

Developing 5th Generation Cellular IoT Devices

Radio Communication Test Station MT8000A

Radio Communication Analyzer MT8821C

Cellular IoT, which has expanded its use cases since 4G LTE, is now under development for its successor technology specifications in 5G NR. While similar technologies are adopted for the same applications between 4G and 5G IoT, there are many changes. So, 5G IoT device development will require various tests to improve performance, such as RF transmission/reception characteristics, throughput, and power consumption, similar to those required for 4G IoT.

Cellular technology has realized the dramatic improvement in data transmission speed per the progress of generation. Today's widespread use of smartphones for video viewing, shopping, and payment procedures is based on this speed increase.

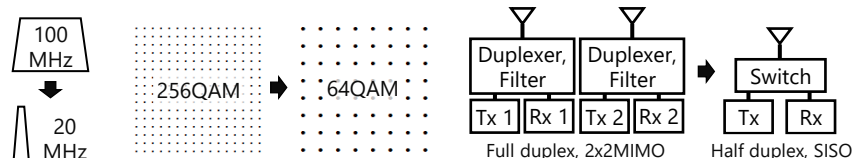
■ Data Rate Transition

Generation	1G	2G	3G			4G		5G
Typical standard	AMPS	GSM	UMTS	HSPA	HSPA+	LTE (Cat-4)	LTE-Advanced	5G NR
Data rate [bps]	10 k	64 k	384 k	7 M	42 M	150 M	1 G	10 G

On the other hand, higher speeds also lead to higher power consumption, component costs, and wider mounting area, making it difficult to use in applications that do not require high-speed communications. The 4G LTE standard was subdivided into several categories according to speed, and relatively low-cost chipsets and modules with low-speed specifications has satisfied such requirement without high-speed. In 4G, cellular IoT standards such as Cat-M1 and NB-IoT have also been established for low speed, long operation time, and miniaturization, and quickly expanded the market. 5G NR, cannot meet the demand for low cost and long operation time without modification since it was developed to achieve "ultra-high speed," so the technology for IoT called Reduced Capability (abbreviated as RedCap, also called 5G NR-Lite, is under development.

3GPP plans to develop RedCap in two phases by Release17 and 18, Release 17 to be completed in mid-2022 and Release 18 in 2024. Development of chipsets has already begun, and wireless telecommunication modules and IoT devices with RedCap function are expected to be available as early as 2024. To reduce cost and power consumption, cellular IoT communication technology has simplified hardware specifications and includes several power-saving features

- Simplification of hardware spec
 - Narrower channel bandwidth
 - Simplification of modulation technology
 - Support for half-duplex
 - Reduced # of antennas and TRx chains

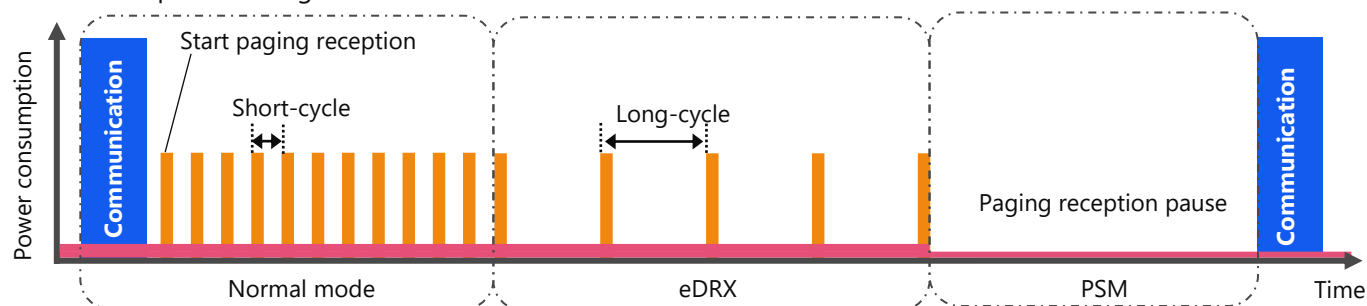


Power saving features

- extended Discontinuous Reception (eDRX)
 - Extend the interval of receiving a paging signal from the base station during idle mode.
- Power Saving Mode (PSM)
 - The timer setting stops receiving paging signals from the base station for a specified time.
- Relaxed cell monitoring
 - Extend or stop the cycle of measuring the reception quality by neighbor cells.

These features are useful for use cases where infrequent data communications are made from a fixed location, and can be optimized per purposes such as longer uptime, smaller batteries, etc.

■ Illustration of power saving features



■ Comparison of Cellular Technologies

	4G				5G	
	LTE Cat-4	LTE Cat-1	LTE Cat-M1	NB-IoT	5G NR (FR1, Rel-15)	RedCap (FR1, Rel-17)
Max. bandwidth	20 MHz	20 MHz	1.4 MHz	180 kHz	100 MHz	20 MHz
Max. data rate (FDD) DL/UL [bps]	150 / 50 M	10 / 5 M	1 / 1 M	127 / 158.5 k	350 / 175 M	150 / 50 M
Max. modulation scheme DL/UL	64 QAM / 16 QAM	16 QAM / 16 QAM	16 QAM / 16 QAM	QPSK / QPSK	256 QAM / 256 QAM	64 QAM* / 64 QAM
Duplex mode	Full	Full	Full / Half	Half	Full	Full / Half
MIMO	Support	No support	No support	No support	Support	Support
Max. antennas	2	2 (For Rx)	1	1	4	2
Power saving feature	-	-	eDRX, PSM	eDRX, PSM	-	eDRX, PSM, Relaxed cell monitoring

* 256 QAM is optional

RedCap Rel-17 has the communication performance equivalent to LTE Cat-1~4 in 4G and is an alternative to these technologies. In addition, while Cat-M1 and NB-IoT are 4G-based technologies using narrow band, they continue to be supported in 5G NR. In IoT where long-term operation tends to be a prerequisite, RedCap, Cat-M, and NB-IoT are extremely useful technologies which are expected to continue stable operation after the transition from 4G to 5G, and are expected to become the mainstream of IoT communications in the future.

Cellular IoT standards are based on 4G and 5G, respectively, but with modifications and additions as described above, and are not the same technology. Excellent communication performance and uptime are critical factors in order to achieve high customer satisfaction in the cellular IoT product market, so it is necessary to evaluate RF performance and functionality using test equipments that support the cellular IoT standards.

Anritsu contributes to the spread of IoT through the following 4G/5G test and measurement instruments to engineers adopting cellular IoT technologies.

Test and Measurement Solutions for 4G/5G testing

■ Radio Communication Test Station MT8000A (Supports 5G NR/RedCap)



With a 5G base station simulating function, a single MT8000A test platform supports both the FR1 (to 7.125 GHz), including band n41, and the FR2 (millimeter-wave) bands used by 5G. Combining it with MX800010A NR TDD Measurement Software and OTA Chamber enables both 3GPP defined millimeter-wave RF test with call connection and beamforming test. With SmartStudio NR MX800070A, functional tests such as IP data transfer and power consumption tests at high throughput can be performed simply by operating the GUI without developing complex test scenarios.

■ Radio Communication Analyzer MT8821C (Supports LTE/LTE-Advanced/Cat-M/NB-IoT)



Designed for R&D of mobile devices (User Equipment), such as smartphones, tablets and IoT modules. It builds on the technologies and knowhow of its popular predecessor: MT8820C which is preferred by UE and chipset vendors worldwide. MT8821C supports all technologies, ranging from LTE-Advanced to 3G/2G, with its easy-to-use measurement functions for efficient RF adjustment and verification in one unit.

It supports Cat-M/NB-IoT RF characteristics measurement and IP data transfer tests, and has been widely adopted for development stages of cellular IoT-equipped devices.