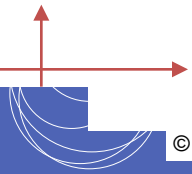


# SPECTRUM AND REGULATIONS FOR 5G DEVELOPMENT – MANUFACTURERS' VIEW

Global mobile Suppliers Association  
Håkan Ohlsén (hakan.ohlsen@ericsson.com)

“The 26-28 GHz India 5G Spectrum Workshop”  
27-28 September 2018, New Delhi



# LEAD THE TECHNOLOGY PATH FROM LTE TO 5G

Please visit GSA website for latest eco-system information and a wide range of industry reports: <https://gsacom.com>

**Spectrum**

**Making 26 GHz a Successful 5G band**

The first phase of 5G has been specified and knowledge building are well underway and subsequent commercial services are planned from 2019 onwards in Asia and North America. This white paper from the GSA outlines the opportunity in the 3300-4200 MHz frequency range which is the band of spectrum available for mobile in the US, Japan and other countries such as South Korea, India and China. It is therefore a competitive

**The Future of IMT in the 3300-4200 MHz Spectrum**

This white paper from the GSA outlines the opportunity in the 3300-4200 MHz frequency range which is the band of spectrum available for mobile in the US, Japan and other countries such as South Korea, India and China. It is therefore a competitive

**Evolution from LTE to 5G - April 2018 Update**

GSA's Evolution from LTE to 5G report provides an status view and analysis of the Advanced and 5G markets, and confirms technology trends. The report is updated, analysed and verified by GSA and is referenced by the whole ecosystem. Key market factors driving investment in LTE, including

**LTE in Unlicensed Spectrum**

GSA summarises LAA network trials as well as deployments, and the availability of chipsets, modules and devices. GSA welcomes additions...

**Progress to Gigabit LTE Networks**

Over the past 12 months, mobile network operators and their vendor partners have been deploying a range of technology features. [Read more](#)

**LTE, 5G and 3GPP IoT Chipsets: Status Update**

GSA is continuously tracking the mobile industry and reporting on adoption of 3GPP standardized technologies and the expansion of the... [Read more](#)

**Chart By Form Factor**

Form Factor	Percentage
Smartwatch	0.1%
Wearable	0.1%
IoT Module	0.1%
Camera	0.1%
Phone	0.1%
Printer	0.1%
Smart PC	0.1%
Phone	0.1%
Smartwatch	0.1%
Wearable	0.1%
IoT Module	0.1%
Camera	0.1%
Phone	0.1%
Printer	0.1%
Smart PC	0.1%
Phone	0.1%

Spectrum reports

Industry reports

Ecosystem reports

The Spectrum Group within GSA (GSA SG),  
is the GSA focus group for policy matters related to the radio frequency spectrum  
and radio regulatory matters,  
pertaining to the successful evolution of the family of 3GPP technologies and  
International Mobile Telecommunication (IMT) of ITU  
and associated administrative, operational and technical aspects.

# SPECTRUM GROUP STRUCTURE

GSA Executive Meeting

Global platform with regional and national footprint, promoting global harmonization while adapting to unavoidable regional specifics

GSA Spectrum Group

Chairmanship

Advisory company group

Coordination Region 3

Coordination Region 1

Coordination Region 2

Coordination ITU

Coordinator  
**APT**  
Regional team members

Coordinator  
**CJK**  
Regional team members

Coordinator  
**ASMG**  
Regional team members

Coordinator  
**ATU**  
Regional team members

Coordinator  
**CEPT/EU**  
Regional team members

Coordinator  
**RCC**  
Regional team members

Coordinator  
**CITEL**  
Regional team members

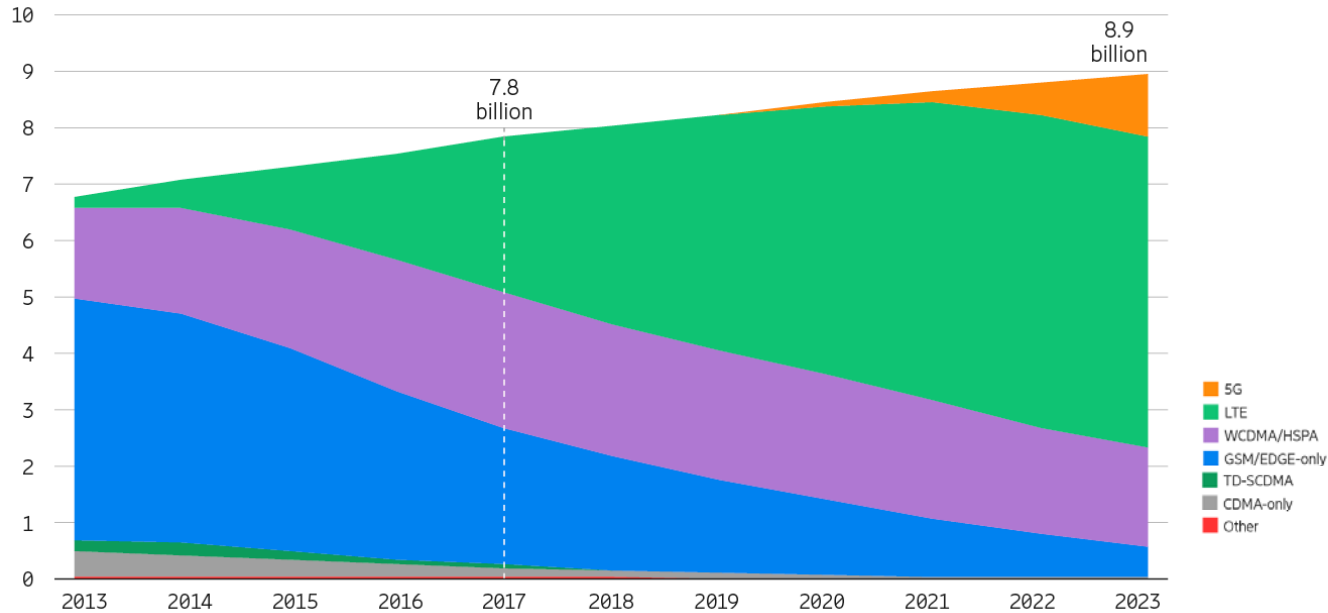
Coordinator  
**US/C**  
Regional team members

Coordinator  
**ITU**  
Regional team members

70+ experts have joined the GSA Spectrum Group discussions



# 1 BILLION 5G SUBSCRIPTIONS IN 2023



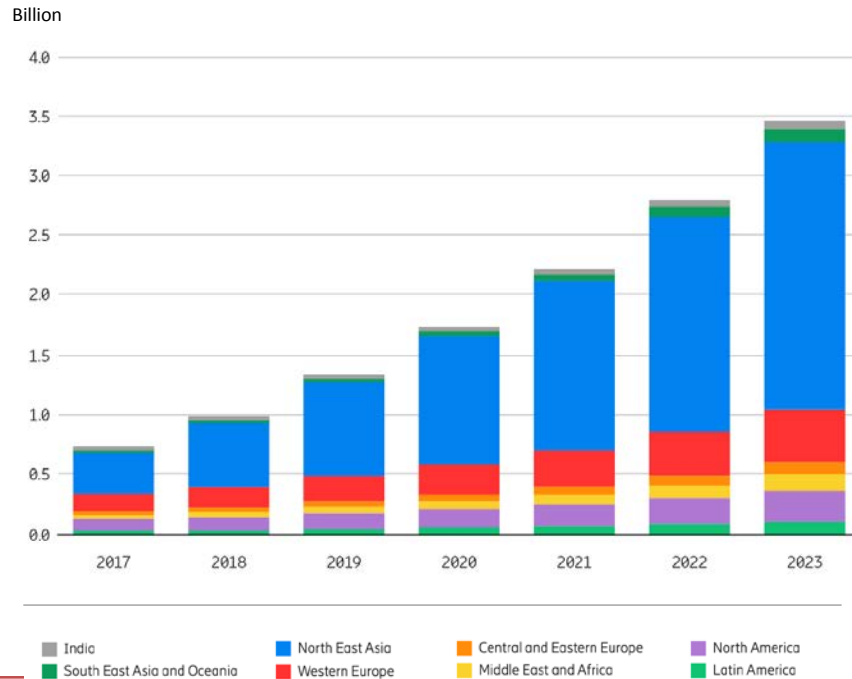
Note: IoT connections and Fixed Wireless Access (FWA) subscriptions are not included in this graph

## 5G in 2018

First commercial launches

A 5G subscription is counted as such when associated with a device that supports NR as specified in 3GPP Release 15, connected to a 5G-enabled network.

# CELLULAR IOT CONNECTIONS PER REGION



Cellular IoT connections in 2023 expected to reach 3.5 billion, with 30% annual growth rate.

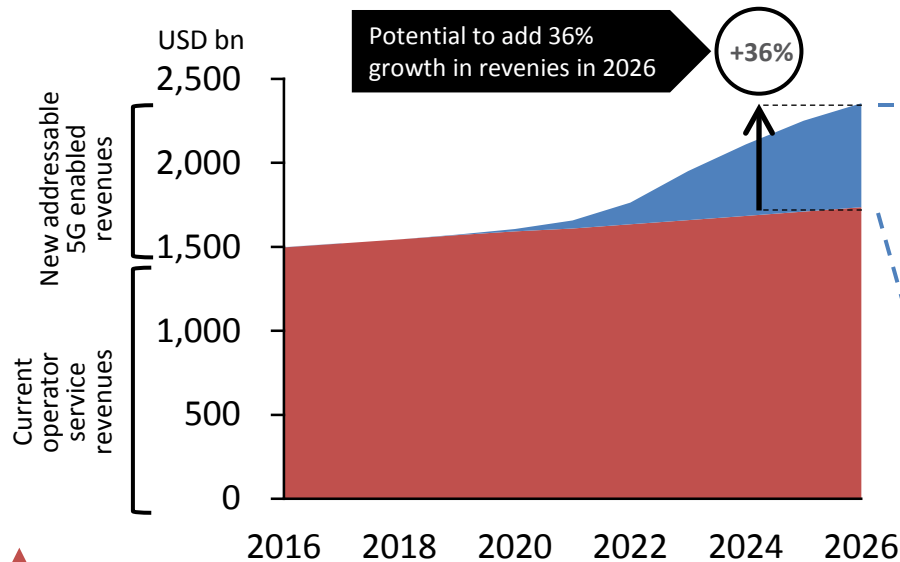
## Connected devices (billion)

IoT	2017	2023	CAGR
Wide-area IoT	0.8	4.1	30%
Cellular IoT <sup>2</sup>	0.7	3.5	30%
Short-range IoT	6.2	15.7	17%
<b>Other devices</b>			
PC/laptop/tablet	1.6	1.7	0%
Mobile phones	7.5	8.6	2%
Fixed phones	1.4	1.3	0%
<b>Total connected devices</b>	<b>17.5</b>	<b>31.4</b>	<b>11%</b>

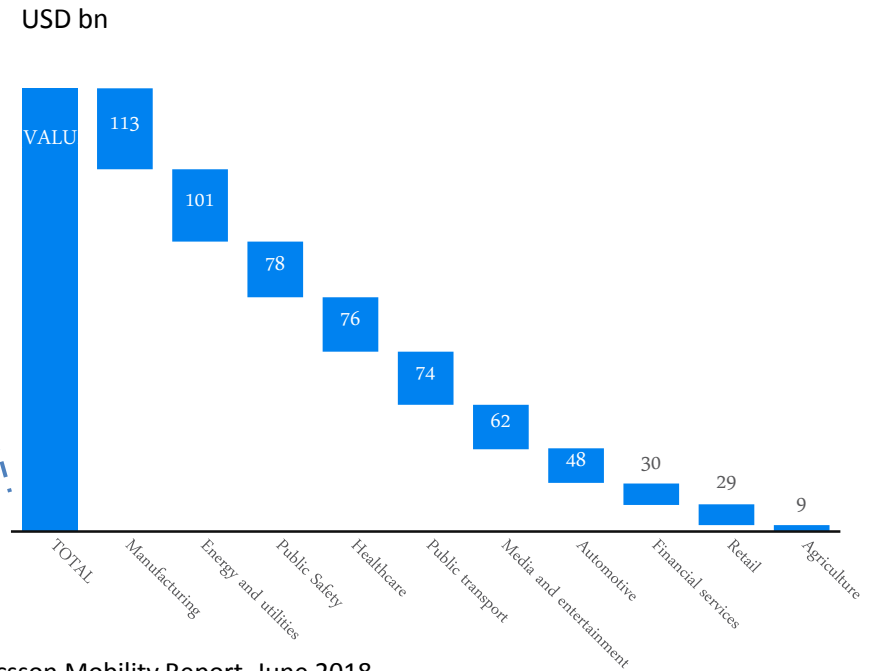
These figures are also included in the figures for wide-area IoT

# OPERATOR OPPORTUNITY ADDRESSING INDUSTRY DIGITALIZATION WITH 5G

## Current and 5G addressable revenues

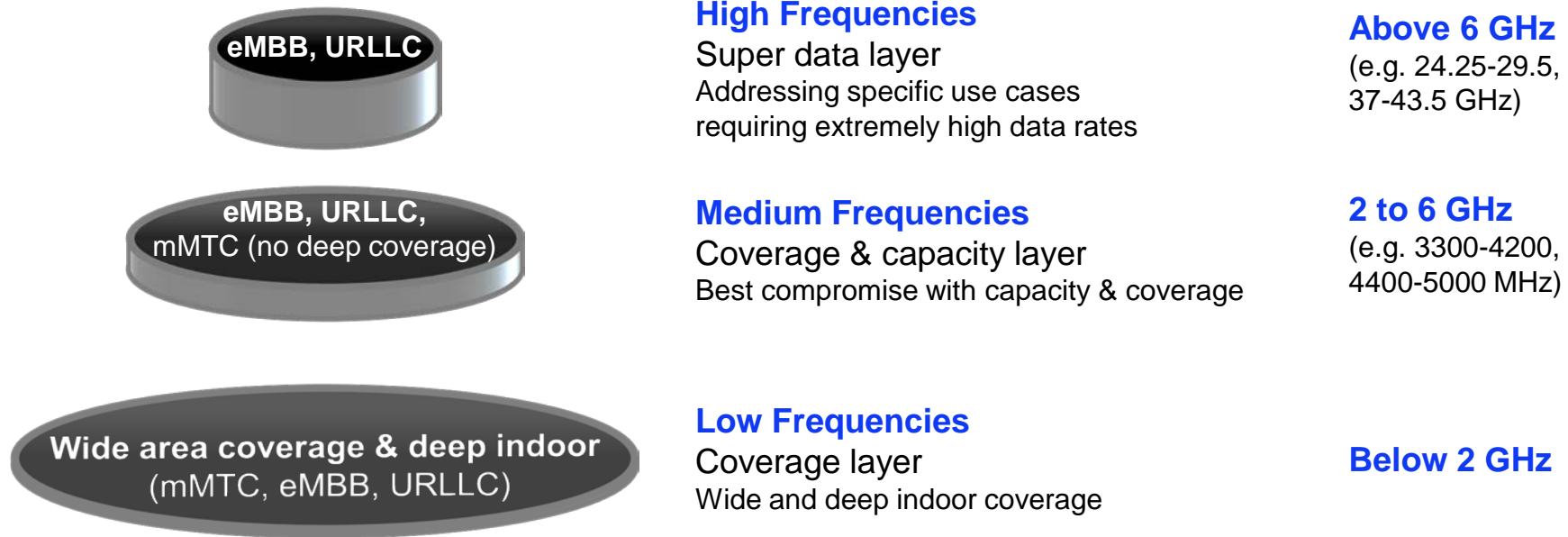


## Split per industry (2026)



# SPECTRUM FOR 5G: MULTI LAYER APPROACH

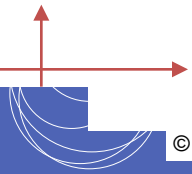
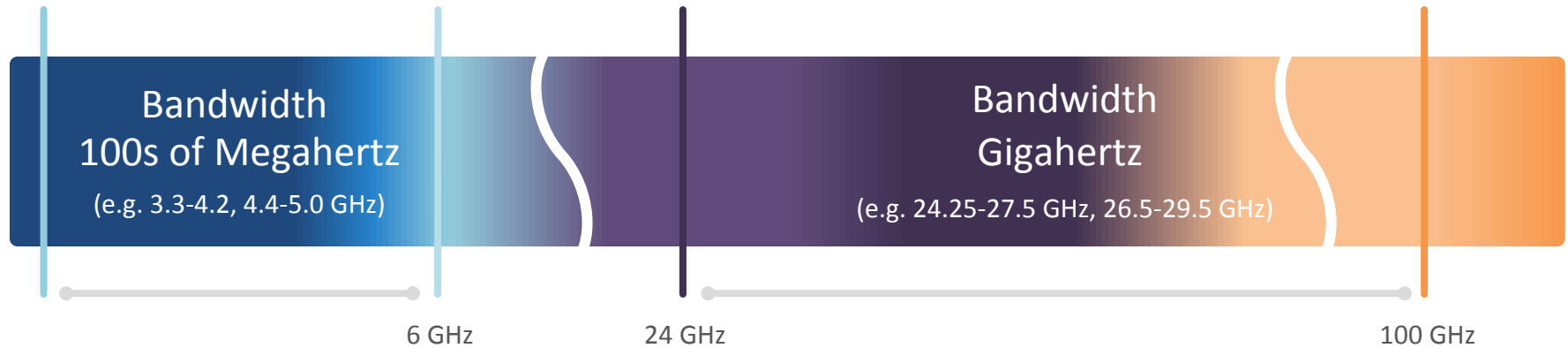
Various 5G applications and services will require access to appropriate spectrum from within the three layers already in the initial phase.





# THE LARGE BANDWIDTH OPPORTUNITY

The next frontier of mobile broadband for extreme throughput and capacity



# 3GPP BANDS FOR 5G NEW RADIO (NR)

Frequency range designation	Corresponding frequency range
FR1	450 – 6000 MHz
FR2	24250 – 52600 MHz

The frequency ranges in 3GPP Release 15 for 5G NR designed for the frequency ranges FR1 and FR2

5G NR bands in FR1

NR – below 6 GHz			
Band	Frequencies MHz	BW MHz	Duplex mode
N77	3300 – 4200	10 – 100	TDD
N78	3300 – 3800	10 – 100	TDD
N79	4400 – 5000	40 – 100	TDD
N80	1710 – 1785	5 – 30	SUL
N81	880 – 915	5 – 20	SUL
N82	832 – 862	5 – 20	SUL
N83	703 – 748	5 – 20	SUL
N84	1920 - 1980	5 – 20	SUL
N86	1710 - 1780	5 – 40	SUL

5G NR bands in FR2

NR – mmWave			
Band	Frequencies GHz	BW MHz	Duplex mode
n257	26.5 – 29.5	50 – 400	TDD
n258	24.25 – 27.5	50 – 400	TDD
n259	[40.5] – 43.5	50 - 400	TDD
n260	37.0 – 40.0	50 - 400	TDD
n261	27.5 – 28.35	50 – 400	TDD

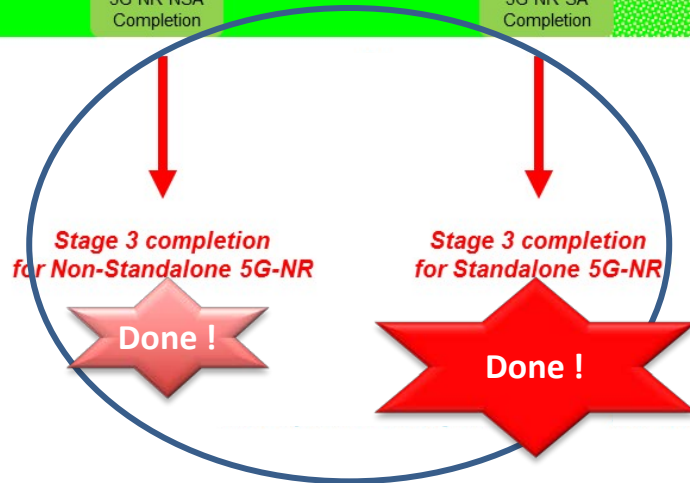
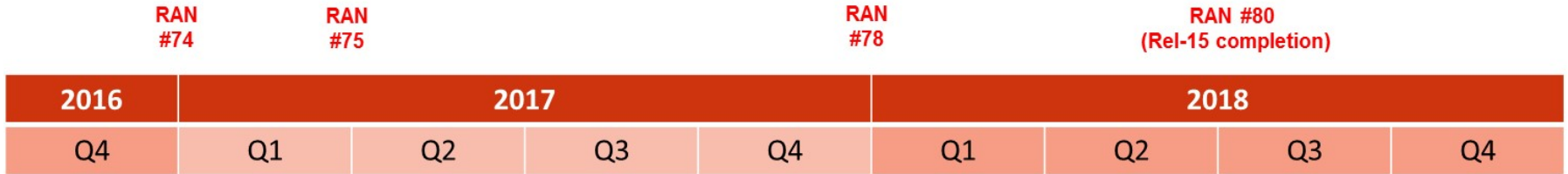
NR – refarmed			
Band	Identifier	BW MHz	Frequencies (UL/DL)
n1	IMT Core band	5 – 20	1920 - 1980 / 2110 - 2170
n2	PCS 1900	5 – 20	1850 - 1910 / 1930 - 1990
n3	1800	5 – 30	1710 - 1785 / 1805 - 1880
n5	850	5 – 20	824 - 849 / 869 – 894
n7	IMT Extension	5 – 20	2500 - 2570 / 2620 - 2690
n8	900	5 – 20	880 - 915 / 925 - 960
n12	US 700 Lower A,B,C	5 - 15	699 – 716 / 729 - 746
n20	CEPT 800	5 – 20	832 - 862 / 791 - 821
n25	PCS 1900 G	5 - 20	1850 - 1915 / 1930 – 1995
n28	APT700 LTE	5 – 20	703 – 748 / 758 – 803
n34	TDD 2000 Upper	5 - 15	2010 - 2025
n38	IMT Extension Gap	5 – 20	2570 - 2620
n39	China TDD 1900	5 - 40	1880 - 1920
n40	TDD 2300	5 - 80	2300 - 2400
n41	TDD 2600	10 – 100	2496 - 2690
n51	TDD L-band, local	5	1427 – 1432
n66	AWS Extension	5 – 40	1710 - 1780 / 2110 – 2200
n70	AWS-3/4	5 – 25	1695 - 1710 / 1995 – 2020
n71	US 600	5 – 20	663 – 698 / 617 - 652
n75	Extended SDL L band	5 – 20	N/A / 1432 – 1517
n76	Extended SDL L band, local	5	N/A / 1427 – 1432

5G NR bands in FR1

The most harmonized bands are specified as 5G NR bands  
 New bands for 3300-4200 MHz, 4400-5000 MHz and mmWave

# 3GPP RAN Release 15

– Specs for both NSA and SA 5G NR are available now



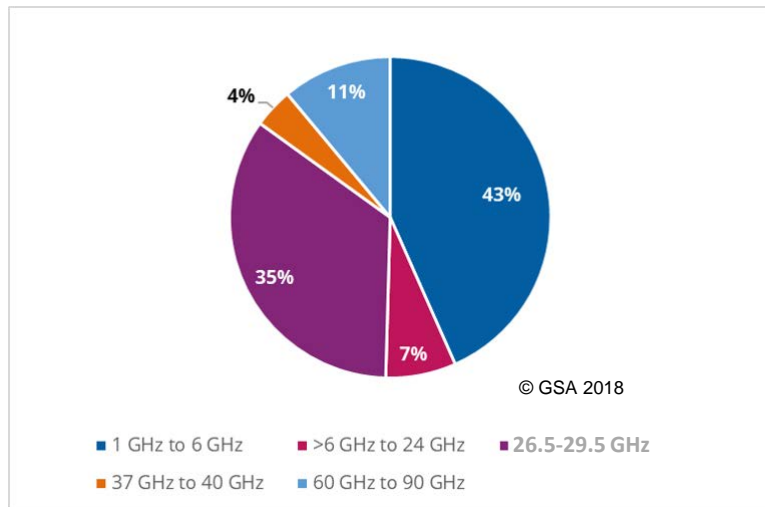
NSA = Non StandAlone = EPC core ("Option 3") & LTE anchor  
SA = StandAlone



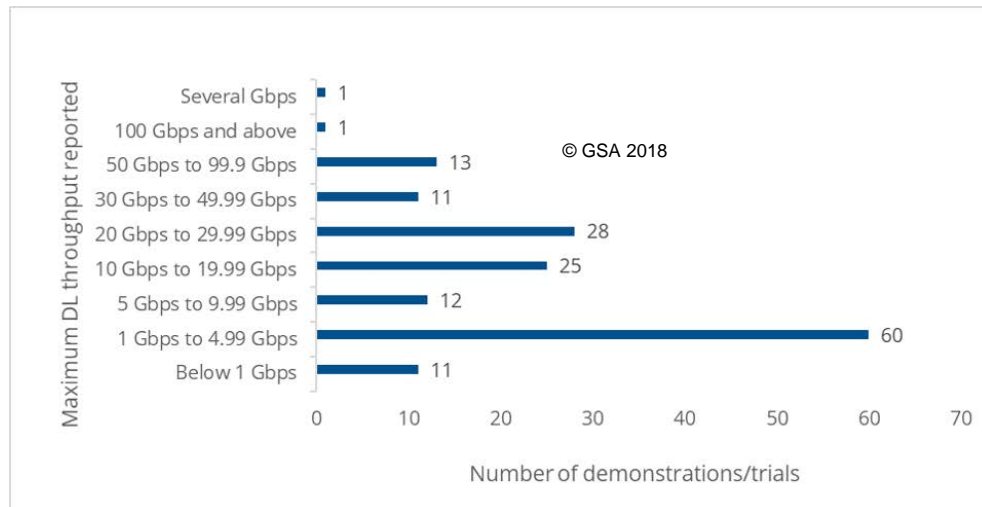
# GLOBAL 5G STATUS – SNAPSHOT JULY 2018

## Spectrum bands and network throughput of trials

Distribution of 5G demonstrations and trials by broad spectrum ranges (base: 261 demos/trials)



Network throughput (DL) reported in 5G demonstrations and trials (base: 165 demos/trials)



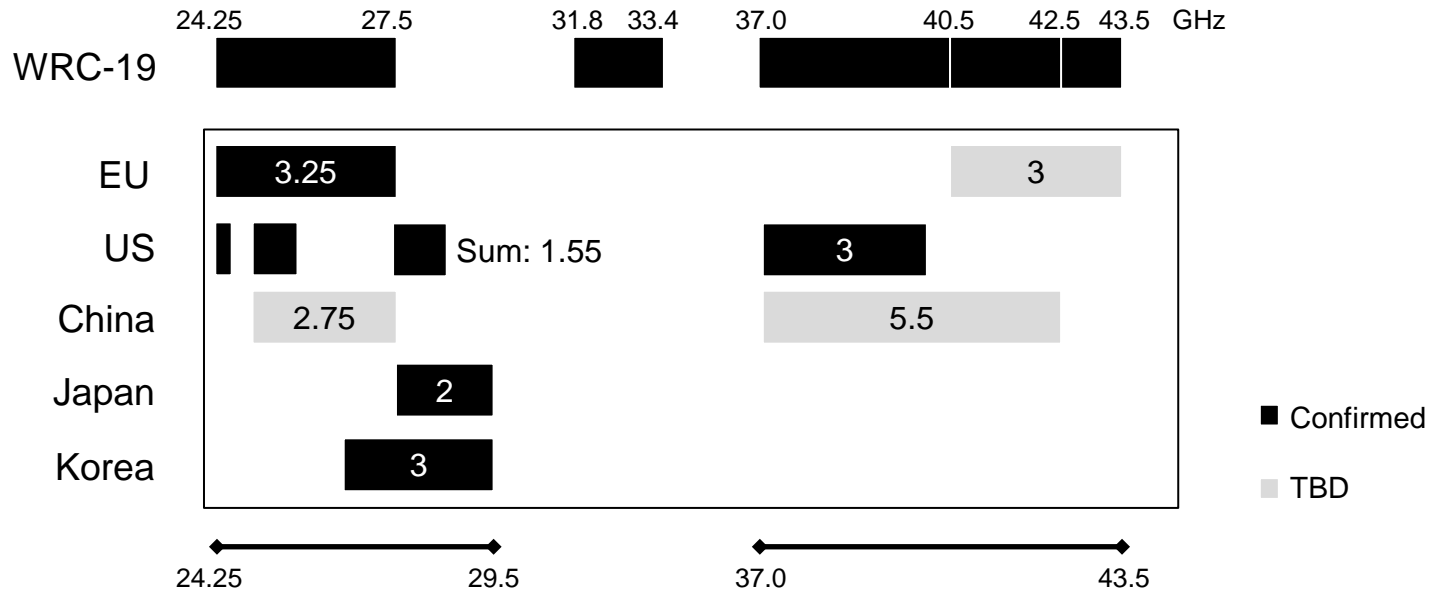
These slides contain extracts from the GSA report “Global Progress to 5G - Trials, Deployments and Launches” available from the GSA website at [www.gsacom.com](http://www.gsacom.com)

# 5G COMMERCIAL ANNOUNCEMENTS AND INDICATIONS

Country	Middle frequency bands	High frequency bands	Commercial time plan
China	<ul style="list-style-type: none"> <li>• <b>3.3-3.6</b> and <b>4.8-5.0</b> GHz: release in 2019</li> <li>• Consider 4.4-4.5 GHz</li> </ul>	<ul style="list-style-type: none"> <li>• Consider <b>24.75-27.5</b> and 37-42.5 GHz bands for 5G</li> </ul>	2020
Japan	<ul style="list-style-type: none"> <li>• Release maximum 500 MHz from <b>3.6-4.2</b> and <b>4.4-4.9</b> GHz in 2019Q1</li> <li>• 3.4-3.6 GHz: already used for LTE</li> </ul>	<ul style="list-style-type: none"> <li>• Release <b>27.0-29.5</b> GHz or a part in 2019Q1</li> </ul>	2020
South Korea	<ul style="list-style-type: none"> <li>• <b>3.42-3.7</b> GHz: auctioned in 2018</li> </ul>	<ul style="list-style-type: none"> <li>• <b>26.5-28.9</b> GHz: auctioned in 2018</li> </ul>	2019 Q1
EU	<ul style="list-style-type: none"> <li>• <b>3.4-3.8</b> GHz: auctions have started</li> </ul>	<ul style="list-style-type: none"> <li>• Release (auction) of <b>24.25-27.5</b> GHz band (or a portion) auctions started</li> </ul>	2020
USA	<ul style="list-style-type: none"> <li>• 3.55-3.7 GHz (CBRS)</li> <li>• Consider <b>3.7-4.2</b> GHz</li> </ul>	<ul style="list-style-type: none"> <li>• <b>27.5-28.35</b> and 39 GHz trials underway with commercial deployments in 2018</li> <li>• Auction additional <b>28 &amp; 24</b> GHz in 2018</li> </ul>	2018

Some other markets have also announced their spectrum plans for 5G, including: Australia, Canada, Hong Kong, India, New Zealand, countries in the Middle East, etc.

# GLOBAL DEVELOPMENTS IN THE 26, 28 AND 40 GHZ BANDS



The range 24.25-29.5 and 37-43.5 GHz are the most promising high frequencies for early 5G commercialization globally

# EQUIPMENT AVAILABILITY FOR THE 26 GHZ AND 28 GHZ BANDS

## A number of announcements have been made regarding commercial equipment availability

- **Intel**, its 5G Modem supports 5G operation in both sub-6GHz bands and 28 GHz spectrum in the U.S., Korea, and Japan with a single device implementation. It pairs the 5G RFIC with the 28 GHz RFIC—supporting 5G New Radio features including low latency frame structure, advanced channel coding, massive MIMO, and beamforming
- **Qualcomm**, has announced the availability of its Snapdragon™ X50 5G NR modem family with 4G/5G multi-mode support, dual connectivity and up to 5 Gbps download speeds. Commercial solutions supporting mmWave and sub-6 GHz band will be available in late 2018 allowing for commercial devices in the first half of 2019.
- **Samsung Electronics**, has unveiled its end-to-end portfolio of 5G mobile network products and solutions **for 2017** which included chipsets, consumer devices for fixed wireless access connectivity, a 5G Radio Base Station (5G Access Unit) and Next-Generation Core Network infrastructure
- **Ericsson**, is planning to release 5G base stations for 24.25 – 27.5 GHz and 26.5 – 29.5 GHz by the first half of 2019
- **Huawei**, will be ready to provide E2E 5G commercial products compliant with the 3GPP standard in 2018, including New Radio and New Core equipment.
- **Nokia**, equipment for 28GHz is already available for trials since early 2017 as part of NOKIA 5G FIRST solution and commercial availability is planned for 2019. This RF can also be used for early trials at 26 GHz in the upper 1 GHz of the band.



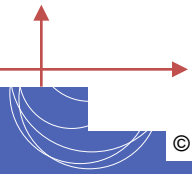
- GSA strongly supports and promotes utilization of high-band spectrum in the **26/28 GHz and 40 GHz** frequency ranges, especially for **5G NR applications including eMBB and URLLC**, (e.g. hotspots, Fixed Wireless Access systems, etc.).
- GSA's view is that in order to provide full 5G NR capabilities, a **minimum of 1 GHz of contiguous bandwidth per network** is needed in each of the 26/28 and 40 GHz frequency ranges from the high-band spectrum.
- As a summary view, the **following spectrum bands will be key frequency ranges** for early 5G NR deployments globally (noting that countries may make different parts of these bands available):
  - ✓ 3300 MHz – 4200 MHz
  - ✓ 4400 MHz – 5 GHz
  - ✓ 24.25 GHz – 27.5 GHz
  - ✓ 26.5 GHz – 29.5 GHz
  - ✓ 37.0 GHz – 43.5 GHz
- **5G NR equipment which supports the 28 GHz and 3.4-3.8 GHz bands is available in 2018.** Equipment that is fully 3GPP standards compliant will be available in 2019 for these frequency bands.
- Based on government announcements and market demand, equipment which supports **other key 5G bands will be available** in a timely manner.

***AI 1.13 to consider identification of frequency bands for the future development of International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution 238 (WRC 15);***

- GSA supports the identification of **new spectrum** globally for IMT (5G NR) under WRC-19 agenda item 1.13.
- GSA strongly supports and promotes with highest priority the **24.25 – 27.5 GHz and 37.0 – 43.5 GHz** frequency ranges for an identification for IMT at WRC-19 agenda item 1.13. Spectrum within these two ranges provides opportunities for early 5G deployments.
- GSA does **not support the 31.8 – 33.4 GHz** frequency range for an identification for IMT.
- GSA supports consideration at WRC-19 of an identification for IMT in the ranges **45.5-50.2 GHz and 50.4-52.6 GHz**. The range 47.2-48.2 GHz is already allocated to 5G NR in the USA which is anticipated to stimulate market demand in other countries and regions. We recognise that there may be challenges due to the passive services on both sides of 50.4-52.6 GHz and its limited size.
- GSA views 66 - 71 GHz, 71 – 76 GHz and 81 – 86 GHz as important bands for 5G. GSA views on IMT identification of these bands is under development.



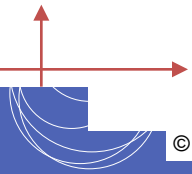
- Preference is for **exclusive licenses**
- Auctions represent a fair regime by **providing a rational market value** of dedicated exclusive spectrum to users who value it the most; therefore auctions:
  - Should be designed to stimulate spectrum usage
  - Should be designed to maximise benefit for society
  - Should be designed to stimulate investments in infrastructure
  - Should not be designed to maximise revenue
- Greatest benefit to society (e.g. increased GDP) is in its sustained use



# KEY TAKEAWAYS TO ENABLE 5G IN ASIA

## 5G represents a new communication paradigm for Asian society:

- ❑ **Simultaneous access to low, mid and high bands** will be needed to meet all major 5G requirements and use cases
- ❑ **700 MHz, 3 & 4 GHz, 26, 28 & 40 GHz**, primary bands for early 5G deployments globally
- ❑ **Expeditious and timely regulatory action** is needed to make the existing harmonized mobile bands suitable for 5G in Asia
- ❑ **Affordable access** to spectrum is fundamental to users; **greatest benefit to society** from spectrum (e.g. increased GDP) is in its sustained use
- ❑ **3GPP technologies exist to start industrial and societal IoT implementation NOW!**





Global mobile Suppliers Association

Promoting the Mobile Broadband Technology Roadmap

[www.gsacom.com](http://www.gsacom.com)

