5GMF activities for 2020 and beyond in Japan

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5G Workshop between Regional initiatives
Lisbon, Portugal
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1. Background
Traffic trend of mobile communication

- 1.5~2.0 times increase trend per year
- A 2.0 times increase per year equals
- 1,000 times increase within 10 years!!

Roadmap towards implementation of 5G mobile in Japan

ARIB 2020 and Beyond Ad Hoc (20B AH)

- Established in September 2013
- Leader: Takehiro Nakamura (NTT DOCOMO)
- 31 ARIB Members joining (as of 1 March 2015)
- Organizational Structure

2020 and Beyond AdHoc

- Service and System Concept WG (WG-SC)
- System Architecture & Radio Access Technology WG (WG-Tech)

White Paper
“Mobile Communications Systems for 2020 and beyond”
http://www.arib.or.jp/ADWICS/20bah-wp-100.pdf

5GMF takes over and advances the 20B AH’s output.
2. Organization of 5GMF
Objectives

Objectives of 5GMF:

- To promote R&D in 5G mobile technology and research and study of 5G mobile standardization
- To collect information relating to 5G mobile and exchange thereof with other organizations
- To correspond and coordinate with related organizations on issues related to 5G mobile
- To promote awareness and disseminate information related to 5G mobile
Organizational Structure of the 5GMF

General Assembly

Chair: Prof. Emeritus YOSHIDA, Susumu (Kyoto Univ.)
Vice-Chair: Dr. SAKAUCHI, Masao (NICT)
Mr. SHINOHARA, Hiromichi (NTT)

Secretariat (ARIB, TTC)

Secretary General: Dr. SATOH, Keihei (ARIB)
Deputy Secretary General: Mr. OKAMOTO, Yasushi (TTC)
Mr. OHMURA, Yoshinori (ARIB)

Advisory Board

Strategy & Planning Committee

Chair: Prof. MORIKAWA, Hiroyuki (Tokyo Univ.)
Acting Chair: Mr. INAKAMURA, Takehiro (NTT DOCOMO)

Technical Committee

Chair: Prof. SAMPEI, Seiichi (Osaka Univ.)
Acting Chair: Mr. MATSUNAGA, Akira (KDDI),
Mr. NAKAMURA, Takaharu (FUJITSU)

Service & Application Committee

Chair: Mr. IWANAMI, Gota (INFOCITY)
Acting Chair: Mr. HAYASHI, Toshiki (GEO NETWORKS)

Network Architecture Committee

Chair: Prof. NAKAO, Akihiro (Tokyo Univ.)
Acting Chair: Dr. KAWAMURA, Ryutaro (NTT)
5GMF Members

Members: 84 (as of 7 Oct. 2015)  Ordinary members: 67, Individual members: 14, Special members: 3 (MIC, ARIB, TTC)
3. 5G mobile Concept in 5GMF
Radio Access Technologies for 5G mobile

- Non-orthogonal multiple access
  - Advanced modulation, coding and Waveform
  - New radio frame structure
  - Advanced interference cancellation/suppression

- Advanced Antenna, Massive MIMO, MU-MIMO
  - Higher frequency bands (~mmWave)
  - Flexible spectrum management

- C/U-plane splitting
- D2D communication
- M2M communication
- Large number of devices per cell

- Linear Cell, Mobile Relay
  - Flexible/Virtual RAN
  - Self Organizing/Optimizing network
  - Ultra-dense cells control
  - Inter-working among multiple RAT’s

- Multi-RAT/Multi-Band/Multi-Layer coordination
- Advanced beam forming

- Terrestrial-Satellite Cooperation

Framework for 5G RAN

Dashed line indicates that the exact typical throughput associated with 5G RAN are not yet determined.

Normalized Typical User Throughput [bps/device]

Coverage expansion

Higher throughput

Enhanced - IMT-Advanced

New RAT(s)

Increase capacity

5G RAN

User density [10^4 devices/km^2]

Big Cell  Small Cell

IMT-Advanced

10^{-3}  1  10^3

Isolated  Rural  Urban  Dense  Extreme

Potential Application enabled by 5G mobile

Quality of User Experience (Reliability, Low latency)

- Online trading
- Telemedicine
- Autonomous driving
- Augmented/Virtual reality
- Computer-supported cooperative work
- 4K/8K live streaming for public sports viewing
- Sensor-assisted rehabilitation
- Infrastructure surveillance
- Dynamic hot-spot services

Applications delivered by existing technologies

Quantity of Data (Peak data rate, Number of devices)
4. Action plan toward 5G mobile
4.1 Action plan (mid-term) of 5GMF

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<th>CY 2014</th>
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<td>Future IMT Vision</td>
<td>WRC15</td>
<td>Requirements</td>
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<td>AWG in Japan (9-13 Mar.)</td>
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<td>Consideration on proof of 5G mobile concept</td>
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Proof of 5G mobile concept

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4.2 5G Integrated Verification Trial

Objectives:

- Estimation of research and development result in 5GMF activities
- Estimation of the operation of an overall 5G mobile
- Demonstration of outputs on 5GMF to domestic and international organizations
- Promotion for practical use of 5G mobile
Aims of 5G Integrated Verification Trial

- Launch an integrated verification trial in FY2017 connecting radio access, network, and applications to ensure smooth commercialization of 5G systems by 2020.

- Evaluate 5G services in actual environments, after evaluating basic functions in the initial phase, in order that the views of application developers and users are reflected as research and development efforts progress.

- Contribute to global R&D and standardization efforts of 5G systems by having an open environment for the verification trial in Japan, allowing for participation of relevant parties, enterprises and universities involved in 5G systems research worldwide, thereby accelerating the widespread adoption of 5G systems.
Schedule Overview

- Verification to commence from FY2017

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<td>5G commercialization Lower frequency bands</td>
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- Basic studies
- Detail studies (Venue, frequency band, budget, participating organizations/soliciting enterprises, etc.)
- Trial environment construction
- Survey on user needs, studies on applications/services

- FY2015: Tokyo Olympic/Paralympic Games
- 2019: Rugby World Cup
- 2020: Tokyo Olympic/Paralympic Games
- 2021: Rugby World Cup
- 2022: Tokyo Olympic/Paralympic Games

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Spectrum to be Used for Verification Trial

- Both lower frequency bands (frequency bands used in existing systems, below 6GHz) and higher frequency bands (centimeter, millimeter waves) to be included in the scope of verification trial.

- The specific frequency bands to be used in the verification will be selected in the course of finalizing the details of the system to be evaluated.
Integrated Verification Trial Participants

- Open to general participation by any enterprise agreeing to the “Aims of Verification” in Japan and abroad including:
  - Parties involved in the research and development promoted by the Ministry of Internal Affairs and Communications
  - 5GMF Members
  - Other carriers, vendors, application developers, etc.

- Broad participation of relevant parties is desired in light of the trial’s nature: an integrated verification trial combining radio, network and applications
Venue

- Tokyo (In view of the 2020 Tokyo Olympic/Paralympic Games)
- Local cities
Verification Trial Plans (Conceptual)

- Select typical urban indoor/outdoor environments as venues for the verification trial
  - Outdoor: Vehicular areas, street canyons, open squares
  - Indoor: Shopping mall, offices
- Solicit experiments for speed/capacity enhancement and latency improvement in each environment
- Antenna installations will be shared by multiple trial participants to the extent possible
- Each trial participant will use different frequency bands. Frequency sharing conditions to be confirmed.
5. Global collaboration on 5G
Collaborate bilaterally with other organizations

- **5G PPP**
  - Meeting, Munich, 11 April 2014
  - MoU signed, Frankfurt, 25 March 2015

- **Korea 5G Forum**
  - Meeting, Tokyo, 19 August 2013
  - Meeting, Tokyo, 3 July 2014
  - MoU signed, Tokyo, 6 April 2015

- **Wireless World Research Forum (WWRF)**
  - MoU signed, e-mail, 21 August 2015

- **Indonesia 5G Forum**
  - MoU signed, Bali (Indonesia), 21 September 2015
  - Meeting, Bali (Indonesia), 22 September 2015
Hold workshops on 5G related issues

- CEATEC-Japan, Chiba, 8 October 2014
- 18th Meeting of the APT Wireless Group, Kyoto, 9 March 2015
- Wireless Technology Park, Tokyo, 28 May 2015
- CEATEC-Japan, Chiba, 8 October 2015
Global Collaboration on 5G (3)

- MOU exchange ceremonies with 5G associations worldwide
  - 5G Infrastructure Association: 25 March 2015
  - Korea 5G Forum: 6 April 2015
  - Wireless World Research Forum (WWRF): 21 August 2015 (e-mail)
  - Indonesia 5G Forum: 21 September 2015
6. Summary
Summary(1): Target of 5GMF

- Lead R&D and international standardization to implement 5G mobile for 2020 and beyond
  - Publish White Paper and Implementation roadmap

- Demonstrate verification tests on Proof of Concept
  - Summarized the results of pre-verification research by the end of June 2015 and call for the participation of 5GMF members
  - Perform verification tests (mobile network + wired network + mobile application) from FY 2017

- Contribute actively internationally through collaboration with international organizations
  - Promote the sharing information and vision for 5G mobile with overseas organizations in Europe (5G-PPP), Korea (5G Forum), China (IMT-2020 PA, FuTURE Forum), etc
Summary(2): Goals of 5GMF

- International collaboration and Standardization
- Innovation by R&D through Industry-Academia-Government Cooperation

5GMF leads the discussion of 5G mobile in the world
Thank you for your kind attention!

http://5gmf.jp/en/