

Human in the CPS Loop

Communications in C-Avatar Society

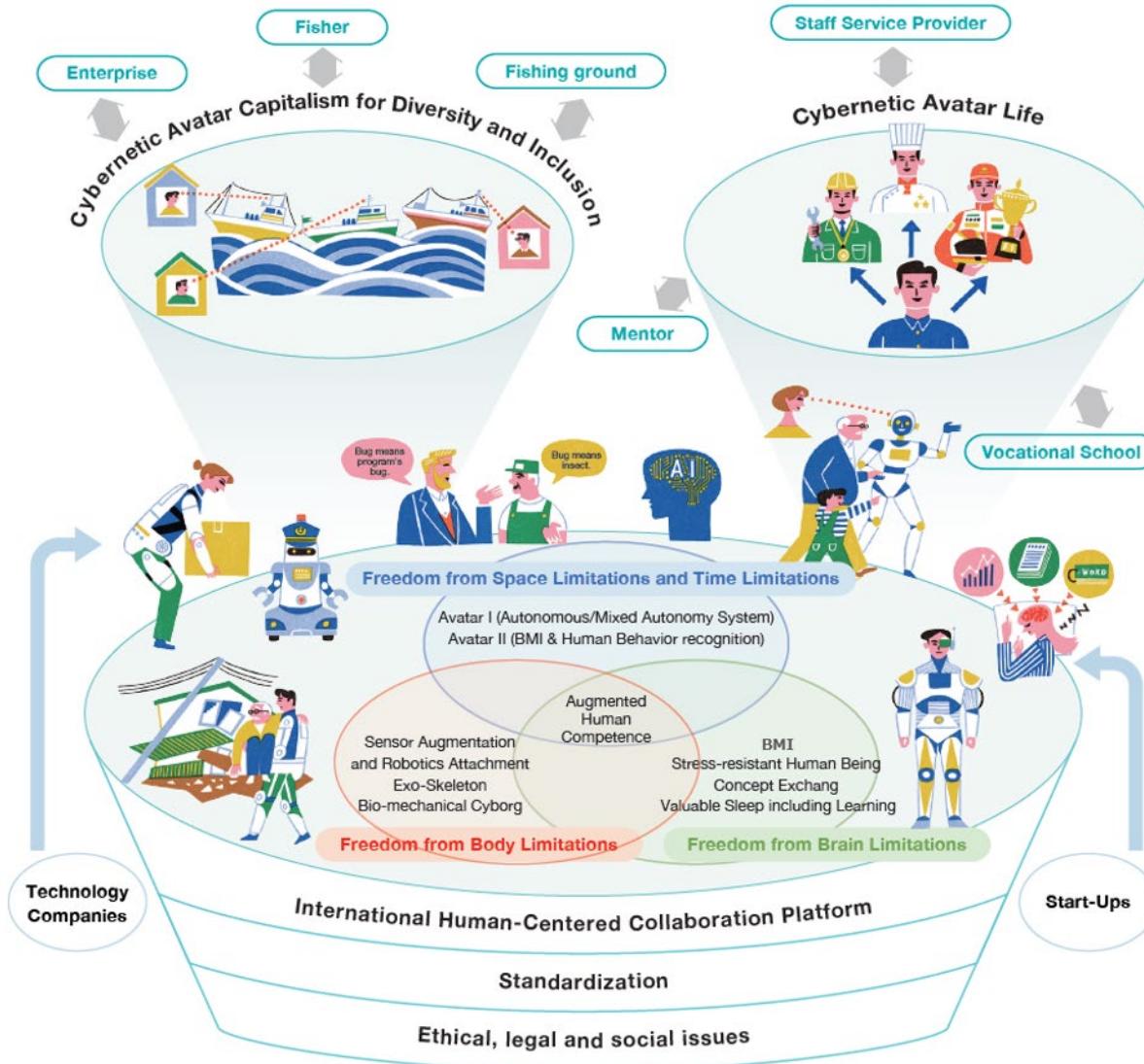
Hideyuki Tokuda, Ph.D.

President, National Institute of Information and Communications Technology(NICT)

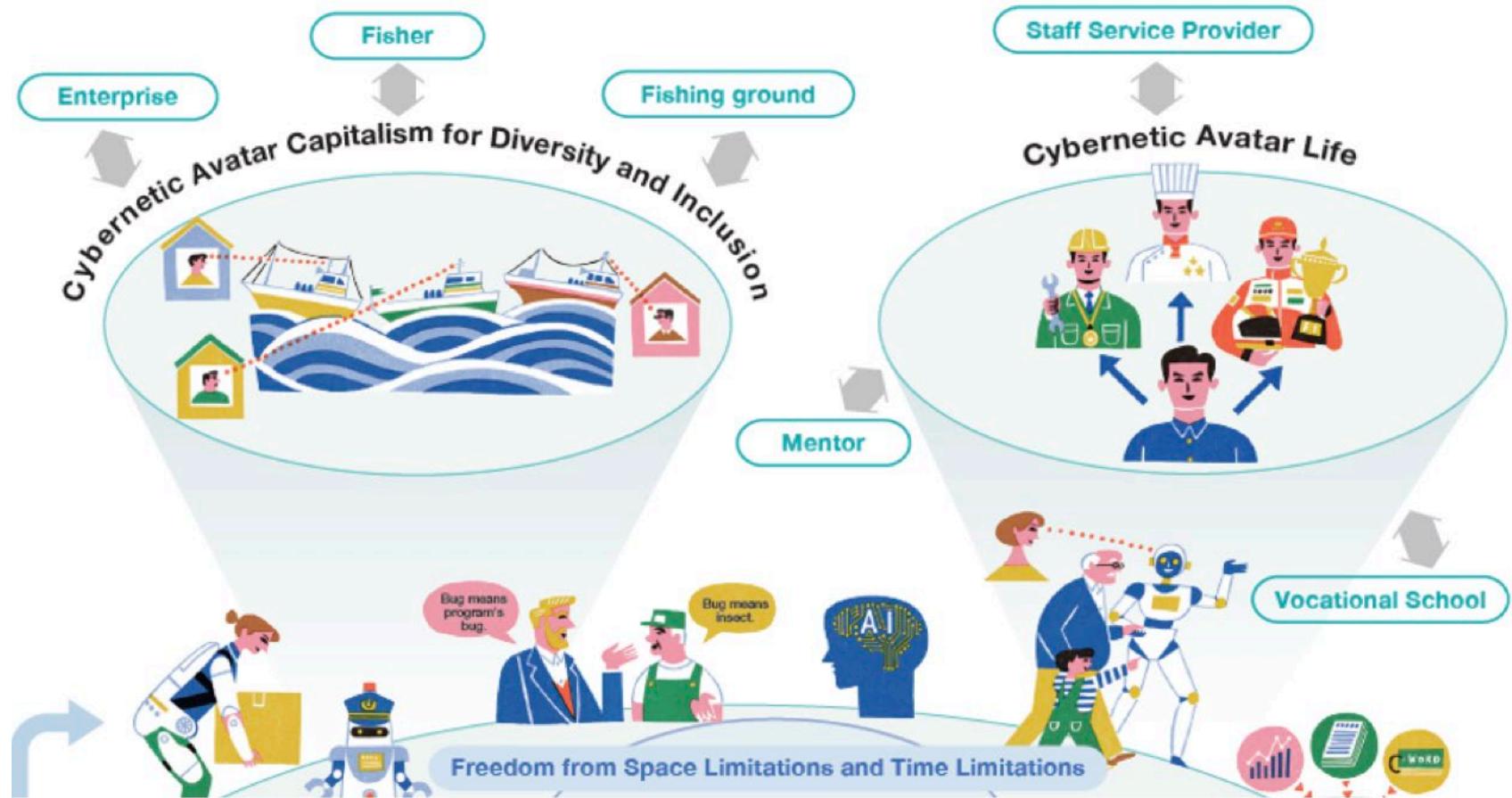
Professor Emeritus, Keio Univ.

tokuda@nict.go.jp

Is C-Avatar Society Society 6.0?



Communications in C-Avatar Society



A bit of history

Sci&Tech

Nov. 18, 2013 | 04:54 PM

Robots let doctors 'beam' into remote US hospitals



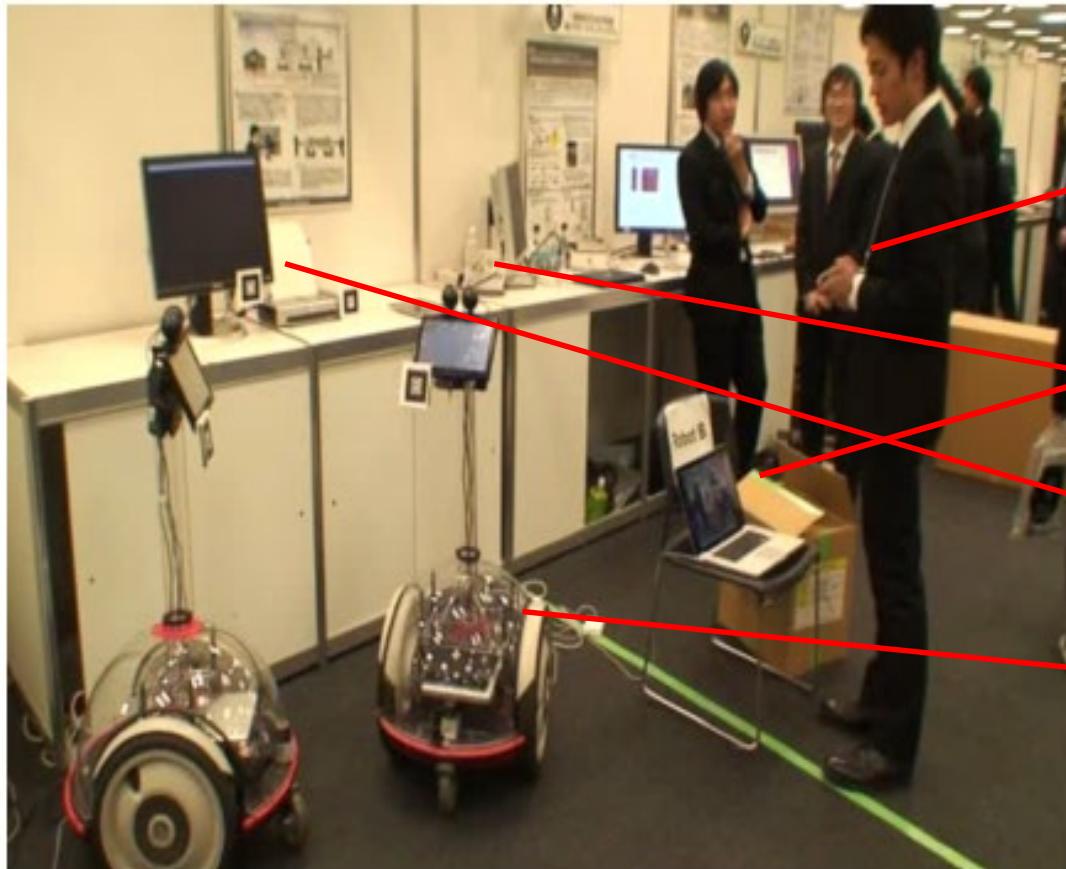
<https://www.dailystar.com.lb/Technology/International/2013/Nov-18/238202-robots-let-doctors-beam-into-remote-us-hospitals.ashx>

Robot-In (KEIO-SFC ORF2010)

A Network Robot-based Service

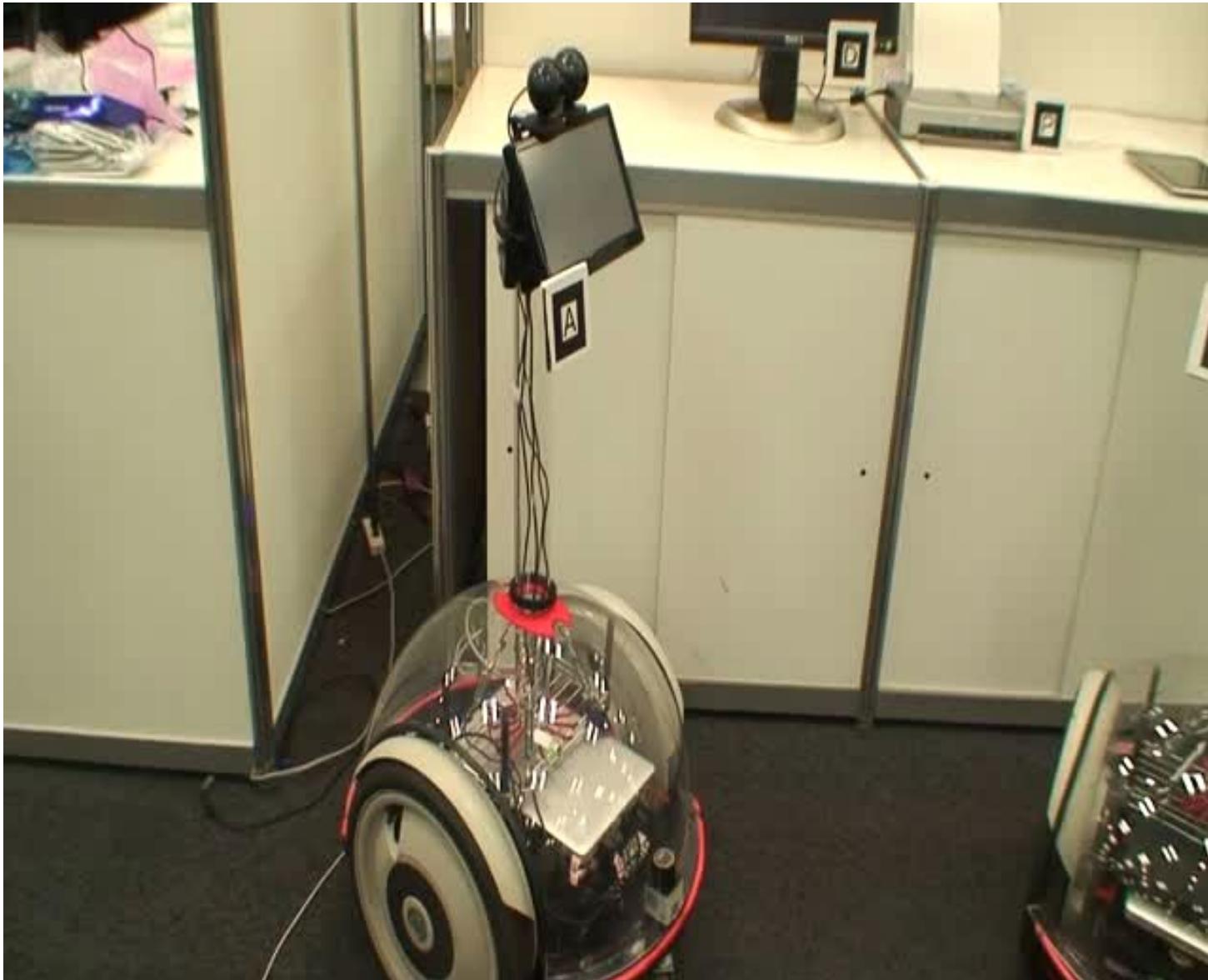
<remote presence service, robot control, HCI, service mash up, privacy control>

Robot-In: A Network Robot

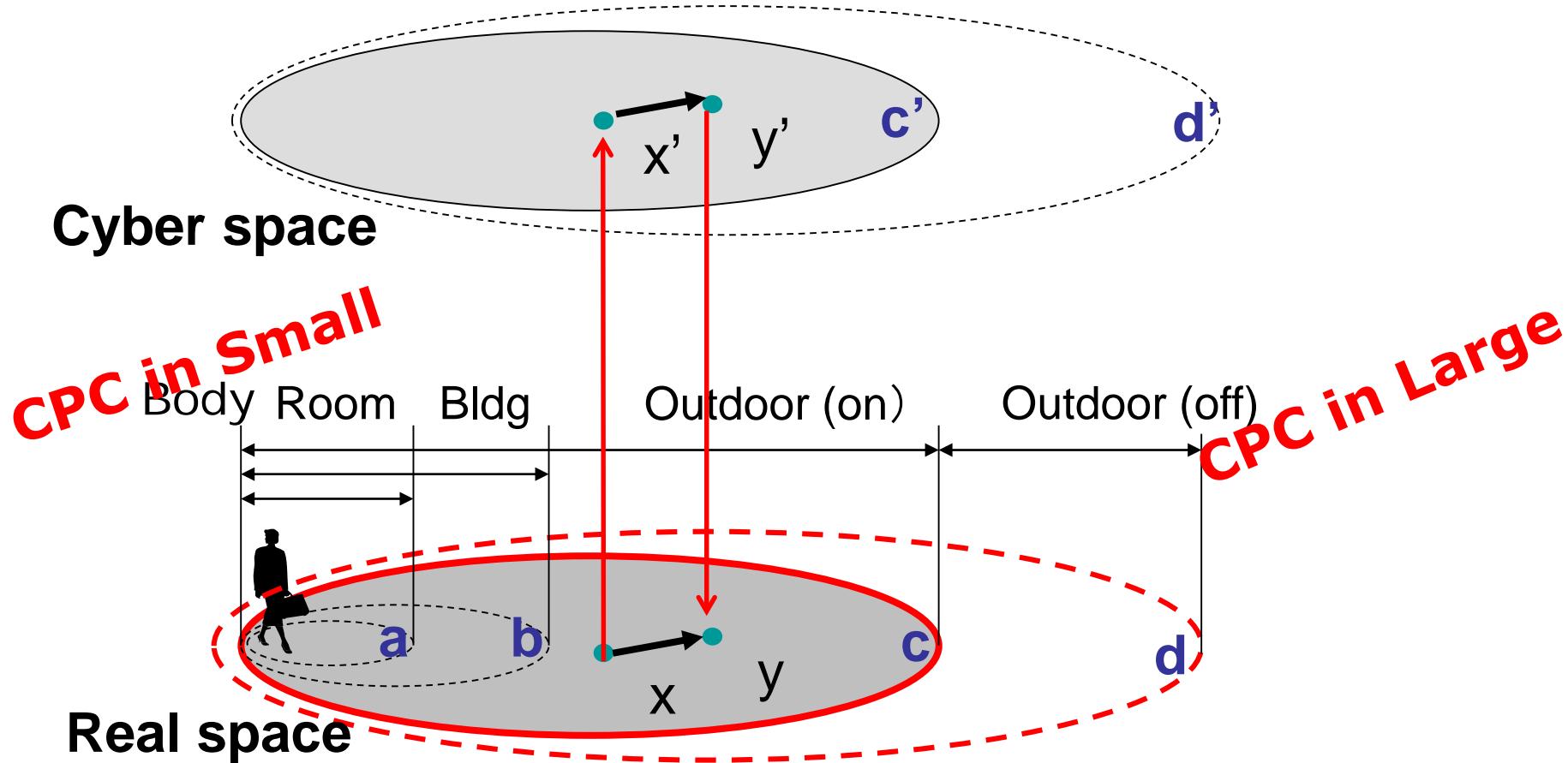


Motion Controller
PC
Camera
AR Marker
Segway-base

Tele-Presentation with Robot-In (ORF2010)



Cyber-Physical Coupling in Ubiquitous Services



H. Tokuda, J. Nakazawa, T. Yonezawa: "Ubiquitous Services: Enhancing Cyber-Physical Coupling with Smart Enablers". IEICE Transactions 94-D(6): p1122-1129 (2011)

Communication Infrastructure for Society 6.0

Beyond 5G/6G

Supporting Human in the CPS Loop

Terahertz Communication

eMBB, URLLC, mMTC

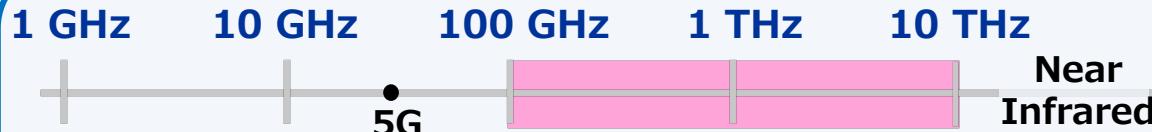
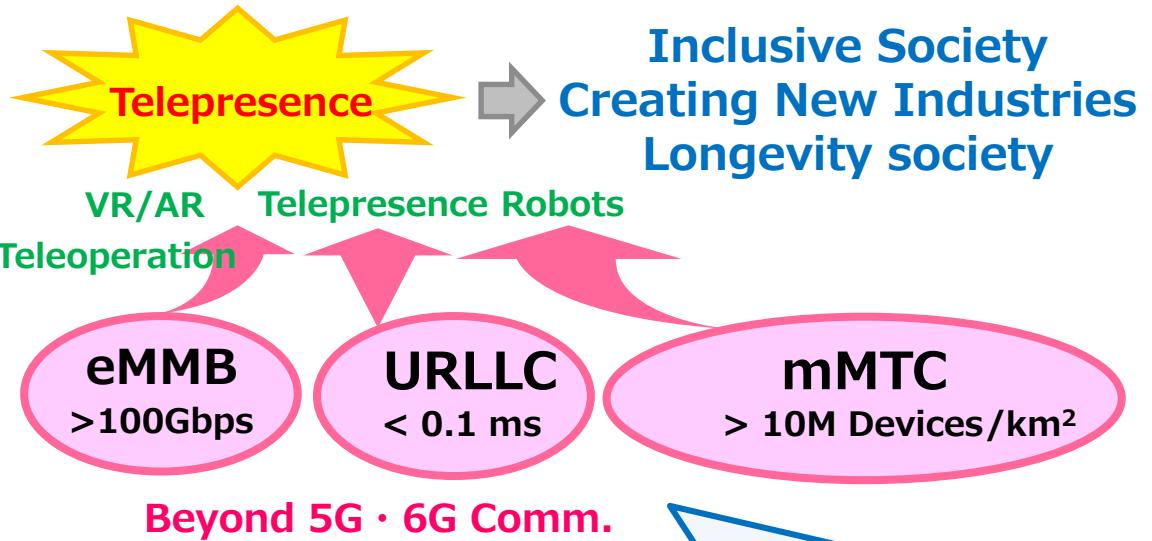
300GHz -> 100Gbps (2016.2)

In World Radio communication Conference (WRC2019), 275-296GHz, 306-313GHz, 318-333GHz, 356-450GHz total 137GHz frequency band can be used without restrictions on land mobile and fixed operations

5G (10-20Gbps @2020~)

Beyond 5G (100Gbps ? @2030?)

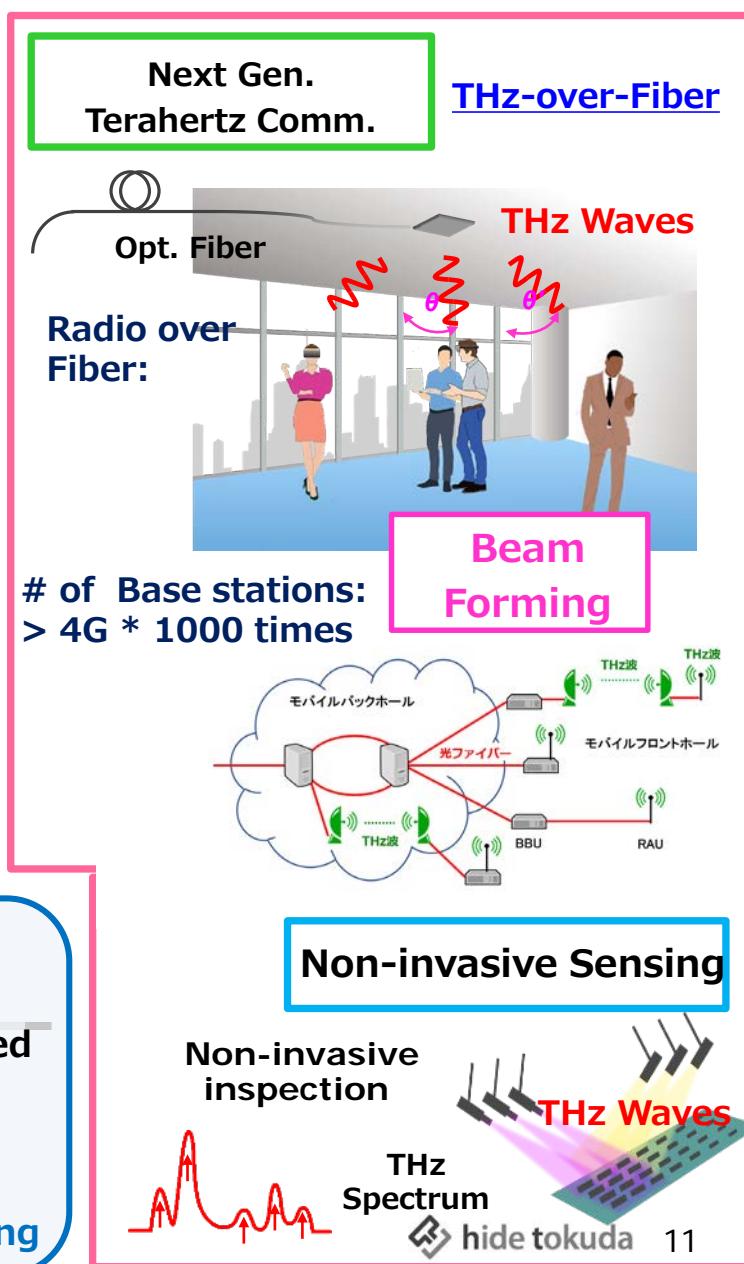
Beyond 6G (1Tbps ? @2040?)



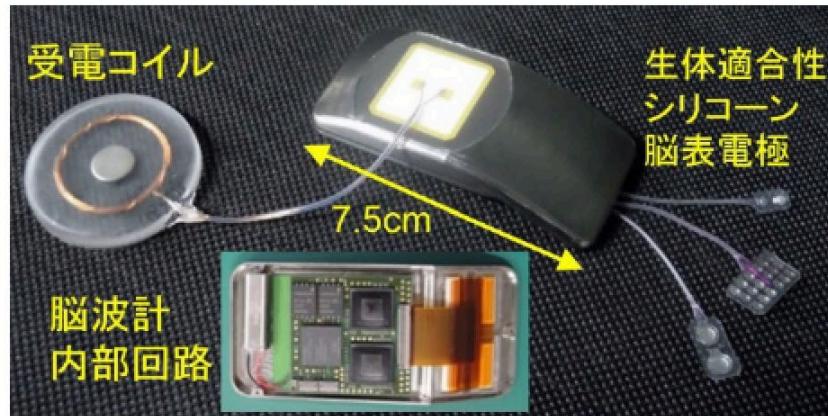
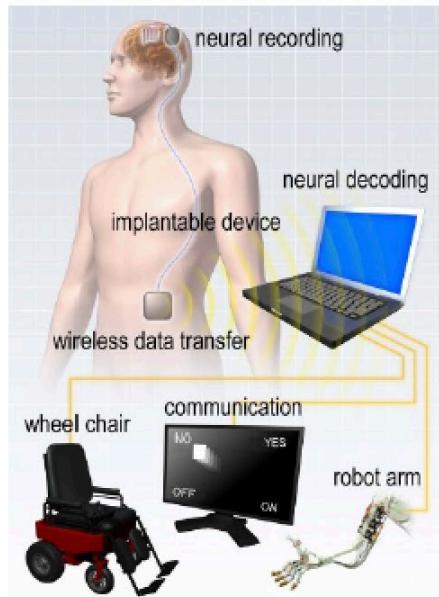
*US FCC (2019)
95 GHz-3 THz
Is released for experiment

Terahertz (0.1-10 THz)
Beyond 5G · 6G Comm.

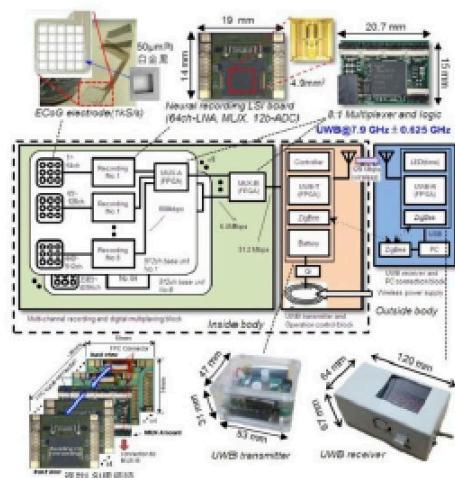
Non-Invasive Sensing/Imaging



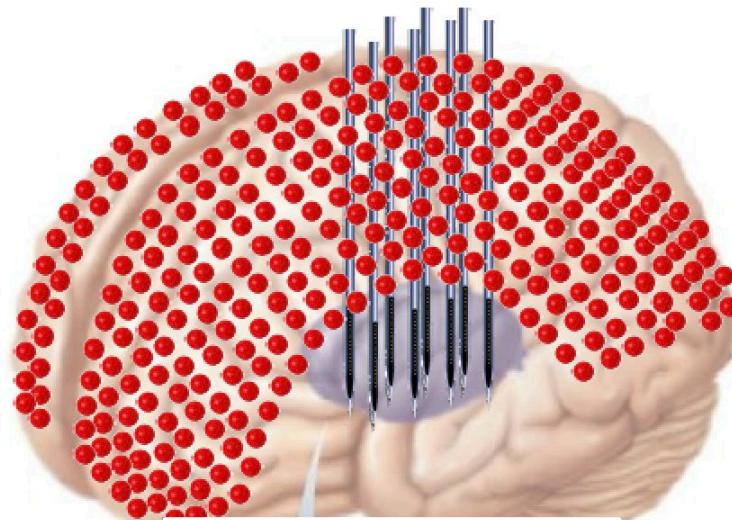
Communications with Brain (by NICT CiNET)



Clinical BMI System



UWB 4096ch System

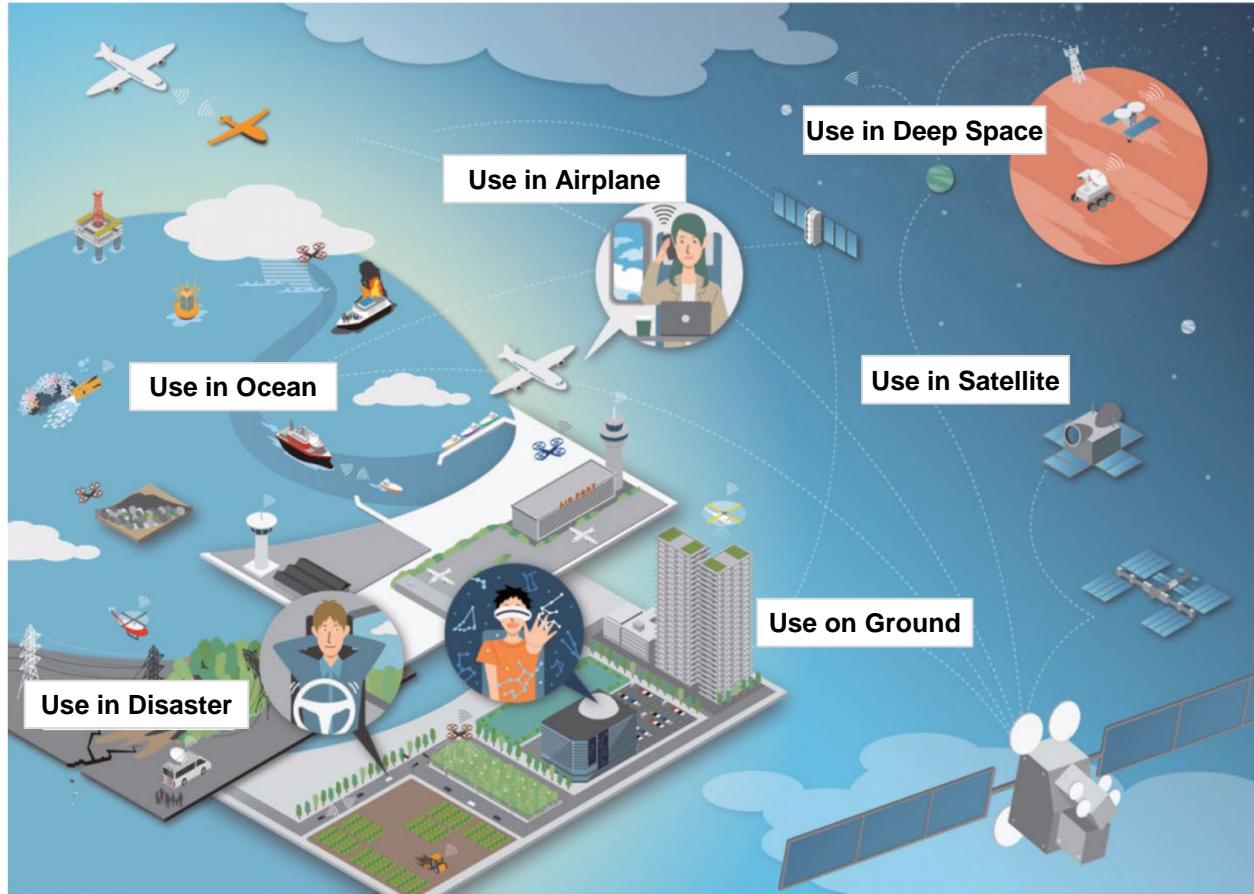


Super Multi-point Measurement system

Avatars in Extreme Env.

Supporting Human in the CPS Loop

Freedom from Space and from Time C-Avatars Life in Extreme Env.



Use Cases of Human-Avatars Communication in Society 6.0
(図の出典: https://app.journal.ieice.org/trial/100_8/k100_8_819/index.html)

**Reliable Comm.
Safe and Secure Comm.
with Avatars**

Disconnected Avatars in Extreme Environment



(出典 <https://matome.naver.jp/odai/2147337695656137401>)

Connectivity Disconnected Operations Safety & Security

is not always guarantee in Extreme Env.

CPS Loop in Weak Connectivity

