NEC Industrial IoT - Building the Foundation for Next-Generation Monozukuri

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Abstract

The trend towards a fully networked future - where everyday objects embedded with electronics, software, sensors, and connectivity, enabling them to exchange data with each other and with operators, central databases, and so on - has become inescapable. Throughout the world, especially in Germany and the United States, businesses and industries are actively utilizing the Internet of Things (IoT) to innovate business processes as well as products and services, which in turn will lead to reforms in business models and industrial structure. Japanese manufacturers are no exception. From increasing a company's competitiveness to addressing the demands of stakeholders, the incentives driving the move to IoT are intensifying. At NEC, we believe that there are two key areas in which IoT can play a critical role: process innovation (for networked plants), which enhances flexibility by optimizing control of facilities and equipment in real time; and product innovation (for networked products), which increases added value by offering new services and new ways to use products. NEC Industrial IoT is the solution that will support the achievement of both process innovation and product innovation.

Keywords

manufacturers, monozukuri*, IoT, M2M, big data, Industrie 4.0, CPS, open innovation

1. Introduction

As ICT devices become ever smaller and less expensive, it is becoming easier and easier to add intelligent functions to things other than computers and connect them to the Internet. The IoT (Internet of Things) is spurring new innovations in various areas and industries. As the manufacturing industry faces increasing challenges in the business environment such as multipolarization of the global market, diversification of customer needs, and intensification of price competition, the trend to enhance value chain innovation is accelerating. IoT technology is seen as critical to meeting these new challenges.

When we turn to look at what is happening around the world, two trends stand out (**Fig. 1**). In Europe, Germany is pushing a German national strategic initiative through industry-academia-government collaboration. Known as, Industrie 4.0 (the fourth industrial revolution), this initiative seeks to enhance international competitiveness by improving the productivity of manufacturers through advanced automation. Although the term Industrie 4.0 only came into existence in 2011, its researchers began studying IoT in 2006. They are active in international standardization activities and announced a standardization framework called the Reference Architecture Model Industrie 4.0 (RAMI 4.0) in April 2015.

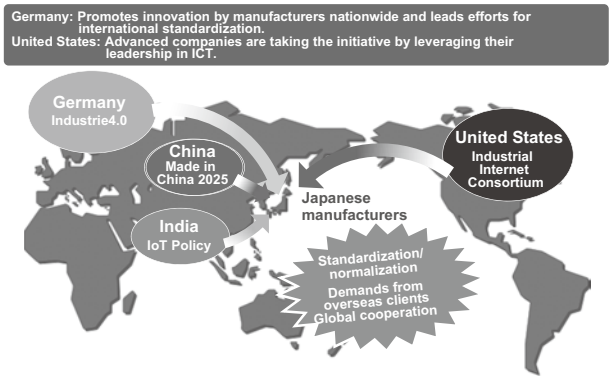

Fig. 1 Worldwide trends in the promotion of IoT for industrial applications.

In the United States, in the meantime, major corporations led by GE are taking the initiative, prioritizing the collection of data and results that could be useful in terms of business.

* monozukuri: Japanese word that refers to manufacturing which is in harmony with nature and that adds value to society.

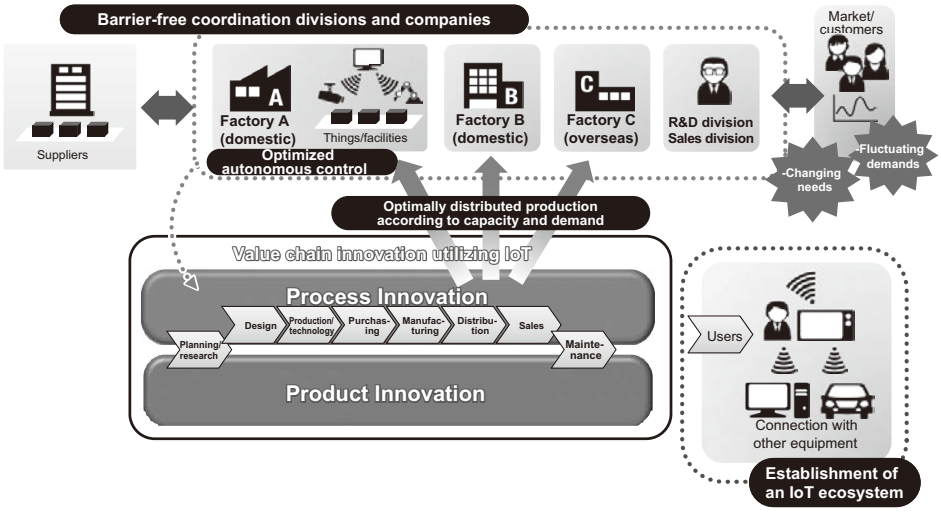

Fig. 2 Two innovations utilizing IoT.

2. Two Innovations Made Possible by IoT

NEC believes there are two ways IoT can be applied to promote innovation in the manufacturing industry (**Fig. 2**). The first is process innovation. This can be applied at all stages of manufacturing, creating true networked plants where monozukuri processes are smart and online. The second way IoT can be utilized is in product innovation, where built-in feedback mechanism can drive improvements in products and support the creation of new services.

In process innovation, IoT can facilitate coordination between facilities within a factory and between the products, components, and workers in order to execute autonomous control. In addition, any changes can be handled flexibly - for example, rapid information transmission and optimally distributed production can be achieved through coordination between factories as well as with suppliers and subcontractors. By supporting both automatization and autonomization, IoT makes it possible to achieve mass-customization without increasing costs.

In product innovation, IoT offers a myriad of possibilities. Both customer experience and product functionality can be enhanced by incorporating IoT technology in the product and connecting it to the network. At the same time, the product can be continuously improved by collecting and analyzing data about how, when, and where the user uses the product. The results of the data analysis can then be reflected in the planning of new products. This creates a virtuous circle, where products and services continue to create new values even after they have been put on the market.

3. Features of NEC Industrial IoT

NEC has announced the introduction of the NEC Industrial IoT, which takes advantage of IoT to promote next-generation monozukuri for manufacturers. An overview of NEC Industrial IoT is shown in **Fig. 3**.

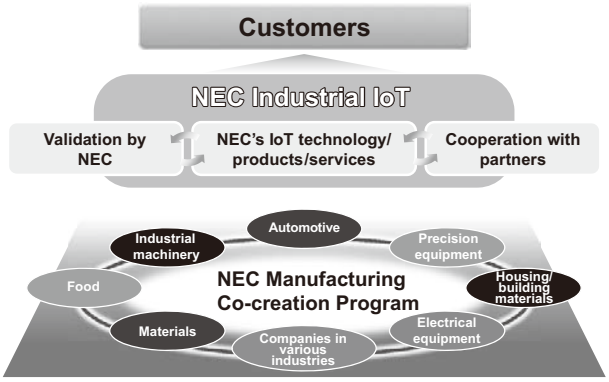

Fig. 3 NEC Industrial IoT framework.

NEC Industrial IoT has four major advantages.

The first advantage is the utilization of NEC's advanced IoT technology. Thanks to NEC's extensive technological expertise in big data analysis technology, image analysis technology, and network technology, we have the tools and the skills needed to apply IoT where it is needed in order to facilitate innovation of monozukuri.

The second is that we use our own systems and technology at NEC. That means NEC Industrial IoT has already been put to the test at NEC Group and its effectiveness has been confirmed.

The third is the expansion of offered value through cooperation with partners. We make it possible to offer optimal solutions to customers by combining NEC's specialty technologies such as system integration and networking with partners' specialty technologies such as facilities/equipment and robotics.

The fourth and final is co-creation with customers. Creating together with customers - that's the biggest advantage of NEC Industrial IoT.

The Manufacturing Co-creation Program, which NEC has been operating since 2012, will further be expanded. We will contribute to the strengthening of the monozukuri of Japanese manufacturers by cooperating with relevant government agencies and organizations. At the same time, we will share the issues customers are facing in the utilization of IoT and the measures they are taking to solve those issues, as well as testing and validating systems.

4. NEC Industrial IoT - Technologies and Solutions

The utilization of advanced IoT technology in NEC Industrial IoT is discussed in detail below.

Next-generation monozukuri will take advantage of IoT technologies to create value and enhance products by collecting data, analyzing and making decisions based on the data, automatically controlling devices, and so on (**Fig. 4**). The first step is digitization in which actual sites, things, and conditions are turned into data. This data can then be analyzed and visualized using big data analysis technology.

Based on this analysis, IT, facilities/equipment, and operational technology (OT) will be connected to each other via software-defined networking (SDN) - a flexible network construction technology. Actual execution of command and control will be implemented by the manufacturing execution system (MES). The result will be automatic control and optimization of devices in real time.

By incorporating sensors in manufactured products, actions and behavior can be converted to data. Using secure transmission and encryption protocols that data is sent to the company's database where it can be analyzed and used for product maintenance, as well as in the planning and research of future products.

4.1 Digitization of Actual Sites, Things, and Conditions

The level of digitization at production sites varies from one industry or company to the next. When viewed from a general perspective, many processes have not yet been digitized sufficiently. The high cost of upgrading facilities to proceed digitization of data on the site puts a significant burden on the customer. Another critical problem is the information that cannot be gathered from automated facilities such as the movements of humans and the conditions of objects. In addition to the incorporation of various sensors and smart devices, NEC's exclusive image processing systems allow you to turn actual sites and things into data without impacting the operations of existing facilities and without having to add new large-scale facilities or data collection systems.

For instance, the object fingerprint identification technology that NEC is developing is the world's first.

Until now, it has been necessary to attach a tag such as RFID to every product or component or to add a process and equipment for marking in order to distinguish and manage a single product or component. Using this object fingerprint authentication technology, however, you can distinguish individual differences based on subtle irregularities on the surface of the object (**Fig. 5**).

You will reap great benefits from this technology when it is achieved with an inexpensive, popular camera instead of a special, expensive camera.

We are planning to implement evaluation and enhancement of this technology in order to put it into practical use in production sites. In addition to this technology, the digitization of the site is executed by using leading-edge image analysis technologies including an instrument panel reading system, AR utilization operation support system using wearable devices, and traffic line monitor system that captures the movements of workers at a factory by collecting data to improve traffic lines.

4.2 Illumination of Invisible or Hidden Aspects

By analyzing digitized and collected data, big data analysis technology can shed light on aspects of the world that are normally hidden from view.

There are many issues related to the utilization of big data in monozukuri, but the problems of quality and equipment failure detection are especially critical in terms both of their impact

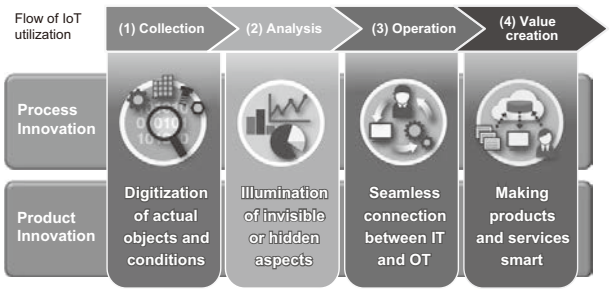

Fig. 4 IoT utilization flow in monozukuri innovation.

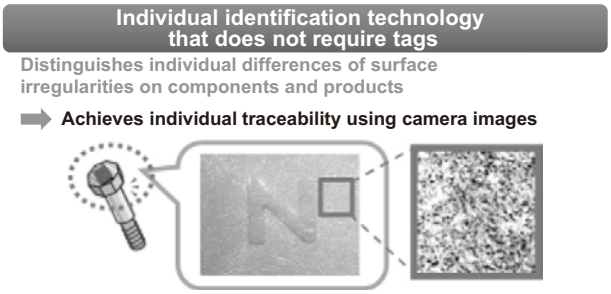

Fig. 5 Component identification using image recognition.

and their complexity. When defects in quality occur, not only are immediate financial losses generated in terms of the cost of the product, but further losses may be sustained if solving the problem requires temporarily shutting down production. Similarly, the occurrence of equipment failure can lead to the suspension of the production line. Improvements in yield rates and operating rates increases throughput, leading to a reduction in production costs.

First, all available on-site data (4M data) regarding monozukuri should be collected, and the relationship between the data should be examined carefully. Doing so can make it easier to obtain multifaceted perspectives and awareness.

Next, by utilizing big data analysis, it is possible to identify the factors that contributed to a quality defect that could not previously be detected. From this, the optimal processing conditions can be derived and applied to production to further improve quality. It is also possible to make practical use of big data technology for optimization control, enabling the best-possible quality to be achieved by predicting the quality based on the processing precision result data of a certain process or component and by dynamically altering the processing conditions in the next process.

Moreover, by facilitating detection of unusual equipment behavior and early detection of symptoms of failure, potential failures can be dealt with before they reach a critical level, minimizing the occurrence of unscheduled shutdowns and helping make possible a factory whose operations run continuously, without interruption.

NEC utilizes world-class big data analysis technology and engines that exploit state-of-the-art heterogeneous mixture learning technology and invariant analysis technology to sift through enormous volumes of data to discover trends and patterns that would previously been undetectable.

4.3 Seamless Connection with IT and OT

OT stands for operational technology and refers to control systems. It is also called factory automation and process automation.

OT systems and IT systems such as production management systems are not necessarily connected. The reality is that in many cases the lines connecting OT and IT systems are humans, so to speak. In the world of OT, there is a greater variety of communication standards and formats than in the world of IT. Moreover, there are few engineers who are familiar with both IT and OT. Consequently, forging reliable links between these two seemingly incompatible systems is difficult.

NEC's market-leading computer system for manufacturing plants overcomes these problems by integrating terminals and devices produced by the industry's leading manufacturers that utilize industry-standard interfaces and protocols all mediated by linkage with the MES (**Fig. 6**).

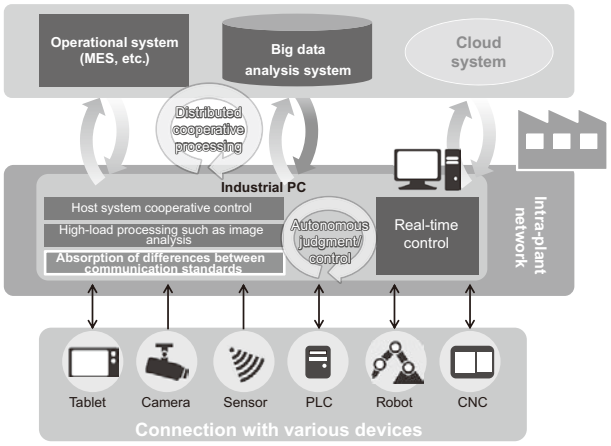

Fig. 6 Integration of IT and OT.

It is also possible to easily handle changes in production lines and to improve the management level of unified security settings through effective application of SDN in the intra-plant network. This will play a significant role in providing network support to next-generation monozukuri in which a huge amount of data will need to be processed and exchanged, and where sudden and dramatic changes in the business environment will need to be adapted to quickly and effectively.

4.4 Platform for Connectable Products

This is a solution to support the IoT utilization of the very products the customers offer. Providing IoT platform and integrating NEC's proprietary assembly systems into the customers' products will enable the continuous creation of new value via the networks even after products and equipment have been put on the market.

5. Conclusion

By way of conclusion, a map of services and technologies that are systemized as the core of the NEC Industrial IoT is shown below (**Fig. 7**). These services and technologies will continue to evolve to meet our customers' needs through our research and development and through cooperation with our partners.

As for the next-generation monozukuri, we will continue to offer a full range of services, including everything from consulting and determining the applicability of IoT technology to the development and introduction of solutions.

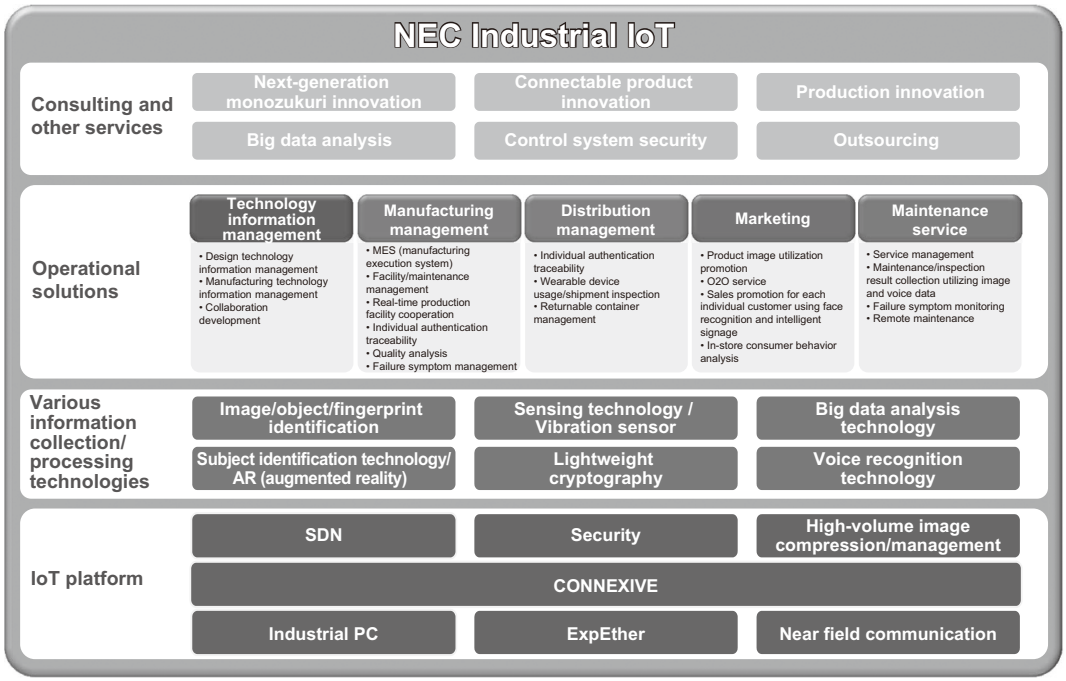

Fig. 7 NEC Industrial IoT service and solution systems.

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