#### Note

This document is almost machine translated. If there are any discrepancies, inconsistencies, or contradictions between the translation provided and the Japanese version, the Japanese version shall take precedence.

**Software Modernization Committee Report** 

# Toward the Next Stage of Software

## ~Toward a prosperous Japanese society

## that shines brightly in the world~

March 31, 2025

Software Modernization Committee



Information-technology Promotion Agency, Japan

#### Contents

1. Introduction
1.1 Greetings from the Chairperson
1.2 Subjects of this report
1.3 Software Modernization Committee Overview, Approach $\ldots$
2. Vision
2.1 Aiming Direction
2.1.1 The society that Japan is aiming to create
2.1.2 The necessity of creating new businesses based on solving social issues
2.1.3 Using Software as a Growth Strategy15
2.1.4 A major shift in software development has occurred due to rapid technologica
innovation
2.2 Our Vision for the Next Stage of Software
2.2.1 What to work on in the future
(1) Organization
(2) Human resources 25
(3) Technology
(4) Institutions and Infrastructure
2.3 Road Map
2.4 Gap between manifested vision and reality
3. Discussion of future directions
3.1 Overview
3.2 Movement around this committee
3.2.1 Public Awareness Activities
3.2.2 Gathering and publicizing the latest domestic and international trends
3.2.3 Facilitating dialogue across organizational boundaries
3.2.4 Advancement of AI utilization
3.2.4 Advancement of AI utilization
3.2.4 Advancement of AI utilization
3.2.4 Advancement of AI utilization       39         3.2.5 Promotion of advanced requirements definition, modeling & simulation       39         3.2.6 Promote open source and Building Blocks       40         3.2.7 Promoting Data Engineering       41
3.2.4 Advancement of AI utilization       39         3.2.5 Promotion of advanced requirements definition, modeling & simulation       39         3.2.6 Promote open source and Building Blocks       40         3.2.7 Promoting Data Engineering       41         3.2.8 Promotion of Legal Tech       42
3.2.4 Advancement of AI utilization       39         3.2.5 Promotion of advanced requirements definition, modeling & simulation       39         3.2.6 Promote open source and Building Blocks       40         3.2.7 Promoting Data Engineering       41         3.2.8 Promotion of Legal Tech       42         3.2.9 Promote standardization of contracts, terms and conditions, etc.       43
3.2.4 Advancement of AI utilization       39         3.2.5 Promotion of advanced requirements definition, modeling & simulation       39         3.2.6 Promote open source and Building Blocks       40         3.2.7 Promoting Data Engineering       41         3.2.8 Promotion of Legal Tech       42         3.2.9 Promote standardization of contracts, terms and conditions, etc.       43         3.2.10 Promotion of Cloud-Edge-IoT       44
3.2.4 Advancement of AI utilization       39         3.2.5 Promotion of advanced requirements definition, modeling & simulation       39         3.2.6 Promote open source and Building Blocks       40         3.2.7 Promoting Data Engineering       41         3.2.8 Promotion of Legal Tech       42         3.2.9 Promote standardization of contracts, terms and conditions, etc.       43         3.2.10 Promotion of Cloud-Edge-IoT       44         3.3 Movements outside this committee       45

## 1. Introduction.

#### **1.1 Greetings from the Chairperson**

Remarkable progress is being made in digital technologies, such as generative AI, which are having a significant impact on society and industry. Not only is digital technology a powerful tool for solving social issues such as the declining birthrate, aging population, environmental problems, energy issues, and disaster countermeasures, it is also expected to create new business opportunities. As AI takes over much of the work involved in developing information systems, laborintensive development systems will disappear. Conversely, as the application of digital technology expands rapidly, the demand for human resources that can plan, judge the appropriateness of, and promote the implementation of its applications in society will increase.

The world is naturally paying attention to digital technology and pouring huge investments into it. There are concerns, however, that Japan is falling behind. Over the past decade, digital transformation (DX) has received much attention, but in Japan, the focus has been on defensive DX, such as streamlining and improving existing businesses, rather than offensive DX, such as creating new businesses. Without an accurate understanding of the principles of competition and the changes in industrial structure brought about by technological innovation and without taking action to prepare for the future, Japan will find itself in a state of shrinking equilibrium as its population declines. Even maintaining social infrastructure will become a question of how to do so. Many companies will be forced to change their business models, and engineers will need to acquire new skills. Whether we view this great wave as a threat or an opportunity depends on our response.

For society as a whole to enjoy the benefits of digital technology, we must properly understand the characteristics of the software that makes it possible and use it effectively in a wide range of areas. Steel is not only produced by the steel industry but also used by many other industries to support society. Computer software is perhaps even more widely applied than steel, supporting and

fundamentally changing all kinds of industries. It will enter individuals' lives whether they like it or not.

Harnessing the power of software and making it useful is more important than ever and has entered a new phase. As hardware and network performance increase and AI and big data enable processing beyond human knowledge, the application areas are rapidly expanding in combination with the Internet of Things (IoT) and robotics. Automated driving is the symbolic area of competition. However, it is not just a few geniuses creating clever theories and technologies to bring happiness to humanity.

The real world has become a testing ground for technologies through social experiments involving the collection and analysis of large amounts of data on people's lifestyles and reactions. The process of repeated trial and error has begun to achieve what was previously impossible by using failure as a source of inspiration. The goal is to develop and supply new products and services that create great value by analyzing physical phenomena, as well as the behavior and emotions of companies and individuals. The more collaborators obtained, the greater the possibility of ultimately securing high profits. It is a competition to improve unfinished technology and create products and services.

Software does not diminish with use. Since software does not wear out, it is a tool that creates more value the more it is used. Additionally, since software does not require a physical manufacturing process, defects can be corrected relatively easily and the necessary functions can be gradually realized through repeated trial and error. Therefore, it is possible to implement functions that were previously implemented in hardware in software, modify them flexibly to meet market needs, and provide high value.

The automotive industry is racing to develop software-defined vehicles, taking advantage of software's characteristics. The realization of automated driving is also based on accelerating development by leveraging this characteristic. In the future, software will be used to create functions in various areas, and updates will be made to increase products' value after they are released to the market. Thus, a software-defined society will soon emerge, one in which many products and services that meet market needs are developed through market dialogue. A

sustainable society that can achieve affluence and happiness requires a quick transition to a software-defined society that can respond to changes and uncertainties to enable rapid business development.

Technologies that could solve social issues are emerging, but it will take a concerted effort to link these technologies to the well-being of many people. Expecting genius inventions or perfected, convenient products will only lead to exploitation by giant tech companies. Rather than playing "bread and circuses," individuals, businesses, and government agencies must realize that they must address their own problems. They should also keep an eye on available technologies, explore what works for them, and join the movement to actively use them. The more people who deepen their understanding of software, enjoy its benefits, and contribute to developing their organizations and society, the more likely society will be able to enjoy software's benefits.

Every day, we use uniform products and services offered globally, which bear enormous costs, including those from advertising. However, Japan has built an affluent society by supplying valuable products to the world while bearing the burden of importing natural resources. The same is true in the world of softwarebased information services, which paves the way for importing standard, low-cost services and exporting valuable services that help people around the world facing challenges.

Products and services in a software-defined society are created and refined through the participation of diverse engineers, experts, and users. It's important to note that product development and problem-solving occur through open and frequent dialogue among those involved. Social concerns, foresight, and collective knowledge nurture products and services. Unlike societies divided between giant tech companies and the super-rich on one side and the working class left behind on the other, Japanese society still retains a sense of unity and establishes dialogue among a broad range of people. In other words, Japan is well-positioned for the development of a software-defined society.

By stimulating dialogue across a wide range of people and industries, including regional characteristics, organizations large and small, and people of all ages and genders, and by utilizing technologies that facilitate this dialogue, such as various

types of modeling, VR/AR, digital twins, and simulations, we can maximize the power of software to address social issues and create new demand and employment opportunities. While actively utilizing and contributing to the development of emerging global technologies is similar to the approach taken by other countries, Japan may have a unique path in terms of how society as a whole can reap the benefits of these technologies.

With broad public participation and by stimulating dialogue among diverse people, companies, and organizations, we can ensure high industrial competitiveness and profitability by utilizing digital technology to confront social challenges and provide solutions to the world. However, to spread the benefits to every corner of society, beneficiaries must reach out on their own.

The Software Modernization Committee, in cooperation with several softwarerelated industry associations and based on the results of a survey conducted by the Japan Information Technology Promotion Agency, has held a series of expert discussions. We published an interim report, received feedback from many people, and compiled a final report after further discussions. The door to great possibilities is now open before us. However, if we wait, nothing will happen, and the population will continue to decline. Following in the footsteps of other countries will yield little and will only perpetuate the past 30 years. We must understand the unprecedented changes occurring now and proactively adopt the emerging technologies and approaches to navigate the sea of uncertainty and pursue our country's unique wealth. I hope this conference will inspire many to find the path forward.

> Software Modernization Committee Committee Chairman Takeshi Hayama

## 1.2 Subjects of this report

Some of the target audiences for this report are listed below.

- Corporate management
  - Executives and managers of user and vendor companies. They can use this report as a reference when making critical decisions about developing and executing business strategies.
- Software developers and those interested in the field
  - Software developers and others interested in the field Professionals working in software development, as well as individuals with technical knowledge and an interest in software engineering trends, can use this report as a reference for making critical decisions in developing and executing business strategies. They can refer to this report to learn about current trends and future directions.
  - Industry luminaries and research organization officials
    - Industry luminaries and research organization officials Highly influential industry personalities and experts from research organizations that collect and analyze data may refer to this report to learn about the direction of the industry and the latest trends. They can use the information in this report to contribute to the industry's overall development.

### 1.3 Software Modernization Committee Overview, Approach

The Independent Administrative Institution Information-Technology Promotion Agency of Japan (hereinafter referred to as "IPA") invited industry experts to form the Software Modernization Committee (hereinafter referred to as "the Committee") in July 2024. The Committee discusses the direction that Japanese society and industry should take to maximize the value of software, referring to domestic and international software trends. The Committee also examines visions, roadmaps, and measures for fiscal year 2025 and beyond based on the current situation in Japan.



Figure1 Approach of this committee

The members of this committee and the results of its meetings are listed below.

Name	Name	Affiliation	Remarks
Committee	Takeshi	NTT DATA GROUP CORPORATION	
chairman	Hashiyama		
Committee	Hiroshi	TOSHIBA CORPORATION	JEITA <sup>1</sup>
member	Kaneko		Recommendation
Committee	Hajime	SIOS Technology, Inc.	JOPF <sup>2</sup>
member	Kurosaka		Recommendation
Committee	Takuya	NEC Corporation	
member	Saito		
Committee	Akihiro	Hitachi Solutions, Ltd.	
member	Saimi		
Committee	Akihiko	Future Architect, Inc.	MCIS <sup>3</sup>
member	Nagasaka		Recommendation
Committee	Kazumaro	Obic Business Consultants	SAJ <sup>4</sup>
member	Hino	Co.,Ltd.	Recommendation
Committee	Norihisa	Japan Users Association of	JUAS⁵
member	Fujimoto	Information Systems	Recommendation
Committee	Osa	SCSK Corporation	JISA <sup>6</sup>
member	Horii		Recommendation
Committee	Minoru	TIS Inc.	
member	Yasunaga		
Committee	Hiroyuki	eXmotion Co., Ltd.	JASA <sup>7</sup>
member	Watanabe		Recommendation

Table1 List of committee members

<sup>&</sup>lt;sup>1</sup> Japan Electronics and Information Technology Industries Association https://www.jeita.or.jp

<sup>&</sup>lt;sup>2</sup> Japan OSS Promotion Forum https://ossforum.jp

<sup>&</sup>lt;sup>3</sup> Measurement Council for IT Systems https://www.mcis-jp.org

<sup>&</sup>lt;sup>4</sup> Software Association of Japan https://www.saj.or.jp

 $<sup>^{\</sup>scriptscriptstyle 5}$  Japan Users Association of Information Systems https://juas.or.jp

<sup>&</sup>lt;sup>6</sup> Japan Information Technology Services Industry Association https://www.jisa.or.jp

<sup>&</sup>lt;sup>7</sup> Japan Embedded Systems Technology Association https://www.jasa.or.jp

Holding format	Date	Main Theme	
1st Committee Meeting	June 11, 2024	Brainstorming about the direction to take.	
2nd Committee	July 18, 2024	Discuss how to proceed with the future of	
Meeting		this committee.	
1st Workshop	August 1, 2024	Examine the future of Japan in light of	
(Held by volunteer		social trends.	
members)		Examining the future direction that	
		Japanese society is aiming for.	
3rd Committee	August 22, 2024	Discussion on the direction to take.	
Meeting			
2nd Workshop	September 5, 2024	Discussion of the committee's future	
(Held by volunteer		roadmap.	
members)			
4th Committee	September 25, 2024	Discussion of the interim report that lays	
Meeting		out the future roadmap.	
5th Committee	October 24, 2024	Discussion of the 2024 Software Trends	
Meeting		Survey <sup>8</sup> .	
6th Committee	December 19, 2024	End-of-year report discussed.	
Meeting			
Intensive study group	January 29, 2025	Roadmap to be included in the end-of-year	
		report.	
7th Committee	March 3, 2025	Review and discussion of end-of-year	
Meeting		reports.	

#### Table2 Results of the event

<sup>&</sup>lt;sup>8</sup> IPA "Release of "2024 Software Trend Survey" Survey Result Data and Call for Analysis Reports" https://www.ipa.go.jp/digital/software-survey/software-engineering/result-software2024. html

In parallel, the IPA also holds the "Legacy System Modernization Committee<sup>9</sup>." This committee visualizes the factors surrounding the current legacy system<sup>10</sup>, analyzes them from various angles, and examines how to address them.

While the Software Modernization Committee examines the path forward by backcasting from the future vision, the Legacy System Modernization Committee takes a bottom-up approach, starting from the current issues and working in both directions to solve problems.

<sup>&</sup>lt;sup>9</sup> IPA "Legacy Systems Modernization Committee"

https://www.ipa.go.jp/disc/committee/legacy-system-modernization-comittee.html

<sup>&</sup>lt;sup>10</sup> Systems that have become outdated in terms of technology, bloated and complex systems, and black boxes, which in turn have become a drag on management and business strategies and the cause of high cost structures.

## 2. Vision

### 2.1 Aiming Direction

#### 2.1.1 The society that Japan is aiming to create.

On June 21, 2024, the government approved the "Basic Policies for Economic and Fiscal Management and Reform 2024: Realizing a Growth-Oriented Economy Driven by Wage Increases and Investment<sup>11</sup>" (hereinafter referred to as "Basic Policy 2024"). Basic Policy 2024 was formulated to guide the sustainable growth of the Japanese economy and the resolution of social issues. It is an important policy document that sets the direction for future economic and fiscal management.

The Basic Policy 2024 establishes a long-term growth vision for the Japanese economy, setting the goal of achieving a nominal GDP of 1,000 trillion yen around 2040. This goal demonstrates a strong commitment to overcoming pressing social issues such as the declining birthrate, aging population, regional disparities, environmental problems, and the maintenance of social infrastructure. It aims to create a sustainable economic society where every citizen can enjoy prosperity and happiness.

<sup>&</sup>lt;sup>11</sup> Cabinet Office, "Basic Policies for Economic and Fiscal Management and Reform 2024." https://www5.cao.go.jp/keizai-shimon/kaigi/cabinet/honebuto/2024/decision0621.html



Figure2 "Basic Policy 2024 PR Material - General Remarks" (Source: Cabinet Office)

Similarly, the Japanese government has long promoted the concept of a future society called "Society 5.0<sup>12</sup>" This new vision combines cyberspace and physical space in a highly integrated manner to achieve economic development and solve social issues.



Figure3 "Society 5.0" (Source: Cabinet Office)

<sup>&</sup>lt;sup>12</sup> Cabinet Office, "Society 5.0," https://www8.cao.go.jp/cstp/society5\_0/

Furthermore, the Digital Agency's "Priority Plan for the Advancement of a Digital Society<sup>13</sup>" presents the following six goals of a digital society, based on the principle of "human-friendly digitization where no one is left behind."

- Growth Strategy through Digitalization
   Aim to raise productivity and digital competitiveness across society,
   contributing to the development of a sustainable society.
- Digitalisation in semi-public sectors such as medical care, education, disaster prevention, and support for children
   Developing data-linkage infrastructures to ensure a safe and secure society.
- Regional revitalization through digitalisation
   Enhancing the attractiveness of regions and ensuring the development of a digital society that promotes sustainability.
- A digital society where no one is left behind Develop a digital society where everyone can benefit from digital advancements in their daily lives.
- Fostering and securing digital talents
   Enhance a society where digital talents are nurtured and secured.
- International strategy, including the advancement of DFFT <sup>14</sup>
   Realize a society that fosters cross-border data flows with trust.

<sup>&</sup>lt;sup>13</sup> Digital Agency, "Priority Plan for the Digital Society," https://www.digital.go.jp/policies/priority-policyprogram

<sup>&</sup>lt;sup>14</sup> Data Free Flow with Trust: It is a concept that aims to promote the distribution of trustworthy and free data.

# 2.1.2 The necessity of creating new businesses based on solving social issues.

To achieve the goals outlined in the Basic Policy 2024 and other policies, such as "establishing a sustainable economic society in which each and every citizen can experience affluence and happiness," Japan must take the lead in developing solutions to a variety of issues, including declining birth rates, an aging population, environmental problems, energy issues, disaster preparedness, and growing disparities. The issues of a declining and aging population and the need for energy efficiency are particularly relevant to Japan, and are increasingly recognized as similar challenges around the world. Therefore, Japan's advanced efforts have great potential to attract international attention and spread widely.

#### Creating new businesses that solve social issues and expand globally.

Solving these social issues can also present great business opportunities. Many of Japan's issues are common worldwide, and the country has the environment and advanced knowledge necessary to take advantage of global technology. As the domestic market continues to shrink, existing businesses will likely find it difficult to grow in the future if they continue to operate only in the domestic market. Therefore, developing overseas markets for existing businesses and creating new businesses that solve social issues and deploy these solutions in overseas markets will lead to significant economic growth.

Additionally, given the increase in overseas human resources and tourists, it will be essential for domestic companies and local governments, whose main market is domestic, to develop systems that accommodate people of diverse nationalities and backgrounds.

#### Avoid the "innovation dilemma."

Advances in digital technology should, by definition, create great business opportunities. However, survey results in Japan indicate that DX is mainly aimed at improving the efficiency of existing businesses, and in few cases, it is linked to the creation of new businesses. If we ask companies that are currently profitable, it is natural that they will respond that they are making efforts to increase sales and profits by improving the efficiency of existing businesses. However, the "innovation dilemma," in which the stronger the existing business, the slower it is to adapt to the new environment, has decimated many good companies in the past. And this dilemma is expected to repeat itself in the future. Some companies are focusing on overseas expansion in anticipation of shrinking existing markets, developing new markets domestically, or working to solve various problems and commercialize them. With a declining population and labor shortages becoming more apparent, this is by no means an easy path, but even if companies try to maintain the status quo, they are headed for decline.

#### Don't settle for the status quo; take on bold challenges instead.

The desire of many people and companies to maintain the status quo is proof that current society is reasonably stable. However, in this day and age, when the global environment demands change and science and technology require reform of existing industries, maintaining the status quo is unacceptable. Unless we take on new challenges in new areas, our society is doomed to shrink. It's important to recognize that Japan is, in a sense, a "blessed" society where it's hard to find motivation for new challenges.

Unsurprisingly, new challenges have been encouraged to help Japan emerge from the post-bubble doldrums. For example, capital efficiency has been emphasized in recent years, and there is a need to improve PBR<sup>15</sup> and ROE<sup>16</sup>. Improving existing businesses could achieve a 1% or 2% increase in profit margin. However, dramatically doubling or tripling the profit margin will require switching to a completely different business model or boldly venturing into the blue ocean rather than continuing to compete in the red ocean.

To encourage new challenges, we must create a social environment that supports bold challenges and the creation of new businesses. It is also important

<sup>&</sup>lt;sup>15</sup> Abbreviation for Price Book-value Ratio, an indicator of the relationship between a company's stock price and its net assets.

<sup>&</sup>lt;sup>16</sup> Return on Equity (ROE) is a value that indicates how much profit a company has generated from shareholders' investments. It is also an indicator of a company's management efficiency.

to improve the accuracy of estimates regarding the impact of population decline and confront its seriousness head-on.



Figure4 Growth Image

### 2.1.3 Using Software as a Growth Strategy

This growth strategy hinges on the use of digital technology, particularly software. Software is no longer limited to packaged programs and apps; it has become an essential part of everything from smartphones and consumer electronics to automobiles and social infrastructure. The superiority of software directly affects competitiveness and is linked to the creation of value for society as a whole.

Recently, the concept of "Software-Defined" has gained popularity in various fields, including software-defined vehicles (SDVs). In SDVs, the software controlling the hardware is updated continuously to respond flexibly and quickly to unpredictable and evolving needs.

#### Example: Software-Defined Vehicle

Even after selling the car, the software can be updated remotely to add functions and improve performance. This makes it possible to improve performance, driving assistance, and accident prevention functions and increases the possibility of realizing new functions that were previously impossible.

#### Example: Software-Defined Satellite

The Voyager spacecraft, launched in 1977, has been exploring beyond the solar system while undergoing software updates. Most recently, in October 2023, the fuel injection system was changed to extend the satellite's life.

#### Understand and extract software characteristics.

The modern era is known as the "VUCA age" (standing for variability, uncertainty, complexity, and ambiguity), and the ability to respond quickly and flexibly to unpredictable changes is becoming increasingly important. The concept of "software-defined" supports this agility, and its application to society as a whole is the "software-defined society."

In a software-defined society, all social systems are controlled and optimized by software. The integration of software and social infrastructure enables more flexible and efficient social management. This integration enables more flexible and efficient social management. This integration brings many benefits, such as efficiency, adaptability, fairness, safety, reduced environmental impact, and economic growth.

For instance, the concept of "Rule as Code (RaC<sup>17</sup>)," where legal systems and rules are implemented in software, is gaining popularity in a software-defined society. This will enable flexible and rapid operation in response to technological and social changes. Benefits include the automatic application of taxation and social security systems according to individual income and circumstances, eliminating cumbersome procedures. Additionally, people will be able to receive government services that meet their own conditions. It will also be possible to simulate how changes to the system will affect people in advance, and social rules can be optimized in a timely manner in response to social changes.

<sup>&</sup>lt;sup>17</sup> A method of codifying laws, regulations, and policies into a machine-readable format.

#### **Creating New Value with Software**

In a software-defined society, new technologies, such as AI, can be quickly applied to increase the value of products and services. Large amounts of data can be collected and analyzed by AI to make quick, accurate decisions that surpass human knowledge. AI can also collect large amounts of data for analysis. Through trial and error, it is possible to refine the results and create new value that has never been seen before. If Japan leads the transition to a software-defined society and continues to create new value, it will be a major driving force in realizing a sustainable economic society in which people experience affluence and happiness.

#### Take the initiative and participate in the social feedback loop.

However, we cannot reap the benefits of a software-defined society by remaining passive and waiting for digital technology to evolve. We must take the initiative to carry out experiments that solve social issues and promote the realization of ideas through a social feedback loop.

#### Redefining Industry through Digital Engineering

Digital engineering — the integrated use of digital models and underlying data to develop, test, evaluate, and maintain systems — is expected to facilitate visualization and collaboration, as well as enable rapid, accurate, data-driven decision-making<sup>18</sup>. The growing influence of software is entering a new phase, and new ecosystems are forming in a wide range of industry sectors, including manufacturing, urban development, aerospace, energy, health services, finance, transportation, and materials science<sup>19</sup>.

<sup>&</sup>lt;sup>18</sup> DOD INSTRUCTION 5000.97 DIGITAL ENGINEERING

<sup>&</sup>lt;sup>19</sup> "Welcome to Digital Engineering", Digital Engineering, Vol. 1, 2024

# 2.1.4 A major shift in software development has occurred due to rapid technological innovation.

The evolution of AI is fundamentally changing business models and work processes in all industries, including software development. The "Building Blocks" of software utilizing components is advancing, including the proliferation of open-source software and API<sup>20</sup> standardization.

#### The End of Labor-Intensive Software Development

An environment is being created in which AI can assist with or replace laborintensive tasks, such as code creation and test execution. AI is expected to rapidly be applied to tasks managed in terms of man-months and the number of steps required for creation. As development productivity improves dramatically, an evaluation system based on the value of results will be necessary.

## Value creation by highly skilled engineers responsible for strategic planning and requirements definition.

As many software and system development processes are likely to be replaced by AI, the role of humans in business and development will naturally shift to upstream processes, such as strategic planning, design, and defining requirements. These changes will significantly impact Japan and create opportunities. As companies face a growing shortage of resources due to a rapidly shrinking population, AI will handle repetitive and routine tasks. This will allow humans to focus on advanced problem solving and innovation. Consequently, a development system that optimizes the use of limited human resources while generating high added value is anticipated.

## Engineering competence is required to evaluate the validity and make an overall judgment.

On the other hand, even if development can be automated by AI, human engineering capabilities are still necessary to evaluate whether software and systems created by AI correctly meet their intended purpose. A comprehensive

<sup>&</sup>lt;sup>20</sup> Application Programming Interface: A mechanism for linking software, applications, web services, etc.

judgment that includes domain knowledge, logical thinking, conceptualization, and the ability to visualize and oversee the entire system is essential for correctly identifying ambiguities in requirements, inadequacies in specifications, and errors in modeling. If a system is built based solely on what AI presents, it may cause significant damage and pose security risks. Therefore, when using AI, humans must take responsibility for quality assurance, risk management, and decisionmaking.

#### Become someone who can expand their capabilities with AI.

In light of the above, it is highly likely that AI's role in development will expand further in the future and that personnel with only conventional development skills will become obsolete. Additionally, as other advanced technologies emerge, it will be essential to master them in order to properly identify and utilize them. Inevitably, the skill sets required of human resources will change significantly.

In the future, in addition to the ability to evaluate AI-generated deliverables, skills for upstream processes, such as strategic planning, design, and requirements definition, as well as managerial perspectives for implementation in business and society, will be more important. Although creating programs will require less effort, the ability to think abstractly and conceive and control mechanisms that augment human cognition will be necessary to cope with the diversification of input devices and the rapid increase in data volume and processing. These areas cannot be compensated for by conventional programming techniques alone. Therefore, in addition to individuals actively relearning and improving their skills, it is essential for organizations and society as a whole to develop and support a system for training software engineers who can lead the transformation of society and business.

#### Use existing components to speed up response time.

While modularization and the reuse of software components have long been pursued toward the "Building Blocks" of software development, recent years have seen further progress due to the enrichment of service components, progress in standardization, and the increasing performance of hardware. As a result, the trend toward Building Blocks is intensifying, with shorter software development lead times, quicker response to specification changes, and improved productivity and quality. In such an environment, traditional man-month-based<sup>21</sup> management is no longer viable, and evaluation based on the value created is required. In addition, the skills and knowledge of the personnel required have changed, and different capabilities are needed, such as architectural design and knowledge of the use of various components.

#### Employment and trading patterns will also be transformed

Technological innovations, such as AI and Building Blocks, tend to spread globally at an extremely rapid pace. In addition to these innovations, remote work, dual employment, and web conferencing have become commonplace, altering the nature of organizations and the way people work. It is important to take a broad view of technological change that includes these social impacts.

Additionally, the use of software subscriptions is increasing with the development of cloud technologies and services. Traditionally, packaged software was evaluated based on expected results and value after implementation. However, with the spread of subscription models, cost-effectiveness and value are clarified on a granular basis, such as monthly or per processing unit. Additionally, the "Fit to Standard" concept, which involves adapting one's company to standardized business processes rather than customizing them for one's own use, is spreading. Its adoption is accelerating due to the advantage of a quick response to updates.

<sup>&</sup>lt;sup>21</sup> The concept is based on "man-months," the amount of work that can be completed by one person over the course of one month.

#### 2.2 Our Vision for the Next Stage of Software.

For society as a whole to reap the benefits of digital technology and use it as a driving force for growth and solving social issues, it is essential that every citizen take an interest in digital technology and actively participate. Unlike other countries, Japanese society is not as severely divided and maintains an environment in which it is relatively easy to establish a broad dialogue. For example, a bottom-up improvement culture has taken root in corporate workplaces, where opinions are solicited from front-line employees and passed up through the management chain to executives. This style of dialogue-based collaboration can be further utilized as one of Japan's strengths in the future.

## Using the real world as a testing ground to gather wisdom through dialogue.

Proactively utilizing AI and data to build highly accurate hypotheses and repeat a rapid and efficient verification cycle is necessary. This approach enables a flexible response to social changes and achieves sustainable solutions to social issues and economic growth.

#### Vision

As diverse stakeholders engage in open dialogue, we can leverage the characteristics of software for rapid and frequent hypothesis testing and updates while actively utilizing AI and data. This allows us to demonstrate the unique Japanese meticulousness and high quality of our products. Furthermore, we will provide superior products and services that can be used internationally and contribute to building a sustainable economic society in which every citizen can experience affluence and happiness.



Through the value creation cycle outlined in this vision, we will enable businesses to develop quickly and flexibly in response to global changes. We will also realize an interoperable and scalable system and expand the value creation cycle by increasing the number of people who can work globally.

#### 2.2.1 What to work on in the future.

To realize the vision, it is essential to maximize the potential of digital technology and share its benefits with society.

Accurate information gathering and analysis are prerequisites for this. We must continuously understand the trends in software technology and global markets, and then strategically promote technological development, application, and human resource development.

The following four perspectives will be organized to promote the utilization of software and strengthen development capabilities.

#### (1) Organization

Instead of thinking along the two axes of user and vendor companies as in the past, collaboration between the two is becoming increasingly important. At the same time, collaboration among related parties, including the supply chain, is required more than ever. In the following, we discuss organizational reform efforts that are particularly important for realizing the vision.

#### **Business Model Transformation in the AI Era**

Situations will arise everywhere where the use of AI technology can solve previously insurmountable problems and provide higher value. A shift to a business model that accurately captures such opportunities for change is required. Focus on value creation that can be expected to generate high profits, rather than on trading labor hours.

## Integration of digital technology with other fields (integration of business and IT)

Problem solving requires collaboration between experts in the target area and experts in the available technologies, and it is important that not only digital technologies but also various technicians, researchers, and experts in business and systems work together to find appropriate solutions. Innovation will be accelerated when diverse experts develop a common vision and work together. From the outset, technical experts should be included in the study to properly evaluate technological options for solving problems. At the same time, technical experts must not confine themselves to their own areas of expertise, but must be equipped with a social perspective and interpersonal skills to facilitate the dialogue necessary to demonstrate their expertise.

#### Sharing case studies and creating opportunities for dialogue

Diverse perspectives from people with different backgrounds are essential to solving social issues. The voices of not only experts and government officials, but also residents and businesses facing challenges in the field are absorbed and their knowledge is shared. This will result in highly effective solutions and build cooperative relationships that transcend organizational boundaries.

#### Cooperation and standardization throughout society

Not only specific organizations working independently, but also society as a whole working together to standardize systems and processes, thereby laying the groundwork for effective use of data and technology. Examples include the development of common platforms and data spaces. Standardization contributes to new entrants and cost reduction, and is a major force for promoting innovation.

#### Transformation into a High Agility Organization

In a changing environment, it is impossible to systematically try to achieve a perfect solution. Creating value in uncharted territory requires agility to make decisions in the midst of uncertainty, quickly admit mistakes, and correct course. In order to control risks and promote organizational learning, consideration must also be given to systematically incorporating technological measures from the perspective of enhancing agility, such as utilizing existing components and bringing system development in-house.

#### Strengthen ordering capabilities

As acquirers of information systems, those who use information systems to perform their tasks have the responsibility to build consensus within the company and clearly communicate the requirements to the suppliers of information systems (including internal development departments). They must also implement appropriate task management for development and operation. As an ordering party, it is necessary to ensure compliance and to strengthen its ordering capabilities by, for example, utilizing standard visualization methods. The ratio of information technology investment to private-sector capital investment is 17.9% as of 2022, which is a large proportion, and since the ratio of information technology investment will further increase in the future, it is essential for those who place orders to improve their own digital skills.

#### Responding to the mobility of human resources

In the software industry, the mobility of human resources is increasing year by year, transcending the traditional boundaries between the development side and the user side. Not only vendor companies but also user companies on the user side need to demonstrate that their organizations are capable of continuously providing growth opportunities through the presentation of career paths, introduction of skill standards, and appropriate performance management, so that excellent human resources can stay and demonstrate their abilities. At the same time, it is necessary to establish a mechanism for visualization and accumulation of knowledge so that operations can be maintained smoothly even when there is a flow of human resources.

#### (2) Human resources

The shortage of human resources in the software and digital fields has been pointed out on various occasions. Improving the literacy of users and training experts is an urgent issue. In this section, we discuss efforts that are particularly important for this purpose.

#### Improve user literacy

In order to spread the benefits of digital technology widely, it is essential for non-IT technicians such as citizens, users, user company managers, and government officials to improve their IT literacy in the age of AI according to their respective positions. In addition, it is important for society as a whole to develop a culture of challenge and trial and error, with a mindset of "not seeking perfect service from the beginning," "nurturing the entire society," "sharing the joy of participation," and "viewing failure as a learning opportunity. Once such a culture takes root, it can be expected that digital technology will be used continuously and skills will improve.

#### Professional development and intensive training

Apart from improving the literacy of users as a whole, it is also important to create a system in which companies and universities intensively train high-level experts with deep knowledge in specific technological areas and link their expertise to solving social issues. In fields such as advanced software development, AI technology, and security, R&D led by experts will greatly influence competitiveness. Experts are expected to aim for the world's top level and contribute to and actively participate in the creation of world-class technologies while competing and cooperating with experts from other countries.

#### Improvement of global skills

As the domestic market shrinks, it is important to expand globally with an eye on overseas markets. It is also important for both companies and engineers to aim for growth through constant awareness of the latest technologies and friendly competition with overseas companies and research institutions. Skills that anticipate globalization, such as language and cross-cultural understanding, the ability to quickly catch up with overseas technological trends, and an awareness of proactively using what is available, will be in greater demand.

It is also important to participate in global communities such as OSS and grow through friendly competition on a global scale.

#### (3) Technology

In order to respond to the increasing complexity of social issues, technologies and mechanisms that enable diverse stakeholders to engage in dialogue, promptly verify the results, and provide feedback are required. Below we discuss some of the technologies that will be particularly important in realizing a software-defined society.

#### Requirement definition, design, development, and testing using AI

AI is bringing about major changes in software development. AI is being used in all processes of the software lifecycle, including specification creation, code generation, and testing, and will also facilitate reverse engineering. The skill sets of the human resources required in the future are also expected to increase. It is also highly likely that the skill sets of the personnel required in the future will focus more on upstream processes and validation.

#### Visualization and modeling for dialogue facilitation and decision making

In order to facilitate smooth decision-making amidst the differing opinions and values of the parties involved, it is necessary to actively utilize visualization and modeling techniques in documentation to promote common understanding. The use of a common language (model) can accelerate consensus building overcoming differences in position and expertise by clearly expressing situations and issues, suppressing differences in perception, avoiding emotional arguments, and promoting discussion from an objective perspective. It also makes it easier to grasp abstract concepts and to adjust flexibly in response to changes in the environment and circumstances.

#### Simulation technology that enables prior verification

In the age of VUCA, it is difficult to predict the future based on past rules of thumb. It is important to explore diverse possibilities through multifaceted studies and simulations by utilizing business modeling, VR/AR, and digital twin. In particular, the ability to replace physical experimentation, prototyping, and construction activities will be of great benefit in the manufacturing and construction industries. Furthermore, the impacts and risks of each alternative can be simulated, and data and logic can be used to improve persuasiveness and increase the likelihood of rational decisions.

#### Agile development methodology for rapid hypothesis testing

To achieve rapid hypothesis testing, it is more important to "adapt quickly" than to "proceed as planned. Approaches to this include agile development methods such as Agile Development<sup>22</sup> and DevOps<sup>23</sup>.

#### **Building Blocks and Open Source**

The "Building Block" approach, in which small independent elements are combined to build a large system, is important. This approach makes it possible to construct a system that is resistant to change because only the necessary parts can be flexibly updated without having to rebuild the entire system in response to changes in the market or technology. Building Block is often provided as Open Source Software (OSS)<sup>24</sup>, and there are also commercial Microservices<sup>25</sup>. Proactive use of these will be important in a rapidly changing society.

#### Data engineering to provide data for software

It is important for software to be able to access data efficiently, and databases and data linkage infrastructures need to be developed for this purpose. In addition, it is important to realize a data management system that provides high-quality data for accurate processing.

#### (4) Institutions and Infrastructure

In a society undergoing rapid change and a declining population, flexibility and efficiency are required in social systems and infrastructure. In this section, we discuss some of the initiatives that are particularly important for achieving these goals.

<sup>&</sup>lt;sup>22</sup> A method of repeating the development, implementation, and testing of functions in a short cycle in the development of systems and software.

<sup>&</sup>lt;sup>23</sup> A method to coordinate software development and operations to develop and deliver software more quickly and efficiently

<sup>&</sup>lt;sup>24</sup> A generic term for software that allows users to use, examine, reuse, modify, extend, and redistribute the source code for any purpose.

<sup>&</sup>lt;sup>25</sup> A method of building an application by combining multiple independent services.

#### Digitization of institutional information

The use of digital technology opens up the possibility of operating the legal system more efficiently and flexibly. In addition, it is necessary to accurately respond to changes in technology and society. This will require not just improvements in the speed of software development, but also a mechanism to achieve a fundamental review of operations that incorporates software technology in the creation of systems, such as legal tech, and the development of common contract and development standards.

#### Realization of a Safe and Secure Society

As the use of software expands into all areas, there is an increasing need to ensure security and privacy. It is also essential to strike a balance between convenience and innovation. In response to these advanced requirements, the development and deployment of services that take advantage of Japan's technological capabilities is expected.

#### Developing a system that incorporates Edge

In order to maintain and manage public infrastructure such as roads, bridges, water supply and sewage systems, and electric power grids with less manpower in a Japanese society where the population will continue to decline, a system is required that utilizes data collected from installed sensors to detect abnormalities and perform predictive maintenance in real time. In order to effectively utilize such a large amount of sensor data, it is necessary to develop an efficient management mechanism, including the architecture of Cloud-Edge-IoT<sup>26</sup>.

#### 2.3 Road Map

Based on the 2.20" and the "2.4Gap between manifested vision and reality", we have organized a roadmap for the realization of a sustainable economic society in which each citizen can experience prosperity and happiness.

<sup>&</sup>lt;sup>26</sup> Mechanisms and technologies that combine cloud computing, edge computing, and the Internet of Things (IoT).

Around 2030, AI-based software and system development will be in full swing, and we will see a shift away from labor-intensive development. In order to cope with such an era, it is necessary to promote necessary initiatives in terms of "Organization," "Human resources," "Technology," and " Institutions and Infrastructure" as listed in "2.2.1 What to work on in the future.

By promoting these initiatives, we aim to achieve the transition to a softwaredefined society by 2040, overcome social challenges, and realize a sustainable economic society.



Figure6 Roadmap

There are also Sustainable Development Goals<sup>27</sup> (Sustainable Development Goals, SDGs) that the United Nations aims to achieve by 2030, and as part of this, the Global Digital Compact (GDC)<sup>28</sup> was adopted in September 2024 to accelerate efforts from the digital side. The GDC was adopted in September 2024 to accelerate efforts from a digital perspective. Many countries have also set 2030 as the target year for their digital strategies, and it is an important milestone for the

<sup>&</sup>lt;sup>27</sup> United Nations Information Center "Sustainable Development Goals"

https://www.unic.or.jp/activities/economic\_social\_development/sustainable\_development/sustainable\_deve lopment\_goals/

<sup>&</sup>lt;sup>28</sup> United Nations "Global Digital Compact".

https://www.un.org/digital-emerging-technologies/global-digital-compact

realization of a digital society. Japan is also aiming for a digital society by 2030, but as a preliminary step, it needs to overcome the "2025 cliff<sup>29</sup>", which includes issues such as breaking away from legacy systems and strengthening human resources.

Since many parties are involved in software and system development, the ideal is diverse. Platforms and companies that provide service components are required to provide software based on accurate collection and analysis of social needs, and to make continuous improvements. In particular, they need to have a global perspective, develop services while collecting the latest information, and establish a system that allows them to practice spiral improvement. Furthermore, companies that provide embedded software and software for Edge devices are expected to expand globally, as there are relatively few institutional and language barriers in Japan, and it will be important to strengthen their efforts to be aware of network services.

In addition, companies that promote DX (digital transformation) and companies that support it need to develop an architecture that can respond quickly to changes in society and technology, constantly incorporate the latest technologies, and create a system that can realize a combination of technologies and components that constantly produce high performance. It is necessary to create a system that can always incorporate the latest technologies and combine technologies and components that produce high performance.

Finally, individuals need to consider skills-based career management and career advancement, while developing skills with an awareness of the global market. The English language barrier is rapidly becoming lower with the evolution of AI. In the future, it will become increasingly important to have an attitude of gathering information, participating, and practicing at a global speed.

#### 2.4 Gap between manifested vision and reality

In order to achieve speed and flexibility under the vision and create new businesses, it is necessary to overcome the gap with reality. The need for business

<sup>&</sup>lt;sup>29</sup> METI "DX Report - Overcoming the IT System "2025 Cliff" and Full-Scale Development of DX" https://www.meti.go.jp/shingikai/mono\_info\_service/digital\_transformation/20180907\_report. html

reform and the sophistication of development techniques have been pointed out in the past, but improvements have been slow in coming. We must identify the gaps and fill them for further development.

#### Galapagosization due to lack/stagnation of information collection

Due to insufficient global information gathering, the introduction of the latest technologies and methodologies has remained stagnant to the present. As a result, in Japan, it is easy to be carried away by superficial topics, leading to a delay in infrastructure development. Furthermore, awareness-raising activities for management are not sufficient, and awareness of the need for change has not fully penetrated the market.

#### Impact of society-wide atrophy and risk aversion on innovation

Amid rapid technological innovation, ambiguous areas (gray zones) in the existing system are increasing. While domestic companies are taking a cautious investment stance due to concerns about institutional risks, foreign companies see this as a blue ocean and are launching new software services one after another to dominate the market. In addition, excessive attention to security, privacy, and other risks has been seen in some cases to inhibit productivity and innovation, and efforts are needed to strike a balance between the two.

#### Delay in business reform

The current situation is that business reform based on digitalization has not progressed sufficiently due to being bound by conventional practices and systems. Although the introduction of non-customized software such as business packages is gradually spreading, many clients plan software development without conducting business reform, and contractors, while aware of the issues, follow their clients' requests, resulting in the repeated construction of inefficient software.

## Unmodernized requirements definition, design, development, and operational methods

Many businesses still rely on office software for documentation and drafting for system design, and have yet to adopt design and development methods that have become mainstream worldwide, such as model & simulation. This situation is very different from other engineering disciplines such as mechanical, architectural, and electrical, where model-based manufacturing and simulation using CAD<sup>30</sup> are prevalent. In addition, the Building Blocks of software using building blocks such as OSS has not progressed, and continuous improvement mechanisms such as DevOps have not fully taken root because the client and contractor are different.

#### Dependence on man-months

The use of subscription<sup>31</sup> and cloud-based package services<sup>32</sup> is gradually spreading, and the concept of compensation based on the value created by software is becoming more widespread. However, man-month-based contracts are still the norm in software development, and as in the manufacturing industry, there is a need to clearly demonstrate the return on investment for the value created.

#### **Remaining legacy systems**

Many Japanese companies and public institutions still have legacy systems, and maintaining and operating them has become a challenge. Black box IT systems have difficulty adapting to modern IT environments such as AI and data utilization, leading to higher operating costs, lower operational efficiency, and reduced competitiveness.

<sup>&</sup>lt;sup>30</sup> Computer Aided Design: Technology that uses computers to create blueprints and drawings.

<sup>&</sup>lt;sup>31</sup> A business model in which a fee is paid for the right to use the service for a certain period of time.

<sup>&</sup>lt;sup>32</sup> A form of service that provides software and services remotely over the Internet.

#### IT person shortage

The shortage of IT personnel is becoming more serious every year and is expected to accelerate further in the future. In addition, the skill sets required are likely to change significantly with the emergence of AI and other new technologies. To cope with this situation, it is essential to improve productivity through thorough utilization of AI and data, as well as to strengthen reskilling and human resource development so that they can flexibly adapt to the rapidly changing technological environment.

## 3. Discussion of future directions

The development of digital technology has increased the importance of software more than ever, and efforts have begun to address the new situation. The Digital Governance Code 3.0<sup>33</sup> was revised in September 2024 as a guideline for management, and DX certification<sup>34</sup> and DX promotion indicators<sup>35</sup> are being reviewed accordingly. Through these efforts, the digitalization of companies is being promoted, and software and data management and human resources are important pillars in this process.

The Digital Skill Standards (DSS)<sup>36</sup> are systematizing skills and human resources, and the Industrial Cyber Security Study Group<sup>37</sup> is promoting the concepts of "Secure by Design<sup>38</sup> " and "Secure by Default<sup>39</sup> " in terms of security, as well as strengthening measures for the entire supply chain. In addition, the enhancement of measures for the entire supply chain is also being promoted.

These are the basic environment, and as the role of software has entered a new phase, it needs to be strengthened even further.

<sup>&</sup>lt;sup>33</sup> Ministry of Economy, Trade and Industry, "Digital Governance Code," https://www.meti.go.jp/policy/it\_policy/investment/dgc/dgc.html

<sup>&</sup>lt;sup>34</sup> Ministry of Economy, Trade and Industry "DX Certification System"

https://www.meti.go.jp/policy/it\_policy/investment/dx-nintei/dx-nintei.html

<sup>&</sup>lt;sup>35</sup> IPA, "Guide to DX Promotion Indicators," https://www.ipa.go.jp/digital/dx-suishin/about.html

<sup>&</sup>lt;sup>36</sup> Ministry of Economy, Trade and Industry, "Digital Skill Standards,"

https://www.meti.go.jp/policy/it\_policy/jinzai/skill\_standard/main.html

<sup>&</sup>lt;sup>37</sup> Ministry of Economy, Trade and Industry, "Industrial Cyber Security Study Group,"

https://www.meti.go.jp/shingikai/mono\_info\_service/sangyo\_cyber/index.html

<sup>&</sup>lt;sup>38</sup> IT products (especially software) must be secured from the design phase. Identification of prerequisite cyber threats and risk assessment are essential.

<sup>&</sup>lt;sup>39</sup> Users (customers) should be able to use IT products (especially software) securely immediately after purchase without additional cost or hassle.

### 3.1 Overview

Based on the axes of effort indicated in "2.2.1What to work on in the future ", the proposed activities for FY2025 and beyond are organized around this committee. This committee plans to sequentially implement activities related to software enhancement, mainly in technology and software engineering, after determining priorities. Some of the related activities that will be undertaken outside of this committee, such as security, human resources, and DX promotion, will be described in "3.3Movements outside this committee".

Table3 List of proposed activities centered on this committee for FY 2025 and beyond

Point of View	Axis of an initiative	Proposed Activity Themes
General	General	Public Awareness Activities
		(Software-Defined Society, Value-Oriented, etc.)
	Information Gathering and Analysis	Gathering and publicizing the latest domestic
		and international trends
Organization	Cooperation and standardization	Facilitating dialogue across organizational
	throughout society	boundaries
Technology	Requirement definition, design,	Advancement of AI utilization
	development, and testing using AI	
	Visualization and modeling for dialogue	Promotion of advanced requirements definition,
	facilitation and decision-making	modeling & simulation
	Simulation technology to enable prior	
	validation	
	Agile development methods for rapid	
	hypothesis testing	
	Building Blocks and Open Source	Promote open source and Building Blocks
	Data engineering to provide data for	Promoting Data Engineering
	software	
Institutions	Digitization of Institution information	Promoting Legal Tech
and		Promote standardization of contracts, terms and
infrastructure		conditions, etc.
	Developing a system that incorporates	Promotion of Cloud-Edge-IoT
	Edge	

The Committee is scheduled to continue to meet once a quarter in FY2025 as a forum for reviewing and confirming the status of the project (the content of the project will be reviewed as necessary based on progress and trends in the world).

## 3.2 Movement around this committee

The following is a detailed description of the activities presented in "3.1 Overview".

## 3.2.1 Public Awareness Activities

### **Current Status and Objectives**

- Society as a whole does not have a deep understanding of the importance of dialogue and software, the idea of a software-defined society, and the need for each of the initiatives recommended in this report.
- We have not been able to get out of the man-month basis and have not been able to move to value-based transactions.
- Therefore, we aim to achieve a state in which their importance is widely recognized and the entire society is encouraged to take a positive attitude toward actively reaping the benefits of digitalization, and in which dialogue is activated.

- Preparation of public awareness materials
  - Create and publish a guide that communicates the contents of this report in an easy-to-understand manner.
- Activities in cooperation with industry associations, etc.
  - Consideration will be given to establishing a subcommittee in cooperation with industry associations.

## 3.2.2 Gathering and publicizing the latest domestic and

## international trends

## **Current Status and Objectives**

- In order to ensure speed and flexibility in responding to global changes, it is necessary to continuously and accurately grasp the world's software technology trends and markets.
- However, there are still many design, development, and operational methods that have not been modernized and information that is Galapagosized.
- Therefore, we aim to improve the literacy of society as a whole by regularly collecting and disseminating information on the situation in Japan and the latest trends in the world.

## **Assumed Activities**

- · Research and dissemination of overseas trends
  - To collect and disseminate information on trends in advanced software research institutes and international conferences in Europe and the United States.
- Domestic Software Trend Survey
  - Conduct an annual software trend survey and publish the results in open data.

## **3.2.3 Facilitating dialogue across organizational boundaries**

## **Current Status and Objectives**

- Companies and organizations facing business challenges are each considering the use of digital technology and conducting various trials and social implementations. Although many successful examples have been reported, the impact has yet to be felt to the extent of changing industrial structures and social life.
- People working to solve critical problems must know the appropriate technologies and use a combination of diverse professional skills to apply and implement them effectively.

 When actually applying the available technology, it is important to properly understand what is easy and what is difficult. Placing unreasonable demands on engineers based on inadequate knowledge will not lead to the desired results. The key to success lies in matching the problem to be solved with the appropriate technology, as well as sufficient cooperation between the parties involved.

#### **Assumed Activities**

- Promoting dialogue among diverse organizations
  - Consider measures to improve the environment for interaction and information sharing among diverse organizations and to promote their participation.
- Promoting dialogue among experts in different fields
  - > Facilitate dialogue among experts in different fields.

## 3.2.4 Advancement of AI utilization

#### **Current Status and Objectives**

- It is said that the introduction of AI-based requirements definition, design, development, and testing will spread, and the way software is developed and operated will change dramatically.
- With technology advancing every day, many people do not fully understand its use, benefits, and risks.

#### **Assumed Activities**

- · Disseminating information to promote AI utilization
  - To consolidate and disseminate information on requirement definition, design, development, testing, reverse engineering, etc. using AI.

## 3.2.5 Promotion of advanced requirements definition, modeling

## & simulation

#### **Current Status and Objectives**

 Design using modeling is widely used in the automotive and aerospace/defense industries, but the enterprise domain is still predominantly document-based and is not very widespread. Some are beginning to make use of modeling, such as in no-code and low-code.

- In the age of AI, more emphasis will be placed on upstream processes such as planning and defining requirements and demands.
- The use of modeling and simulation allows for extensive and rapid dialogue and hypothesis testing.
- Based on the above, we aim to promote modeling and simulation in the upstream process and to make development agile.

## Assumed Activities

- Creating a modeling guide
  - Develop a guide on the current status, significance, and methodology of modeling.
- Creation of a Guide to Requirements and Requirements Definition
   Methodology
  - Develop a guide on the current status, significance, and methodology of requirements and requirements definition.
- Collection and dissemination of advanced modeling and simulation case studies
  - Collect examples of the use of modeling and simulation in Japan and abroad.

## 3.2.6 Promote open source and Building Blocks

## **Current Status and Objectives**

- In order to achieve rapid development in the VUCA era, active use of open source software (OSS), one of the building blocks, is essential.
- While the use of OSS is progressing in Japan, the ecosystem has not yet been sufficiently developed, including contributions to OSS projects by the government and private sector, the development of utilization policies, and the training of open source personnel.
- In light of this situation, we aim to achieve a state where the government and private sector understand the importance of increasing their

responsiveness to the open source ecosystem and can practice giving back to the OSS community.

• It also aims to Building Blocks, including open source.

### **Assumed Activities**

- Understand the current status of the open source ecosystem and consider measures to realize it
  - > Examine the state of the open source ecosystem and how to sustain it.
- Spreading awareness of the organization's strategic decision-making process
  - Organize and disseminate information on the impact of open source on business.
- Raising awareness of Building Blocks
  - Organize and disseminate information about the Building Blocks. In addition, organize information on the concept of value.
  - In the case of Building Blocks and continuous updating of each component, management of its components will be important. To this end, SBOM<sup>40</sup>, which manages software configuration, will be studied and promoted.

## 3.2.7 Promoting Data Engineering

## **Current Status and Objectives**

With the rapid digitization of information through AI and other means, and the increasing importance of data-driven decision making, there is a growing need for "data engineering" to build and operate an infrastructure for efficiently collecting, storing, processing, and analyzing large amounts of data. In addition, ensuring a data management mechanism that provides high-quality data can ensure accurate processing.

<sup>&</sup>lt;sup>40</sup> Software Bill of Materials: A bill of materials for software that includes the names of the components that make up the software, version information, dependencies, developer information, etc.

• On the other hand, data engineering is still a new concept, and it is not yet widely used in Japan.

### **Assumed Activities**

- · Dissemination of information to promote data engineering
  - Consolidate and disseminate information on data linkage infrastructure, data design, and data management.

## 3.2.8 Promotion of Legal Tech

### **Current Status and Objectives**

- As for domestic trends, the Digital Agency is promoting the digitization of legislative affairs and the promotion of data utilization of laws and regulations<sup>41</sup>, but this has yet to spread throughout society.
- By expressing laws in software, legal technology can be used to shorten the law and rule-making cycle and to verify laws in advance, and we believe that legal technology will help realize a highly agile software-defined society.
- Based on the above, we aim to conduct surveys and studies on methodologies for incorporating legal technology into the formulation and operation of laws and rules, etc., and to develop a foundation for promoting its diffusion.

- Basic research and demonstration in collaboration with universities, private sector, and organizations
  - We will grasp the status of international efforts, organize the overall picture, verify the effectiveness through legal tech demonstrations, and examine methodologies that can be commonly referred to when formulating laws and rules.

<sup>&</sup>lt;sup>41</sup> Digital Agency, "Promotion of Digitization of Legislative Affairs and Utilization of Data on Laws and Regulations," https://www.digital.go.jp/policies/legal-practice

## **3.2.9** Promote standardization of contracts, terms and conditions, etc. Current Status and Objectives

- In relation to the standardization mentioned in the technology pillar, IPA has long published a common frame based on the Software Life Cycle Process (henceforth SLCP)<sup>42</sup> and the Information System Model Transaction and Agreement (henceforth Model Agreement)<sup>43</sup> as well as documents and templates that can be used as standards.
- However, both documents do not keep up with the latest developments and technology, and the information is outdated.
- As for the world's needs, there is a high demand for new SLCPs and templates for contracts and terms and conditions for new technologies such as AI and data utilization.
- Based on the above, we aim to promote and develop new standards and modernization.

- · Research and disseminate the latest information on the software lifecycle
  - Collect, organize, and disseminate information on software lifecycle processes and system lifecycle processes, etc.
- Expansion of model contracts and development of templates for new contracts, clauses, terms and conditions, etc.
  - Develop a model for rules for software and related conventions such as APIs.

<sup>&</sup>lt;sup>42</sup> SLCP: Software Life Cycle Process, a series of work processes from software development to operation and maintenance of the developed product.

 $<sup>^{\</sup>rm 43}$  IPA, "Information Systems, Model Transactions and Contracts,"

https://www.ipa.go.jp/digital/model/index.html

## 3.2.10 Promotion of Cloud-Edge-IoT

## **Current Status and Objectives**

- In order to maintain and manage public infrastructure such as roads, bridges, water supply and sewage systems, and electric power grids with less manpower in a Japanese society with a declining population, it is essential to have a system that can detect abnormalities and perform predictive maintenance in real time by utilizing data collected from installed sensors,
- In order to efficiently utilize large amounts of data such as sensor information, it is important to introduce edge computing, which distributes the load of the cloud and enables real-time processing.
- Although Japan has a high market share in the field of sensor technology, it has not yet fully designed and developed an integrated architecture that utilizes sensors.
- Based on the above, we aim to promote and develop an efficient management mechanism, including the Cloud-Edge-IoT architecture.

- Disseminating information on the latest trends and leading practices in Japan and abroad
  - > Organize domestic and international Cloud-Edge-IoT trends.
- Study to establish a domestic promotion system
  - Organize domestic related groups and organizations, and discuss the nature of cooperative relationships.

## 3.3 Movements outside this committee

The following is a partial list of developments outside this committee related to the axis of initiatives. See the links in the footnotes for details.

Organization	Examples of Activities	Related Initiatives Axis
IPA "Legacy Systems Modernization Committee" $^{\pm\mp}$	Study and promotion of legacy system	Organization] Transformation into a High
ー! ブックマークが定義されていません。	breakaway	Agility Organization
IPA Digital Infrastructure Center	DX Certification System <sup>34</sup>	Organization] General
Digital Transformation Department	DX Promotion Indicators <sup>35</sup>	
	Digital Case Study Database44	
IPA "Study Group on the Ideal Indicators for	Review of DX Promotion Indicators	Organization] General
Promoting Corporate DX		
IPA "Study Group on the Ideal Indicators for		
Promoting Corporate DX <sup>45</sup>		
IPA Digital Infrastructure Center	Promoting Data Space <sup>46</sup>	Organization] Cooperation and
Digital Engineering Department		standardization throughout society
data space group		Technology] Data engineering to provide data
		for software.
IPA Digital Human Resource Center	National Examination for Information Processing	Human resources] General
	Technicians <sup>47</sup>	
	Digital Skill Standards (DSS <sup>36</sup>	
Ministry of Economy, Trade and Industry "Study	Revision of Digital Skill Standards (DSS)	Human resources] General
Group on Digital Human Resource Development in		
the Society 5.0 Era		
Study Group on Digital Human Resource		
Development in the Age of Society 5.0" by the		
Ministry of Economy, Trade and Industry <sup>48</sup>		
IPA Digital Infrastructure Center	unexplored project49	Human resources] Training of specialists and
Innovation Department		intensive training
IPA Security Center <sup>50</sup>	Reinforcement of information security measures	Institutions and Infrastructure] Realization of
	Promote secure information infrastructure	a Safe and Secure Society
Ministry of Economy, Trade and Industry	Strengthening Industrial Cybersecurity	Institutions and Infrastructure] Realization of
"Industrial Cyber Security Study Group <sup>51</sup>		a Safe and Secure Society

#### Table4 List of movements outside this committee

<sup>44</sup> IPA "Digital Case Study Database," https://case-studies.ipa.go.jp/

<sup>45</sup> IPA, "Study Group on the Ideal Indicators for Promoting Corporate DX".

https://www.ipa.go.jp/disc/committee/dx-suishin-committee.html

<sup>46</sup> IPA, "Promoting Data Space," https://www.ipa.go.jp/digital/data/data-space.html

<sup>47</sup> IPA, "Exam Information," https://www.ipa.go.jp/shiken/index.html

<sup>48</sup> Ministry of Economy, Trade and Industry "Study Group on Digital Human Resource Development in the Society 5.0 Era".

https://www.meti.go.jp/shingikai/mono\_info\_service/society\_digital/index.html

<sup>49</sup> IPA, "About Unexplored Projects," https://www.ipa.go.jp/jinzai/mitou/about.html

<sup>50</sup> IPA, "Information Security," https://www.ipa.go.jp/security/index.html

<sup>51</sup> Ministry of Economy, Trade and Industry, "Industrial Cyber Security Study Group,"

https://www.meti.go.jp/shingikai/mono\_info\_service/sangyo\_cyber/

## 4. Conclusion

Unlike fields such as machinery and architecture, where engineering has been established through millennia of history, software has been engineering for as short a period as 100 years. Furthermore, as can be seen from recent changes, technology is changing on a quarterly or monthly basis. It is difficult to establish engineering in such a context. However, given the current situation where software is the foundation of society, it is imperative to solve this difficult problem.

The minimum that must be achieved as engineering is to establish reproducibility and verifiability, as well as interoperability and the ability to model & simulate. Unfortunately, these are difficult to achieve in a world designed with office software.

In addition, the move away from the man-month has long been talked about, but has yet to be realized. While many things in society are traded based on the value of how much one is willing to pay for the product or service, in software, prices are still formed based on the cost of how many people made the product. On the other hand, software is beginning to show signs of being valued according to its value through applications and subscriptions, and as the methods of service realization are changing, such as the use of AI and the Building Blocks, we may finally be able to break free from this peculiar industry practice.

The social environment is changing dramatically with AI, cloud services, Building Blocks, digital twin, and even global marketization. Moreover, as social issues such as a declining population reach their limits, the entire software industry needs to rethink the nature of engineering and change toward solutions.

While organizational transformation is also important, human resource mobility is also increasing. It is also possible for human resources themselves to pivot their skills to adapt to changes in the environment and to effect change. The transformation of human resources may begin prior to the transformation of the organization. Both organizations and human resources will need to be aware that they will be selected. To this end, it will be necessary to swiftly grasp changes in the environment and work for change.

This committee has extensively analyzed and discussed the situation in Japan and abroad, and we hope that this report will be the first step toward change toward 2030 for globally competitive user companies, vendor companies, and engineers.

> Information-technology Promotion Agency, Japan Digital Infrastructure Center Kenji Hiramoto, Center Director



This report is provided "as is" without warranty of any kind, either express or implied, including but not limited to the implied warranties of usefulness, accuracy, or noninfringement of intellectual property rights.

In no event will we be liable for any damages incurred by readers of this report as a result of their use of the information contained herein.