

# Metaverse application and standardization with autonomous mobile robots, bi-directional CDN and autonomous network

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(\* ) The research results were obtained from the commissioned research [No.01701] by National Institute of Information and Communication Technology (NICT), JAPAN."

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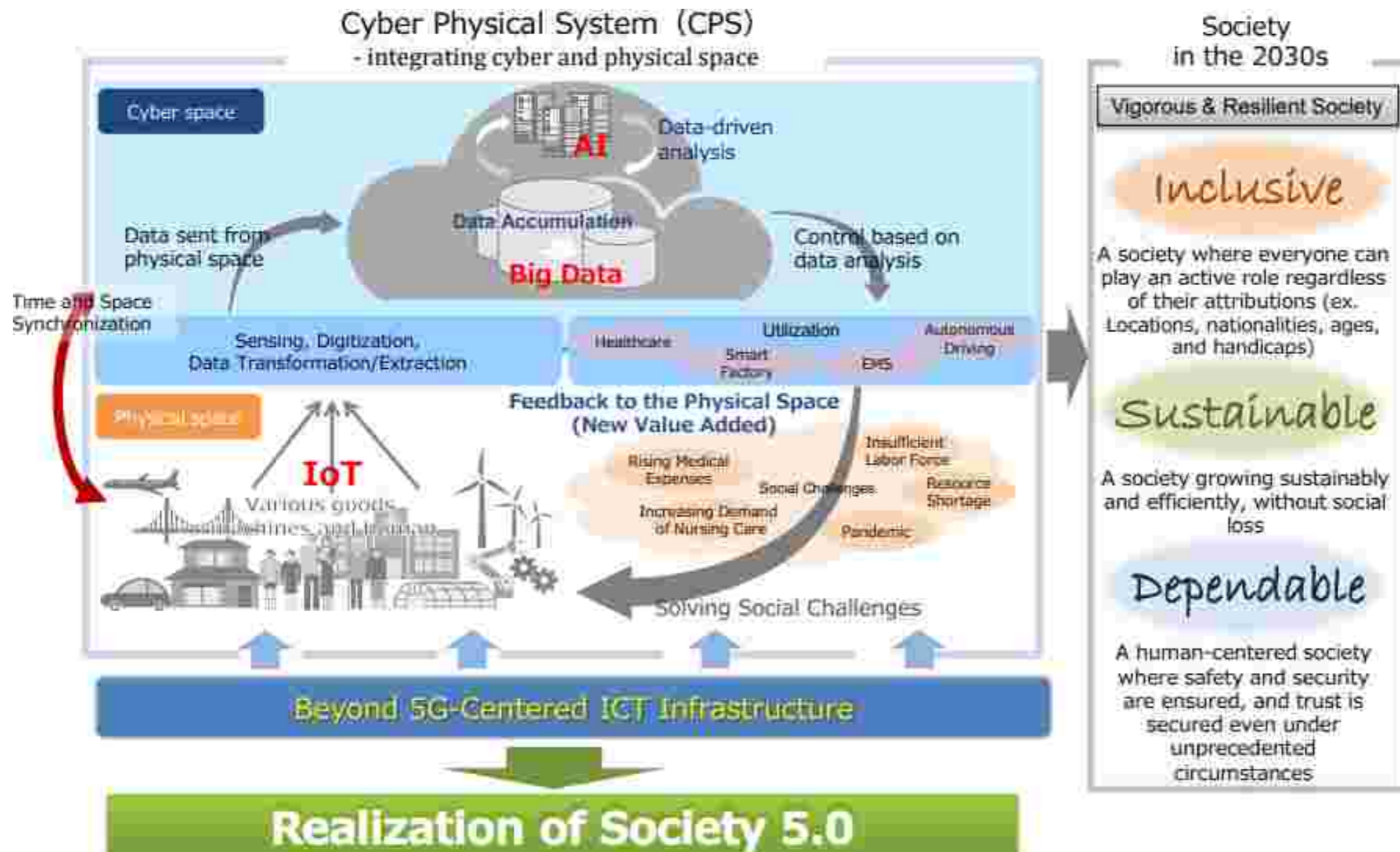
## ■ Metaverse application with autonomous mobile robots, bi-directional CDN and autonomous network

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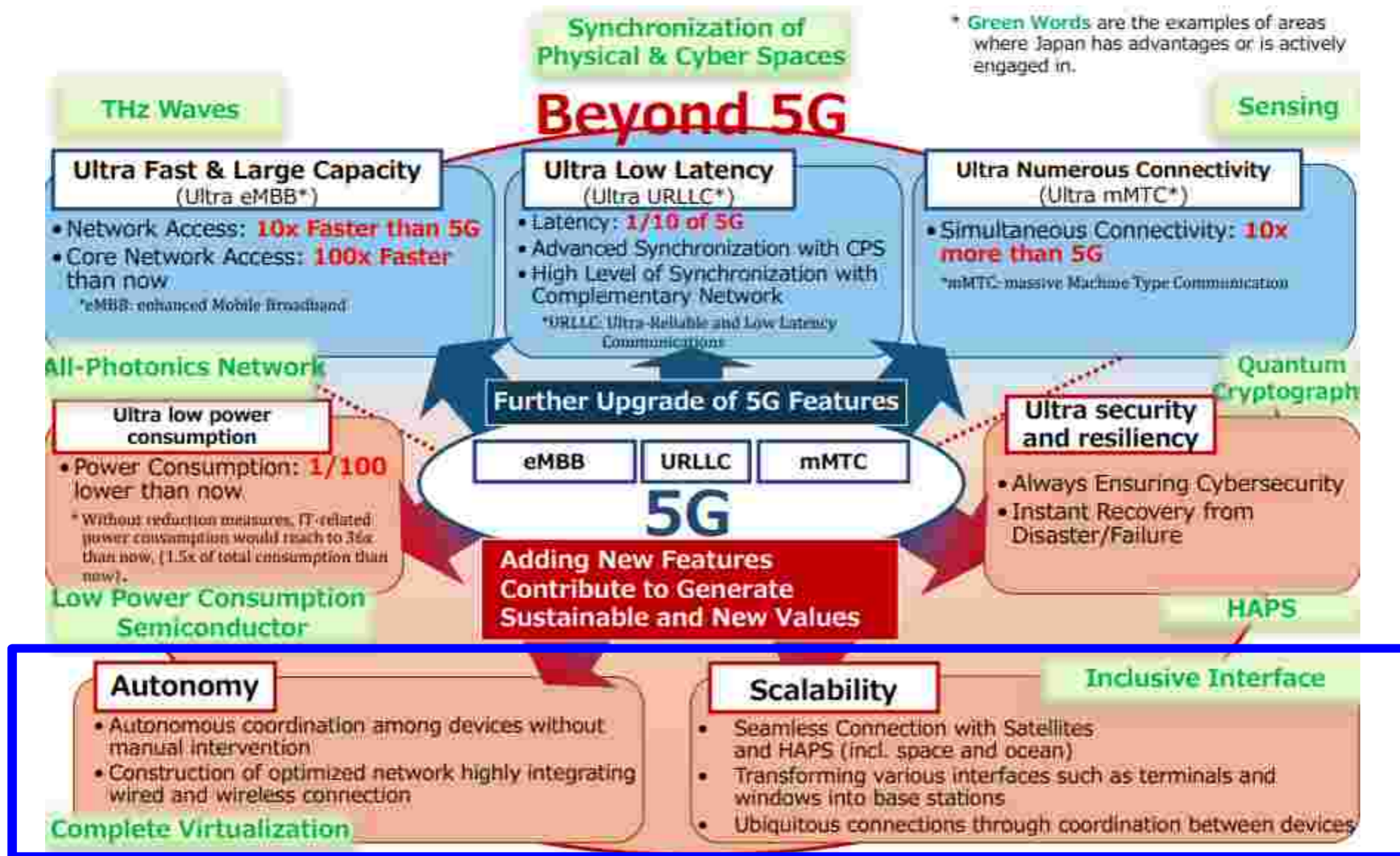
## ■ Digital twin collaboration

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# Society in the 2030s



# Key features for Beyond 5G

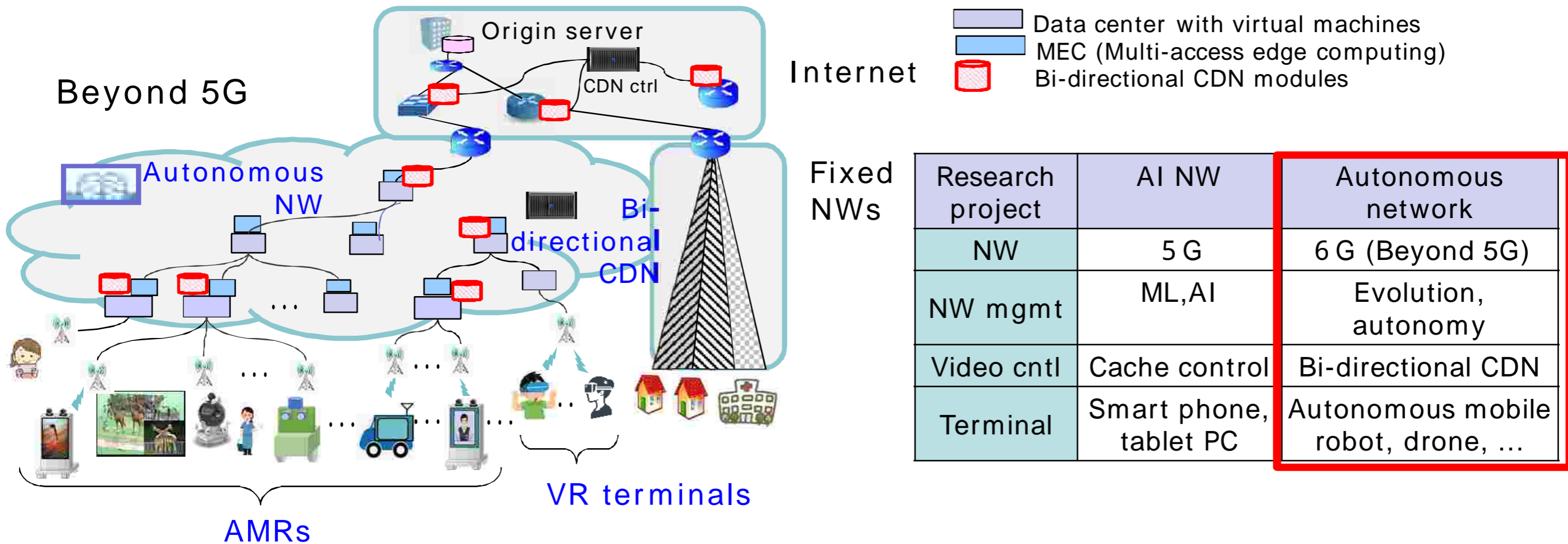




- Metaverse application with autonomous mobile robots, bi-directional CDN and autonomous network
- = Coordinated Autonomous Network (AN)  
for Beyond5G

# Overall architecture for coordinated autonomous network

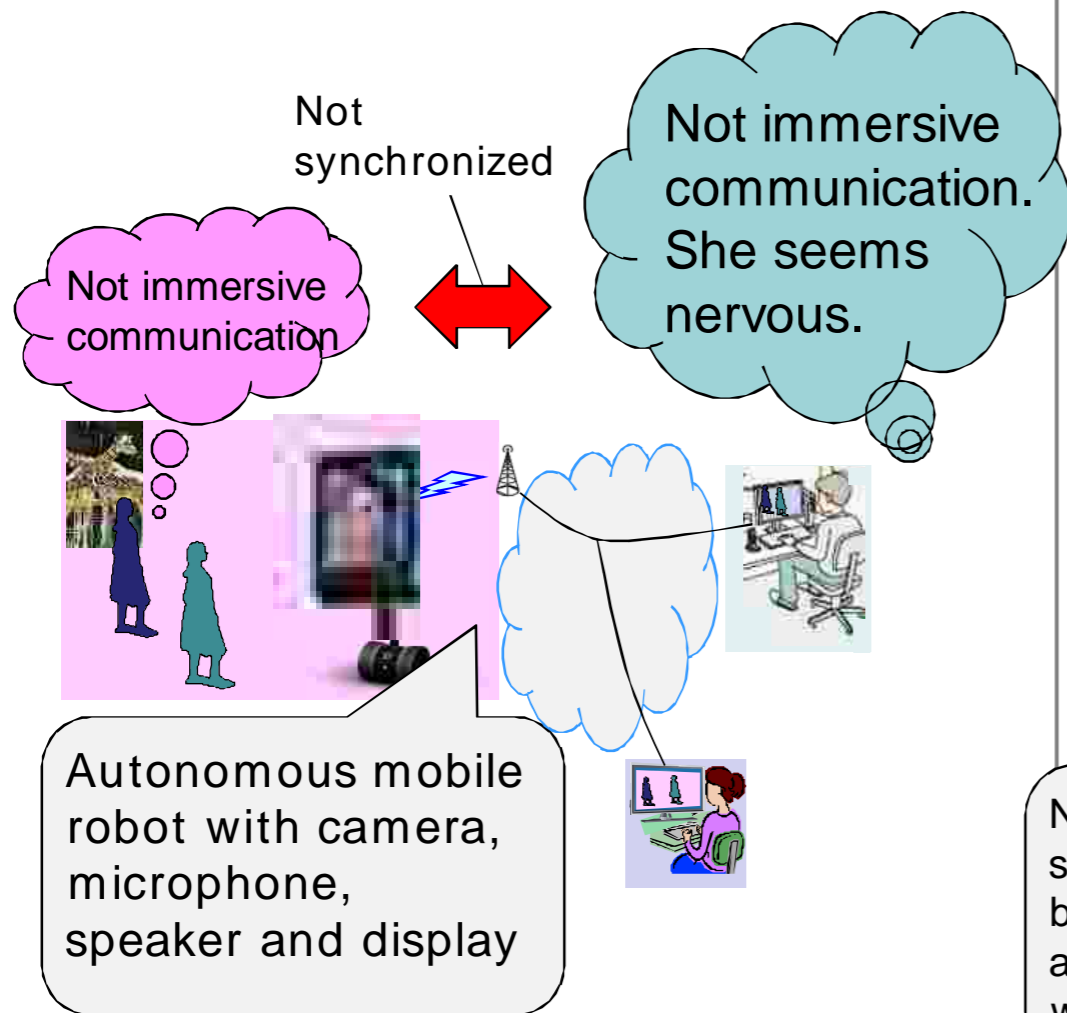
- Co-ordinated AN is necessary to satisfy the future huge and complicated requests from new emerging services in B5G era.
- Coordination between autonomous network (NW provider) and bi-directional CDN (Service provider) is important.



# New service over coordinated AN including metaverse

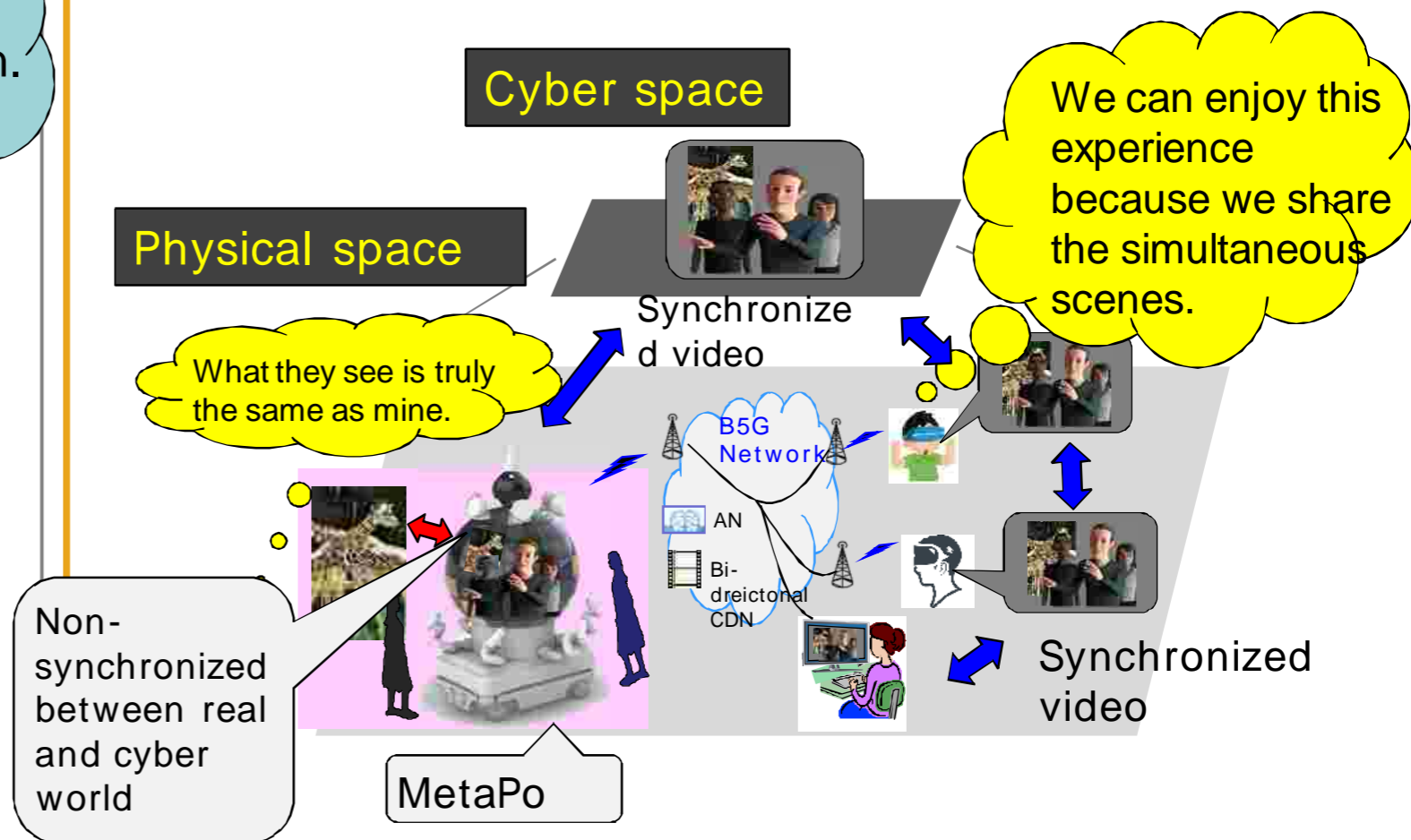
## Now

- ◆ Not immersive communication



## Future

- ◆ Participants in one party can enjoy one virtual space.
- ◆ **Coordinated AN provides functions to share the simultaneous scenes to all remote participants.**
- ◆ Multiple video sources are available in one party.



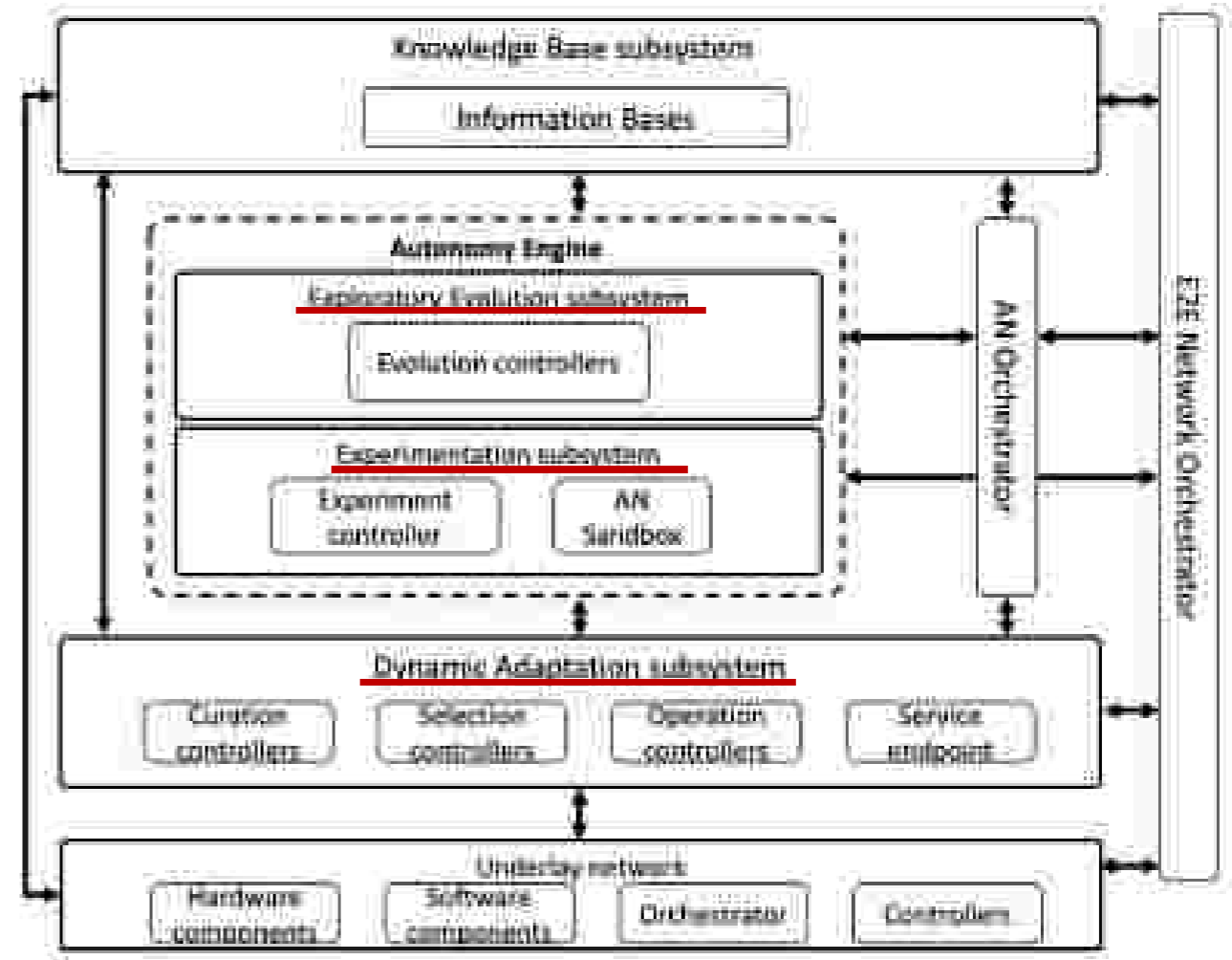
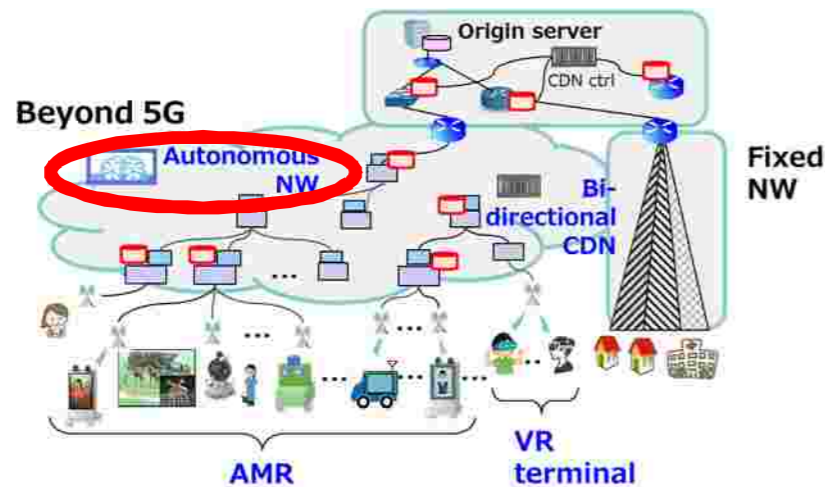
# New service over coordinated AN including metaverse





# Autonomous network architecture[\*]

- High-Level Framework for Autonomous Network was discussed in ITU-T FG-AN based on our research group member contributions.
- The goal of this architecture is to support
  - ✿ the continuous evolutionary-driven creation,
  - ✿ validation,
  - ✿ and adaptation
 of a sea of closed-loop controllers to a network and its services
- The network and its services may become autonomous.



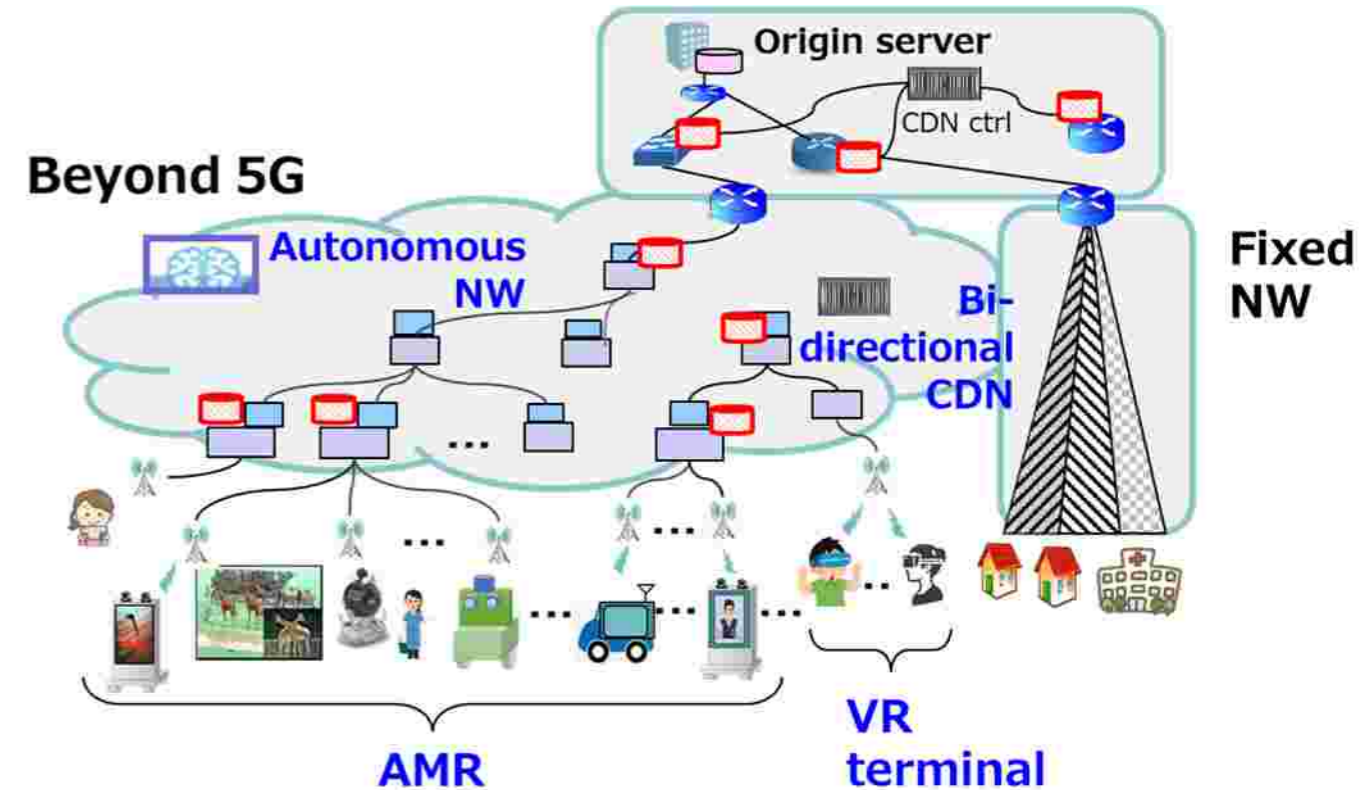
[\*] ITU-T Technical specification Architecture framework for Autonomous Network, <https://www.itu.int/en/ITU-T/focusgroups/an/Documents/Architecture-AN.pdf>

# Bi-directional CDN(\*)

- It communicates with AN and compensate AN limit by application layer information
- It will store contents not only from origin in Internet but also from video in AMR.
- It provides short cut path to B5G mobile network users and provide synchronized communication even over heterogeneous networks

## Bi-directional CDN

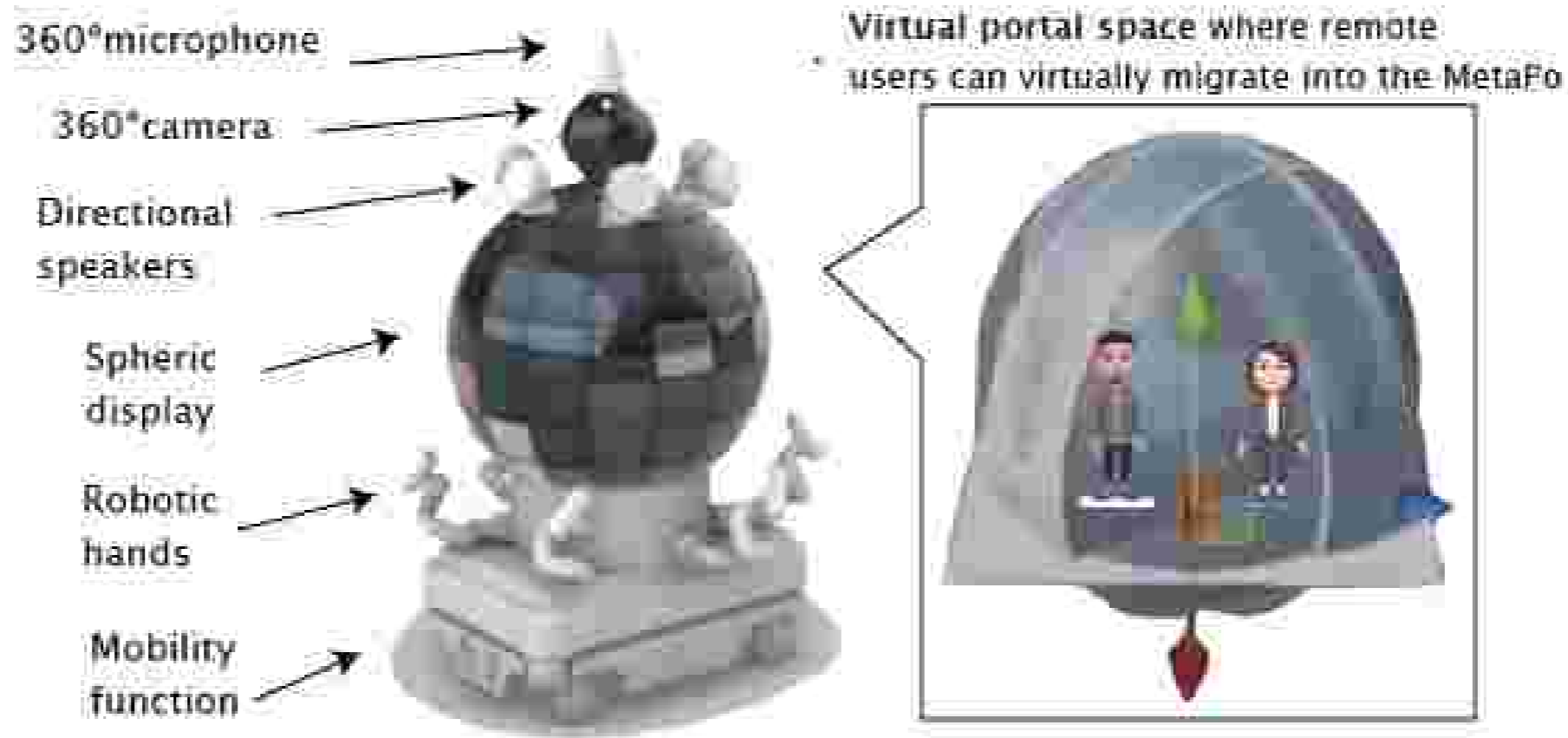
- = Videoo service platform in B5G era
- = Cache server control,  
+ delay management for synchronized comm.  
+ video transcoding for old terminals,  
+ AN communication..



(\*) Hideki Yamamoto, et.al., "Study on enabling video services with the use of an autonomous mobility robot connected to an autonomous network", IEICE Technical Report IN2022-32(2022-09) (in Japanese)

# Autonomous mobile robot as Metaverse terminal: MetaPo(\*)

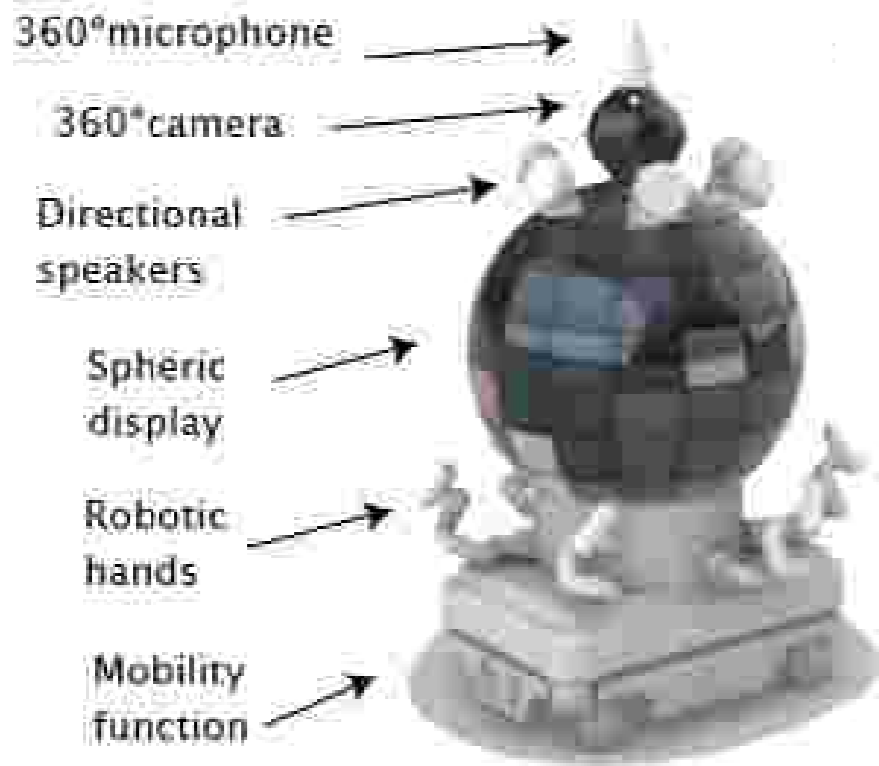
- MetaPo is a portal that connects distributed physical and cyber spaces.
- Four-wheel, 360 ° camera, spherical display, microphone, directional speakers, and magic hands.
- Virtual portal space for remote users to virtually migrate into the MetaPo.



(\*) Takuro Yonezawa, Nozomi Hayashida, Johanners Przybilla, Yutaro Kyono, Kenta Urano, and Nobuo Kawaguchi: "MetaPo: A Robotic Meta Portal for Interspace Communication", SIGGRAPH '22 Posters.(2022)

# MetaPo: A Robotic Meta Portal for Interspace Communication (\*)

- MetaPo is designed to work as a portal that connects distributed physical and cyber spaces



(\*) Takuro Yonezawa, Nozomi Hayashida, Johanners Przybilla, Yutaro Kyono, Kenta Urano, and Nobuo Kawaguchi: "MetaPo: A Robotic Meta Portal for Interspace Communication", SIGGRAPH '22 Posters.(2022)

# Autonomous mobile robot as Metaverse terminal MetaPo(\*)

- Mixed link and immersive link are provided by MetaPo.



- ◆ **Mixed Link** connects remote spaces by treating them as equal. Users in each space can communicate with users in another space using the panoramic audiovisual media
- ◆ **Immersive link** means that MetaPo platform provides additional "warp" mode.

(\*) Takuro Yonezawa, Nozomi Hayashida, Johanners Przybilla, Yutaro Kyono, Kenta Urano, and Nobuo Kawaguchi: "MetaPo: A Robotic Meta Portal for Interspace Communication", SIGGRAPH '22 Posters.(2022)

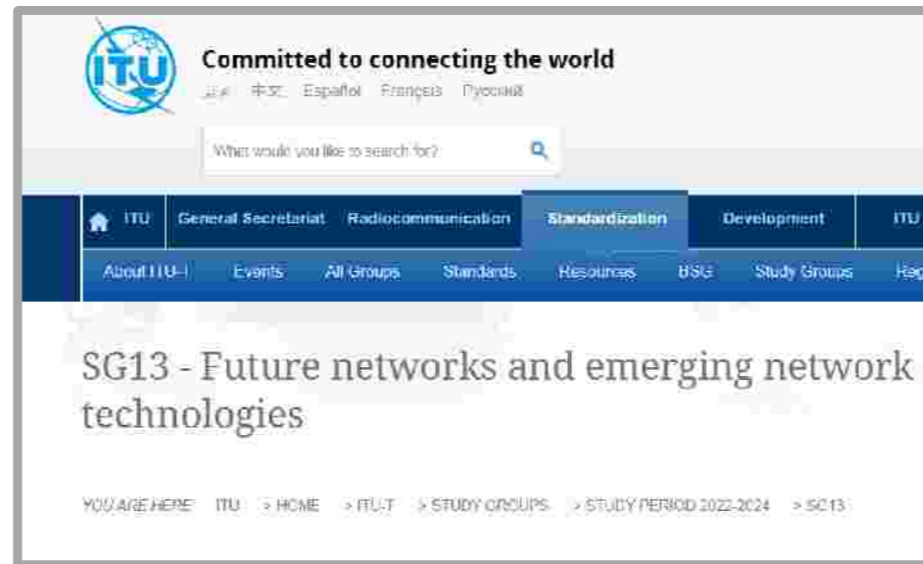
# Standardization from Coordinated autonomous network

- To implement the research output in the real world around 2030, we study what to standardize.
- We started to propose new work items in SG13, SG16 (\*) and ASTAP.
- Some coordinated autonomous network service will be metaverse use-cases.
- We plan to submit contributions if a standardization group (FG) will be established in ITU-T.

## AMR as Multimedia terminal



## Use case and architecture of AN



## Gap analysis to coordinated AN



## Metaverse standards

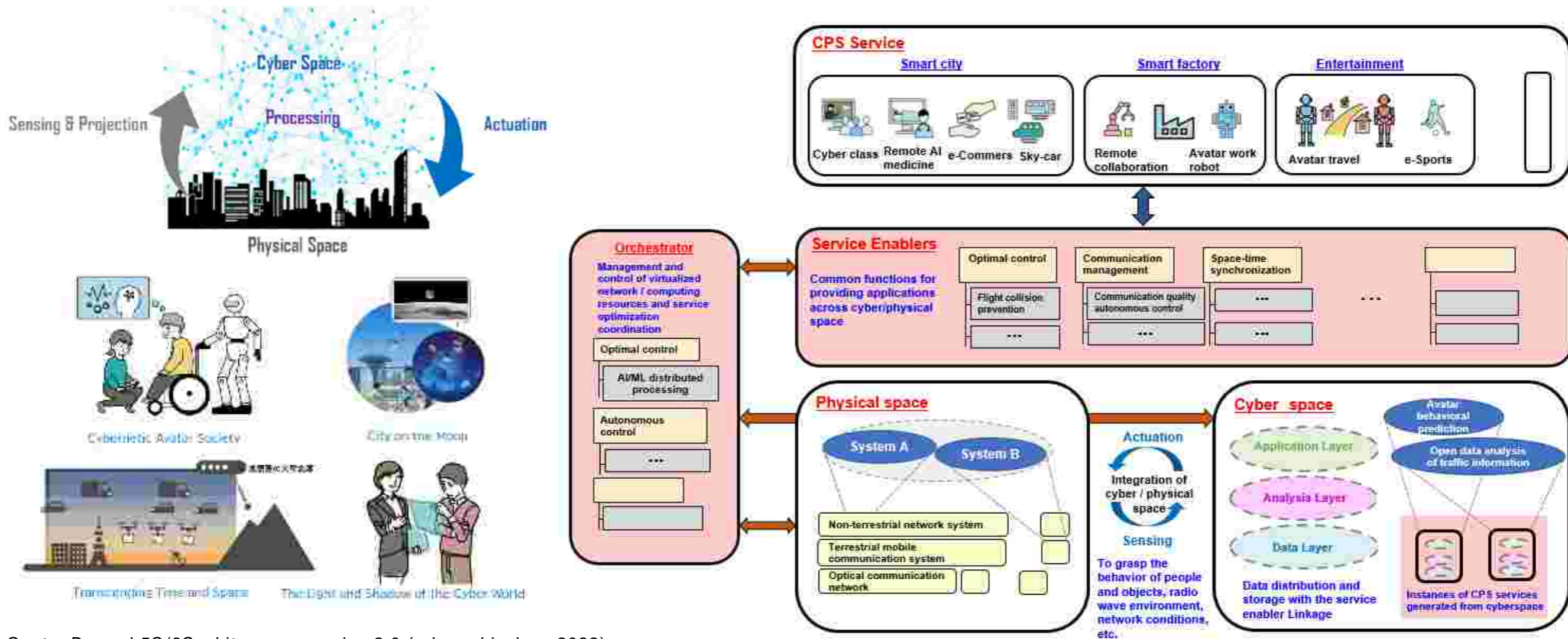
(\*) C-153 New: H.AMR-MM-REQ: Proposal of a new work item on "Requirements for multimedia functions for autonomous mobile robots connected with network" (Q27/16, Q26/16, Q21/16, Q13/16)



# ■ Digital twin collaboration

# Beyond 5G/6G Functional Architecture (NICT)

- CPS services utilize CPS through **Service Enablers**
- Each system/function in Physical Space and Cyber Space is mediated by **Orchestrator**

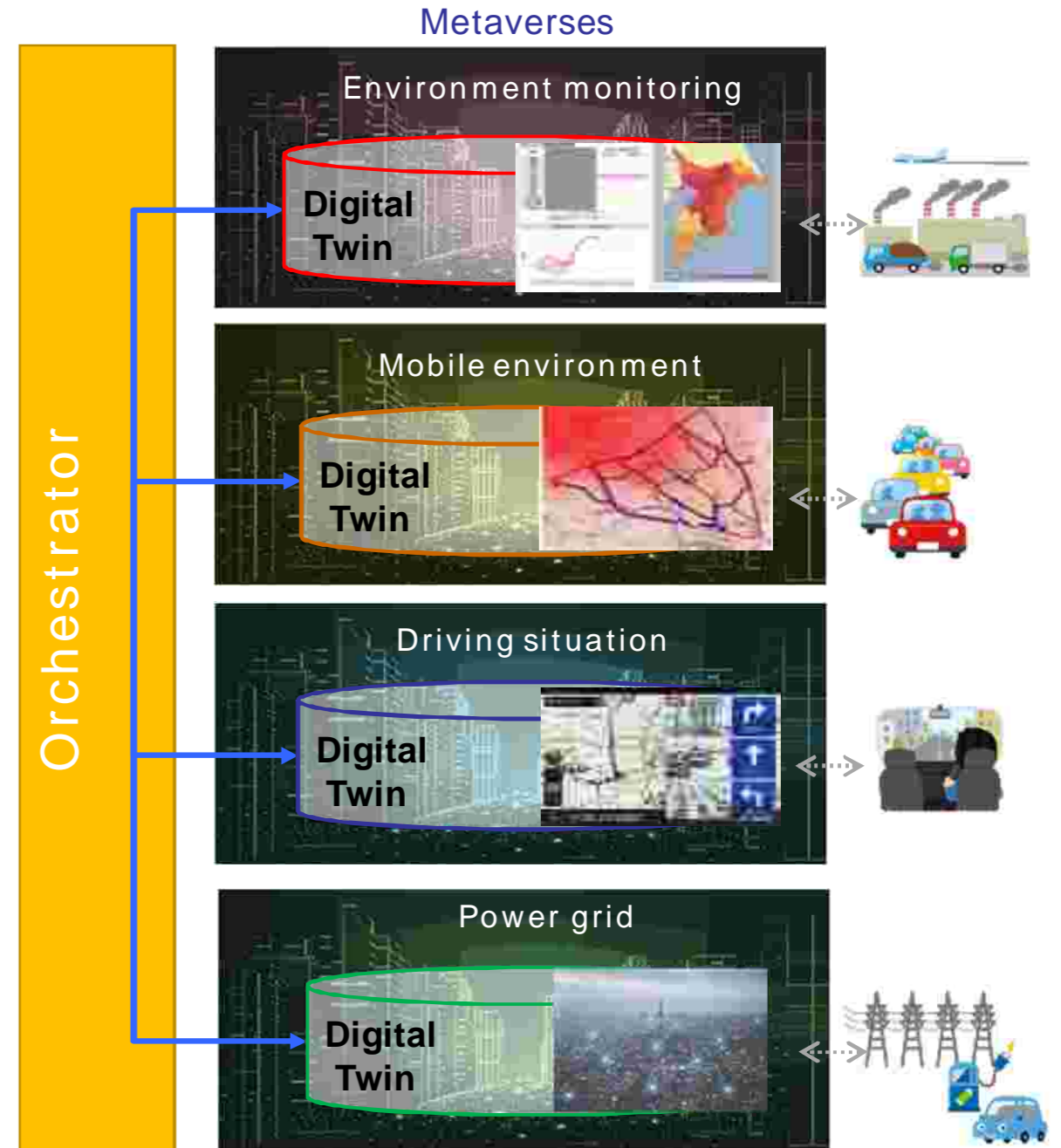
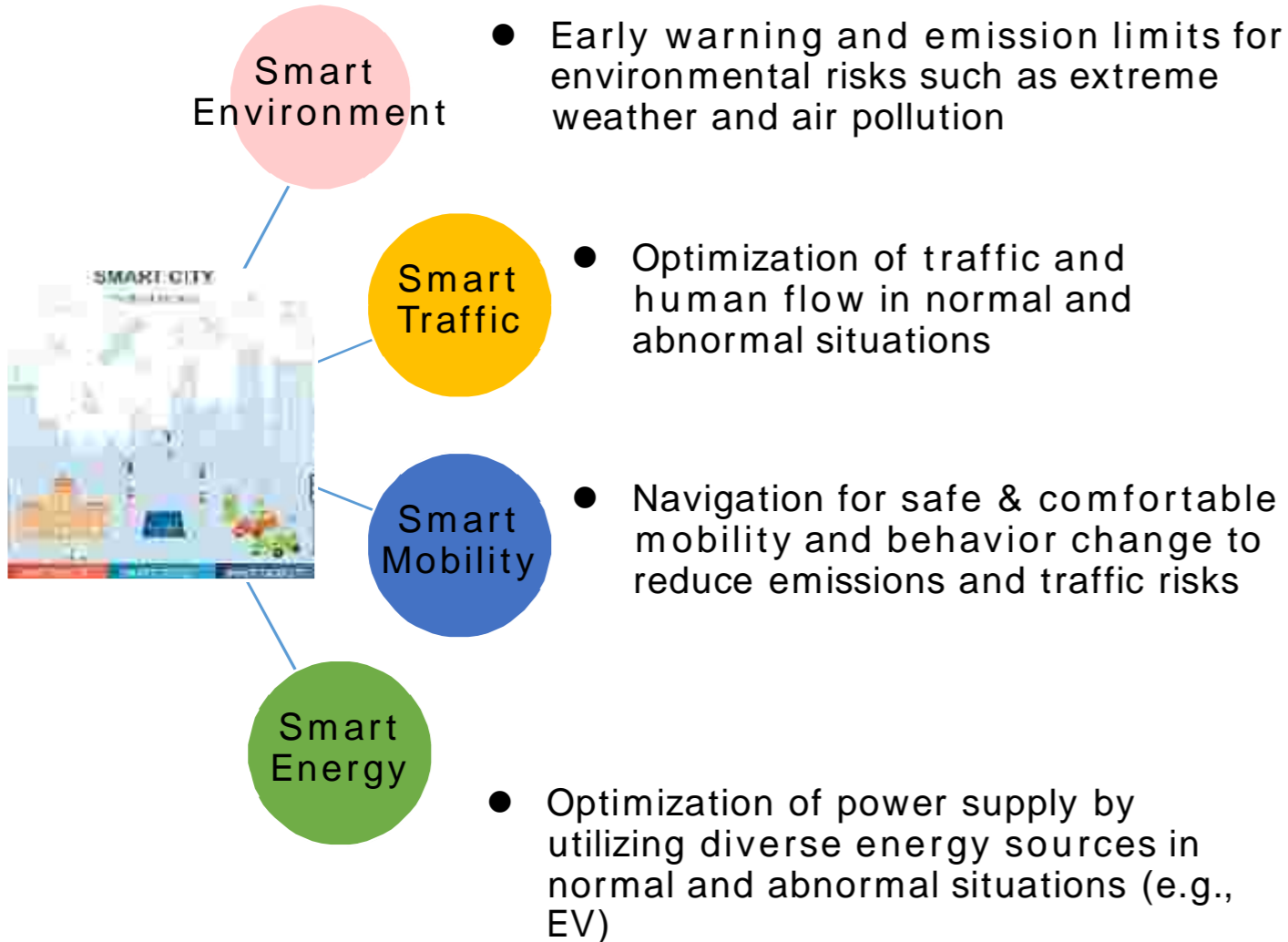


Quote: Beyond 5G/6G white paper version 2.0 (released in June 2022)  
[https://beyond5g.nict.go.jp/images/download/NICT\\_B5G6G\\_WhitePaperEN\\_v2\\_0.pdf](https://beyond5g.nict.go.jp/images/download/NICT_B5G6G_WhitePaperEN_v2_0.pdf)



# Digital Twin Collaboration: A Use Case

## ● Smart and Sustainable City



# Issues for Digital Twin Collaboration

- Orchestrator functions for digital twin collaboration
  - Synchronization: Synchronize the location, time and entities between digital twins
  - Brokering: Control message exchange between digital twins (delivery, latency, security, etc.)
  - Translation: Transform messages syntactically and semantically exchanged between digital twins
  - Federation: Transparently access to multiple autonomous digital twins thru a federated digital twin
- Information models, security, access protocols for interoperability among digital twins
- High-volume, low-latency, super-diverse inter-digital twin communication technology at the level of Beyond 5G/6G
- Ethical issues associated with digital twin interoperability
  - E.g.,) "Gemini Principles" of information management (National Digital Twin, UK)
    - Purpose: public goods, value creation, insight
    - Trust: security, openness, quality
    - Function: federation, curation, evolution

\*) [Bolton A, Enzer M, Schooling J et al. 'The Gemini Principles: Guiding values for the national digital twin and information management framework, Centre for Digital Built Britain \(2018\).](#)



# Thank you for your attention.

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