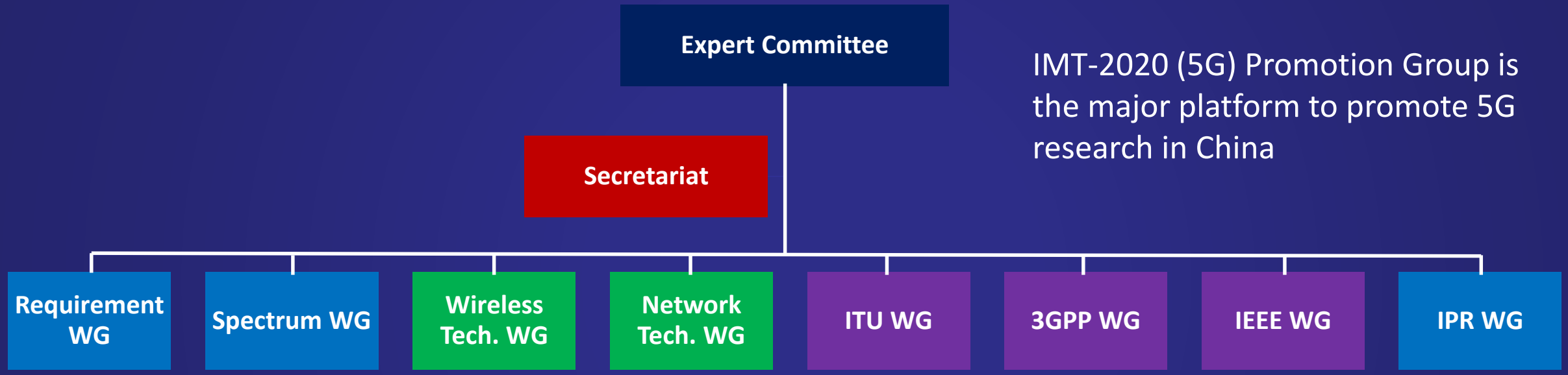
5G Research Status in China

IMT-2020 (5G) Promotion Group

September 10, 2015

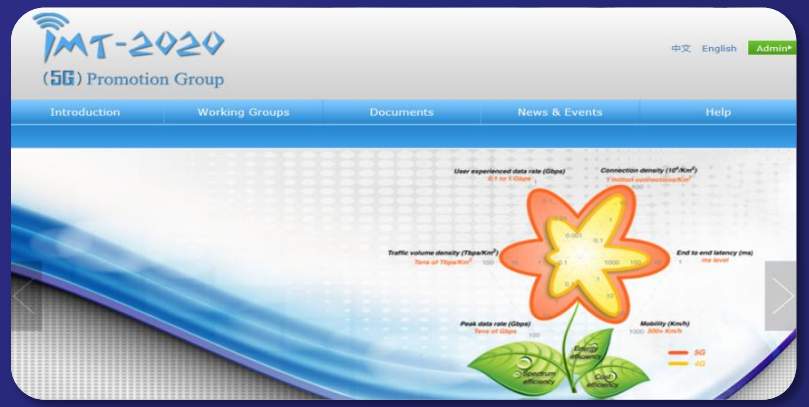
IMT-2020 (5G) Promotion Group Structure



IMT-2020 (5G) Promotion Group is the major platform to promote 5G research in China

- The Group has 56 members including the main operators, vendors, universities, and research institutes in China.

- Official website: www.IMT-2020.cn



IMT-2020(5G) Promotion Group Activities

5G Summit

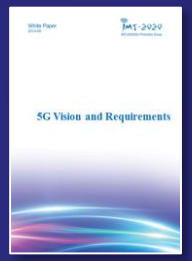
2013: 5G Vision

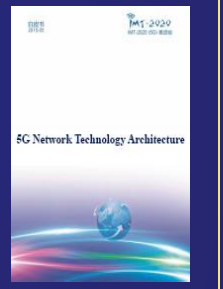
2014: 5G objective& capability

2015: 5G Technology architecture

5G Whitepaper

- May 2014: 5G Vision and Requirements
- Feb 2014: 5G Concept
- May 2015: 5G Wireless Architecture
- May 2015: 5G Network Architecture



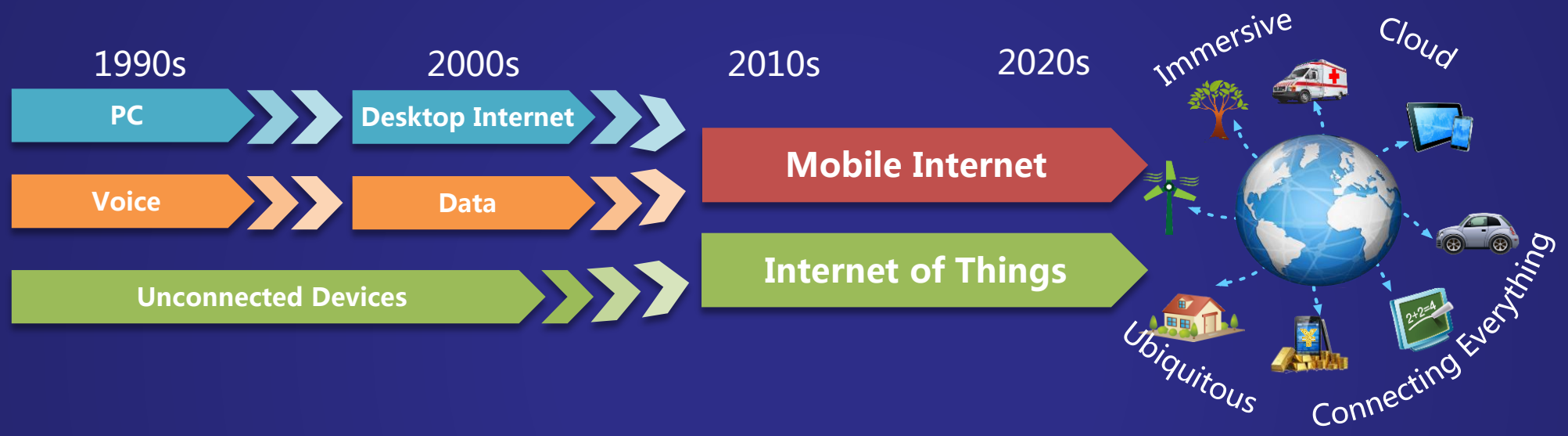


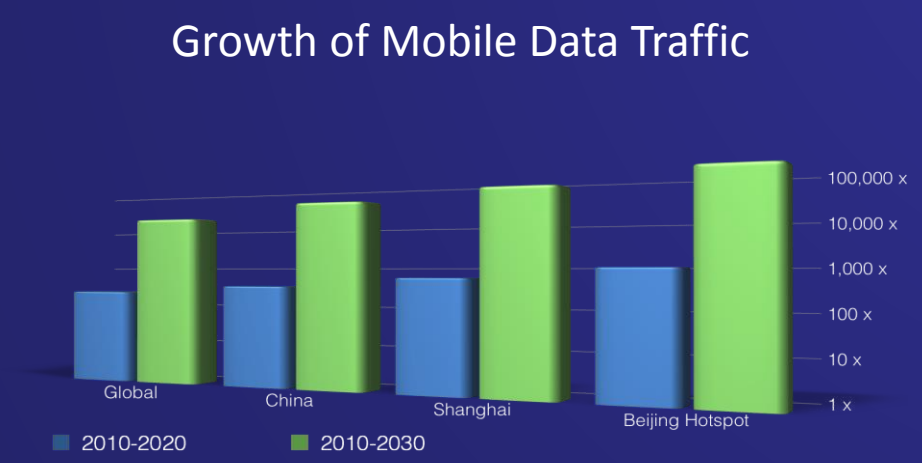
International Cooperation

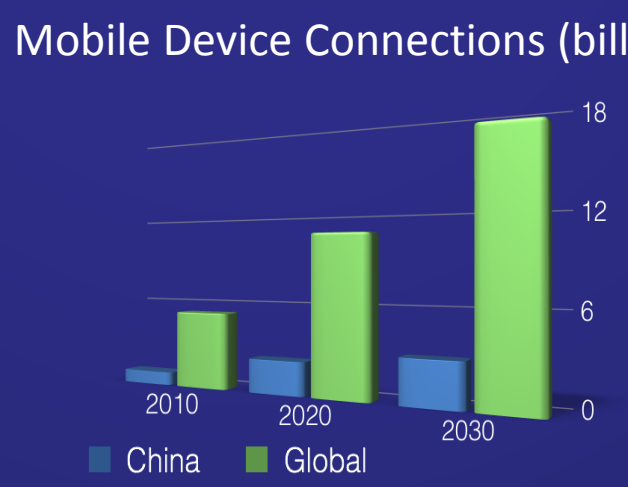
IMT-2020 PG will be more positive and open to co-work with the global industry

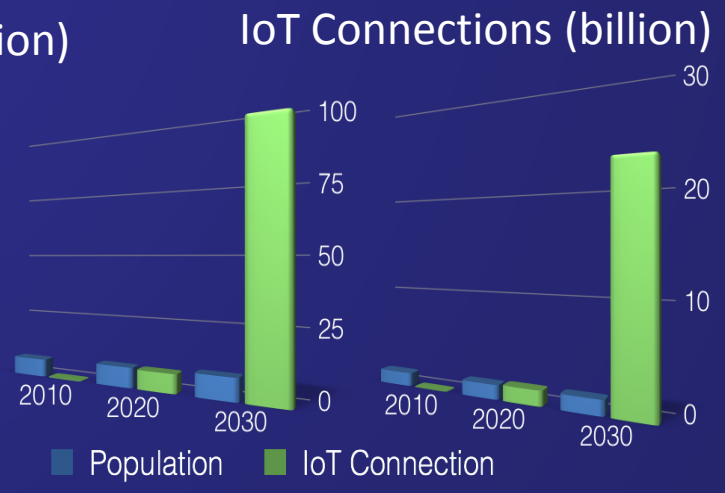
5G PPP · 5G Forum · 5G IMF The Fifth Generation Mobile Communications Promotion Forum · ngmn the engine of broadband wireless innovation · ··

5G Main Drivers and Marketing Trends







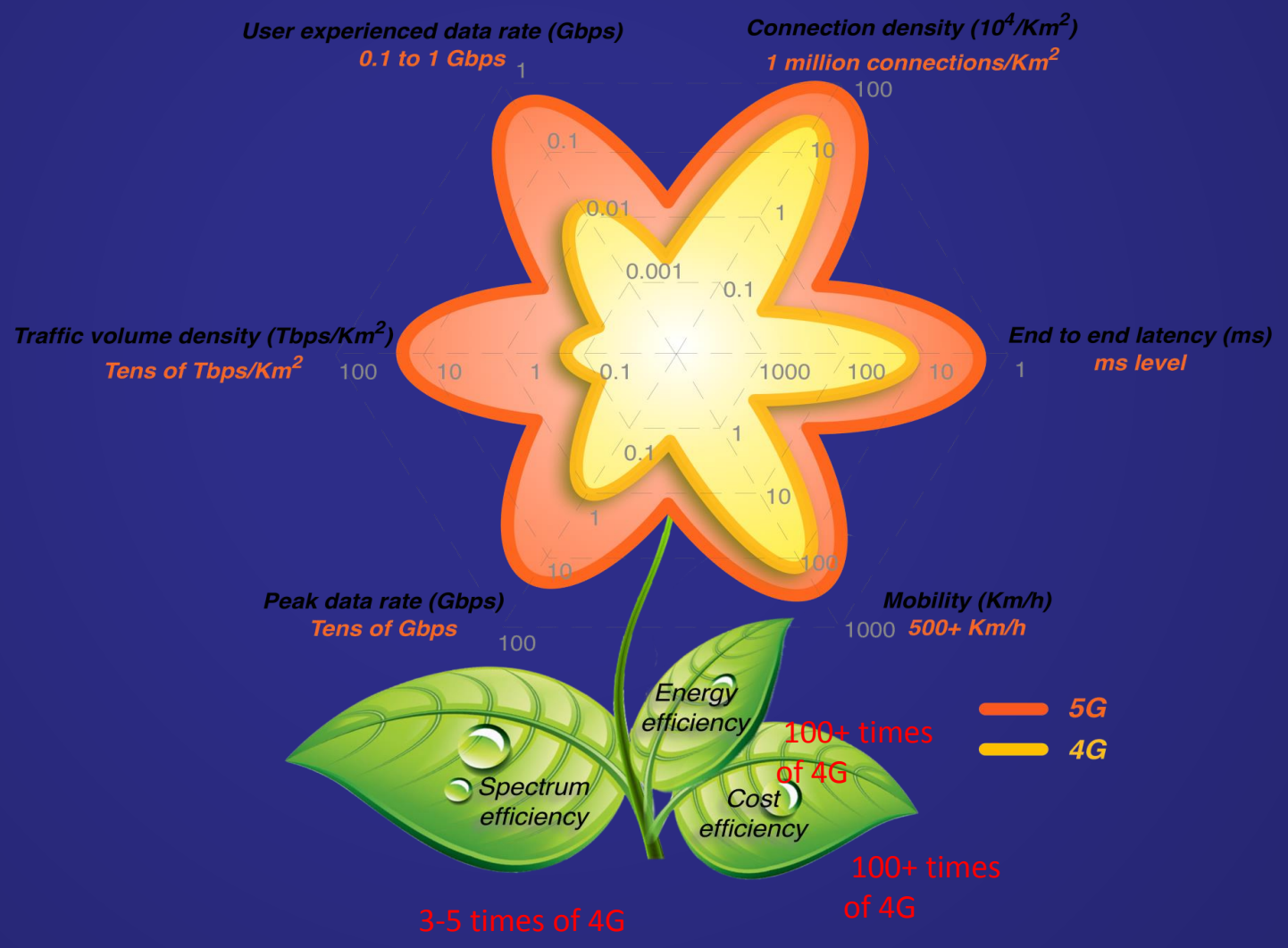


Visions of 5G Life--
Information a finger away, everything in touch

5G Key Capabilities

6 performance capabilities

3 efficiency capabilities



5G Technical Scenarios and Challenges

Mainly for Mobile Internet

Seamless Wide-Area Coverage

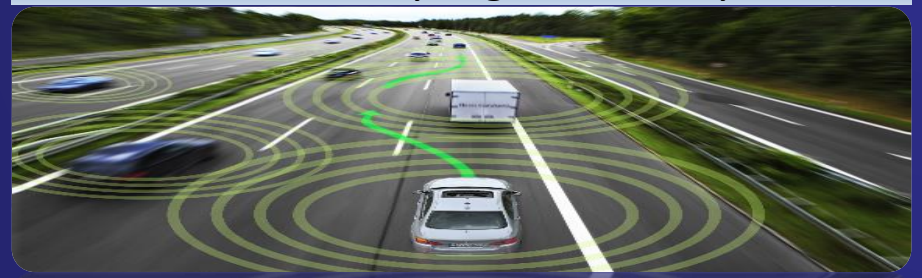
- User experienced data rate: 100 Mbps

High-Capacity Hot-Spot

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

Mainly for IoT (new scenarios)

Low-Latency High-Reliability



- Air interface latency: 1 ms
- Reliability: nearly 100%

Low-Power Massive-Connections

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

5G Potential Candidate Bands Research

Low-frequency bands below 6GHz are always necessary for IMT

2015

ITU WRC-15

High-frequency bands within 6-100 GHz can be introduced in 2019 and beyond

2019

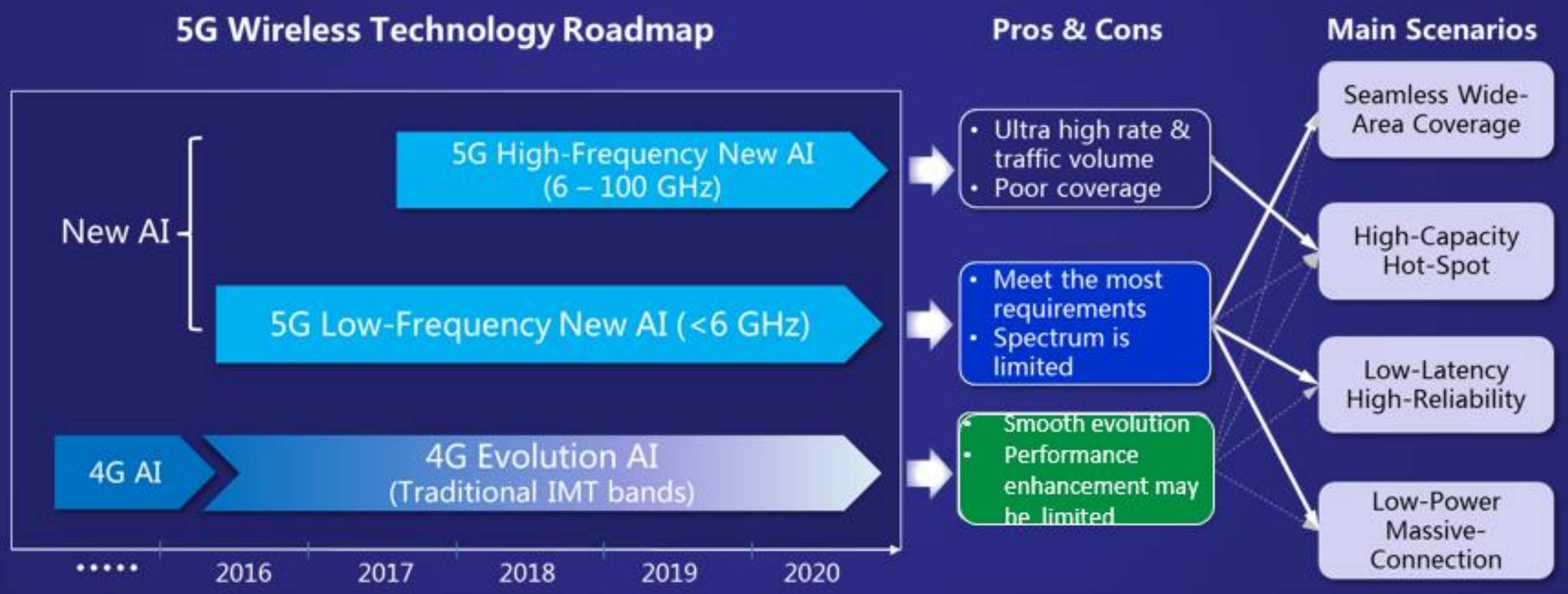
- Exploit the bands identified for IMT in the Radio Regulations, including 450-470MHz, 698-806MHz, and 3400-3600MHz

- Several potential candidate bands within 6~100GHz are selected.
- With different channel properties and coexistence situations.
- Studies on channel measurement, modeling and coexistence are ongoing work.
- To promote establishing a new agenda item in WRC-19.

0 | 450 MHz | 2G/3G refarming | 3GHz | 3.3~3.4 | 3.4~3.6 | 4.4~4.5 | 4.8~4.99 | 6GHz | ••• | 24-30 | 31-34 | 40-50 | ••• | 71-76 | ••• | 81-86 | ••• | 100GHz

Get new bands below 6GHz in WRC-15 AI 1.1

5G Wireless Technology Roadmap



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

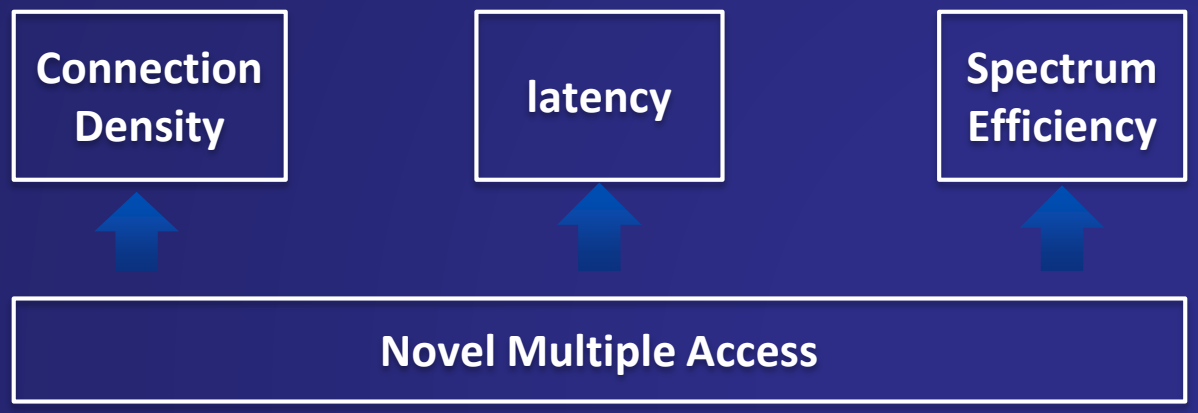
Ultra-Dense Network

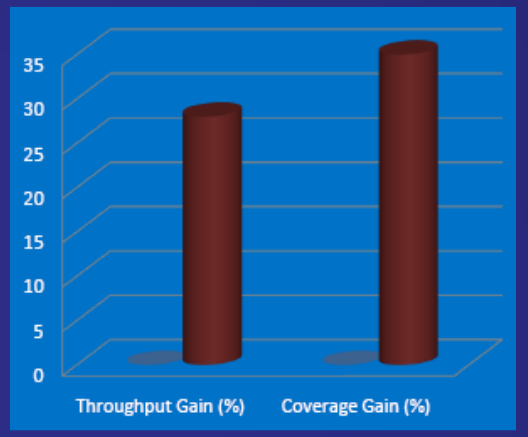
Massive MIMO

All-Spectrum Access

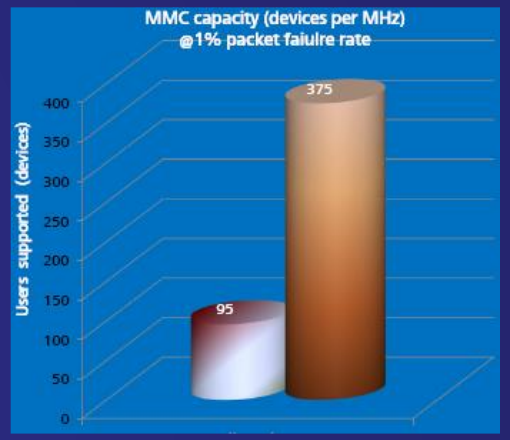
New Network Architecture

Novel Multiple Access





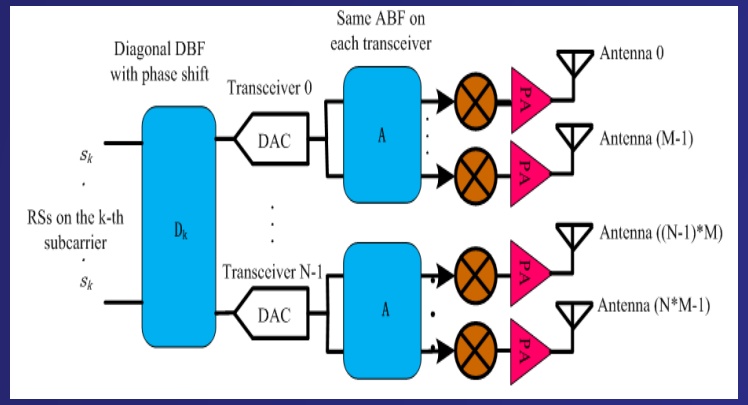
Downlink

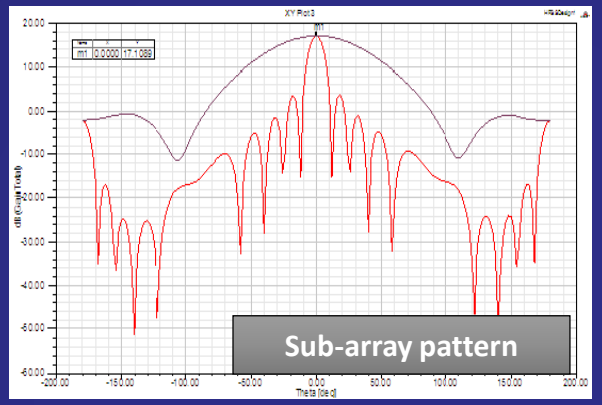


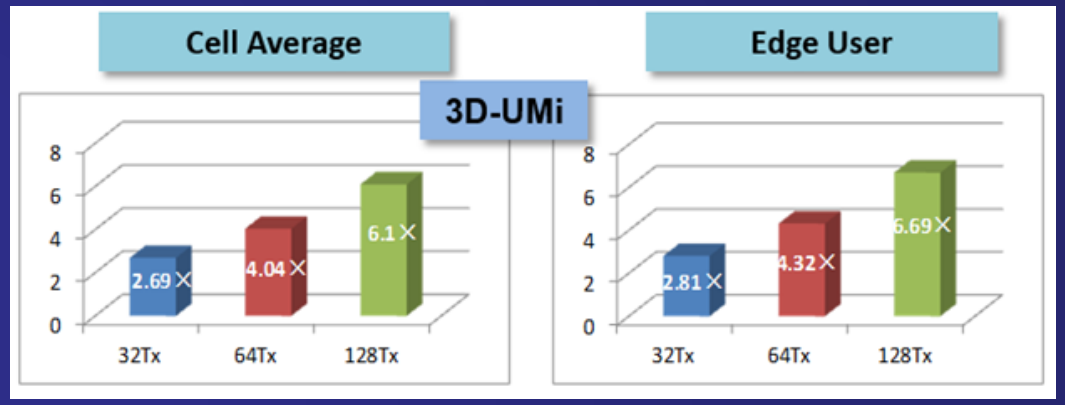
Uplink

- NMA is one of the 5G core technologies, applicable to a variety of 5G typical scenarios
- NMA can significantly improve the spectrum efficiency and access capability by superimposing multi-users information in the same transmission resources and utilizing advanced algorithm to recover multiuser information at the receiver
- Advantages:
  - Connection density → above 300%
  - Latency → grant free transmission
  - Spectrum efficiency enhancement→ DL: ~30%

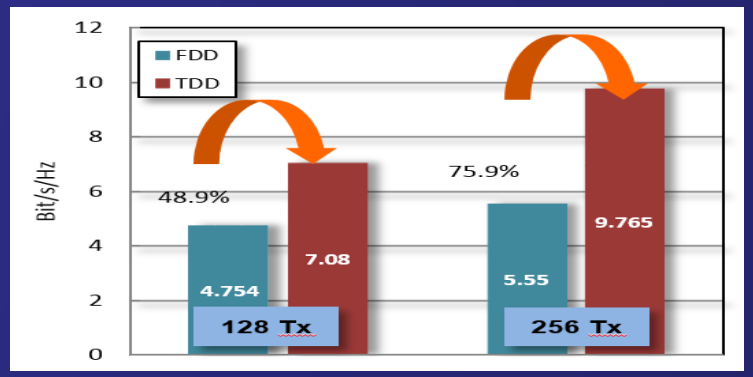
Massive MIMO

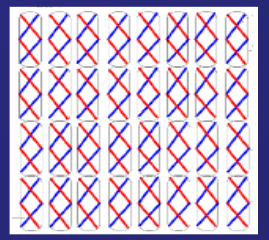






- Massive MIMO is one of most efficient way to improve spectrum efficiency, especially for outdoor scenarios.
- More suitable for TDD mode due to channel reciprocity
- Compared with legacy LTE, Massive MIMO can achieve ~10X spectrum efficiency in theory.
- Massive MIMO is close related with frequency band:
  - Low frequency band: improve spectrum efficiency by multi-user spatial multiplexing
  - High frequency band: compensating the increased path loss
- RF front end and antenna cost is key for industrial application





Ultra-Dense Network

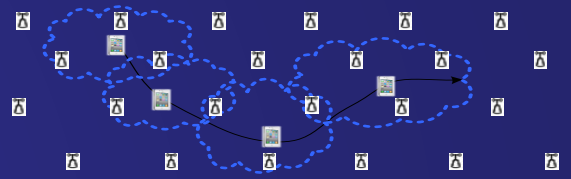
UDN Scenarios

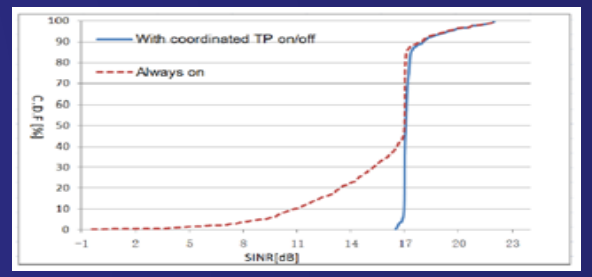
Problems

- More frequent handovers
  - More signaling overhead
  - more often Ping-pong
- Increased interference
  - Loss of throughput
  - Capacity limited
  - Decreased QoE

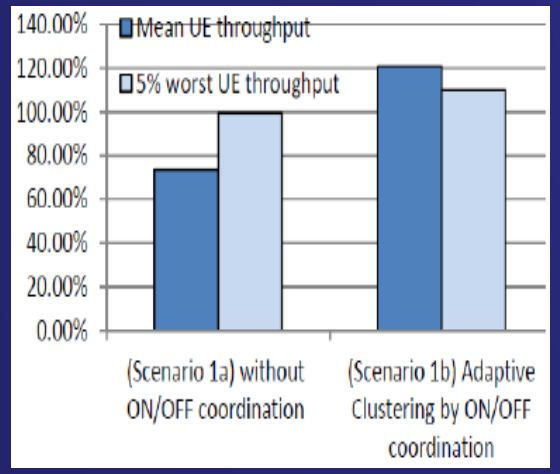
Cell virtualization

- User always at the "center" of the cell
- Effective way to deal with mobility and interference in UDN
- User is served by one or several TP dynamically
- Simulation result show that SINR can be keep >16.5dB





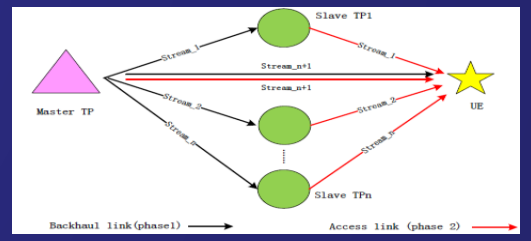
Interference suppression

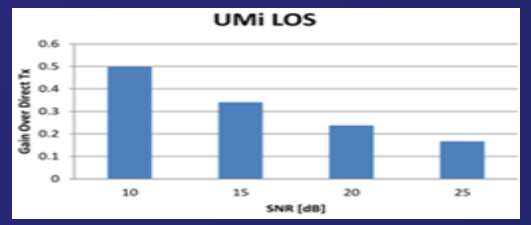


- Adaptive clustering is a effective interference avoid method
- Adaptive clustering by turning on/off small cells based on the proportional fair metrics assuming different interference conditions

Joint access and backhaul

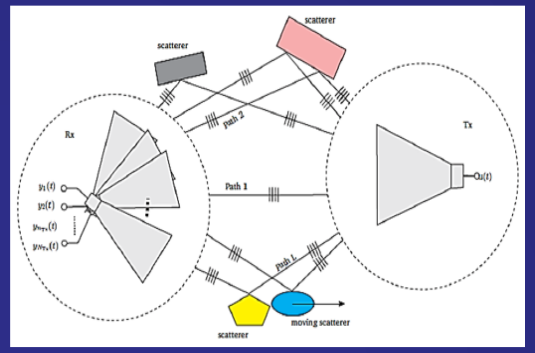
- Backhaul link: of broadcast nature
- Access link: of multiple access
- Gain come from:
  - Diversity gain due to route selection
  - Multi-hop gain

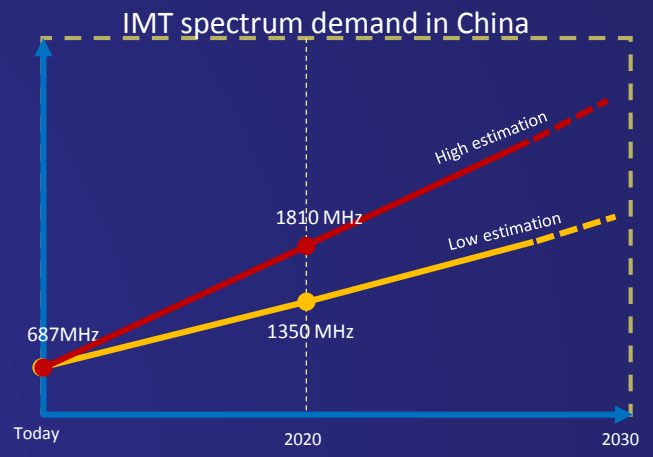


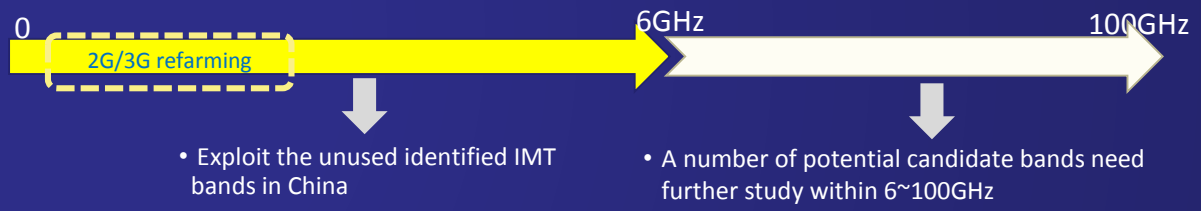


All-Spectrum Access

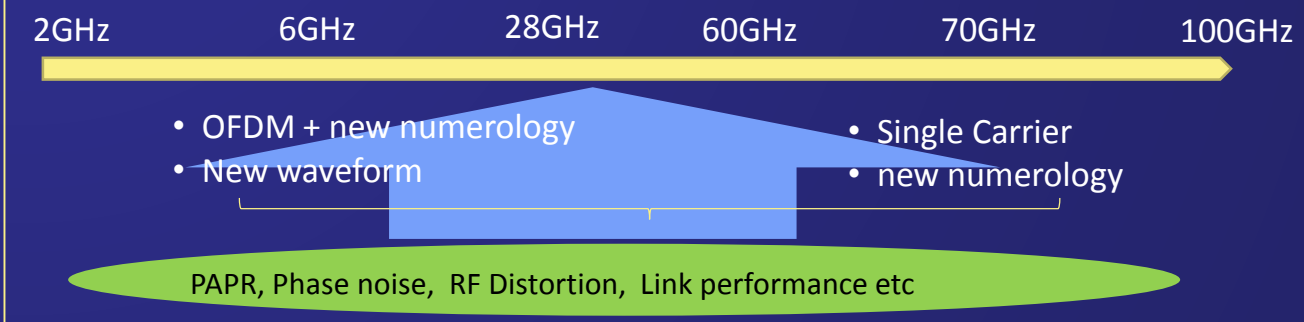
- Spectrum demand by 2020 in China: more than 1350 MHz spectrum resource
- No agreement on 5G candidate frequency band in global industrial
- No consensus on methods for high frequency measurement and modeling by now
  - Horn antenna vs. omnidirectional antenna
  - Channel transmission characters for HF bands different from LF bands
  - existing modeling method not suitable for HF band







- HF channel measurement and modeling is the foundation of the potential candidate band selection and system scheme design
- New air interface design is needed, closely related with frequency band
  - Short frame design, dynamic beam tracking, new waveform, new numerology



5G AI Technical Framework

Frame Structure & Channelization

Flexible TTI, reference signals, physical channels, ….

Duplex | **Waveform** | **Antenna** | **Multi-Access** | **MCS**

Protocol

- Grant-free
- Adaptive HARQ
- Energy-saving mechanism

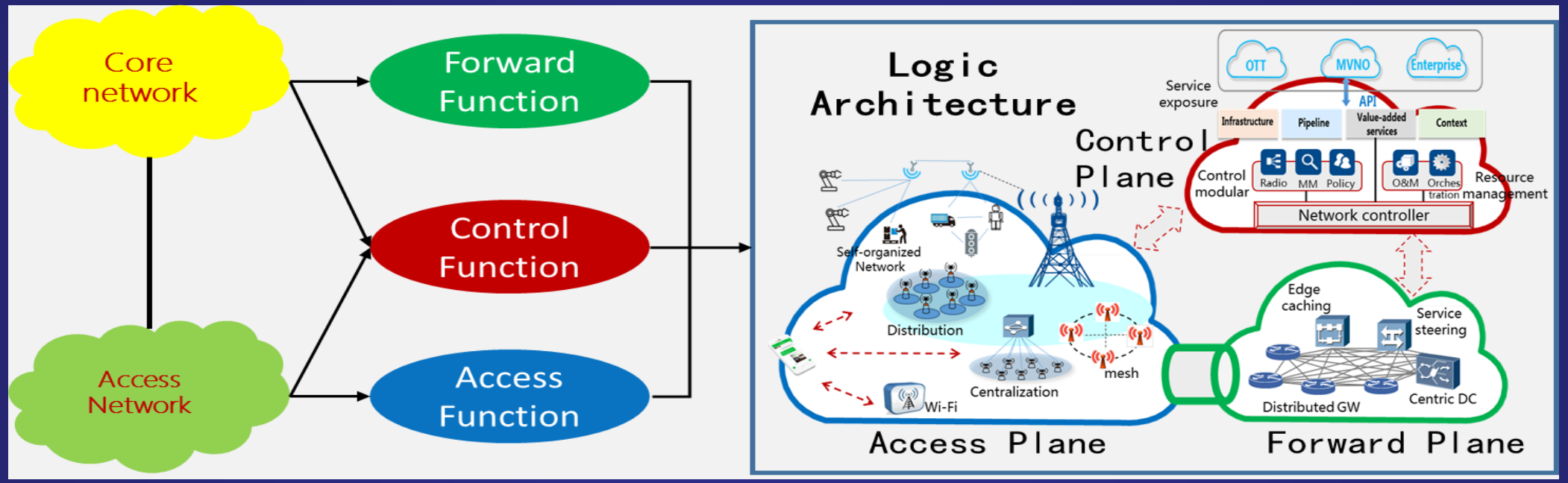
- Scenarios & KPIs
- Available bands
- Equipment capability
- Cost requirement
- ……

Requirement sets → **Flexible configuration** → **Optimized AI solutions**

e.g., Soft-Defined Radio

- Adapt to specific scenarios, even including the future possible new scenarios

Network Technologies Architecture



Access Plane	Control Plane	Forward Plane
• Diversity of network topology • User and service aware • Multi-RAT co-existence • Enhanced cooperation	• Logically centralized unified control • Global resource MGMT (inc. Radio) • On-demand orchestration • Friendly open platform	• Distributed GW • Simplified functions • Improved programmability • Edge computing and storage

Summary

- Mobile internet and IOT are main drivers of 5G
- 5G typical scenarios include seamless wide-Area coverage, high-capacity hot-spot, low-latency high-reliability and low-power massive-connections
- 5G concept can be defined by “A Core KPI + A Group of Key Technologies”, Massive MIMO, NMA, UDN and all spectrum access will be the core technologies for 5G.
- 5G roadmap includes new AI and 4G evolution AI, new AI has two branches: low frequency and high frequency new AI
- Based on unified AI technical framework, the optimized technical solutions can be derived for specific scenarios by flexibly configuring technical modules and parameters.

THANK YOU!

www.imt-2020.cn