

Cellular Mobile Networks

Lecture 2

IoT Security

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Cellular Mobile Networks – 2G

- Global System for Mobile Communications (GSM) is the second-generation mobile communications technology. It is a standard developed by the European Committee for Standardization in 1992. It incorporates digital communications technologies and a unified network standard, which ensures the quality of communications and enables it to develop various new services. The data rate of GSM is 9.6 kbit/s.
- General Packet Radio Service (GPRS) is a mobile data service available to GSM mobile phone users. It is a data transmission technology of the second-generation mobile communications and an extension of GSM. GPRS provides data rates of 56–114 kbit/s.



Cellular Mobile Networks – 3G

- 3G is the third generation mobile communications technology. It supports high-speed data transmission and can transmit voice and data simultaneously with a rate of several-hundred kbit/s. 3G is a mobile communication system that integrates wireless communications and multimedia communications such as the Internet. Currently, 3G has three standards: CDMA2000, WCDMA, and TD-SCDMA. The latest WCDMA technology HSPA+ supports a downlink rate of up to 42 Mbit/s.



LTE UE Categories

- The LTE UE category indicates the UE access capability level, in other words, the transmission rate level supported by a UE. For example, LTE category 4 indicates that the LTE network access capability level of the UE is 4.

Level	Downlink Rate (Mbit/s)	DL-MIMO	Uplink Rate (Mbit/s)
1	10	1	5
2	50	2	25
3	100	2	50
4	150	2	50
5	300	4	75
6	300	2 or 4	50
7	300	2 or 4	150
8	1200	8	600
9	450	2 or 4	50
10	450	2 or 4	100

LTE UE Category 1

- UE category 1 supports a downlink rate of up to 10 Mbit/s, enabling IoT devices with lower power consumption and costs to connect to LTE networks. LTE operators around the world deploy LTE networks based on 3GPP Release 8 or later. As such, operators can simply reconfigure parameters to permit the access of UE category 1 without needing to upgrade the networks.
- Although higher rates are supported for UE category 4 or later, the costs are relatively high for the IoT industry. Therefore, using UE category 1 is most cost-effective.

Cellular Mobile Networks – 5G

- The fifth-generation mobile communications network, 5G's theoretical maximum transmission rate can reach 10 Gbit/s, which is 100-fold improvement over 4G. With 5G, a 1 GB movie can be downloaded in eight seconds.
- ITU Radiocommunication Sector (ITU-R) defined three major 5G application scenarios in June 2015: enhanced Mobile Broadband (eMBB), Massive Machine-Type Communications (mMTC), and ultra-reliable low-latency communication (URLLC), as well as eight capability specifications, including the throughput, latency, connection density, and spectral efficiency.
- On June 6, 2019, the Ministry of Industry and Information Technology (MIIT) officially issued 5G commercial licenses to China Telecom, China Mobile, China Unicom, and China Broadcast & Television, and announced the start of 5G commercialization on October 31, 2019.



Comparison of Cellular Mobile Network Technologies

	2G	3G	4G	5G
Frequency band	Authorized frequency band (mainly 900 MHz)	Authorized frequency band (mainly 900 MHz and 1800 MHz)	Authorized frequency band (1800–2600 MHz)	Authorized frequency band: C-band, mmWave
Transmission rate	GSM: 9.6 kbit/s GPRS: 56–114 kbit/s	TD-SCDMA: 2.8 Mbit/s CDMA2000: 3.1 Mbit/s WCDMA: 14.4 Mbit/s	Downlink Category 6/7: 300 Mbit/s Category 9/10: 450 Mbit/s	10 Gbit/s (Balong 5000 chips support a downlink rate of 4.6 Gbit/s and an uplink rate of 2.5 Gbit/s)
Typical application	POS and smart wearable devices	Vending machines, smart home appliances	Mobile terminals, video surveillance	AR, VR, assisted driving, automated driving, and telemedicine

LPWA - SigFox

- The SigFox network uses Ultra Narrow Band (UNB) technology. Its transmission power consumption is low and the data connection is stable. Its radio link uses the unlicensed ISM radio frequency band. Frequency usage varies according to national laws and regulations. The 868 MHz frequency band is widely used in Europe, and the 915 MHz frequency band is used in the United States.
- The network adopts ultra narrow-band modulation technology. A single base station can transmit network messages over a distance of over 1000 km. Each base station supports a maximum of one million IoT devices.
- SigFox is preferred for IoT connections as it uses free frequency bands, devices that consume little power, and a simplified network architecture.



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LPWA - LoRa

- The Long Range (LoRa) is a physical-layer-based technology that implements data communications over networks. It is maintained and managed by the LoRa Alliance. The technology supports bidirectional data transmission and complies with a series of open source standards. The specific solution for network implementation is called LoRaWAN, which is developed by Semtech and supported by IBM. The application of LoRa includes automatic meter reading, smart home appliance, building automation, wireless warning and security systems, industrial monitoring and control, and remote irrigation systems.
- LoRa uses unlicensed spectrum.

LPWA – NB-IoT

- NB-IoT is a cellular based narrowband IoT. It is built on a cellular network and requires a bandwidth of only 180 kHz. It can be directly deployed on legacy GSM, UMTS, and LTE networks to reduce deployment costs and implement smooth upgrades.
- NB-IoT is an emerging technology widely used for LPWA IoT markets. It features enhanced coverage and wide connections with low rates, costs, power consumption, and the optimal architecture.
- According to 3GPP Release 14, NB-IoT supports base station positioning and mobility scenarios with a speed less than 80 km/h.



LPWA - eMTC

- eMTC is a wireless IoT solution proposed by Ericsson. The solution designs the soft features of the wireless IoT network based on LTE access technology. It is mainly used in IoT scenarios that require low rates, deep coverage, low power consumption, and a considerable number of connections.
- eMTC features a higher rate (up to 1 Mbit/s) and power consumption and smaller coverage and capacity than NB-IoT. eMTC also supports voice communications.

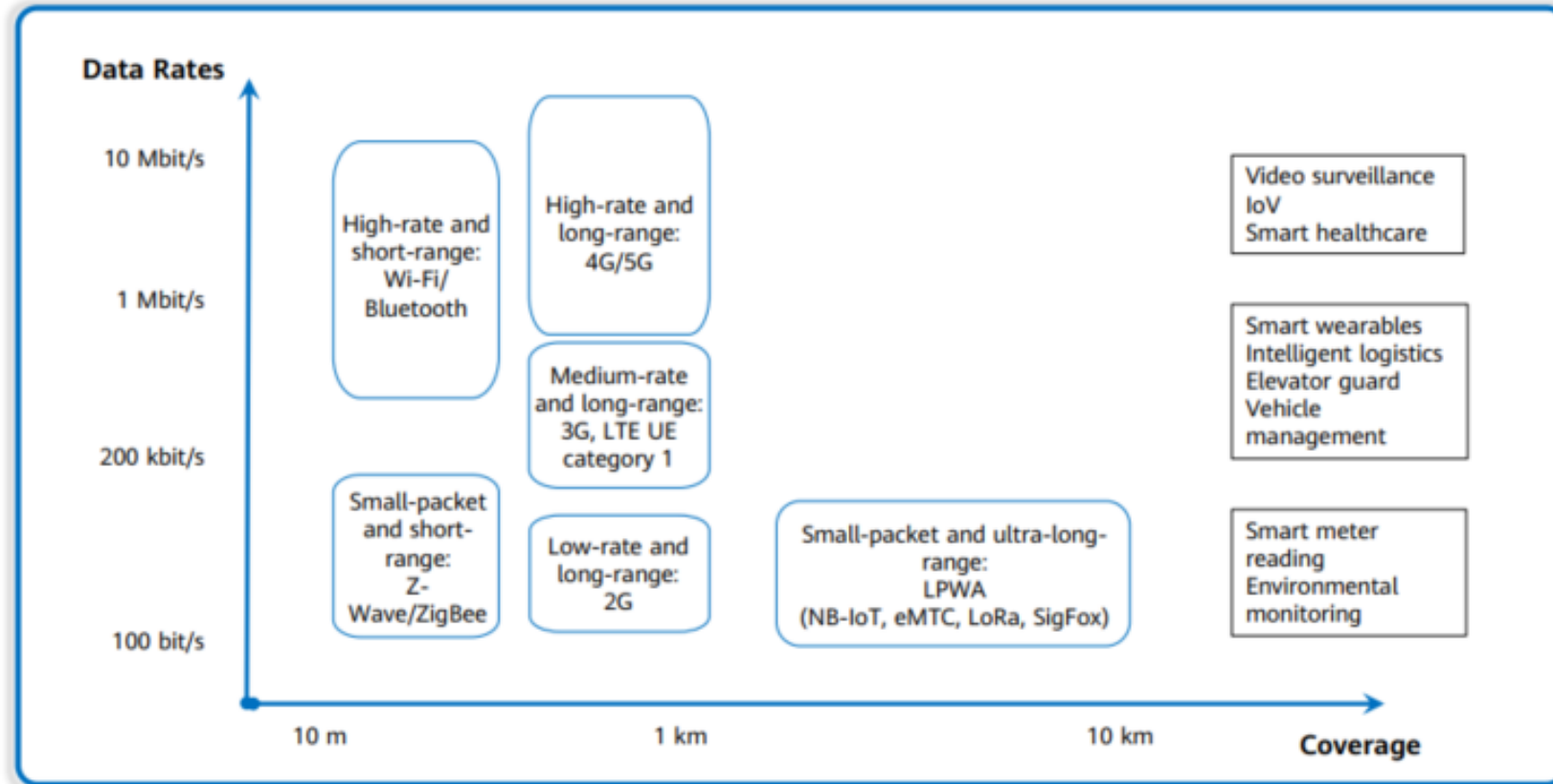


Comparison of LPWA Technologies

	SigFox	LoRa	NB-IoT	eMTC
Frequency band	Sub-GHz unlicensed frequency band	Sub-GHz unlicensed frequency band	Mainly sub-GHz licensed frequency band	Sub-GHz licensed frequency band
Transmission rate	100 bit/s	0.3–5 kbit/s	< 250 kbit/s	< 1 Mbit/s
Typical distance	1–50 km	1–20 km	1–20 km	2 km
Typical application	Smart home appliances, smart electricity meter, mobile healthcare, remote monitoring, and retail	Smart agriculture, intelligent building, and logistics tracking	Water meter, parking, pet tracking, garbage disposal, smoke alarm, and retail devices	Shared bicycle, pet collar, POS, and smart elevator

Chapter
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Comparison of Wireless Communications Technologies





Thank You