Dr. Iwao Hosako, Executive Director,
Beyond 5G R&D Promotion Unit


NICT
National Institute of
Information and Communications Technology

National Institute of Information and Communications Technology

Japan's only public research institute specialising in ICT

Personnel and Budget

- **Location: HQ in Koganei, Tokyo**
- **Personnel: ~ 1380**
- **Researchers: ~ 730**
- **Budget: ~28.68 Billion Yen + α (2023)**
  approx. ~ 180M€ (@ €/¥ = 160)

- **5th Mid-to-Long Term Plan: April 2021 – March 2026**

Public Services:

- Japan Standard Time
- Space Weather Forecast
- Wireless Equipment Testing & Calibration
- Cybersecurity Training

R&D: 5 Main Research Areas

- Advanced Electromagnetic Wave Technology
- Innovative Networks
- Cybersecurity
- Universal Communication
- Frontier Science

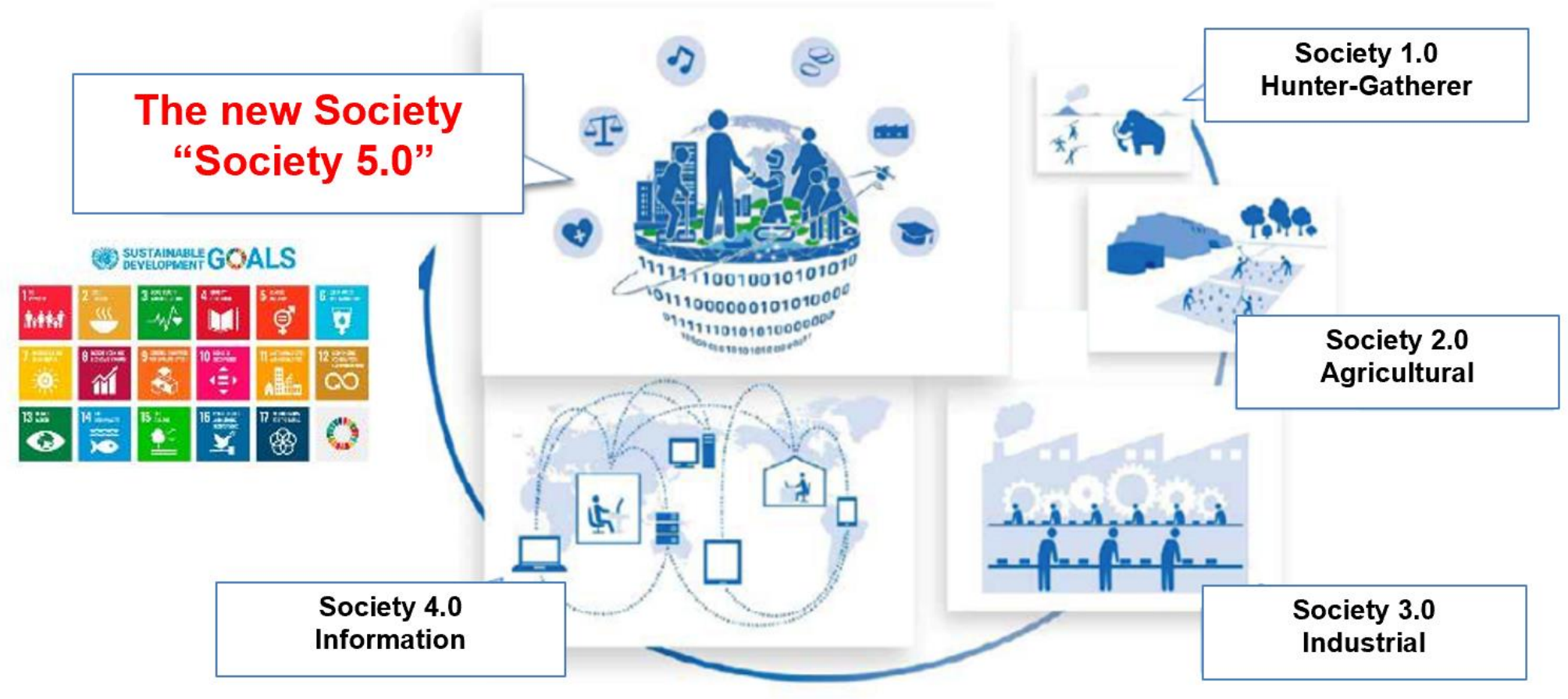
Funding Agency:

- B5G R&D Project / Domestic ICT Projects
- US-Japan Projects
- EU-Japan Projects
- ASEAN-IVO Projects
- Taiwan-Japan Projects

Outline of R&D for B5G/6G in the 5th Mid-to-Long Term Plan (April 2021 – March 2026)

JAPAN's Vison for Future Society
Safe and Secure Society 5.0

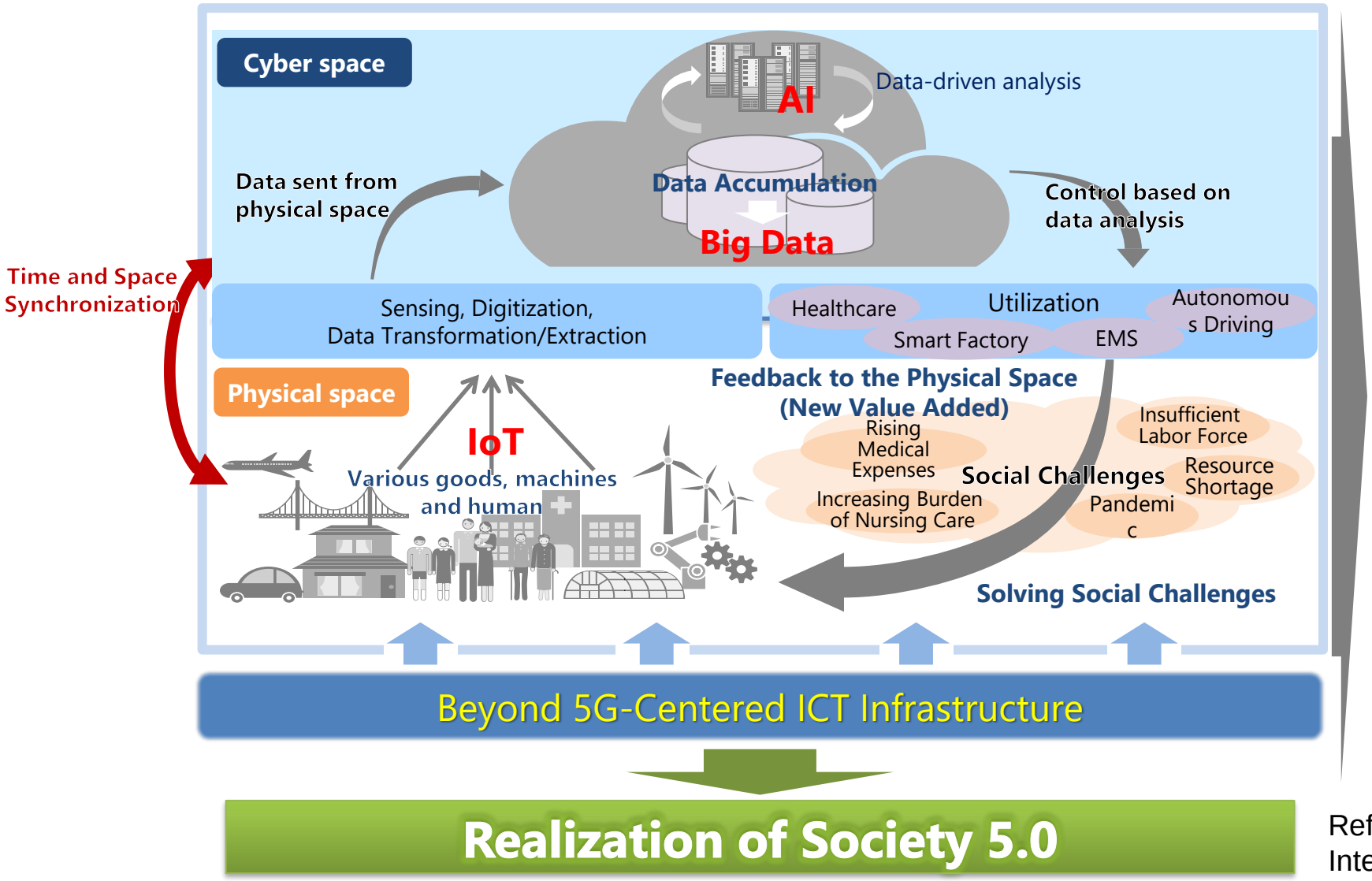
- **Safe and Secure Society 5.0 is a human-centered, sustainable and inclusive society.**
- **Through systems that achieve advanced fusion of the physcial and cyber spaces, we can solve both economic and social issues.**



(From the Cabinet Office)

CPS Vision for Society in the 2030s by MIC

Cyber Physical System（CPS）
- integrating cyber and physical space



Society in the 2030s

Vigorous & Resilient Society

Inclusive

A society where everyone can play an active role regardless of their attributions (ex. Locations, nationalities, ages, and handicaps)

Sustainable

A society growing sustainably and efficiently, without social loss

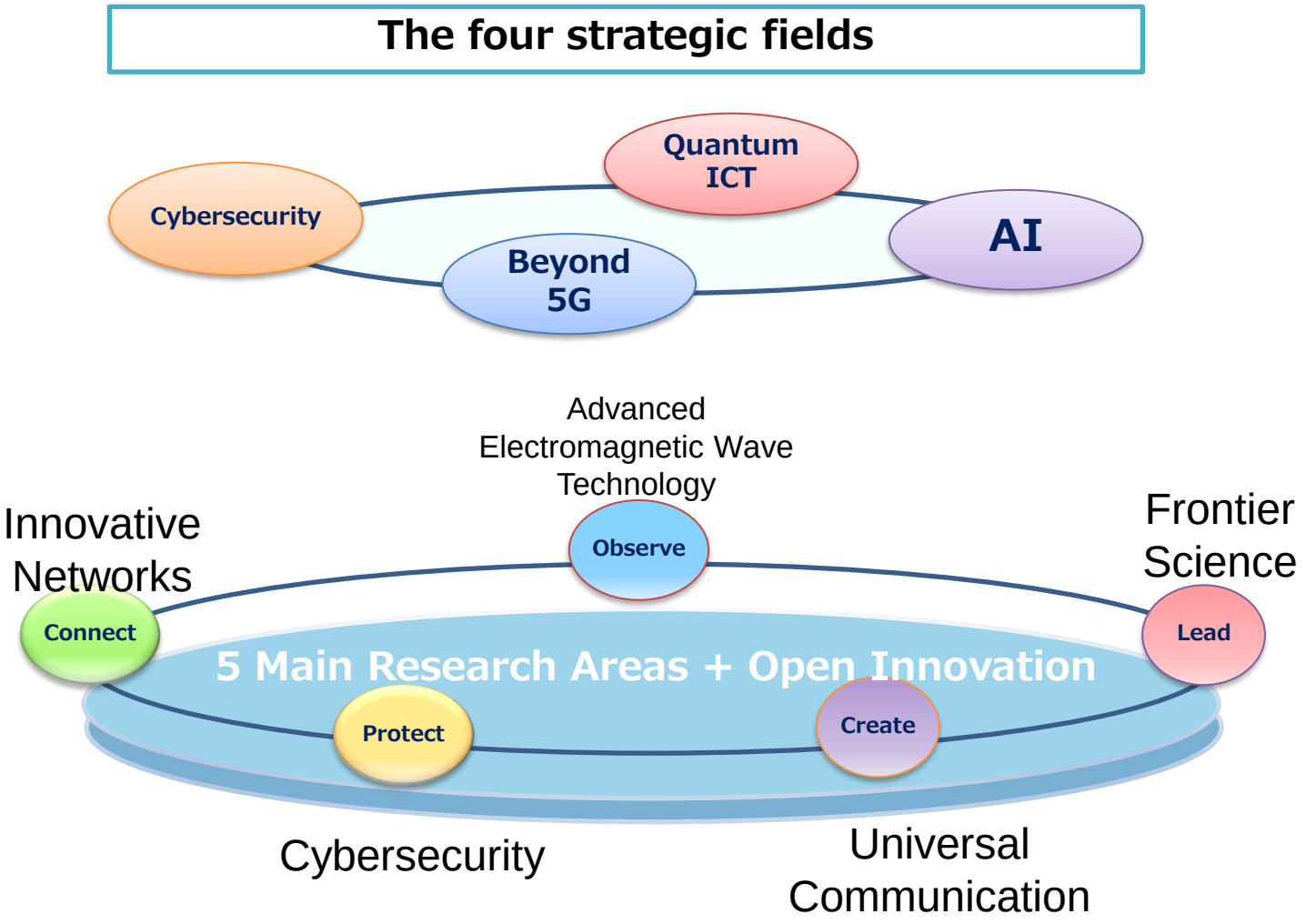
Dependable

A human-centered society where safety and security are ensured, and trust is secured even under unprecedented circumstances

Ref.: Beyond 5G promotion strategy, Ministry of Internal Affairs and Communications, June 2020.

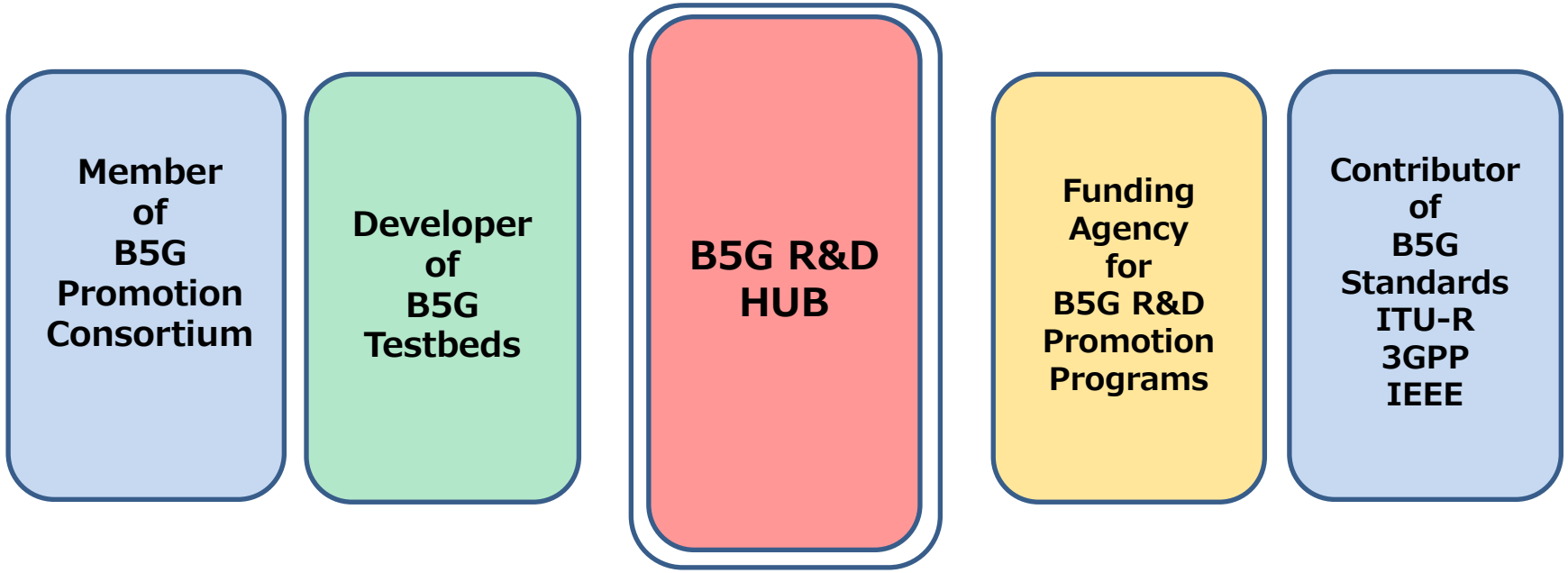
New ICT Strategies for the Beyond 5G Era

From the Information and Communications Council, ICT Strategy Council



NICT's Role for B5G/6G Development

- NICT is a R&D HUB for B5G/6G Development in Japan
- NICT offers B5G Testbeds for Developers
- NICT serves as a Funding Agency of B5G R&D Promotion Programs
- NICT is a member of B5G Promotion Consortium
- NICT is a contributor of B5G Standards (ITU-R, 3GPP, etc)



Beyond 5G R&D Promotion Programs (FY2020 - 2022)

NICT R&D Laboratories

B5G R&D Projects

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Beyond 5G R&D Promotion Programs
FY2020-FY2022: Call 1(2020/2021)、Call2(2022) 、Call3(2022)、…

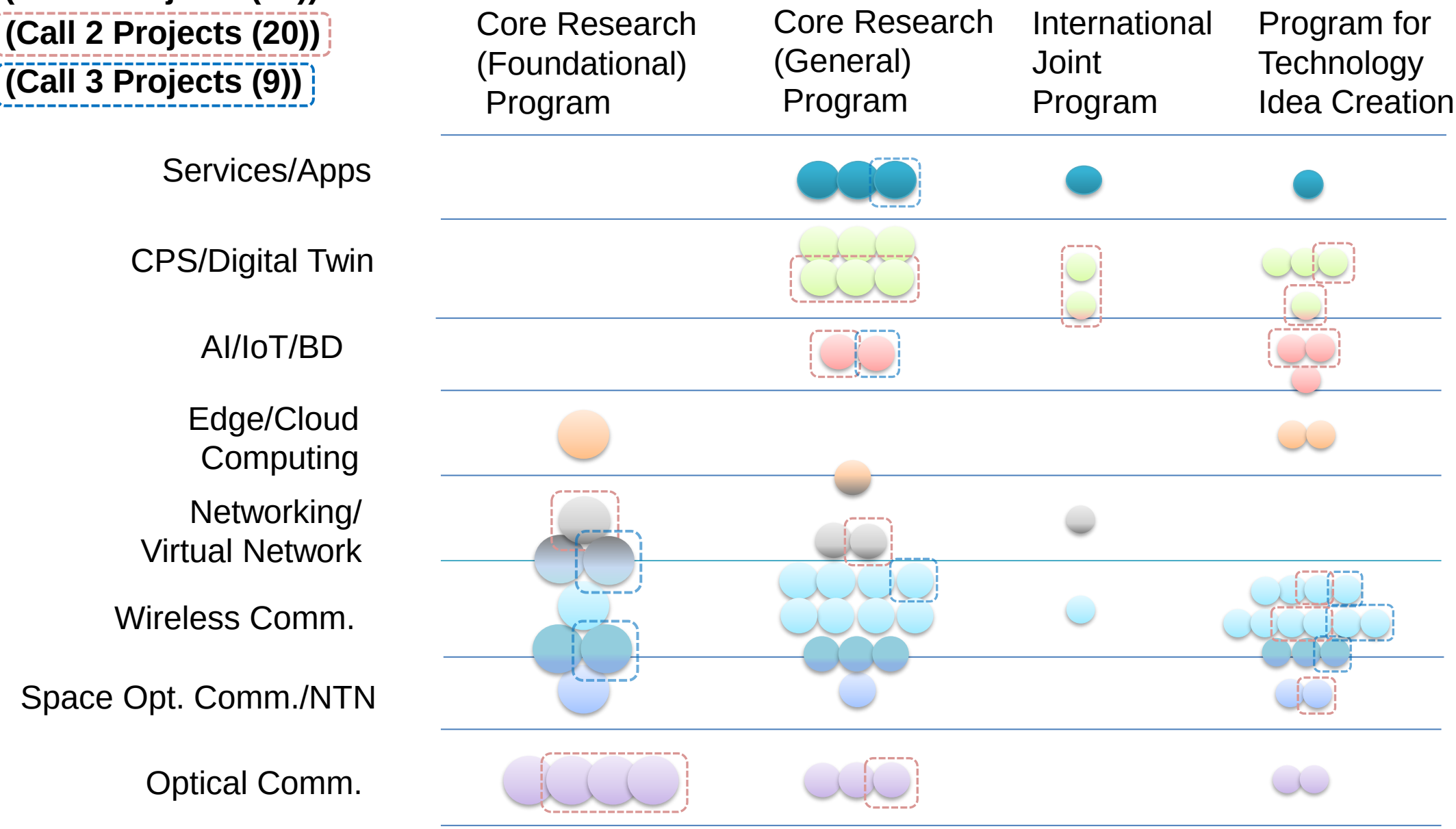
Core Research (Foundational) Program※	Core Research (General) Program	International Joint Program	Program for Technology Idea Creation
6 projects (2020/2021) **4** projects (2022) **2** projects (2022) Budget：0.5B～x.0Byen/year R&D Period: 3-5 years	**20** projects (2021) **6** projects (2022) **3** projects (2022) 0.3B～0.5Byen/year 3-5 years	**3** projects (2021) **2** projects (2022) 50M～100M yen/year 2-3 years	**15** projects (2021) **8** projects (2022) **4** projects (2022) 50M～100Myen/year 2-3 years

(as of Jan. 2023)

※NICT gives detailed research plans with specific development goals for the public invitation

Beyond 5G R&D Promotion Programs (FY2020 - 2022)
Call 1,2,3 Portfolio (as of Jan. 2023)

(Call 1 Projects (44))
(Call 2 Projects (20))
(Call 3 Projects (9))



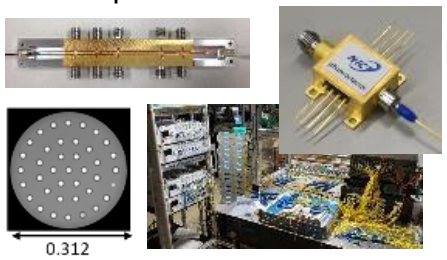
B5G R&D Testbed & Platform

■ Extend and improve testbed environment to accelerate B5G development

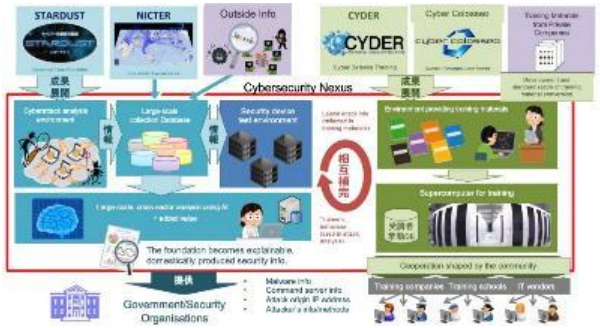
- **Beyond 5G/6G Transmission Infrastructure Technology Development Environment**
- **Ultra-high-speed optical communication technology development facilities supporting Beyond 5G / 6G**
- **Highly reliable and highly plastic Beyond 5G / 6G-IoT test bed**

Terahertz Testbed

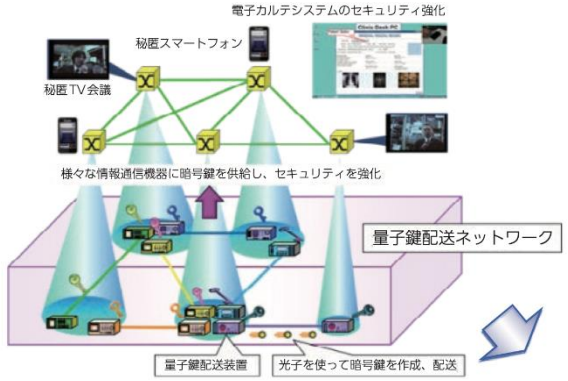
Ultra High Volume Optical Network



Cybersecurity Nexus



QKD Network



Optical Comm. Testbed

Socially Intelligent Communication

Simultaneous interpretation

Neuroscience and Brain Technology

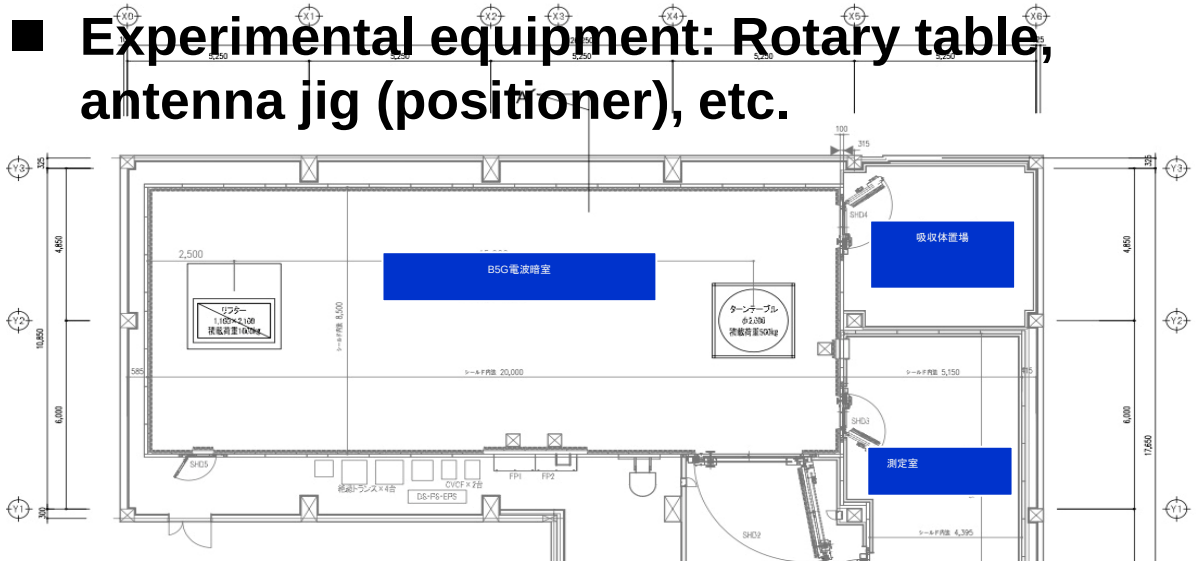
Terahertz-band anechoic chamber and measurement facilities

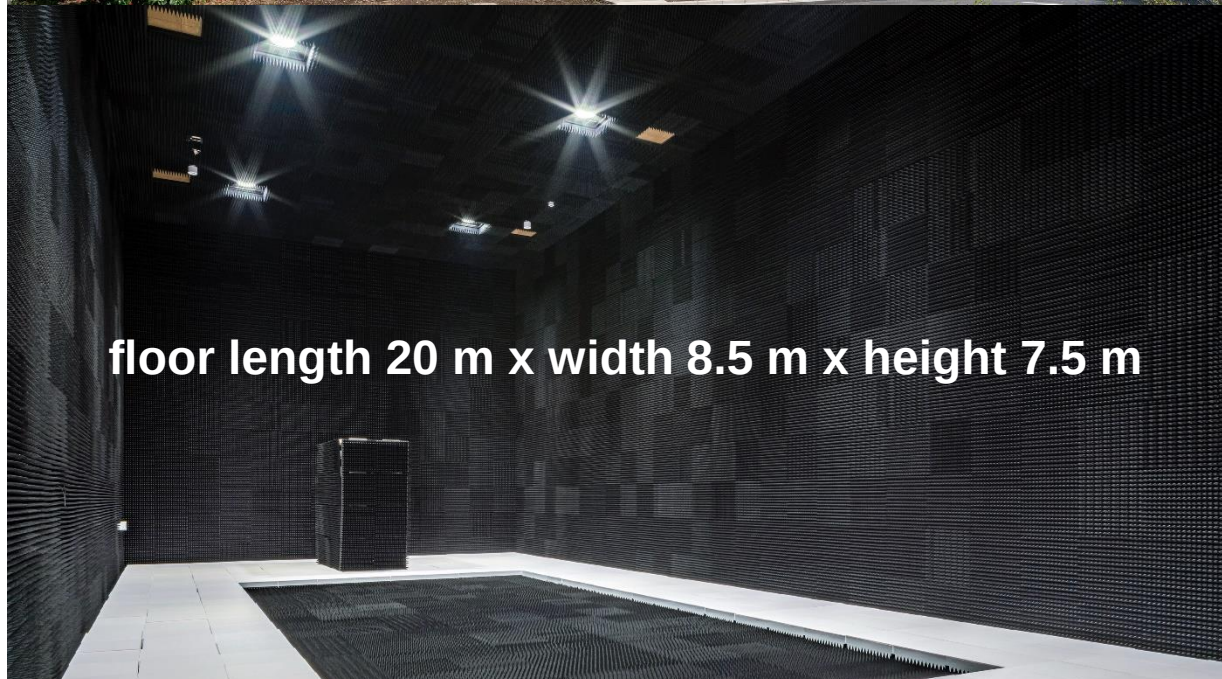
Outline

- Developed by Beyond 5G R&D Promotion Program
- In service from June 2023
- Building, Chamber, and Measurement facilities

Specification

- 6-sided anechoic chamber with absorbers on all six interior surfaces
- Target frequency: 10 GHz to 500 GHz
- Experimental equipment: Rotary table, antenna jig (positioner), etc.

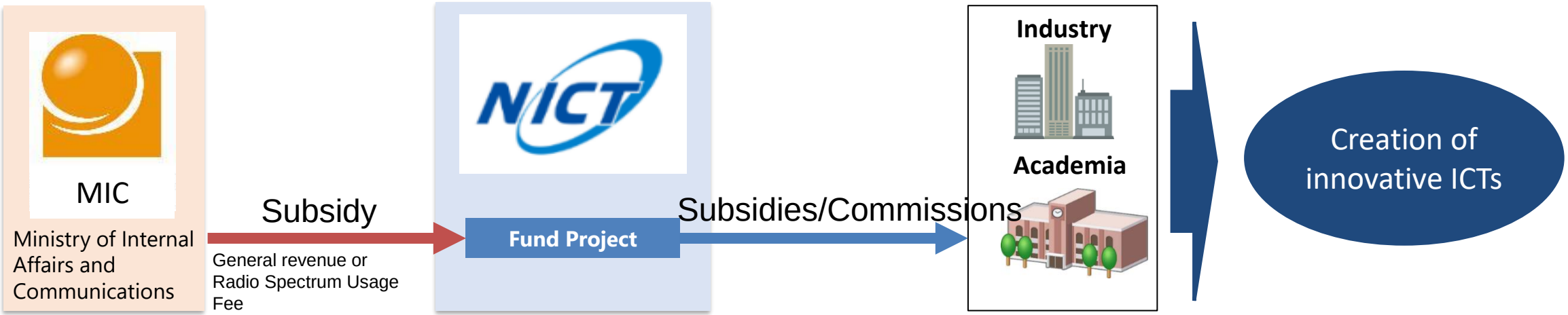




Innovative Information and Communication Technologies (Beyond 5G (6G)) Fund Project (From FY2023 -)

- With regard to the next generation of information and communications infrastructure, Beyond 5G (6G), which is expected to be introduced in the 2030s, we aim to develop technologies that originate in Japan, implement them in society, and deploy them overseas in order to strengthen our international competitiveness and ensure our economic security.
- NICT will establish a permanent fund to promote research and development of innovative information and communication technologies and support research and development by private companies and universities on key technologies for Beyond 5G (6G).

※The Radio Spectrum Usage Fee Fund budget is used to research and develop technologies that contribute to the efficient use of radio waves.



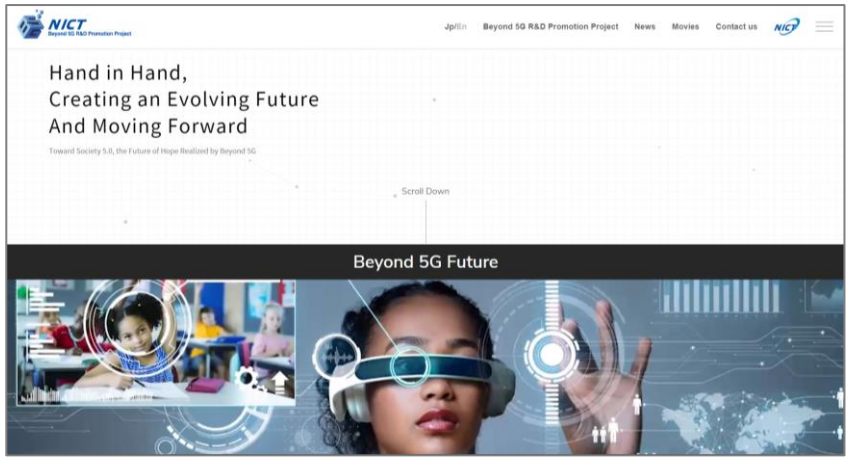
- **Supplementary budget for FY2022: 66.2 billion yen (approx. 415M€ @€/¥=160) (including 3.5 billion yen from spectrum usage fees)**
- **Initial budget for FY2023: 15.0 billion yen (spectrum usage fees) (approx. 94M€ @€/¥=160)**

Beyond 5G R&D Project Portal Site

Portal site

- Published in March 2022. Project related information is posted as a portal site. We are providing notifications of new R&D recruitment and summaries of adopted R&D projects.
- English content is gradually expanded.

https://b5g-rd.nict.go.jp/en/



Brochure

Includes an overview and testbed overview.

https://b5g-rd.nict.go.jp/en/B5G_pamphlet_en_202204.pdf

Program details (In Japanese only)

Information about each project, Program, and other.

https://www.nict.go.jp/collabo/commission/B5Gsokushin.html

Beyond 5G R&D (Self Researches)

NICT R&D Laboratories

B5G R&D Projects

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Beyond 5G R&D Promotion Programs

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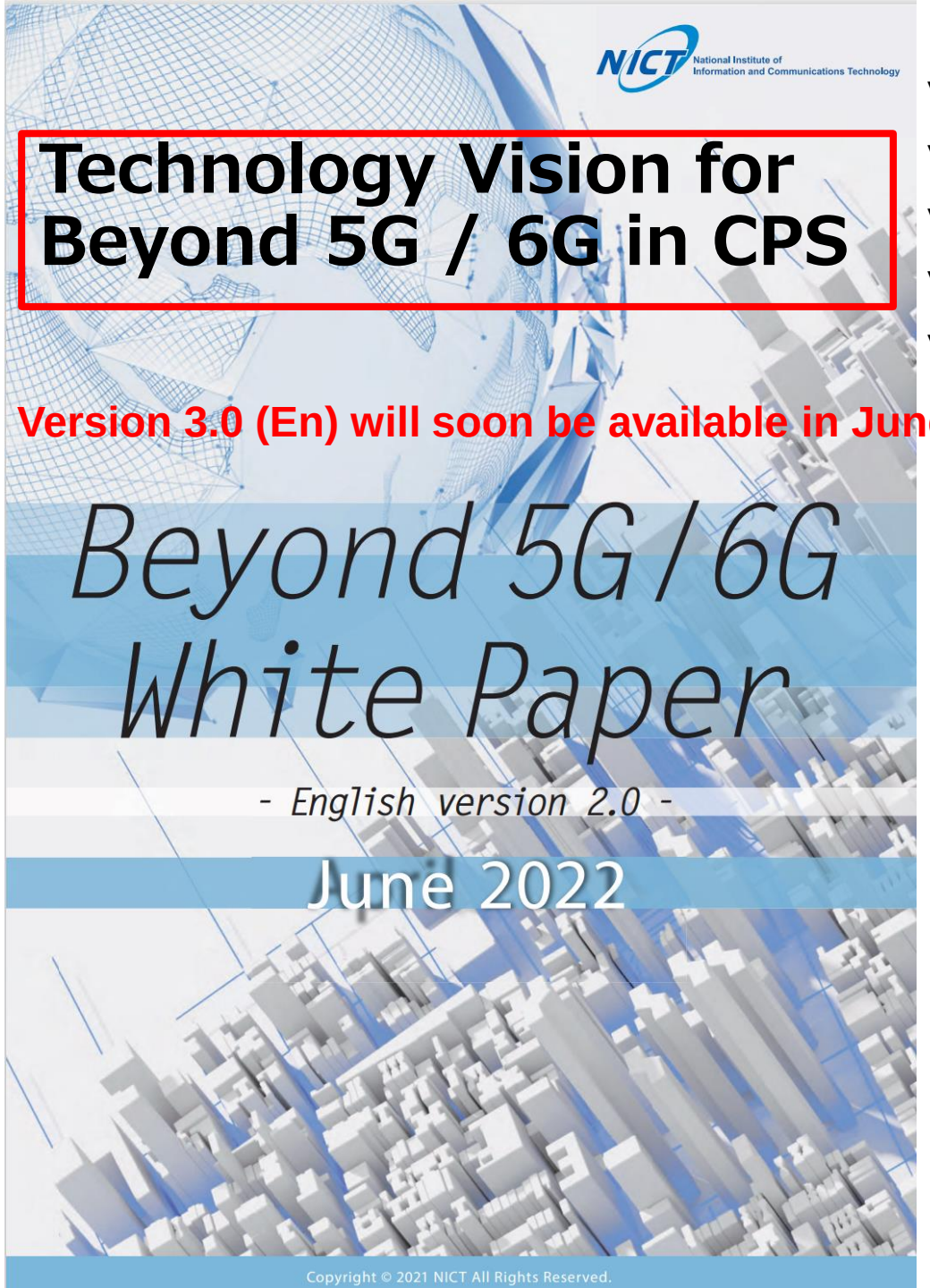
(as of Jan. 2023)

※NICT gives detailed research plans with specific development goals for the public invitation



■ We created five scenarios,

V1.0 [Scenario 1] **Cybernetic Avatar Society**,

V1.0 [Scenario 2] **City on the Moon**,

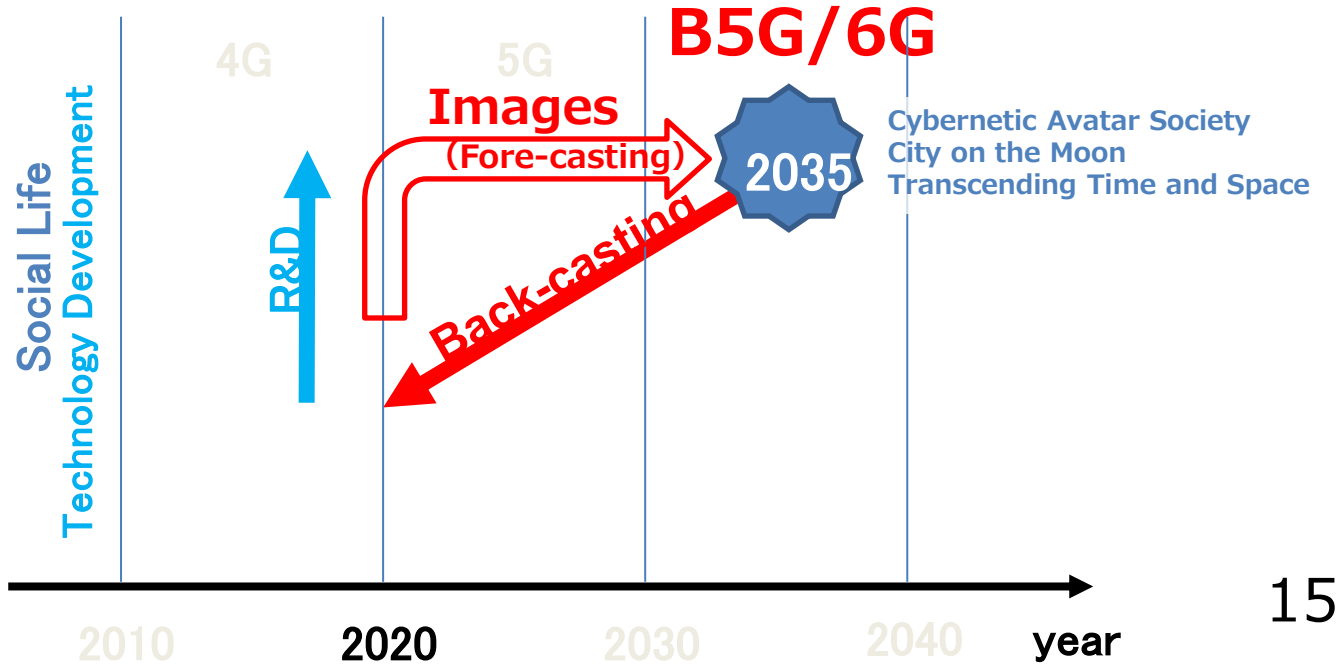
V1.0 [Scenario 3] **Transcending Time and Space** and

V2.0 [Scenario 4] **Light and Shadow of the Cyber World**

V3.0 [Special Scenario 1] **My new life in Apple Town**,

which are images of social life around 2035 and identified the necessary key technologies by back casting from the future society described in these scenarios.

■ The white paper shows the scenarios, the use cases that appear in the scenarios, the key technologies and requirements to realize them, the R&D roadmap, and the deployment strategy.



Some videos of Beyond 5G /6G scenarios

Scenarios 1 to 3 are available on YouTube “NICTchannel”.

YouTube “NICT channel”

- **Scenario 1 :** https://youtu.be/b467RRHaYMQ
- **Scenario 2 :** https://youtu.be/DekDHTdJwjI
- **Scenario 3 :** https://youtu.be/hw6o1HlAOGU

Key Technologies for Beyond 5G / 6G

T1.	Ultra-high-speed and high-capacity wireless communication	
	T1.1	Terahertz wave
	T1.2	All-optical network (high-capacity optical fiber communication)
	T1.3	All-optical network (optical and radio convergence technology)
T2.	Ultra-low latency and ultra-multi-source connection	
	T2.1	Edge computing technology
	T2.2	Adaptive wireless network construction technology
	T2.3	Adaptive wireless network application technology
	T2.4	Autonomous localization, tracking and reservation technologies for radio wave radiation space
	T2.5	Autonomous M2M network construction technology with super multi-connection
T3.	Wired and wireless communication and network control technology	
	T3.1	Network control technology (Zero-touch automation)
	T3.2	Frequency allocation and sharing management
	T3.3	Private wireless system management (Local Beyond 5G)
	T3.4	Advanced wireless emulator
T4.	Multi-Layer wireless systems - NTN	
	T4.1	Satellite and non-terrestrial communication platform
	T4.2	Optical satellite communication
	T4.3	Maritime communication
	T4.4	Underwater and submarine communication
	T4.5	Cooperative control of multi-layered networks

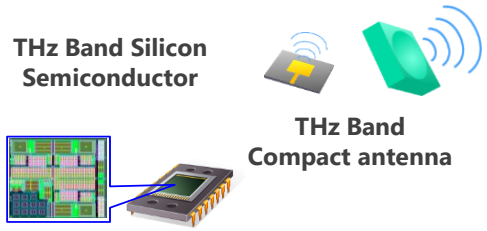
T5.	Space-time synchronization	
	T5.1	Wireless Space-Time Synchronization
	T5.2	Chip-Scale Atomic Clock
	T5.3	Generation and sharing technology for reference time
T6.	Ultra-security and reliability	
	T6.1	Emerging security technology
	T6.2	Cyber security technology based on real attack data
	T6.3	Quantum cryptography
	T6.4	Electromagnetic environmental technology
	T6.5	Resilient ICT
	T6.6	Sensing
T7.	Ultra-realistic and Innovative Applications	
	T7.1	Brain information reading, visualization, and BMI technology
	T7.2	Intuition measurement, transmission and assurance technologies
	T7.3	Real 3D avatars, multisensory communication and XR technology
	T7.4	AI analytics and dialogue technology using language and extra-linguistic information
	T7.5	Edge AI behavioral support
	T7.6	Simultaneous multi-lingual interpretation, paraphrase and summarization technology
	T7.7	Automated driving
	T7.8	Drones

- **The key technologies are extracted and categorized from the use cases.**
- **Beyond 5G/6G Services are created with proper combination of the technologies.**

Technologies for Beyond 5G / 6G

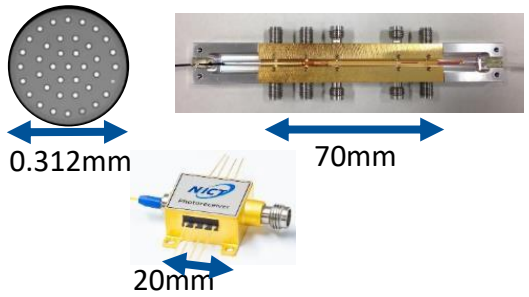
Terahertz Wireless Comm.

Increasing the capacity of wireless communications



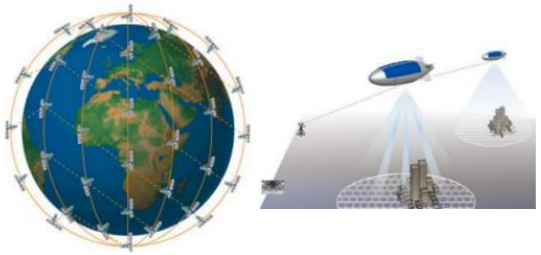
Multi-Core, Multi-Mode Fiber

Increasing the capacity of the core network
Multi-core fiber, multi-mode fiber, etc.



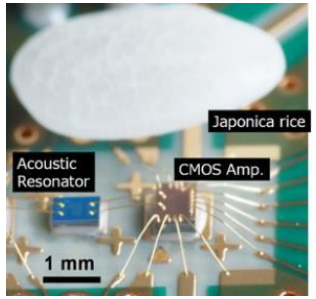
NTN: Coverage expansion

Satellite constellations, HAPS, etc.



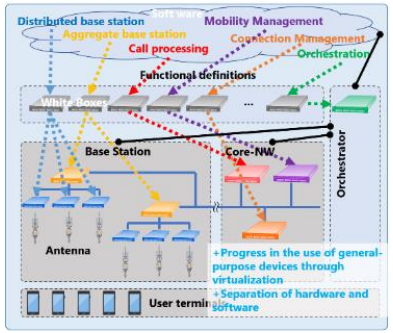
Space-time synchronization

+Inter terminal coordination
+Non-GPS positioning system
+Remote synchronization



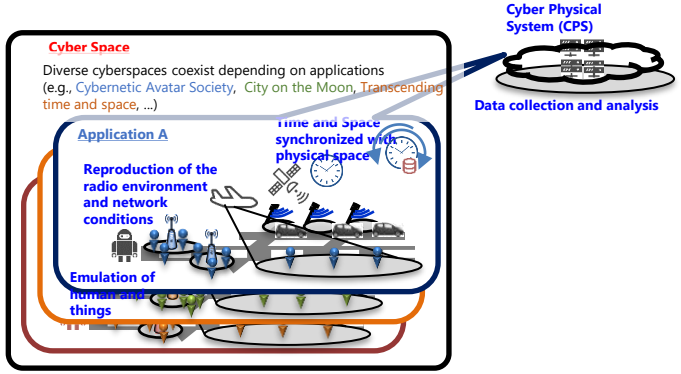
Virtualization

+Cloud native
+Highly available resource allocation
+Network Control with AI
+Autonomic networks



Network slicing

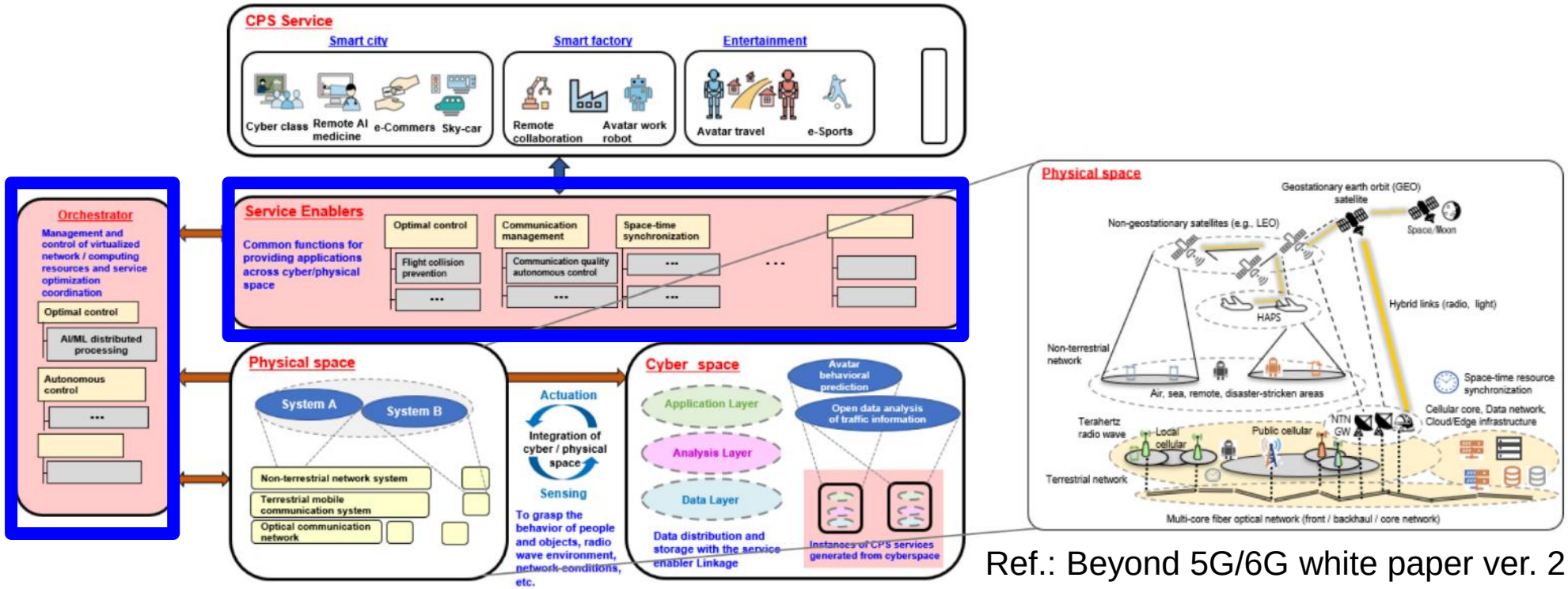
Network functions and resources can be dynamically managed and flexibly selected.



Concept of Beyond 5G / 6G Architecture for Open Service Platform

Key functions of Beyond 5G / 6G platform

- The platform should accommodate various sub-systems
- The platform should be open, where the sub-systems are coordinated for optimal combination.
- Architecture of the Beyond 5G /6G platform needs to be discussed on a cross-industry basis.



Ref.: Beyond 5G/6G white paper ver. 2, NICT, Mar. 2022.

Key functions

- **X-industry Orchestrator** discovers adequate combinations of the sub-systems and federates them to satisfy the requirements from services.
- **Service enabler** interacts with the services and the orchestrator to hide the complexity of the CPS.

Thank you for your attention!

NICT
Beyond 5G R&D Promotion Unit

Some of the web-links

- **NICT (English)** — NICT - National Institute of Information and Communications Technology
- **NICT Channel** — NICT channel - YouTube
- **Beyond 5G R&D Promotion Unit** — TOP - Beyond 5G/NICT
- **Beyond 5G / 6G White Paper** — B5G White Paper - Beyond 5G/NICT
- **Beyond 5G R&D Promotion Program** — Beyond 5G R&D Promotion Project (nict.go.jp)