Executive Summary

This report was prepared in order to consolidate the summary of the Panoramic View Reports published for each field, and to capture the overall picture across fields, taking into account trends in society and policy.

In the world, the values nurtured in the U.S. and Europe based on democracy, market principles, and science and technology have been shaken. With the intensifying confrontation between the U.S. and China, AI/IoT, quantum technology, biotechnology, and some other technologies have become targets of technological hegemony from the perspective of industrial competitiveness and security, and the momentum for international cooperation is waning. COVID-19, which appeared under these circumstances, has changed socioeconomic activities and people's awareness on a global scale. However, threats such as global warming caused by climate change still exist and are becoming more serious. The main theme of science, technology and innovation should be to create a society that can quickly recover and rebuild from these crises (resilient society) without collapse.

In order to realize a better society, there is an increasing orientation toward research and development aimed at solving social issues. The image of the ideal society can change depending on people's values, but people's values will also change in the changing social situation. The mission-oriented research program established in Horizon Europe (2021-2027), the EU's R&D strategy, is an example of such an approach. In addition, the rapid development of information technology and the so-called digital transformation (DX) are transforming society, and data-driven science and technology are transforming R&D activities themselves. The increasing penetration of DX in various research fields is not only increasing the sophistication of research methods, such as improving the speed of search, but is also causing qualitative changes by contributing to the expansion of researchers' ideas.

Toward a better future society, Japan is aiming at carbon neutral by 2050 while promoting the realization of the "super smart society = Society 5.0". In order to achieve these goals, more emphasis is being placed on research and development aimed at solving social issues. However there is still a way to go before a mechanism for setting R&D themes linked with social issues is realized with the participation of various stakeholders. In terms of individual R&D fields, there are, of course, areas in which Japan still holds an advantage, but from a macroscopic perspective, there is concern that Japan's relative position is declining, and the strengthening of Japan's research capabilities is an urgent issue.

Next, we will brief the trends in the major R&D fields and the challenges Japan is facing, as follows. In the environmental and energy field, even in 2020, when socio-economic activities were restricted to prevent the spread of COVID-19, the rate of decrease in anthropogenic greenhouse gases (GHGs) emissions was limited. That exposes the difficulty of transitioning to society with net zero GHGs emissions. As each country advocates green recovery, the importance of "research and development to promote social transition" is increasing. Based on the values of sustainability and inclusiveness, it is important for Japan to conduct research and development in four directions: net zero-emission society (climate change mitigation), adaptive society (climate

change adaptation), resilient society (resilience), and circular society (circular economy).

In the field of Systems and Information Science and Technology (IT), the importance of IT is increasing in a wide range of social and economic activities as a response to the COVID-19 pandemic, from infection prevention to digital transformation of business process. The major technological trends are digitalization and connectedness as represented by cyber-physical systems (CPS) and the Internet of Things (IoT), and the rapid development of AI technology and robotics to make everything smarter and more autonomous. In recent years, consistency with social demands and securing human autonomy are required in many areas of IT.

Nanotechnology, along with the materials technology that has supported human society and civilization, underpins almost all application areas as a technology driver. In the field of nanotechnology and materials, a seek for new technologies in communication and information processing that surpass the limitations of CMOS for applications such as IoT and AI continues. Also, the trend of introducing machine learning into materials development, such as materials informatics, is beginning to be widely recognized around the world. In Japan, there are several challenges to be solved, such as "advanced control of quantum states" and "development of smart material by nanomechanical control".

In the field of life science and clinical medicine, "to provide more people with higher quality medical services in a stable manner" and "to allow more people to obtain higher quality food in a stable manner" have become urgent issues in the world. Research and development that requires the understanding of society and the public, such as personalized medicine and bioeconomy, continues to be a major trend. In Japan, designer cell (cell therapy), agriculture that reduces the environmental load under climate change, AI x Bio, etc., as well as the construction of medical research platform and innovation ecosystem to promote research and development creatively and efficiently have been big issues.

Based on the results of the above overview, it is necessary to recognize that Japan's relative position in science and technology is declining, and that the overall challenge is for Japan to gain the R&D capability to compete with the world's major countries. We should tackle the following issues:

(1) In the R&D to address social issues, from the stage of setting R&D issues, proceed with the participation of not only researchers with various specialties but also a variety of stakeholders.
(2) While using DX in R&D activities as the driving force for reform, structurally reform research environments in various aspects such as not only DX but also flexible employment arrangements like cross-appointments.
(3) Create an R&D environment where young people can engage in curiosity-driven research that is attractive to them over the long term, while linking this to the development of young human resources.
(4) Establish an innovation ecosystem where industry, academia, and government can cooperate in a complementary manner, flexibly recombining partners as research progresses.

(5) Each policy maker and researcher should acquire a worldview and historical perspective, and engage in cross-disciplinary collaboration.

The contents of this report will be disseminated to relevant stakeholders, and the CRDS will continue to study in depth the issues that have emerged as challenges for Japan. It is hoped that this report will contribute to the implementation of the 6th Basic Plan for Science, Technology and Innovation, which will be launched in FY2021. We also hope the report will serve as a foundation for trust between science and technology and society and contribute to the development of diverse international cooperation in science and technology.