

China's journey towards 5G

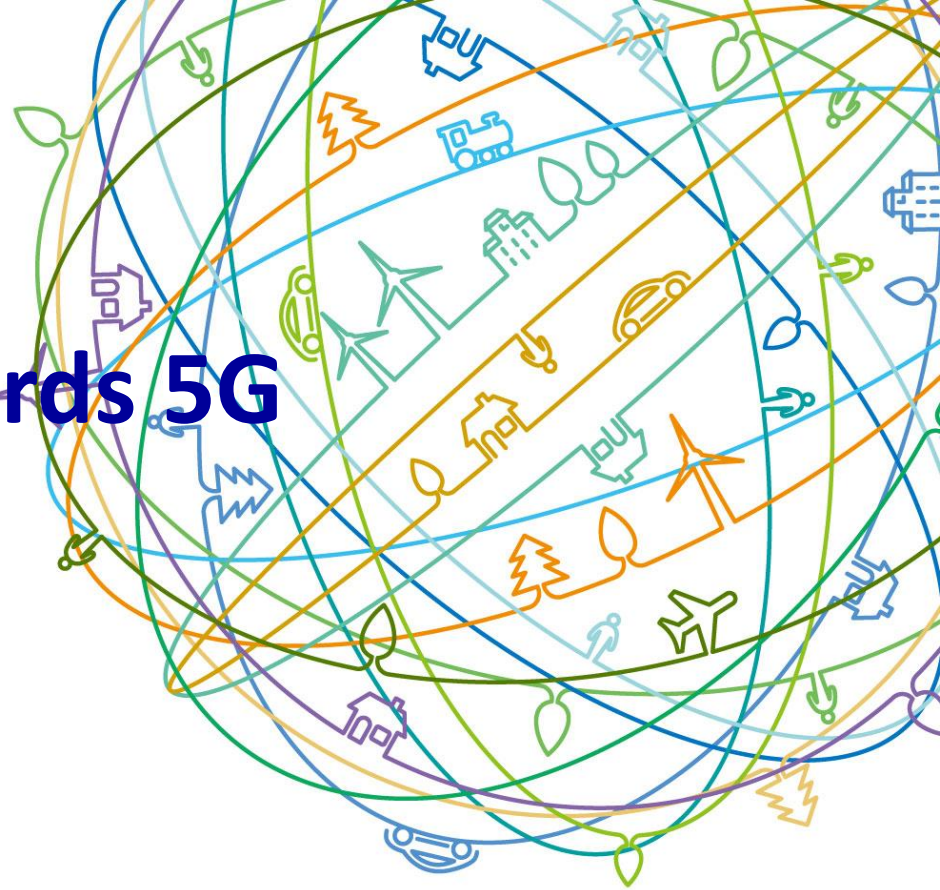
IMT-2020 (5G) PG and FuTURE Forum

Ming Lei

5G Huddle

Copenhagen, Denmark

October, 2015



China's major 5G organizations



Profiles

	IMT-2020 (5G) PG (Promotion Group)	FuTURE Forum
Missions	<ul style="list-style-type: none"> ● Target standardization & industrialization ● Promote China's competence in 5G R&D ● Strengthen international R&D cooperations 	<ul style="list-style-type: none"> ● International NPO & NGO ● Develop an open and neutral international platform to promote R&D ● Strengthen international R&D cooperations
Government Involvements	<ul style="list-style-type: none"> ● MIIT (Ministry of Industry and Information Technology) ● MOST (Ministry of Science and Technology) ● NDRC (National Development & Reform Commission) 	<ul style="list-style-type: none"> ● Supports from MIIT, MOST and NDRC ● Raise funding on its own
Founding time & website	<p>2013.2 http://www.imt-2020.cn/en</p>	<p>2005 (5G started from 2014.3) http://www.future-forum.org/en/</p>
History (predecessors)	<ul style="list-style-type: none"> ● PG for 3G: China was trying to catch up Outcome: TD-SCDMA as an international standard ● PG for 4G: China was at the same pace with the world Outcome: TD-LTE as an international standard ● PG for 5G: China wants to lead in some tech areas Outcome (expected): 5G standards with Chinese footprints 	<ul style="list-style-type: none"> ● Established for R&D in B3G / 4G ● 5G SIG was established in 2014.3 (supervised by Dr. Chih-Lin I)

Profiles

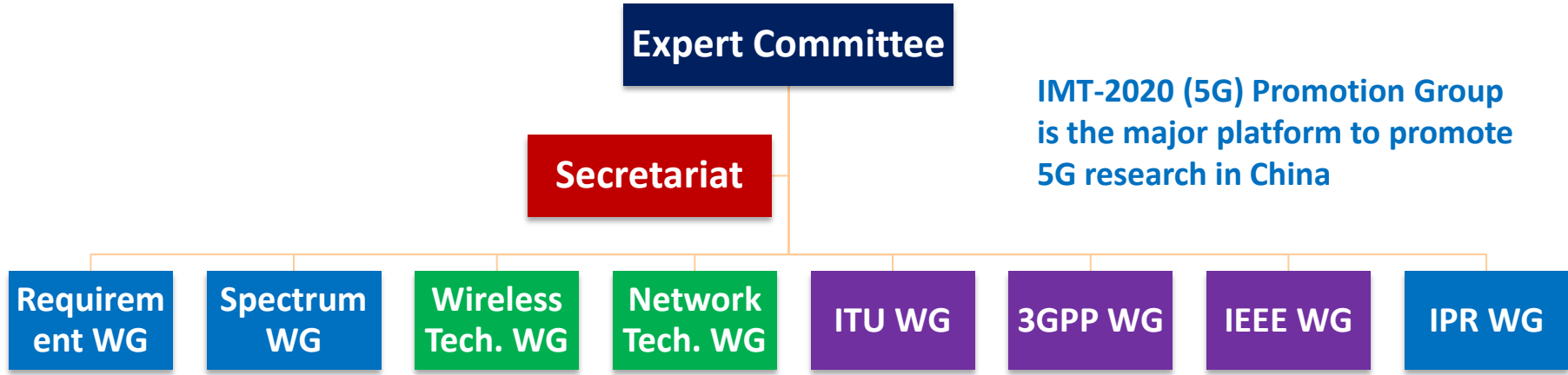
	IMT-2020 (5G) PG (Promotion Group)	FuTURE Forum
Members	56 (China only) Regulators, operators, vendors (infrastructure, terminal & chipsets), academia (universities), R&D institutes, government orgs	36 (international) Regulators, operators, vendors (infrastructure, terminal & chipsets), academia (universities), R&D institutes, government orgs
Openness	<ul style="list-style-type: none"> ● Only open to Chinese organizations for now ● Will gradually open up to the world, time TBD 	Open to any organizations worldwide (based on membership)
5G White Papers	<ul style="list-style-type: none"> ● 2014.5: 5G Vision & Requirements ● 2015.2: 5G concepts (incl. technologies) ● 2015.5: 5G radio and network technical architectures 	<ul style="list-style-type: none"> ● 2014.11: 5G White Paper ● 2015.11: 5G White Paper V2.0
Events	<ul style="list-style-type: none"> ● 5G Summit, annually, every May (based on invitation) ● WG meetings, every 1~2 months (China only) 	<ul style="list-style-type: none"> ● 5G Workshop, annually, every November (open) ● WG meetings, every 2~3 months (open) ● Seminars, workshops, ... (open)



IMT-2020 (5G) Promotion Group



Structure of IMT-2020 (5G) PG



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

- The Group has 50+ members including the main operators, vendors, universities, and research institutes in China.



Official website: www.IMT-2020.cn



5G Summits (annually) of IMT-2020 (5G) PG

Plan to hold a 5G summit every year in late May to facilitate 5G development and global collaboration.

2013: 5G Vision



2014: 5G Objective & Capability



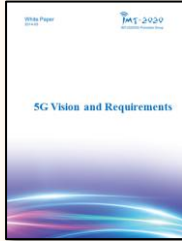
2015: 5G Technology Architecture



- Preliminarily discuss 5G vision, requirements & technologies
- Identify 5G vision & requirements and clarify 5G objective & capability
- Propose 5G wireless and network technology architectures

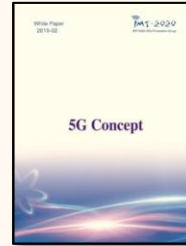
White papers of IMT-2020 (5G) PG

1 5G Vision and Requirements (May 2014)



- 5G Drivers & Market Trends
- Services, Scenarios & Performance Challenges
- Sustainability and Efficiency Requirements
- 5G Key Capabilities

2 5G Concepts (Feb. 2015)



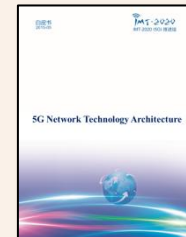
- 5G Technical Scenarios
- 5G Key Technologies
- 5G Concept
- 5G Technology Roadmap & Time Plan

3 5G Wireless Technology Architecture



- 5G Scenarios & Technical Requirements
- 5G Wireless Technology Roadmap and Framework
- Consideration on 5G Air Interface Design

4 5G Network Technology Architecture



- 5G Network Challenges & Trends
- Consideration on 5G Network Design
- 5G Functionality, Features &
- Key technologies

Published in May 2015

International cooperations of IMT-2020 (5G) PG



- 5G PPP: The MoU was signed in September 29, 2015
- 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



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

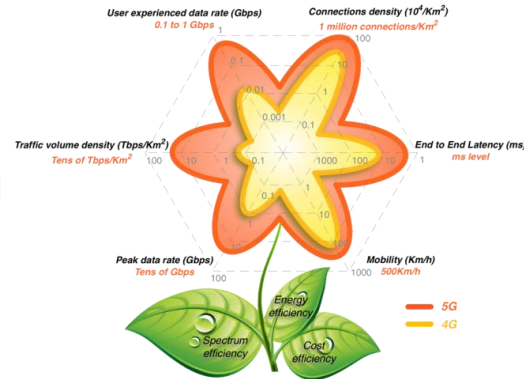
5G Vision and Requirements

Identified 5G vision and requirements

Main Drivers: Mobile Internet and Internet of Things

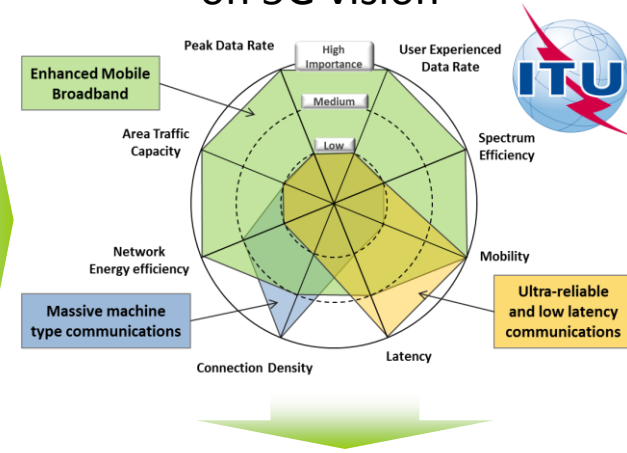


5G Vision: Information a finger away, everything in touch



5G Key Capability ---- 5G Flower

Promote global consensus on 5G vision



ITU IMT-2020 vision has been completed in June 2015.

5G Scenarios & Challenges

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/km²

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

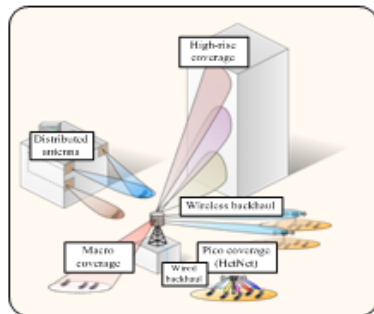


- Connection density: 10⁶ / km²
- Ultra-low power consumption
- Ultra-low cost

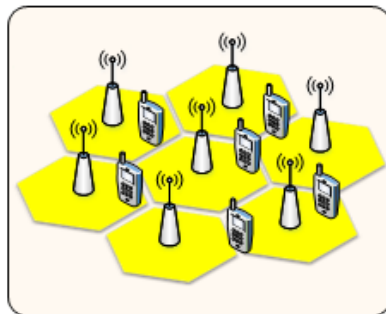
5G candidate radio technologies

Key Enabling Technologies

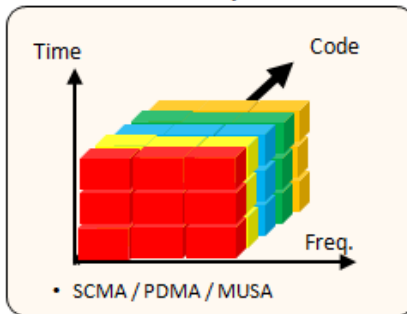
Massive MIMO



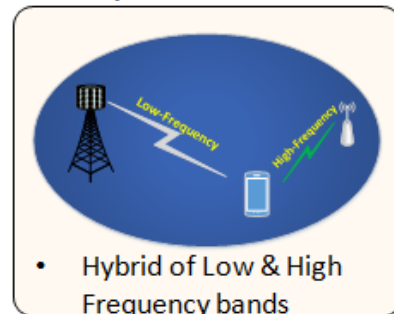
Ultra-Dense Network



Novel Multiple Access

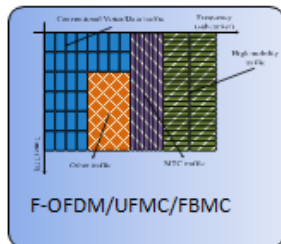


All-Spectrum Access

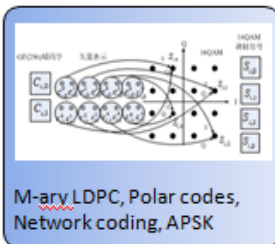


Other Promising Technologies

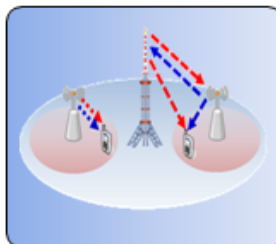
New Multi-Carrier



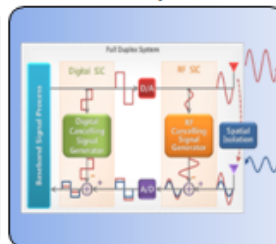
Advanced MCS



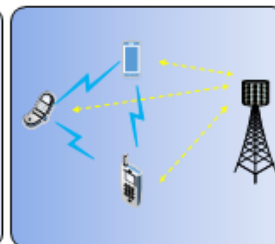
Flexible Duplex



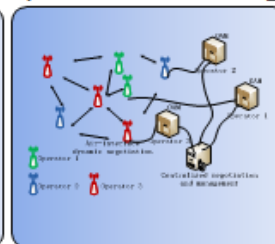
Full Duplex



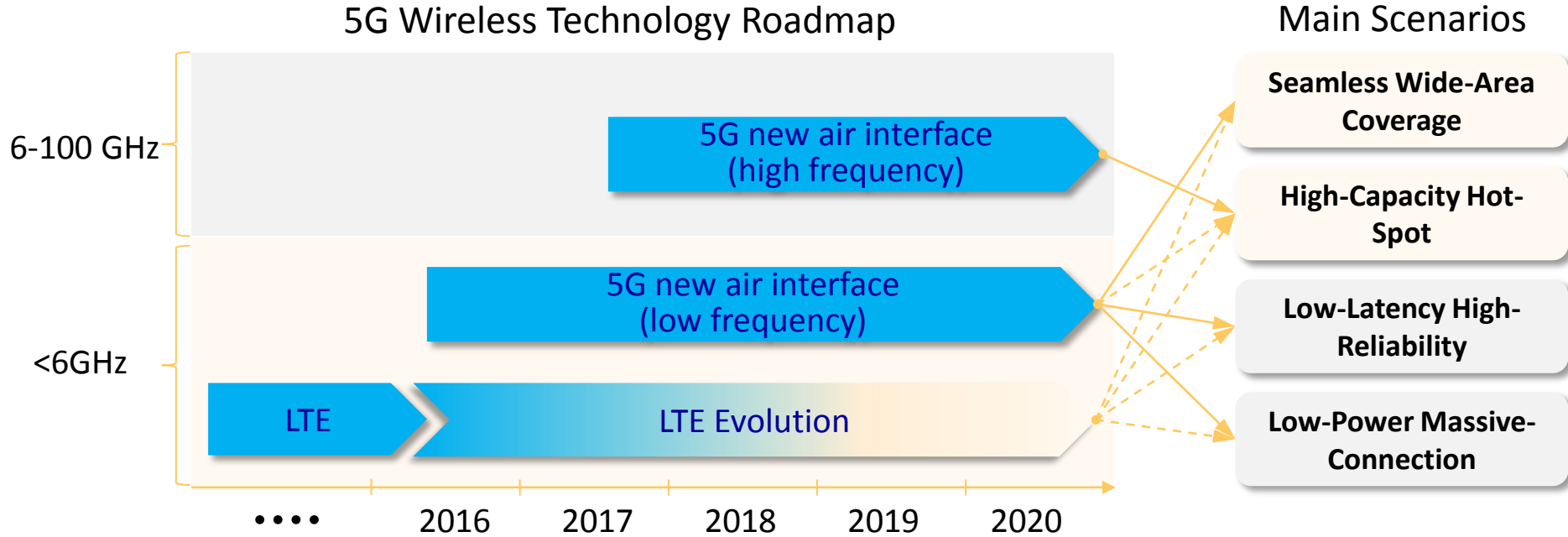
D2D



Spectrum Sharing



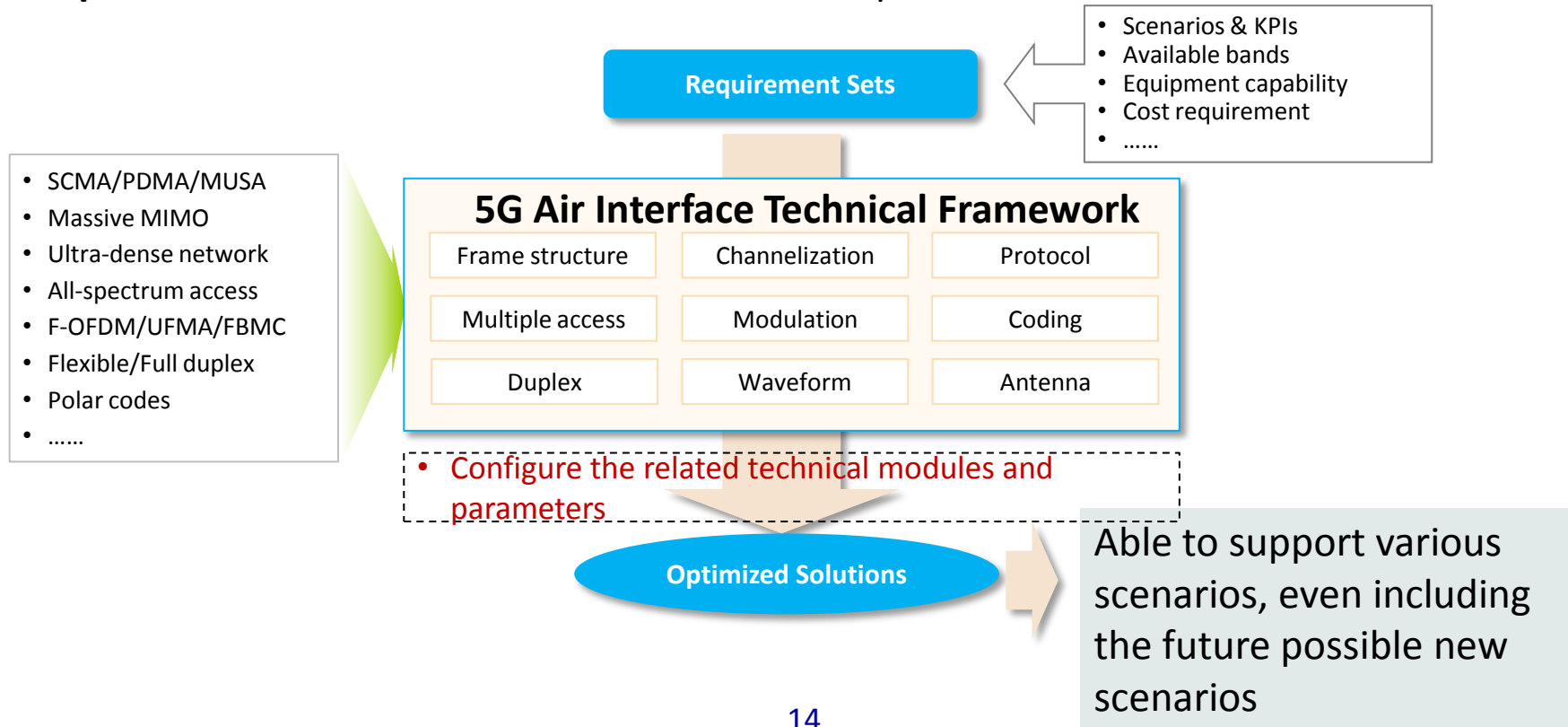
5G radio technology roadmap



- The 5G wireless technology roadmap consists of **the new air interface** and **LTE evolution**.
- The 5G new AI has two branches: **low-frequency** and **high-frequency**.

5G air interface framework

- A **unified**, **flexible**, and **configurable** framework is needed to better balance the **performance** for diverse scenarios and the implementation **cost**



5G network architecture

Driven by **5G requirements** and **new technologies**, 5G network can be logically decoupled into **three planes**

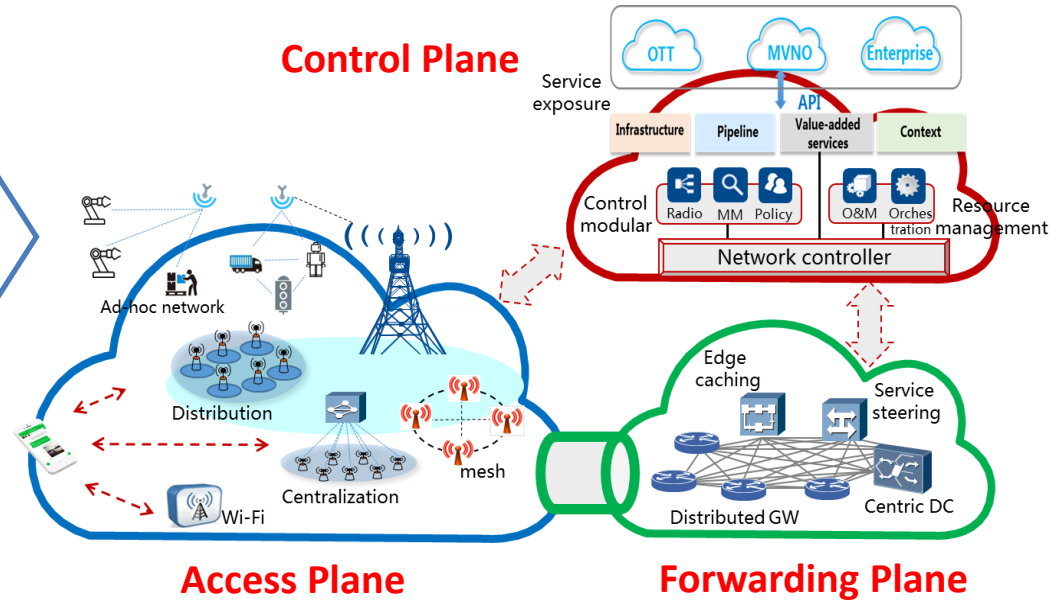
5G Requirements

- 5G scenarios and KPI
- Operation enhancement
- Smooth evolution consideration

New Technologies

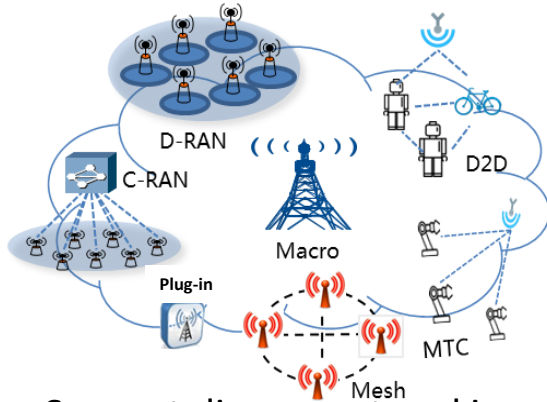
NFV separation of software and hardware
provide flexible infrastructure platform

SDN separation of control function and forwarding function , impact on architecture design



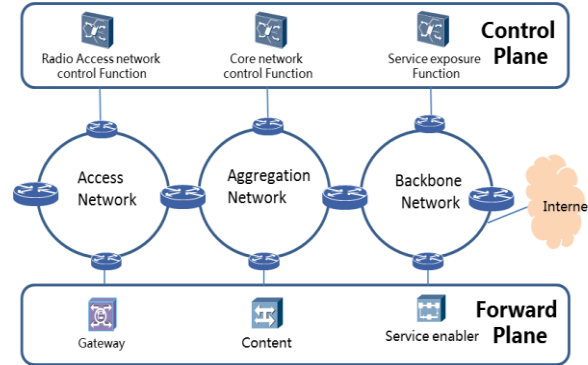
5G network features

Diversified RAN networking



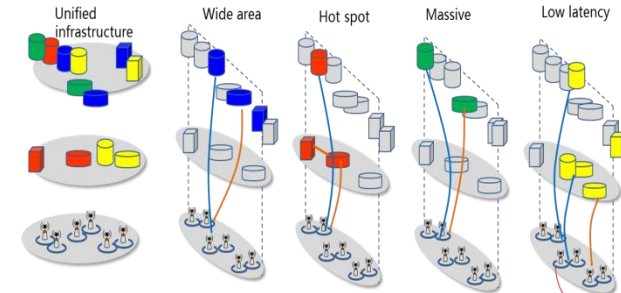
- Support diverse networking mode: C-RAN, D-RAN, Mesh, D2D, BS plug-in
- To fit different 5G wireless scenarios

Flexible function enabling



- Modularized Network function
- Network functions can be deployed flexibly based on NFV platform

On-demand slicing



- One Logical Architecture, maps to multiple Service Slices.
- Orchestrating network resource on-demand for each slice.
- Isolated slices ensure efficiency, elasticity, security and robustness

5G candidate frequency bands

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



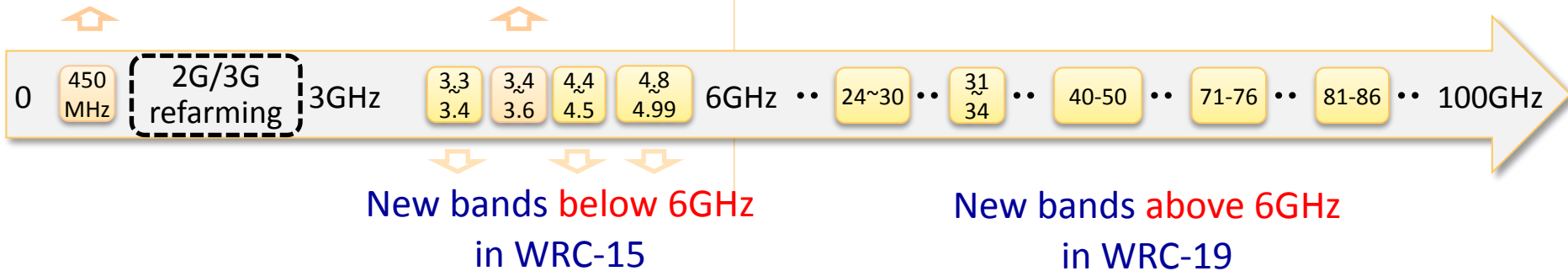
2015

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

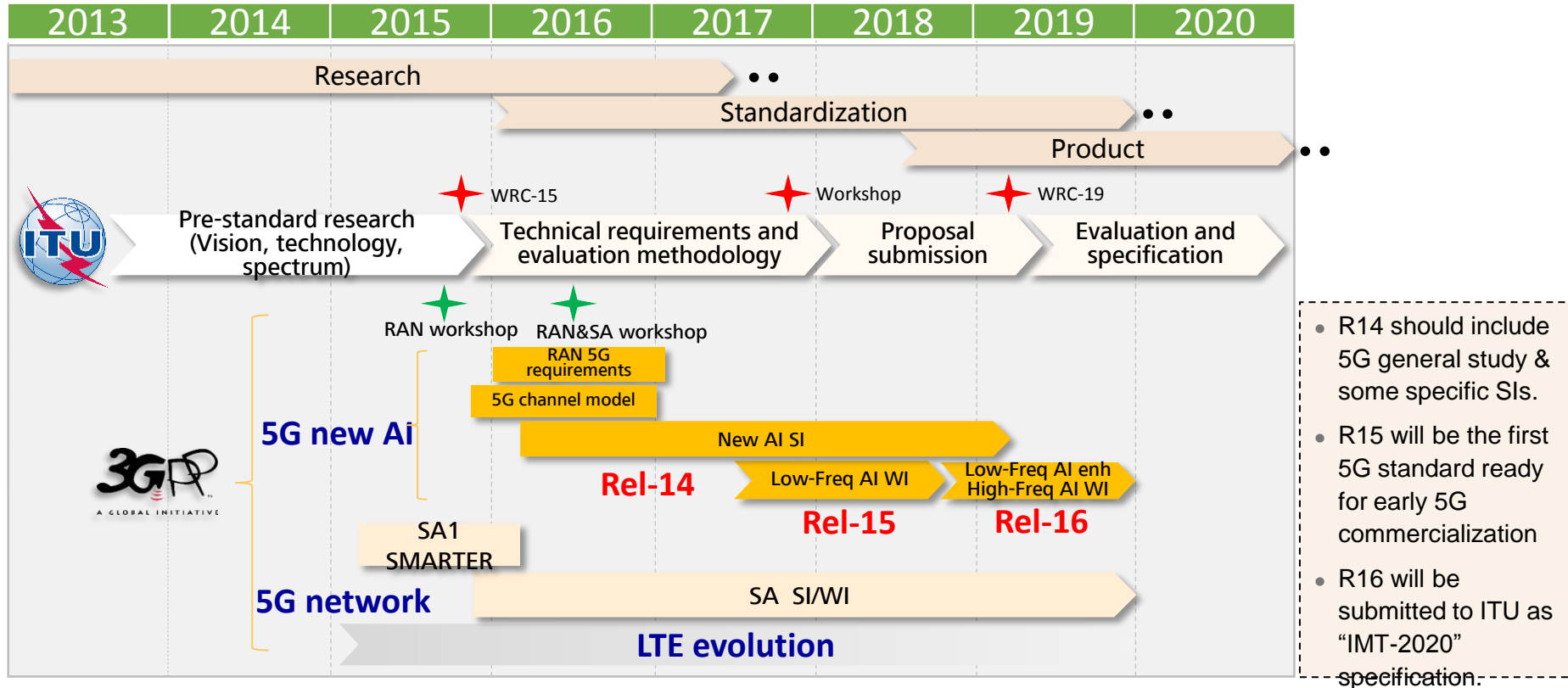
2019

- 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.
- Different bands have different channel properties and coexistence situations.
- Studies on channel measurement, modeling and coexistence are ongoing.
- To promote establishing a new agenda item in WRC-19.



5G standardization timeline





FuTURE Forum



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 includes:

✓ **General**

✓ Massive MIMO

✓ UDN

✓ **Flexible multiple access**

✓ High-frequency communications

✓ Agile duplex

✓ Test and measurement

✓ **Security**

General white paper

7 specific technology white papers



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 – **General White paper**

✓ **Framework and overall objectives** of 5G

- ◆ Overall requirement of 5G
- ◆ Spectrum strategy
- ◆ Technology trends
- ◆ Testing Requirements
- ◆ Roadmap towards 2020
- ◆ 5G Design Framework

✓ **User centric network architecture**

- ◆ Overall 5G network architecture
- ◆ Overall Objectives of radio access network
- ◆ Framework of radio access network
- ◆ Technology Enablers

✓ **Software defined air interface**

- ◆ Overall Objectives of SDAI
- ◆ Framework of SDAI
- ◆ Technology enablers

✓ **5G security**



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 - **Massive MIMO**

- ✓ Key Technologies:
 - ✓ channel measurement & modeling
 - ✓ transmission & receiving schemes
 - ✓ reference signal design & enhancement
 - ✓ Channel state information acquisition
 - ✓ large-scale active array design and test
 - ✓ large-scale antenna & high-frequency band transmission
 - ✓ heterogeneous & dense deployment oriented network framework for massive MIMO
- ✓ Technology verification:
 - ✓ system-level simulation results
 - ✓ prototype
- ✓ Candidate solutions for Standardization



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 – UDN

- ✓ Deployment Scenarios
- ✓ Key Technologies
 - ✓ Performance Evaluation of Density
 - ✓ Cell Virtualization
 - ✓ Interference Management and Suppression
 - ✓ Joint Access and Feedback
 - ✓ Network Architecture
- ✓ System verification:
 - ✓ System-level Simulation
 - ✓ Prototype Verification
- ✓ Comments on Standardization



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 - **Flexible Multiple Access**

- ✓ BDM
- ✓ ISIM-OFDMA
- ✓ MUSA
- ✓ NOMA
- ✓ Network NOMA (N2OMA)
- ✓ PDMA
- ✓ RSMA
- ✓ SCMA

The fundamental, characteristics, advantage, challenge, scenario, performance simulation and prototype of every scheme is introduced in each section.



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 – High-Frequency Communications

- ✓ Several aspects for high frequency band communications
 - ✓ High frequency spectrum
 - ✓ Characteristics of high frequency bands
 - ✓ Typical applied scenarios for high frequency band communications
- ✓ Channel measurement and modeling
 - ✓ Basic principles for channel measurement and modeling
 - ✓ Link budget for high frequency bands
 - ✓ Channel measurement and modeling results
- ✓ Key technologies:
 - ✓ High frequency and millimeter-wave integrated circuit
 - ✓ Adaptive cognitive spectrum and unified adaptive air interface design
 - ✓ Beamforming
- ✓ Technology verification
 - ✓ System level simulation results
 - ✓ Experimental system / prototype



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 - Agile Duplex

- ✓ Flexible Duplex
 - ✓ Application Scenarios
 - ✓ Key Techniques
 - ✓ FDD Solutions
 - ✓ TDD Solutions
 - ✓ Virtual Full Duplex
 - ✓ Inter-cell Interference Management
 - ✓ Procedure and Sin
 - ✓ Verification
- ✓ Full Duplex
 - ✓ Application Scenarios
 - ✓ Key Techniques
 - ✓ Verification
- ✓ Candidate solutions for Standardization



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 – Test and Measurement of Air Interface and Network Infrastructure

- ✓ The Channels: Requirements for Channel sounding and modeling by Spectrum Strategy
 - ✓ Wireless Radio Channel Characteristics
 - ✓ Wireless Channel sounding for 5G
 - ✓ Comparing existing sounding technique
 - ✓ Assessing MIMO sounding methods
 - ✓ Ensuring measurement accuracy
 - ✓ Channel parameter estimation
- ✓ The Air Interface: Measurements Requirements for Software Defined Air Interface
 - ✓ Test for new waveforms and multiple access schemes
 - ✓ Measurements for full duplex and flexible duplex
 - ✓ Lab test for Massive MIMO, including definition for test specs, test proposals, and calibration
- ✓ The System and network infrastructure test and Measurement
 - ✓ Service and System Level Centric Testing
 - ✓ New Metrics for Networks and Users
 - ✓ Energy consumption



5G White Paper V2.0: rethink mobile communications for 2020+

5G White Paper V2.0 - Security

- ✓ Network Security
- ✓ Terminal Security
- ✓ Physical Layer Security
 - ✓ Key technologies:
 - ✓ Physical Layer Secure Transmission Technology
 - ✓ Physical Layer Key Generation Technology
 - ✓ Enhanced Authentication
 - ✓ Technology verification
 - ✓ System level simulation results
 - ✓ Experimental system / prototype



FuTURE 5G ICT Summit 2014, Beijing



Focusing on the 5G demand and standards vision, the 5G technology vision, the 5G key technology and enabling technology, and 5G service applications and terminals.

FuTURE FORUM organized Future 5G ICT Summit on 6-7 November 2014 in Beijing.

Nearly 300 representatives from 5G Expert Group of 863 Plan, ITU-R, 5GPPP, Korean 5G Forum, Japan 5G research group, WIT Club, 5G organizations in countries and regions including USA and Australia, and internationally reputed communication enterprises and research institutes.



FuTURE 5G ICT Summit 2015, Beijing

Time: November 5th to 7th, 2015

Venue: New Century Grand Hotel Beijing

Organizations:

Host: FuTURE FORUM

Co-host: China Mobile

Special Support:

- General Expert Group of the 863 Important and Special Project on Broadband Network
- General Expert Group of 863 Network and Communication Program
- General Expert Group of 863 Major and Special Program on 5G Technologies
- National Mega S&T Program
- IMT-2020 Promotion Group

Special Acknowledgment: 5GPPP, 5G Forum, 5GMF, WIT CLUB

FuTURE 5G ICT Summit 2015, Beijing

Summit Arrangement

November 5th

Workshop 1: Workshop on Mobile Internet Security Innovation

Workshop 2: Sino-Europe 5G Technical Workshop

(FuTURE FORUM 5G SIG vs. 5GPPP METIS-II & NORMA)

November 6th -7th

- * Future 5G Technical Development-Future 5G Applications
- * Demonstration of 5G R&D results
- * Release of FuTURE FORUM 5G White Paper 2.0
- * Launch of Open 5G Platform and Open-Source Community
- * The 10th Anniversary of FuTURE FORUM

Registration Fee:

Non-member: RMB 2800yuan/person

Member: RMB 1800yuan/person

Registration Link: <http://www.future-forum.org/zhuanti/151105/reg.html>

Thank you !