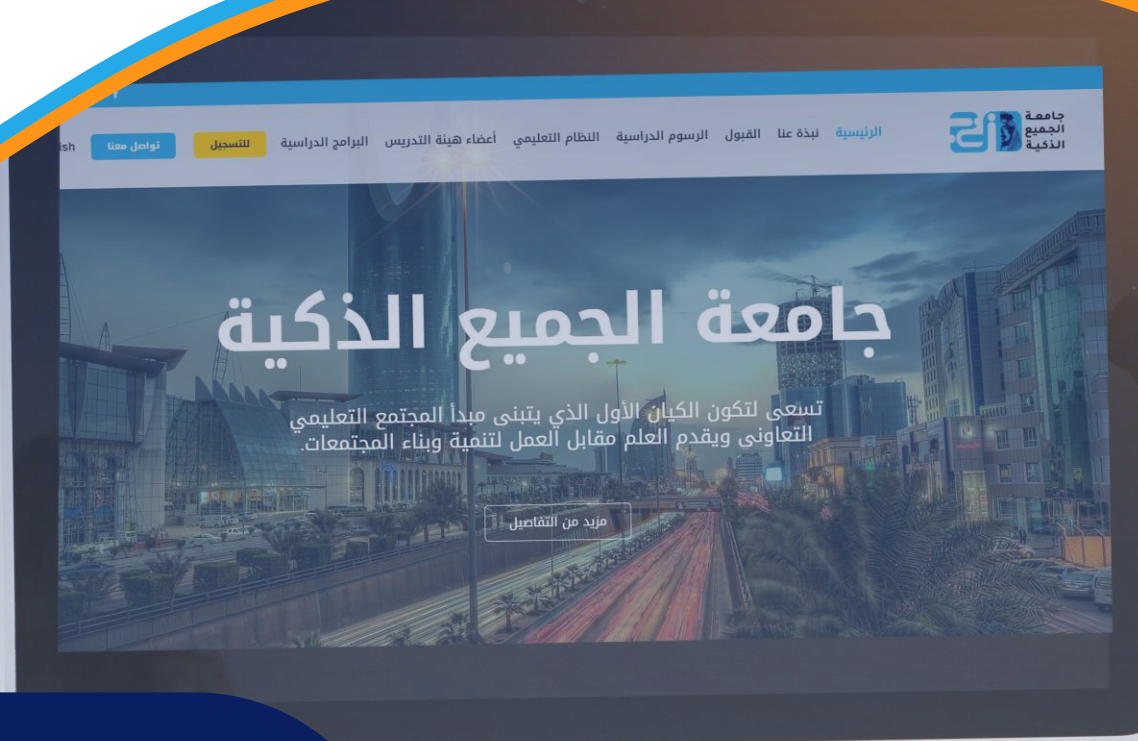




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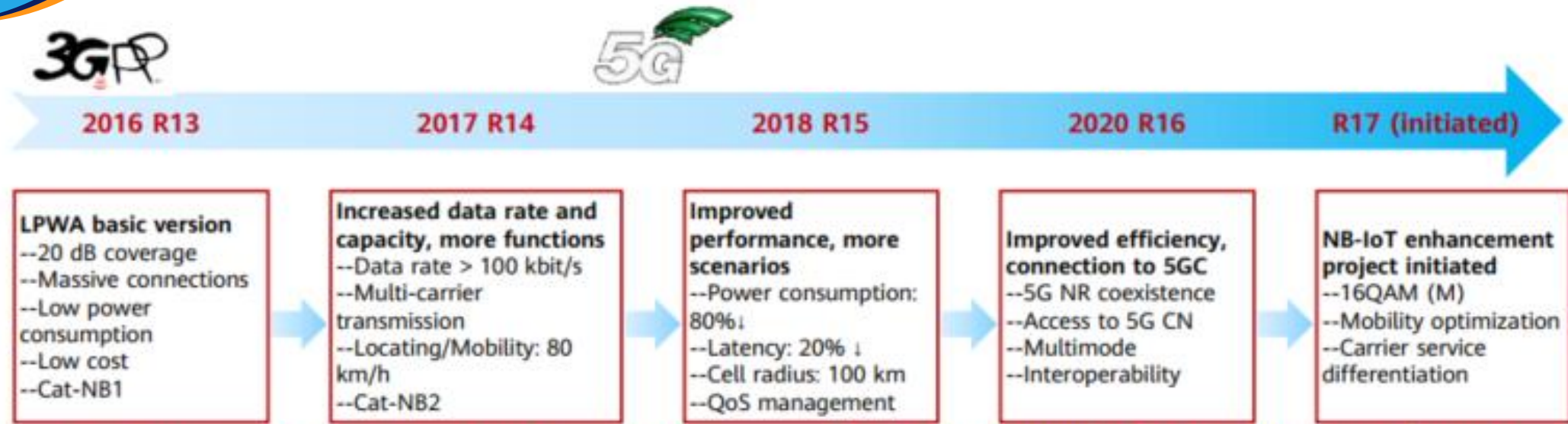
IoT Security
Prepared by Dr. Abdelrhman Ahmed
Lecture 3

NB-IoT Communication
Technologies and Solutions

- Unlike the traditional Internet, the Internet of Things (IoT) works in diverse and complex communications scenarios. Different wireless communications scenarios vary in their requirements. We summarize the communications scenarios in which small packets are occasionally transmitted through passive devices as low-power wide-area (LPWA) scenarios.
- In LPWA scenarios, NB-IoT is one of the most widely used technologies. This technology complies with the 3GPP specifications, deployed on authorized frequency bands of operators, and provides a public network for IoT devices, encouraging the development of IoT public utilities.

At the end of this course, you will have knowledge of:

- **The evolution of the NB-IoT standards and the development of the NB-IoT industry**
- **Key technologies of NB-IoT**
- **NB-IoT application scenarios and solutions**



Technologies Defined by 3GPP Will Evolve to 5G

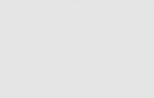
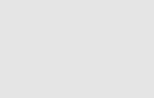
- On July 7, 2019, 3GPP and the 5G Promotion Group of MIIT put forward the NR and NB-IoT proposals to the ITU.
- 3GPP Release 15: **NB-IoT and NR can coexist**. Existing UEs are not affected.
- 3GPP Release 16: Technical standards meeting 5G requirements are officially accepted as a 5G technical standards.

The industry recognizes NB-IoT evolution and agrees to incorporate NB-IoT into the overall 5G plan.

Company	Proposal
China Mobile	✓ Jointly promote NB-IoT access to 5G devices and the core network based on R16.
DT	✓ No requirement on developing NR-based LPWA solutions. NB-IoT can meet IMT-2020 requirements.
E	✓ In the 5G era, continue using NB-IoT and LTE-M to meet LPWA service requirements.
Q	✓ NB-IoT/eMTC is 5G mMTC.

Chapter 03

LPWA Technologies Adopted by Global Operators

NB-IoT first + eMTC	  	  	  	  	  	  	  	  
eMTC first + NB-IoT								
LoRA first + eMTC								

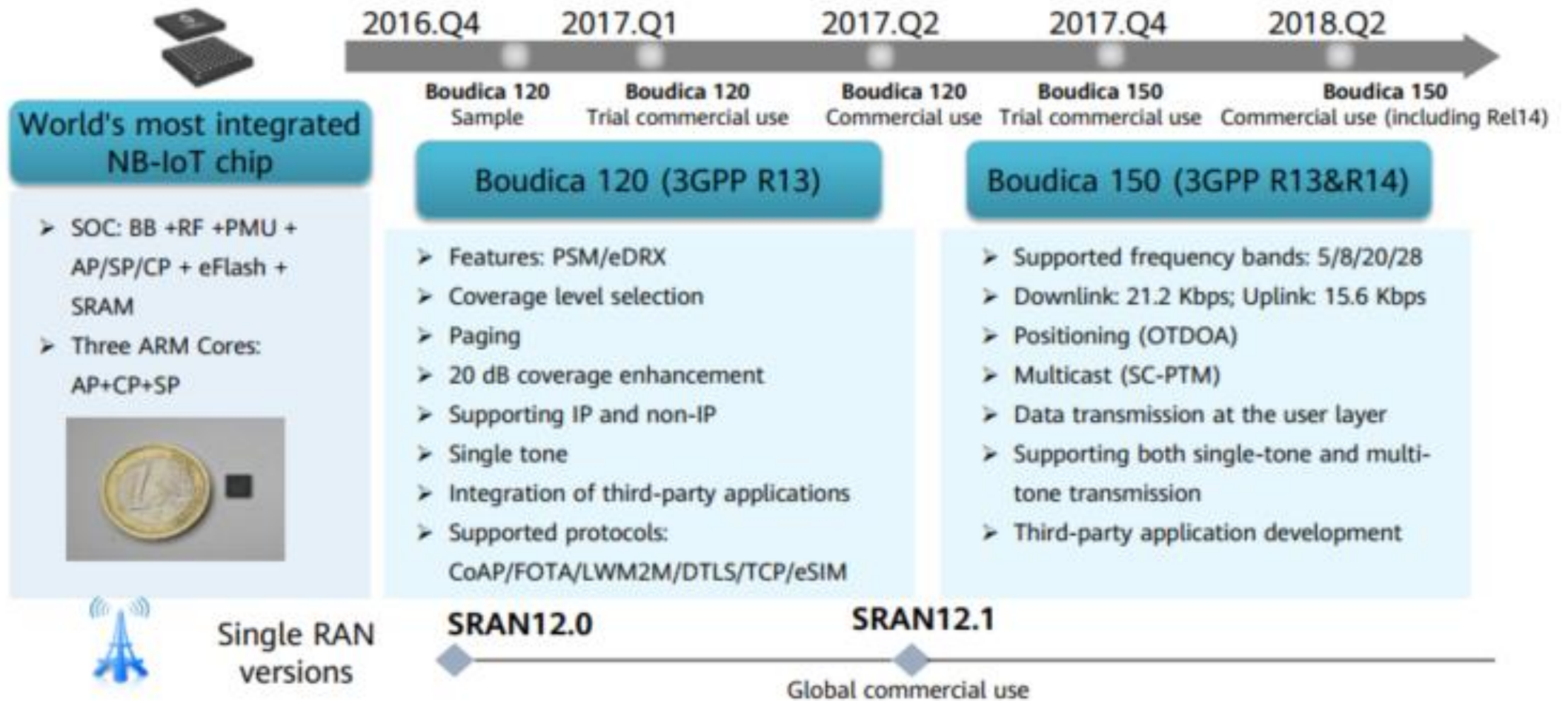
Chapter 03

NB-IoT Spectrum Selections of Global Operators

APT 700 MHz	 Latin America								
800 MHz		 Germany	 Hungary						
850 MHz									
900 MHz	 Germany, Holland, Poland, Austria	 Germany					 		
1800 MHz									

Chapter 03

Huawei Releases World's First Commercial-use NB-IoT Chip and Network Version



Physical layer design

- System bandwidth: 180 kHz
- Downlink technology: OFDMA; SCS 15 kHz; 12 subcarriers
- Uplink technology: SC-FDMA

Physical channels and physical signals

- To simplify implementation, NB-IoT removes unnecessary physical channels, leaving only three types of physical channels and two types of reference signals in the downlink and two types of physical channels and one type of reference signal in the uplink.

- Two types of uplink physical channels:
 - NPUSCH
 - NPRACH
- One type of uplink physical signal:
 - NDMRS

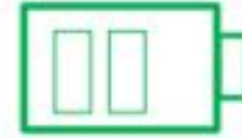


- Three types of downlink physical channels:
 - NPBCH
 - NPDCCH
 - NPDSCH
- Two types of downlink physical signals:
 - NRS
 - NSS

- Through a smaller target rate, repeated transmission, and lower-order modulation, **NB-IoT** physical channels achieve **wider coverage, lower costs, and lower power consumption**.



Ultra-low cost



Ultra-low power
consumption



Ultra-wide
coverage

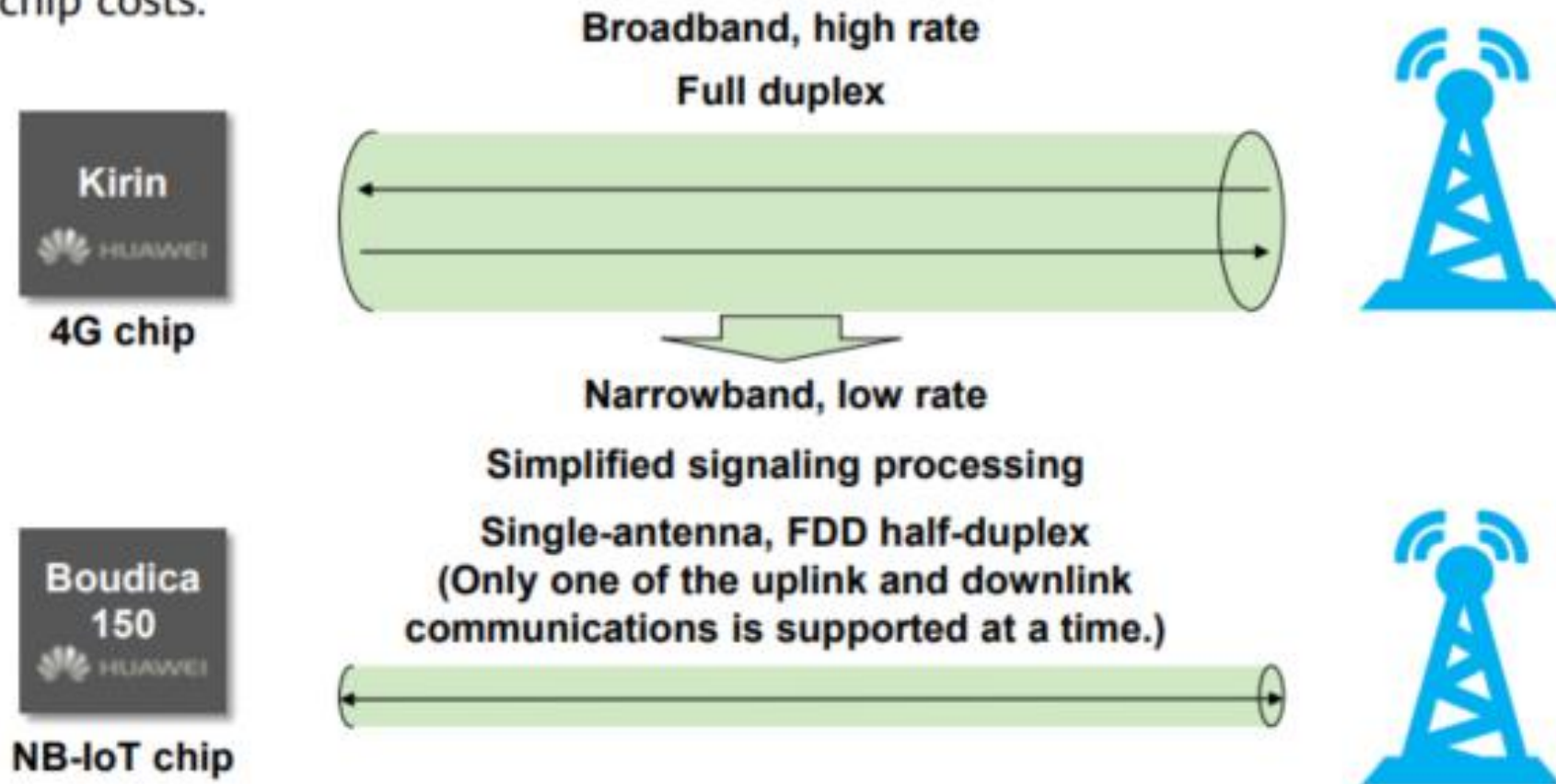


Massive connections

Chapter 03

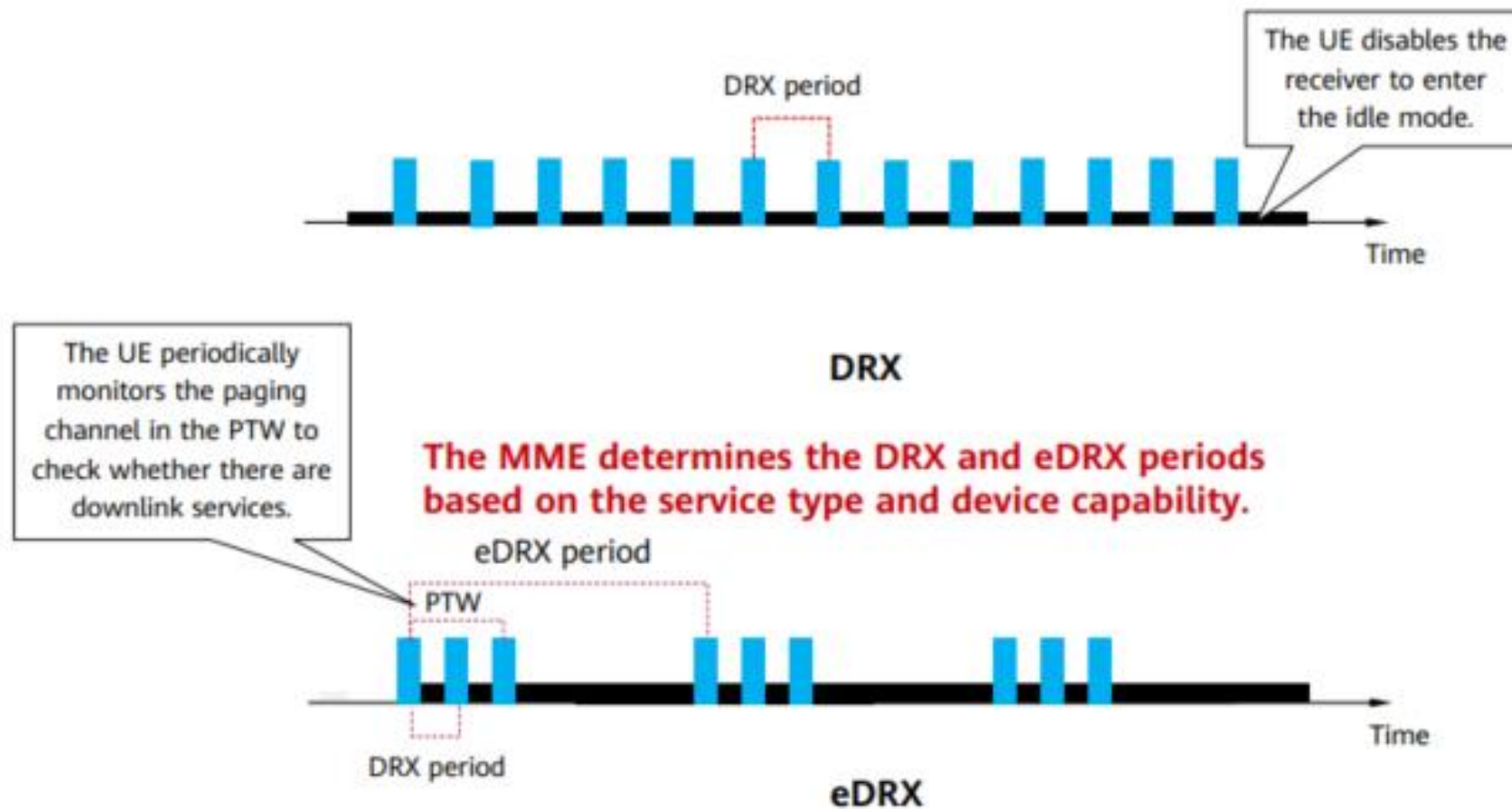
Ultra-low Cost: Communication Chips Specially Designed for IoT

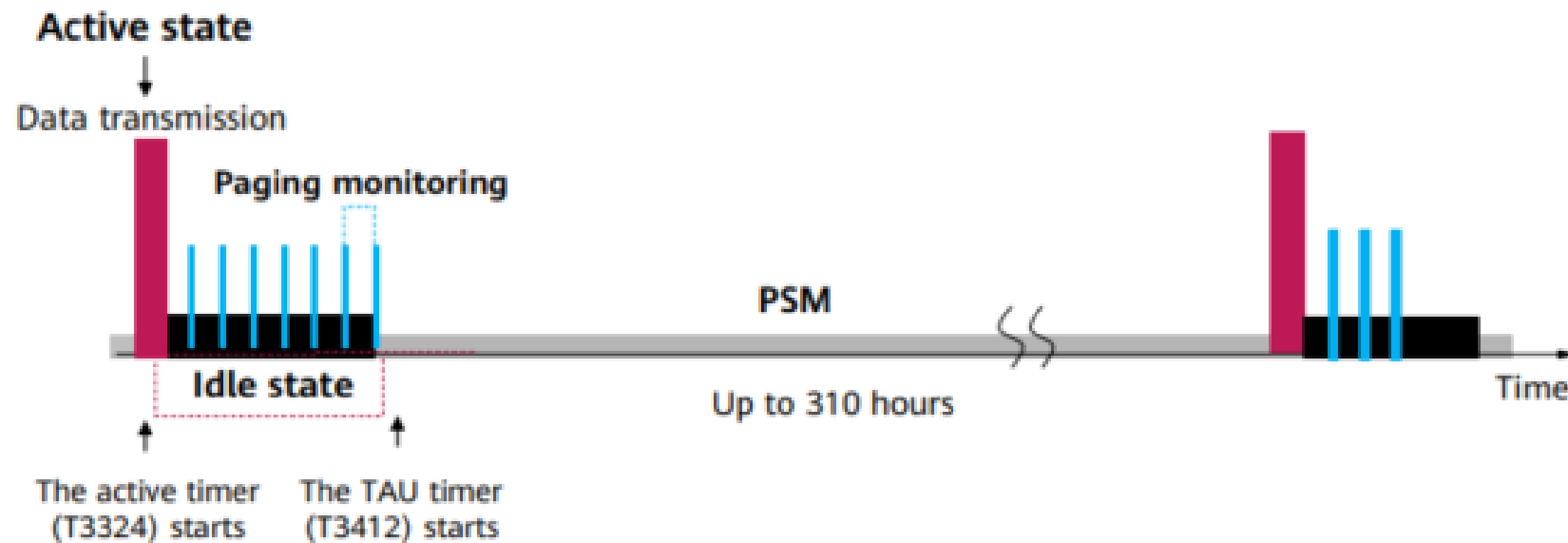
- Non-essential physical hardware modules are tailored using simplified functions and algorithms, reducing chip costs.



Chapter 03

Ultra-Low Power Consumption: DRX and eDRX

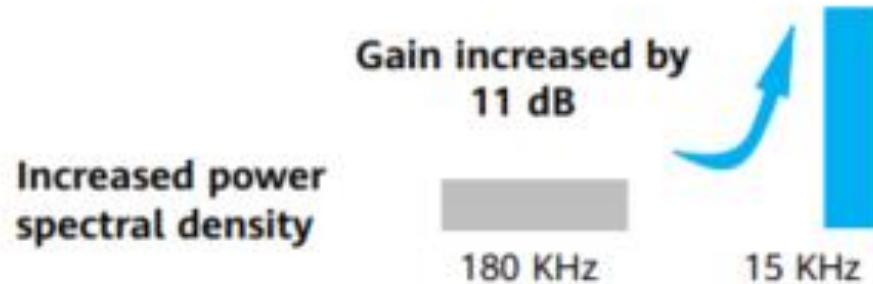




Chapter 03

Ultra-Wide Coverage: Increased Power Spectral Density, Time-Domain Retransmission

Deep coverage solution

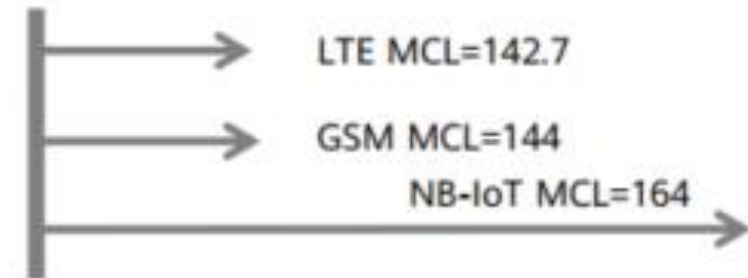


Downlink gain increased by 9 dB
Uplink gain increased by 12 dB

Repeated transmission

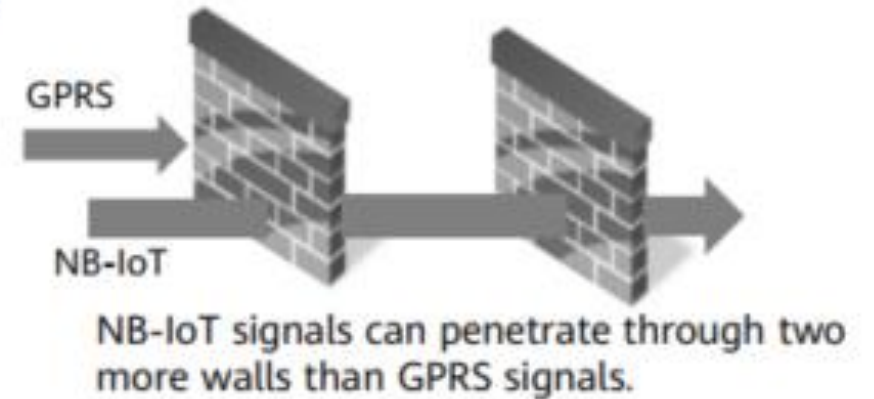


20 dB more maximum coupling loss (MCL) than GPRS



The coverage distance of NB-IoT is three times that of GPRS.

Coverage comparison



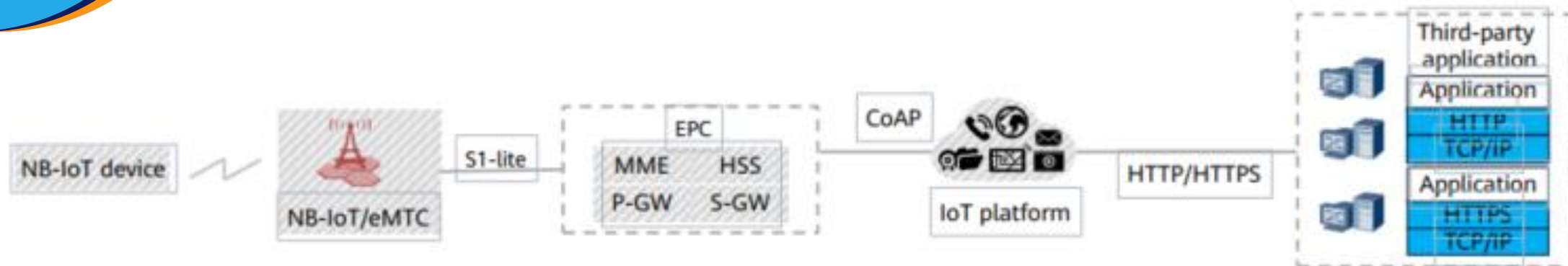
Summary of Key NB-IoT Features



Low Cost	Low Power Consumption	Wide Coverage	Massive Connections
\$5 module cost • Simplified RF hardware • Simplified protocols to reduce costs • Reduced baseband complexity	10-year battery life • Simplified protocols and lower chip power consumption • High PA efficiency • Short TX/RX duration	20 dB gain • Increased narrowband PSD • Retransmission times: 16 • Coding gains	50,000 connections per cell • High spectral efficiency • Small-packet data transmission • Low device activation ratio

Chapter 03

NB-IoT Solution Architecture



NB-IoT device

- Wireless connection
- Virtual SIM card
- Sensor port
- Application residence
- Support for NAS data

NB-IoT eNodeB

- Low-cost site solution
- Supporting large-capacity connections with new air interface

IoT core network

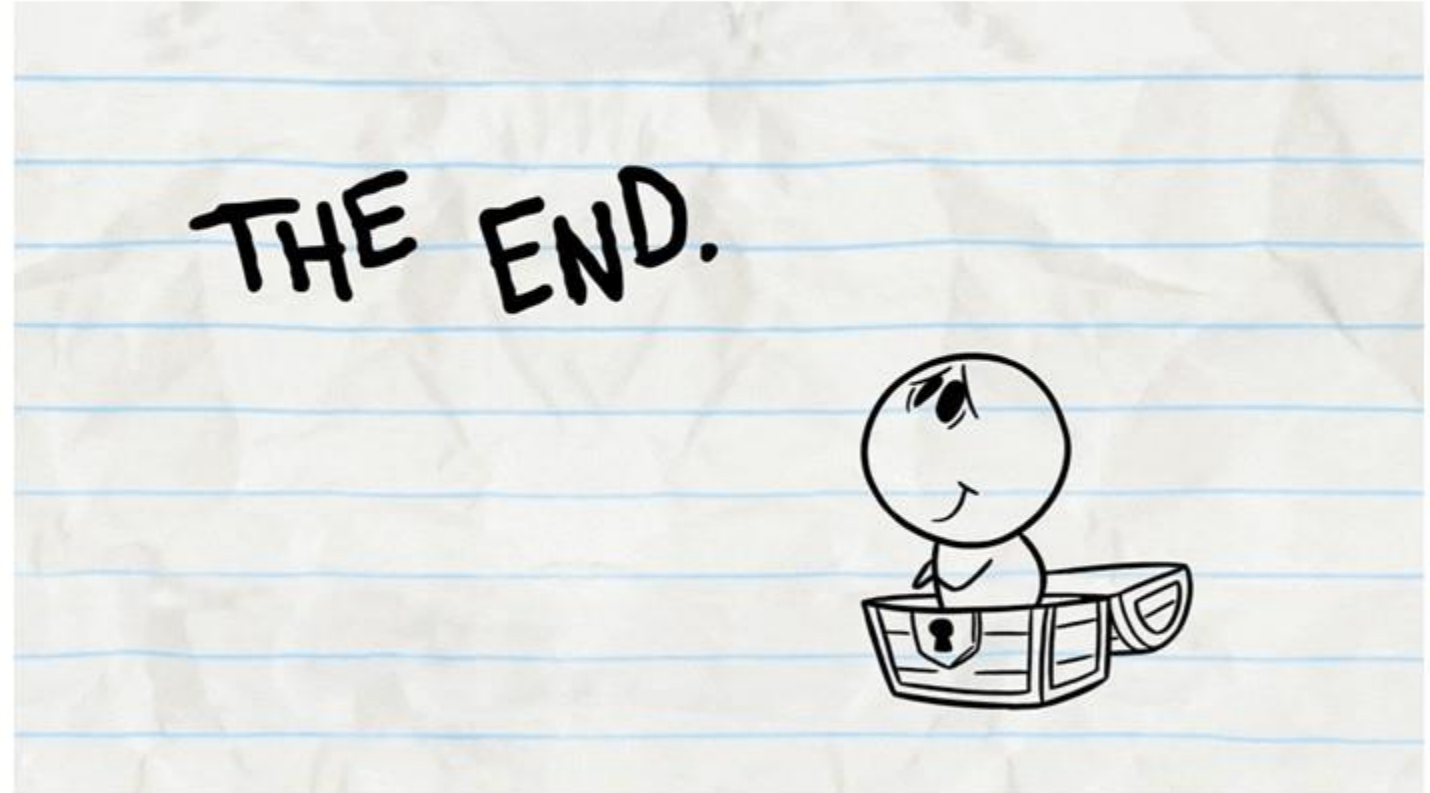
- Mobility, security, and connection management
- Secure access for devices without SIM cards
- UE energy saving
- Congestion control and traffic scheduling
- Billing
- Support for NAS data

IoT platform

- Compatible with application-layer protocol stacks
- Device/SIM OTA
- Device and event subscription management
- Open APIs (to the industry and developers)
- OSS/BSS (for self-help subscriber creation and billing)
- Big data analysis

The End

Please feel free to contact me anytime if you have any questions



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