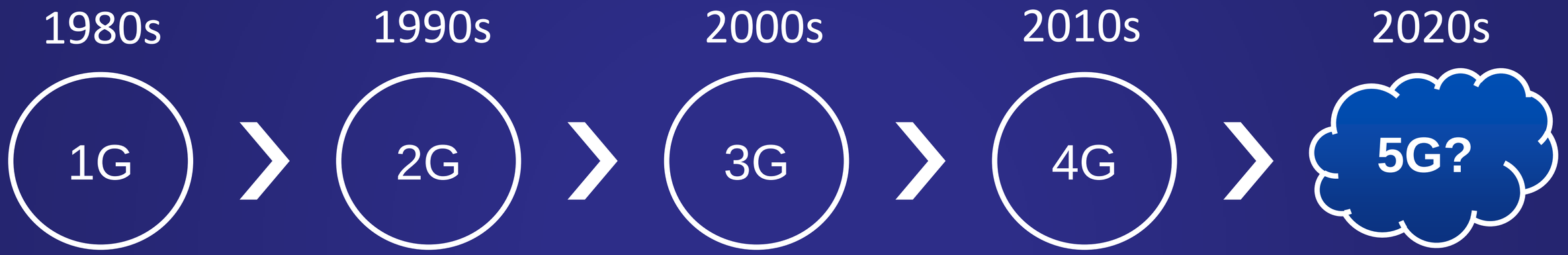
5G Concept

IMT-2020 (5G) Promotion Group

2015-03-10

5G has been a global R&D focus



- **FDMA**
- **Analog voice**

- **TDMA**
- **Digital voice**
- **Low-data-rate services**

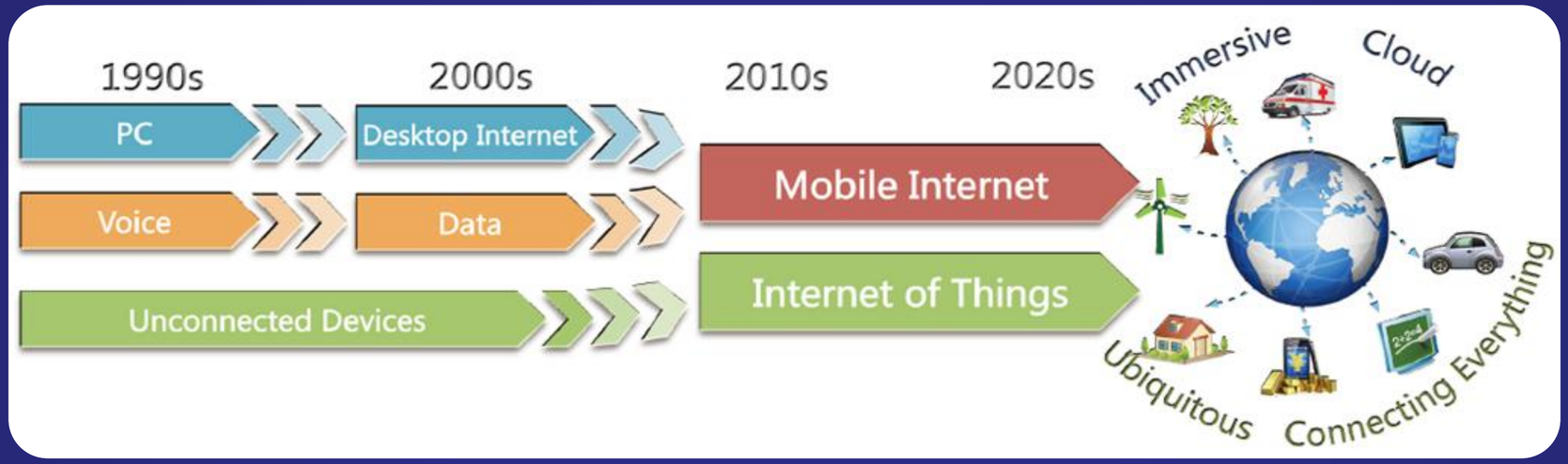
- **CDMA**
- **2 ~ Tens of Mbps (peak data rate)**
- **Multimedia**

- **OFDMA**
- **100M ~ 1Gbps (peak data rate)**
- **MBB**

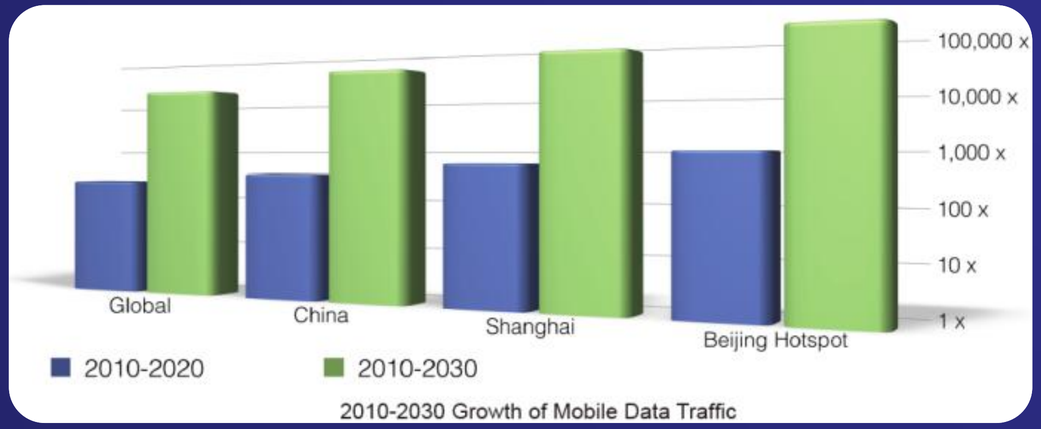
5G Concept?

5G standardization is expected to be launched in early 2016

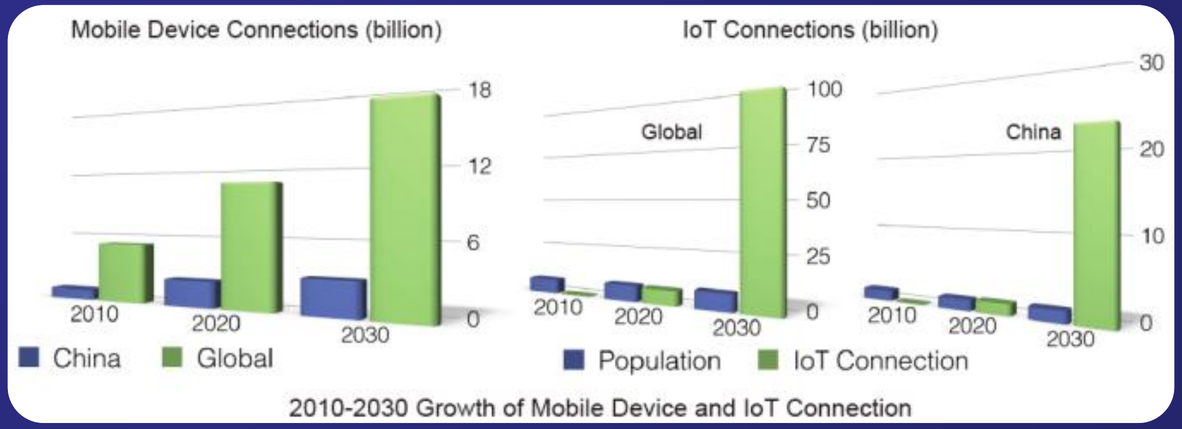
5G Main drivers: Mobile Internet and IoT



Mobile Data Traffic: Thousands of times growth



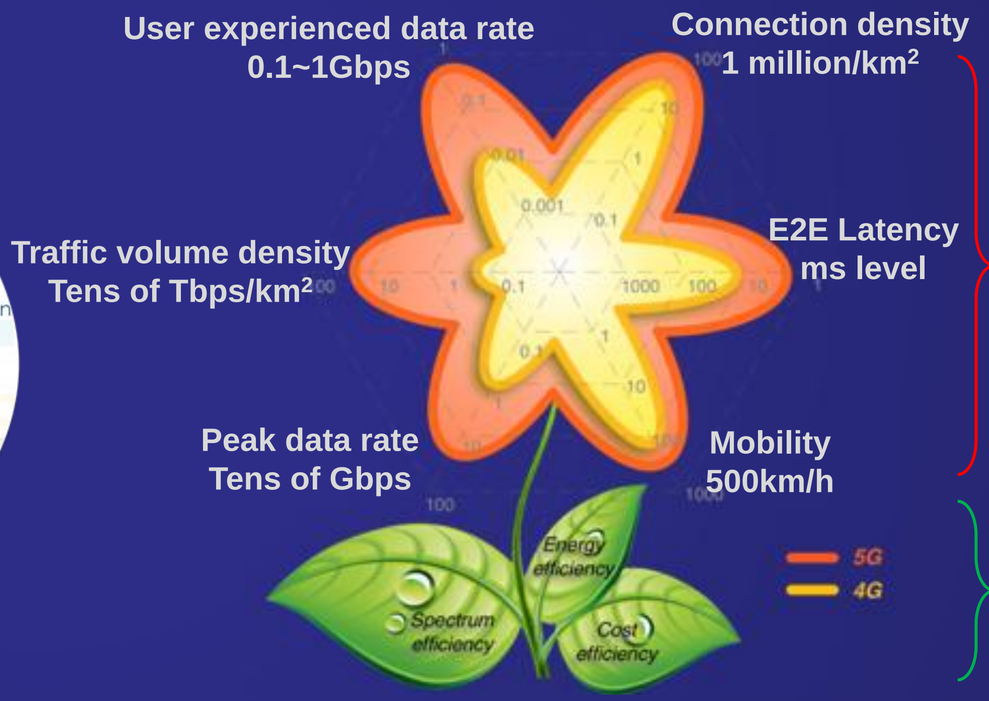
Mobile Internet & IoT Connections: Up to 100 billion



5G Vision and Requirements

5G Vision

5G Key Capabilities



"Information a finger away, everything in touch"
"信息随心至，万物触手及"

User experienced data rate is widely recognized as the most important KPI

5G Technical Scenarios and Challenges

Mainly for Mobile Internet

Seamless Wide-Area Coverage

- User experienced data rate: 100 Mbps

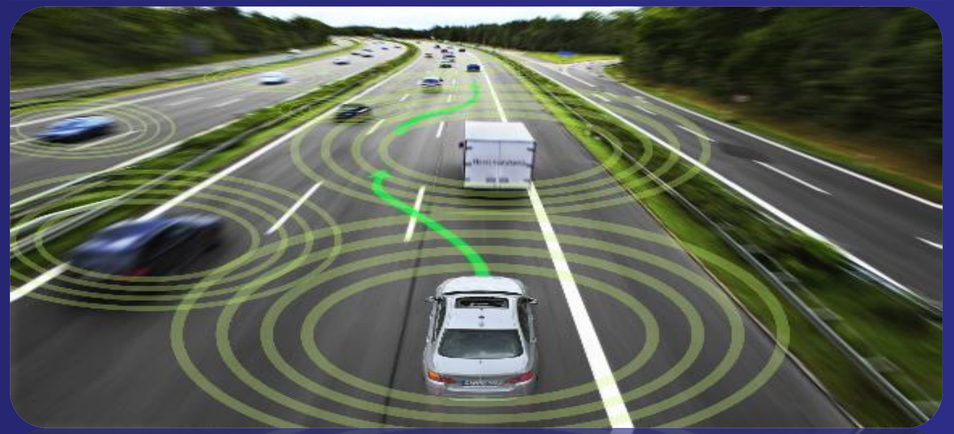
High-Capacity Hot-Spot

- User experienced data rate: 1 Gbps
- Peak data rate: Tens of Gbps
- Traffic volume density: Tens of Tbps/km^2

5G Technical Scenarios and Challenges

Mainly for IoT (new scenarios)

Low-Latency High-Reliability



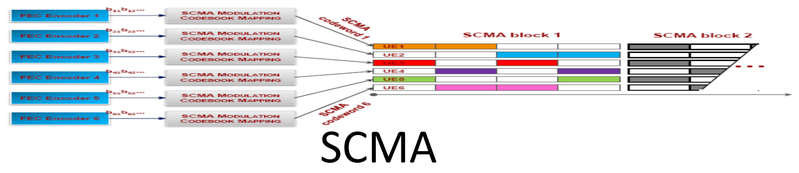
- Air interface latency: 1 ms
- End-to-end latency: ms level
- Reliability: nearly 100%

Low-Power Massive-Connections

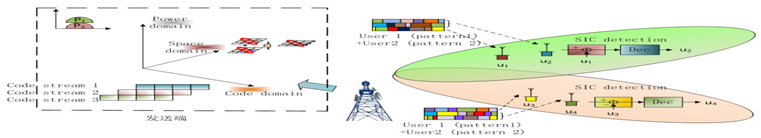
- Connection density: 10^6 / km^2
- Ultra-low power consumption
- Ultra-low cost

5G Key Wireless Technologies

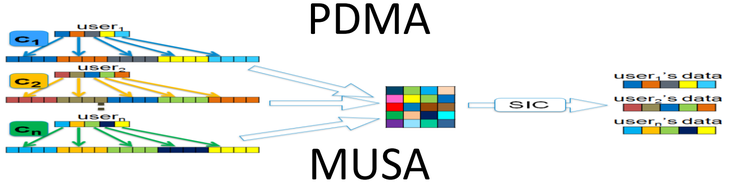
Novel Multiple Access



SCMA



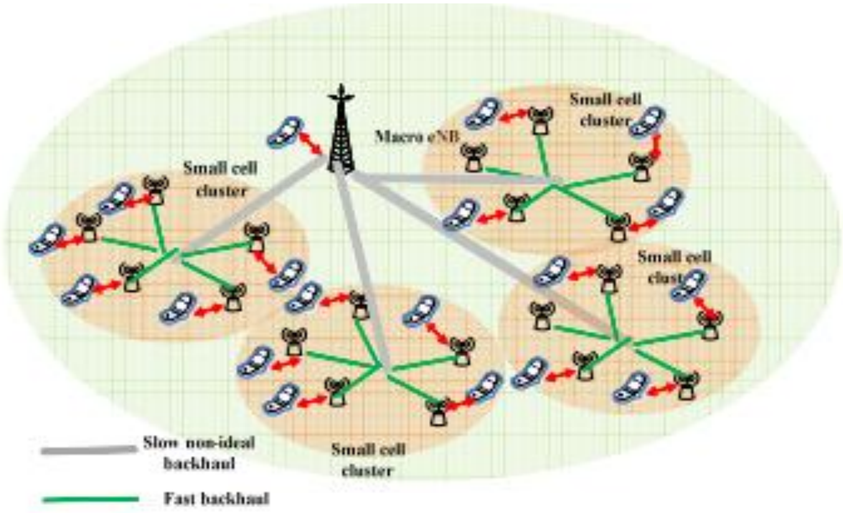
PDMA



MUSA

- Benefit to spectral efficiency, connection capability, and latency in various scenarios
- Candidate schemes: SCMA, PDMA, MUSA, NOMA, etc.

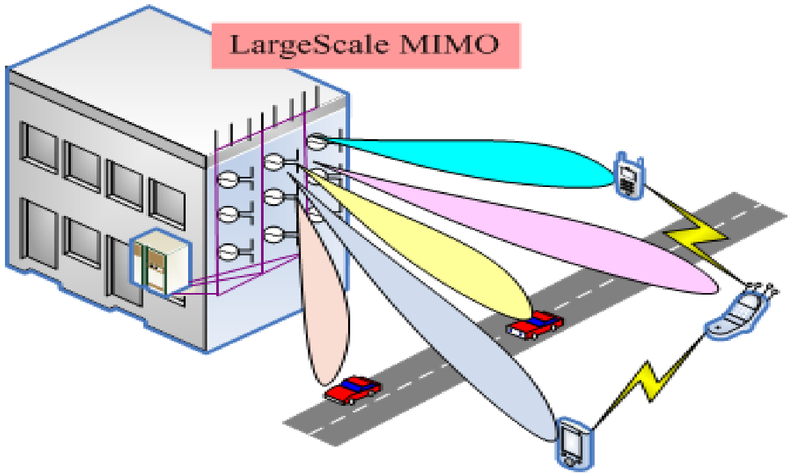
Ultra-Dense Networking



- Most important way to meet 1000x traffic growth.
- Research areas: interference suppression, virtual cell, joint access and backhaul, etc.

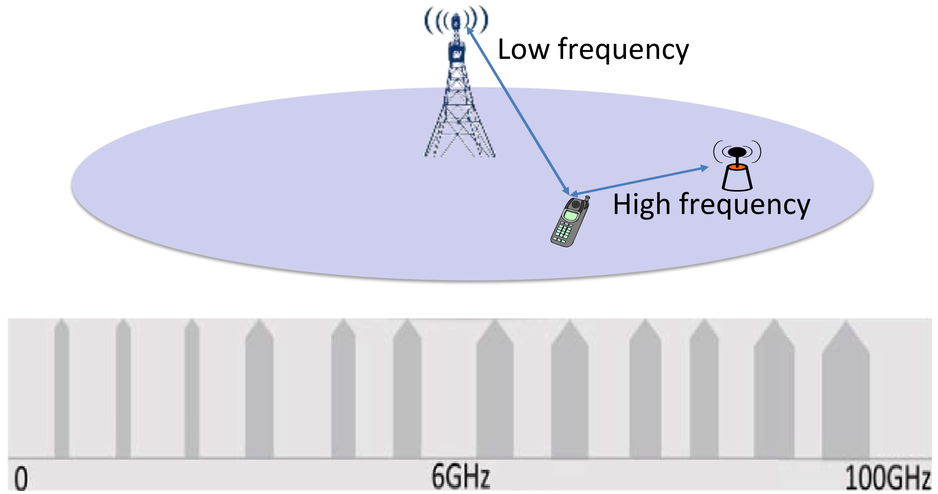
5G Key Wireless Technologies

Massive MIMO



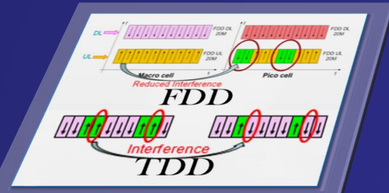
- Improve the spectral efficiency of multi-user systems by several folds
- Key issues: Channel estimation and feedback, reference signal design, antenna array design, and low-cost implementation

All-Spectrum Access

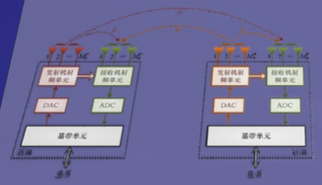


- High / low, paired / unpaired, licensed / unlicensed, contiguous / non-contiguous bands
- Key issues: Channel measurement and modeling, unified access for low and high frequency, RF components

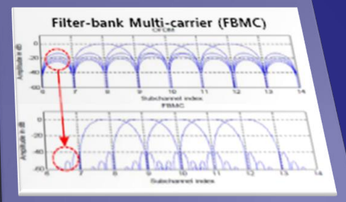
Other Potential Wireless Technologies



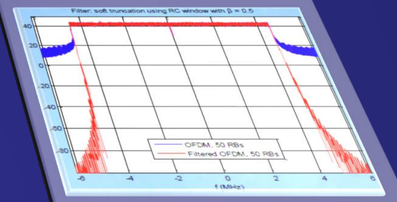
Flexible Duplex



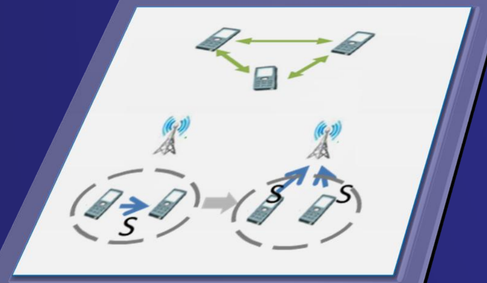
Full duplex



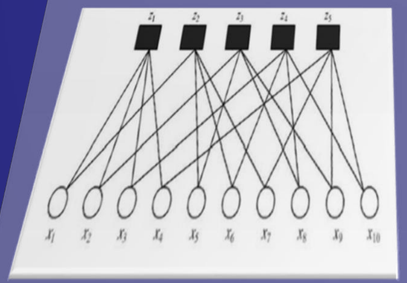
FBMC



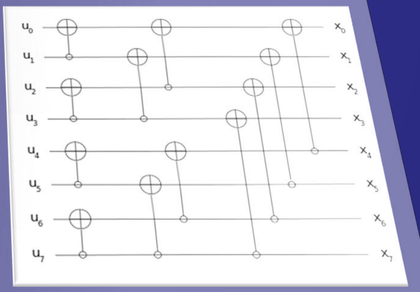
F-OFDM



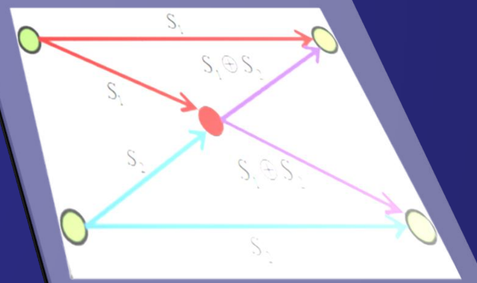
D2D



Q-ary LDPC



Polar codes

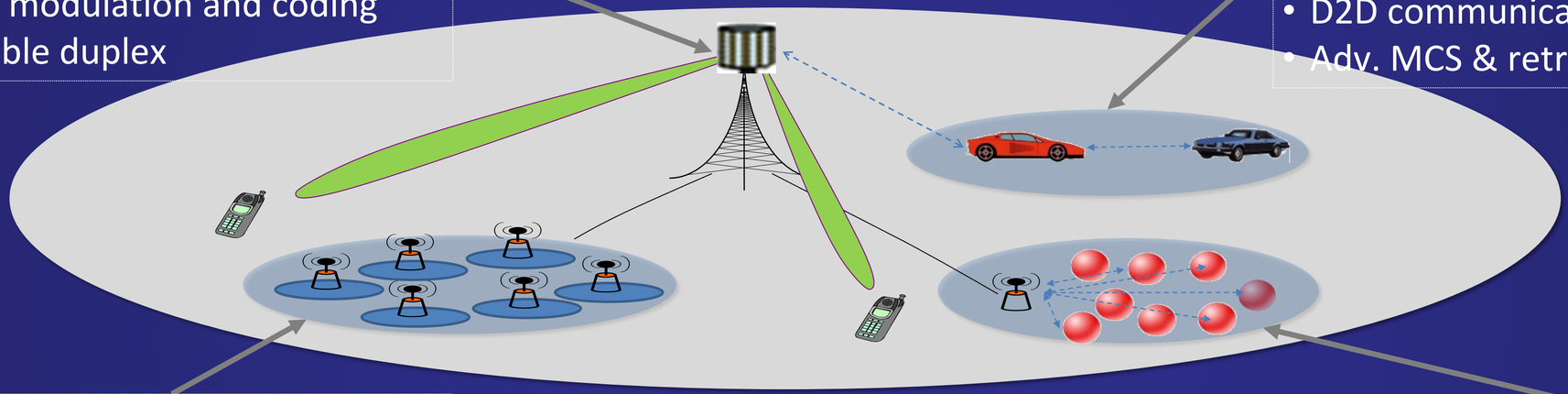


Network codes

Scenarios & Key Wireless Technologies

Seamless wide-area coverage
- Massive MIMO
- Novel multiple access
- Adv. modulation and coding
- Flexible duplex

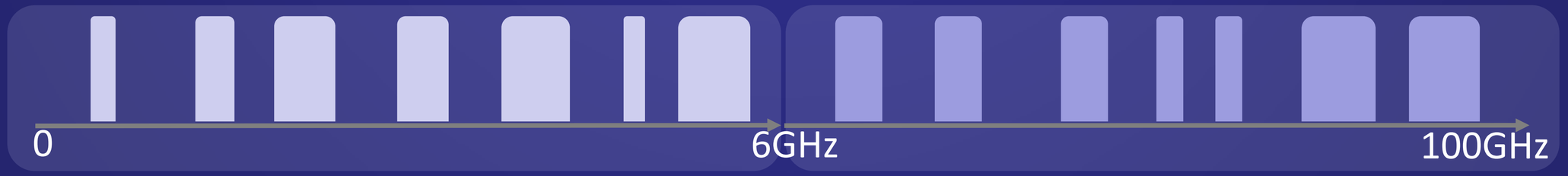
Low-latency high-reliability
- Short frame & optimized signaling
- Novel multiple access
- D2D communications
- Adv. MCS & retransmission



High-capacity hot-spot
- Ultra-dense networking
- Massive MIMO
- Novel multiple access
- Flexible/Full duplex

Low-power massive-connections
- Novel multiple access
- FBMC / F-OFDM
- D2D communications
- Adv. modulation and coding

All-Spectrum Access

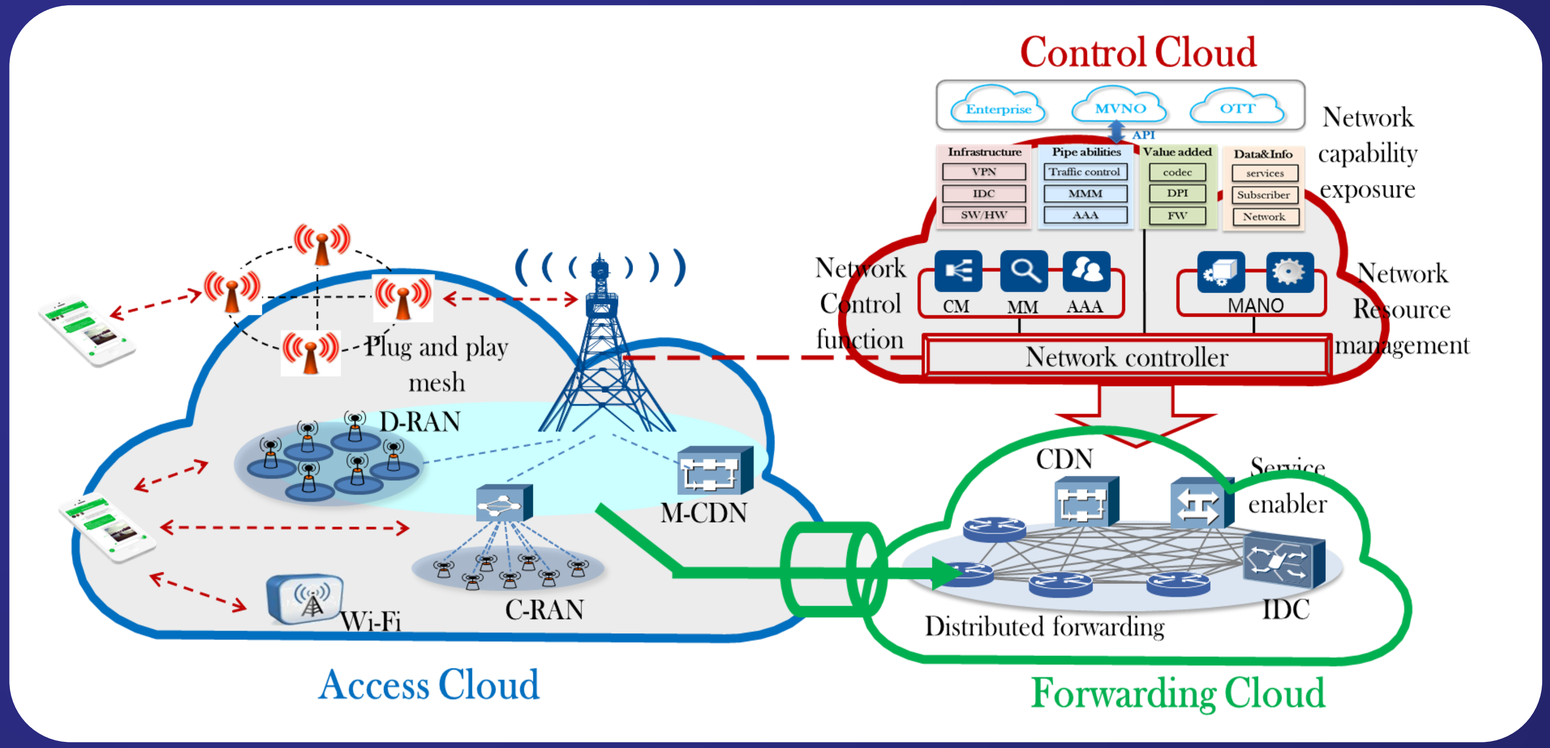


5G Network Architecture

Challenges

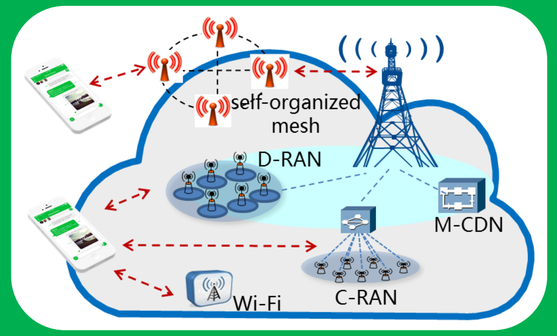
- ms-level E2E latency
- 1000x traffic growth
- Reliable & flexible QoS
- New scenarios & services
- Easier deployment, management & maintenance

“Three Clouds” Network Architecture



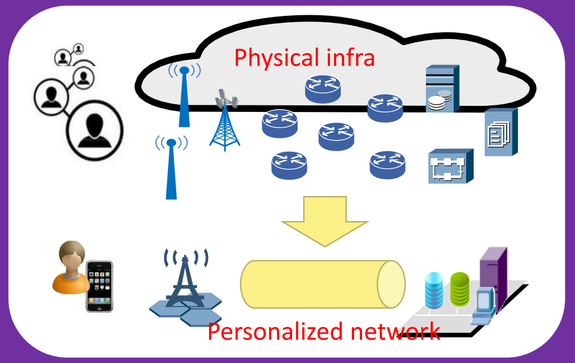
5G Key Network Technologies

New RAN Architecture



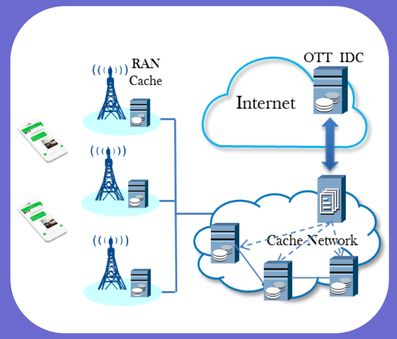
- C/U decouple
- Multi-RATs coordination
- Multi-architecture (C-RAN/D-RAN/Mesh)
- Plug-and-play

Customer-centric Network



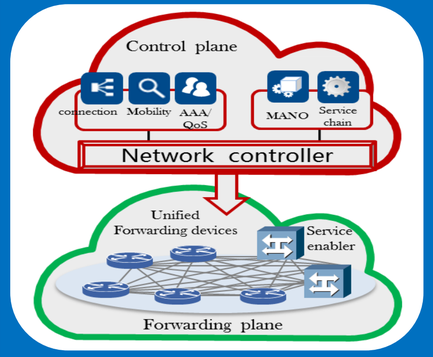
- Customer-centric Access
- Simplify multi-connection management mechanism
- Service provision optimization based on user preference

Mobile CDN



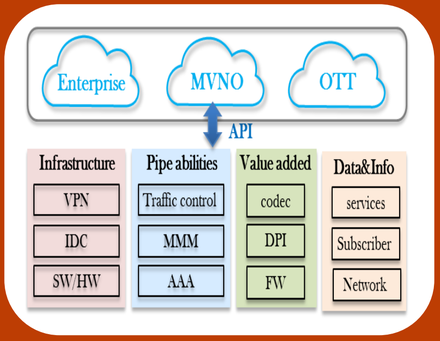
- 2 levels content offloading (RAN and CN)
- ms latency & high data rates
- Good experience

Resource Control and Service Steering



- Real-time traffic monitor
- Per-app resource reservation
- Intelligent value added service provision

Network Capabilities Exposure



- Adapting 3rd requirements to network capabilities
- Customized infrastructure
- Friendly API

5G Concept

5G Concept = “A Core KPI + A Group of Key Technologies”

The core KPI

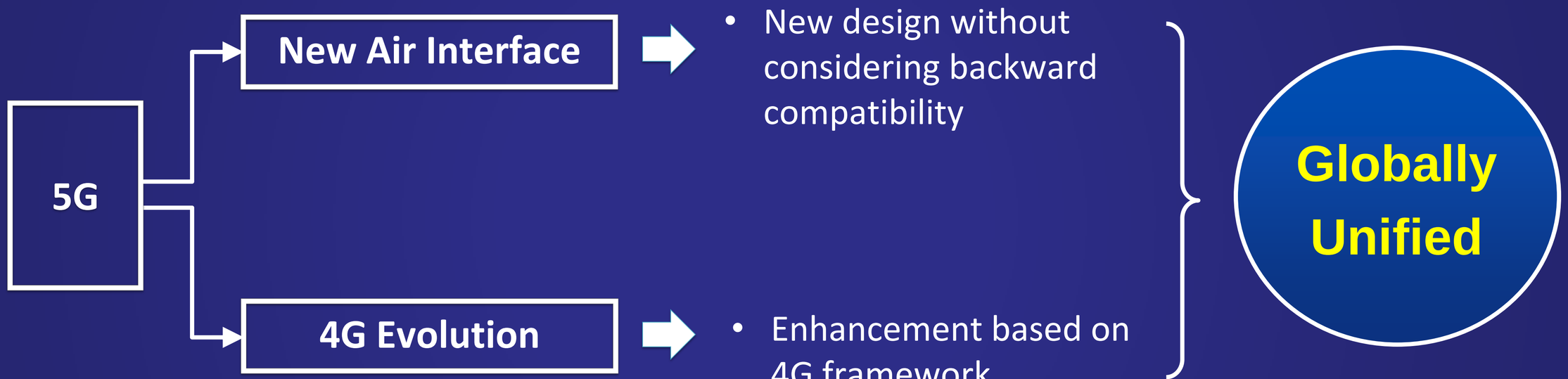
Gbps User Experienced Data Rate

- Traffic volume density
- Connection density
- E2E Latency
- Peak data rate
- Spectral efficiency
- Energy efficiency
- Mobility

The group of key technologies

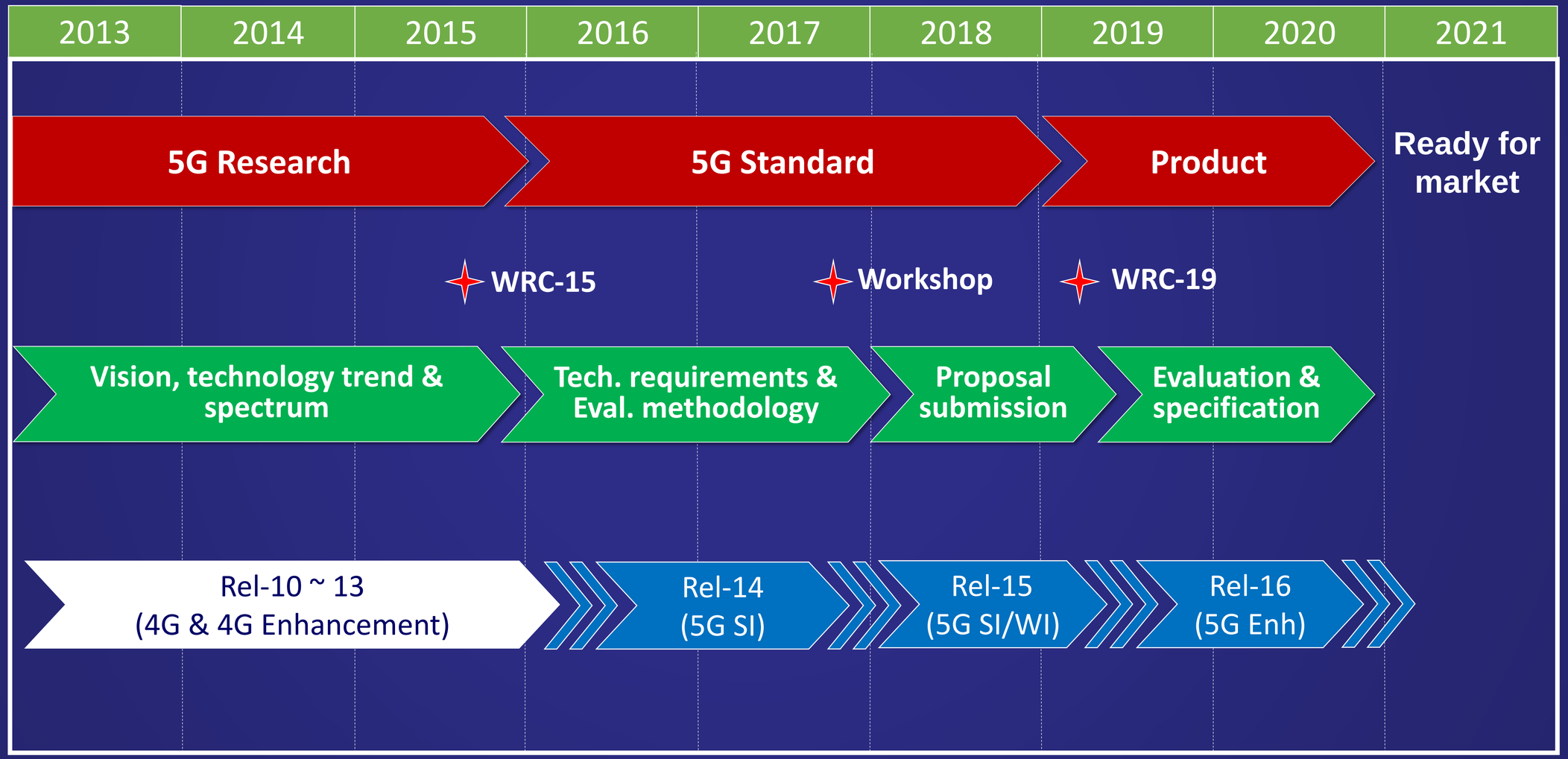
- **Novel Multiple Access**
- **Ultra-Dense Network**
- **Massive MIMO**
- **All-Spectrum Access**
- **New Network Architecture**

5G Technology Roadmap



Note: The next-generation WLAN (802.11ax) is considered as an important supplement to 5G.

5G Time Plan


2013
2014
2015
2016
2017
2018
2019
2020
2021
5G Research
5G Standard
Product
Ready for market
WRC-15
Workshop
WRC-19
Vision, technology trend & spectrum
Tech. requirements & Eval. methodology
Proposal submission
Evaluation & specification
Rel-10 ~ 13 (4G & 4G Enhancement)
Rel-14 (5G SI)
Rel-15 (5G SI/WI)
Rel-16 (5G Enh)

Summary

5G Concept

- The core KPI
  - Gbps user experienced data rate
- Key technologies
  - Novel multiple access
  - Ultra-dense networking
  - Massive MIMO
  - All-spectrum access
  - New network architecture

5G Roadmap & Scenarios

- Technology roadmap
  - New air interface
  - 4G evolution
- Technical scenarios
  - Seamless wide-area coverage
  - High-capacity hot-spot
  - Low-power massive-connections
  - Low-latency high-reliability

THANK YOU!

IMT-2020 (5G) Promotion Group is willing to strengthen international collaboration to promote globally unified 5G standardization and industrialization.

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