Future Outlook for 5G and Anritsu

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Anritsu envision : ensure

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Agenda

Basic Policy of Management Strategy and Business Segments

Evolution of 5G and Beyond5G

- Evolution of Mobile Communication and T&M Market Trend
- Three Features of 5G and their advantages
- New Technologies Introduced for 5G
- 5G Technology Roadmap
- 3GPP Trends for standardization of 5G
- 5G Deployment Scenarios
- Toward Beyond5G

Company Profile

Anritsu Corporation

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Phone: +81-46-223-1111
https://www.anritsu.com

•First founded as Sekisan-sha in 1895.
•Established as Anritsu Electric Corporation on March 17, 1931.
• Paid-up capital: 19,113 million yen (as of March 31, 2019)
• Sales volume: 99,659 million yen (consolidated) (Year ended March 31, 2019)
• Employees: 3,778 (consolidated) (as of March 31, 2019)
836 (non-consolidated) (as of March 31, 2019)

Basic Policy of Management Strategy

- ☑ Prosecute the policy " Continuous profitable growth"
- ☑ Make our best to accomplish 2020VISION/ GLP2020

＊GLP2020 Plan = FY2018~FY2020

Outline of our business segments

T&M
Evolution and advances of networked society

- Mobile : 5G, LTE
- Network Infrastructure : Wired, Wireless NW
- Electronics : Electronics parts, Wireless Equipment

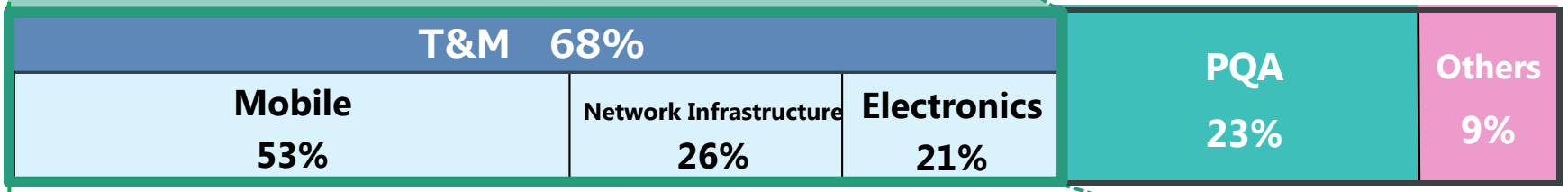
PQA
Food Safety and security

- X-ray inspection systems
- Metal Detector
- Checkweighers

Others

- IP network equipment
- Opt. devices

(Revenue by business segment)
99.7 Billion Yen consolidated revenue in FY2018



(Sales of T&M business by region in FY2018)

T&M: Test & Measurement PQA : Products Quality Assurance

Outline of our business segments <T&M>

Network Infrastructure

Electronics

Mobile

Mobile networks

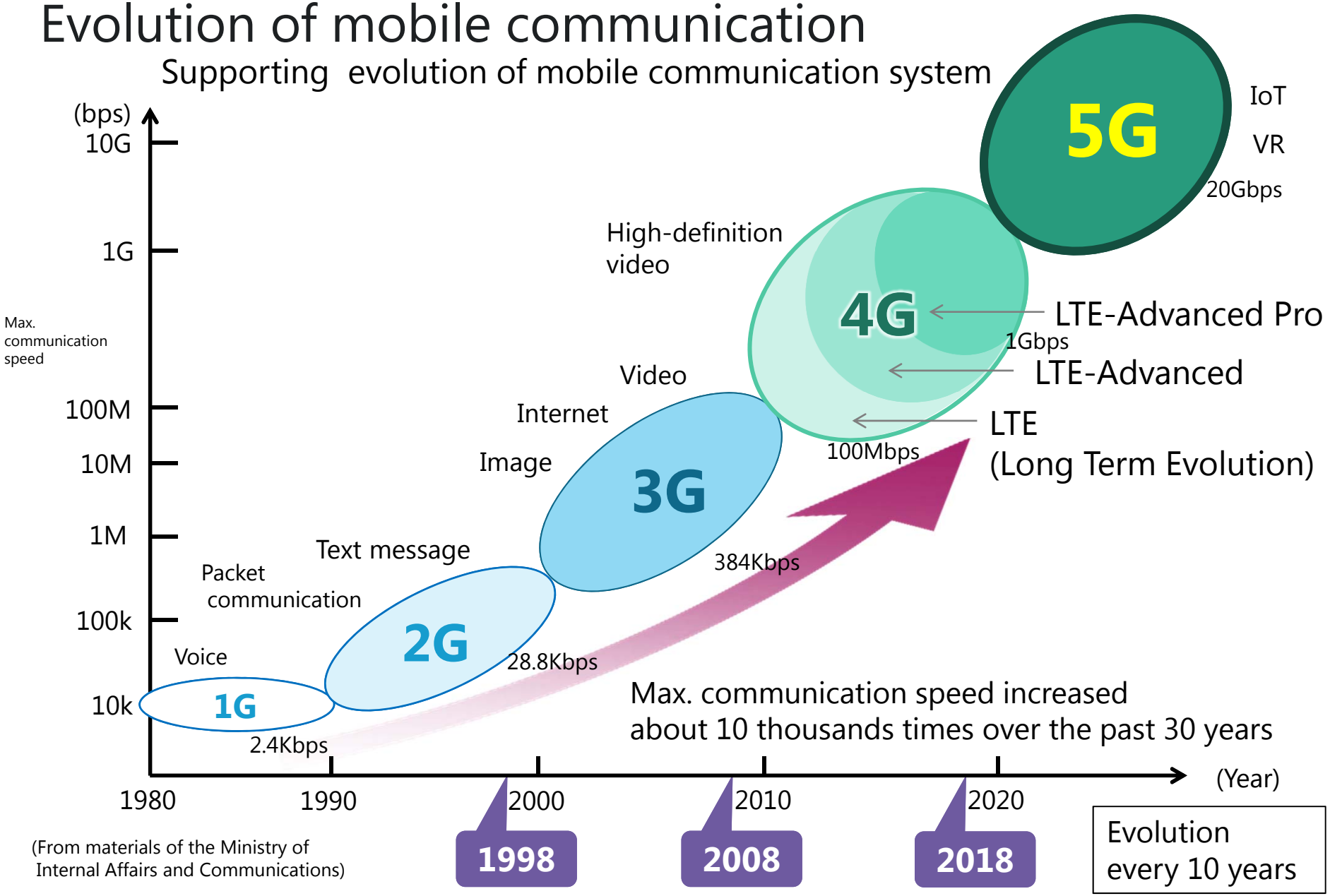
Mobile

	R&D	Manufacturing	Installation/ Maintenance
Wireline Communication	**Network Infrastructure (26%)**		
Wireless Communication	**Mobile (53%)**		
General Purpose	**Electronics (21%)***		

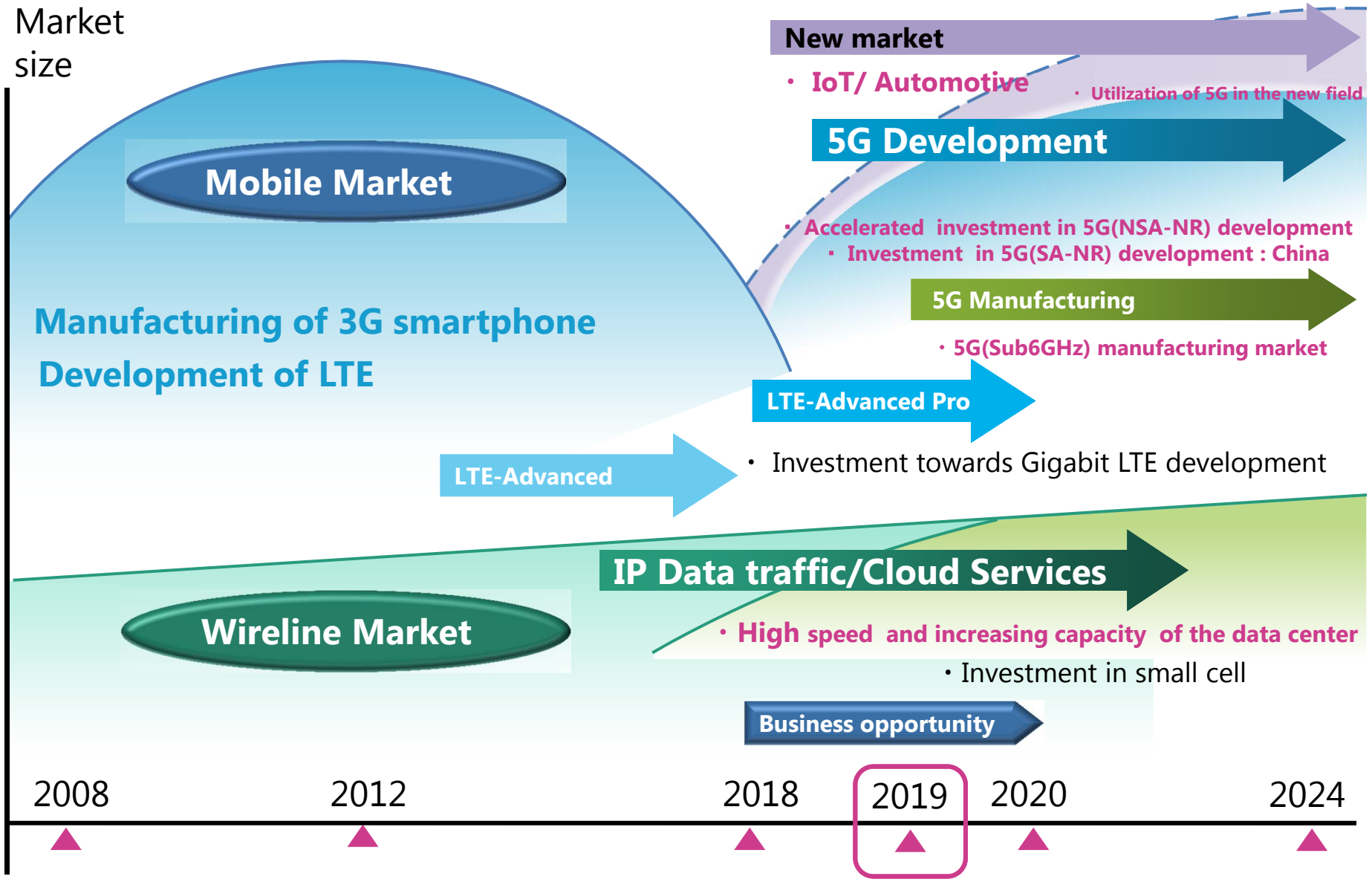
*Electronics components etc.

Evolution of mobile communication

Supporting evolution of mobile communication system



Mobile market trends and Business opportunity

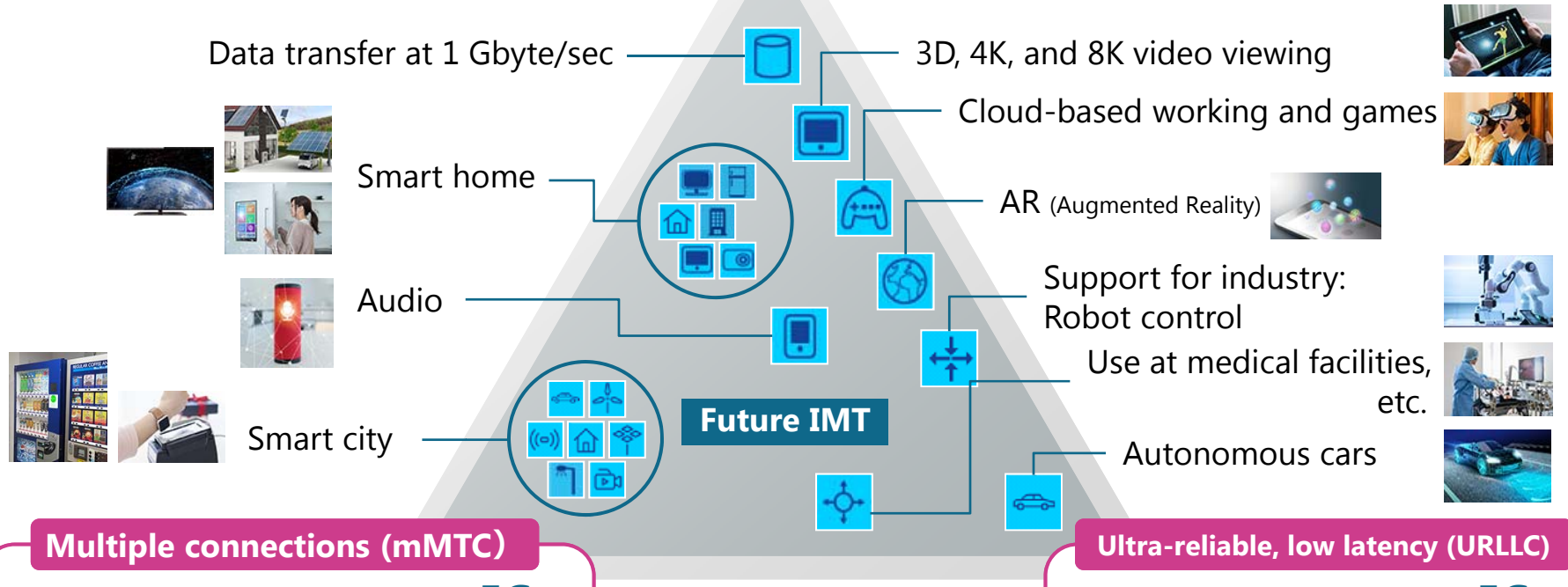


Three Features of 5G

Source: Recommendation ITU-R M.2083 "Framework and overall objectives of the future development of IMT for 2020 and beyond"

High speed/Large capacity（eMBB）

	LTE	5G
Peak speed (downlink)	1 Gbps	20 Gbps
(uplink)	100 Mbps	10 Gbps
User-experienced speed	10 Mbps	100 Mbps



Multiple connections (mMTC)

	LTE	5G
Number of simultaneously connected terminals [Number of terminals/km^2]	10^5/km^2	10^6/km^2

Ultra-reliable, low latency (URLLC)

	LTE	5G
Latency of wireless connections	10ms	1ms

Three Features of 5G and their advantages

High speed/Large capacity（eMBB）

	LTE	5G
Peak speed (downlink)	1 Gbps	20 Gbps
(uplink)	100 Mbps	10 Gbps
User-experienced speed	10 Mbps	100 Mbps

Not just download a two-hour movie in three seconds,

but also

Cloud-based working and games

Peak speed (downlink): 20 Gbps > Typical optical fiber

- **Communications that previously required a wired connection replaced by wireless**

Peak speed (uplink): 10 Gbps

- **Realization of remote control of construction machinery at disaster sites and extreme locations**

(LTE was not fast enough to send high-definition video at required speed.)

Three Features of 5G and their Effects

High speed/Large capacity（eMBB）

Latency on wireless connections reduced to 1 ms

- **In reality, what matters is end-to-end latency, which is reduced by improvements in the network itself.**

When combined with “large capacity,” remote operation of construction machinery, tele-surgery, and convincing VR and AR can be realized.




Multiple connections (mMTC)

Number of simultaneously connected terminals [Number of terminals/km²]

LTE	5G
10^5/km²	10^6/km²

Ultra-reliable, low latency (URLLC)

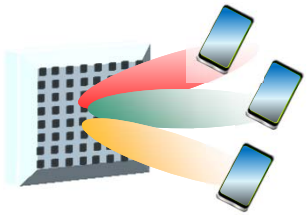
Latency of wireless connections

LTE	5G
10ms	1ms

New Technologies Introduced for 5G

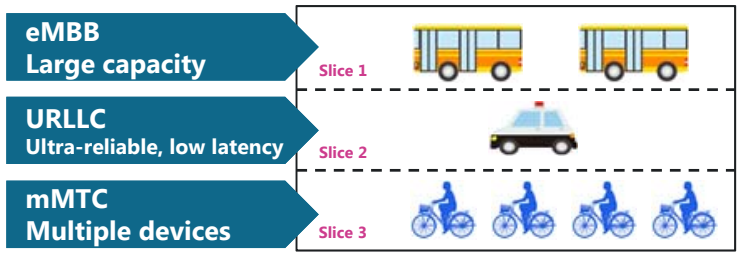
➢ Millimeter waves
➢ Beam forming

Massive MIMO antenna for 5G 28 GHz



By controlling the phases of individual elements, it can form beams in any direction and simultaneously communicate with multiple users.

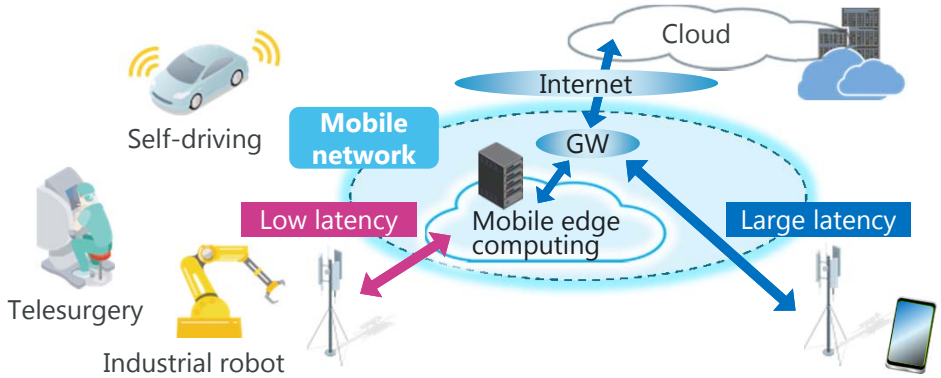
➢ Network slicing



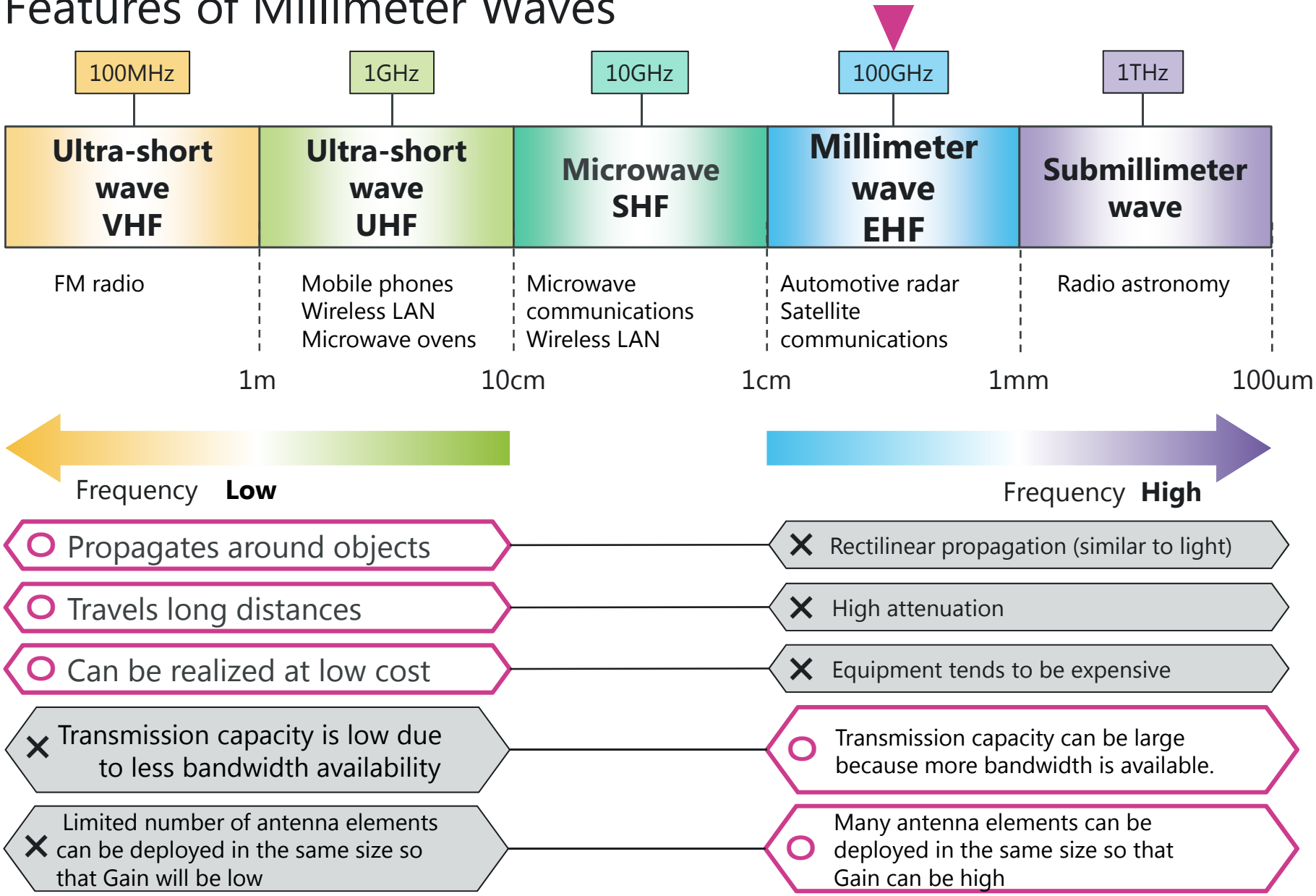
Network Slices separate network into multiple slots by application and services that enable dynamic management of function and resources for flexible modification.

➢ Edge computing

5G network configuration



Features of Millimeter Waves

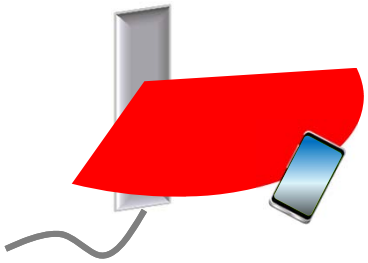


Use of Beam Forming for Millimeter Waves

➢ **With millimeter waves, many antenna elements can be deployed in the same size.**

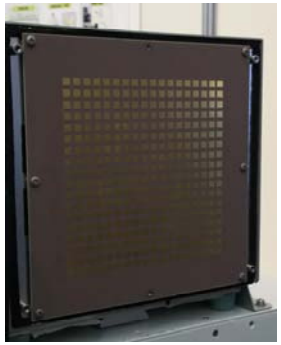
Antenna element spacing is a half of wavelength, yielding a 5 cm spacing for 3 GHz and a 5 mm spacing for 30 GHz

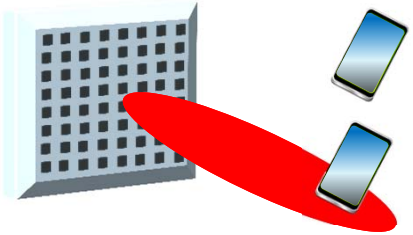
LTE antenna



➢ Nearly non-directional in a horizontal plane

Massive MIMO antenna





➢ Radio waves can be directed toward specific users.

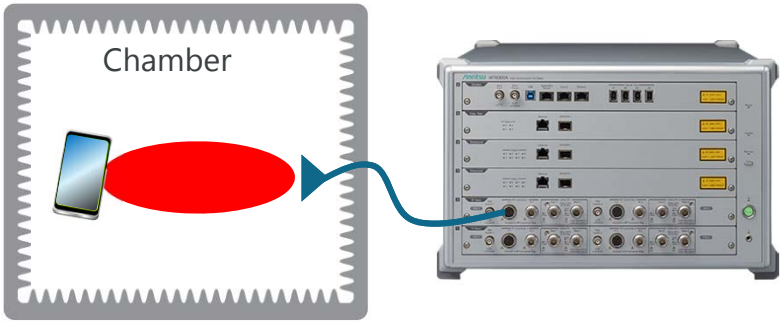
➢ Spatial losses can be compensated for by increasing gain at the antenna.

New Challenges for Measurement of Millimeter Waves

Changing testing methods

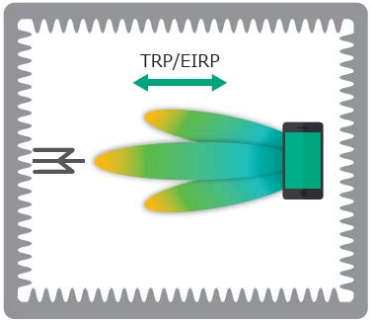
- **Conventional testing method**

- **Testing method for millimeter waves**

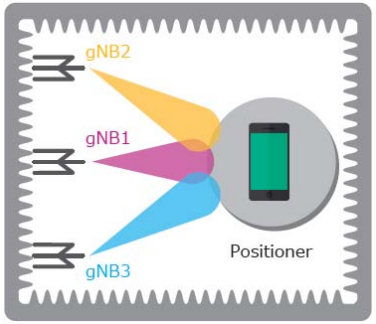


Connection between equipment and DUT changes from cable to OTA（Over The Air)

Additional test criteria



- Total power measurement
- Radiated power in a given direction

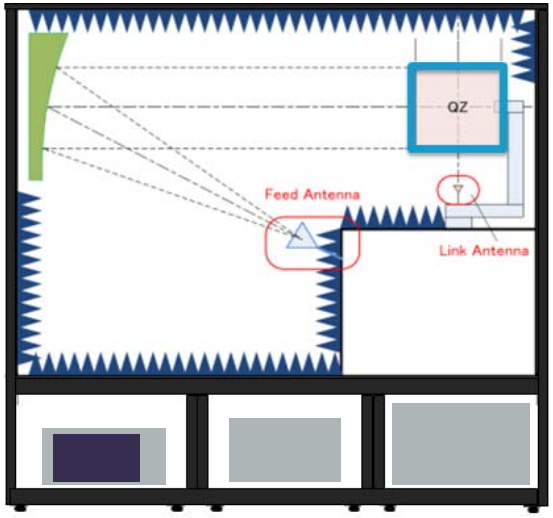


- Beam forming test

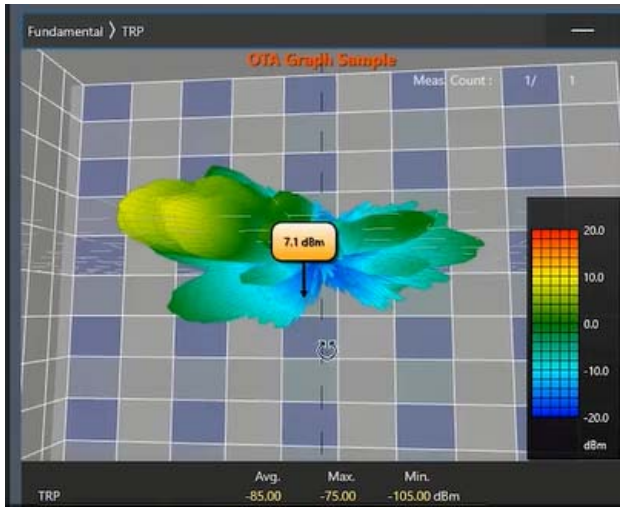
OTA Measurement System

CATR（Compact Antenna Test Range) chamber

MA8172A



Inside structure



Example of power measurement

OTA test method leveraged from antenna measurement technology developed over several years.

Roadmap of 5G

＊Created by Anritsu referring to publicly available information

CY2018	CY2019	CY2020

5G 3GPP Rel.15 NSA/SA specifications (Phase1 Ultrahigh speed)

★ WRC-19

★ Rel.16 (Phase2 Extended use cases such as ultra-low latency, multiple simultaneous connections)

Rel.15 Commercial chip development

Rel.16 Chip development

Pilot device development

Expand commercial device development

Rel.16 Device development

Launch of 5G services by major business operators in various countries

Expand 5 G services

NSA + Millimeter wave (C) *Introduce Sub6 in the future

NSA + Sub6(C) *Introduce Millimeter wave in the future

SA & NSA + Sub6 (P)

SA or NSA+ Sub6 (C)

NSA + Sub6 (C)

NSA + Sub6 (C)

NSA + Sub6 (C)

NSA + Sub6 (C)

NSA + Sub6 (C)

NSA + Sub6 (C)

NSA + Sub6 &Millimeter wave (P)

NSA + Sub6 &Millimeter wave (C)

[Legend]
P. Trial, Pre-service, Pre-commercial
C. Commercial Service

5G Testing Anritsu

5G related events

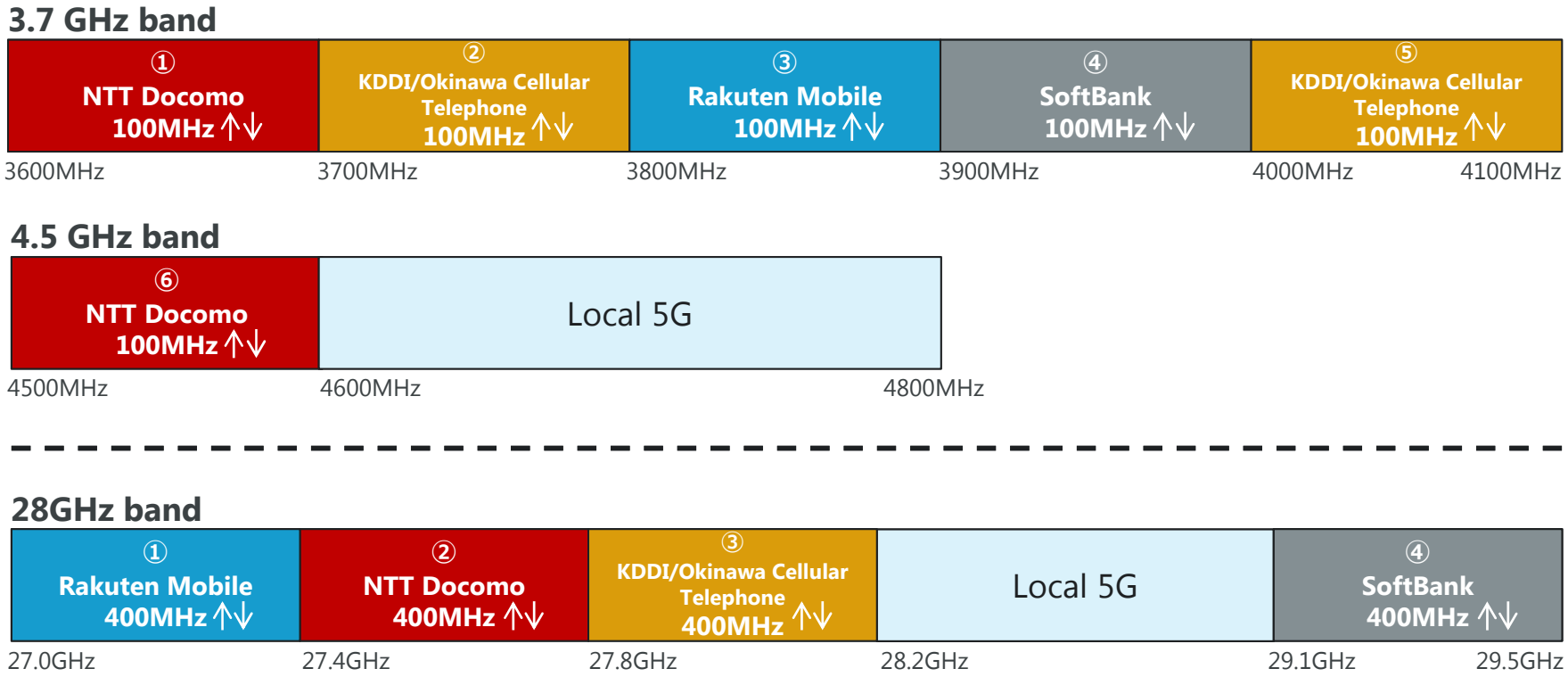
5G frequency assignment

MWC19

Rugby World Cup

Tokyo Olympics・Paralympic

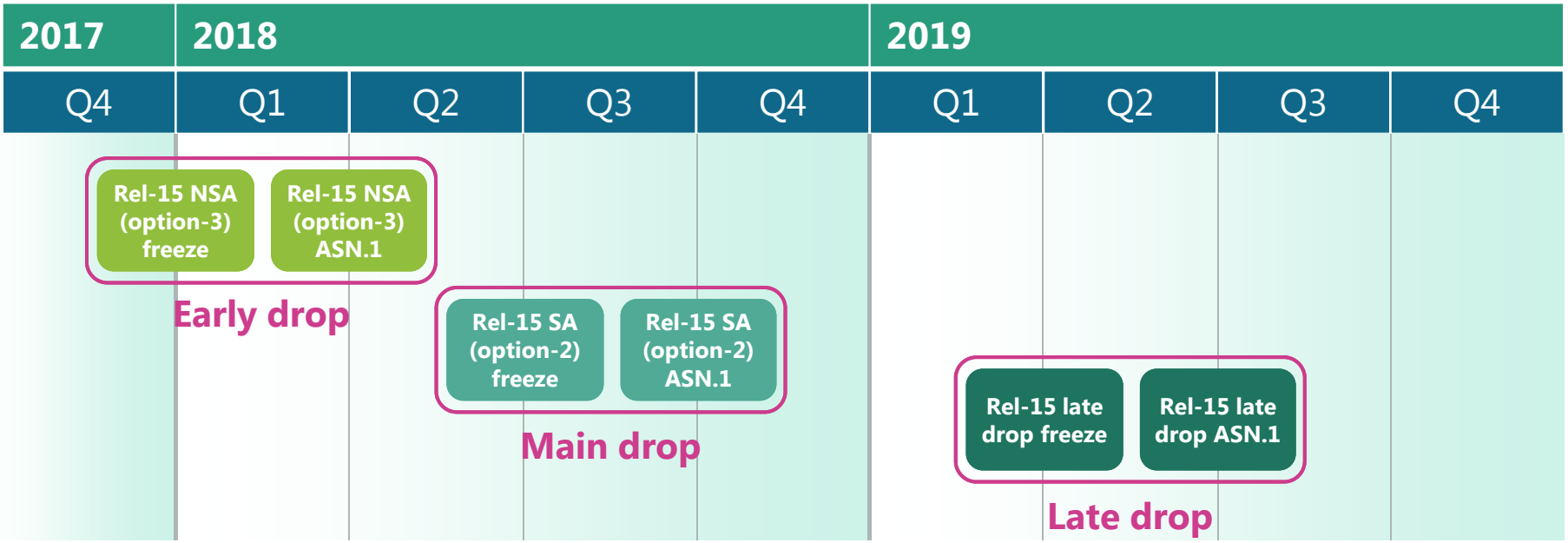
Frequency Allocation in Japan



Japan's Ministry of Internal Affairs and Communications reviewed the area development, facilities, services, and other factors, the band allocation was determined in April 2019.

Reference: Approval to Applications for Establishment Plans on Specified Base Stations for introducing 5G Mobile Communications Systems (outline)

3GPP Trends for standardization of 5G Release15



Early drop

NSA
Non-Standalone

Main drop

SA
Standalone 5G

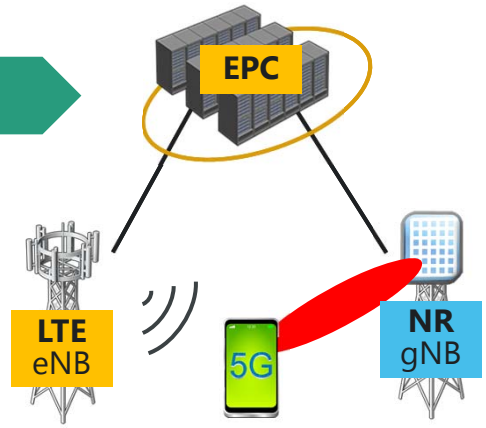
Late drop

Core network replaced with a 5G core

Both NSA and SA will enable services that satisfy requirements for ultra-high speed, low latency, and multiple simultaneous connections.

Non-Standalone / Standalone

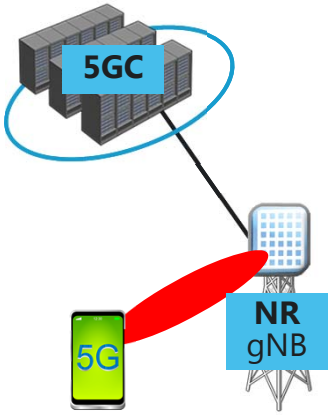
NSA



LTE base stations and core network used as anchors for mobility management and to ensure coverage

Network can be constructed quickly and at low cost

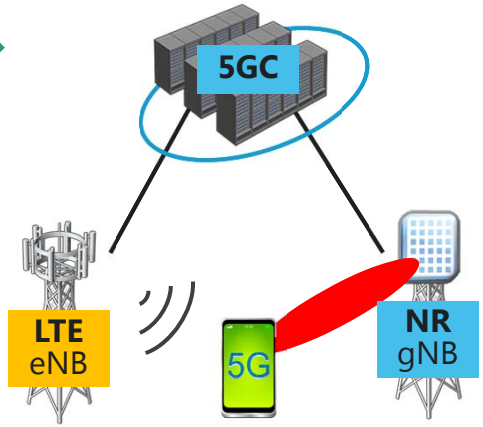
SA



Network constructed using 5G base stations and a 5G core network

5G advantages will be available from the beginning

Late drop

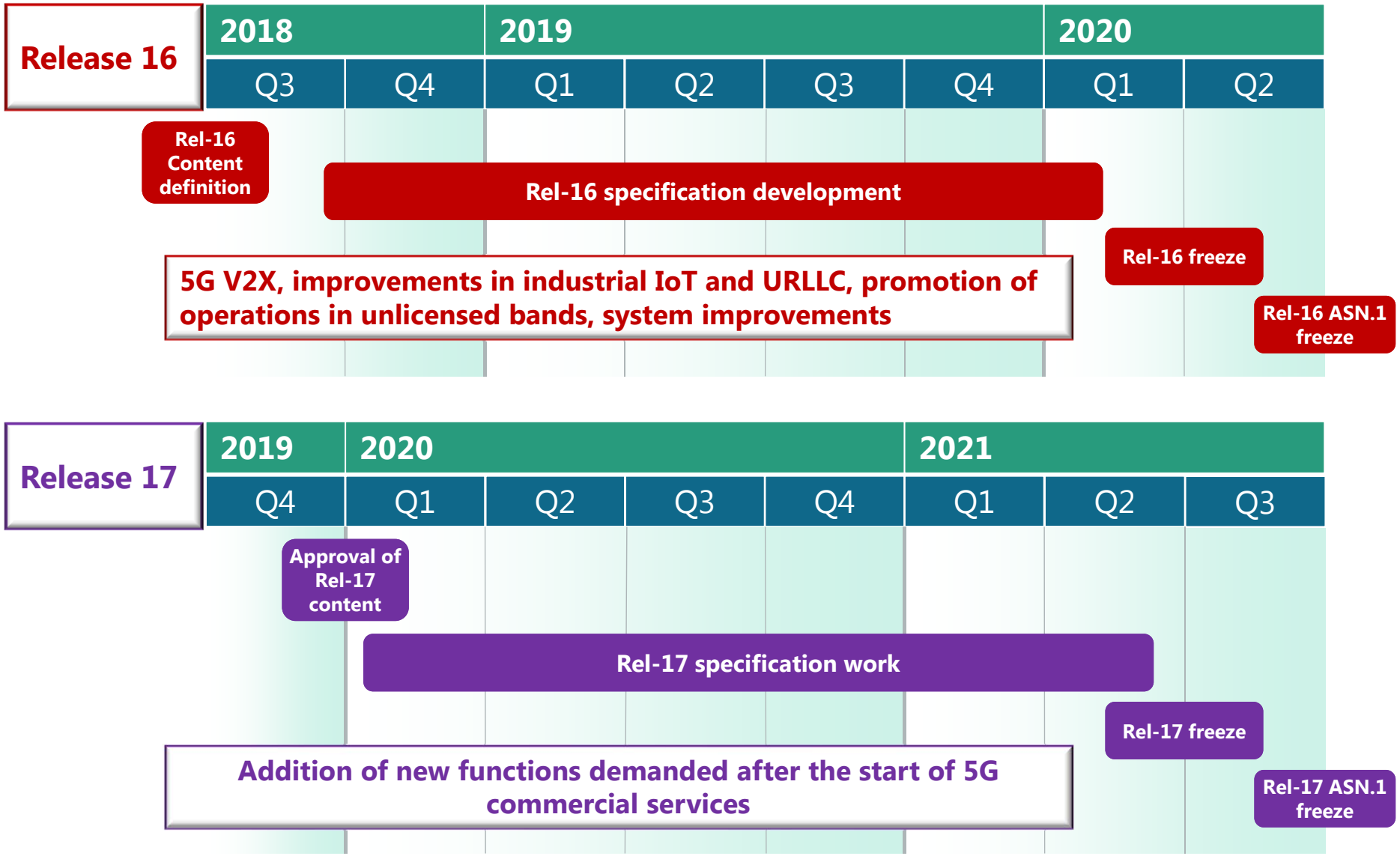


NSA core network will become 5GC

5G advantages will be available under NSA too.

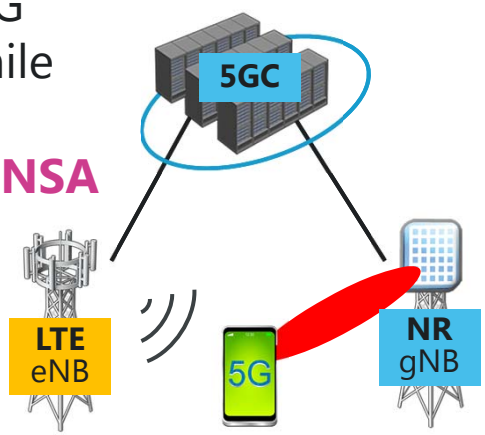
NSA：Non-Standalone　SA：Standalone
EPC：Evolved Packet Core　5GC：5G Core Network
eNB: Evolved NodeB　gNB: Next-Generation NodeB

3 GPP Trends for standardization of 5G　Release16,17

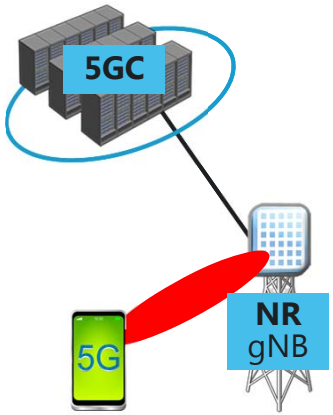


5G Deployment Scenarios

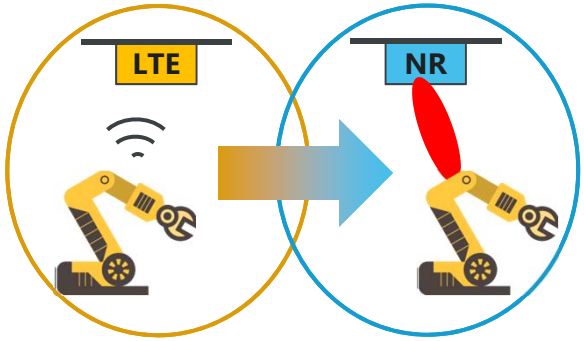
Increasing 5G coverage while using LTE networks as **NSA**



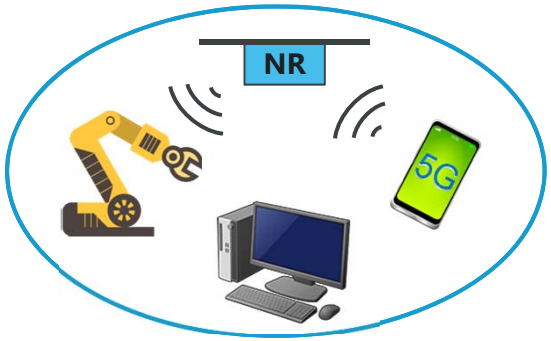
Networks built as **SA** to take advantage of 5G benefits



Migration **from local LTE to local 5G（SA）**



Services in a small area using **local 5G（SA）** networks

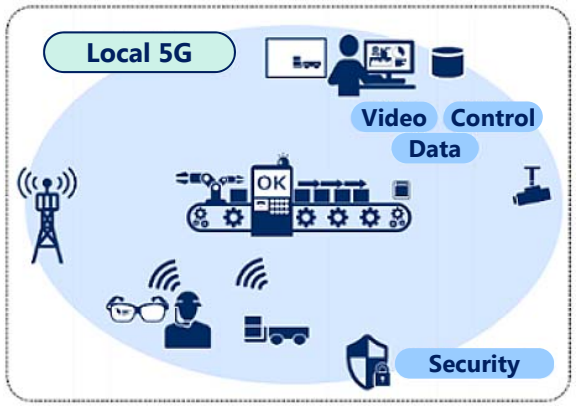


Why is Local 5G drawing much attention?

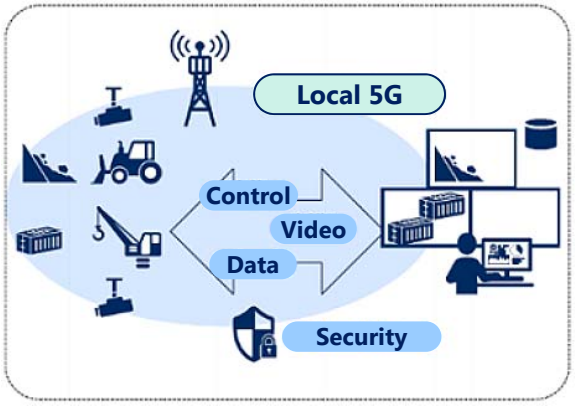
➢ Local 5G can leverage max benefit of 5G advantages

<Image cases using local 5G>

Smart factory



Remote control of heavy machinery



(From materials of the Ministry of Internal Affairs and Communications)

- **Bandwidth can be monopolized→High stability**
- **Local communication→Security can be assured**
- **User businesses can determine the area and time of introduction**

Toward Beyond5G

Remaining challenges for 5G and response to eternal themes

➢ The Beyond5G concept at DARPA：

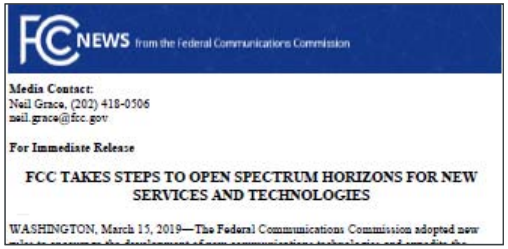
Sharing wide range of frequency bands, with automatic optimal bandwidth allocation based on the specific wireless communication application

➢ Aims for Beyond 5G：

Further advancement of 5G
e MBB, mMTC, URLLC

➢ Goals：

- Transmission capacity：
  100Gbps（5 times 5G）
- Connection density：
  107 units/km2 (10 times 5G)
- Latency：
  nearly zero

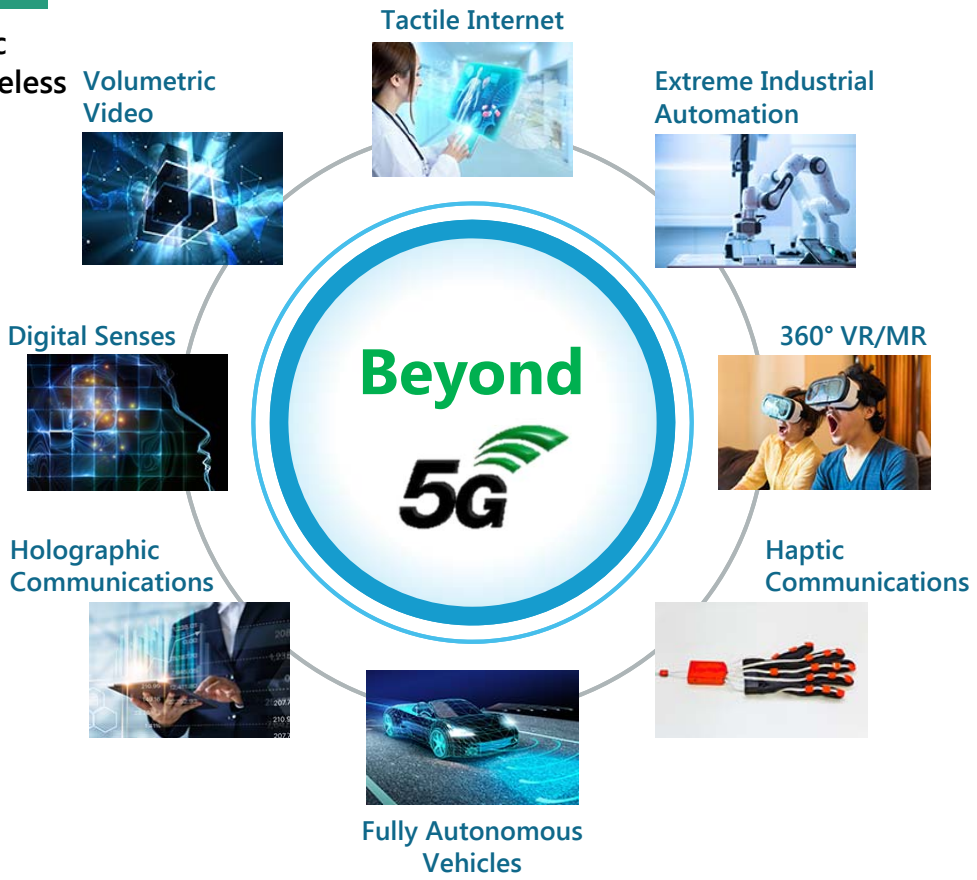

FCC NEWS From the Federal Communications Commission

Media Contact:
Neil Grace, (202) 418-0506
neil.grace@fcc.gov

For Immediate Release

FCC TAKES STEPS TO OPEN SPECTRUM HORIZONS FOR NEW SERVICES AND TECHNOLOGIES

WASHINGTON, March 15, 2019—The Federal Communications Commission adopted new



Advancing the use of even higher frequencies (millimeter and terahertz waves)

eMBB： enhanced Mobile Broadband, mMTC： Massive Machine-Type Communications
URLLC: Ultra-Reliable, Low-Latency Communications

In the field of communication measurement, Anritsu has provided testing solutions that meet the needs of customers' development processes, thereby contributing to the early commercialization of 5G. In the future, we will continue to build our technical knowledge to support the spread and evolution of 5G, followed by Beyond5G, and work closely with our customers to contribute to the development of society.


Anritsu
envision : ensure