Hitachi Research Institute Report

Intensifying Competition for Supremacy over Social and Industrial Data and Data Accumulation in Edge Pursued by the EU

Takeshi Matsumoto, Senior Manager, 2nd Research Department
Daisuke Yasuda, Associate Senior Researcher, Management Research Group, 2nd Research Department

It has been a while since data came to be referred to as the "oil of the 21st century." In 2011, the World Economic Forum focused on the value of personal data and, in its report titled "Personal Data: The Emergence of a New Asset Class" issued the same year, emphasized the high economic value of personal data, stating that "Personal data is the new oil of the Internet and the new currency of the digital world." Data can easily be collected via the Internet, and enclosures and monopolization by companies are likely to occur. In fact, platform providers, such as GAFA[1] in the U.S. and BAT[2] in China, have grown rapidly by leveraging their capability to collect and utilize personal data. The competition between U.S. and Chinese firms to collect personal data has developed into a political issue between the two countries and is intensifying. In the 10 years since the World Economic Forum released the report, we have seen active investments in robotics, IoT and other digital technologies in the area of social and industrial systems and wider penetration of IoT devices. Consequently, the use of not only personal data but also data on things (referred to as "Social and Industrial Data" in this paper) has come to be recognized as a source of economic growth. And today, competition between countries and between companies over Social and Industrial Data is intensifying, as was the case with personal data. A point to highlight is that in addition to the U.S. and China, the EU lies at the center of this competition. The EU is highly competitive in industrial systems, particularly in the manufacturing industry, and has been actively engaging in data accumulation and use in both policy deployment and corporate activities. This paper provides an overview of digital technology investments and the expansion of data generation and distribution in social and industrial systems and examines the intensifying hegemonic competition among the U.S., China, and the EU over data. At the same time, it discusses the EU's efforts to construct its own data governance architecture, which is clearly different from those of the U.S. and China, for the purpose of data accumulation and use.

1. Expanding Social and Industrial Data

Corporate investment in digital technology has been increasing in recent years. According to a survey conducted by the World Economic Forum, investments by 16,000 leading firms in 14 industries around the world expanded 1.6 times from approximately USD 1.5 trillion to USD 2.4 trillion in four years from 2016 to 2020. Looking at the composition of investment targets, investments in SNS, etc. by digital service providers dropped from 35% to 25% while investments in IoT and robotics by social and industrial system companies rose from 55% to 58%, driving the overall investment amount. Generation of digital data is also expanding. According to IDC, a research firm, the amount of data generated worldwide is expected to grow rapidly and increase about fivefold from 33 zettabytes in 2018 to 175 zettabytes in 2025. If we divide this into personal and Social and Industry Data, it is predicted that personal data will lead the expansion at an annual average growth rate of 26.0%, from 19 to 96 zettabytes. Meanwhile Social and Industrial Data is expected to increase at a faster rate of 28.0%, from 14 to 79 zettabytes, driven by active investment in IoT. Social and Industrial Data are generated and distributed through a social and industrial system consisting of a cloud platform, edge, and communication infrastructure linking the same. The edge includes a motion device, such as a machine tool, robot, and vehicle, a sensing device, such as a camera and sensor, and a control system such as PLC.[3] Operation information is sent from the edge device to the cloud platform via the communication infrastructure. Conversely, data, such as production plans, operation plans, control instructions and set values, are sent from the cloud platform to the edge via the communication infrastructure.

2. Intensifying Hegemonic Competition among the U.S., China and the EU over Social and Industrial Data

With the digitalization of social and industrial systems in mind, the world's leading countries and regions have begun to focus on these digital technologies and Social and Industrial Data as sources of industrial competitiveness. Let's take a look at the initiatives of each country and region in the aforementioned three areas of cloud platforms, communication infrastructure, and edge. The U.S. is intensifying its research on AI for national security purposes. China is pursuing an industrial strategy of reinforcing the development of 5G/AI and robots. The EU is promoting digitalization of the manufacturing industry as one of its digital single market policies. Each country is starting from an area of its strength while beginning to expand into other areas and boost its competitiveness.

2.1 U.S.: Cloud-consolidation of data driven by private Investment

The strength of the U.S. lies in the international competitiveness of the cloud platforms developed by private companies. According to Gartner, in the public cloud market,

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[1]   A collective acronym for the four firms: Google, Apple, Facebook, and Amazon.
[2]   A collective acronym for the three firms: Baidu, Alibaba, and Tencent.
[3]   Programmable Logic Controller.

U.S. firms, such as Amazon and Microsoft, account for large shares of 89% of the U.S. market and 68% worldwide.[4] In addition, these firms are looking to leverage their software technology to advance into the area of communication infrastructure while increasing their investments in cloud platform development. For example, Microsoft acquired Affirmed Network, a network virtualization software company, in March 2020 and began providing carriers with cloud-based 5G virtualization solutions. Compared with these efforts by private firms, the U.S. government's policy-based involvement in data accumulation has been limited thus far, with a focus on tightening sanctions against Chinese firms by strengthening export controls and inward investment restrictions related to 5G. In the U.S., the private sector's investment has played a leading role in consolidating, integrating, and utilizing data in the cloud platform, and the government seems to be calmly observing the efforts of these private firms or avoiding taking restrictive policies.

2.2 China: New infrastructure plan for integrating data on cloud

China's strength lies in communication infrastructure, particularly 5G. Communication infrastructure is the "pipeline" of data, which connects the edge with the cloud platform. Having strength in the "pipeline" works to their advantage in the generation and distribution of Social and Industrial Data. China's Huawei and ZTE are proceeding with the international deployment of 5G base stations, and as mentioned above, the U.S. government has tightened regulations on China, causing friction between the two countries. This is a sign that China's 5G is technically competitive enough for the U.S. to feel threatened. At the National People's Congress in May 2020, the Chinese government announced its industrial development plan regarding "new infrastructure." The construction of new infrastructure calls for enhancing investments in seven areas, consisting of four for promoting innovation - 5G, big data (datacenter), AI, and industrial IoT - and three for strengthening social infrastructure vulnerability - high-voltage power transmission, high-speed railways, and charging stations -. Of these, high-speed railways account for a majority of investments, followed by edge data centers, AI, and IoT. With Alibaba and Tencent already firmly established in the cloud market in China, the government likely has a strategy to use industrial IoT to gather data from the edge for accumulation on China's cloud platform through the 5G "pipeline."

2.3 EU: Decentralized accumulation of data in edge under industry-government collaboration

In contrast to the approach of the U.S. and China, the EU is aiming for data accumulation in edge.[5] Presumably, there are two reasons for this. One is that unlike the U.S. and China, the EU has no internationally competitive cloud vendors nor communication equipment vendors and instead relies heavily on U.S. and Chinese firms. The other is that the EU's industrial system firms, such as Siemens, ABB/B&R, and Schneider,

have built a strong installed base of control systems for edge in and outside Europe. The European Commission first adopted regulation on a framework for the free flow of non-personal data in the EU in June 2019 to prevent U.S. firms from locking users into their cloud platforms. Article 6 of the regulation urges cloud service vendors to develop self-regulatory codes of conduct that include information to be provided to users prior to the conclusion of a service contract, such as the processes, timeframes, charges, and technical requirements that apply in case a user wants to cancel a service. The purpose of this provision is to enable a user to easily transfer data from an existing cloud platform to a platform of another service provider or to its own information system. Simultaneously, in February 2020, the European Commission announced its European Strategy for Data, in which edges where data are decentralized and integrated are referred to as "data spaces", and disclosed a plan to establish an environment for data to be circulated and utilized through industry-government collaboration by investing EUR 6 billion. Further, in June, the Commission announced its policy to invest in development for edge computing technologies, including edge AI for promoting data sharing and use, with a view to enhancing the technical capabilities to implement data spaces.[6] The Commission has proposed the establishment of 9 common European data spaces, including industry, Green Deal and mobility (Figure 1).
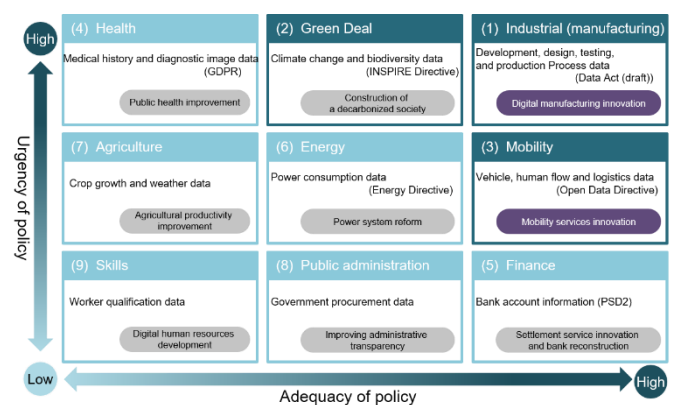
Source: Compiled by Hitachi Research Institute by referring to European Commission materials

Figure1: Nine "data spaces" in the European data strategy

The industrial data space will promote sharing of data covering development to production among businesses, mainly in the manufacturing industry, and achieve manufacturing innovation with the use of digital technologies. Meanwhile, the mobility data space is set to support the creation of new mobility services through linking various data mutually by introducing the Open Data Directive that promotes sharing of data generated in multiple modes of transport. In each data space, the storage and analysis technology, which were previously placed in the cloud platform, are installed in the edge where data generated are analyzed and fed back to operating equipment, etc. The ultimate aim of the European Commission is to achieve data integration in edge through repeated verifications performed under industry-government collaboration for industrial implementation.

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[4] The exception is the Chinese market, where Amazon has a share of only 8%. In China, Alibaba accounts for 39%, Tencent for 14%, and thus two Chinese companies account for a 51% plus majority.

[5] Mr. Erik Otto discusses the background and policies behind the EU's decentralized data integration and management approach in a subsequent paper in this journal.

[6] Mr. Tanaka discusses the EU's new industrial strategy, including investment in technology development, which complements the European data strategy, in a subsequent paper in this journal.

## 3. EU Accelerates Industrial Implementation of Data

3.1 Data use in the manufacturing field for connecting SC and EnC[7]

The European Commission is promoting the development of use cases for data distribution in the social and industrial infrastructure sectors in order to realize a single European digital market. In the manufacturing sector, it is aiming to accelerate smart manufacturing using big data and data distribution, centering on BOOST 4.0 under the Horizon 2020 program. [8] BOOST 4.0 is a public-private partnership development grant project in which about 50 companies and organizations participate. With a total private investment of EUR 120 million (EUR 100 million of which is for corporate development) over a three-year period and 10 factories of participating firms specified as show case "Lighthouse Factories," the project leads digital production verification, including predictive maintenance and operation optimization. For example, FCA (Fiat Chrysler Automobiles), supported by Siemens, links field devices with PLC, MES, and ERP to optimize EnC using edge data. Through this verification, FCA aims to automate production lines and improve the flexibility of the manufacturing process in response to changes in the market. It also seeks to optimize the timing and frequency of maintenance and eliminate quality issues by analyzing equipment operation data of production facilities. Meanwhile, Whirlpool, a household appliances manufacturer, is collecting, analyzing data on operation after product sales and delivery and testing a system for projecting demand for after-sales services, such as repair. Through the use of edge data at SC that focuses on after-sales services, and obtaining information that helps to eliminate redundancy in producing and stocking repair parts and improve products, Whirlpool aims to improve customer service and increase the efficiency of product development and production (Figure 2).

FCA
Smart Factory

ERP-MES-PLC-field device cooperation improves the flexibility of production lines, optimizes maintenance, and eliminates quality defects.

EnCM area managed by FCA

SCM area handled by Whirlpool

Whirlpool
After–sales service
Demand projection

In order to reduce waste in the production and inventory of repair parts and obtain guidelines for product improvement, established a system to **obtain operation data from products in the market** and optimize operation through simulation

Source: Compiled by Hitachi Research Institute by referring to BOOST.4.0 materials

Figure2: Main initiatives of BOOST 4.0

Under the BOOST 4.0 project, efforts are under way to build a business model for realizing smart manufacturing based on the knowledge gained through these verifications. In addition, steps are being taken to set international standards for data use and construct security authentication systems in line with RAMI 4.0 (Reference Architecture Model Industry 4.0), which defines common languages and technical specifications that link IT, communication, applications, and other layers.

3.2 Development of data businesses through Green Deal

The European Commission announced the European Green Deal, which sets a target of being climate neutral, i.e. no net emissions of greenhouse gases, in 2050, and provides an action plan, including a review of related regulations. As part of this plan, the Commission has set a policy objective of establishing a European Green Deal data space. The role of the Green Deal data space is to encourage action toward climate neutrality by monitoring compliance with laws and regulations related to climate change countermeasures and the circular economy, and by making companies' environmental considerations visible. Specifically, the Commission launched a "GreenData4all[9]" initiative to review the existing guidelines for the use of environmental information, the Access to Environment Information Directive (2003/4/EC), and the INSPIRE Directive (2007/2/EC), which promotes the use of geospatial data for environmental and disaster preparedness. The Commission aims to build a system to quantify and verify corporate efforts to reduce environmental impact, such as controlling greenhouse gases and using recycled materials and parts. In Europe, steps have been taken to promote information disclosure on initiatives that contribute to environmentally sustainable economic activities, such as the enforcement of the EU Taxonomy Regulation and a legislative proposal requiring businesses to carry out due diligence concerning human rights and environmental impact. In order to bolster accurate information disclosure, it is crucial to ensure the reliability, distribution, and promotion of use of edge data generated from sources of environmental impact, such as factories and power plants. As the implementation of the Green Deal policy progresses in the future, there will likely be accelerated efforts to launch new environmental data businesses in Europe.
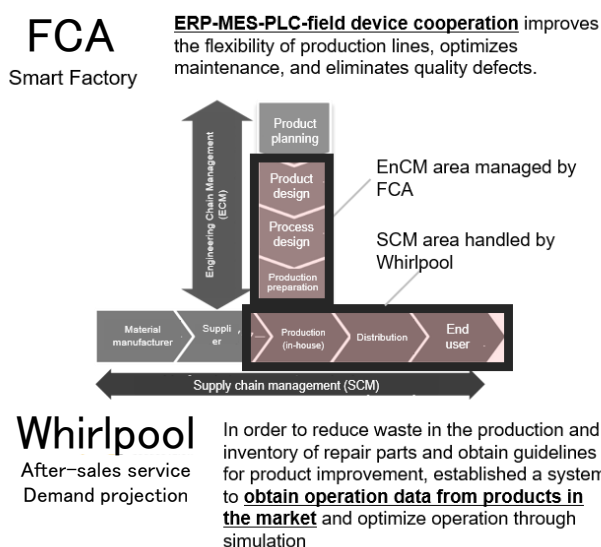
4. Cloud Federation Architecture Supporting Decentralized Data Governance in the EU

As described in the previous three chapters, as the use of data advances under the control of social and industrial infrastructures, the need to process a large amount of IoT data generated from factories and products in real time increases. Meanwhile, concern grows over the risk that data sovereignty could be threatened by placing large amounts of data that serve as the source of international competitiveness on servers of firms outside the region. Against this backdrop, there has been

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[7] SC: Supply Chain; EnC: Engineering Chain

[8] Dr. Sawada and Dr. Takamoto discuss the prospect of data use in the European manufacturing industry in a subsequent paper in this journal. in the European manufacturing industry in a subsequent paper in this journal.

[9] An initiative of the European Commission to review relevant directives and establish technical specifications, such as ensuring interoperability, to promote the distribution and use of environmental information.

growing attention on decentralized data governance, which enables real-time processing of large amounts of data in close proximity. With the increasing oligopoly of US and Chinese IT platform companies in the cloud market, the European Commission aims to protect European data sovereignty and strengthen European industrial competitiveness, particularly in the social and industrial infrastructure fields, by building a secure data management and distribution infrastructure through GAIA-X.[10] According to persons associated with GAIA-X, the project is not intended to create new European cloud service providers to compete with Microsoft, Amazon, Alibaba and others. It aims to build a decentralized data infrastructure through cloud federation that interconnects and operates existing public and private clouds and other computing in Europe. Led by GAIA-X Foundation established by 22 German and French firms and organizations, including Siemens, Atos, SAP and IDSA, discussions are underway on cloud federation architecture, such as (1) development of ontologies and APIs to improve data interoperability, (2) ensuring data infrastructure interconnection, and (3) securing technical specifications for security and privacy. GAIA-X is also developing about 40 use cases in the fields of manufacturing, smart living, mobility, etc. It plans to build prototypes and start operation by early 2021. The U.S. National Institute of Standards and Technology (NIST) is also considering a reference architecture model for cloud federation. Going forward, when data use at the edge created from social and industrial infrastructures becomes the main area of competition for digital supremacy, GAIA-X and other decentralized data governance models will likely attract greater attention.

5. Conclusion

The first half of this paper focused on Social and Industrial Data, which will be a source of future economic growth, and discussed the efforts of the U.S. and China to integrate data into cloud platforms as well as the clearly distinct initiative of the EU to build decentralized edge architecture. The latter half described the expedited efforts in Europe toward the industrial implementation of decentralized architecture and the trends in cloud federation, which supports data distribution. In Europe, while manufacturing and other traditional industries are highly competitive, there are no massive IT platform providers like those in the U.S. and China. This industrial structure and current challenges are very similar to the circumstances in Japan, and Europe's efforts to accumulate data in edge should be closely watched when considering the direction of Japan's policy and industry. In addition, Europe's rule-driven effort to promote data use has a close affinity to the "Data Free Flow with Trust (DFFT)" concept advocated by the Japanese government. In order to promote Japan's digital transformation of society and industry and enhance its international competitiveness, it is important to move forward with the formation of international data governance rules in cooperation with Europe and other countries and regions that share such value.

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[10] Prof. Dr. Boris Otto discusses GAIA-X's efforts and future prospects in a subsequent paper in this journal.