Project: IEEE P802.15 Working Group for Wireless Specialty Networks (WSNs)

Submission Title: [Harmonization of Scientific and Commercial Radio Uses, and their Social Services and Industrial Innovation]

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Source: [Ryuji Kohno] [1;Yokohama National University(YNU), 2;YRP International Alliance Institute(YRP-IAI)]

Address [1; 79-5 Tokiwadai, Hodogaya-ku, Yokohama, 240-8501 Japan
2; YRP1 Blg., 3-4 HikarinoOka, Yokosuka-City, Kanagawa, 239-0847 Japan]

Voice:[1; +81-90-5408-0611], FAX: [+81-45-383-5528],

Email:[1: kohno@ynu.ac.jp, 2: kohno@yrp-iai.jp] Re: []

Abstract: [This document contains a part of Ryuji Kohno's keynote speech at URSI-Japan Centennial Celebration Symposium 1922-2022, Tokyo,12th Nov. 2022 to introduce discussion on harmonization between scientific(RAS, EESS etc.) and commercial radio(IMT, IEEE802 etc.) uses, primary and secondary uses in radio regulation, among various primary uses, secondary uses such as IEEE802.15 and 802.11 and so on. To discuss a manner of harmonizing various coexisting radio in overlaid frequency bands, it is presented at Wireless New Generation(WNG) session in IEEE802.15 November meeting 2022. .URSI; International Union of Radio Science]

Purpose: [information]

Harmonization of Scientific and Commercial Radio Uses, and their Social Services and Industrial Innovation

Ryuji KOHNO

IEEE Life Fellow
Member, Radio Regulatory Committee, MIC, Japan
Associate Member, Science Council of Japan (SCJ)
Chair, IEEE802.15 TG6ma
Yokohama National University, Japan
YRP International Alliance Institute, Japan
kohno@ynu.ac.jp

Ref. This is a part of Ryuji Kohno's keynote in URSI-Japan Centennial Celebration Symposium 1922-2022, Nov. 12th, 2022

Harmonization of Scientific and Commercial Radio Uses, and their Social Services and Industrial Innovation

Agenda

1. Necessity of Harmonization between Scientific and Commercial Radio Uses
2. Demands for Social Services and Industrial Innovation
3. Case of Ultra Wind Band(UWB) Radio Systems
3.1 UWB Radio Medical and Social Service Uses Coexisting with Scientific Uses
3.2 International Standard for UWB Systems e.g. IEEE802
3.3 Japanese and Global Regulations for UWB
4. Case of Wireless Power Transmission(WPT) Systems
4.1 WPT Radio Commercial and Social Infrastructure Uses
4.2 Regulation for WPT
5. Solution by Regulatory Science
5.1 Regulatory Science for Medical Devices
5.2 Regulatory Science Center for Harmonization between Scientific and Commercial Uses
6. Concluding Remark

Harmonization of Scientific and Commercial Radio Uses Based on Regulatory Science

Scientific Use

Radio Astronomy(RAS)

Space Exploration Ship, Earth Exploration Satellite（EESS)

Weather satellite,

Public Use

Remote Medicine

Medical Use

Medical Body Area Network(BAN)

Harmonization is necessary to keep requirement of all stakeholders

WPT ⇔ Wi-Fi, IoT, 5G, 6G Cellular

Communication, Broadcasting Satellites

Grand Penetrate Radar

Collision Avoidance Radar

Disaster Prevention Radio

Commercial Use

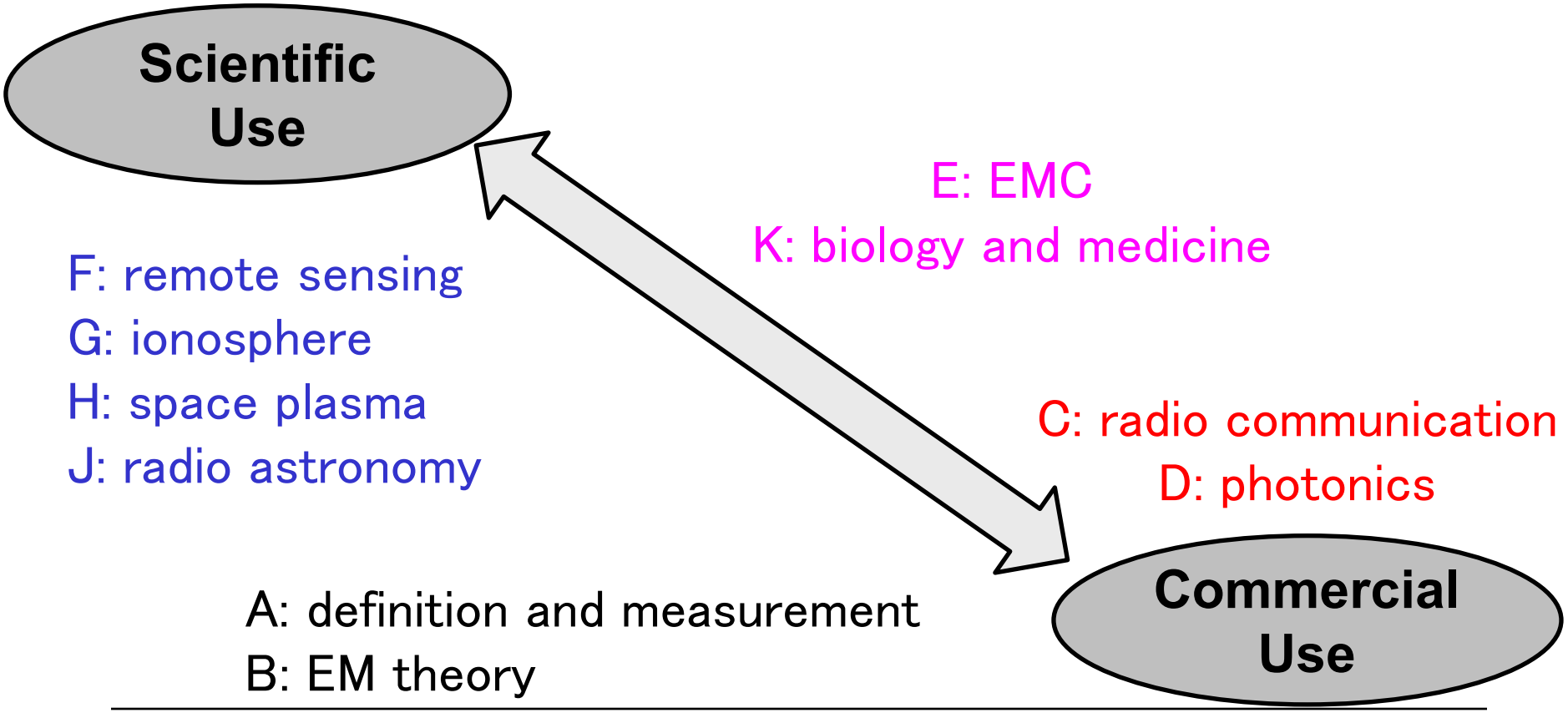
Necessary Harmonization between Scientific and Commercial Radio Uses

- According to increase of radio uses, relationship between primary and secondary users is not simple unlike last decays.
- Frequency spectrum = common resource
- Regulation should play an important role to harmonize among
  - Commercial radio services
  - Scientific and other non-commercial services

URSI（Union Radio-Scientifique Internationale）

Venue for Harmonization between Scientific and Commercial Radio Uses

URSI Commission A-K have been covering research and development in all science and technologies for scientific non-commercial and commercial uses. Wide spectrum of scientists related to this issue.



URSI-GASS 2011: URSI's interest in ITU,
Special Session on URSI-ITU relations, Istanbul, Turkey Aug.18, 2011

Harmonization in Ultra Wide Band(UWB) Regulation for both Scientific and Commercial Radio Usages

Global Regulatory Compliance for UWB Medical Healthcare and ITS Coexisting with Scientific Radio Uses for EES & RAS

Ryuji KOHNO

Chairman
Regulatory Committee for UWB Systems, Ministry of Internal Affair and Communications (MIC), Japan
Director, Professor
Medical ICT Center, Yokohama National University, Japan
Finnish Distinguished Professor (FiDiPro)
CWC, University of Oulu, Finland

Special Workshop: Harmonization of Scientific and Commercial Radio Uses, ***AP-RASC 2013 Taipei, Taiwan 15:30-17:30, Sept. 4, 2013***

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CEO, University of Oulu Research Institute Japan–CWC-Nippon, Co. Ltd.

Keynote
URSI-Japan Centennial Celebration Symposium 1922-2022,
November 12th, 2022

Harmonization of Scientific and Commercial Radio Uses, and their Social Services and Industrial Innovation

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Vice-President, YRP International Alliance Institute, Japan

Demands for Radio Uses to Achieve Social Services and Business Innovation in SDGs

Approach with Radio to Achieve SDGs

Solving Social Problems

Communication between Humans and Things

Expansion of Communication Environment

Sophistication of Cyber-Physical Fusion

Harmonization of Scientific and Commercial Radio Uses, and their Social Services and Industrial Innovation

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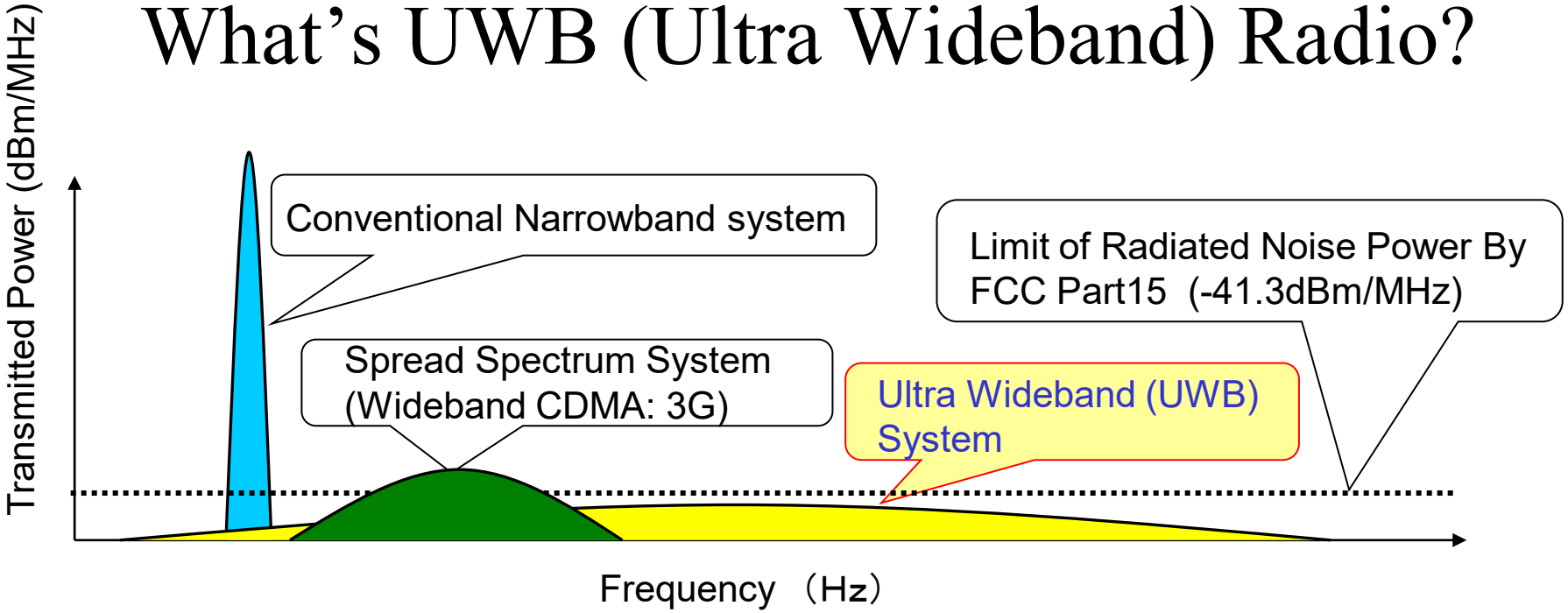
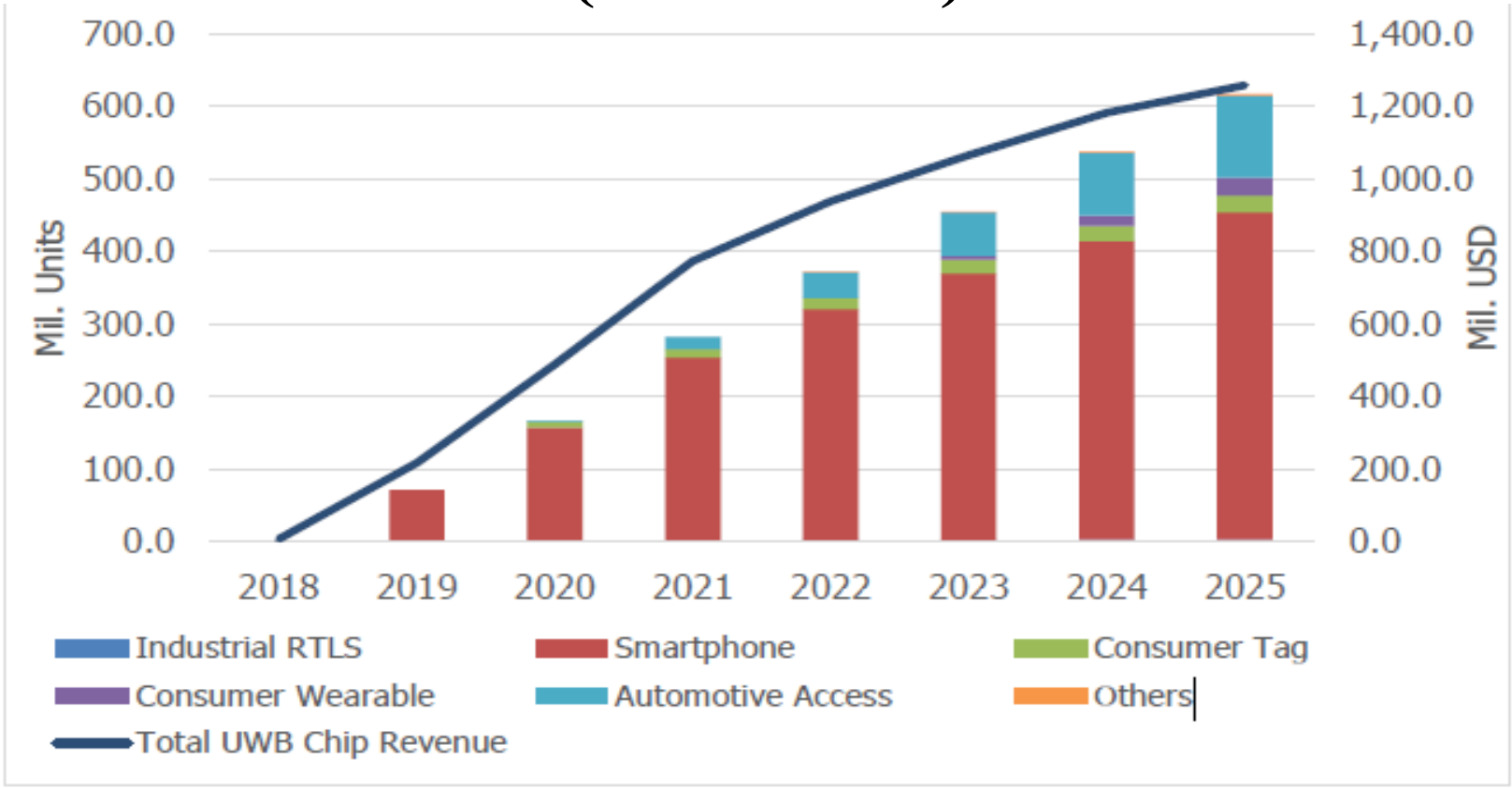
What's UWB (Ultra Wideband) Radio?



1. Power Spectrum Density is extremely low (lower than noise)
   ⇒ Little damage and interference to existing systems and human body
2. Time duration of a pulse is extremely short (a few nsec)
   ⇒ High resolution ranging and positioning of devices
3. Occupied frequency bandwidth is extremely wide （GHz）
   ⇒ Ultra-high speed and capacity transmission

UWB Device Shipment & Chip Revenue (2018-2025)



- Fourth wave: hitting the mainstream In the mobile handset (smartphone)
- Source: https://www.fcc.gov/ecfs/filing/107142666226784

BAN: Body Area Network

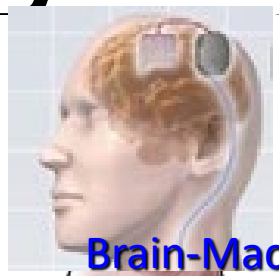
Wearable BAN

Tele-metering or sensing vital signs with various sensors

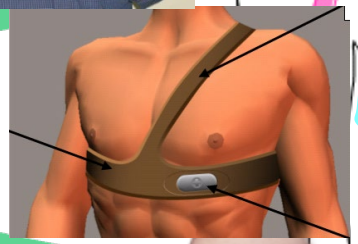
ECG
EEG
Blood Pressure
Heart Beat
Body temperature
Suger rate
Medical images
And video
Etc.

Implant BAN

Tele-control of Medical Equipment and Devices



Brain-Machin-Interface(BMI)



Pace Ma

Ultra Wide Band: UWB can solve a problem of radio usage in and around a human body

Wearable Glucose Sensor & Insulin Pump

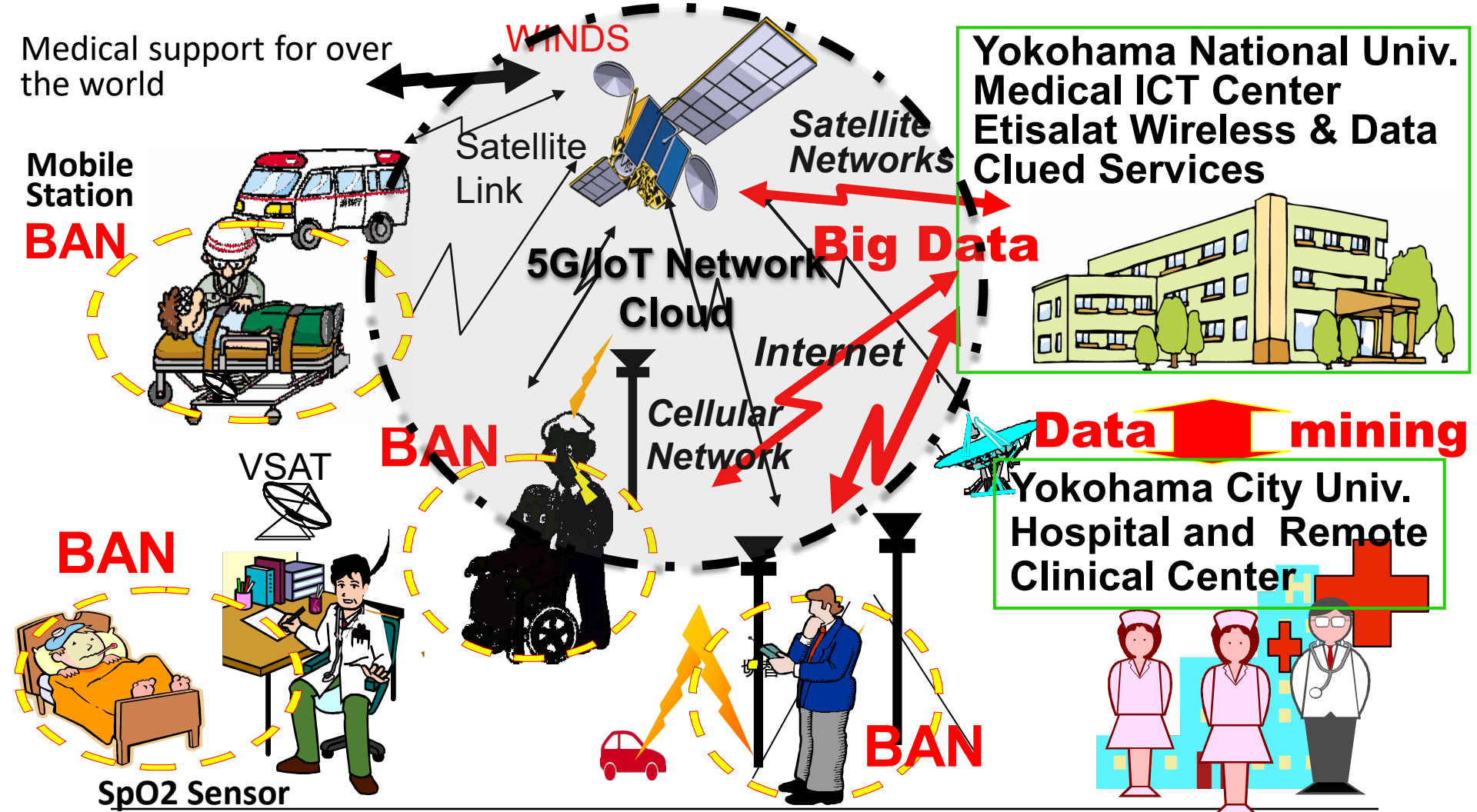
Sandal for Rehabilitation

SpO2 Sensor

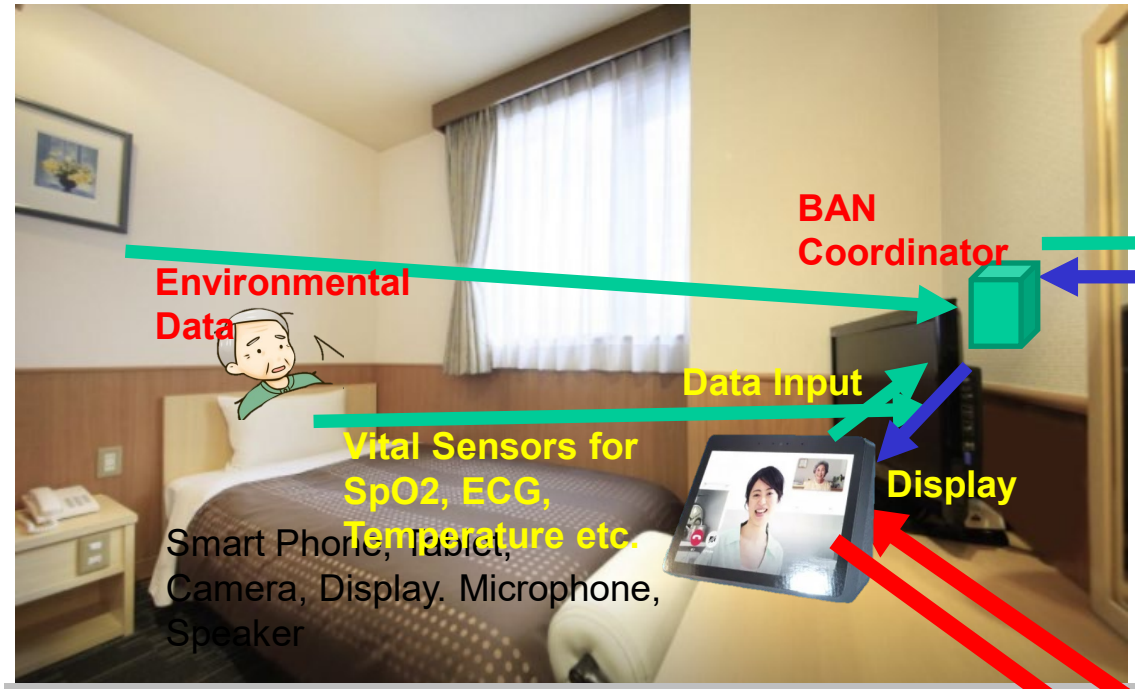
Remote Medicine; Digital Healthcare
Network of Vital Sensors and Medical Actuators and Robots etc.

Capsule Endoscope

Vision of Medical Infrastructure Based on BAN, 5G/6G Cloud, and AI Server for Pandemic and Daily Life



BAN Platform Use Cases in Remote Treatment for COVID-19 Patients under Quarantine at Home



Remote Maintenance of COVID-19 Patients at Home Using Platform of Integrated Vital Sensors/Wireless BAN/5G Cloud/AI Analysis

Family

Data Collection and Analysis

Analyzed results for health condition

Cloud Remote Monitoring Service

Without Clinical Staffs, health condition of COVID-19 patents can be monitoring and rescue them immediately.

Integrated Data

Remote Therapy and mental care keeping distance

Analyzed results

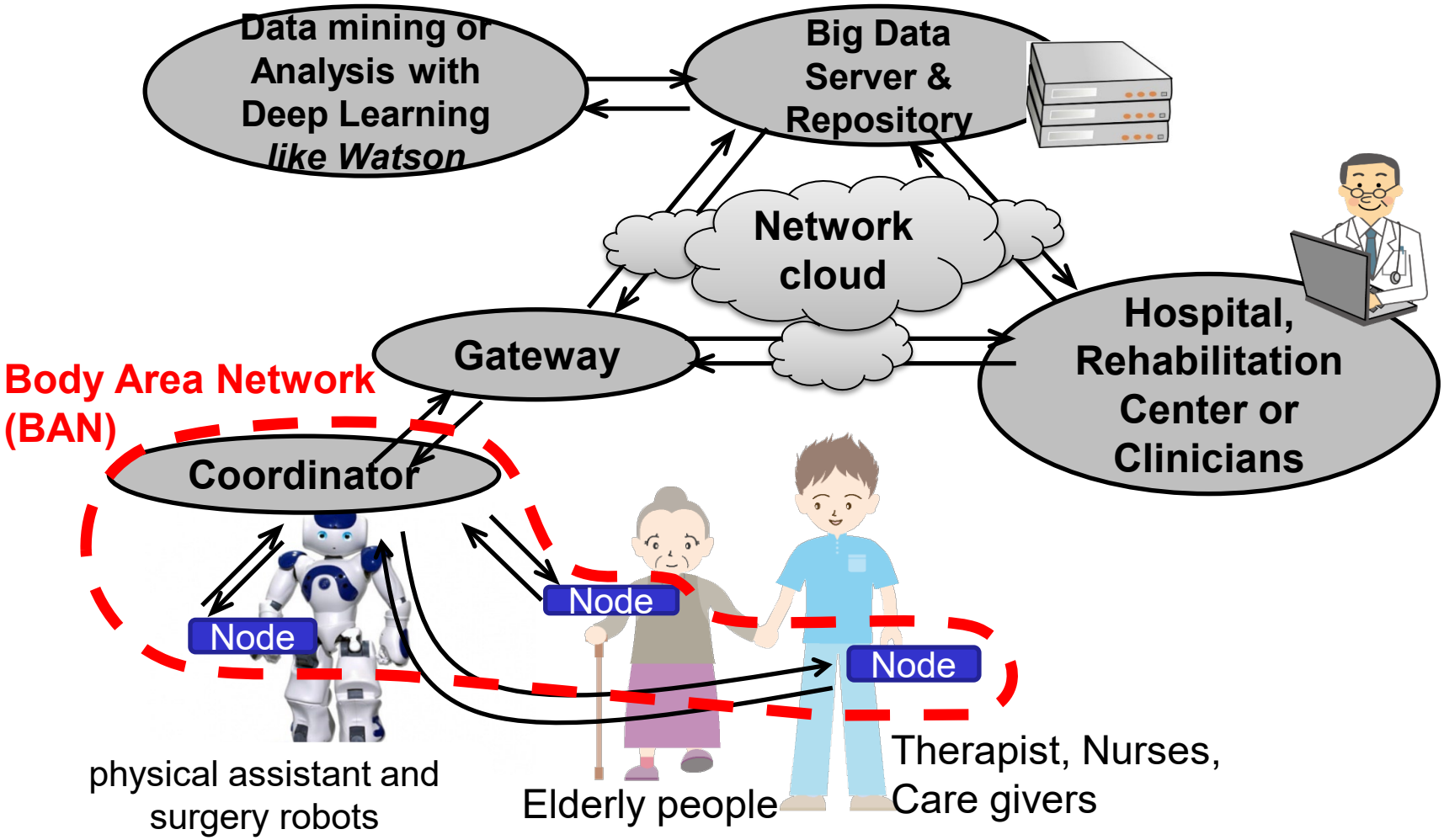
Command for care of patients

Real-time remote monitoring and care

Dialog

Medical Care Center and Government Control Center

Platform by Wireless BAN, Network Cloud, Big Data Server with Data Mining for Elderly People Care



Demands of Dependable Radio Uses for Sustainable Social Services

Population Ageing & Medical crisis
Healthcare Service(Medical ICT)

Cost of energy … fuel supply & demand
Energy Network(Smart Grid)

Increasing environmental requirements
CO_2 Reduction, Green Innovation

Escalating security concerns
Public Safety, National Defense

Heightened investor demands
Global Borderless Economics

Driving Technology

Dependable Radio Uses for SDGs

Harmonization between Scientific & Commercial Radio Uses

Common Secure and Dependable Social Infrastructure Platform Based on integrated BAN/Cloud/AI Server

AI Big Data Mining Server with Deep Learning ex. : *Watson*

Data Base Registry Centre

In daily life, for safety condition of social infrastructure such as bridge, bldgs. In disaster, for rescue of victims big data can be mined with AI.

Private Network

4G, 5G, WiFi Network Cloud

Gateway

Gateway

City Government, Maintenance Company,

Private Network

Body Area Network; (BAN)

Coordinator

Coordinator

Location

Vital Sign

Vibration

AE

Temperature

Vibration

AE

Location

Speed

Vibration

Bridge

Road

Bldg.

Car

Victim

Emergency Rescue of Victims in Disaster

In daily life, BAN can monitor resilient level of social infrastructure while in disaster environment, BAN can be instantaneous ad-hoc networks for emergency rescue.

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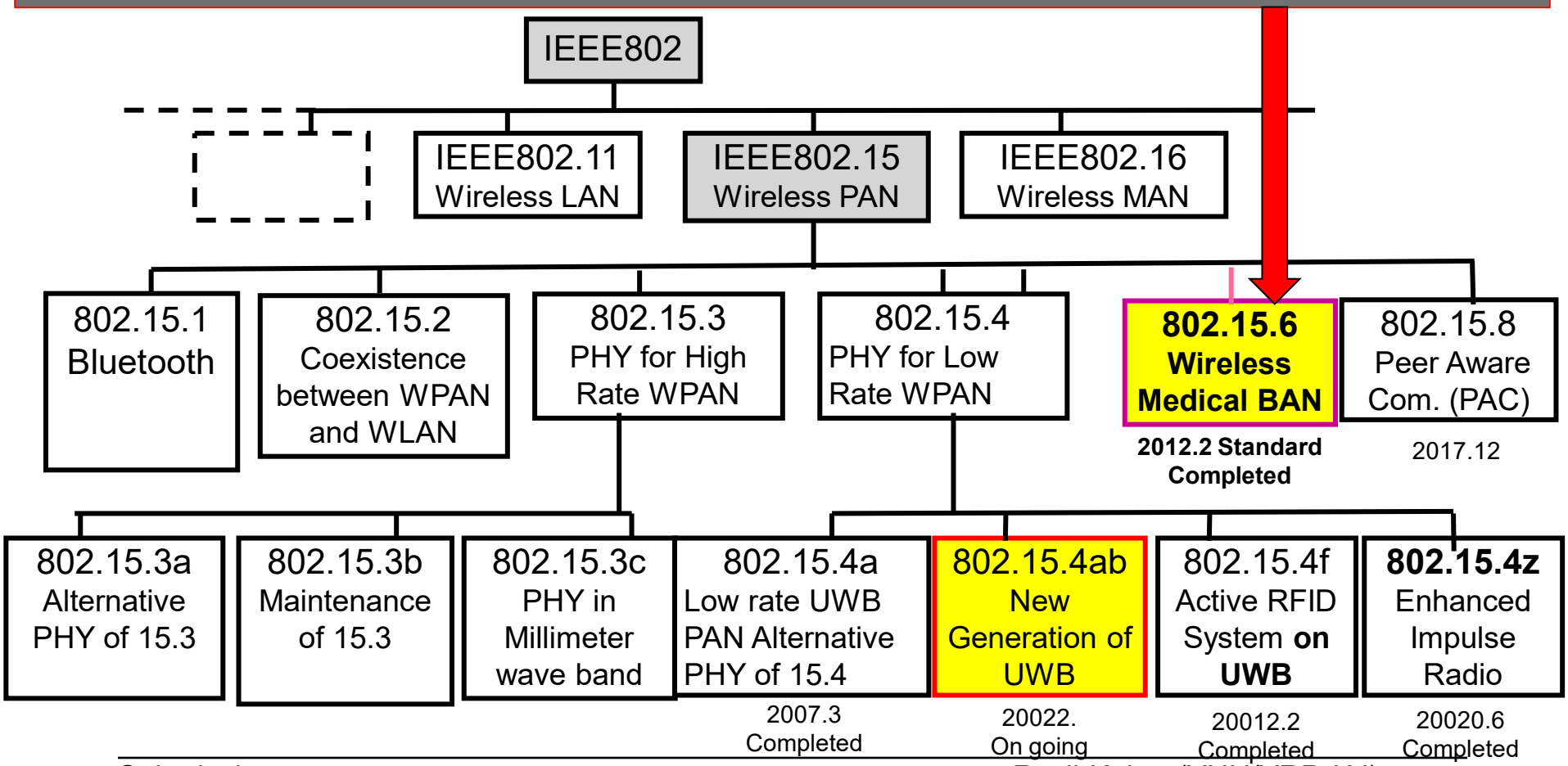
IEEE802.15 International Standard of WSN/WPAN(Wireless Specified Network, Personal Area Network)

Red Marked Standards Use UWB Radio

- IEEE802.15.1: Bluetooth
- IEEE802.15.2 (Compatibilities)
- IEEE802.15.3a (High-rate UWB WPAN)
- IEEE802.15.3c (mm-wave WPAN)
- IEEE802.15.4a (Low-rate UWB WPAN)
- IEEE802.15.4f (Low-rate UWB RF-ID)
- IEEE802.15.4z (EIR; Enhanced Impulse Radio)
- IEEE802.15.4ab (New Generation UWB WPAN)
- IEEE802.15.5 (Mesh Network for WPAN)
- IEEE802.15.6 (BAN; Body Area Network)
- IEEE802.15.6ma (Dependable BAN for Human & Vehicle Bodies)
- IEEE802.15.7 (Visible Light Communication)
- IEEE802.15.8 (PAC; Peer Aware Com.)

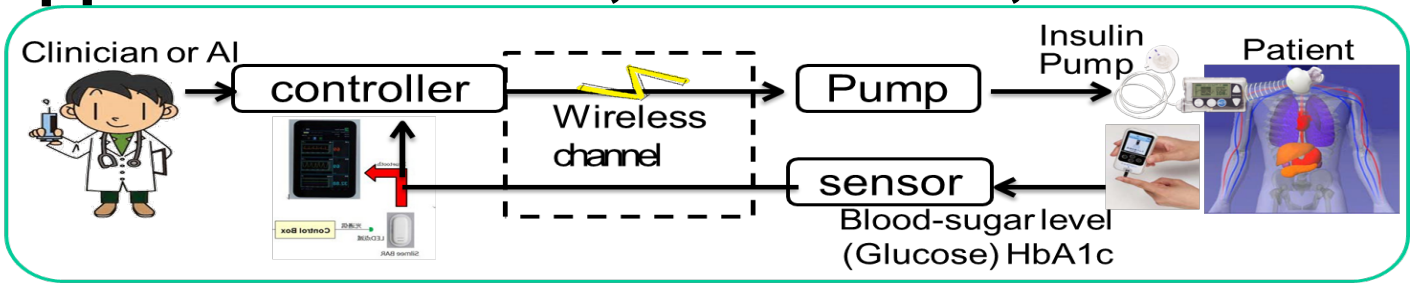
New Standard of Wireless BAN with Enhanced Dependability for Human and Car Bodies

IEEE802 TG15.6ma Promotes Revision of BAN Standard 802.15.6 with Enhanced Dependability for Human & Car Bodies Chaired by Kohno



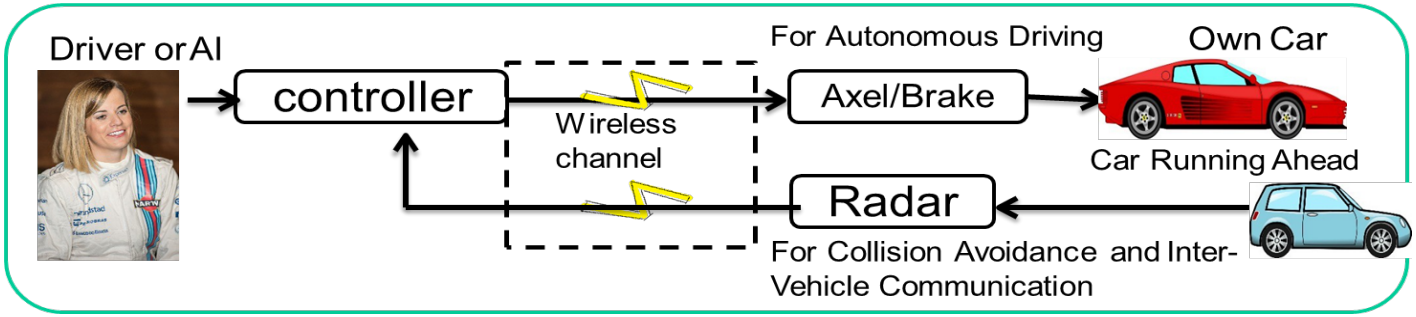
International Standard WBAN for Human and Vehicle Bodies Applied for Medical, Automotive, and others

BAN Use case 1: Remote Medicine



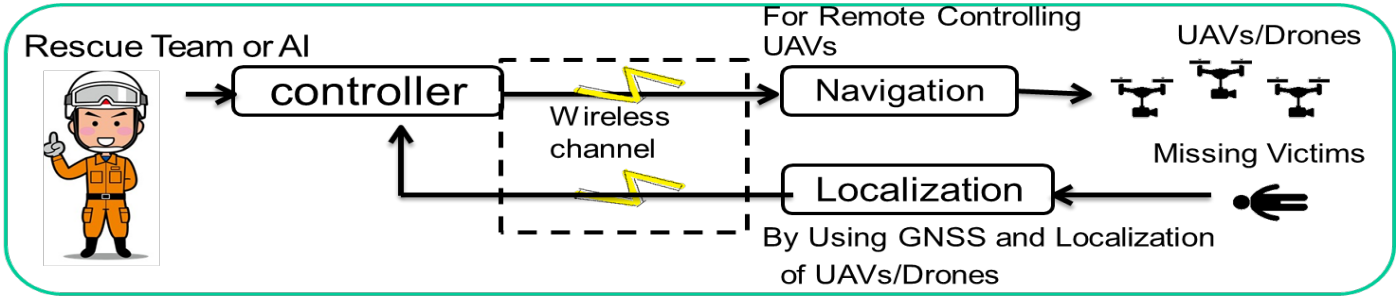
Wireless Feedback Sensing and Controlling Loop for Diabetes Patients

BAN Use case 2: Autonomous Car Driving



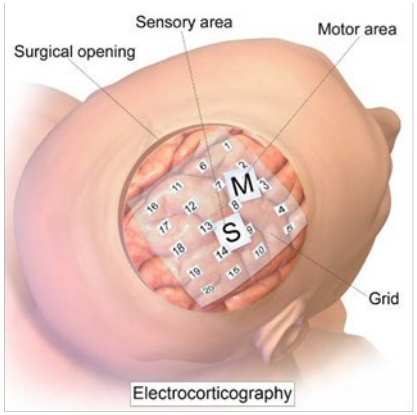
Wireless Feedback Sensing and Controlling Loop for Autonomous Car Driving

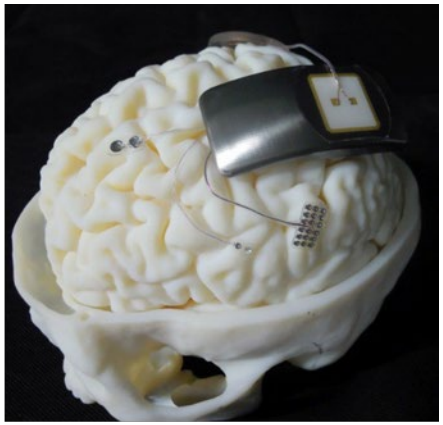
BAN Use case 3: Remote Controlling UAV/Drone

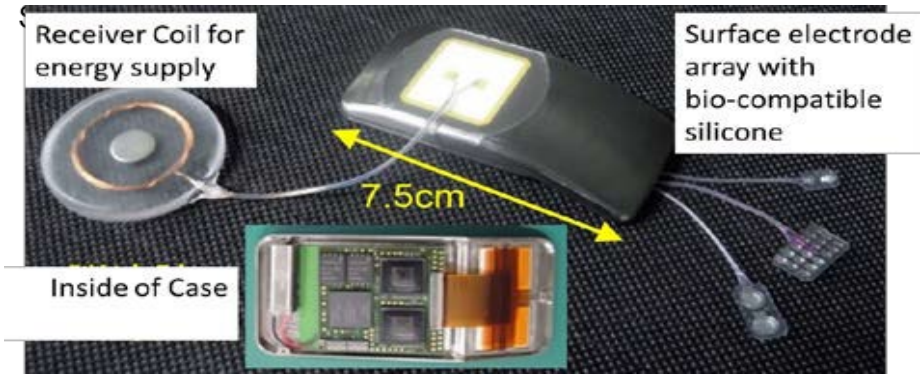


Wireless Feedback Sensing and Controlling Loop for Rescue of Victims

UWB BAN Applied for Brain-Machine-Interface(BMI) for High Reliability and Low Human Impact







Eco（Electrocorticogram) detected with implanted thousands of electrodes is transmitted in wireless by BAN with high capacity and dependability.

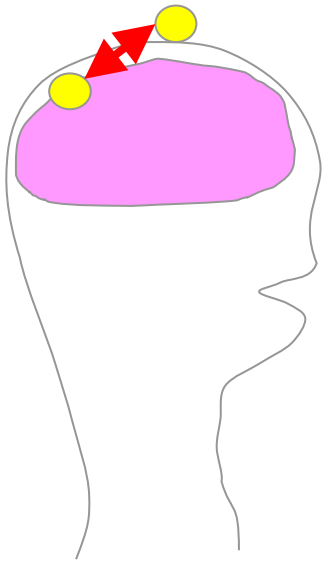
Brain-Machine-Interface(BMI) systems for Clinical Support to Disability such as autonomous robot hand control and communication assistance.

4.2 Channel models and scenarios in use case of BMI and BCI

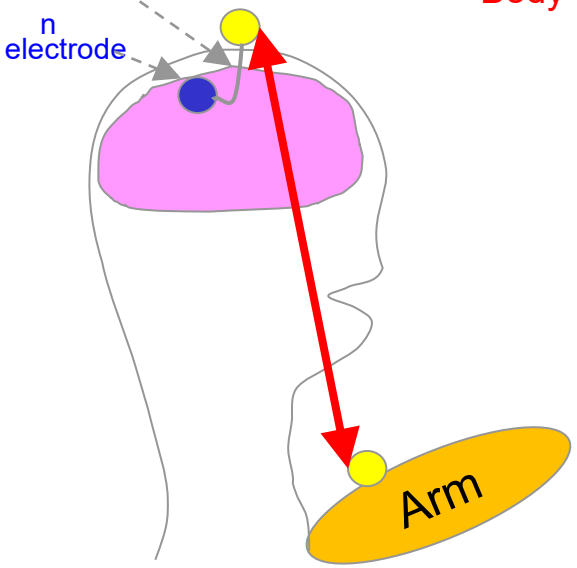
We will define what is BCI and BMI.

Specific use cases
Implant to Body Surface for BCI
Implant to External for BCI
Body surface to body surface for BCI
Body Surface to External for BCI
Implant to body surface for capsule endoscopy

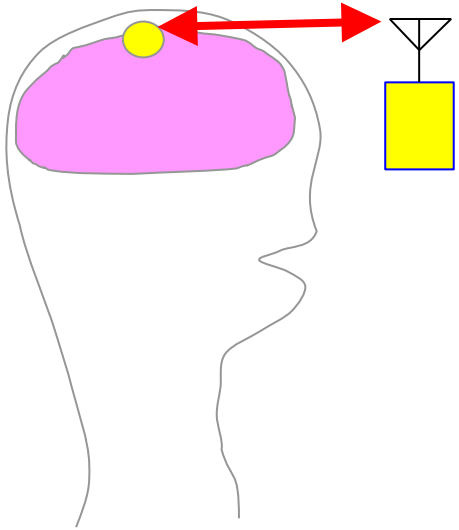
Body Surface to Body Surface for BCI



Implant to Body Surface for BCI



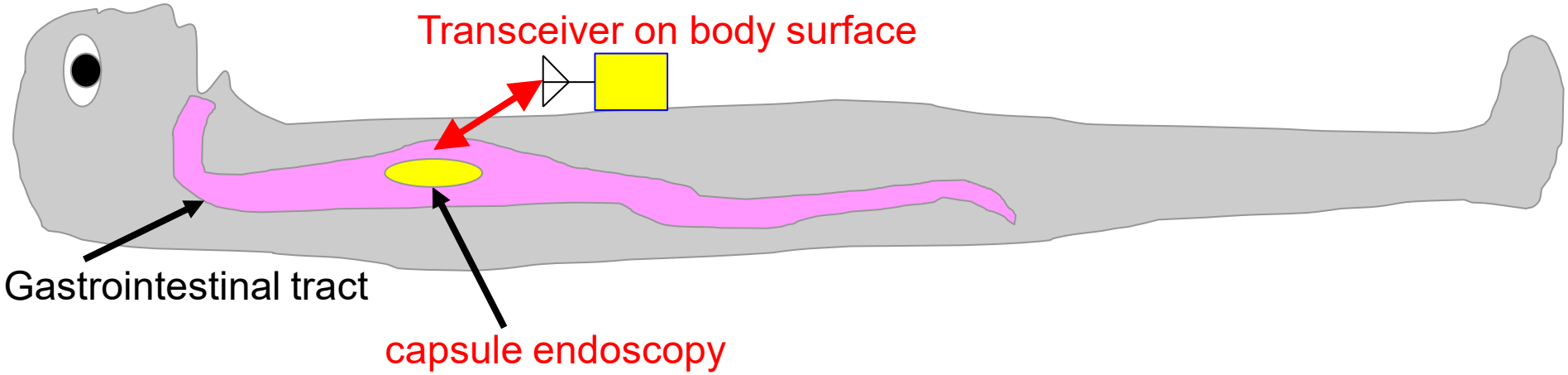
Body Surface to External on-body surface for BCI



Implant to External for BCI

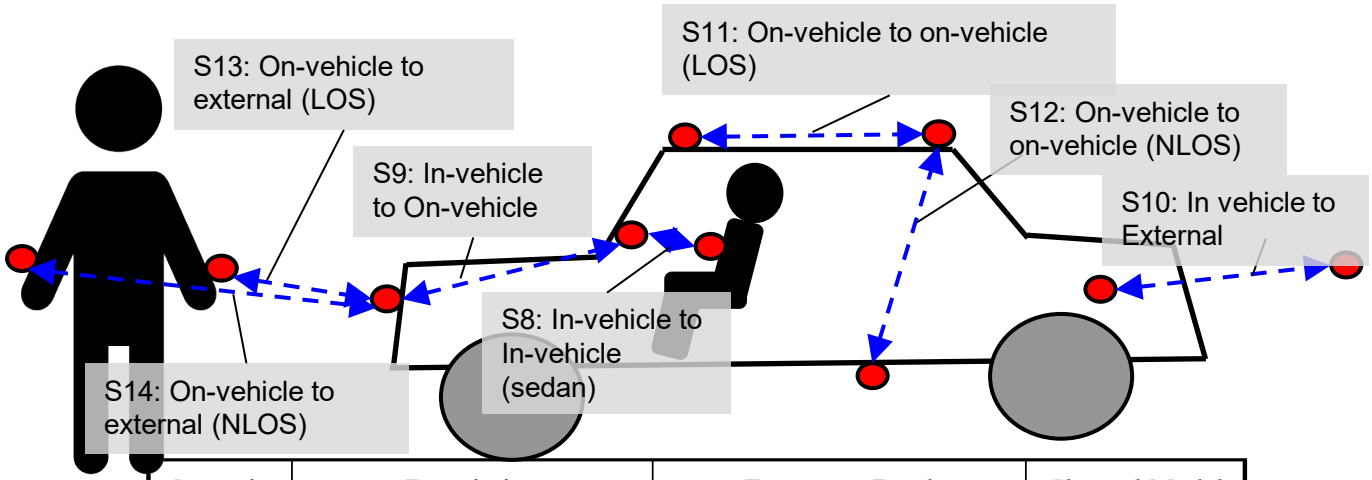
4.3 Channel models and scenarios for capsule endoscopy

Specific use cases
Implant(head) to on-body for BCI
Implant to External for BCI
Body surface to body surface for BCI
Body Surface to External for BCI
Implant to body surface for capsule endoscopy



Implant to Body Surface for Capsule Endoscopy

4.4 Channel models and scenarios in IEEE802.15.6ma

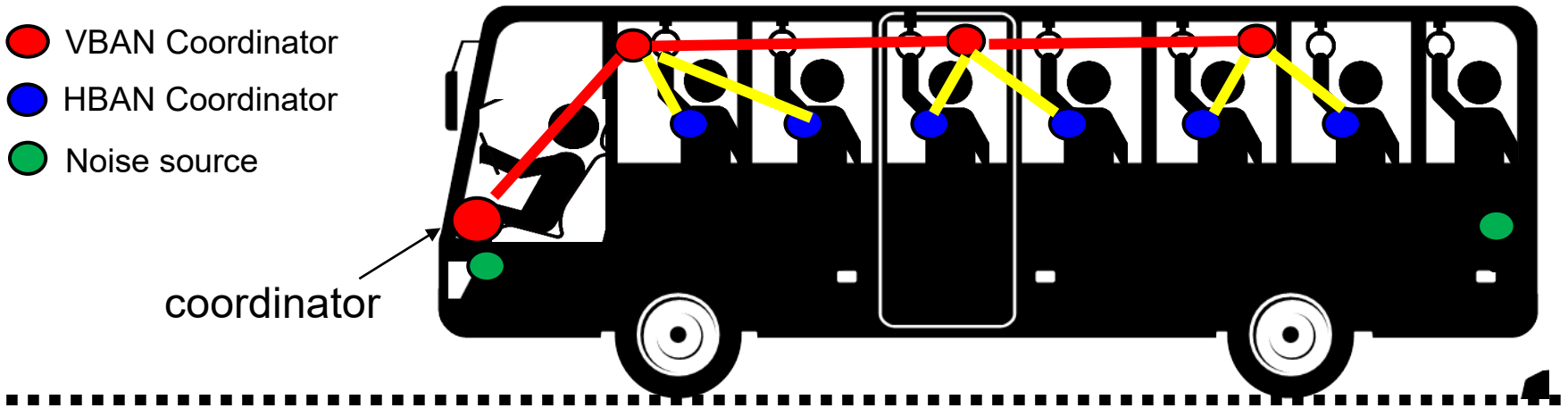


Scenario	Description	Frequency Band	Channel Model
S8	In-vehicle to In-vehicle (sedan)	2.4, 3.1-10.6 GHZ	CM8
S8.1	In-vehicle to In-vehicle (passenger bus)	2.4, 3.1-10.6 GHZ	CM8.1
S9	In-vehicle to On-vehicle	2.4, 3.1-10.6 GHZ	CM9
S10	In vehicle to External	2.4, 3.1-10.6 GHZ	CM10
S11	On-vehicle to on-vehicle (LOS)	2.4, 3.1-10.6 GHZ	CM11
S12	On-vehicle to on-vehicle (NLOS)	2.4, 3.1-10.6 GHZ	CM12
S13	On-vehicle to external (LOS)	2.4, 3.1-10.6 GHZ	CM13
S14	On-vehicle to external (NLOS)	2.4, 3.1-10.6 GHZ	CM14

4.4 Use Case of Coexisting Multiple HBAN and VBAN

Nodes and coordinator are in cabin room Geometrical configuration

➡ Original channel models, common channel model to IEEE 802.15.4a and IEEE802.15.6-2012



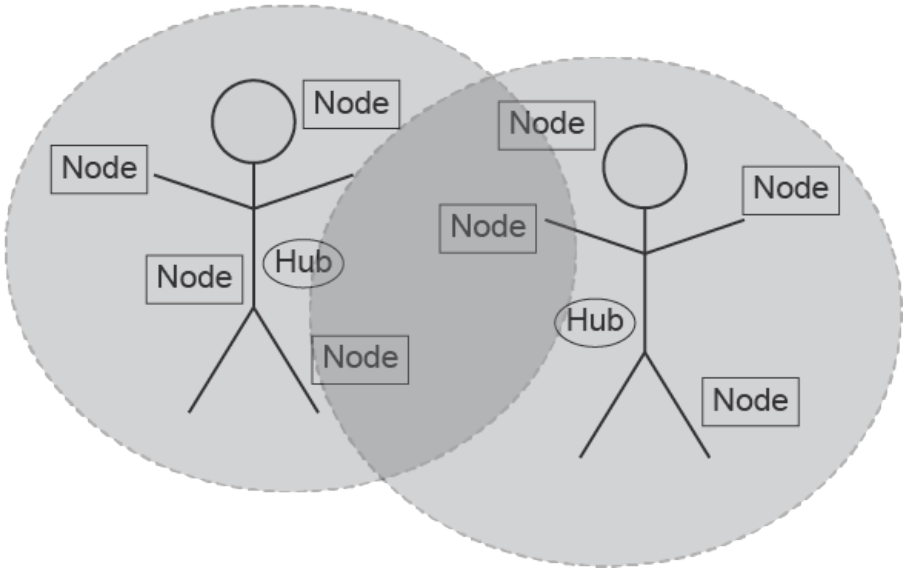
Use case

- Entertainment for passengers
  - Nodes are in cabin room / coordinator is in cabin room.

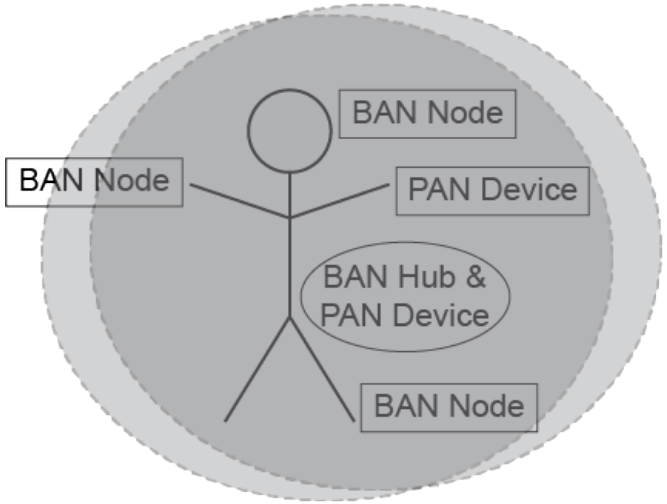
scenario		Sedan/RV / SUV with engine	Sedan/RV / SUV without engine	Bus	Cargo / pickup	Special purpose
8.1vv	VBAN coordinator and VBAN coordinator	Case 3.1a		Case 3.1a	Same as 3.1a	---
8.1vh	VBAN coordinator and HBAN coordinator	Case 3.1b				---

5.1 Interference among BANs or BAN and other systems

- There would be cases where BANs or BAN and other networks are spatially collapsed.

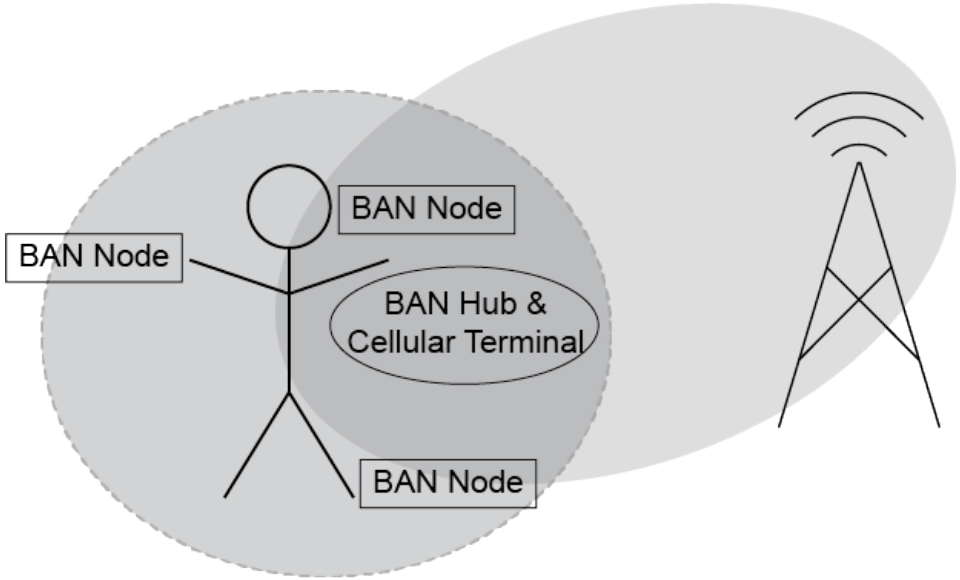


Case 1: BANs, using same frequency bands

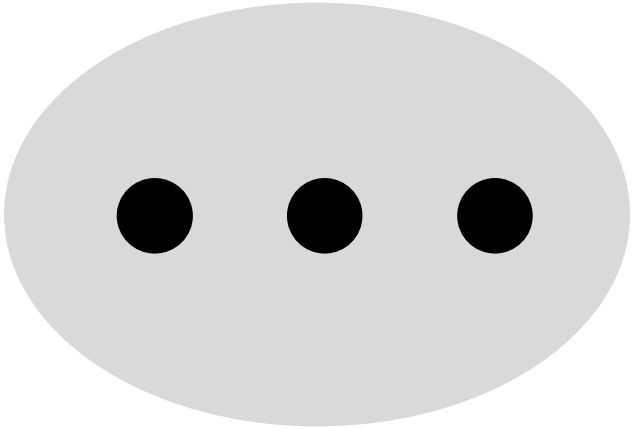


Case 2: BAN and PAN, using same frequency bands

5.2 Interference among BANs or BAN and other systems



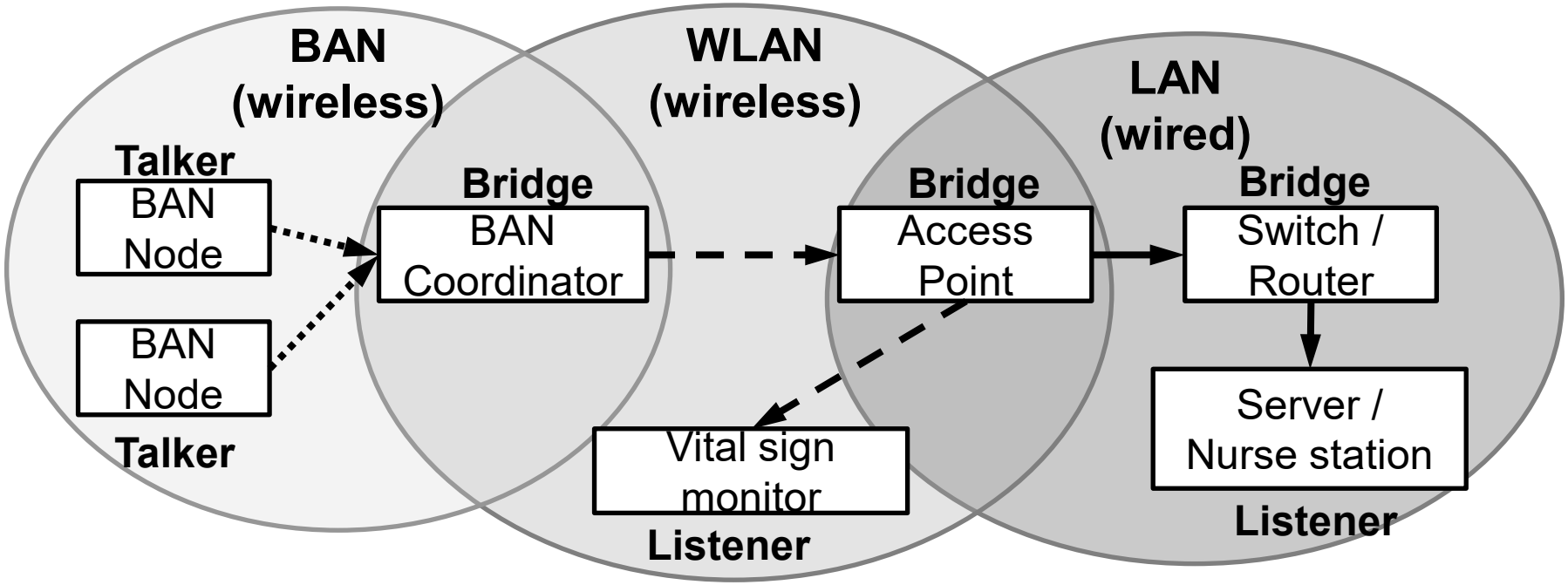
Case 3: BAN and other piconets such as cellular network or Wi-Fi, some part of their frequency bands are overlapped.



Case 4: Case 1 to 3 combined

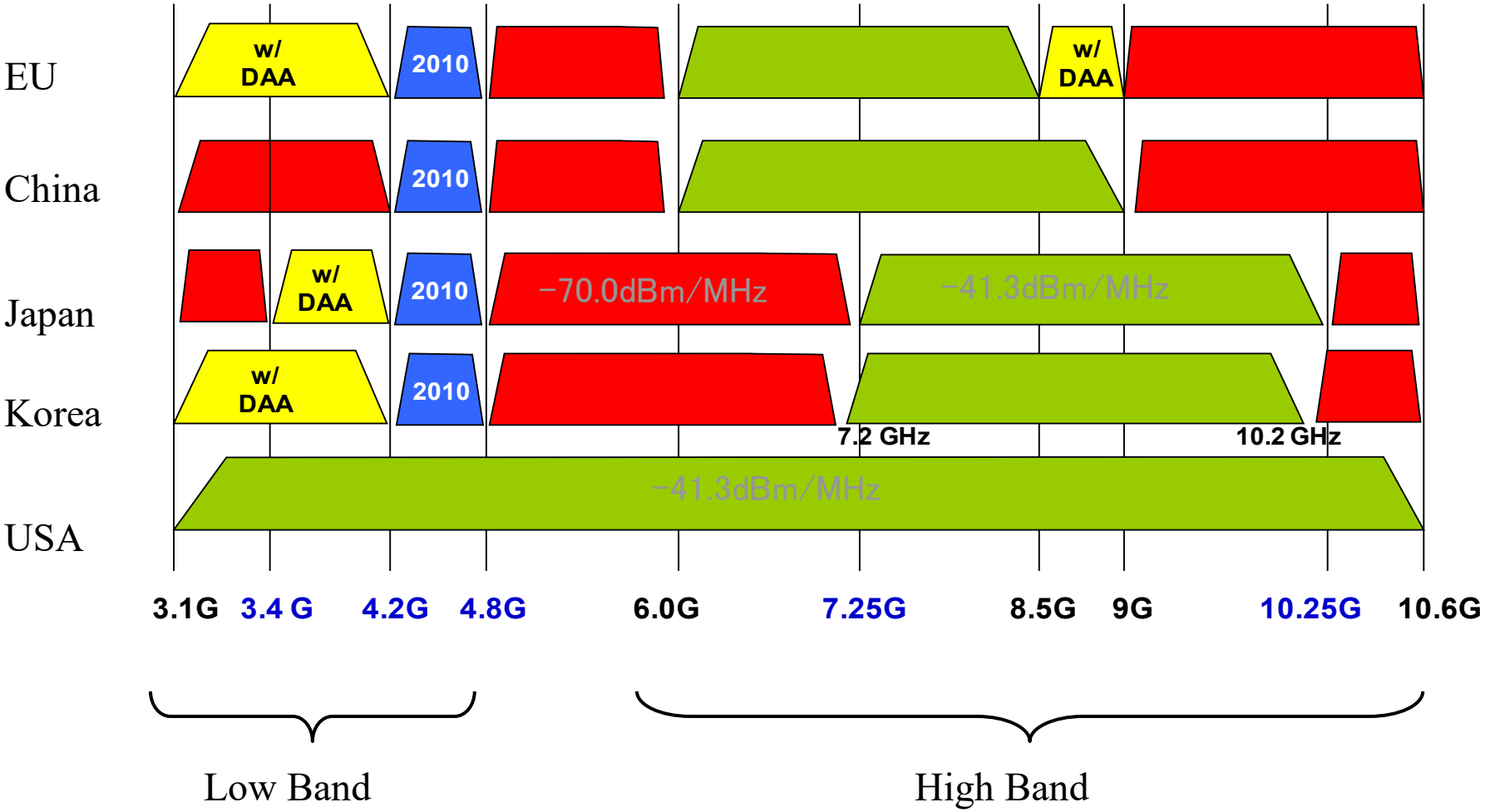
- The concept of 802.1 MAC Bridge can be extended to enhance dependability.
- The coordinator can manage interference or packet collision among same or different BANs (VBAN and/or HBAN), PANs, and other piconets.

5.4 Possible bridging in 802.15.6ma



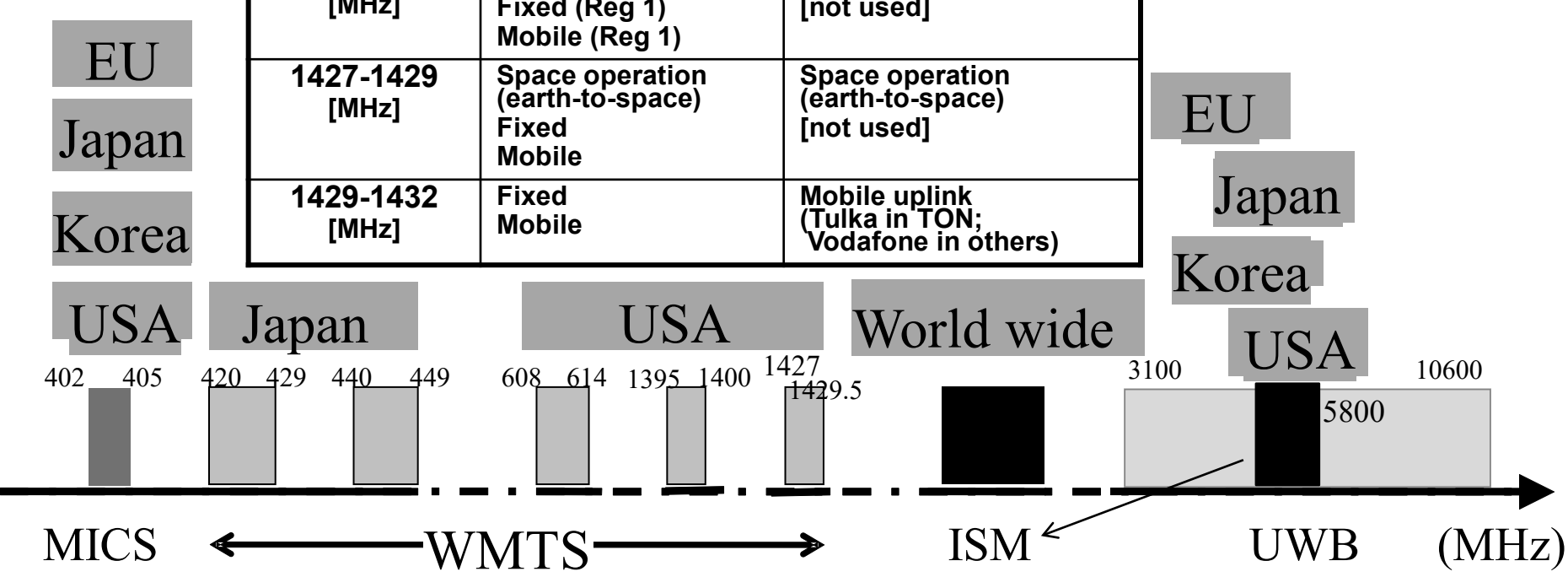
- BAN coordinator may relay frames to outer network as a MAC Bridge.

World Wide UWB Regulation



Frequency Regulation for Medical Use

Frequency	ITU	MIC in Japan
608-614 [MHz]	Broadcasting	Broadcasting (TV channel 36)
1395-1400 [MHz]	Radiolocation Fixed (Reg 1) Mobile (Reg 1)	Radiolocation [not used]
1427-1429 [MHz]	Space operation (earth-to-space) Fixed Mobile	Space operation (earth-to-space) [not used]
1429-1432 [MHz]	Fixed Mobile	Mobile uplink (Tulka in TON; Vodafone in others)

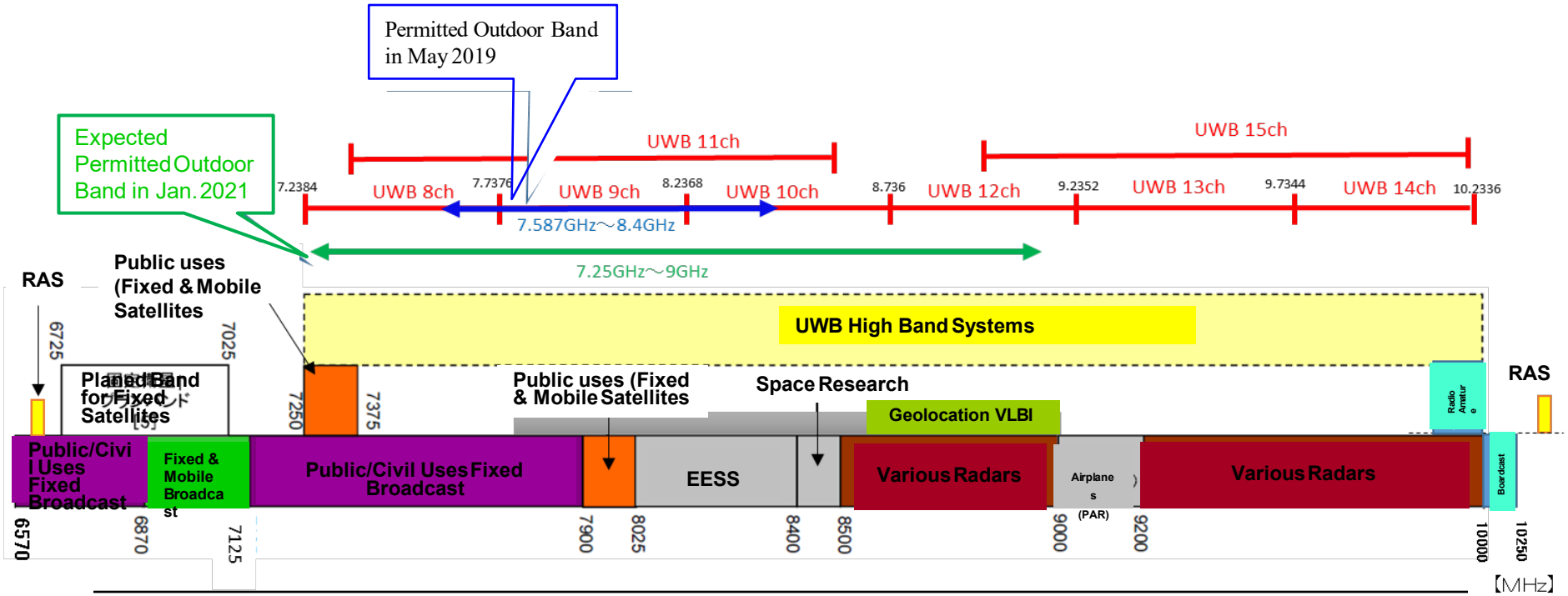


BAND for WMT (Wireless Medical Telemeter) in FCC(USA)

- 608-614 MHz; Also for radio astronomy and UHF TV
- 1395-1400 MHz
- 1427-1432 MHz; Also used for non-medical telemetry

Radio Outdoor UWB Uses in the Frequency Band 7.25-9.00GHz (in MIC, Japan, January 2021)

- Red lines indicate channels defined by IEEE802.15.4a.
- Although Ch 9 in 7.587-8.4GHz
- **Blue line** was allowed for outdoor use in May 2019,
  MIC has started investigation to allow wider band 7.25-9.00 GHz **Green line** wand it is expected to allow it for outdoor use in January 2021



Possible Victim Systems by UWB Radio

Category 1: Commercial and Hobby Systems

1. Fixed Microwave System
2. Broadcasting System
3. DSRC for ITS
4. Cellular Phone(4th Generation)
5. Wireless Access
6. Amateur Radio Communication System

Category 2: Public Safety

7. Maritime Radar
8. Aeronautical and Meteorological Radar

Category 3: Scientific Systems (Passive Receivers)

9. **Earth Exploration Satellite Service (EESS)**
10. **Radio Astronomy Service (RAS)**

Remained Issues in UWB Regulation and Solution for Joint Study of URSI and ITU

1. Primary and Secondary Uses in Radio Regulation

- Priority Order (Science vs Society Benefit)
- Life Critical Uses vs Scientific Uses

2. Technical Solution and Legal Solution

- Measurement and Detection Technologies for low density radio signals for RAS, EESS as well as UWB
- Special Regulation in Emergency different from usual.

3. Global and Regional Regulations

- Regional Constraint vs Global Mobility
- URSI and ITU-R Task Share ➔ **WRC23**

WRC23

- **ITU World Radiocommunication Conference 2023 (WRC-23)**
- Dubai, United Arab Emirates, 20 November to 15 December 2023
- https://www.itu.int/wrc-23/#:~:text=Dubai%2C%20United%20Arab%20Emirates%2C%2020%20November%20to%2015%20December%202023

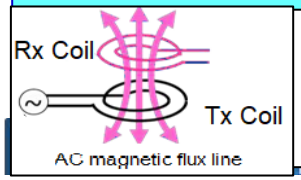
Harmonization of Scientific and Commercial Radio Uses, and their Social Services and Industrial Innovation

Agenda

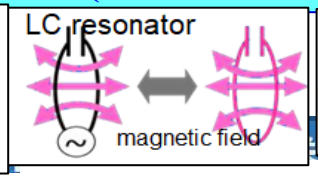
1. Necessity of Harmonization between Scientific and Commercial Radio Uses
2. Demands for Social Services and Industrial Innovation
3. Case of Ultra Wind Band(UWB) Radio Systems
3.1 UWB Radio Medical and Social Service Uses Coexisting with Scientific Uses
3.2 International Standard for UWB Systems e.g. IEEE802
3.3 Japanese and Global Regulations for UWB
4. Case of Wireless Power Transmission(WPT) Systems
4.1 WPT Radio Commercial and Social Infrastructure Uses
4.2 Regulation for WPT
5. Solution by Regulatory Science
5.1 Regulatory Science for Medical Devices
5.2 Regulatory Science Center for Harmonization between Scientific and Commercial Uses
6. Concluding Remark

Wireless Power Transmission Technologies

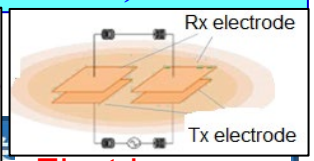
Near-field WPT (Commercialized)



Electromagnetic Induction Type



Magnetic Resonant Coupling Type



Electric Coupling Type

[feature]

- Based on magnetic coupling resonance between two coils of receiver and transmitter.
- Large power, high efficiency
  ⇔ limited transfer distance.

[Power] several W – 100s kW.

[distance] several mm – several 10 cm.

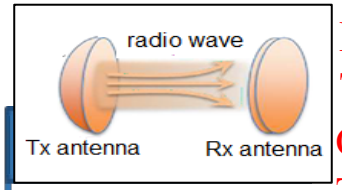
[efficiency] around 90%

Applications

Charge for smartphones

Charge for EV

Far-field WPT (Under develop stage)



Microwave Radio Transmission Type

Optical Wireless Transmission Type

- Based on electro-magnetic wave transmission using antennas.
- . Long distance transfer
  ⇔ low efficiency

[Power] some milli W – some 100 W.

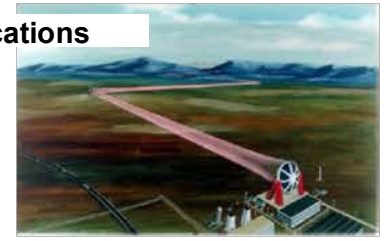
[distance] some meters – some 10 km.

[efficiency] up to 10% in general.

[application] wireless sensors, power transfer to the disaster area.

Power supply to the sensors

Applications



Power supply to the disaster area

(Ref. MIC Regulatory Committee Report)

Use Cases of Microwave Radio WPT(1/2)

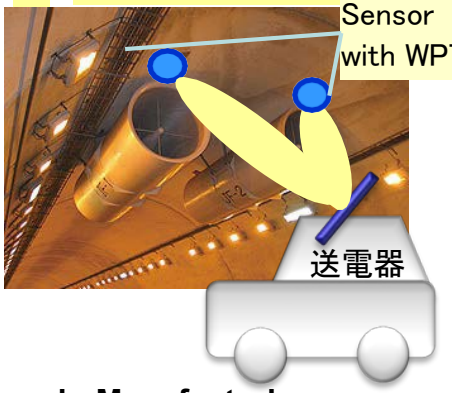
WPT Use Cases
Microwave Radio WPT for indoor & outdoor uses with some 10W

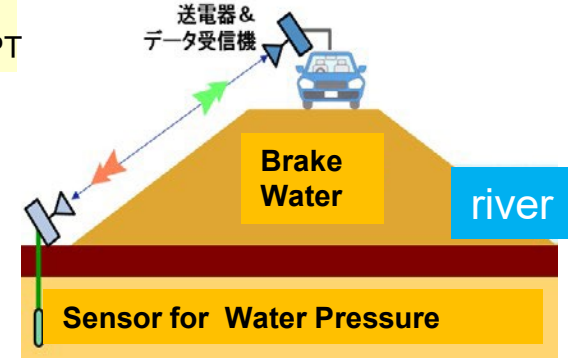
①FA/IoT

Charging and recharging Sensors, Wearable Devices etc. (Longer Transmission Distance, Maintenance Free)

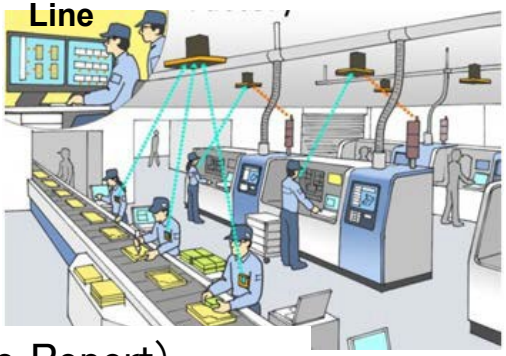
Test and Maintenance for Infrastructures with sensors, drones etc. preventing accidents and disasters

WPT Charging for Sensors in Factory

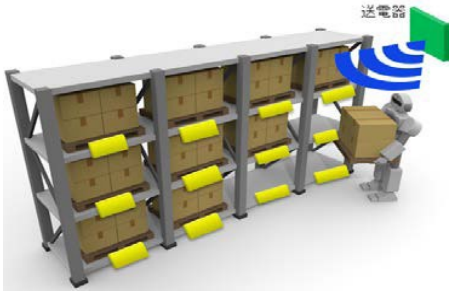




WPT for Sensors in Manufacturing Line



WPT for Display in Storage, Delivery in Factory and shops



(Ref. MIC Regulatory Committee Report)

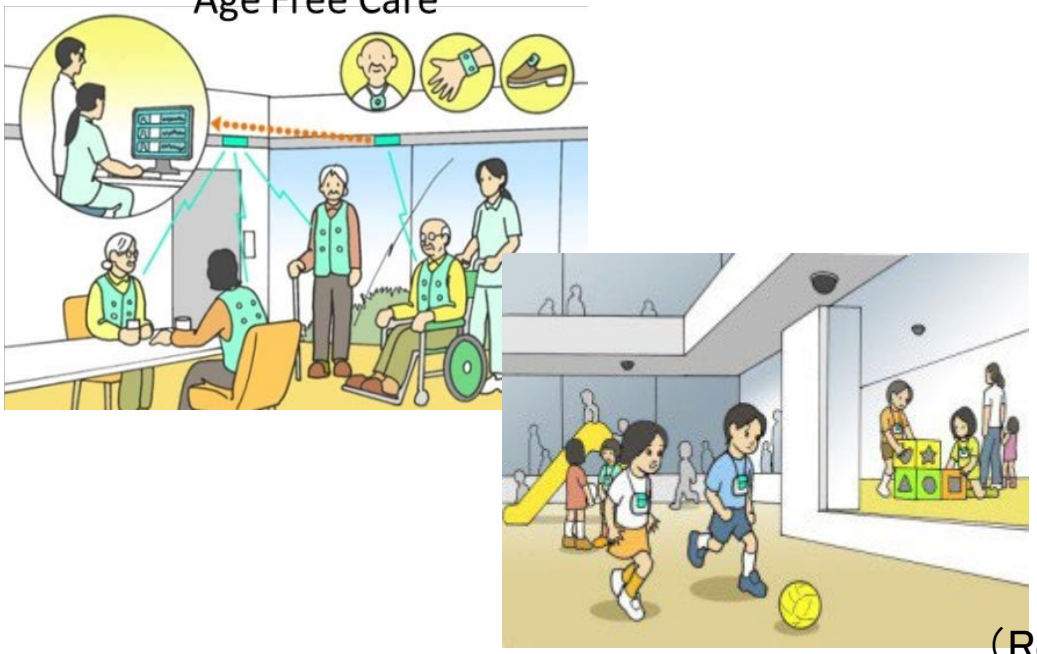
Use Cases of Microwave Radio WPT(2/2)

WPT Use Cases
Microwave Radio WPT for indoor & outdoor uses with some 10W

②Sensor for Elderly & Child Care

Charging and recharging batteries of sensors and wearable devices with maintenance free

WPT for remote care and maintenance



③ Mobile Devices ex. Smart Phone, Tablet

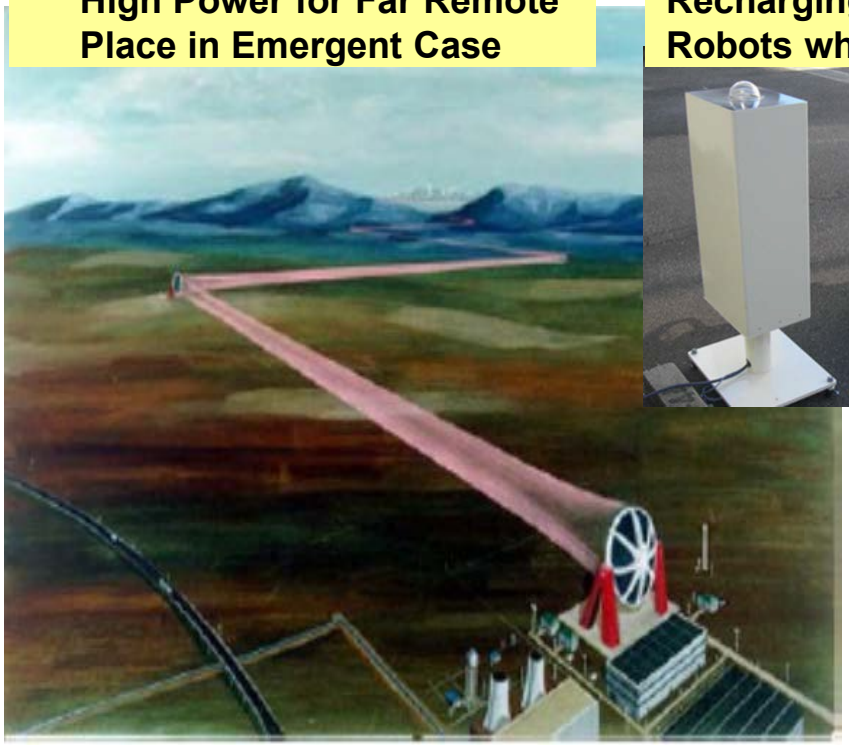
Remote charging and recharging batteries of smart phones, IoT devices in office, shops, and public space

(Ref. MIC Regulatory Committee Report)

Use Cases of Microwave Radio WPT(3/3)

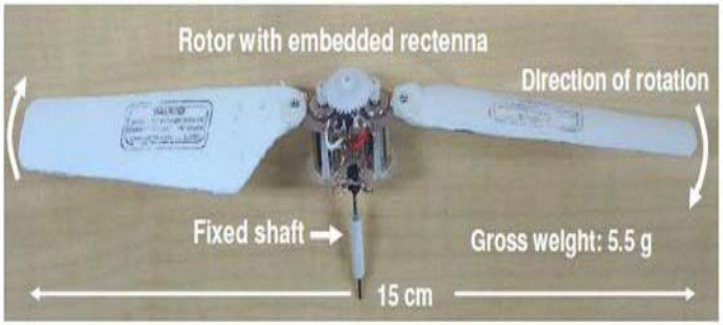
Future Microwave Radio WPT Use case ③ Long Distance and Large Amount of WPT

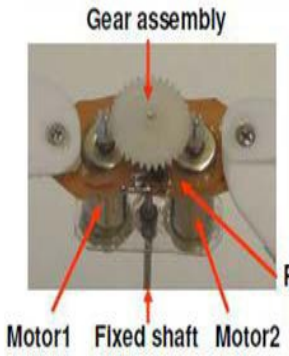
High Power for Far Remote Place in Emergent Case

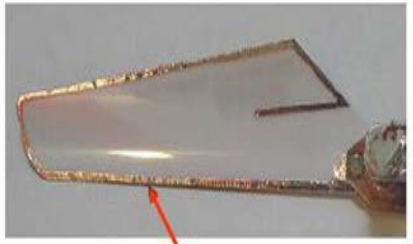


Recharging Multiple Mobile Robots while Moving

Regarding Battery of UAV while keep flying for a long time







※Reference : Report ITU-R SM.2392-0

Interfered Radio Systems that Required to Consider Coexistence

920MHz band

Reference: Microwave Far-Field Study Group Report of Broad-Band Wireless Forum

Interfered system	Frequency （center freq.）
MCA	855MHz↓ 935MHz↑
Personal radio (Japanese regulation)	903.0125～904.9875MHz
LTE-A	907.5MHz↑ 952.5MHz↓
RFID（indoor radio system）	916.8～920.8MHz
RFID（specific low power radio）	916.8MHz～923.4MHz
Telemeter,LoRaWAN etc.	915.9～929.7MHz

2.4GHz band

Interfered system	Frequency
RF tags(indoor radio system)(specific low power radio)	2400～2483.5MHz
Wi-Fi	2400～2497MHz
Low power wireless data communication	2,400～2,483.5MHz
Satellite communication (terminal)	2505～2535MHz↓ 2660～2690MHz↑
WiMAX	2545～2645MHz
Robots	2483.5～2497MHz

5.7GHz band

Interfered system	Frequency
Wi-Fi	5.180～5.570GHz
Electronic Toll Collection System (ETC)	5.795～5.845GHz
Dedicated Short Range Communications (DSRC) system	5.775～5.845GHz

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Established Regulatory Science Center Medical Devices and Services in MM21 Bay Area

(founded in Jan. 2012)

Regulatory Scientific R&D and Compliance Testing field in a Center of Japan, Kanagawa Prefecture

Ms. Fumiko Hayashi, Mayer, Yokohama City Mayor, Japan
Mr. Mr. Matti Pennanen, Mayer, City of Oulu, Finland
Mr. Yuji Kuroiwa, Governor, Kanagawa Prefecture, Japan
Dr. Sinikka Salo, Vice-Major City of Oulu, Finland
Prof. Ryuji Kohno, Director, Medical ICT Center, Yokohama National University, Japan

Kanagawa Prefecture Governor Mr. Yuji Kuroiwa and Yokohama City Mayor Ms. Fumiko Hayashi have leadership to promote Regulatory Science Center in Yokohama, Kanagawa

General Classification and Application Types of Medical Devices for Regulatory Compliance

Higher Benefit & Risk

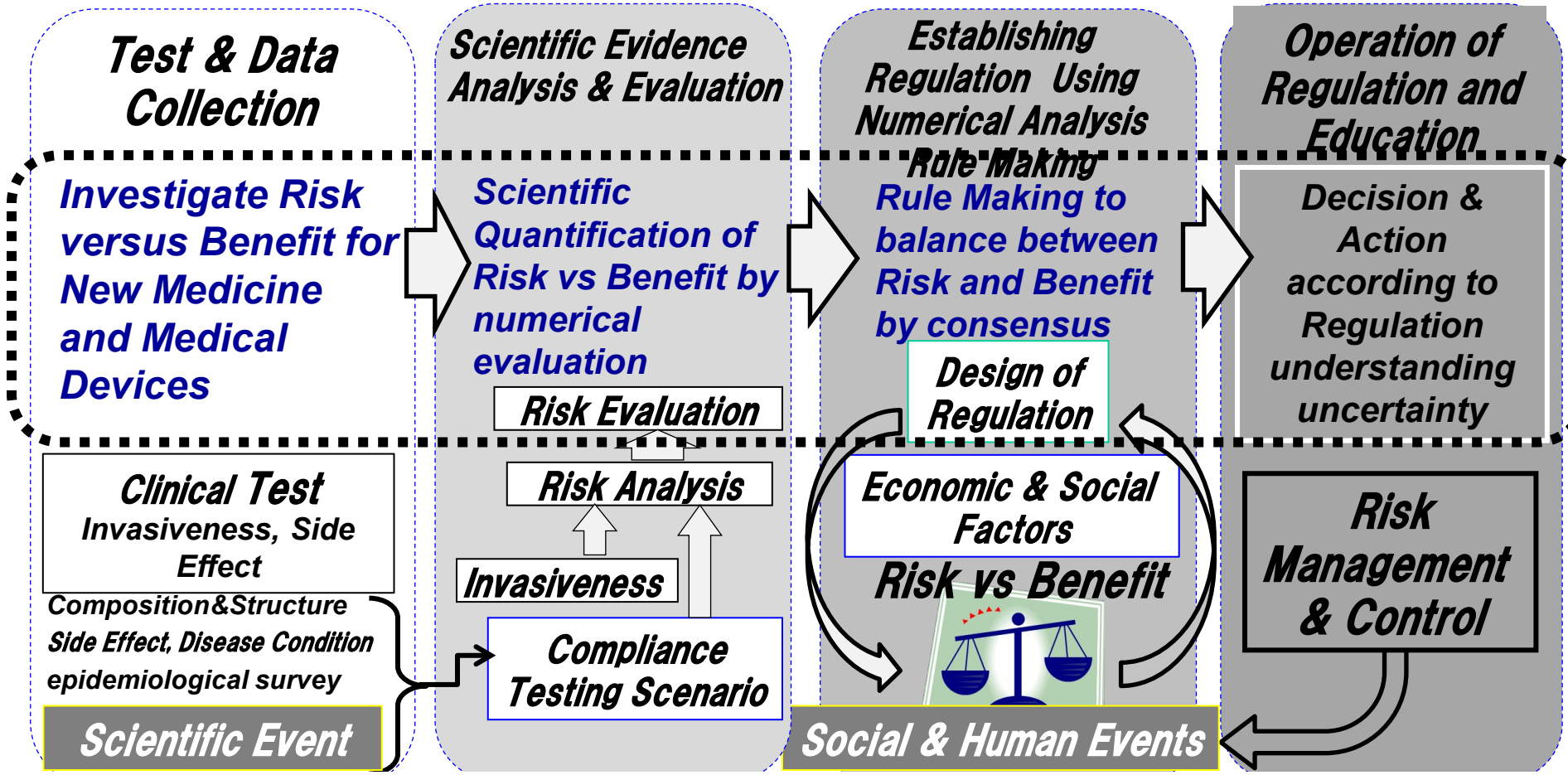
Class in Japan	Global Class	Classification according to Risk for Body	Compliance Test	Testing Body
Ordinary medical devices	Class I	Extremely low risk for human body even in case of broken or unpredictable cases	Submission only	Self test
Managed medical devices	Class II	Relatively low risk for human body in case of broken or unpredictable cases	Registration	RCB*1
Highly managed medical Devices	Class III	High risk for human body in case of broken or unpredictable cases	Regulatory Compliance Test Approval	PMDA*2
	Class IV	Very high risk for human body and dangerous in case of broken or unpredictable cases		

Longer Time for Compliance Test

**1 RCB: 3rd Party Approval*

**2 PMDA: Government Regulator*

Regulatory Science for Clinical Use of Medical Devices and Medicine



- Speed up procedure of regulatory compliance test of medical devices by Regulatory Science.
- Not only patients but also manufactures can be protected for saving life and business by Regulatory Science.

Human Impact vs BER according to Emission Power

Pennes's Thermal Propagation Equation

$$c\rho\frac{\partial T}{\partial t} = \nabla\cdot(\kappa\nabla T) + A_0 + Q_v - b(T-T_b) \Rightarrow \kappa\nabla^2 T + \rho SAR - \rho\rho_b c_b F(T-T_b)$$

1st term; Thermal Propagation

2nd Term; Thermal Radiation to keep proper temperature

3rd Term; Thermal Volume by Millimeter wave

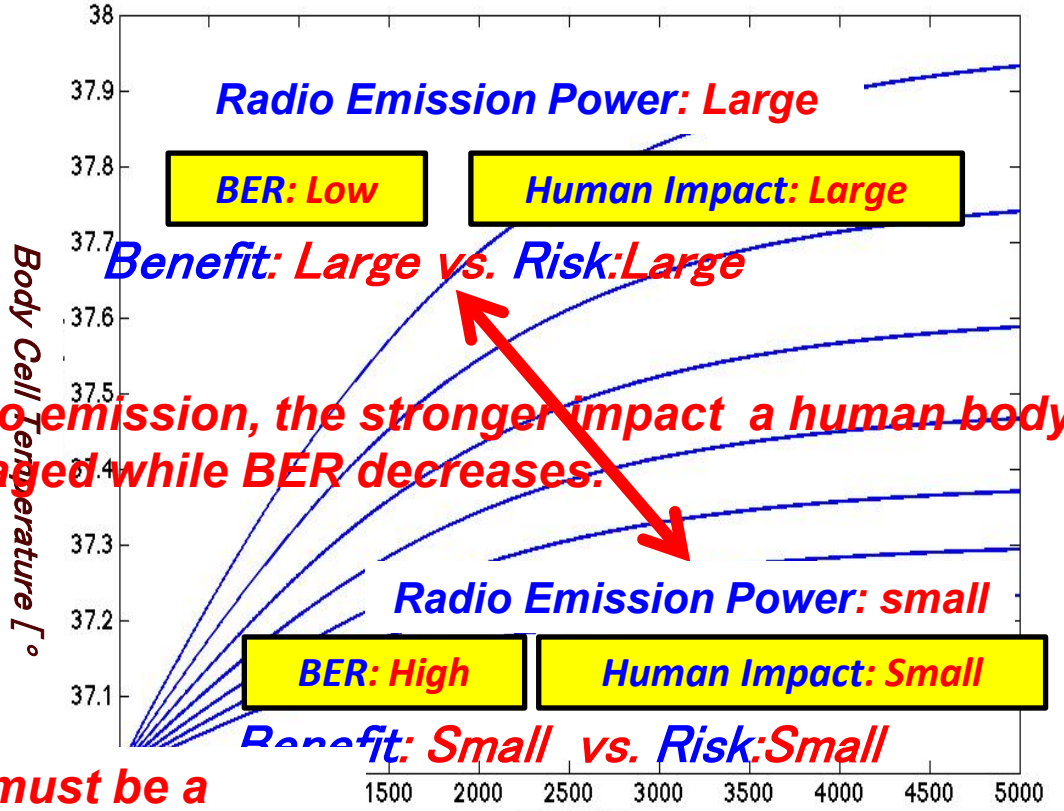
4th term; Thermal Change due to Blood Stream

SAR(Specific Absorption Rate)

EIRP of Emission Power P_t and Antenna Gain G_t for a distance R

$$E = \frac{\sqrt{49P_tG_t}}{R}$$

SAR ∝Pt ∝E 2



Then, radio emission power or SAR must be a numerical parameter to evaluate risk versus benefit of radio medical devices.

Harmonization of Scientific and Commercial Radio Uses Based on Regulatory Science

Scientific Use

Radio Astronomy(RAS)

Space Exploration Ship, Earth Exploration Satellite（EESS）

Weather satellite,

Communication, Broadcasting Satellites

Grand Penetrate Radar

Disaster Prevention Radio

Public Use

Remote Medicine

Medical Use

Medical Body Area Network(BAN)

WPT

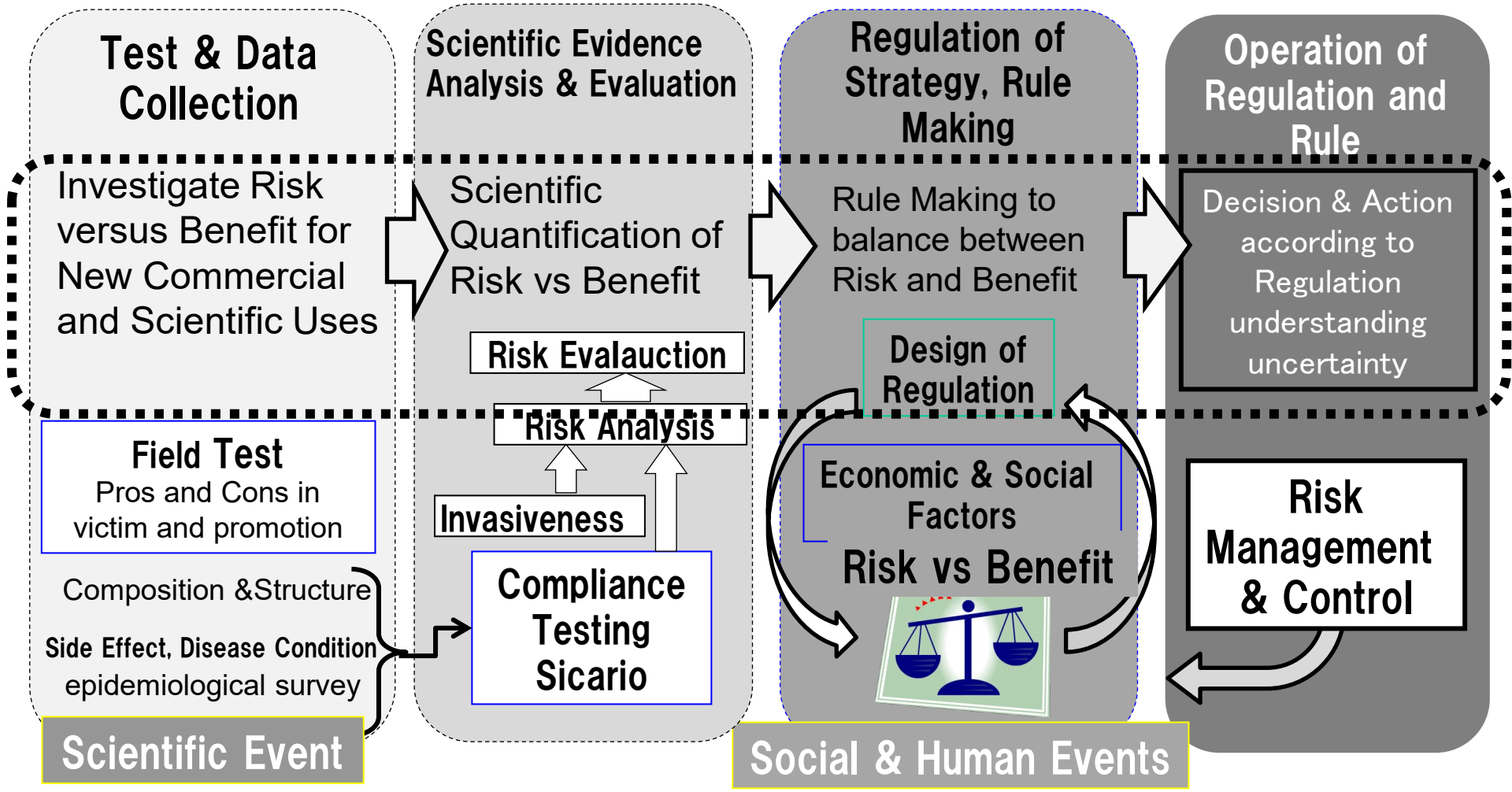
WiFi, IoT, 5G, 6G Cellular

Collision Avoidance Radar

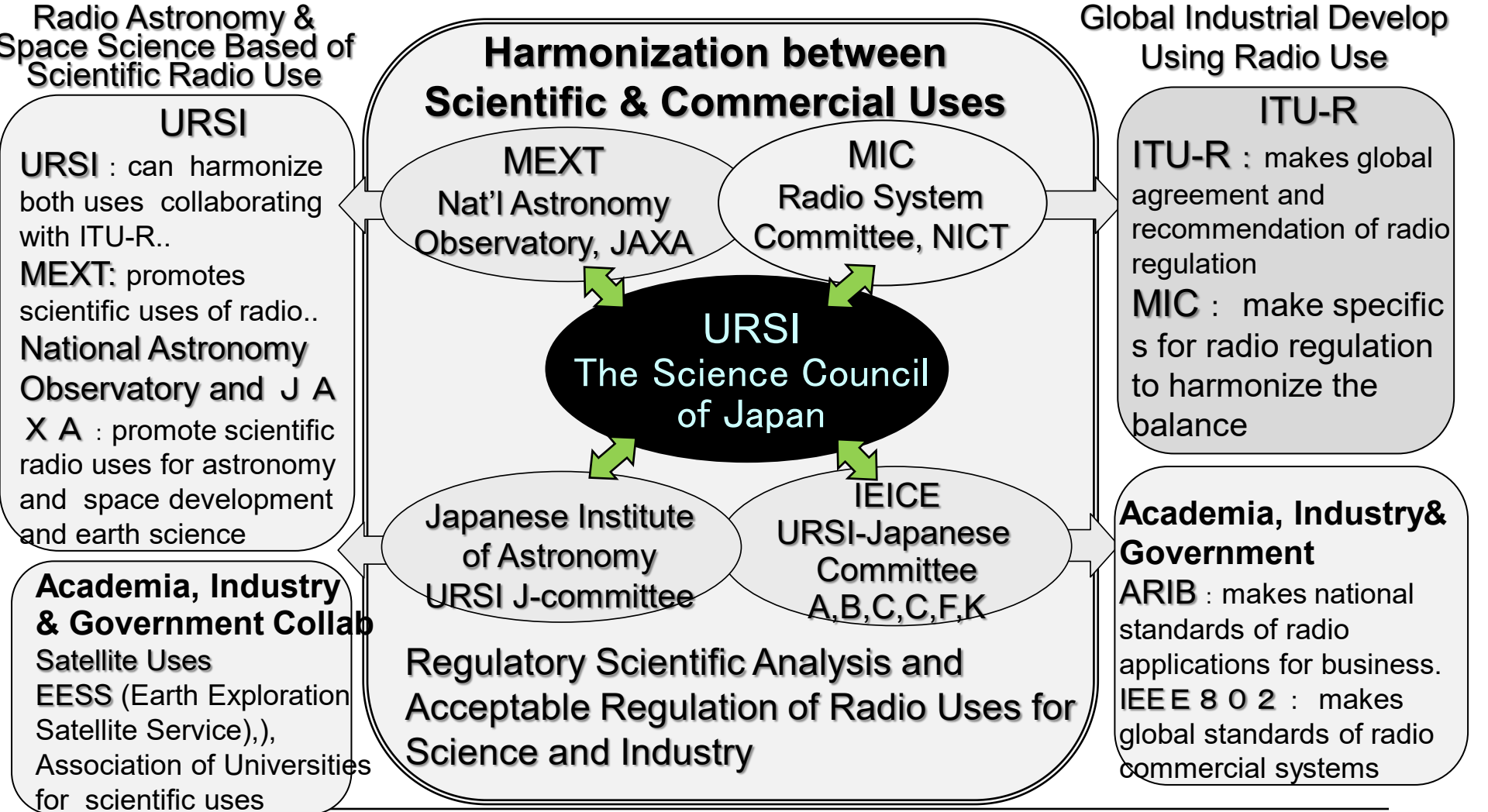
Commercial Use

Harmonization based on Regulatory Science

Regulatory Science for Harmonization between Scientific and Commercial Radio Uses



Science Council of Japan
Center for Harmonization between Scientific and Commercial Radio Uses to Master Plan 2014, 2017, 2020



Research for Regulatory Science for Scientific and Commercial Radio Uses

- Any application of technical innovation, invented technology or system needs to manage the balance between its risk versus benefit considering cost and remained uncertainty for its safe and stable usage.
- Regulatory science manages the balance by
  1. Numerical evaluation of risk, benefit and cost by scientific analysis using newly defined parameters.
  2. Defining permissible values of the parameters with use cases and measurement manners
  3. Making a rule or regulation for the safe application with the defined permissible values.
  4. Determining a procedure to approve the systems compliant to the regulation.

Concluding Remark

- **Commercial radio use** can produce innovative technologies such as UWB, WPT to perform **public services** in SDGs.
- **Scientific radio use** should be protected against interference while commercial radio uses can develop technologies to avoid mutual interference based on **regulatory science**.
- **URSI** must be a venue to study harmonization between scientific and commercial radio uses as a scientific subject while collaborating with **ITU** for global regulation.
- **URSI** can contribute to **provide possible solutions** for the harmonization in various scientific and commercial radio use cases with **100 years activities** in Commission A-K by establishing **Regulatory Science Center.**

URSI GASS 2023

SAPPORO, JAPAN

XXXVth URSI General Assembly and Scientific Symposium

- HOME
- Invitation
- About URSI GASS 2023
- Committees
- Program
- Call for Papers
- Paper Submission

| Dates

August 19(Sat) – 26(Sat), 2023

| Venues

Sapporo Convention Center
Sapporo Business Innovation Center

Check www.ursi-gass2023.jp for regular updates.

Important Dates:

Paper submission site opens: **November 10, 2022**
Paper submission deadline: **January 25, 2023**
Notification of acceptance: **March 15, 2023**

Thank you for your kind attention.
Any Question and Comment?

You can send me an email any time to kohno@ynu.ac.jp