

# Views on IMT beyond 2020

February 12, 2014

ARIB 2020 and Beyond Ad Hoc

# Introduction

- “2020 and Beyond Ad Hoc (20B AH)” was established in Association of Radio Industries and Businesses (ARIB), Japan, to study terrestrial mobile communications system in 2020 and beyond
- This material shows overviews of 20B AH organization and activities as well as our preliminary study results
- Throughout the presentation, the term “5G” is tentatively used to denote the mobile communications system to be commercialized in 2020 and beyond

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- 1. Overviews of ARIB 2020 and Beyond Ad Hoc**
- 2. Market and user trends & 5G roles**
- 3. Typical use cases**
- 4. New capabilities of 5G**
- 5. Framework**
- 6. 5G definition**
- 7. 5G Radio access Technologies**

# **1. OVERVIEWS OF ARIB 2020 AND BEYOND AD HOC**

# Outline of ARIB

- **Objectives:**

- To establish technical standards for radio systems as “ARIB Standards” in the field of telecommunication and broadcasting in Japan

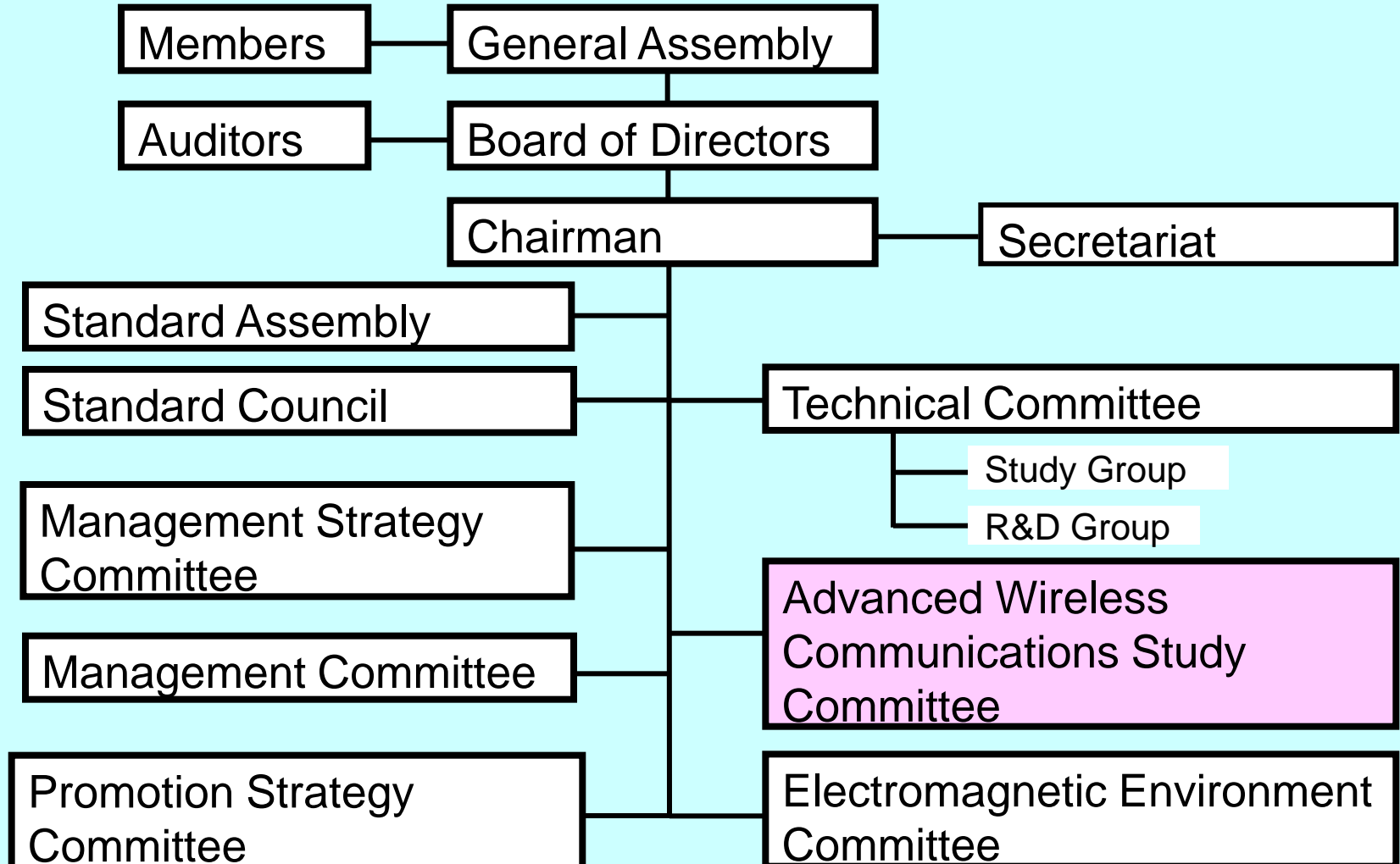
- **Establishment:**

- 15 May 1995 as a public service corporation by merging two organizations RCR & BTA
  - RCR: Research & Development Center for Radio Systems
  - BTA: Broadcasting Technology Association

- **Members:**

- 214 members (as of 1<sup>st</sup> October 2013), including telecom operators, broadcasters, manufacturers, etc.

# Organization of ARIB

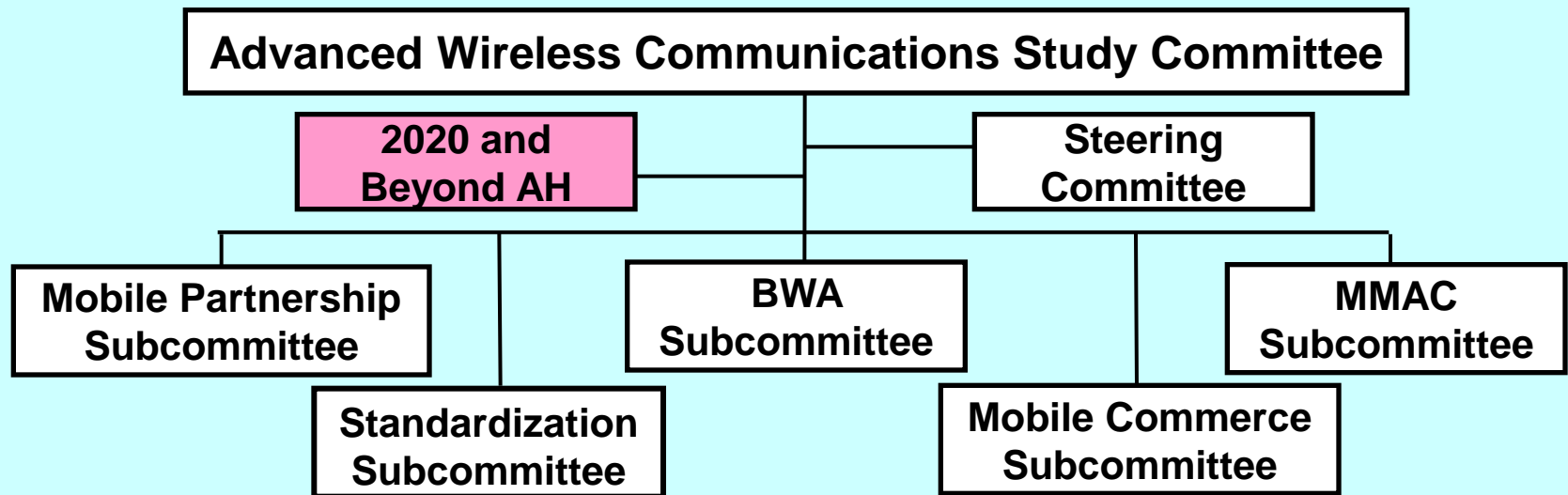


# Advanced Wireless Communications Study Committee (ADWICS)

## ■ Responsibilities

- To conduct technical studies on advanced wireless communication systems (including IMT) in cooperation with other related international/domestic organizations
- To contribute to international standardization activities

## ■ Structure of the Study Committee



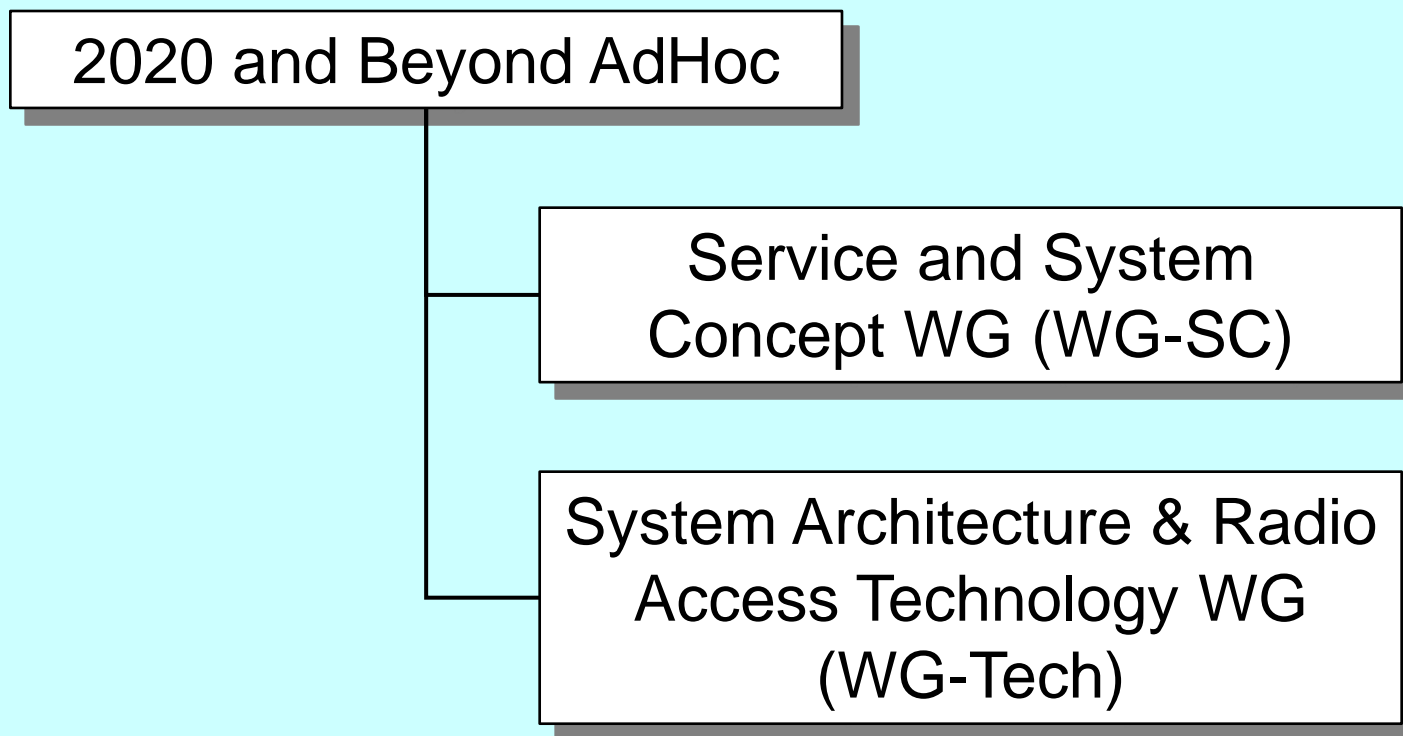
# 2020 and Beyond Ad Hoc (1)

- Established under ADWICS in Sep. 2013
- Leader: Takehiro Nakamura (NTT DOCOMO)
- 31 ARIB Members joining
- Objective
  - To study system concept, basic functions and function distribution/architecture of mobile communication system in 2020 and beyond
- Task
  - Study technologies used for system in 2020B
  - Study system concept and fundamental architecture of 2020B
  - Study services and applications offered by 2020B
  - Cooperation and coordination with other international/domestic organization
- Deliverables
  - White paper, Contribute to ITU and other fora



# 2020 and Beyond Ad Hoc (2)

- Two WGs under 2020 and Beyond Ad Hoc



# Service and System Concept WG

- Leader: Akira Matsunaga (KDDI)
- Scope: Study services and system concept of mobile communication system (not limited to IMT) in 2020 and beyond
- Task: To clarify social roles, key capabilities and key functions of 2020B, study items such as follows
  - Use Case
  - Requirements
  - Capabilities including new Van Diagram
  - Spectrum
  - Traffic forecast

# System Architecture & Radio Access Technology WG

- Leader: Takaharu Nakamura (Fujitsu)
- Scope: Study trends of technologies to be used in 2020B, taking into account study results of Service and System Concept WG
- Task
  - Study technology trends of radio access technologies and other major network technologies
  - Study basic functions and function distribution/architecture of 2020B

# Activities of 20B AH (1)

- In the 2020 and Beyond AdHoc(20B AH) meeting #2 on Nov. 29, a workshop was held as an initial step of AH activities
  - 14 and 4 presentations from AdHoc members and invited professors were provided, respectively
  - Views on variety of services or scenarios and technology trends for ‘2020 & Beyond’ were presented and active/forward-looking discussions took place
  - Summary capturing presentations and the discussion was developed

# Activities of 20B AH (2)

- Based on the summary of the Workshop, further discussion took place at the AH meeting #3 & #4 and following slides were developed to show the current AH views on the mobile communication system in 2020 and beyond
  - The 5G mobile system in this material addresses wireless mobile systems in general, not limited to IMT.
- 20B AH has now been concentrating on study on radio aspects on 5G. Items for further investigation will include non-radio aspects.

## **2. MARKET AND USER TRENDS & 5G ROLES**

# **Market and user trends in the 5G era**

**1. “Everything can be done via the Internet” and people will enjoy its benefit.**

- Always connected to the Internet without users’ being conscious**
- Those non-connected will suffer from disadvantages**

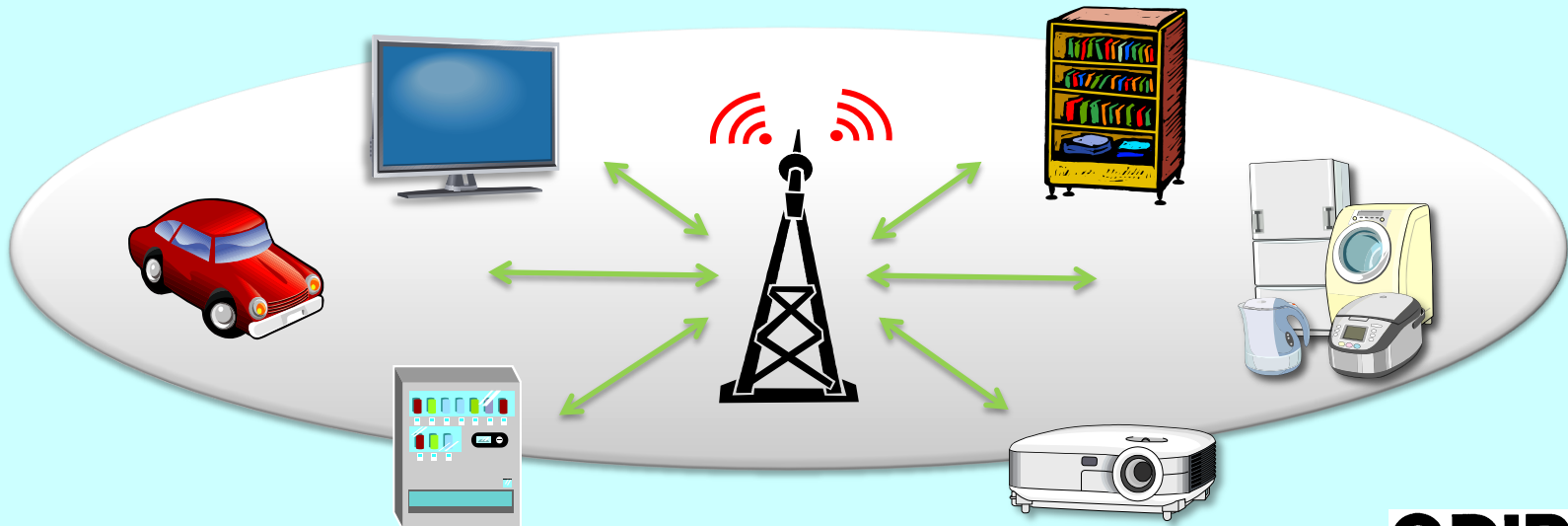
**2. ICT will be used in much more cases and will be applied for vast variety of services.**

# The role of mobile communications in 5G era (1)

5G mobile is expected to

## 1. provide lifeline communication

- to everybody, anytime, anywhere, regardless of locations
- both in case of emergency and in daily lives
- by a wide variety of devices
- connecting everything
- in a secure and reliable fashion



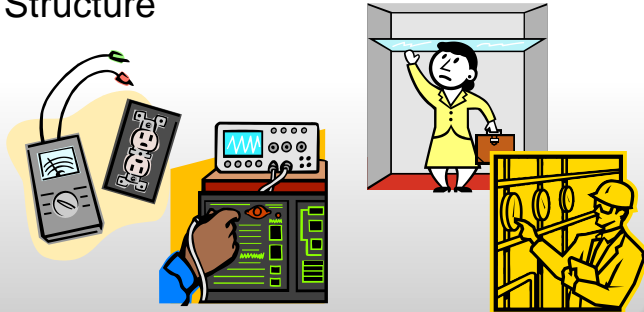


# The role of mobile communications in 5G era (2)

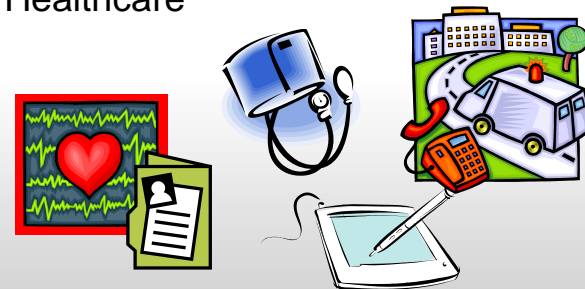
5G mobile is expected to

**2. cope with a huge amount of data from a wide variety of applications, thereby fostering every industry innovation, e.g. M2M**

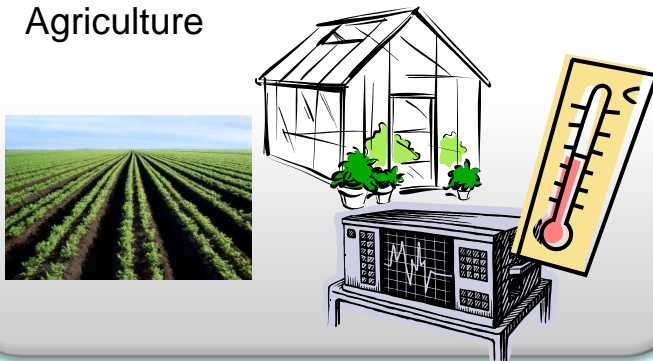
Structure



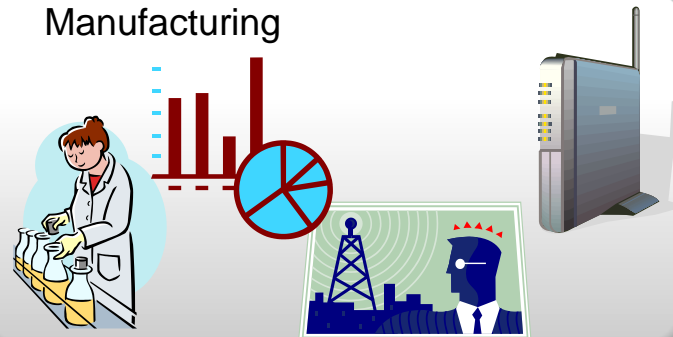
Healthcare



Agriculture



Manufacturing



# The role of mobile communications in 5G era (3)

5G mobile is expected to

## 3. Support flexible life styles

- e.g. working, learning, shopping
- creating community and interest group

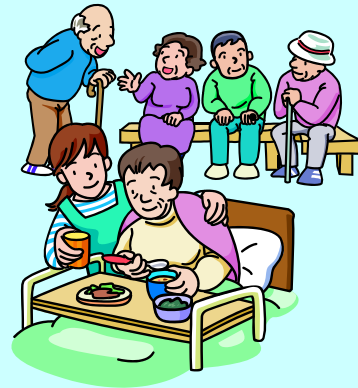


# The role of mobile communications in 5G era (4)

5G mobile is expected to


**4. serve numerous socio-economic requirements in order to address**

- Disaster prevention and relief
- Super-aging society - Medical/Health Care, Nursing Care
- Resource problems e.g. energy saving
- Environmental problem



# 3. TYPICAL USE CASES

# From socio-economic perspective, 5G will enhance user satisfaction for existing services



**Transportation**  
More efficient and safer  
Navigation  
Autonomous driving



**Richer contents**  
Multiuser UHD teleconference  
Purchase enriched video,  
music, book



**Health care**  
Remote medical  
examination

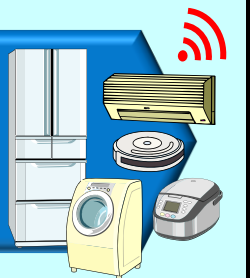


**House**  
Home security

**5G will  
enhance the  
socio-  
economic  
satisfaction**




**Disaster relief**  
Prediction  
Robustness to disaster



**Consumer  
electronics**  
Remote control

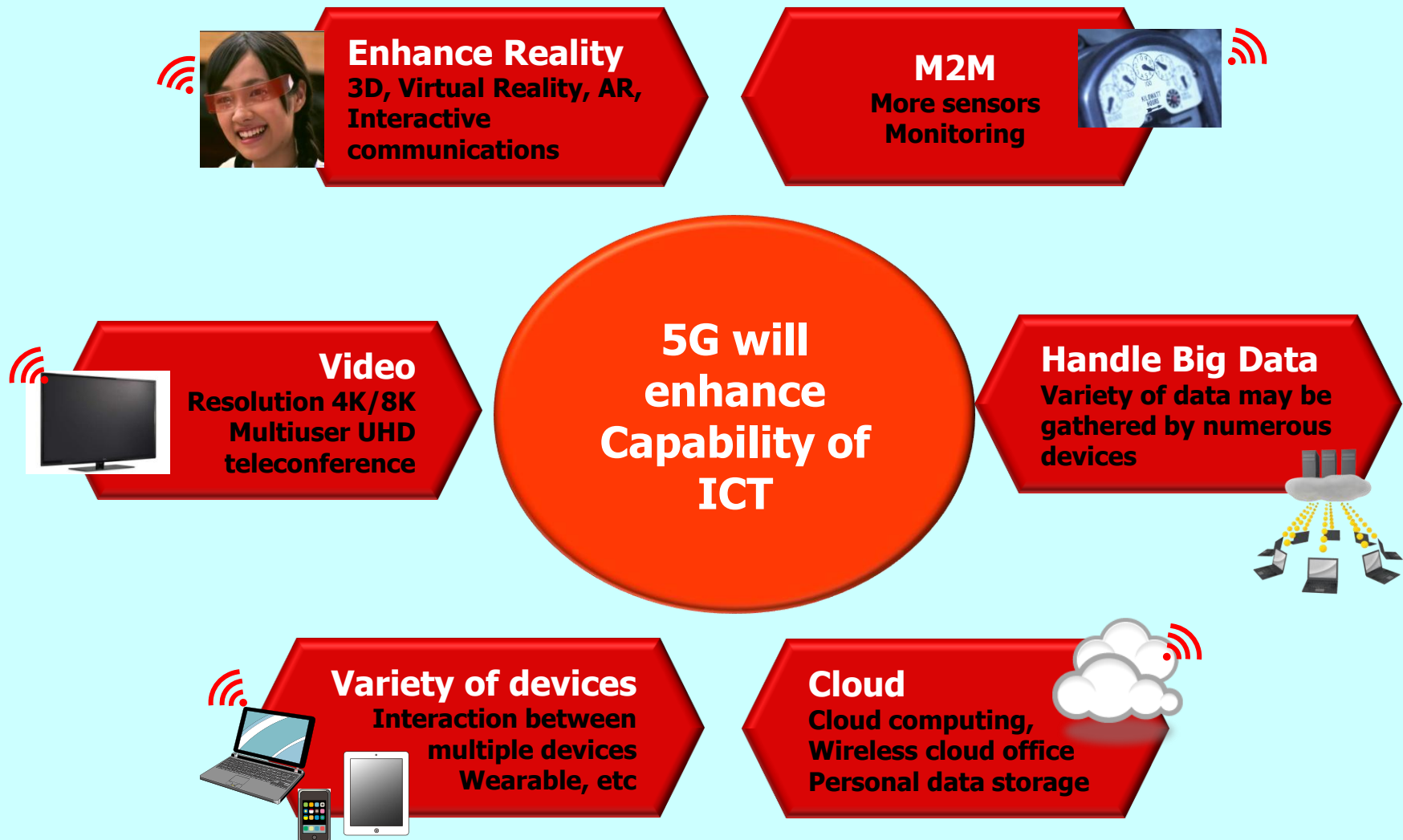


**Education**  
Distance learning  
Virtual experience



**Safety and lifeline system**  
Collision avoidance  
Rescue  
(Distress, Accident, etc.)

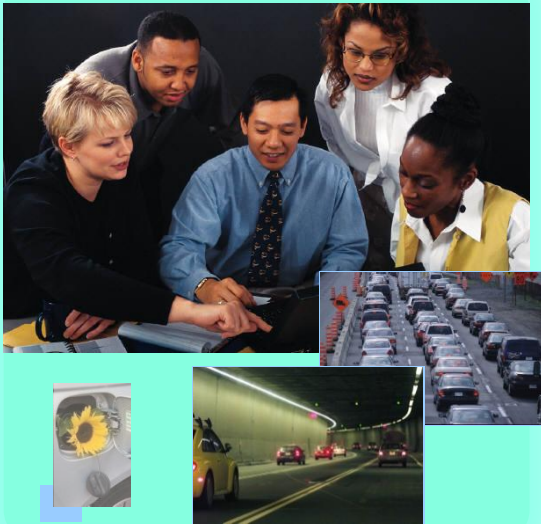
# From perspective of capability of ICT, capability will be greatly enhanced by 5G



# 5G will bear new roles and offer new use cases

## Smart citizen services

Knowledge creation  
Activity support



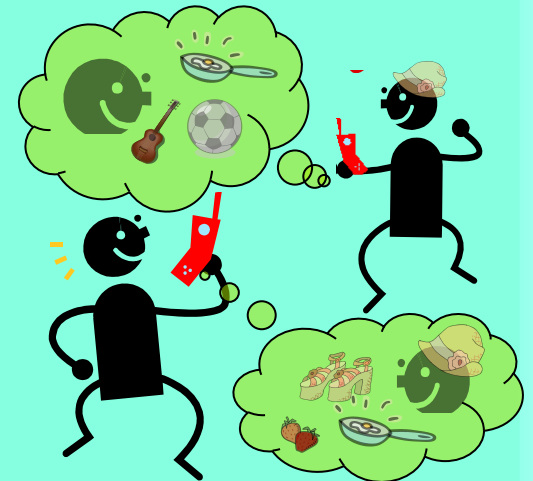
## Share experience

More fidelity, realistic  
Tactile



## Assist communication between unacquainted persons

Share information in proximity



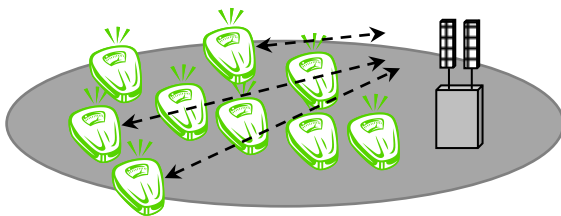
## **4. NEW CAPABILITIES OF 5G**



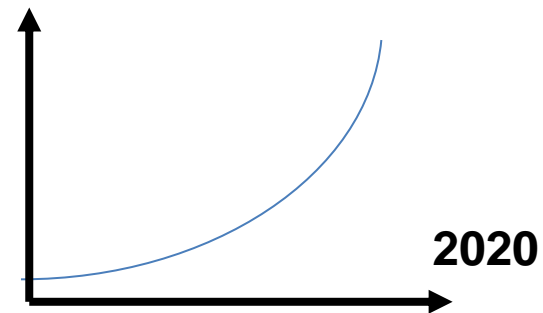
# Required Capabilities for 5G (1)

- Augment system capacity x1,000 to support traffic growth
- Massive Device Connectivity, e.g. 100x
- Higher peak data rate - e.g. > 10 Gbps peak
- Reduced latency - e.g. less than 1ms
- Improved energy efficiency, longer battery life
- Cost reduction, improvement of cost efficiency
- Higher reliability and sustainable system
- Higher performance in high speed mobility
- Robustness to disasters

Massive Device Connectivity,  
e.g. 100x



Augment system capacity x1,000  
to support traffic growth



## **Required Capabilities for 5G (2)**

- Guaranteed connectivity  
to serve as lifeline system**
- Maximizing quality of experience (QoE)  
5G network to be controlled to maximize user  
perception**
- Flexibility to support more diversified application  
needs**
- RAT capability for network virtualization to realize  
flexible and efficient use of network resources  
including multi RAT**

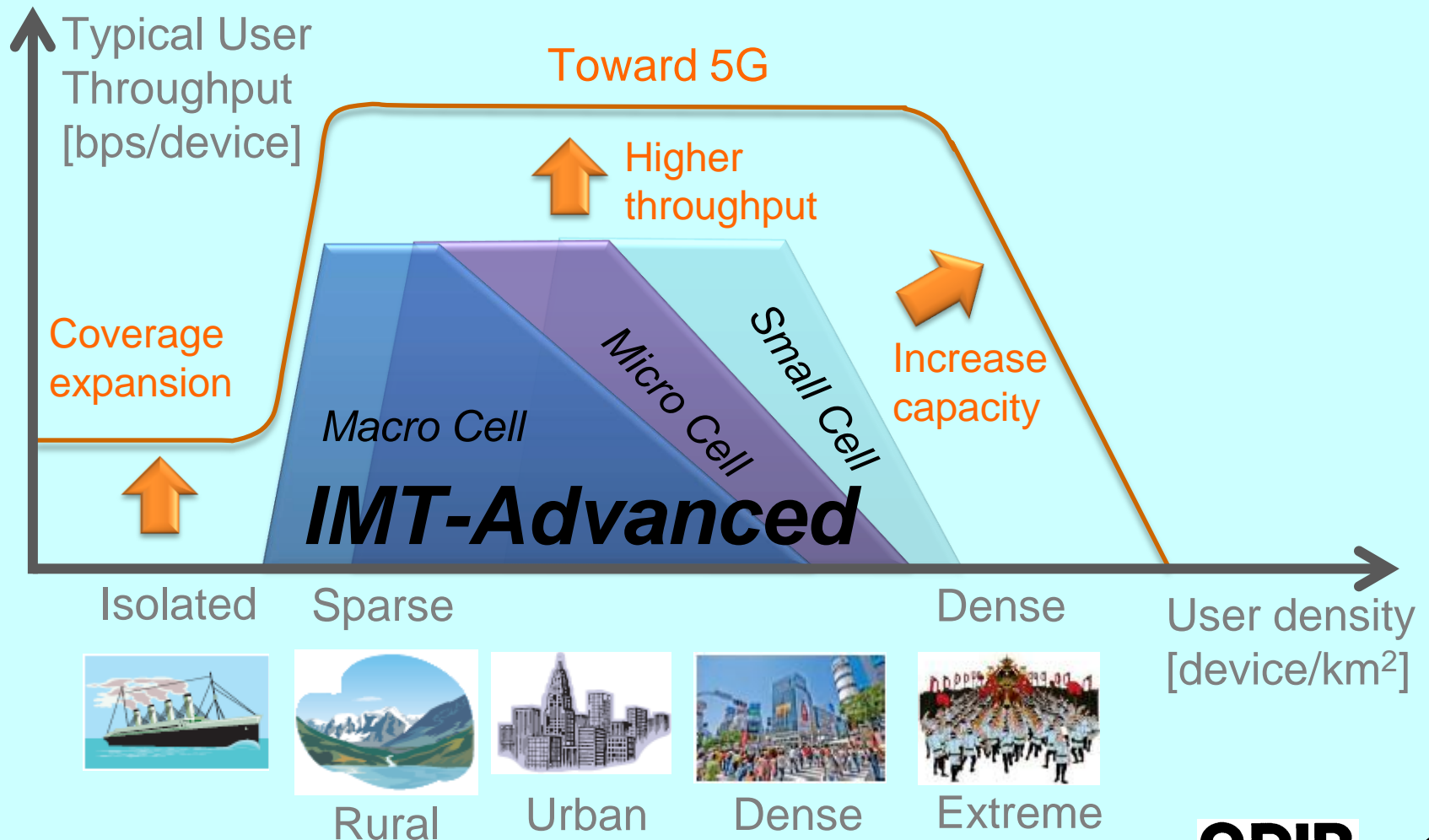
# 5. FRAMEWORK

# Framework for 5G

**In order to illustrate the capability of 5G, three example diagrams under discussion in ARIB are shown as follows.**

- (1) Highlight the difference between IMT-Advanced and 5G**
- (2) Capabilities required by respective application from a user perspective**
- (3) Maximum capability of 5G from system perspective**

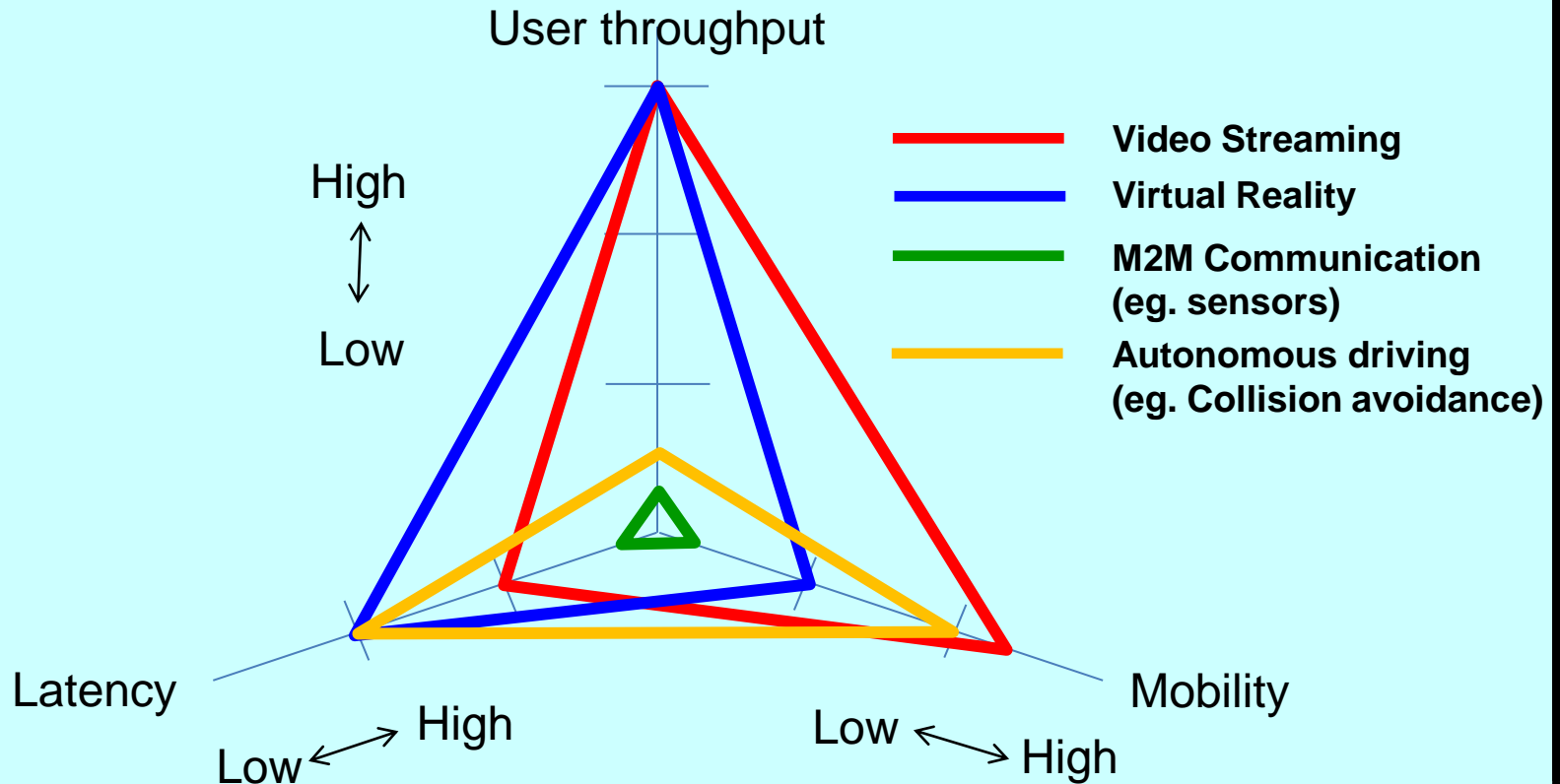
# Example of Framework for 5G (1)



# Example of Framework for 5G (2)

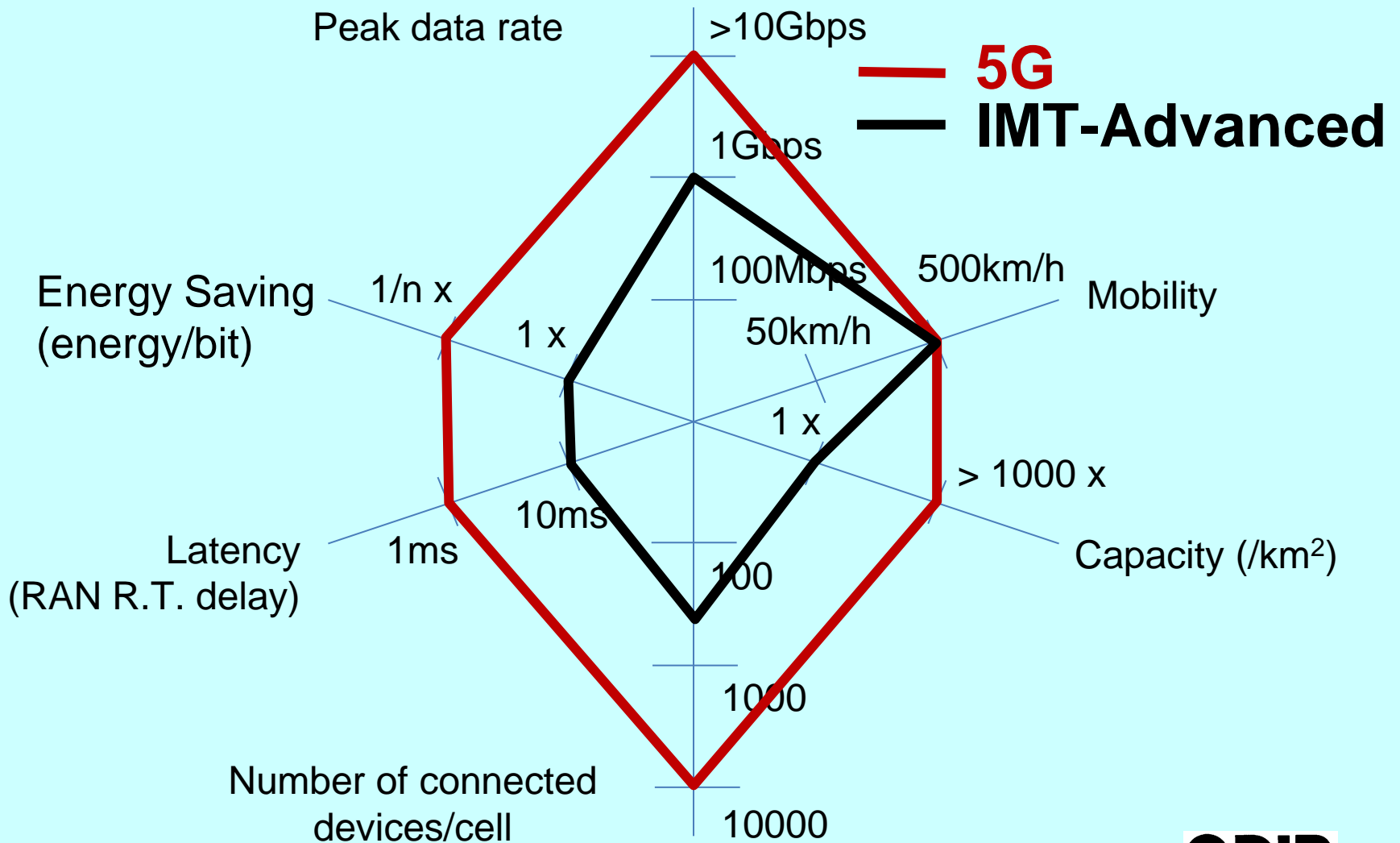
Required capabilities vary depending on applications from a user perspective.

Efficient use of resources will be desirable.



# Example of Framework for 5G (3)

## Maximum system capabilities



## **6. 5G DEFINITION**



# Revolution/Innovation vs. Evolution of RAN

Evolution

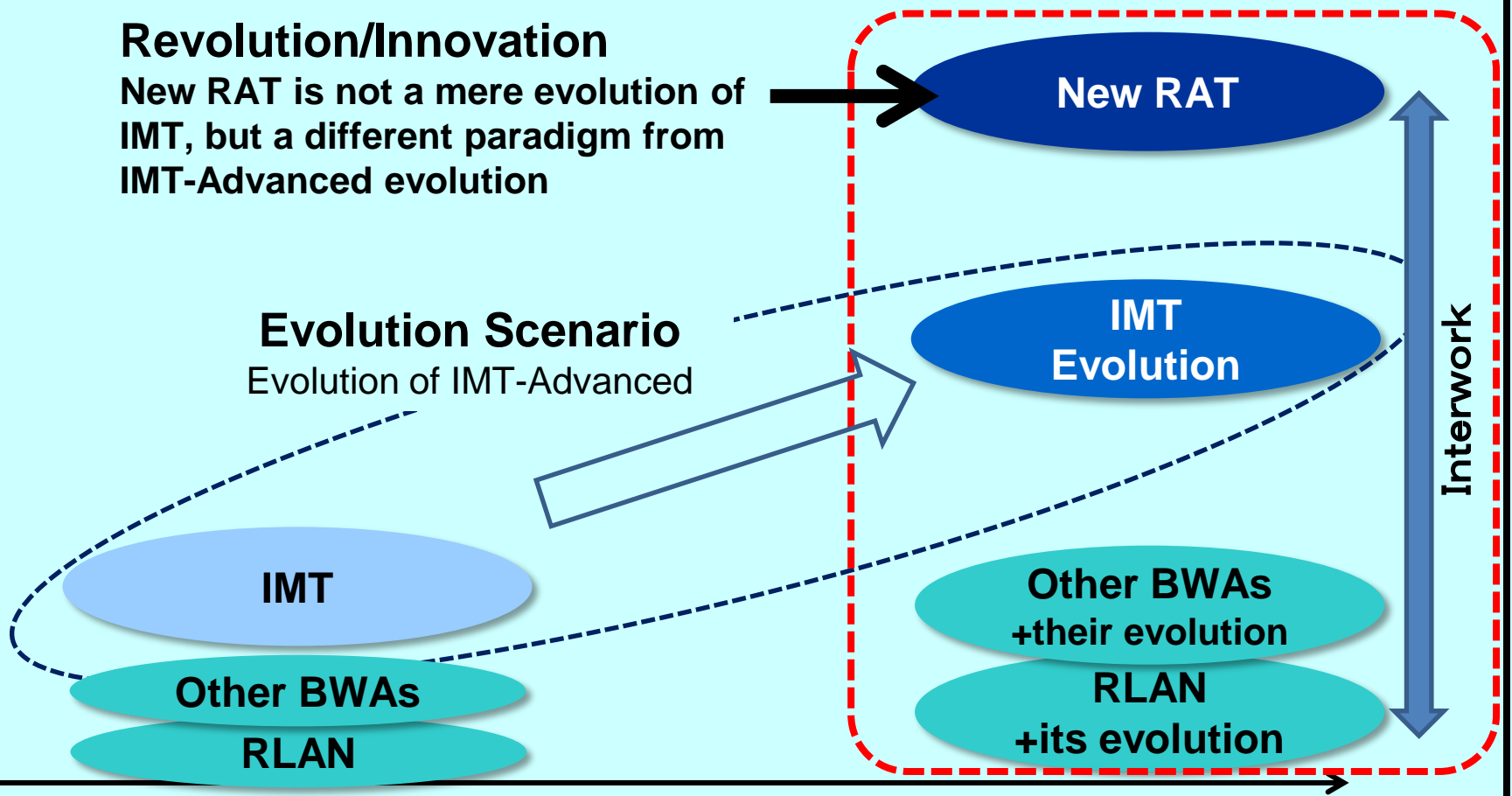
## Revolution/Innovation

New RAT is not a mere evolution of IMT, but a different paradigm from IMT-Advanced evolution

**True 5G RAN**  
Integrated Radio Access Technologies  
Looks seamless from a customer

## Evolution Scenario

Evolution of IMT-Advanced



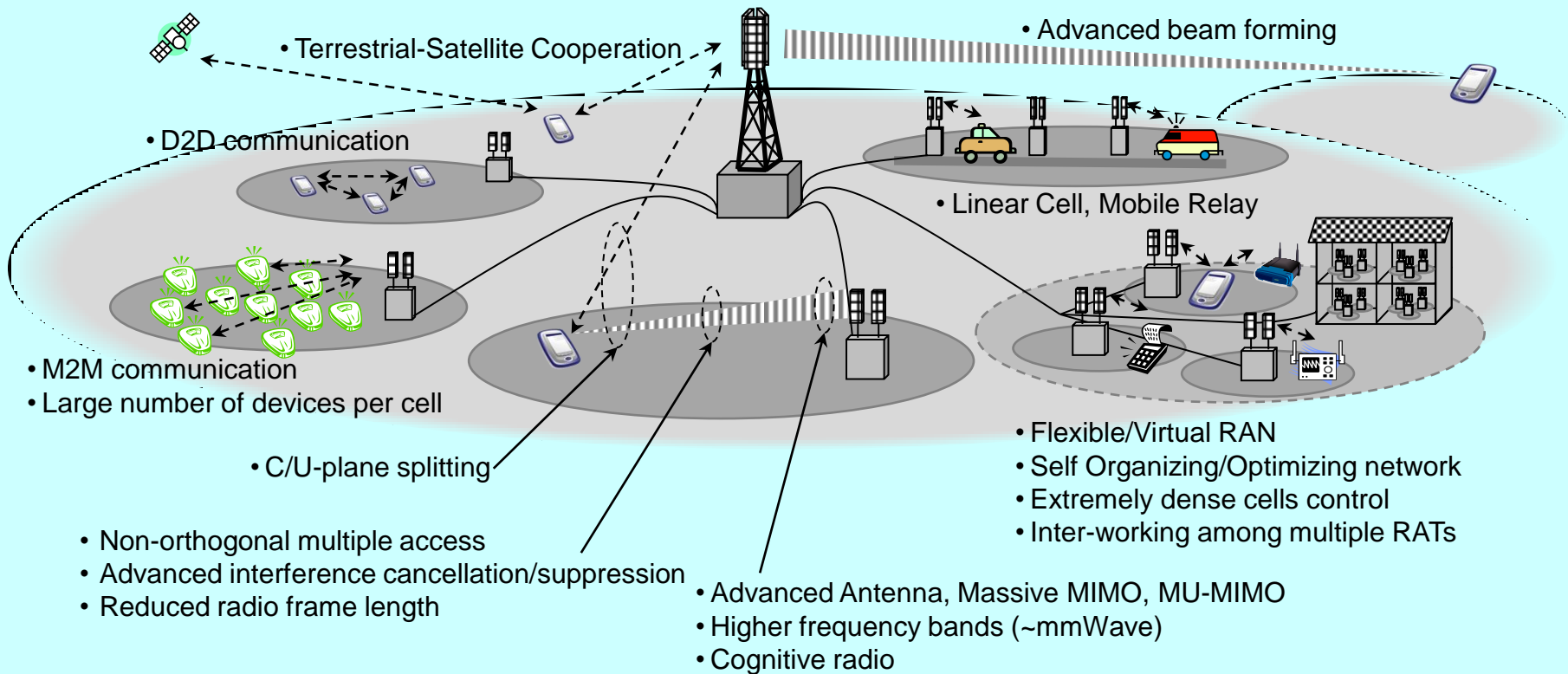
2013

2020 year

# **7. 5G RADIO ACCESS TECHNOLOGIES**

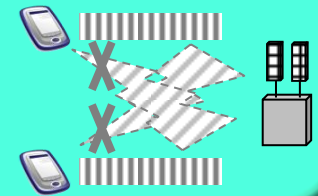
# Radio Access Technologies for 5G system

Technologies shown here may not be exhaustive and subject to further investigations in ARIB 20B AH

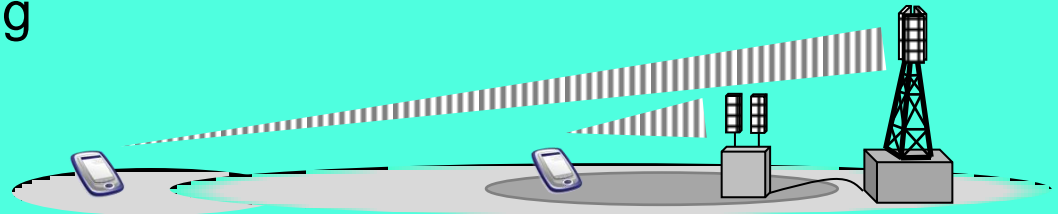


# 5G RAN technologies (1/4)

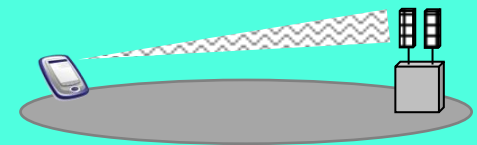
- Non-orthogonal multiple access
- Advanced interference cancellation/suppression
- Reduced radio frame length



- Advanced Antenna Technologies, e.g. Massive MIMO, MU-MIMO
- Advanced beam forming

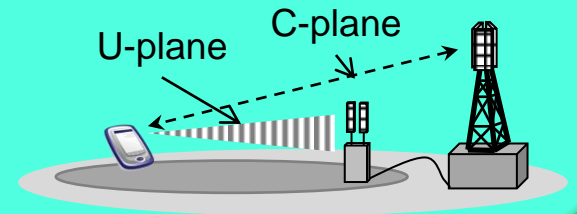


- Higher frequency bands (~mmWave)

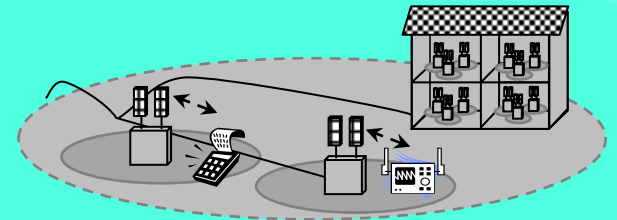


## 5G RAN technologies (2/4)

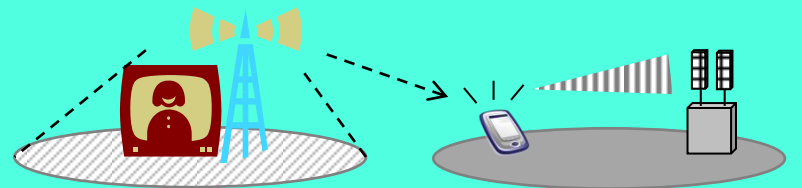
- C/U-plane splitting



- Flexible/Virtual RAN
- Self Organizing/Optimizing network
- Extremely dense cells control

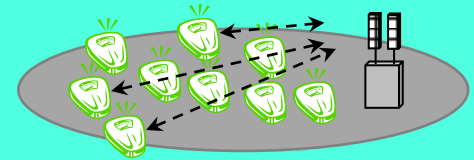


- Cognitive radio

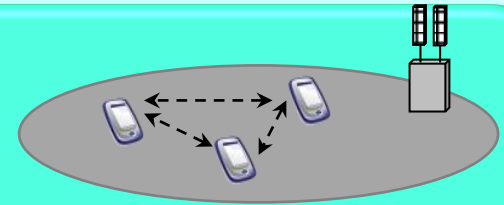


## 5G RAN technologies (3/4)

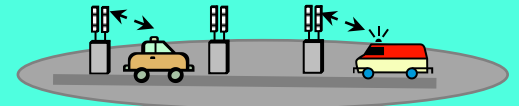
- M2M communication
- Large number of devices per cell



- D2D communication



- Linear Cell, Mobile Relay

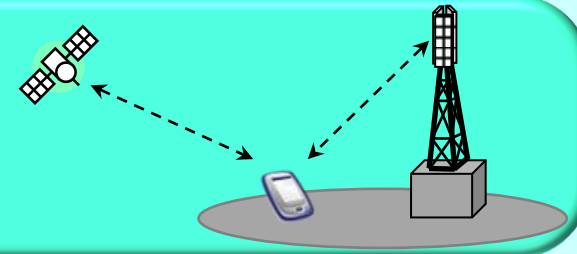


# 5G RAN technologies (4/4)

- Inter-working among multiple RATs
  - With terrestrial IMT RATs
  - With other terrestrial RATs, e.g. RLAN, BWA



- Terrestrial-Satellite Cooperation



# Conclusion

- Overviews of ARIB 20B AH and its preliminary study results for “5G” are shown
  - Market trends and expected role of mobile communications in “5G” era
  - Typical use cases
  - New capabilities of “5G”
  - Framework
  - “5G” definition
  - “5G” Radio Access Technologies
- The preliminary study results may not be exhaustive and yet self-contained.
- ARIB 20B AH continues necessary investigations towards “5G”
- ARIB 20B AH will develop a White Paper to capture our investigation results. Target completion date of the White Paper is the end of August 2014
- ARIB 20B AH is willing to establish collaborations with “5G” research related industrial organizations and academic institutes in order to share our technical activities as well as the investigation results

The term “5G” denotes the mobile communications system to be commercialized in 2020 and beyond. Tentatively used throughout this presentation for the sake of simplicity.