

A look at the companies and organizations working to make 5G a commercial success

# About Ovum

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Market-leading research and consulting business focused on helping digital service providers and their vendor partners thrive in the connected digital economy. We create business advantage for our customers by providing them the actionable insight they need to make smarter decisions faster.

For **digital service providers** and their **technology partners** Ovum provides:

- Unique insight into the highly contested areas of the connected digital economy
- Reliable data, forecasts and analysis on market critical topics and technologies across TMT
- Advice and support to build awareness and generate new opportunities



Global coverage, local market insight



# Presentation Agenda

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- The operator landscape as it applies to 5G
  - What regions are leading in 5G interest
  - What is driving operators to deploy 5G
- 5G standardization process
  - Timeline for 5G standardization
  - What are the different organizations involved in standardization
- Vendors and their 5G ambitions
  - Who are the different major RAN vendors working with and what is their key messages
  - The role of selected other non-RAN vendors such as Intel, Qualcomm, and Cisco



# Operator activities



# Three major application areas for 5G

## Enhanced mobile broadband (including fixed wireless access)

- Offers wider bandwidths than LTE
- Uses spectrum above and below 6GHz
- Uses licensed and unlicensed spectrum
- Incorporates technologies such as massive MIMO
- Examples:
  - 3D video/UHD video
  - Rich media and entertainment

## Ultrareliable, low-latency communications

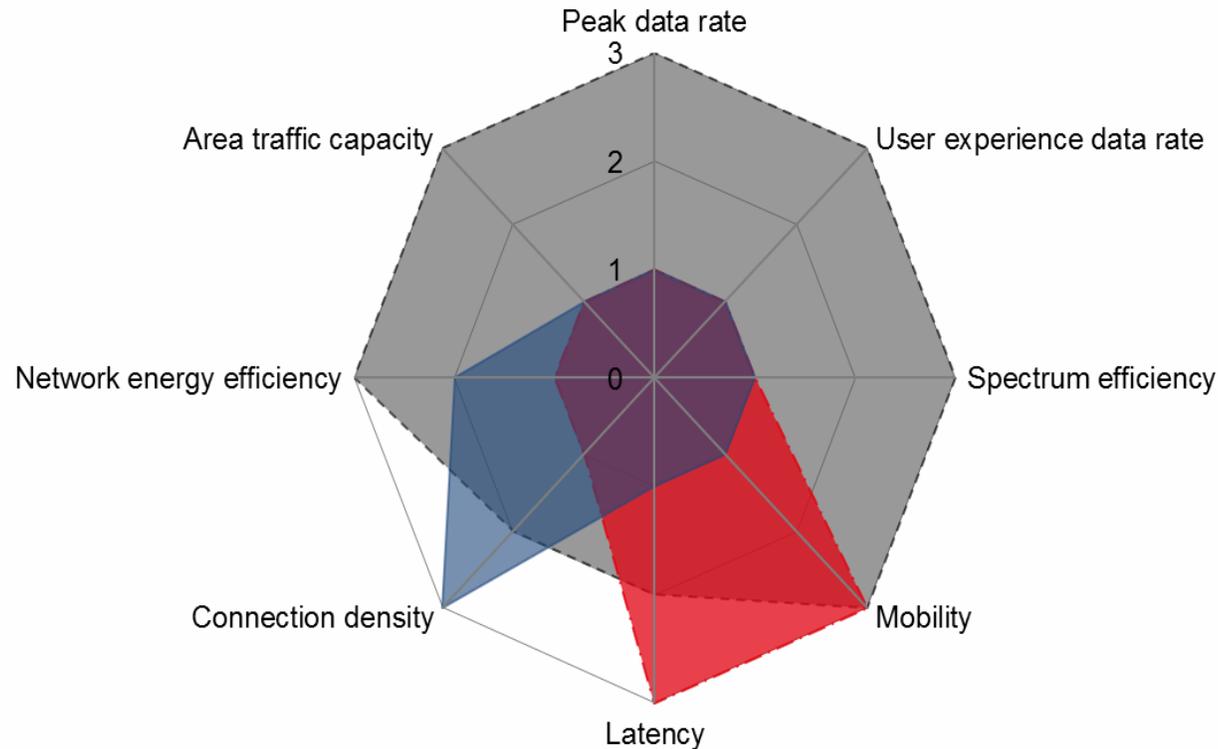
- Supports ultra-low latency transmission (<1ms)
- Supports highly resilient communications with redundancy
- Offers reliable device-to-device communication
- Examples:
  - Industrial automation
  - Autonomous vehicles
  - Telemedicine
  - Augmented and virtual reality

## Massive machine-type communications (IoT)

- Evolves out of narrow-band LTE (eMTC/NB-IoT)
- Has low complexity, and requires low energy
- Follows the ultra-dense, small cell network model
- Eventually adds new waveforms and architectures (e.g. multihop mesh)
- Examples:
  - Smart grid
  - Smart cities
  - Health monitoring



# Key network requirements for those applications



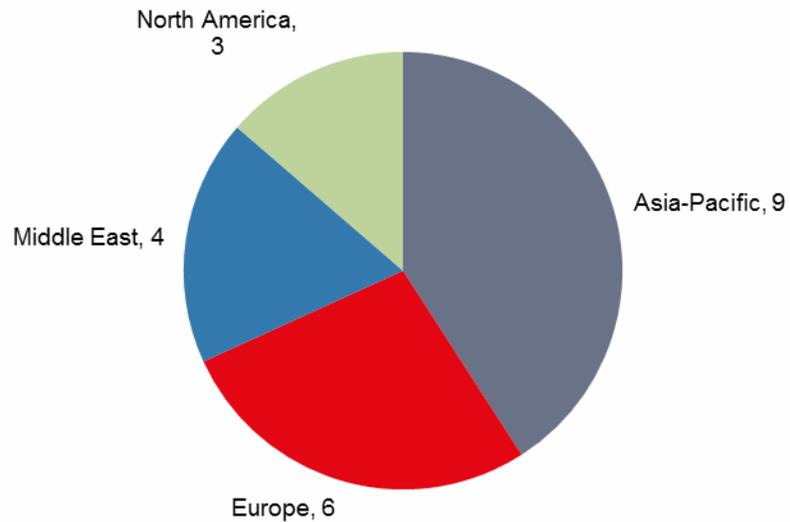
■ Enhanced mobile broadband ■ Ultrareliable & low-latency communications ■ Massive machine-type communications

**It is really too soon to talk about 5G killer applications; network needs to be deployed first. The first operator deployments will be based on enhanced mobile and fixed broadband.**

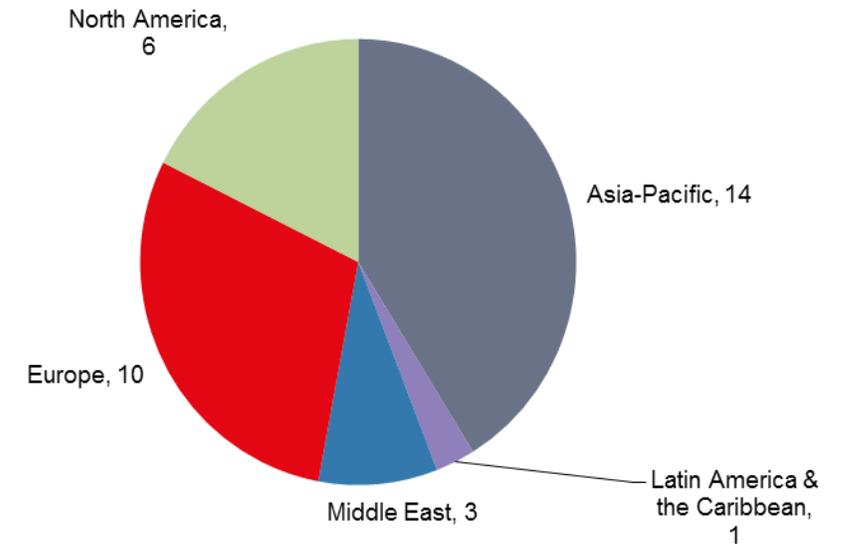


# Public operator 5G activities at end of Q1, 2017

Number of 5G launch dates by region – 22 in total



Number of 5G test/trials by region – 34 in total



## Operator activity highlights

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- In general, early 5G deployments are following early LTE deployments
  - Areas such as South Korea, Japan, and the US are expected to have the first networks
  - China is an exception to this, as it will be one of the first markets to have 5G, but was not one of the first LTE markets
- Early high-profile deployments are being tied to big events such as the Olympics in Japan and South Korea, the Commonwealth Games in Australia, and the World Cup in Qatar
- In the US, operators are not driven by any one big event, but instead are looking at using 5G to create new revenue opportunities with fixed wireless broadband
  - Both AT&T and Verizon have existing fixed broadband services; fixed wireless access could expand the reach of those services. T-Mobile and Sprint have so far shown no interest in FWA and are waiting to use 5G for mobile services
  - All the US operators want 5G for enhanced mobile broadband as well. AT&T targets late 2018 for initial mobile service
  - T-Mobile will deploy 5G in 600MHz. It won't have capacity of other higher-band deployments, but will have coverage for IoT
- Just because an operator hasn't said something publicly about 5G doesn't mean they aren't working on their 5G strategy



# 5G standards and ecosystem forces behind those stanards



# 5G-NR explained

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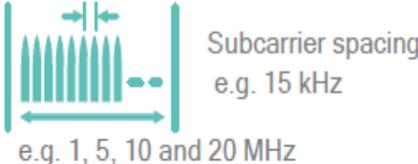
- 5G-NR = 5G New Radio
- Initially providing a more capable and optimized OFDM-based air interface designed to support 5G mobile broadband and beyond
- Adopted by 3GPP as a work item in Release 14, feeding into Release 15. The standards for non-standalone NR are expected to be finished at end of 2017
- Features:
  - Supports multiple accesses for different use cases
  - Supports both TDD and FDD
  - Incorporates advanced wireless technologies such as massive MIMO, mmWave, advanced channel coding, and device-centric mobility
  - Significantly lower latency than LTE
  - Coexists with existing air interface technologies
- Operator trials and early deployments starting 2018



# 5G-NR – example usage models and channel bandwidths

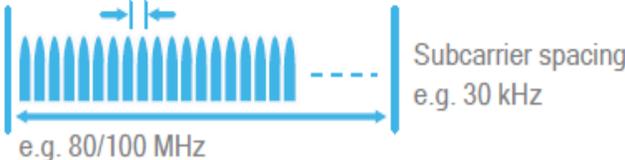
## Outdoor and macro coverage

FDD/TDD <3 GHz



## Outdoor and small cell

TDD > 3 GHz



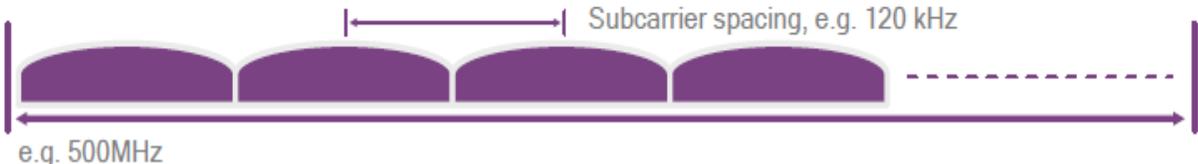
## Indoor wideband

TDD e.g. 5 GHz (Unlicensed)



## mmWave

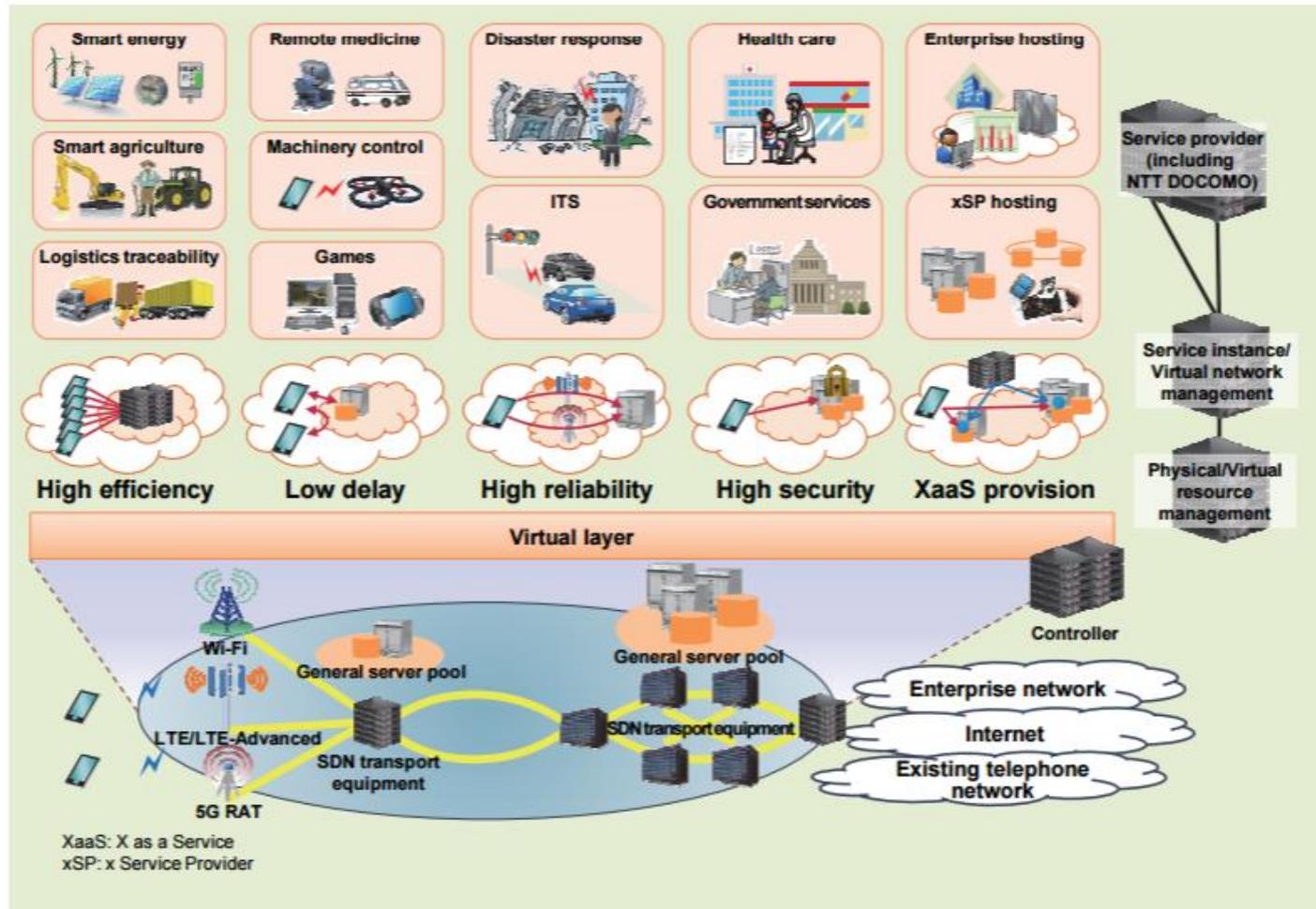
TDD e.g. 28 GHz



Source: Qualcomm



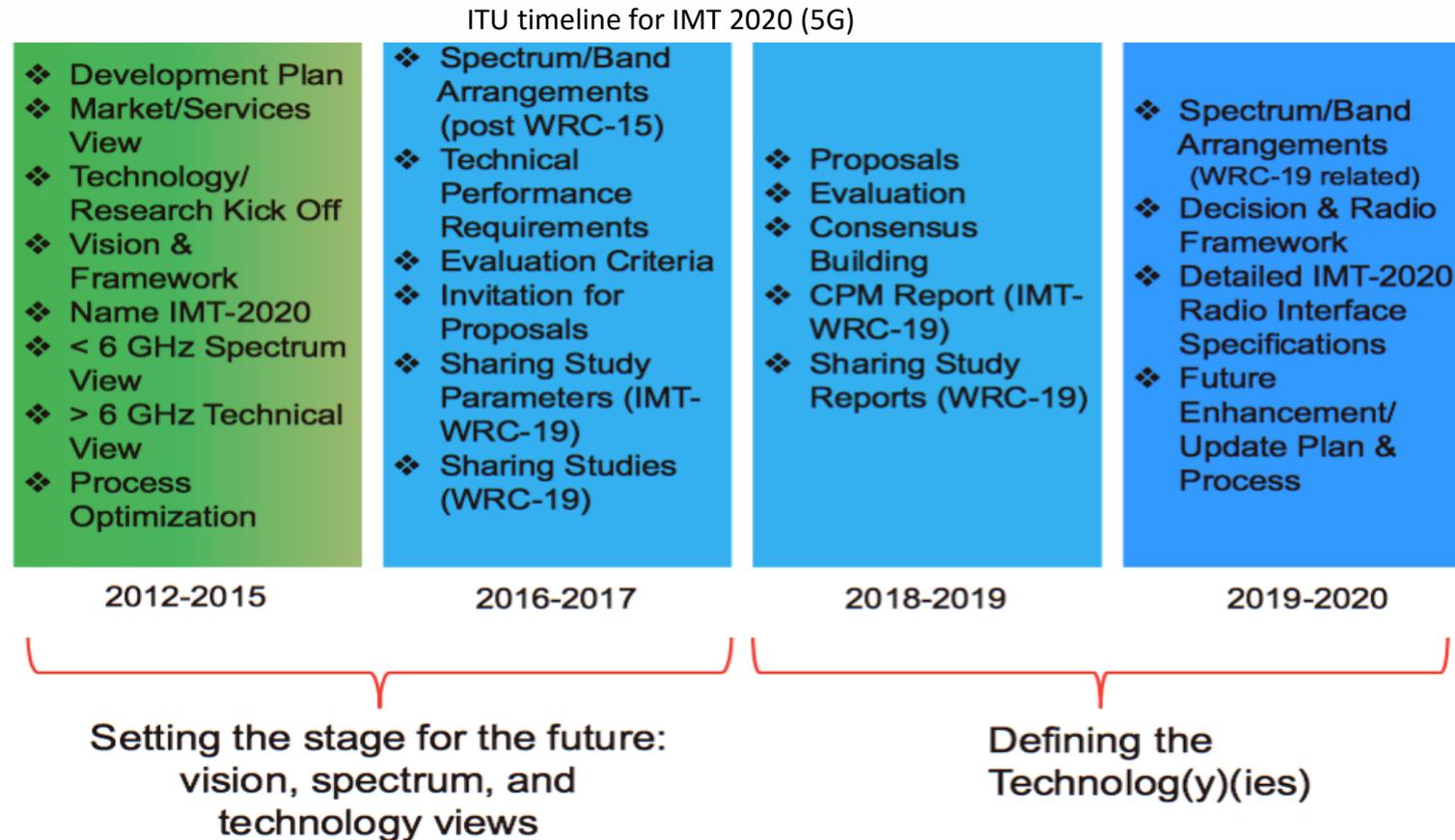
# Slicing approach in 5G NWs



Source: NTT DoCoMo



# 5G standardization will come in multiple phases



Source: ITU

First phase of 5G for non-standalone NR now accelerated to late 2017 or early 2018 for commercial deployment late 2018 or early 2019



## 3GPP timeline for 5G

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- 3GPP is developing 5G technical standards in two phases
- Phase 1 will come as part of Release 15 at the end of 2018
  - Phase 1 will just deal with NR or New Radio
  - Prior to full completion of Phase 1, 3GPP expects the standards for non-standalone NR to be finished at end of 2017
  - Phase 1 will be for enhanced mobile broadband, which includes fixed broadband
- Phase 2 will come as part of Release 16 at the end of 2019. It will include the entire 5G architecture including core network and IoT
- Ovum believes most operators will wait until after 2020 and both phases are complete before deploying a commercial network
- Deploying prior to Release 16 completion risks network not being fully compatible with the standards



# Many organizations, both national and global, are working on 5G development

	ITU-R Working Party 5D - WP 5D is responsible for the program to develop “IMT for 2020 and beyond,” which sets the stage for 5G and the research activities that are emerging around the world.
	The 5G Infrastructure Association - Public Private Partnership has been initiated by the EU Commission and manufacturers, telcos, service providers, SMEs, and researchers. Its role is to deliver solutions, architectures, technologies, and standards for 5G.
	The Fifth Generation Mobile Communications Promotion Forum (5GMF) Japan conducts research & development into 5G and research and study into 5G standardization.
	Korea-based public-private partnership formed to promote 5G mobile communications R&D. Supports collaboration among all 5G-interested parties, including research institutions, manufacturers, and service providers.
	5G Americas is an industry trade organization composed of CSPs and manufacturers. Aim is to advocate for and foster the advancement and full capabilities of LTE wireless technology and its evolution beyond to 5G.
	Role of the IMT-2020 Promotion Group is to promote research into 5G in China. Jointly established by three ministries in China. Members include the leading operators, vendors, universities, and research institutes.
	Based at New York University. Industrial partnership program that brings together academia and industry. Carrying out research into mmWave channel modeling, 5G channel model simulation, and the distributed core architecture.
	The largest UK academic research center is dedicated to the development of 5G mobile and wireless communications. It brings together leading academic experts and key industry partners



## Operator initiatives around 5G standards

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- However, some operators are releasing their own 5G specifications, such as Verizon and Korea Telecom. These may or may not be compatible with the 3GPP standards which are on track for the second half of 2018.
- Others, such as AT&T, say they will adhere to the 3GPP 5G recommendations. Are there going to be non-standardized 5G networks?
- Ericsson says it has seen a lot more cooperation among the wireless community when it comes to standards than previously.

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### 5G Open Trial Specification Alliance



- Common Agreement on 5G Technical Specifications
- Open, Inclusive and Collaborative Approach (chipset/device vendors, network vendors)
- Drive & Shape Vendor Adoption
- Acceleration of Commercial Solutions
- Use Case Development & Validation



# Vendor 5G activities



## Mobile operators in expected early 5G markets and their RAN test/trial partners

Operator	Ericsson	Huawei	Nokia	Samsung	ZTE
China Mobil	Yes	Yes	Yes		Yes
China Telecom		Yes			Yes
China Unicom	Yes	Yes			Yes
Deutsche Telekom	Yes	Yes	Yes	Yes	Yes
Telefonica	Yes	Yes			Yes
Vodafone	Yes	Yes	Yes		
KDDI	Yes		Yes	Yes	
NTT DoCoMo	Yes	Yes	Yes	Yes	
Softbank	Yes	Yes			Yes
KT	Yes	Yes	Yes	Yes	Yes
SKT	Yes	Yes	Yes	Yes	
LGU+	Yes	Yes	Yes	Yes	
AT&T	Yes	Yes	Yes	Yes	
Sprint	Yes		Yes		
T-Mobile	Yes		Yes	Yes	
Verizon	Yes		Yes	Yes	



## 5G RAN vendors

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- Nokia is in a much stronger 5G position, thanks to its Alcatel-Lucent acquisition
  - It improves Nokia's position when it comes to network virtualization, IP networking, backhaul, and small cells – all 5G necessities
  - Nokia messaging is very software focused
- Samsung has benefited in the US with Nokia's purchase of Alcatel-Lucent
  - Samsung is now working with AT&T, T-Mobile, and Verizon on their 5G trials
  - Samsung sees its advantage in less price-sensitive markets that require cutting-edge network technology
- Ericsson has a strong LTE customer base to leverage as those operators move to 5G
  - Ericsson, despite some recent setbacks, is still very much involved in high-profile early 5G trials
  - Its work around connected society, IoT, and smart cities builds the case for 5G and more wireless use cases
- Huawei is a much stronger global vendor coming into 5G than it was when LTE started
  - Outside of the US, Huawei is expected to be a major supplier of 5G radio and core network gear
  - Huawei is strong in antennas and has already started to communicate about FDD massive MIMO (8x8)
  - Marketing very much around "Cloud"
- ZTE strong in China, but still lags Ericsson, Huawei, and Nokia in other markets
  - Antenna and radio technology has always been part of ZTE's differentiation, especially around TDD
  - Continues to have heavy reliance on its domestic market, with early China deployments serving as market validation to gain share in other markets



## 5G RAN marketing filled with hyperbole like “first”, speed claims, and test/trial achievements

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- “China Mobile Quanzhou Branch and ZTE hit record high commercial 3D-MIMO 16-Stream Peak Rate of 2.1 Gbps “ - June 14, 2017
- Ericsson and Verizon test 5G race car using only VR goggles – “The 5G race is on” – May 21, 2017
- “Huawei receives “Biggest Contribution to 5G R&D” award at 5G MENA 2017 Summit” – May 8, 2017
- “Ericsson, SK Telecom, and BMW Group Korea reach new world record speed with 5G” – February 7, 2017
- “Starhub and Huawei achieve speeds of 35Gbps in 5G trials” – January 24, 2017
- “Nokia and Starhub achieve speeds of 4.3Gbps in 5G showcase in Singapore” – November 2, 2016
- “Ericsson first to deliver 5G NR radio” – August 31, 2016
- “Nokia demonstrates world’s first 5G-ready network” – June 28, 2016
- “Samsung’s latest 5G milestone: world’s first mmWave multi-cell handover” – June 29, 2016
- “The world’s first 5G technology-based wireless VR service demonstration implemented by ZTE” – June 2, 2016
- “Huawei and Deutsche Telekom demonstrate world’s first 5G E2E network slicing technology” – February 22, 2016



## Non-RAN vendors are making significant 5G contributions as well

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- Intel – devices and network core; has done trials with NTT DoCoMo, Verizon and AT&T
- Qualcomm – devices, network core, and radio technology R&D; Snapdragon X50 to support 5G new radio; has done trials with the likes of Vodafone, SK Telecom, NTT DoCoMo, Telstra, etc.
- Cisco – core network and transport; partnering with Samsung on Verizon fixed wireless network
- Apple – devices, recently applied for FCC license to test 5G technology on millimeter wave spectrum bands
- Juniper – network virtualization such as its virtual router deployment for LGU+ in S Korea



Remember.....

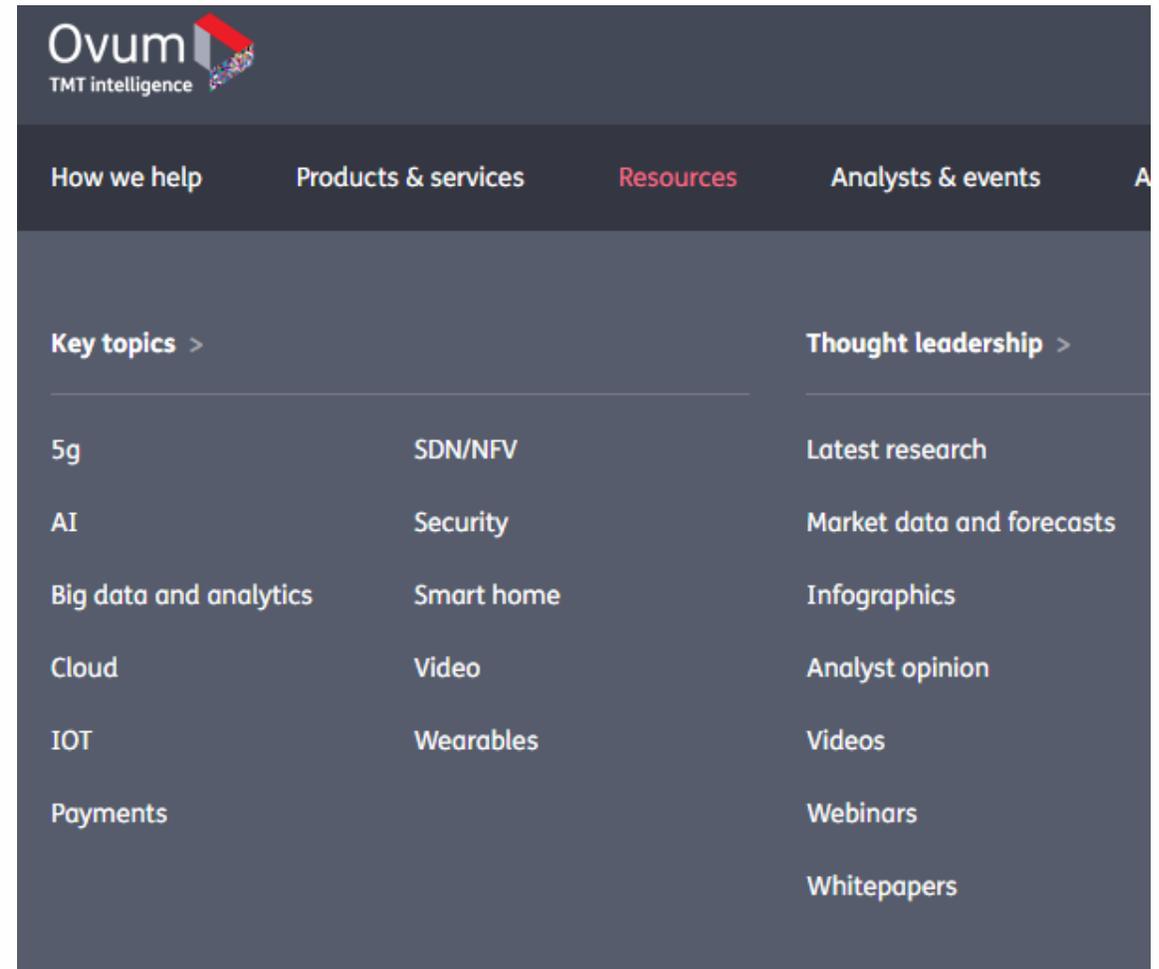
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5G ready is a marketing term not a technology guarantee



- Key topic areas Ovum covers: 5G, AI, Cloud, IoT, Security, etc.
- Available online research: recorded webinars, videos, white papers, etc.
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