Working Group 3

Expanding frontiers through co-evolution of AI and robots

Chair: Prof. Toshio Fukuda, Sub-Chair: Hironori Kasahara Dr.Eng.

【The Moonshot「Area」「Vision」 for setting MS「Goals」candidate】

[Area]

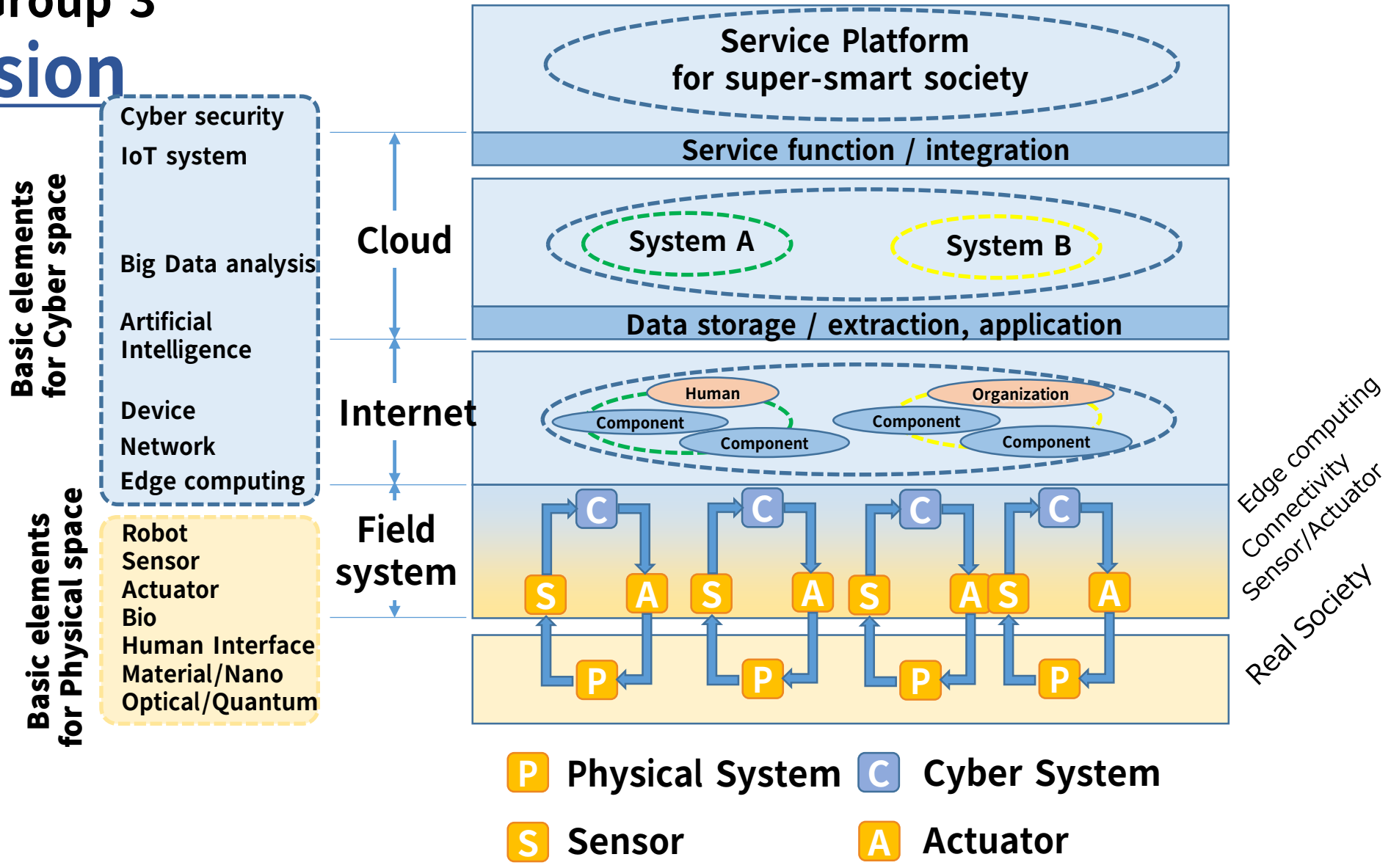
- Turning the aging society into the innovative and sustainable society by harnessing diversity through techno-social transformation
- Exploring frontiers with science and technology.

[Vision]

- Industrial transformation by complete automation
- Automation of Scientific Discovery (AI/Robotics)
- Permanent presence in space (space)

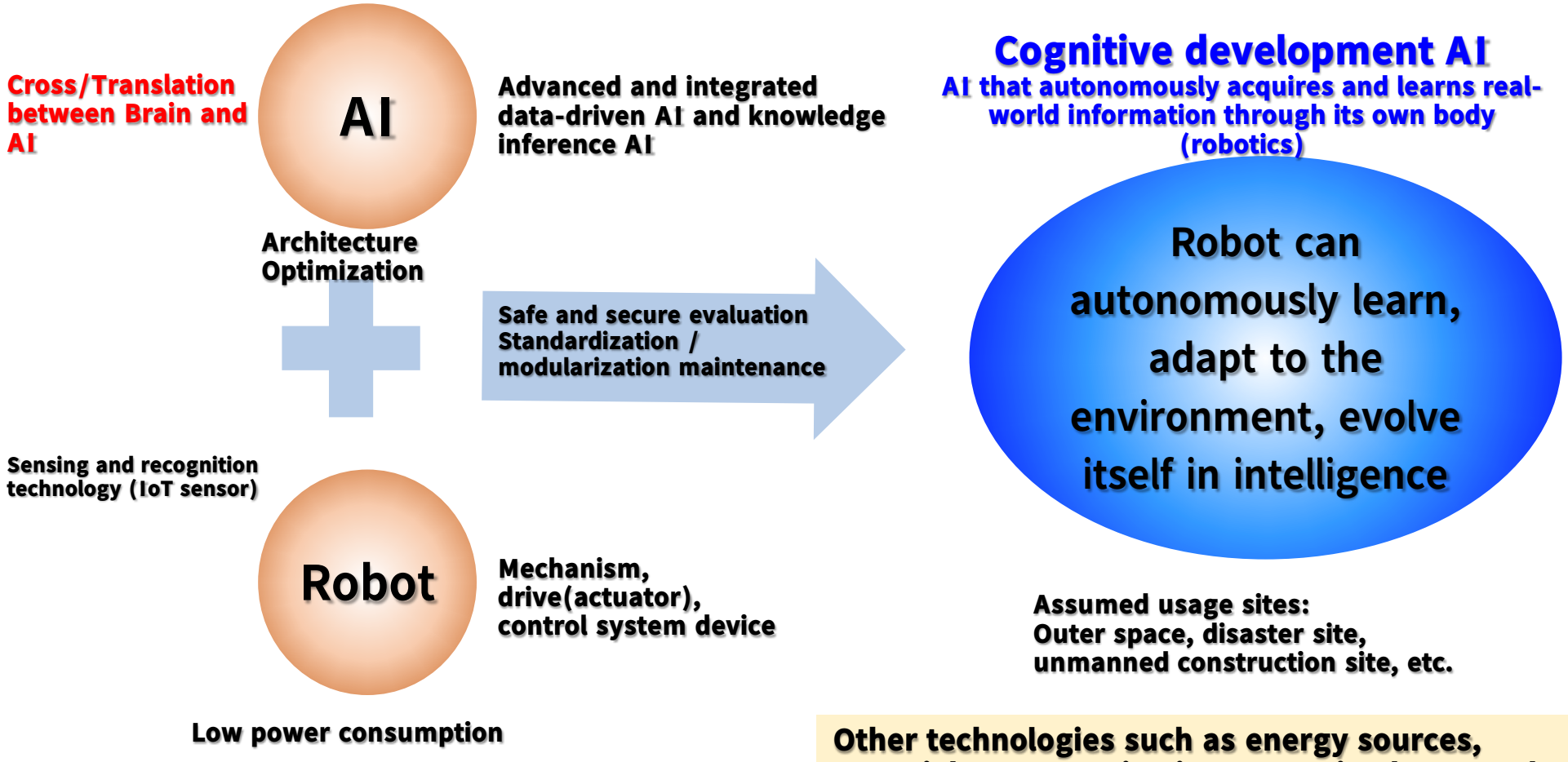
Working Group 3

Discussion



Working Group 3

Discussion

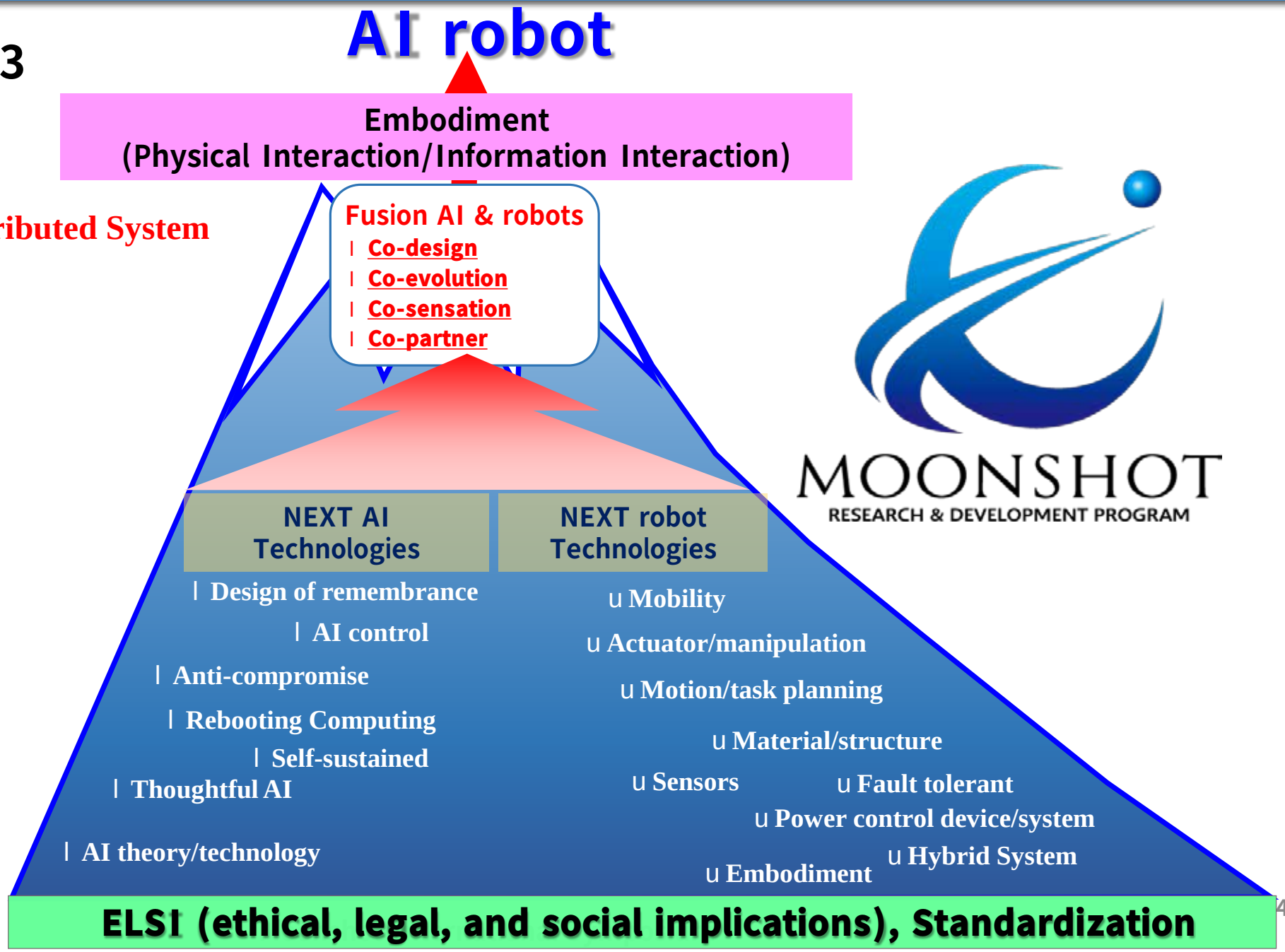


Other technologies such as energy sources, materials, communications, security, large-scale data(big data), human interface, etc.

Working Group 3

Discussion

- Autonomous Distributed System
- Fault tolerant
- Self repair
- Self evolution
- Self learning
- Self organization
- Embodiment
- Empathy



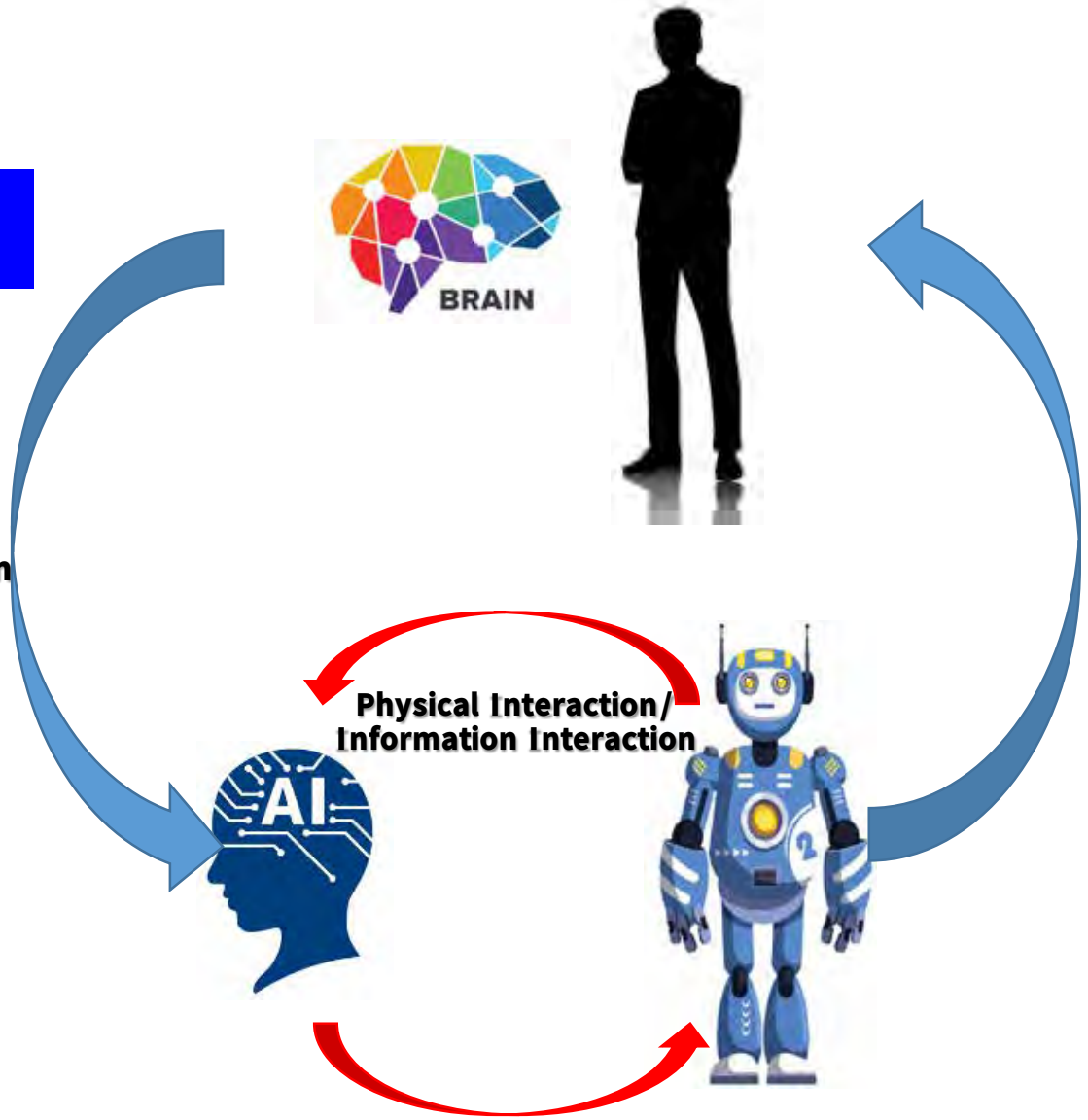
MOONSHOT
RESEARCH & DEVELOPMENT PROGRAM

Working Group 3

Discussion

Co-evolution

Brain⇒AI: Under study
AI ⇒Brain:Not yet studied



Development of AI based on biological information centered on brain activity.

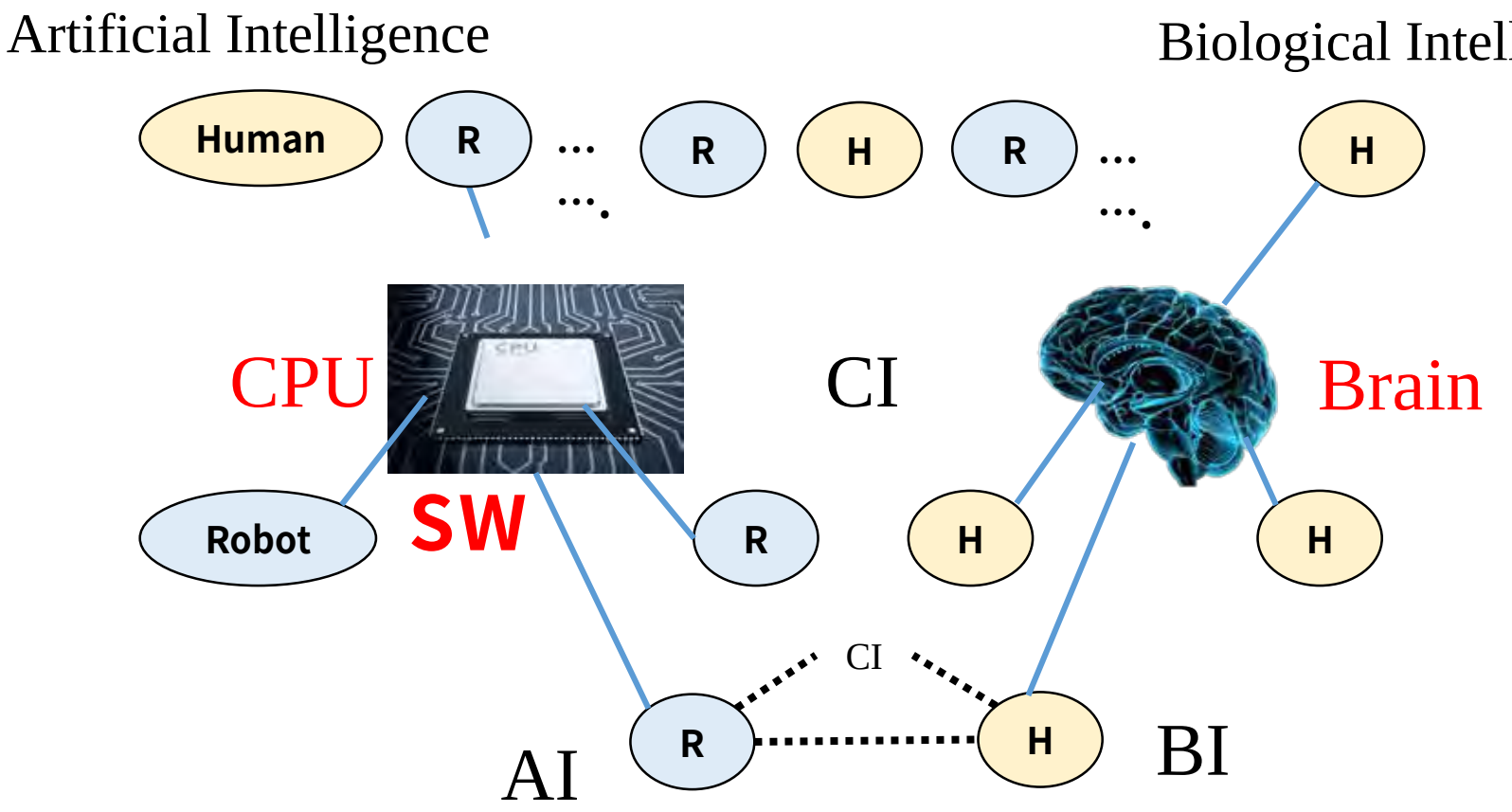
Development of theories and methods that promote human brains to learn from AI, etc.

Working Group 3

Discussion

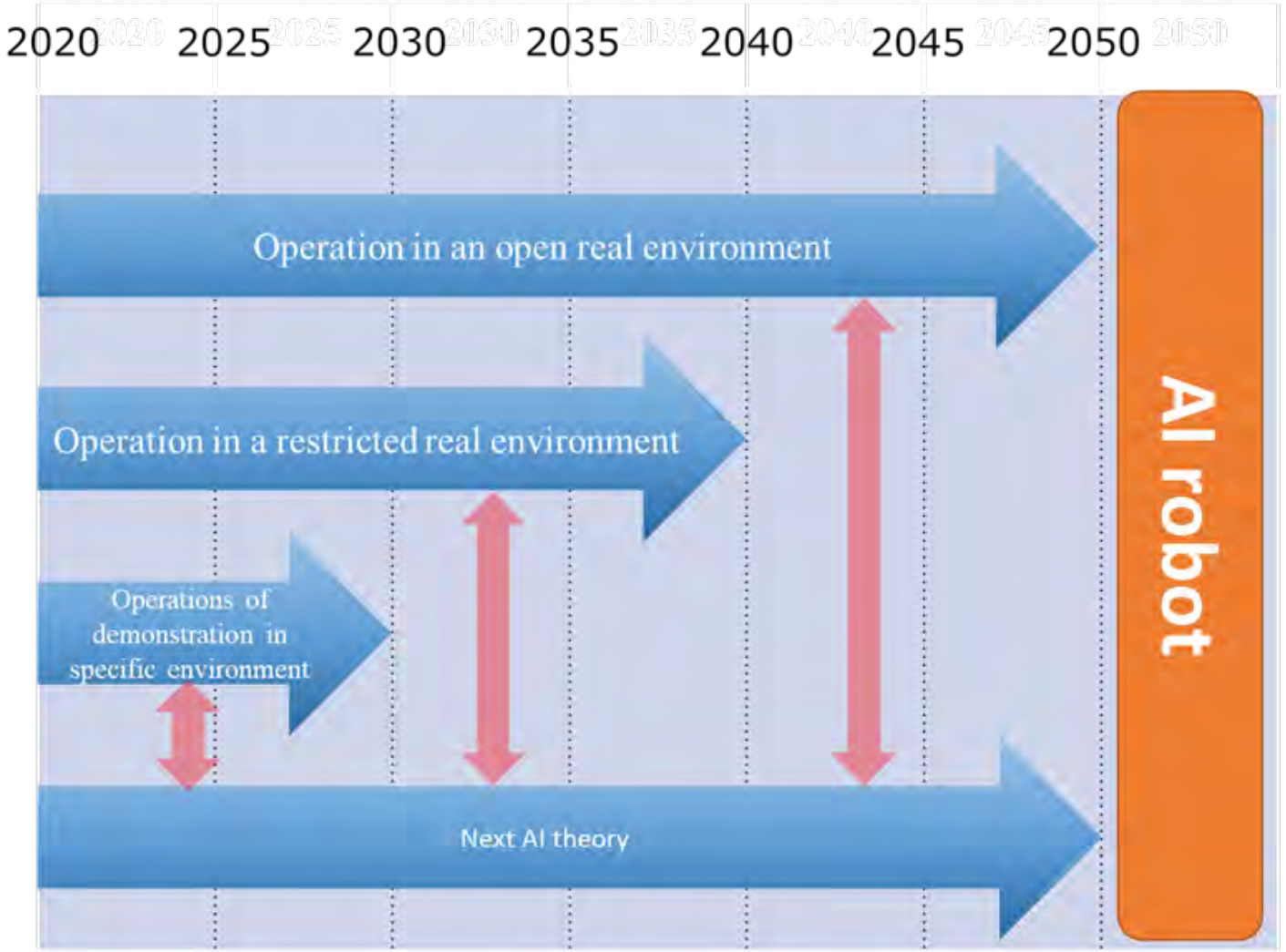
Hybrid

Computational Intelligence



Working Group 3

Discussion



Discussions

Space & Satellite

Fault tolerance, Self-repairing, Self-organization

- Satellites are robots.
- Hayabusa 2 has AI for solving time delay issue(30minutes).
- Intelligent functions are very important for satellite and space is a good example where people could not work.
- Activities on the moon would be a goof field of research for AI and Robotics.
- Reliability is very important for space mission, but not perfectly realized.
  - Computer system has redundancy.
  - Programming is very important for the reliability but depends on human work.
  - AI which learn by itself is very important.
  - In 2050, many people will live on the moon.
  - Unmanned construction(construction by autonomous robots) will be very important.
- Hayabusa 2 has a kind on AI, but future space

Space & Satellite
Fault tolerance, Self-repairing, Self-organization

- Immigration to mars based on successful business is a on-going program, and we do not need to do so.

- Satellite is a very good example of autonomous systems, which requires a lot of R&D of AI and Systems.
- Emergent behavior is also important.
- We do not have enough information of space. We definitely need emergent behavior.

- Autonomous space craft is a good target of moonshot.

- AI and robotics are more and more important for further exploration in deep space.

- Force control is not easy even for lunar missions, because of time delay and amount of information which can be transmissions.
- 100% automation of construction on the moon would be a good demonstration for construction robots.

Comment from AI point of view

- New type of AI is important for the moonshot
  - Integration of neural network and symbolic level, combination of integration of knowledge and perception.
  - Some activities
  - Integration of neural processing and knowledge is important.
- Question:
  - Care robots at home

- We should not recreate a home and we successfully implemented Lomba in existing homes.
- Care robot home requires explicit reasoning.
  - The elderly could not mention their intention completely
- A robot that can take of the elderly at home is a good goal for the moonshot program. This pushes the area of AI very much.

- All family members, including the elderly and young, need AI robot.

Creativity

- Creativity comes from random generation. Evaluation is important part.
- Expectation, which computers do not have, is the good novelty of
- Expectations and tie them together are very important.
- Explainable AI
- Difficulties of teaching students depends on their grade.

- Hypothesis generation

- In 1980s, many papers have been published about the creation

Human-robot interaction

- **Human robot interaction would be very important for future care robot.**
- **The goal in 2050 would be a care robot at home**
  - **In 2040, it would be for care house.**
  - **In 2030, partial realization of the targeted**

- **Robot as a mental partner. Long term robot companion.**
- Everyday, the robot learn its partner's growth, its family.

- **Family robot, whose body could be replaced, but whose data could be transferred.**
- **Thoughtful AI is the necessary new field of AI.**

Human-Robot Interaction

- **Japan is the country where we do not have enough**
- **If the eldery could stay at home, they could save a lot of budget required for taking care of the elderly.**
- **Intelligent assistive systems is important with moonshot devices.**

- **Diamond age**

- Companion robot adapting to family's life is dangerous.
- **1974, Dark star,**
  - **Teach the bomb humanity**

Ethical Problem of AI

- Brooks said that we should not rely on AI so much
- Ethics comes from human's over reliance/expectation.
- AI is a tool.

- MS Chatbot was attacked by people and has been disconnected.
- Discussion on ethics is too early.
- Instead of not doing things because it could be dangerous, we should go ahead.

- No AI could do so bad as expected.
- World wide web was a pure good system.
- Whatever the goal of the moonshot is
- Banning technology for some reason is based on the naïvety.
- Control of technology is naivety.

Disruptive Ideas

- Human brains consists of many neural networks. In the near future, deep learning will generate language.
- Current deep learning lacks in continual learning.
- Continual learning and extendability will be important for AI
- Co-evolution
  - Current robotics lacks in cognition of the environment, interaction with the environtment.
  - Integration of robot and AI is not easy.

- Language is just an interface.

AI and Coevolution of AI and Robot

- Human brains consists of many neural networks. In the near future, deep learning will generate language.
- Current deep learning lacks in continual learning.
- Continual learning and extendability will be important for AI
- Co-evolution
  - Current robotics lacks in cognition of the environment, interaction with the environtment.
  - Integration of robot and AI is not easy.

- Language is just an interface.

- Co-evolution in 2050 is impossible.

- AI is a tool and he could not understand the co-evolution.

From the Floor

- Is there any specific moonshot vision.
  - No more Ebora desease in 20**.
  - Taking care of the elderly or baby sitting in 20**
  - Disaster robotics
    - No more disaster in 2050.
    - Many elderly died, because they did not want to go to a safer place.
    - Mobility assistive device, with nice communication tool, could be a good example to drastically decrease the damage of the elderly.
    - **Evacuation plan, without power, would be very useful**
- **Construction area**
  - 1000 **people were killed every year, and 1/3 is coming from constructions.**
  - Infrastructure maintenance etc. is very important for AI and Robotics.

From the Floor

- **Distributed leaning would be very important**
- What is the most important impact from moonshot?
  - **Longer life expectancy**
    - Enhancing quality of life
  - Results of deep learning could be duplicated all over the world.
    - **Training sets**
- Machine learning and AI technique **are used widely in scientific field with big data, which could be used to advance deep learning.**
- Others
  - **Philosophical discussions may be important.**
  - Who can control the privacy issues of family robots?
  - Cost of electricity in 2050.

Working Group 3 Conclusion

【MS Goal candidate.】

"By 2050, a robot can autonomously learn, adapt to the environment, evolve itself in intelligence and act with human beings"

【Target】

1. By 2050, development of AI robots, that humans do not feel uncomfortable, have physical abilities equivalent to or better than humans and grow with human life.

2. By 2050, the development of an automated AI robot system that aims to discover principles and solutions by thinking and acting in the field of natural science.

3. By 2050, development of AI robots that autonomously judge and act in environments where it is difficult for humans to act.