Research area in Strategic Objective *"System Software Technology to support Safety, Security, and Trust in the era of Society 5.0"*

## Strengthening ICT Infrastructure for Social Change

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## Overview

Japan is promoting Society 5.0, which aims for a data-driven society that will create new and unprecedented value: a society in which humans and objects are connected and a variety of knowledge and information is shared. To realize this, we must promote the strengthening of ICT infrastructure and digital reform so that we can safely and sustainably develop human social activity.

The spread of the novel coronavirus disease (COVID-19) and the process of carrying out measures against this have exposed a variety of challenges relating to ICT infrastructure and digital reform. The digital reform taking place in our social lives is meaningful in that it is allowing people to adapt their everyday lives to the current situation amid the COVID-19 pandemic, stimulating socioeconomic activities, and strengthening social resilience, but it is important to enhance security and protect individual privacy when this reform is being realized. We also need to develop software and systems based on "Security-by-Design" and "Privacy-by-Design" thinking.

In recent years, people have promoted the development of new social systems, such as smart cities, autonomous driving, health and medical care using the Internet of Things (IoT), and the concept of GIGA schools. As AI, Big Data, and IoT technologies evolve, the environment surrounding information infrastructure is undergoing great change. We need the research and development of systems as a whole, understood from a by-Design perspective; domestically produced system software that we can trust in terms of safety and security; and the development of ICT infrastructure.

In this research area, we will interact and inspire researchers of theories (with mathematical and computer science as a basic) and infrastructural technologies for social systems (algorithms, architecture, OSes, networks, databases, IoT, security, languages, etc.). We aim to strengthen the ICT infrastructure for social change by realizing the creation of science and technology innovation that strengthens international competitiveness and the creation of infrastructure software technology that supports security, safety, and trust. Furthermore, we will promote the training of human resources who will contribute to by-design through research and development that is conscious of solving these issues of future social systems and social change.

Please note that this research area is managed as part of the Ministry of Education, Culture, Sports, Science and Technology (MEXT)'s Artificial Intelligence/Big Data/Internet of Things

(IoT)/Cybersecurity Integration Project (AIP Project (Advanced Integrated Intelligence Platform Project)).

**Supervisor's Policy for Application, Selection, and Management of the Research Area**

**1. Background**

During the era of Society 5.0, we expect mutual cooperation concerning a great variety of data obtained from many different social systems, including road traffic, energy, and manufacturing, as well as the creation of new values in society. We are also aware of the necessity of social infrastructure with an eye to the digitization of society and the post-COVID-19 world, looking at the spread of COVID-19 as an opportunity. However, in order to realize this society, we must deal with many different assumed challenges in security, privacy, and platforms. We need to promote a variety of research, including research on dealing with threats aimed at vulnerabilities connected to the core of computation environments, such as hardware, networks, and OSes; ways to safely manage and use personal information, and confidential information and research data from companies; and the realization of information processing and data distribution that understands systems as a whole from a by-Design perspective. We anticipate the realization of ICT infrastructure technologies that will support the safety, security, and reliability of the era of Society 5.0. This will be accomplished as a result of collaboration between researchers of many areas, from architecture to OSes, software, databases, IoT, security, and languages, as they work towards solving the problems of social systems, which are continuing to become more advanced and complex, including smart cities, autonomous driving, health and medical care using IoT, and the concept of GIGA schools; creating information technology connected to social change; developing infrastructural software; and strengthening ICT infrastructure that incorporates forward-thinking telecommunications technologies. We are also promoting foundational research (theories) and applied research (system infrastructure) to achieve this goal.

**2. Research and development objectives and examples of research projects**

In light of the above mentioned background, this research area aims to fundamentally solve problems in the field of ICT infrastructure technology in a way that is based on theoretical knowledge, after gaining an overarching view of social systems as a whole. More specifically, although we are focusing on the research below, applicants are not necessarily limited to this, and we expect more free and challenging proposals.

(1) The creation of technology to build safe systems in a variety of computation environments
・Safety-orientated computer architecture technology created via OS distribution, stratification, etc.

・Technology to create a trusted execution environment (next-generation TEE (Trusted Execution Environments), etc.)
・Technology to create highly reliable infrastructural software that will comprehensively handle everything from edge to cloud
・Formal verification technology to realize safe execution environments
・Technology to create safe social systems that use IoT devices, space-time information, and encryption technologies
・Technology that detects abnormalities and attacks while software is running through direct monitoring of hardware

(2) The creation of technology that gathers and analyzes data and ensures privacy even in an open environment
・Technology that ensures trust through secret computations, such as homomorphic encryption and multi-party computation
・Distributed system technology that makes it possible to dynamically control the extent of mutual trust and disclosure levels
・Distributed data-gathering and analysis technology that takes privacy into account
・Technology that manages privacy policies, and that can respond to international laws for the protection of personal information

(3) The creation of new ICT infrastructure that will support social security, safety, and trust
・Middleware and infrastructural software for the development of highly reliable social systems
・Technology to solve a variety of ICT infrastructure problems exposed during the COVID-19 pandemic
・Technology to create resilient ICT infrastructure that allows collaboration between edge and cloud
・Technology for the construction, management, and control of a distributed data-processing environment made up of several different execution environments
・ICT infrastructure that will realize safe and secure social lives for people, such as health and medical care technologies that make use of IoT
・Infrastructure for management and operation, such as for PHR/EHR, LMS information, and space-time data tailored to the social implementation field

(Other keywords)
Security that uses AI, privacy preserving data mining, the secure use and application of data, risk management, digital reform connected to social change, situational awareness, decision support,

etc.

**3. Assumed research progression**

In this research area, we are not just looking to advance underlying technologies with an eye to the future—we want approaches that are aware of actual social systems, and that consider how to bring theoretical research to the stage of social implementation and how to integrate security and privacy into system infrastructure. Thus, after selection, we actively anticipate collaboration with relevant research areas, including mathematics and natural science; studies of applicable use cases that involve stakeholders such as service providers and the government; the international development of outcomes achieved through open sourcing; and more.

**4. Research period and research costs**

The research period is three years and six months or less; budgets have an upper limit of a total of 40 million yen (not including indirect costs).

**5. Points to note when applying**

We anticipate the training of the next generation of leaders and the creation of cutting-edge outcomes through research that makes a truly great impact, even if it is not easy to achieve. Therefore, we will proactively assess budding and challenging applications with the potential to contribute to the objectives of this research field and are unafraid of failure, if these are presented together with the ambition of the proponent.

In addition, as we aim to realize Society 5.0, we anticipate research proposals that illustrate the social implementation field and specifically envisage use cases to which the proposed technology can be applied (for example, medical care, education, autonomous driving, smart cities, etc.).

When making the proposal, clarify its superiority compared to existing technology. In addition, make sure you are aware of which points will lead to the strengthening of ICT infrastructure if you are proposing "applied research aiming for social change," and be aware of how your work will lead to concrete social change if you are proposing "basic research aiming to strengthen ICT infrastructure."

As one research area of the AIP Network Lab, which organizes MEXT's Artificial Intelligence/Big Data/Internet of Things (IoT)/Cybersecurity Integration Project (AIP), this research area will also contribute to the integrated management of the AIP, including focusing on research projects while collaborating with relevant research institutions, such as the RIKEN Center for Advanced Intelligence Project.