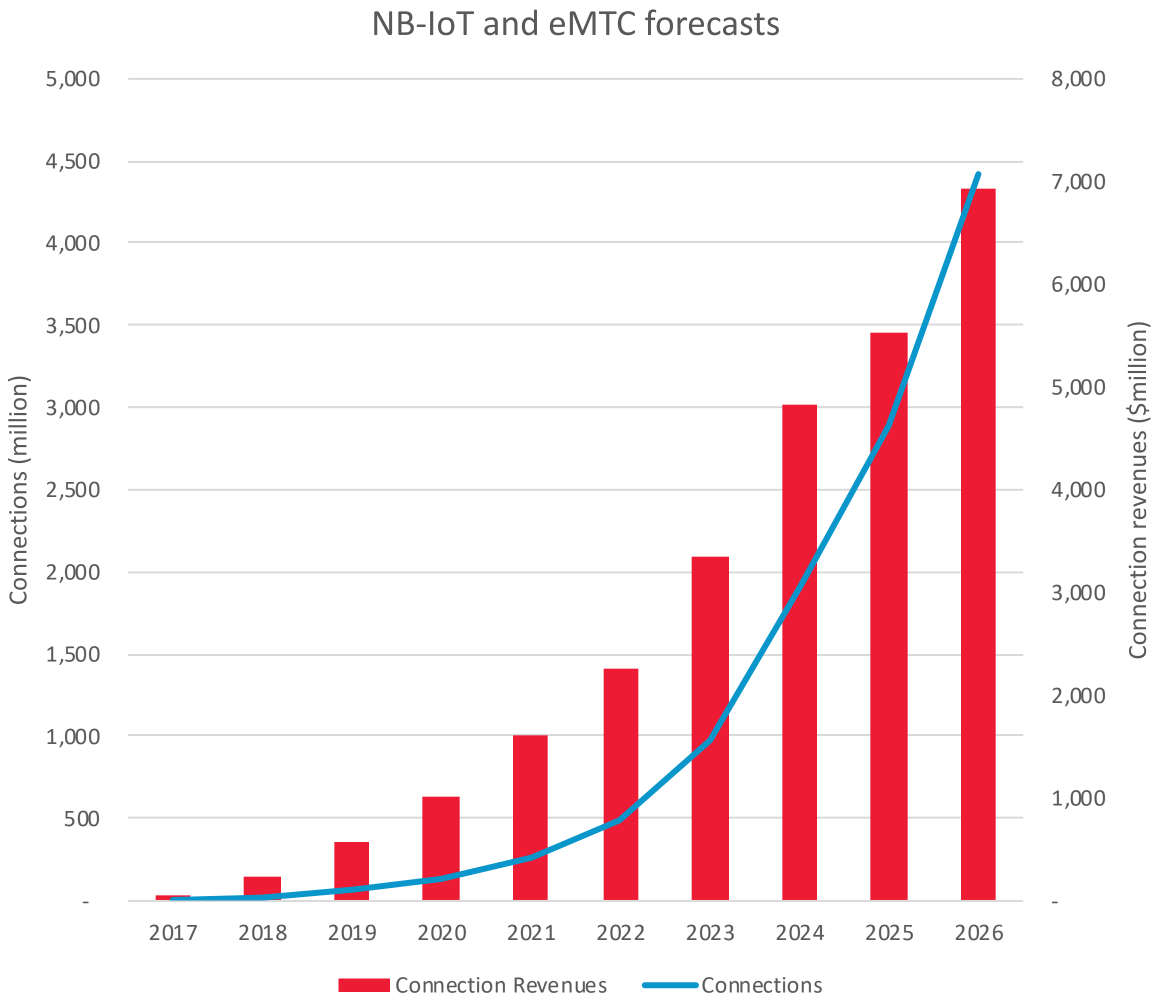
60 networks in 60 Countries

Sigfox End-Devices[3]

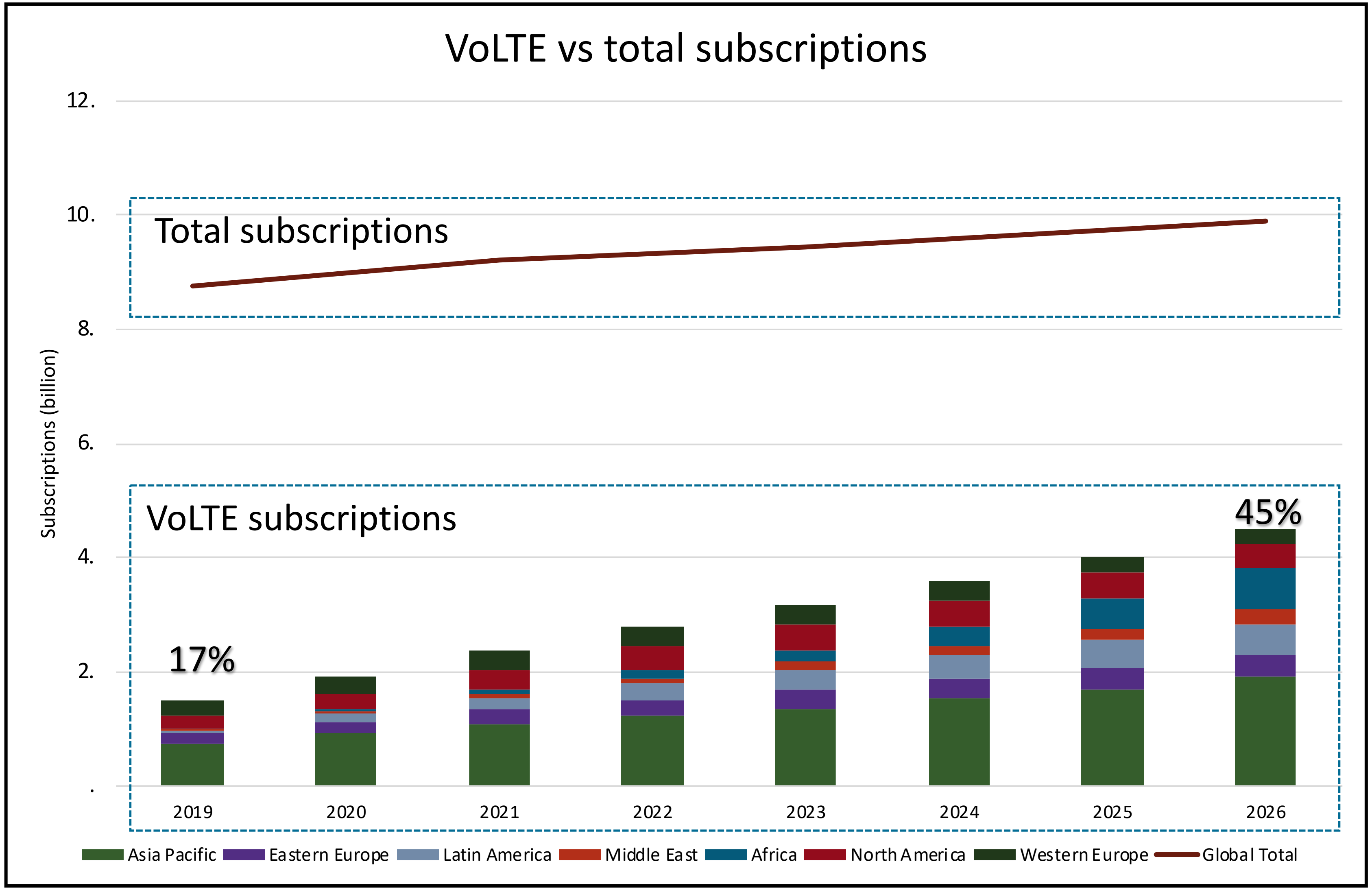
- Environmental sensors- 38%
- Condition-based monitoring devices- 33%
- Asset tracker- 14%
- Smart meters including retrofit solutions- 12%
- Others- 4%

Cellular LPWAN market activities

- Connections growing with a CAGR of 36.7%
- USA has fastest growth, but Asia largest share of connections
- Connectivity alone is starting to be commoditized
    - MSPs making vertical plays in application segments such as vehicle telematics, smart city & smart home
- In 2024, there will be more cellular LPWA M2M connections than any other cellular technology combined
- In 2024, global annual cellular LPWA connection revenue (US$4.8 billion) will surpass those of 2G (US$3.4 billion)
- In 2024, 5G connections will account for just 0.4% of cellular M2M connections and 2.1% of connection revenue



VoLTE subscriptions are growing



- Voice is largely commoditized in developed markets
- But can play an important role in enterprise, even in 5G

VoLTE:

- 262 operators, 120 countries
- 194 operators: HD voice
- >2K devices support VoLTE
- Penetration is very high in developed areas
  - e.g. 85% of EE voice traffic was VoLTE in Glastonbury festival
- VoLTE makes voice just another data service, esp. with SR-VCC

Wholesale market implications

Mobile market trends

- VoLTE starts to dominate developed markets
  - All mobile services are now data driven
- Roaming is tightly regulated
  - It is now longer a cash cow (inside Europe)
- Developed markets have intense competition
  - Unlimited packages are typical across most European markets
- 4G networks are well utilized under yield management
  - Consumers are ready for the next wave of user experience improvement
- Impossible to charge more for 5G
  - Where is the money for nationwide deployments?
- China and challenging macroeconomic status
  - CTOs hesitant to invest significantly in new networks

Wholesale market trends

Several factors: Air travel growth, urbanization, rise of middle class

facebook connectivity

Facebook launches "Middle Mile", wholesale carrier subsidiary

BIPT

Belgium regulator is now enforcing wholesale fiber access regulation

- Security and fraud are becoming a major concern
  - Blockchain is positioned as a key future technology for security
- Data and privacy, as well as sovereignty are top priorities for enterprises
- WebRTC and APIs have decelerated after their initial hype

Wholesale implications

Competition is increasing but operator federation will need to reach new levels for enterprise 5G

Conclusions and recommendations

Conclusions

- Telecom operators will soon need to design application platforms
  - Operator federation (beyond connectivity) and openness will drive platforms
- All mobile services will soon be data, driven by VoLTE
  - Most networks today are “video delivery networks”
- Network slicing presents a major opportunity that will go beyond a country
- Collaboration will be essential for 5G future development
  - Particularly for 5G in enterprise verticals
- 5G can create $6tn of economic value by 2035
  - Enterprise vertical revenues to exceed consumers revenues by 2032

Thank you

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