Research Progress of the Fifth Generation Mobile Communications Promotion Forum

– White paper of “5G Mobile Communications Systems for 2020 and beyond” –

Takaharu Nakamura

Acting chair, Technical Committee of 5GMF

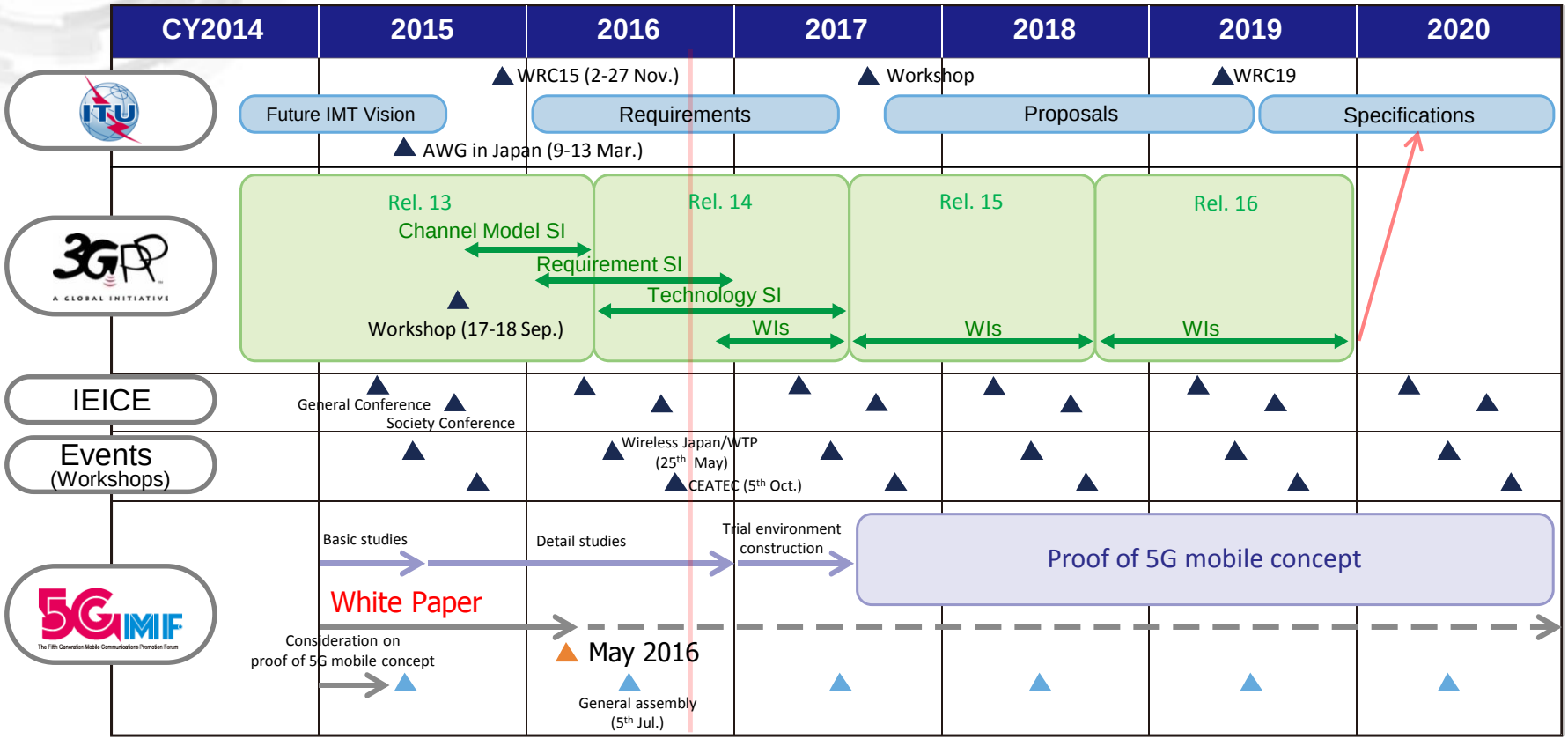
n.takaharu@jp.fujitsu.com

The second Global 5G Event

Rome, Italy

Nov. 10, 2016

Action plan (mid-term) of 5GMF



2

Overview of 5GMF White Paper [3] (with some complimentary information)

[3] 5GMF white paper, “5G Mobile Communications Systems for 2020 and beyond (Ver. 1.0), “, 5GMF, May 2016 (http://5gmf.jp/).

http://5gmf.jp/wp/wp-content/uploads/2016/07/5GMF_WP101_All.pdf

Executive summary: http://5gmf.jp/wp/wp-content/uploads/2016/07/5GMF_WP100_Executive_Summary-E.pdf

5GMF White Paper: Table of contents

5GMIF
The Fifth Generation Mobile Communications Promotion Forum

2.4

5G Key Concepts

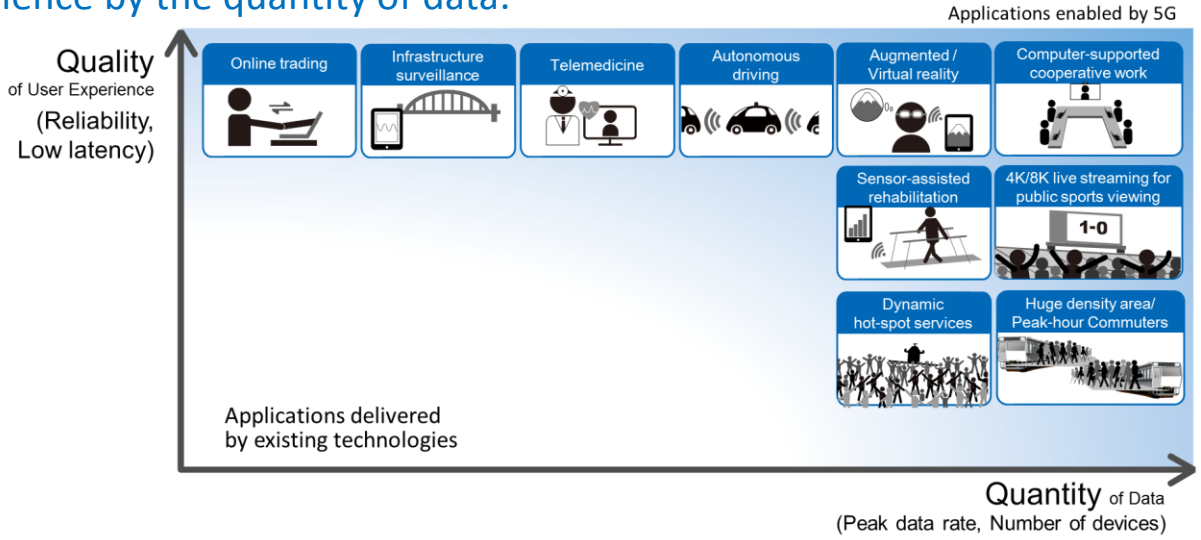
End-to-End Quality in the 5G era

- End-to-end (E2E) quality required by applications and/or users will be far more diversified in the 5G era than what we have seen in the preceding generations.

  For example, the ITU-R Vision recommendation [1] illustrates a number of usage scenarios in which the capabilities required are not identical but diversified depending on the expected E2E quality.

[1] IMT Vision – "Framework and overall objectives of the future development of IMT for 2020 and beyond", ITU-R, Recommendation M.2083-0, Sep. 2015

- The following figure represents potential 5G applications mapped on a domain of the quality in user experience by the quantity of data.



"Mobile Communications Systems for 2020 and beyond", ARIB 2020 and Beyond Ad Hoc Group White Paper, October 2014.

Key Concepts of 5G

Provides two Key Concepts of 5G

1. Satisfaction of End-to-End Quality

- That is the ability to use any kind of application anytime, anywhere **with complete satisfaction in the end-to-end quality of service no matter the use scene**.
- This conceptualization of **"End-to-End Quality"** is **very different** from **previous generations** of mobile communication systems, for which best effort delivery was seen as sufficient.

2. Extreme Flexibility

- 5G networks will need to be **more diverse than previous generations** of mobile communication systems in order **to ensure user satisfaction in End-to-End Quality of services** in services to be deployed in the 2020s.
- 5G networks will be **required to provide "Extreme Flexibility"** In order **to produce this level of End-to-End Quality** for the many services 5G systems will be expected to support.

Key technologies for Key Concepts

Key technologies Needed to Realize Key Concepts

1. Advanced Heterogeneous Networks

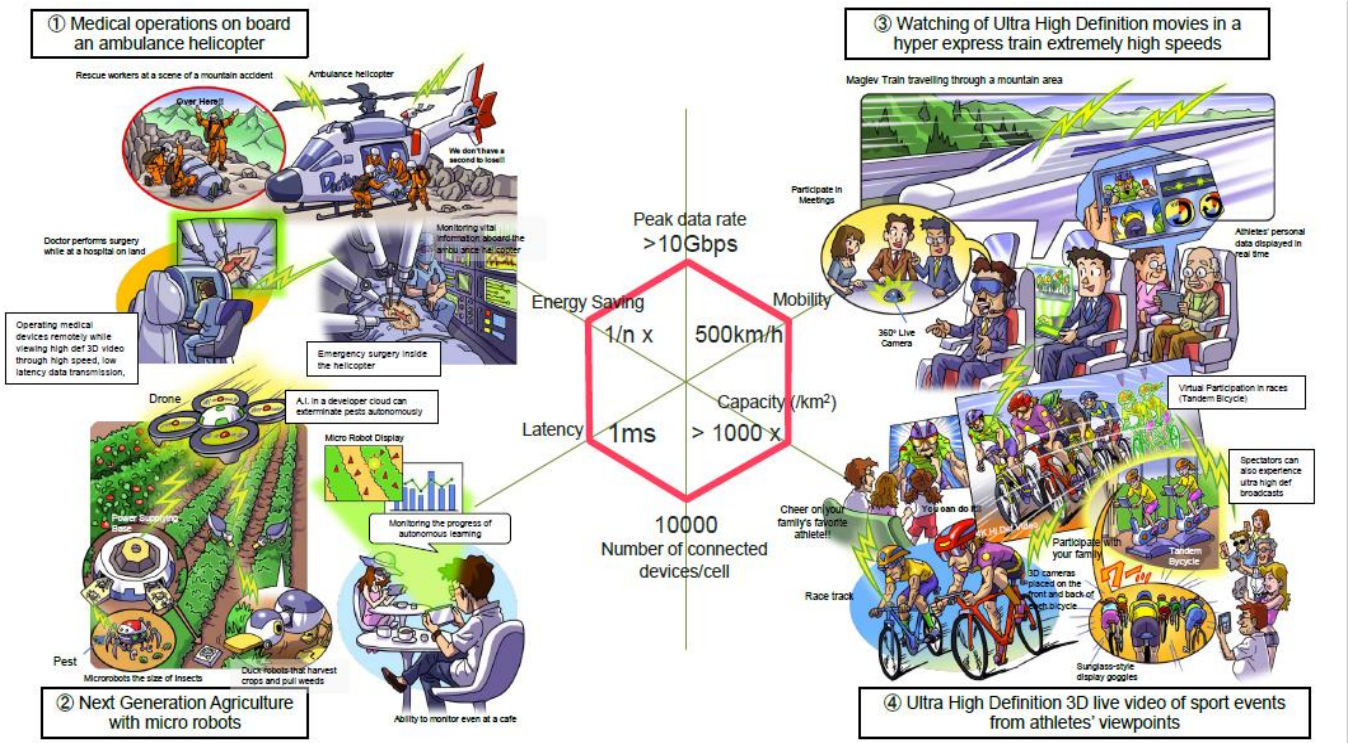
5G will **not** be made up of **a single network**, rather it will **use advanced heterogeneous networks**, 5G radio access technologies (RAT), and **connecting to already existing 2G, 3G, LTE, W-LAN** networks via RAT to create an integrated system that can provide support for a variety of services with flexibility.

2. Network Softwarization

With network softwarization, network devices and components can be designed, introduced, maintained and administered **with easily updated programmable software** as well as ensuring that network devices and components can **easily and flexibly** be used and maintained.

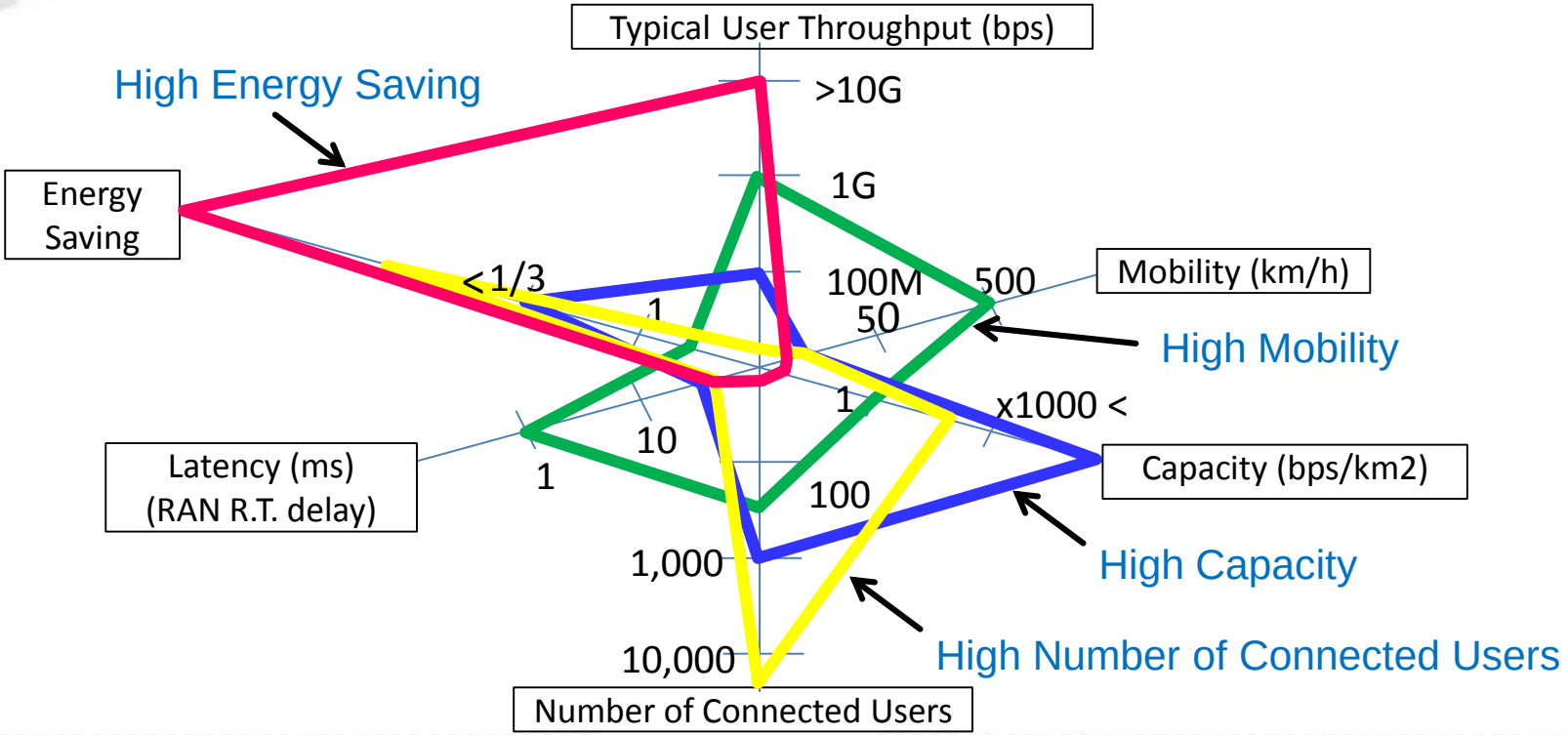
Overview of Future Business and Services

The annex collects the results of open discussions about services and businesses that can be considered from the unique capabilities of 5G



Requirements For User Scenes (Examples)

- 5G systems do not always need to achieve their maximum performance.
- 5G systems will be determined based on individual use scene requirements.



5GMIF
The Fifth Generation Mobile Communications Promotion Forum

2.7

Requirements for 5G and Enabling Radio Access Technologies

Requirements for 5G RAN

Mapping requirements for 5G RAN and 5G typical use cases (eMBB, URLLC, mMTC) in ITU-R Vision recommendation M.2083-0

Required Items	eMBB	URLLC	mMTC
Bandwidth	X	X	X
TRP spectral efficiency	X		X
Peak data rate	X		
Area traffic capacity	X		
Connection density			X
Latency	X	X	
Coverage			X
Mobility	X		
Mobility interruption times	X	X	
Energy efficiency	X		X
Reliability		X	

Note: ‘x’ denotes corresponding requirement in its row should be applied to the use case in its column. Applying relaxed or general requirements to the use cases that are not denoted by ‘x’ is not precluded.

Enabling Radio Access Technologies (1)

◆ Wider bandwidth in higher frequency bands

i. Wider bandwidth
Modulation/Signal processing technologies handling bandwidth beyond 100MHz

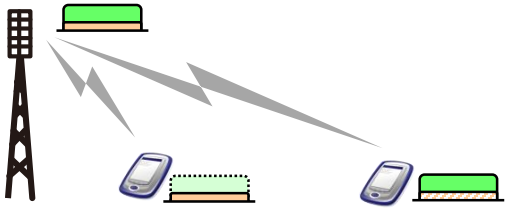
ii. Higher frequency spectrum
RF devices for consumer use

iii. Massive MIMO, Massive antenna array
Higher order MIMO with massive antenna elements

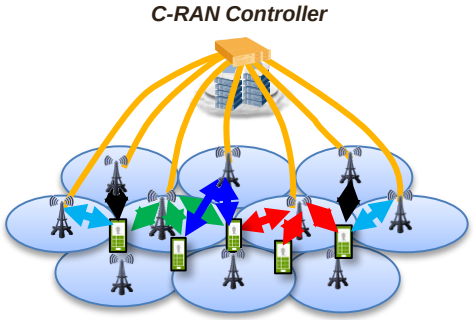
Enabling Radio Access Technologies (2)

◆ New RATs

i. Non orthogonal Multiple Access
ii. Filter Bank Multi-Carrier, Filtered OFDM
iii. Low delay transmission with reduced TTI
iv. Dense network, Control/User plane split
v. Centralized Base band controller and/or Cloud RAN

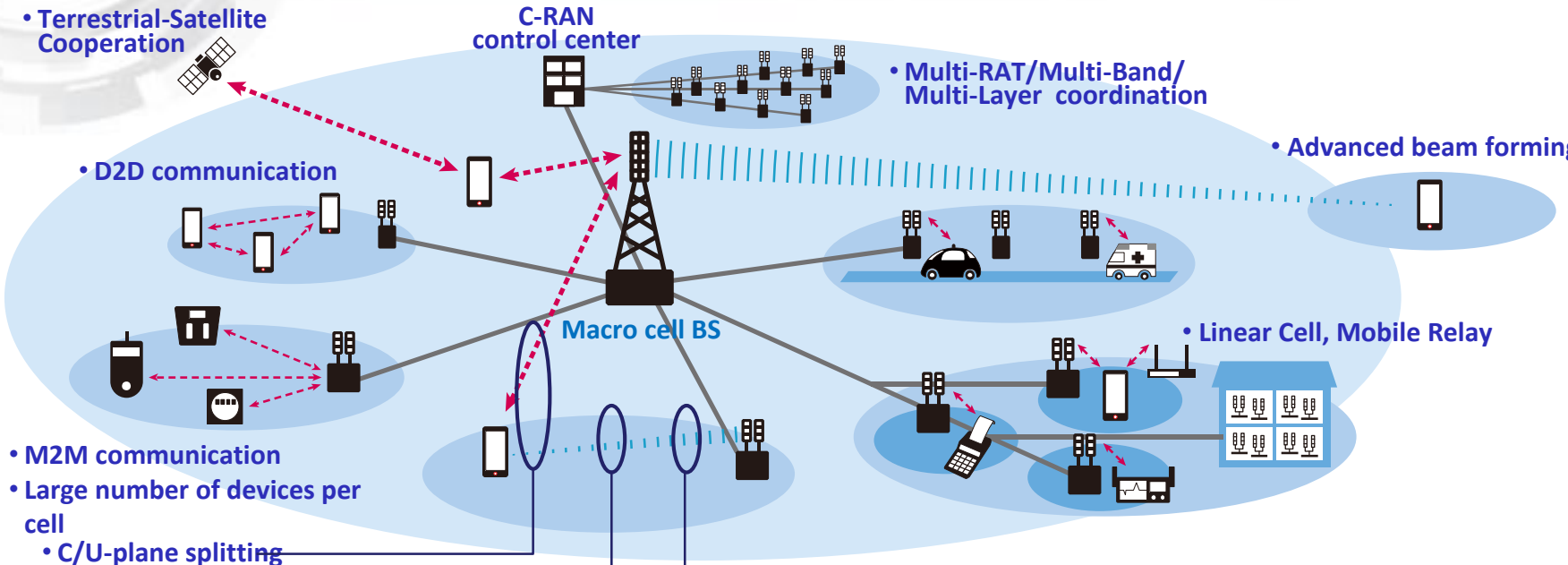


Non-Orthogonal Multiple Access (NOMA)



Claud RAN with Multi-cell coordination

Enabling Radio Technologies



"Mobile Communications Systems for 2020 and beyond", ARIB 2020 and Beyond Ad Hoc Group White Paper, October 2014.

3

Summary

Key concepts and Key technologies of 5G

Two 5G Key concepts

1. **Satisfaction of End-to-End Quality**
2. **Realization of systems with Extreme Flexibility**

Two 5G Key Technologies

1. **Advanced Heterogeneous Network**
2. **Network Softwarization and Slicing**

http://5gmf.jp/wp/wp-content/uploads/2016/08/5GMF_WP100_Summary-E.pdf

Looking ahead the future

- 5GMF will continue the following activities going forward
  - Contributing to the **ITU and 3GPP** on **frequency allotment** and the **development of standards**;
  - Building **relationships with 5G related organizations internationally**;
  - **Promoting** 5G for **potential users in industry**.

- 5GMF hopes discussions on following actions are successful in order to speed up the introduction of the necessary standards and requirements:
  - **Hold 5G Verification Trials** under actual conditions in order to **attract relevant industries to utilize 5G**;
  - **Give demonstrations of 5G characteristics** collaborating **with domestic and international partners**;
  - **Consider a platform** where **service providers** will be able to **easily offer 5G related services to their customers**;
  - **Consider the necessary frequency bands for 5G** both **domestically and internationally**, on which 5G's success depends.

5GMIF
The Fifth Generation Mobile Communications Promotion Forum

Thank you