5G for eHealth
- 5G Utilization in Telemedicine -

Yukihiro OKUMURA, NTT DOCOMO, INC., Japan
Workshop on New Communication Technologies for E-health and Socio-Economic Issues

Introduction
5G Features

High speed/large capacity
- Peak rate: Over 20Gbps *

Low latency
- Transmission latency in Radio Access Network (RAN): 1ms or less *

Massive device connectivity
- No. of simultaneously connected devices: $10^6$ devices / km$^2$ *

Applications:
- AR/VR
- 4K/8K streaming
- Stadium solution
- Smart city, smart home
- Autonomous driving
- Medical/Health care
- Agriculture
- 5G Stadium solution
- 5G Medical/Health care

* Target requirement indicated in ITU-R M.2083-0
Significance of 5G Introduction

Promote “5G” as a pillar of digital transformation

- New Value Creation
- Social Problem Solving

Drastic Improvement of UI/UX
Creating Innovative Services
Improve Productivity

DX: Digital Transformation

IoT, AI, 5G, AR/VR, Cloud
5G Launch Schedule Assumed by NTT DOCOMO

Sept. 20th, 2019: Started "Preliminary Service"

Spring, 2020: Starting “Commercial Service”

- Rugby World Cup
- Olympic & Paralympic Games Tokyo*

Frequency Assignment on SHF (S/C/Ka)-band

* NTT Group is a Gold Partner (Telecommunications Services) of Tokyo 2020 Olympic and Paralympic Games.
Field Trials on New Services by 5G
Japanese MIC’s Projects toward 5G Realization

- 5G R&D projects on elemental technologies in 5G such as ultra high speed, large system capacity, low-latency, massive connection were led by MIC for 4 years
- 5G field trials with 3 years have been held in all over Japan on various application-specific fields for social implementation of 5G

5G R&D Projects (2015-2018)
- Research on elemental technologies in 5G (Ultra high speed, Large capacity, low-latency, Massive connection, …)
- Collaborative research with Europe

5G Field Trials (2017-2019)
- System trial allowing user participation is held in Tokyo and local areas
- Experiments in various fields including logistics and sports

Examples of 5G Field Trial
- Coverage verification experiment in large site
- Outdoor driving experiment
- Outdoor experiment in open square with many people

World’s first social implementation of 5G
- Tokyo Olympics and Paralympics
- Rugby World Cup
- Further evolution

Studies on 5G applications and services
Overview of 5G Field Trials in FY2018

- **massive Machine Type Communications (mMTC)**
  - Stock management
  - Bridge inspection

- **enhanced Mobile Broad Band (eMBB)**
  - Multi-transmission of 8K video
  - Transmission to car/train@over 60mph
  - Sports

- **Ultra-Reliable Low Latency Communications (URLLC)**
  - Remote machinery control
  - Telemedicine
  - Truck platooning
  - Stock management
  - Ports
  - Bridge inspection
<table>
<thead>
<tr>
<th>Technology</th>
<th>Responsible Organization</th>
<th>Main Partners</th>
<th>Trial Overview</th>
<th>Main Trial Locations</th>
</tr>
</thead>
</table>
| **G-I**   | eMBB                     | NTT DOCOMO    | • TOBUTOWER SKYTREE  
• ALSOK (Security)  
• Fukui Pref.  
• Wakayama Pref.  
• Aizu-Wakamatsu City | • **AR/VR content**  
• **Monitoring and Security**  
• **Medical Services** | • Kyoto  
• Gunma  
• Tokushima  
• Wakayama |
| **G-II**  | eMBB                     | NTT Communications | • Tobu Railway  
• West Japan Railway Company  
• Infocity (Contents Company) | • **Transport (High speed railway)** | • Ibaraki  
• Tokyo |
| **G-IV**  | eMBB                     | ATR (Research Corporation) | • Kyushu Institute of Tech.  
• Keikyu Railways  
• Waseda Univ.  
• Maehara elementary school | • **Smart factory**  
• **Station**  
• **School education** | • Fukuoka  
• Haneda Airport International Terminal Station |
| **G-V**   | URLLC                    | Softbank      | • Advanced Smart Mobility Corp. | • **Transport**  
• **Car remote control** | • Yamaguchi  
• Shizuoka |
| **G-III** | URLLC × eMBB             | KDDI          | • Obayashi Corp. (Construction)  
• NEC (Appliance manufacturer)  
• The Univ. of Tokyo. | • **Remote Construction**  
• **Drone surveillance** | • Osaka  
• Nagano  
• Hiroshima |
| **G-VI**  | mMTC                     | Wireless City Planning | • Pacific Consultants (Construction consultant)  
• NICT (National Institute)  
• Higashihiroshima City | • **Smart highway**  
• **Smart office** | • Aichi  
• Hiroshima |
5G Field Trials on New Applications in Medical Field

From 2017, the system trials in the area of telemedicine using 5G was planned and started by Wakayama Prefecture, Wakayama Medical University and NTT DOCOMO.
In FY2017, first field trials on the advancement of telemedicine services using high-definition video transmission using ultra-high-speed communication of the fifth generation mobile communications system (5G) was conducted to provide advanced medical care of urban general hospitals in mountainous and depopulated areas.
Actual field trials of remote medical care were conducted using 5G & Optical link between Medical University and Hidakagawa National Health Insurance Kawakami Clinic for about 3 weeks from the end of February 2018.
FY2017 5G Telemedicine Field Trials

Field trial environment

Used equipment for telemedicine

- 4K teleconference system
- 4K close-up camera
- Tablet-type ultrasonic image diagnosis (echography)
High frequency utilization efficiency and high-speed communication are realized by full digital beam forming technology using a large number of antenna elements.

**Specification of 5G Radio Transmission Equipment**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Band width</th>
<th>Antenna elements</th>
<th>Spatial MUX</th>
<th>Maximum throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-band</td>
<td>100MHz</td>
<td>BS: 64 Mobile: 2</td>
<td>BS: 16 Mobile: 2</td>
<td>5.6Gbps</td>
</tr>
</tbody>
</table>

Active Antenna System for Base Station

Spatial Multiplexing of Maximum 8 users
FY2018 5G Telemedicine Field Trials

C-band 5G area is widely provided
Field trials of 5G telemedicine for
(1) Visiting medical care
(2) Remote medical education

- High resolution video
- High speed wireless communication
- 5G base station

Wakayama Medical Univ. (Wakayama City)

(1) Internal medical treatment for “visiting medical care” realized by 5G

Patient’s Home (Hidakagawa Town)

- 5G mobile terminal
- 4K Portable TV conference system
- 4K close-up camera
- Portable echo
- X-ray image

Kawakami Clinic (Hidakagawa Town)

- 5G base station
- 5G mobile terminal
- Low-latency TV conference system

(2) “Remote medical education” for endoscopic operation realized by 5G

Professional doctor
Patient

4K TV conference system
Close-up camera

4K
2K

Optical network

Echo, ...

Interview

Endoscope

Training model

Internal medical treatment for “visiting medical care” realized by 5G

Field trials of 5G telemedicine for

C-band 5G area is widely provided

Low-latency TV conference system

Professional doctor

Clinic doctor

Clinic doctor

(2) “Remote medical education” for endoscopic operation realized by 5G
FY2018 5G Telemedicine Field Trials

- In FY2018, a base station was installed at a height close to realistic station design, and the entire area of Miyama, Hidakagawa, Wakayama Prefecture was covered by 5G communication area.
- A maximum throughput of 700Mbps was confirmed at the patient's home.

Field Trials Area in 2017

Field Trials Area in 2018

Expand 5G communication area (yellow area) from line to surface
(1) Results of Field Trials on “Visiting Medical Care” with Remote Support

A doctor of a rural clinic visits patient’s home and tries to do medical treatment by sharing “echo” images with a remote medical specialist and by getting help with the specialist.

By sharing high resolution echo images, I can do medical treatment as same as I do on face-to-face. I’d like to use this system as soon as possible.

Wakayama Medical University Hospital
Department of Cardiovascular Image Dynamics
Associate Professor Hozumi

Results of Field Trials on “Visiting Medical Care” with Remote Support
(2) Results of Field Trials on “Medical Training” with Remote Support

A specialist watches real-time images of endoscope operated by young doctor through TV conference system and supports him.

Despite the lecture for a doctor who does not get used to using endoscope, he allowed smooth operation. I felt endoscopic examination for actual patient will be also achievable.

Wakayama Medical University Hospital
Second Course of Internal Medicine
Professor Kitano,

Results of Field Trials on “Medical Training” with Remote Support
Advanced Paramedical Service by 5G

Field Trial on Realizing Efficient Emergency Patient Transport

Possibility of advanced registration of a patient by exploiting information from the ambulance and doctor car shared via 5G with the accepting emergency hospital.
Advanced Paramedical Service by 5G

Echo Image Transmitted by 5G from Doctor-car

4G Quality (reference)