



Trend of 5G application and industry development

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Course Objectives:

Introducing the main 5G service scenarios, technical KPI, and the application directions of mobile Internet and the Internet of things. Analyzing the important problems and main innovations, and looking forward to the trend of 5G development.



Agenda:

- 1. 5G service requirements**
2. Evolution trend of 5G network
3. Activities to promote the development of 5G industry

Mobile communications have changed the way of life



Phone & SMS



Browsing



Shopping



Social network



Navigation



Mobile communications have created a huge industry

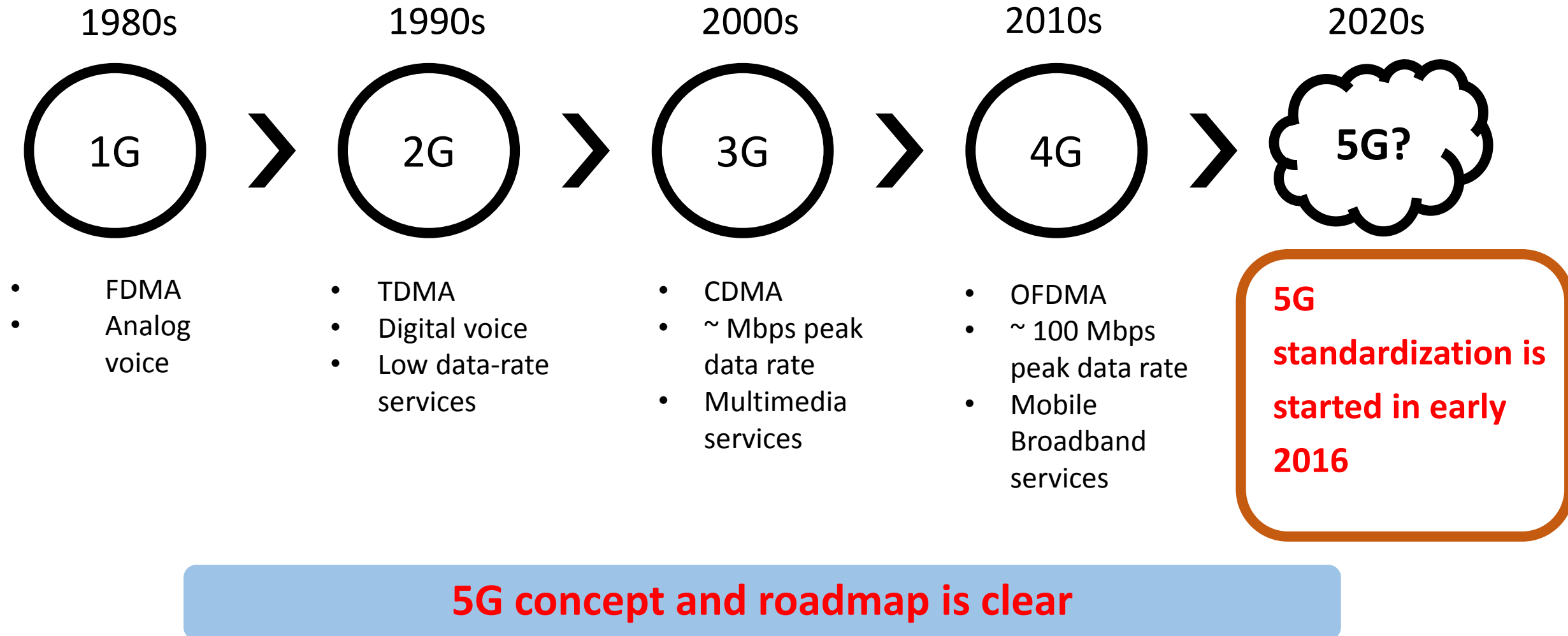
Global mobile users
>7 billion

Global mobile base stations
>16 million

Global mobile terminal shipment
>1 billion

Global mobile market scale
>1.5 trillion USD

5G has been a R&D focus worldwide




5G Use case



Broadband access everywhere

50+ MBPS EVERYWHERE

A speedometer icon with a needle pointing to the number 50, which is highlighted in a green box.

Broadband access in dense areas

PERVASIVE VIDEO

A globe composed of many small, colorful video screens, representing pervasive video.


Higher user mobility

HIGH SPEED TRAIN

A high-speed train in motion on a track, illustrating user mobility.

Massive Internet of Things

SENSOR NETWORKS

A diagram of a sensor network with nodes and connecting lines, representing the massive Internet of Things.

Extreme real-time communications

TACTILE INTERNET

A hand interacting with a virtual interface, representing tactile internet.

Lifeline communications

NATURAL DISASTER

A scene of a natural disaster with debris and damaged structures, illustrating lifeline communications.

Ultra-reliable communications

E-HEALTH SERVICES

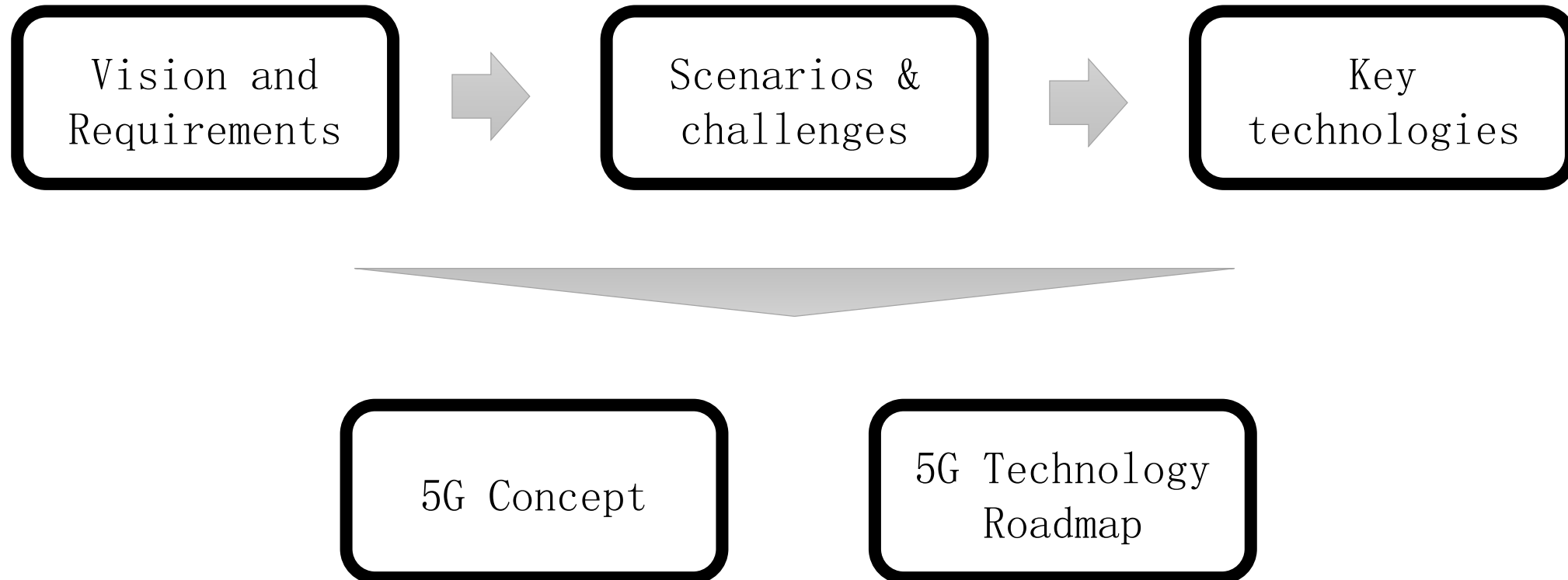
A doctor in a white coat holding a patient's arm, representing e-health services.

Broadcast-like services

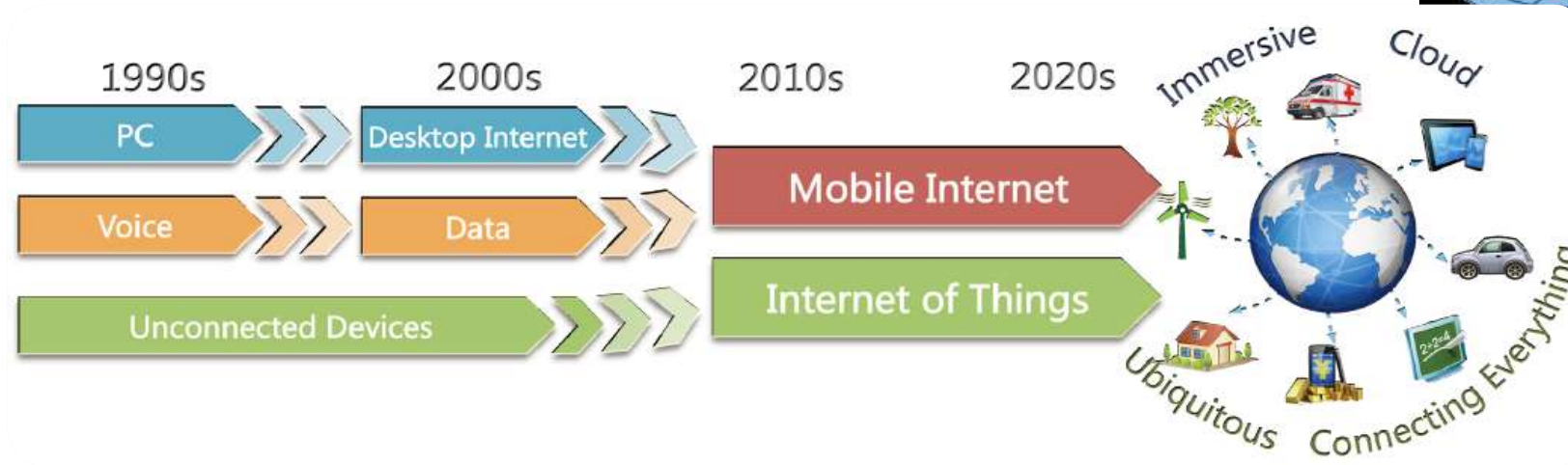
BROADCAST SERVICES

A globe with various icons representing broadcast services, such as a TV, a radio, and a mobile phone.

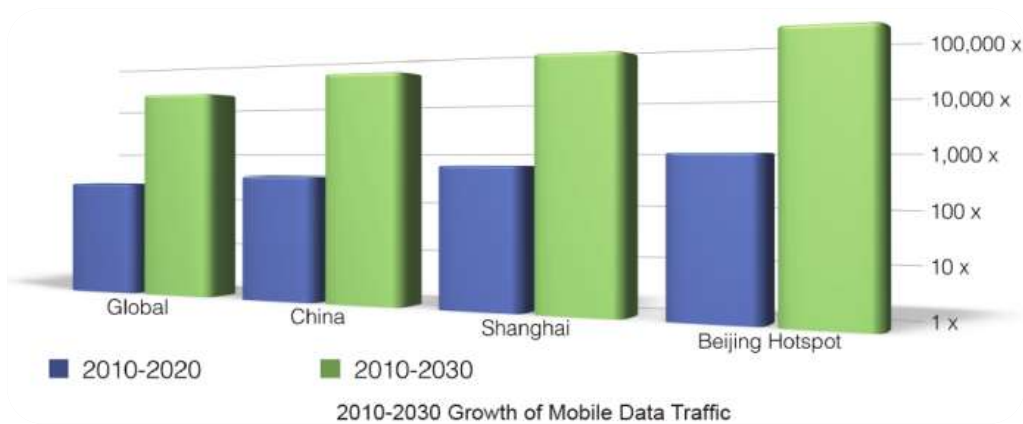
How to define 5G?



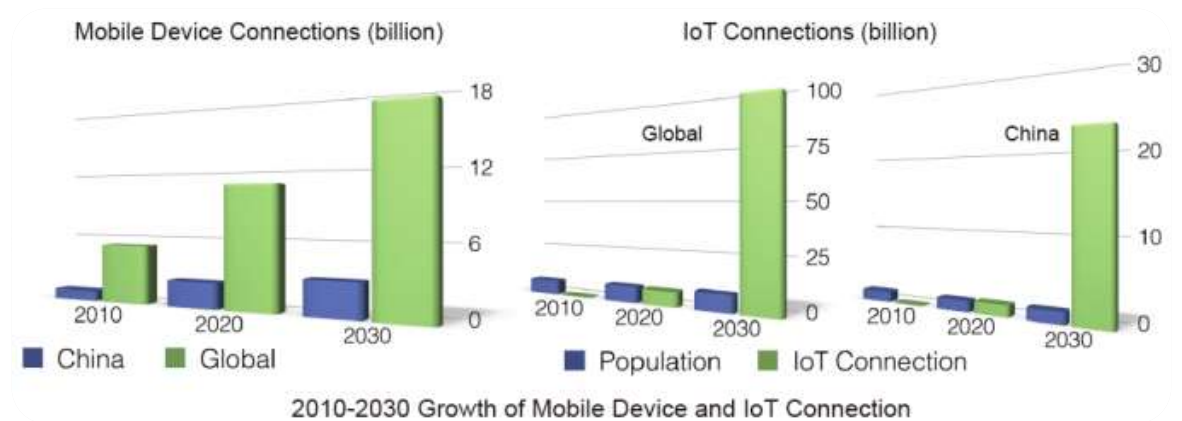
5G Main drivers: Mobile Internet and IoT



Mobile Data Traffic: Thousands of times growth



Mobile Internet & IoT Connections: Up to 100 billion



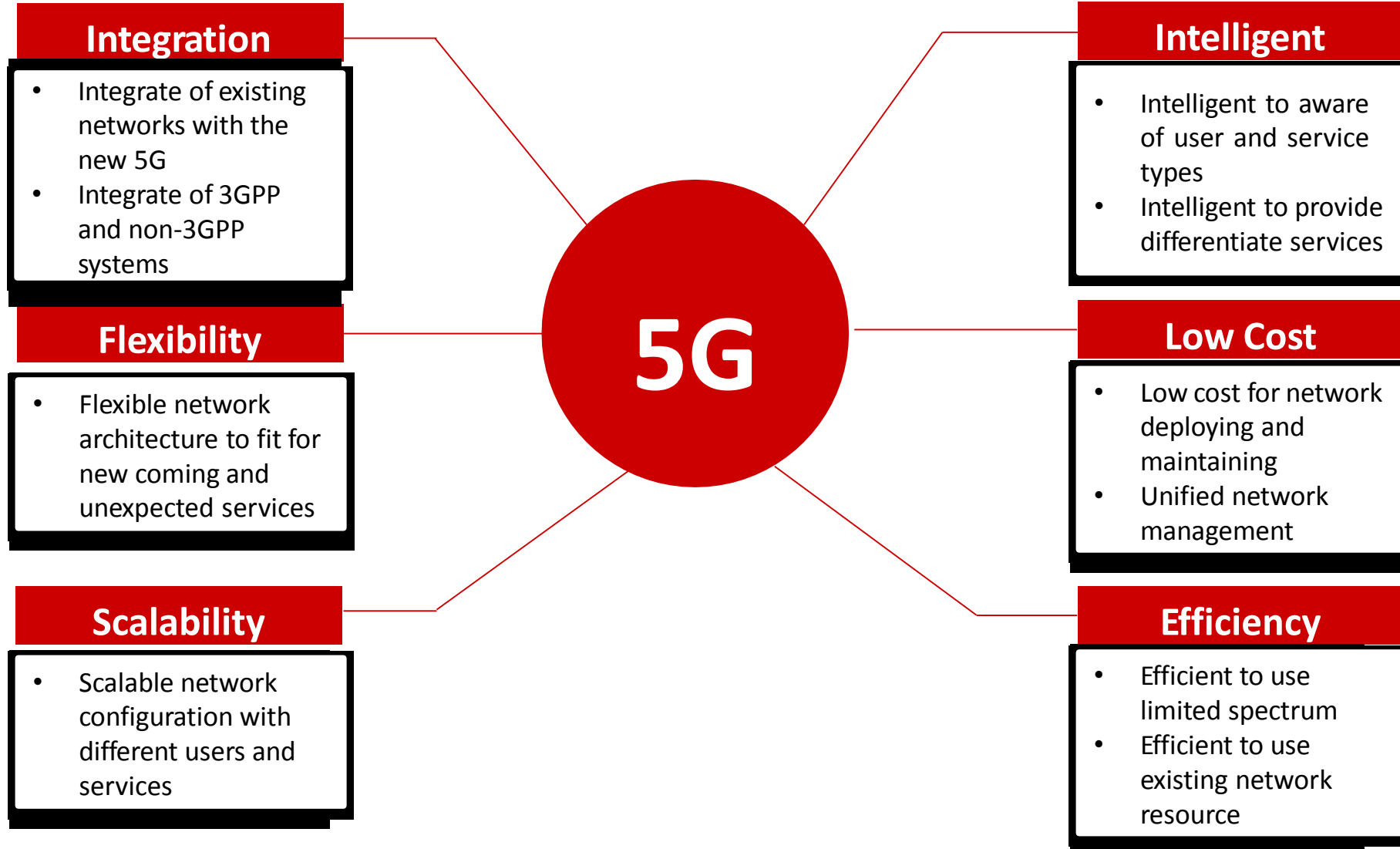
Challenges and Requirements



The three fundamental requirements for building 5G wireless networks are:

- Capabilities for supporting massive capacity and massive connectivity
- Support for an increasingly diverse set of services, application and users all with extremely diverging requirements for work and life
- Flexible and efficient use of all available non-contiguous spectrum for wildly different network deployment scenarios

Requirements on Operation



Vision of 5G life



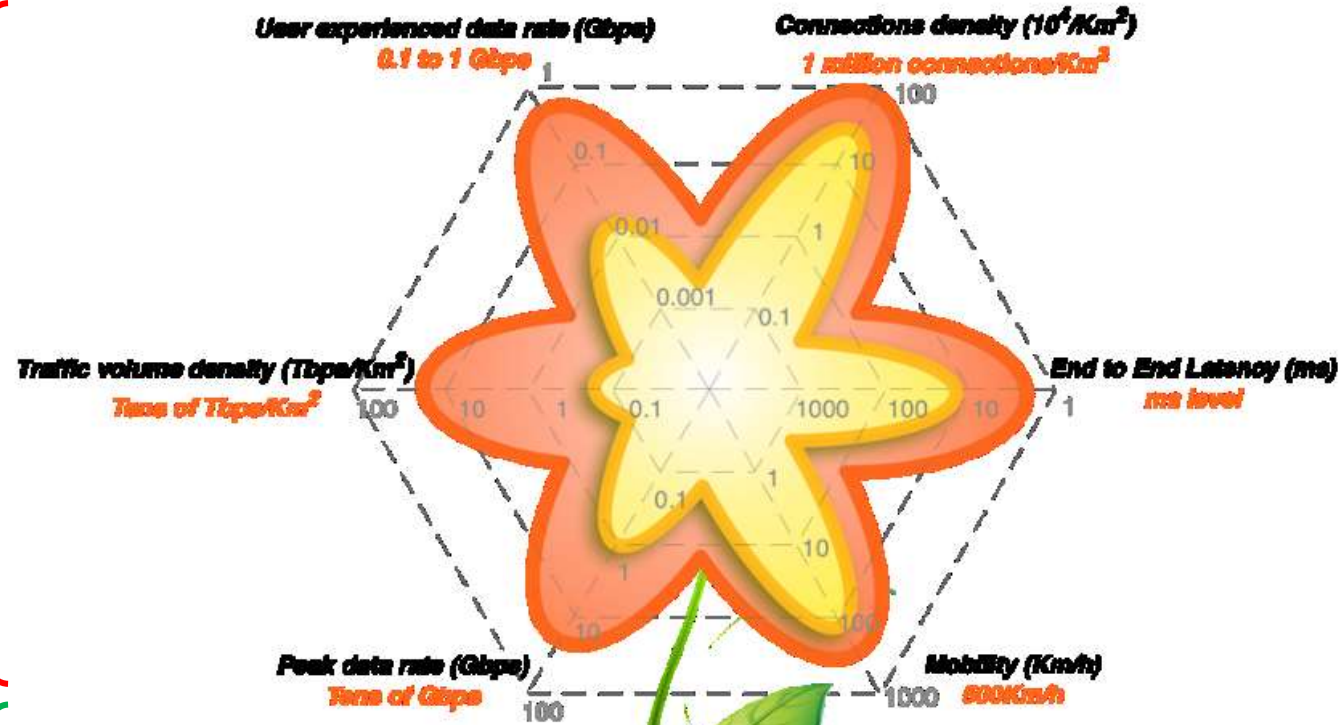
- Fiber-like access data rate
- “Zero” latency user experience
- Up to 100 billion connections
- Consistent experience under diverse scenarios
- Smart optimization based on services and users sensing
- 100 times improvement in energy and cost per bit

5G Vision - “Information a finger away, everything in touch”

5G Key Capabilities: The 5G Flower



Performance Requirements

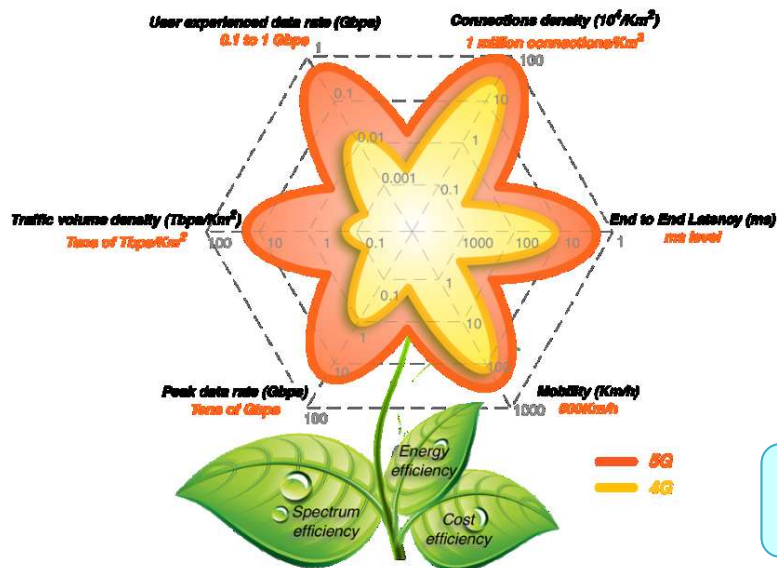


Efficiency Requirements

5G network evolution driven by Key Capabilities and Scenarios



Key Capab.



Typical Scenarios

Mobile Internet

Mobile IoT

Wide-area coverage

Hot-spot coverage

Low latency & high reliability

Low power & massive connections

Challenge to 5G network

Latency

End to End ms-level latency:

- base station to server
- base station to base station

Experienced data rate

Stable user experienced data rate

- 100Mbps in wide-area
- 1Gbps in hot spot

Mobility

New Mobility management mechanism to satisfy the requirement of UDN scenario

QoS

- Backhaul with higher reliability and capacity
- Differential service experience

5G Technical Scenarios and Challenges



Mainly for Mobile Internet

Seamless wide-area coverage



- User experienced data rate: 100 Mbps

Hot-spot high-capacity



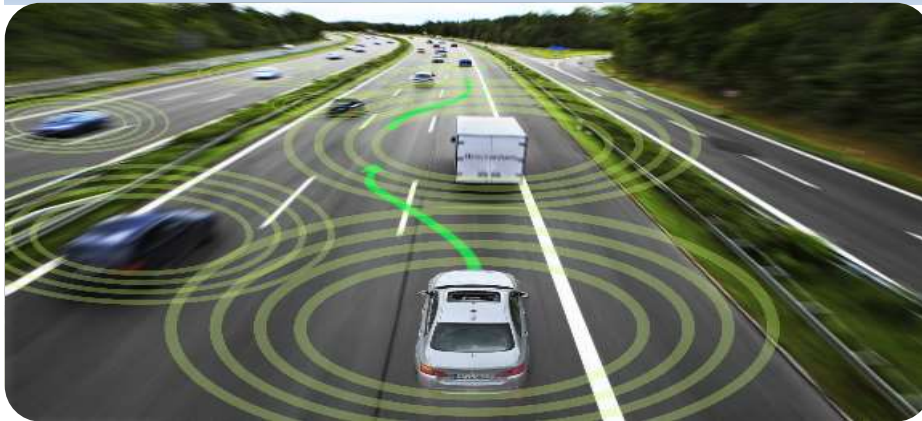
- User experienced data rate: 1 Gbps
- Peak data rate: Tens of Gbps
- Traffic volume density: Tens of Tbps/km²

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

Low power & massive connections



- Connection density: up to $10^6 - 10^7/\text{km}^2$
- Ultra-low energy consumption & cost efficiency



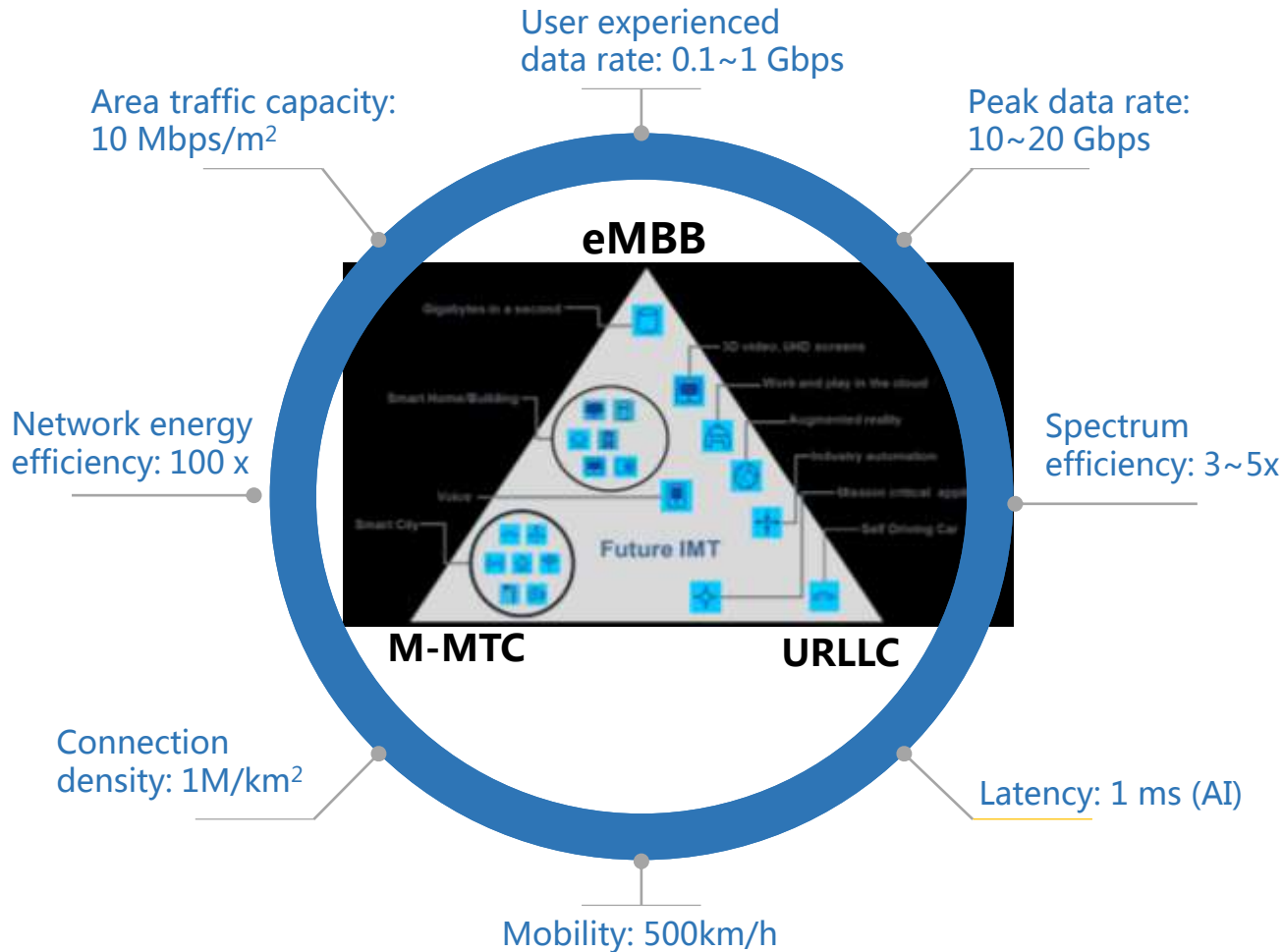
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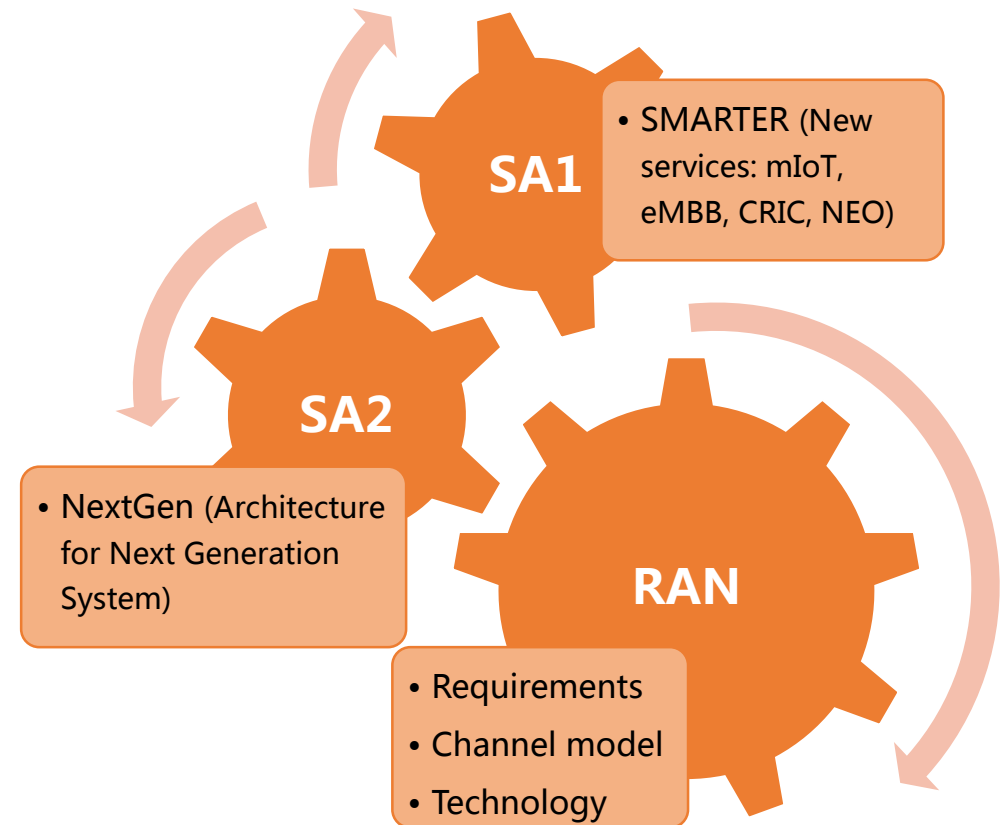
5G – From Research to Standardization



ITU : IMT-2020 vision was completed



3GPP : 5G study items started



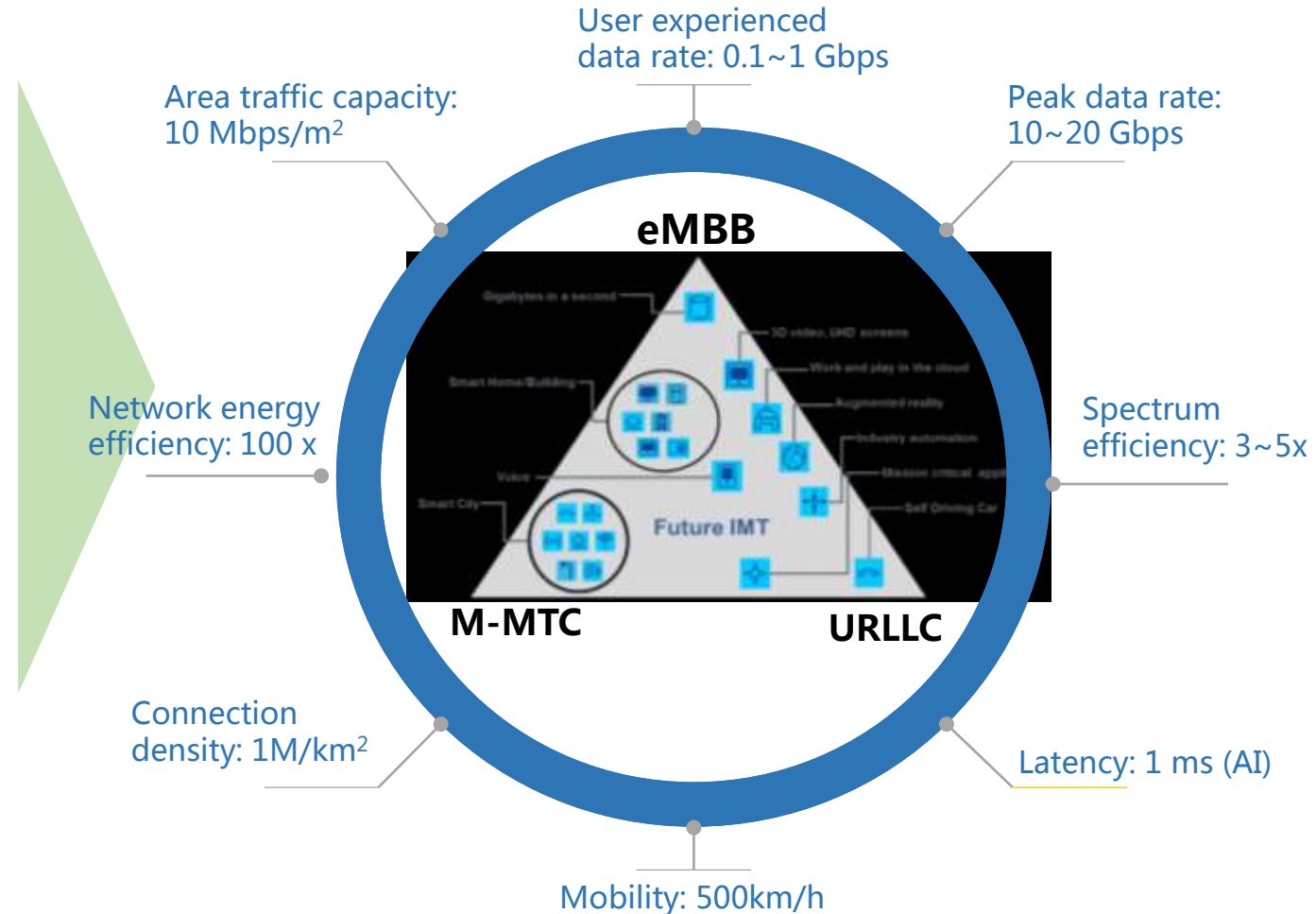
Challenges From 5G extreme KPI



5G extreme KPI

4G network capability

- ✓ Gateway throughput from 10Gbps to 100Gbps
- ✓ Single MME supports twenty million contexts and thirty thousand connections simultaneously ;
- ✓ Latency from eNB to PGW is up to 10ms level

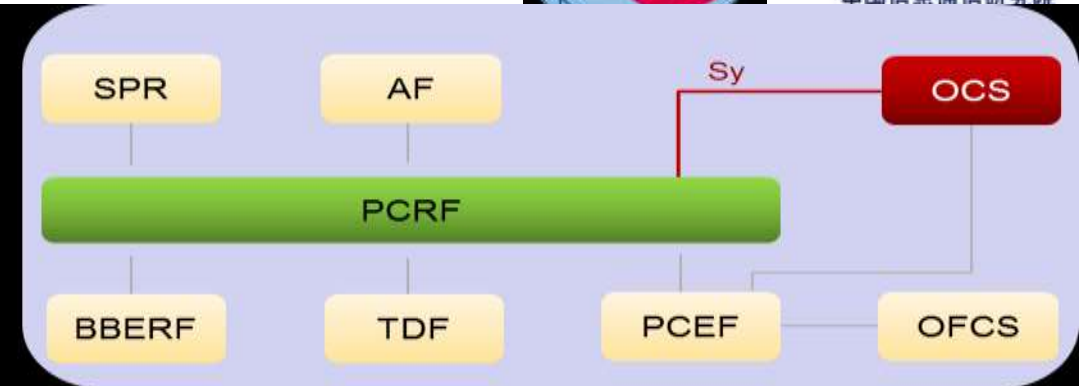
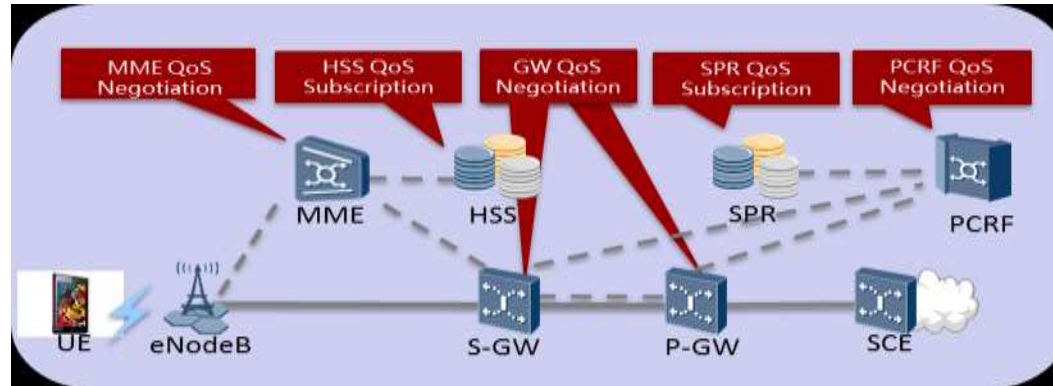


There is a wide (10 times to 100 times) gap between 4G and 5G KPI

The limitations of 4G network architecture

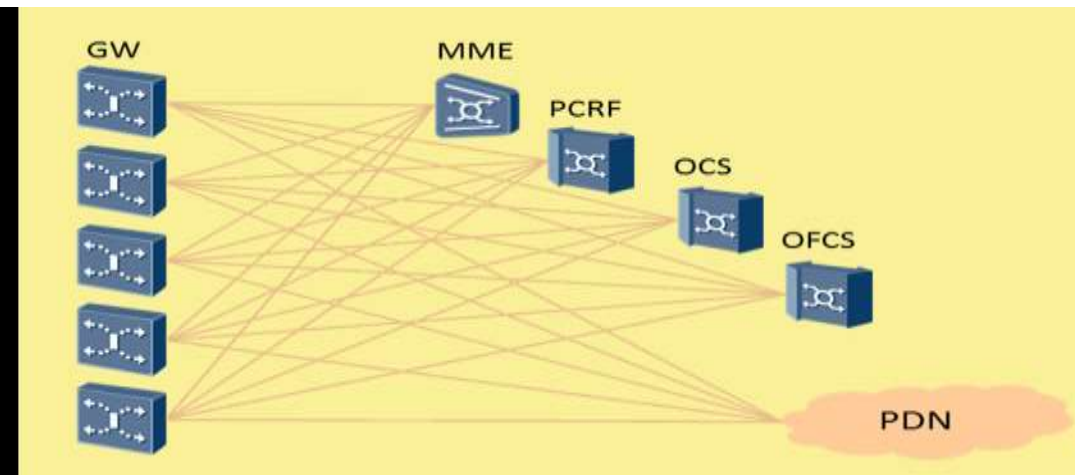
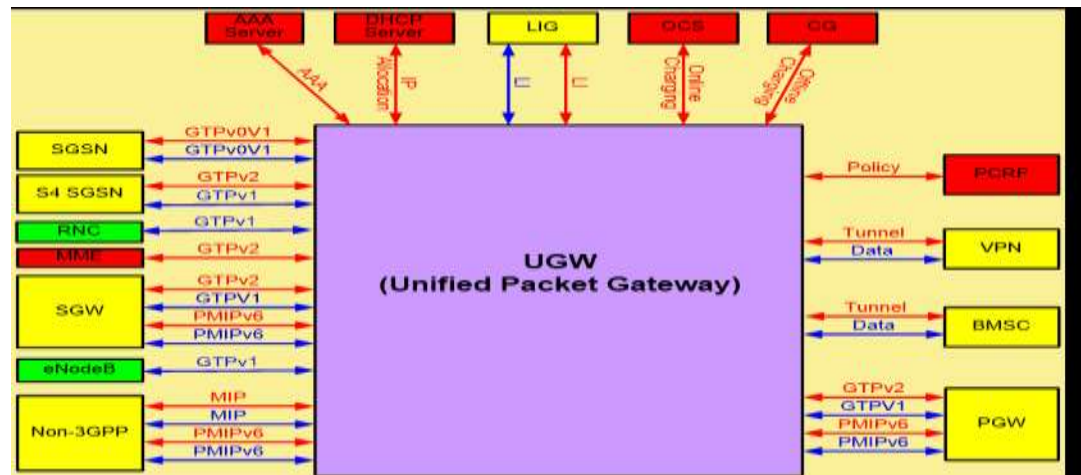


CONTROL PLANE



Control functions and status information are too dispersed and fragmented

USER PLANE



Complexity, many interfaces, location too high

4G architecture is complicated and inflexible , difficult to meet diversified 5G demands perfectly

Opportunities by network and service convergence



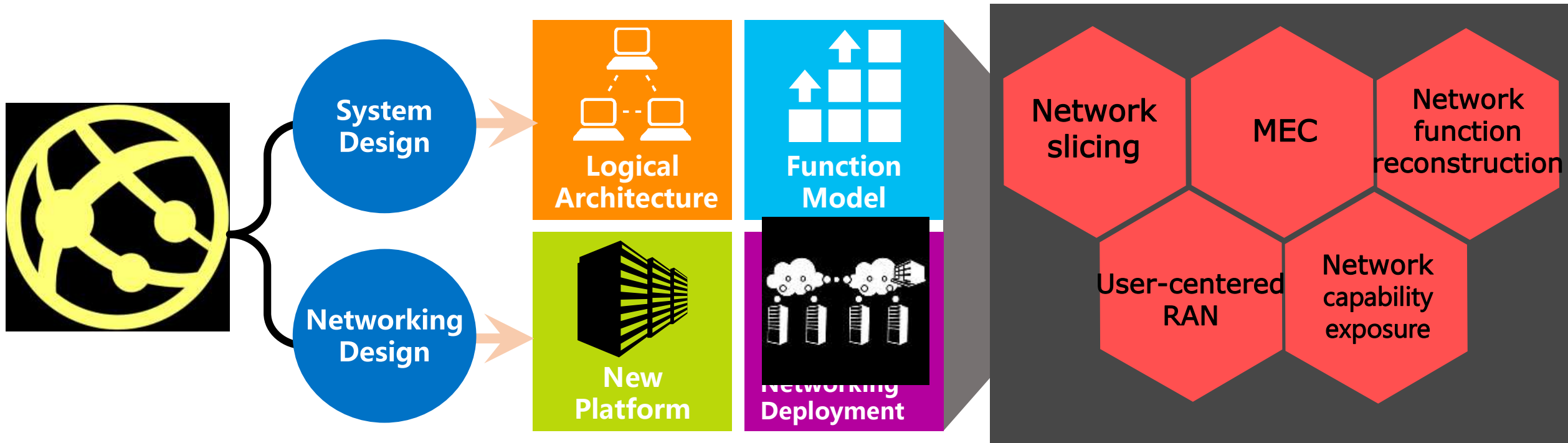
Network-service convergence and on-demand service provision will bring new opportunities

The insight into 5G network design



The 5G network architecture design should involve the following two aspects.

- System Design : Based on modularized functions and three-cloud logical architecture , 5G system will be more adaptive to diverse, extreme service requirements ;
- Networking Design : Based on SDN/NFV, 5G networking will be more flexible to enhance deployment and operation efficiency



5G network driven by new infrastructure



Infrastructure

Architecture

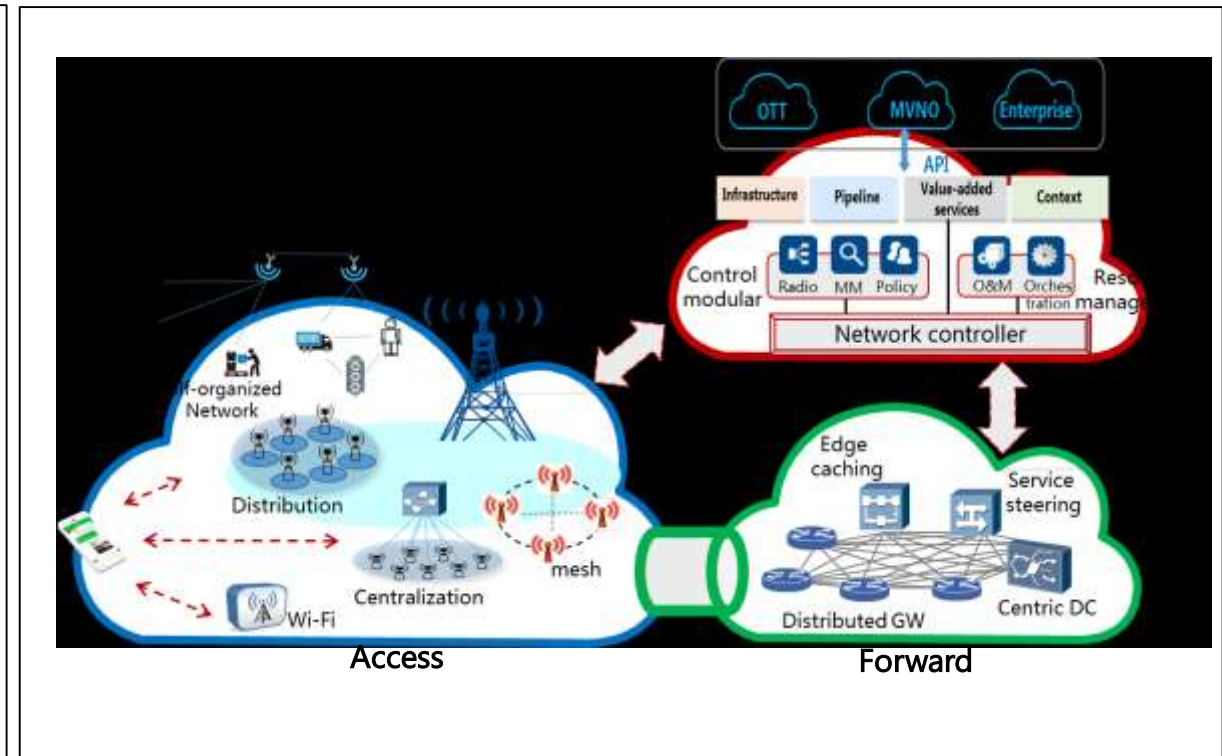
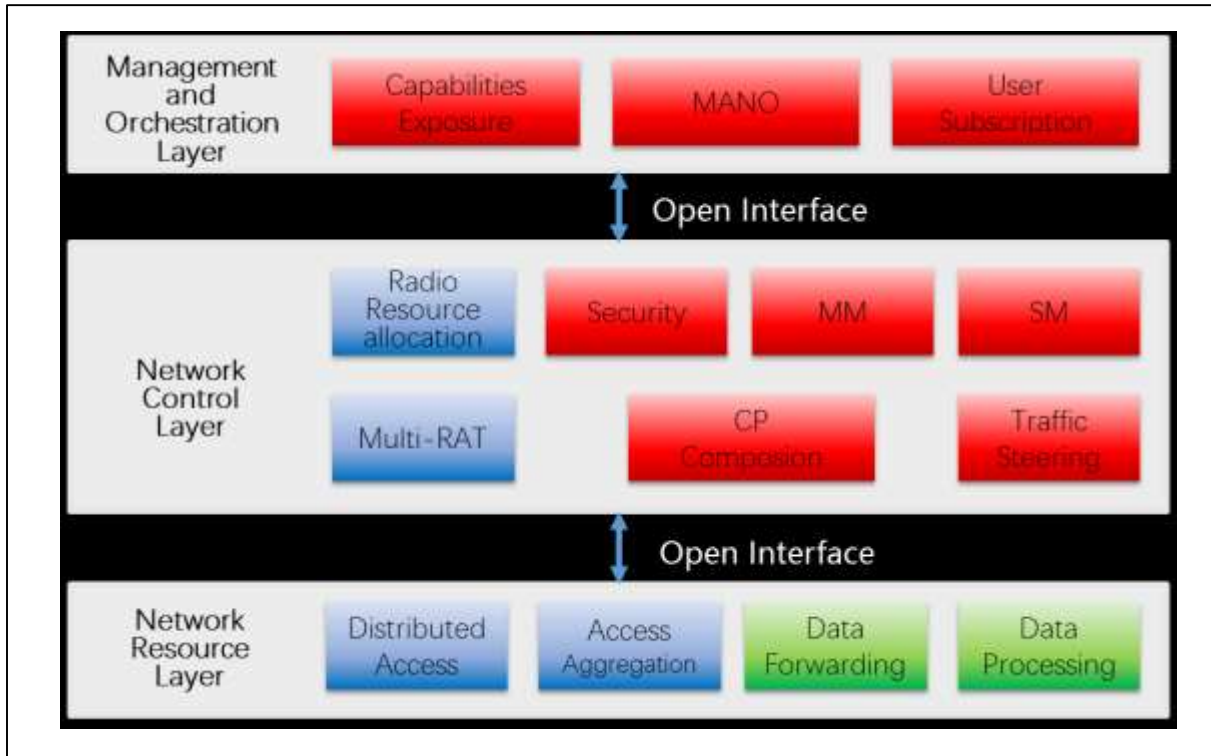
- ① IT and virtualization technology
- ② unified standard hardware
- ③ low cost and short time



- ① C/U separation
- ② Control function reconstruction
- ③ High-performance access, flexible and intelligent

One unified infrastructure + One flexible logical architecture

System Design presents the network functions and E2E logical architecture



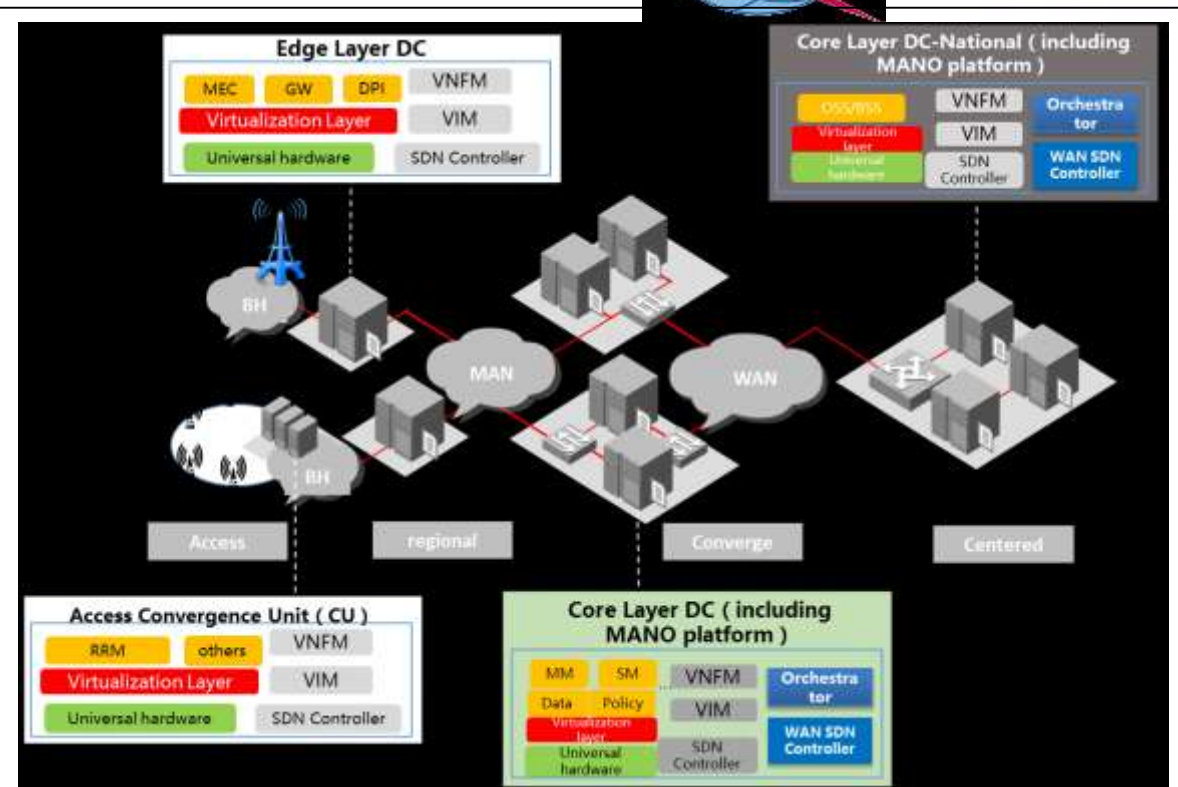
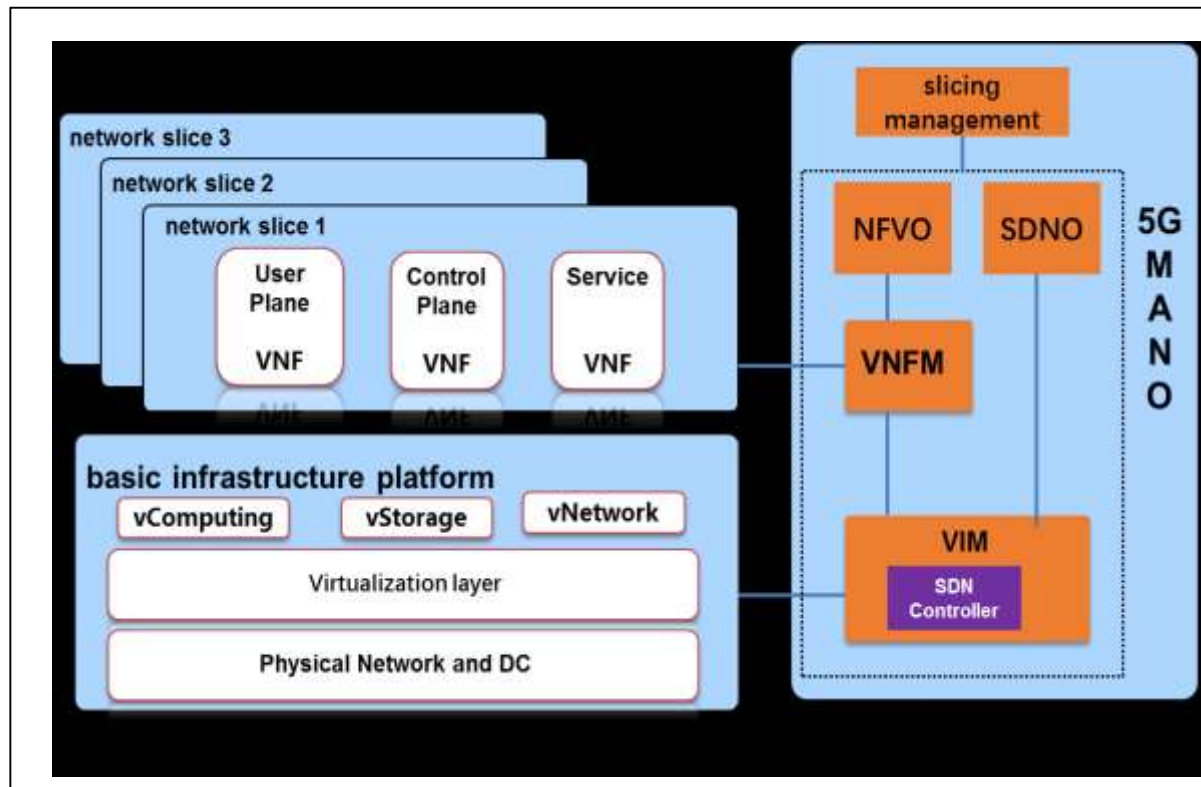
Network Functions Model
 Three-layers network function diagram :

- Network control layer is the core
- Network resources layer provides data access, forwarding, traffic optimization
- The top layer provides the orchestration and capabilities exposure function to the 3rd party.

Logical Architecture

- Access Plane : Multi-RATs, Centralized vs distributed
- Control Plane : centralized control , on-demand reconstruction and orchestration
- User Plane : distributed, simplified

Networking Design presents hardware platform and networking deployment



Hardware Platform

- Using standardized data centers with universal hardware architecture. The platform should support high performance forwarding and carrier level management.
- 5G infrastructure platform take network slice as the customized mobile network instance.

Networking & Deployment

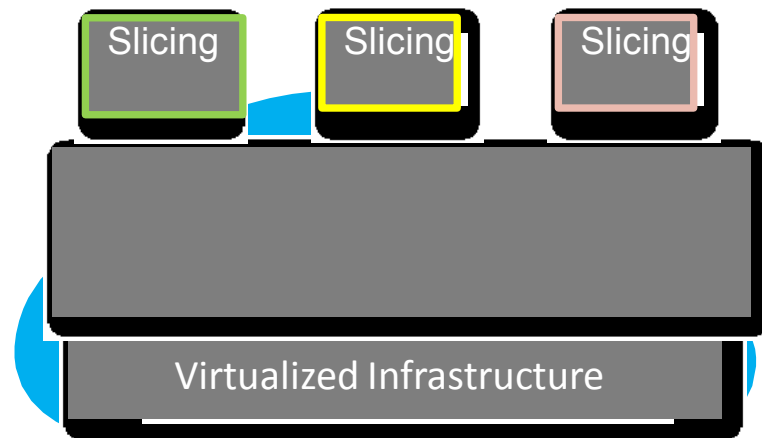
- Four levels networking & deployment based on DC;
- Four levels deployments need not be strictly binding with the geographic location

Network slicing is considered as the key characteristic of 5G network

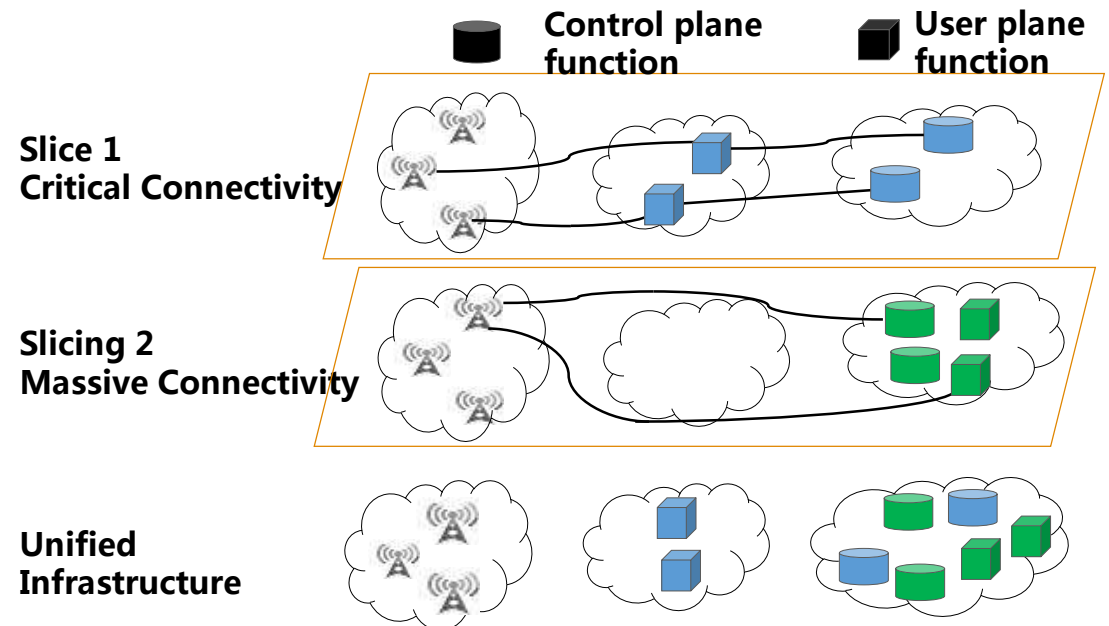


One Unified Infrastructure, Multiple Service Slices

According to different scenarios and based on the common network platform, network slicing deploys different modularized network functions, flexibly schedules network architecture



Different slices select function modules on-demand.



The network slice is the end to end logical network function set, including access network function, core network function, back haul function etc. Slices management and selection are key issues.

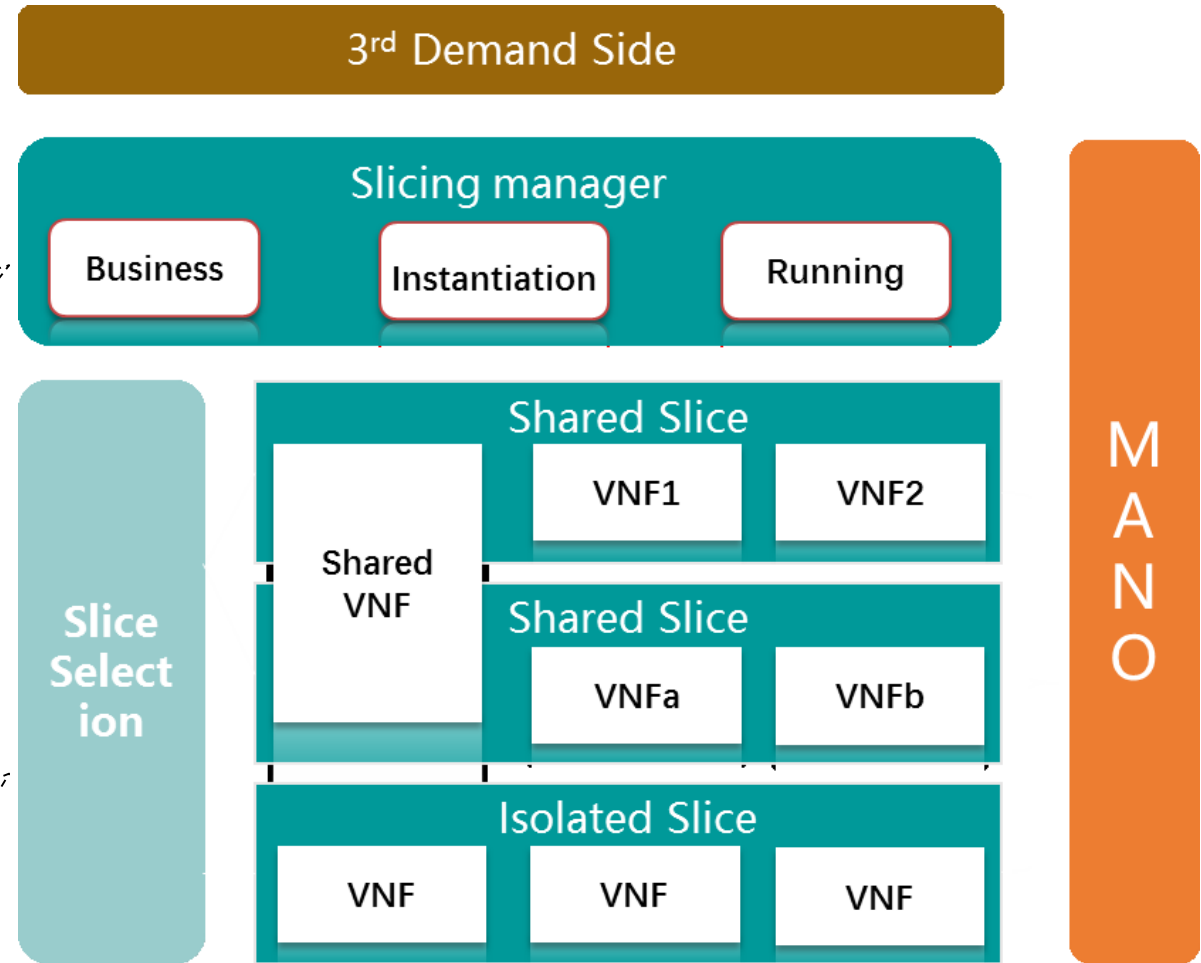
Slice Management & Slice Selection



Slice management function set integrate business operation, virtualized resources platform and network management system together for slice user to provide safely isolated and highly self-controlled dedicated logical network.

Slice selection implement the mapping between user terminals and network slices:

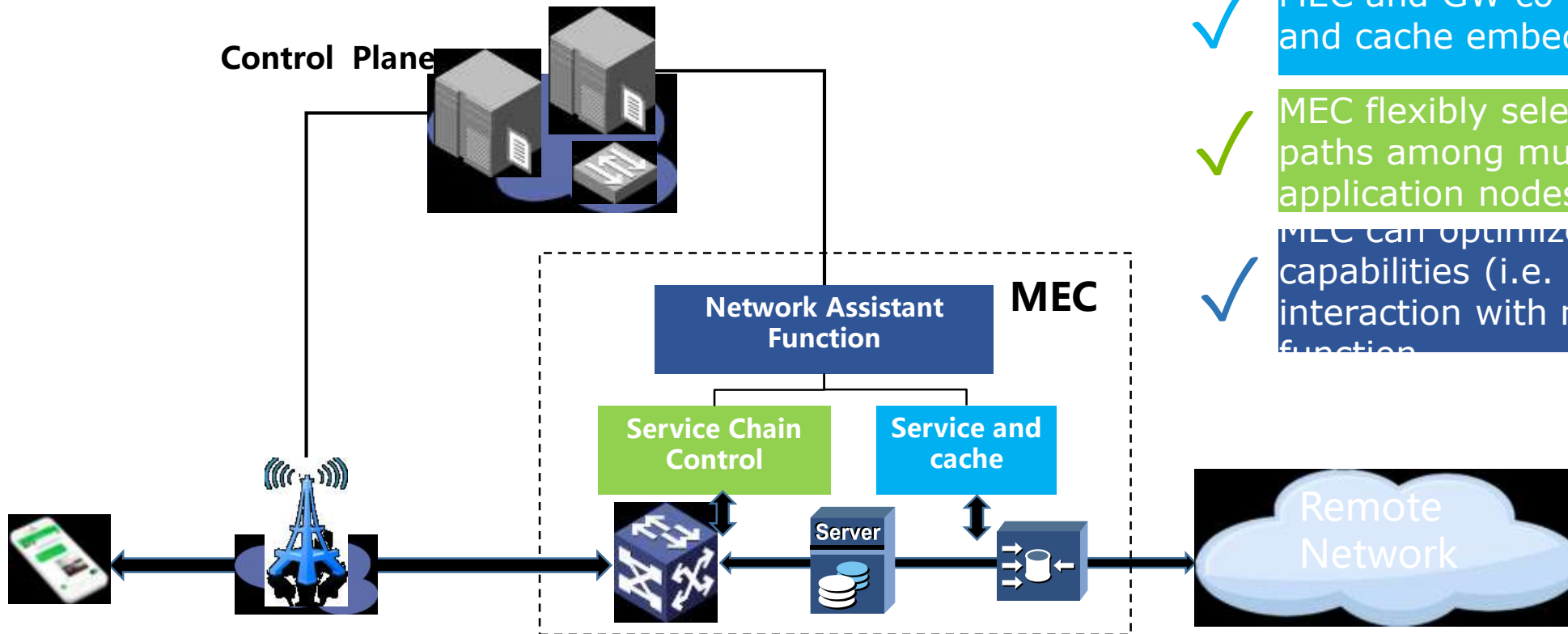
- there are two options for slice selection , one is slices are completely isolated, and the other one is Multiple slices can share certain of network functions.
- A user terminal can access to one or multiple slices at the same time.



MEC will be powerful booster for network and service convergence



MEC sinks the service platform down to the edge of the network which offer mobile users with service computing and data caching capabilities locally, and changes mobile network from single pipeline to the integrated information services enabling platform.

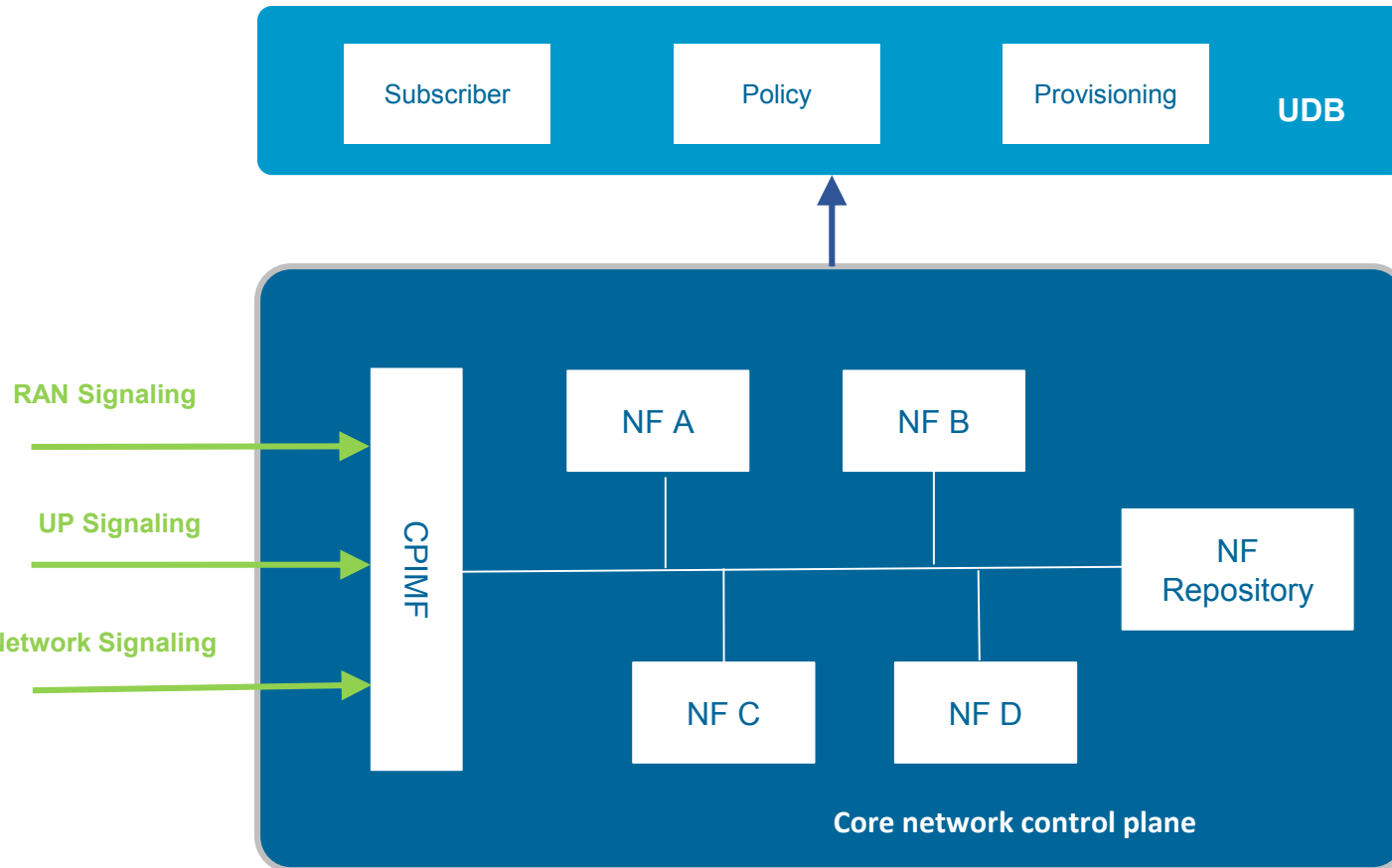


✓ MEC and GW co-deployment. Service and cache embed in network pipeline .

✓ MEC flexibly selects data forwarding paths among multi-distributed application nodes

✓ MEC can optimize its service capabilities (i.e. MM and SM) via tight interaction with network control function

On-demand network function reconstruction



- Control and user plane separation is the basis for the network function reconstruction.
- the control plane could be modularized and reconstructed, which is easy to realize the network function combination.
- The user plane function could be more simplified, and could be deployed in the network on demand.

On demand
SM

On demand
MM

On demand
Security

User-centered RAN



5G RAN will change its “base station-centered” conventional design to the new “User Centric” pattern

Flexible RAN Control

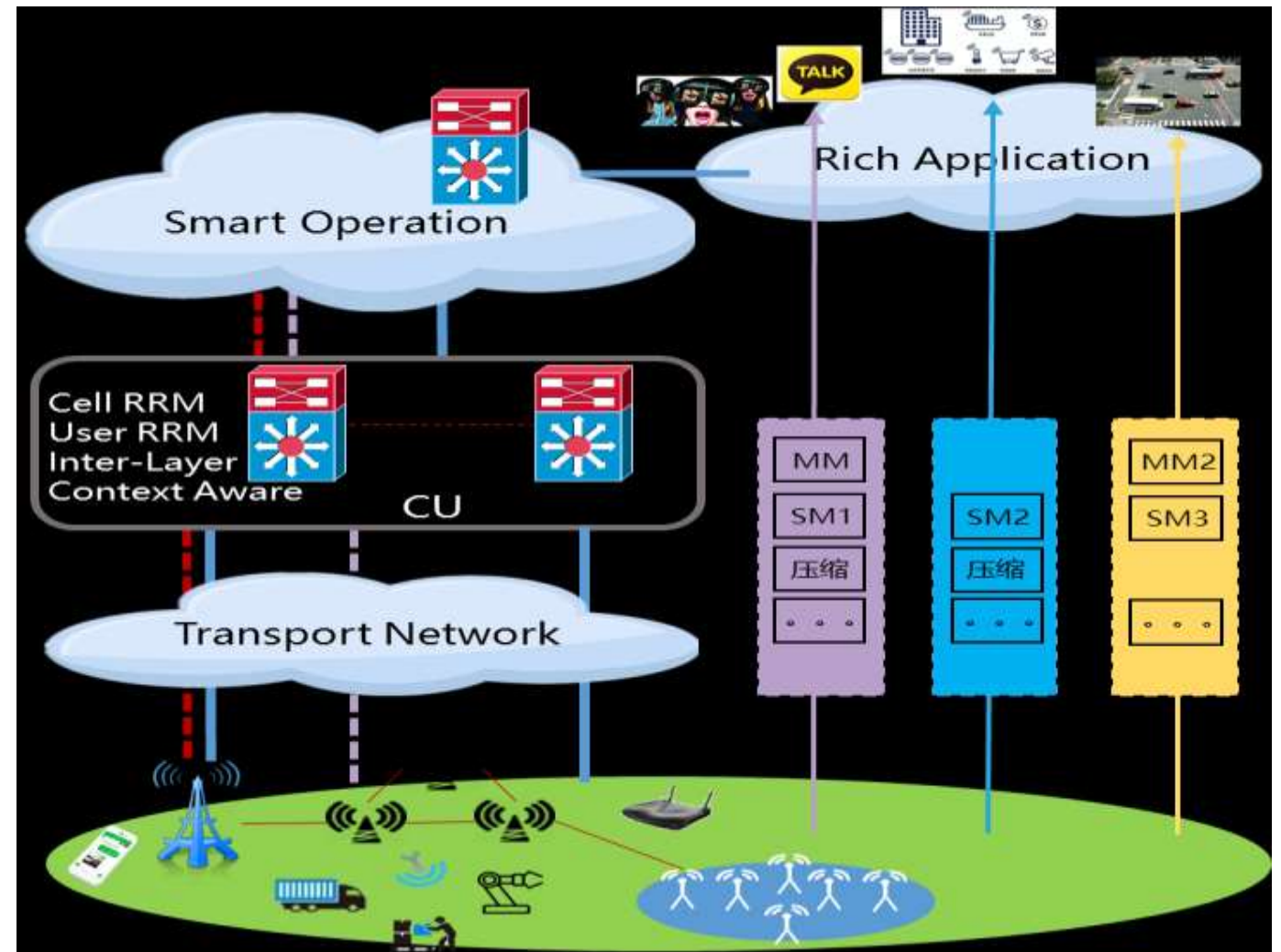
realizes flexible radio processes and simple radio managements

Context Aware Service Delivery

introduce mutual awareness between RAN and application servers, optimize and match RAN resource allocation and application quality control

Customized Access Network

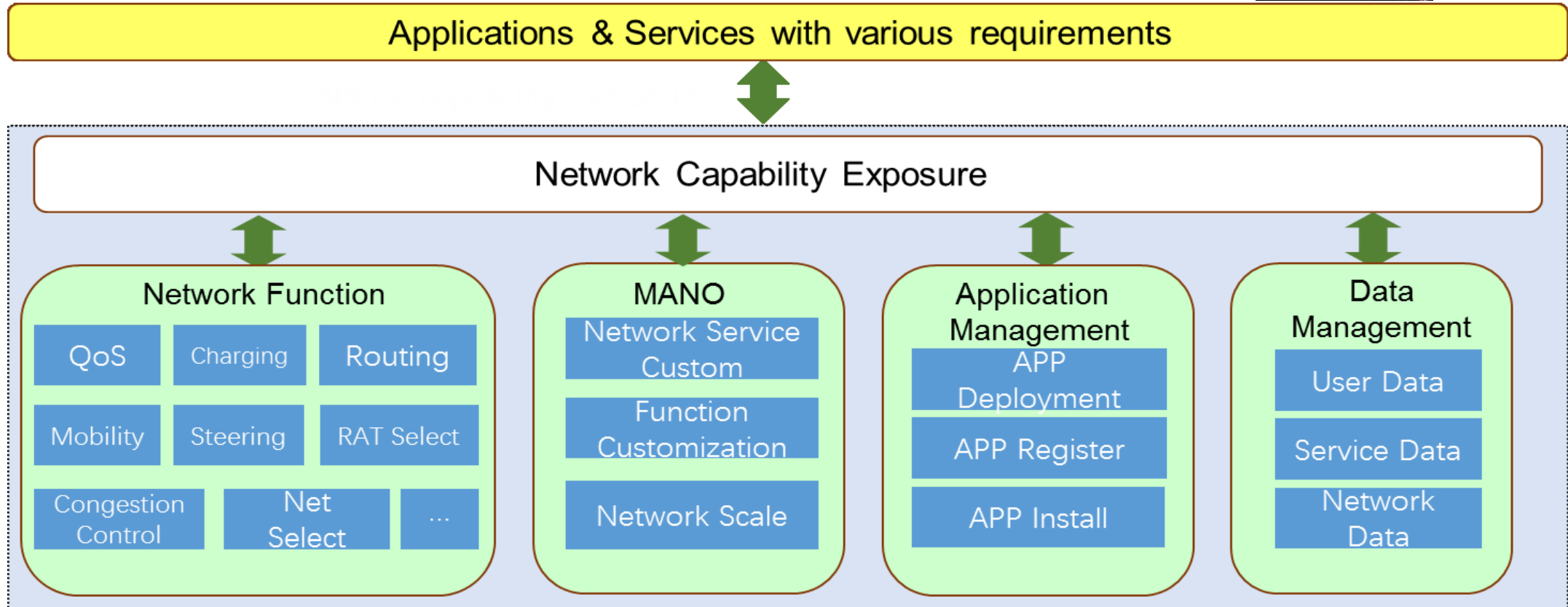
adapt network configuration and differentiate data processing, according to diverse service requirements



Network capability exposure



Provides various network information and capabilities to the 3rd parties to improve user experience



Offering unified exposure of control functions via 5G network centralized control plane

Optimizing infrastructure resources management

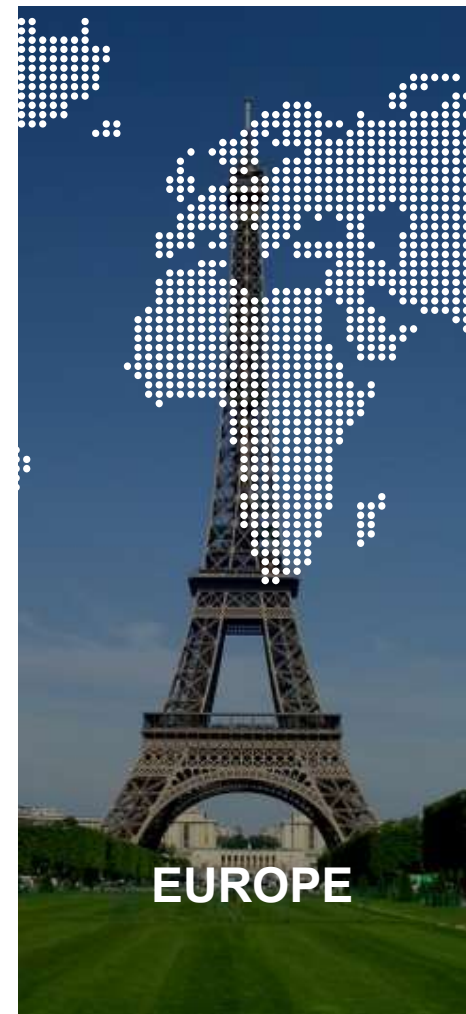
using MEC platform, enable 3rd party application execution inside operator network



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5G – a global topic



IMT-2020 PG Activities — International Cooperation



- 5G PPP: Completed the draft MOU which will be signed soon.
- 5G Forum: Hold two joint meetings per year, and launched two research projects in early 2015.
- NGMN: Established the liaison mechanism, and share the research progress of 5G



Vision



Technology



Standard



Spectrum



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

Main 5G Development Plans in China




- “Made in China 2025” Plan pointed out that China should break through the Fifth generation mobile communication technology comprehensively.




- It is proposed in “the 13th Five-Year Plan” that China should promote the development of 5G actively, and launch 5G in 2020.

5G Research Projects in China



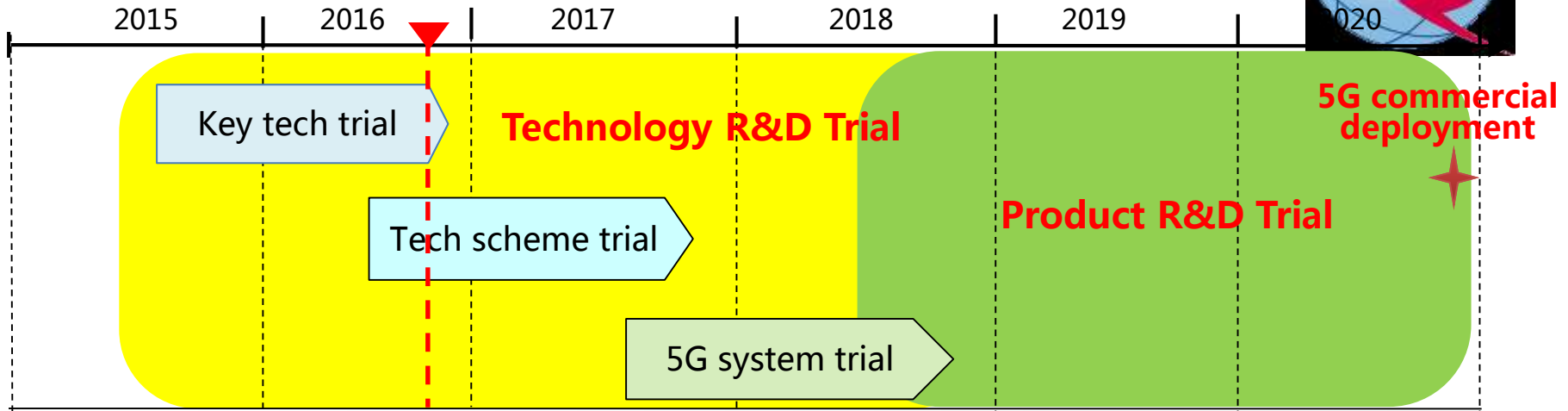
 国家高技术研究发展计划 (863计划)		National 863 Program	
2014		2015	
<ul style="list-style-type: none"> • General Technology • Wireless Key Tech. 	<ul style="list-style-type: none"> • Network Architecture & Key Tech. • Evaluation & Test Methodologies 	<ul style="list-style-type: none"> • Soft Base Station Test Bed • mmWave Indoor Access • Wireless Network Virtualization 	<ul style="list-style-type: none"> • RAN and System Security • Advanced Modulation and Coding



 国家科技重大专项 National Science and Technology Major Project		National Science and Technology Major Project		
2015		2016		
<p>Overall</p> <ul style="list-style-type: none"> • Network Architecture • Standard Evaluation Platform • Analysis and Evaluation on Candidate Bands 	<p>Technology</p> <ul style="list-style-type: none"> • mmWave Key Technologies • Low-Latency High-Reliability Solution • Next Generation WLAN 	<p>Overall & Component</p> <ul style="list-style-type: none"> • 5G Standardization • AD/DA for Base Station • High-Freq PA for Base Station • High-Freq Filter for Base Station 	<p>Wireless Technology</p> <ul style="list-style-type: none"> • Wide-Area Coverage • Low-Power Massive-Connections • High-Freq. Comm. • UDN • Novel Multiple Access 	<p>Network & Service</p> <ul style="list-style-type: none"> • RAN Architecture • 5G Indoor Positioning • Key Technology for Self-Driving Cars

- **Open to all the companies registered in China, including domestic & international ones**

Introduction to China 5G Trials



- **2 Phases** of 5G Trial
 - Phase 1: **Technology R&D trial (2015~2018)**
 - Phase 2: **Product R&D trial (2018~2020)**
- **3 Steps** of Technology R&D trial
 - Step 1: **Key technology trial (2015.9~2016.9)**
 - Step 2: **Technology scheme trial (2016.6~2017.9)**
 - Step 3: **System trial (2017.6~2018.10)**

Progress of China 5G Technology R&D Trial



Objectives

- Promote the development of 5G key technologies
- Verify and improve 5G technical schemes
- Support the global unified 5G standardization

The Results of Step 1 were released on Sept. 22 , 2016



Main domestic and international participants

Research	Operator	Infrastructure	Chipset	Instrument
CAICT (China Academy of Information and Communications Technology) and SRTC (State Key Laboratory of Information and Communications Technology) logos.	Logos for China Mobile (中国移动), China Telecom (中国电信), and China Unicom (中国联通).	Logos for Huawei, Ericsson, ZTE, and Nokia.	Logos for Qualcomm, Intel, Spreadtrum, and MediaTek.	Logos for CETC (China Electronics Technology Group Corporation), StarPoint (星河亮点), Keysight Technologies, and Rohde & Schwarz.

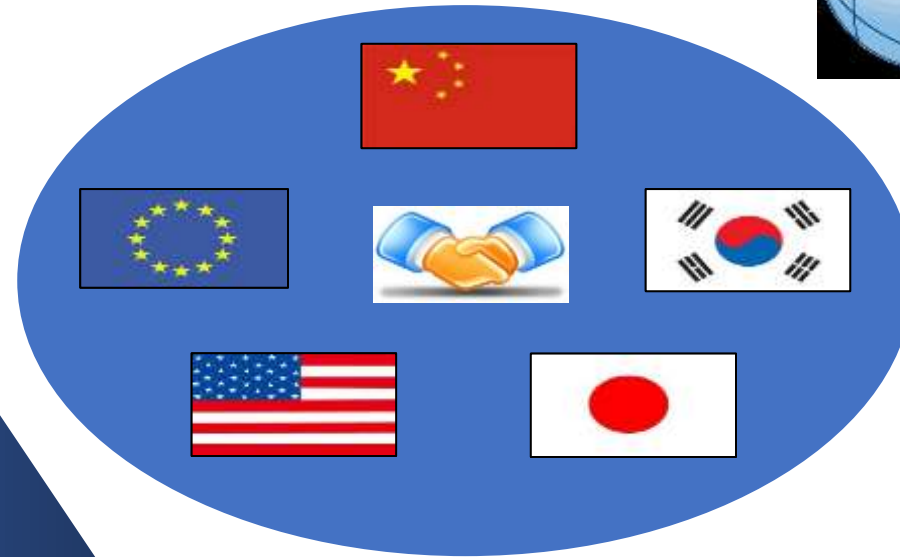
International Cooperation



China has built 5G cooperation mechanism with EU, US, Japan, and Korea on the levels of governments and industrial associations

Both domestic and international companies have joined the 5G Technology R&D Trials of China

Ericsson, Samsung, Qualcomm and NTT Docomo have joined IMT-2020 (5G) Promotion

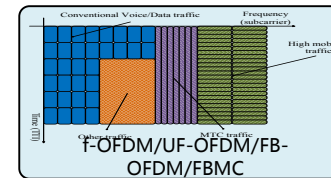
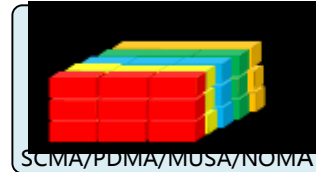


Promotion of 5G technology



Accelerating the promotion of 5G technology, standards and product development.

Accelerating technological innovation



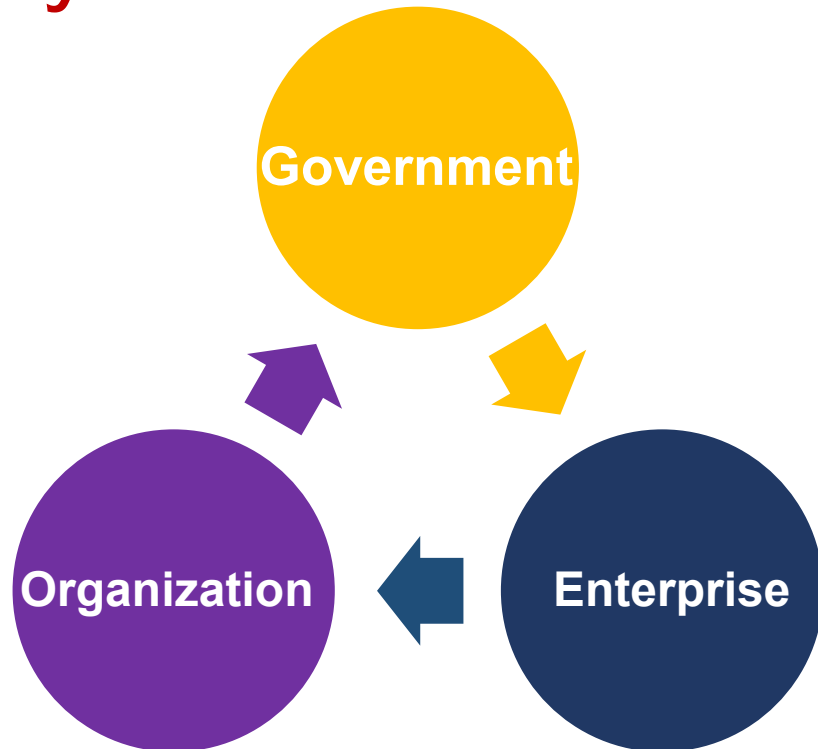
Build a international communicative platform for 5G R&D tails

Strengthening information sharing and cooperation between countries and regions in the 5G R&D Tails

International cooperation



- International cooperation should be further enhanced to build a globally unified 5G standard and industry ecosystem

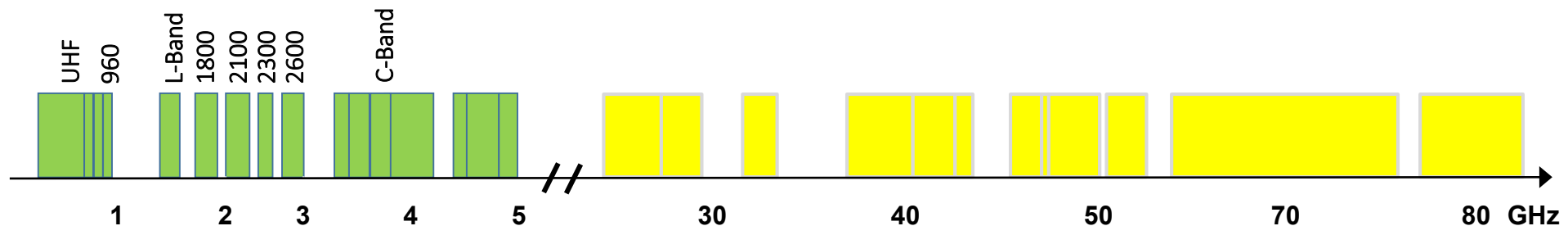


- ✓ Under the framework of ITU and 3GPP , the global unified 5G international standard is actively promoted
- ✓ strengthening the equivalent openness in 5G between other countries and China

Harmonized 5G spectrum



- Improve communications and cooperation between regional groups, administrations and industries
- Promote global coordination on 5G spectrum actively in ITU, for the frequency bands below and above 6GHz
- Identify global/regional harmonized spectrum for IMT to enable economies of scale of 5G



Integration of 5G and vertical industry



- **Strengthen the integration of 5G and vertical industry development**



- ✓ Based on the industry development demands to research and design 5G new network architecture.
- ✓ Industrial internet and car internet will be 5G Key industry applications.

Vertical industries



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Photo:





Thanks for your attention

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