Smart Factory Enabled by Local 5G

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Abstract

The business environment of the manufacturing industry is not only affected by various present changes including labor shortage, the handing over of skills to the next generation and mass-customization, but also by new issues that have surfaced due to the COVID-19 epidemic such as disruption of supply chains and restrictions on the movement of employees. The Smart Factory is a factory that is not only capable of dealing with the presently recognized challenges, but can also respond flexibly to unknown issues that may occur in the future. NEC is promoting the transformation of our factories into smart factories by combining our knowledge as both a manufacturing company and an IT vendor. At the same time, we provide the knowhow of smart factory construction to our customers by making best use of our expertise. This paper introduces the use of local 5G in smart factories.

Keywords

Local 5G, NEC DX Factory, Human Operation Navigation, multi-robot controller

1. Introduction

Recent issues facing factories include mass-customization, the rise of overseas labor cost, shortage of domestic labor, and the handing over of skills to the next generation. In addition, the COVID-19 epidemic has posed new issues such as disruption of supply chains, factory shutdown due to drastic changes in consumer demands, reorganization of production sites and restrictions on employees going to the office. To solve these issues and realize factories that can continue to operate with efficiency, it is necessary to promote the Smart Factory by combining latest technologies such as IoT, AI and 5G[1].

An important technical innovation that can advance the Smart Factory and lead to breakthroughs is 5G. NEC is conducting examinations on how to accelerate the digital transformation (DX) of the manufacturing industry by exploiting features of 5G such as its ultrahigh speed, ultralow latency and simultaneous multiple connections.

2. Expected Role of Local 5G in Smart Factories

At NEC, we envision that 5G- enabled and other future factories will transform production lines and people's work styles. Even if the variety and volume of products change suddenly, there will be no need to change the production line layout or the allocation of workers, as data from automated and wireless systems will be used more effectively.

Employing 5G will make it possible to perform remote operations and control. This will also make it possible to

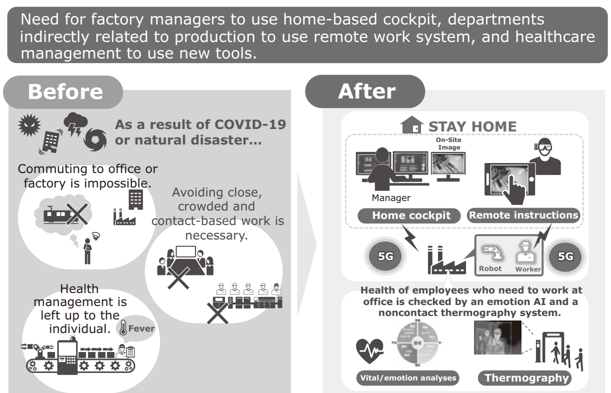

Fig. 1 Transformation of working practices of factory.

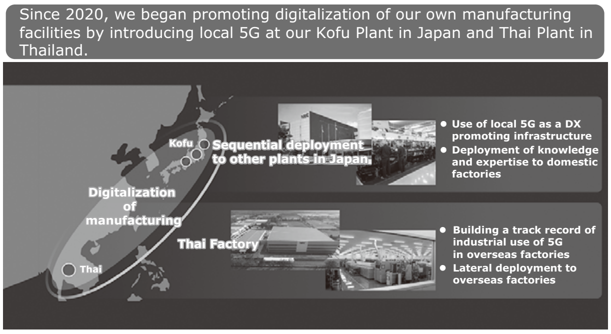

Fig. 2 Local 5G introduction at the NEC Platforms Kofu Plant.

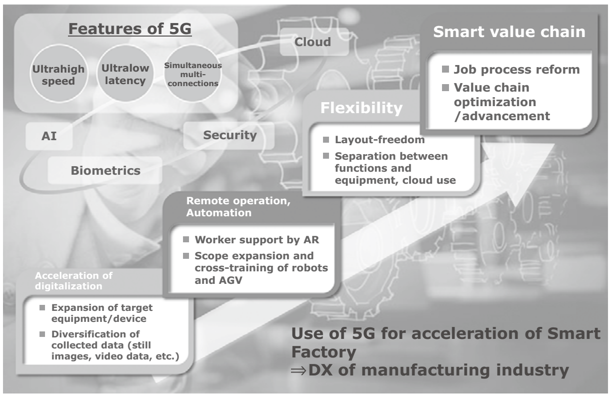

Fig. 3 Use of local 5G in Smart Factory.

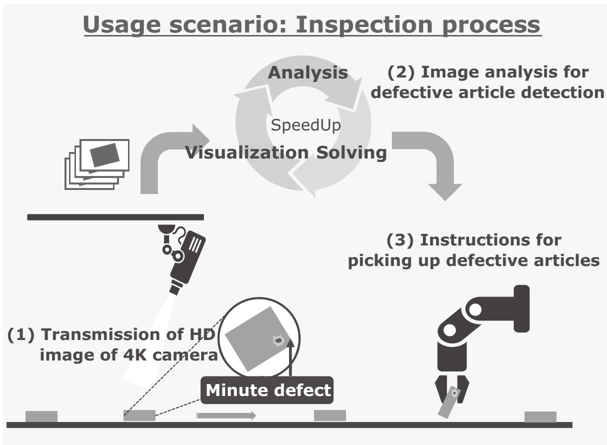

Fig. 4 Usage scenario: Inspection process.

control operations in factories and other working sites while remaining in the office, or to handle stressful or physically demanding tasks comfortably from a pleasant environment.

The result will be a radical solution to the labor shortage problem in the manufacturing industry and a transformation of the working practices in the so-called New Normal society (**Fig. 1**).

NEC has already introduced a local 5G system at our NEC Platforms Kofu Plant located in Yamanashi Prefecture to promote digitalization of our own manufacturing facilities (**Fig. 2**).

3. Use Cases of local 5G at Smart Factories

This chapter introduces actual use cases together with approaches made by NEC (**Fig. 3**).

3.1 Automation of inspection using high definition image and video

Images have been used for inspections in the past, but narrow network bandwidth and other issues restricted the capacity of these systems to record the movement of products and people from fixed cameras and send high-resolution, large-capacity images for post-analysis.

5G makes real-time processing of a series of actions possible based on linkage between cameras and robots, namely capturing minute defects in articles flowing on the production line with high-definition cameras, identifying their characteristics in real time with an AI engine and picking up the defective articles with a robot (**Fig. 4**).

3.2 Supporting workers using augmented reality (AR)

In addition to the shortage of instructors as skilled workers near retirement age, the decline in the working-age population is leading to a chronic shortage of human resources. The shortage of experts, who direct people or control a group with their special skills, and general human resources means the impossibility of passing on the skills to the next generation, resulting in a drop in the technical abilities of manufacturing sites. One of the solutions for the problems of expert shortage, worker shortage and technical ability degradation is to have the remote worker supported by an expert using AR glasses.

On-site workers with little experience are less efficient than skilled workers. Therefore it is obvious that they require some time to complete their work. However, the human resource shortage doesn't allow them to have enough time. This issue can be solved in that even novice workers can complete work in a short period if an expert wearing AR glasses in a remote location can support the work of on-site workers. The real-time guidance given here can also improve the skill of on-site workers in a short period and human resources can be cultivated efficiently. As the AR glasses present the instruction in-

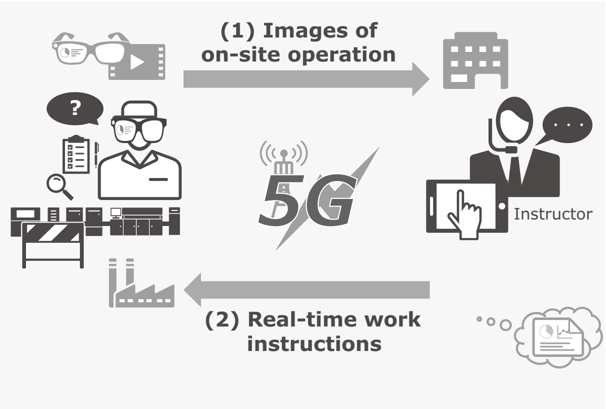

Fig. 5 Usage scenario: Production equipment maintenance.

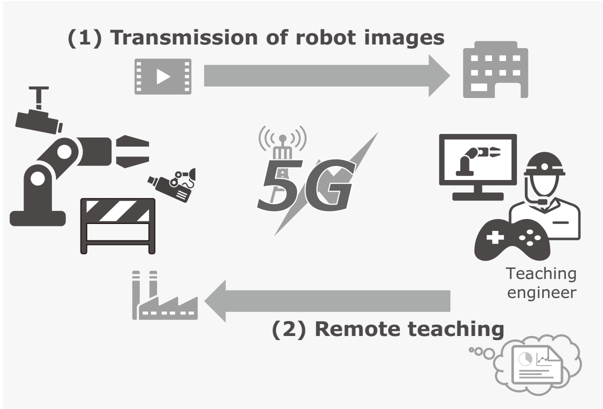

Fig. 6 Usage scenario: Robot teaching.

formation in the field of view, the workers can continue work without stopping to confirm the work instructions, which thereby improves work efficiency.

In this remote work support, 5G is necessary to transmit on-site conditions correctly and in real time to the expert in the remote location. One method for accurate identification of the on-site conditions is to use 4K cameras for real-time transmission of high-definition images. In this way, the expert in the remote location can gain a real sense of presence and thereby provide optimum instructions (**Fig. 5**).

3.3 Remote robot operation/teaching

Robots need to be taught (programmed) the manufacturing procedures matching the product they produce. Teaching of a robot must not be focused on only the product but also the equipment around the robot and coordination with other robots. For this reason, robot teaching requires people with technical skills and know-how. However, the frequency of teaching has increased due to the recent shortage of instructors and progress of high-mix low-volume production, and this has become a new issue in remote robot operations. NEC is therefore studying the use of 5G as a means for robot operations by remotely-located engineers (**Fig. 6**).

In remote operations, the difficulty of control and the stress on operators are highly dependent on the response speeds of robots and machinery to the operator's operations. Therefore, the ultrahigh-speed and ultralow-latency features of 5G have become critical factors for remote operations (**Fig. 7**).

Remote teaching frees engineers from the need to visit the site where robots are installed so efficient teaching can be possible with a small number of people. Since the

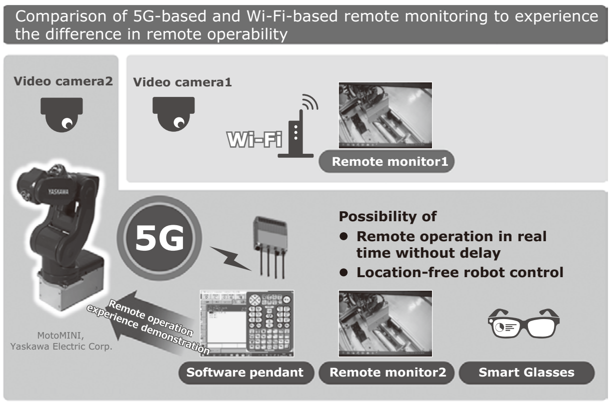

Fig. 7 Demonstration of remote robot control.

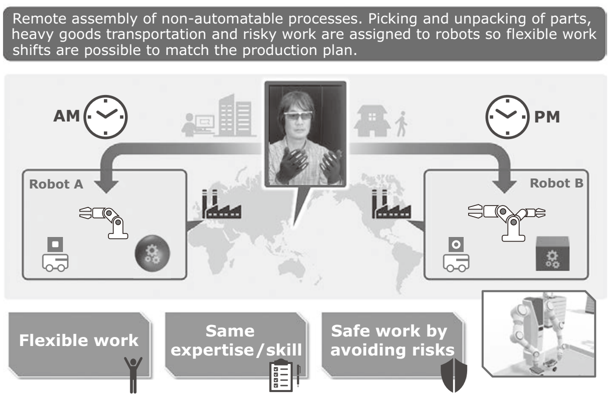

Fig. 8 Remote manual assembly.

robot sometimes moves unexpectedly during the teaching process, teaching has been regarded as risky work. However, if the remote teaching of robots becomes possible, it is also expected to ensure the safety of engineers (**Fig. 8**).

3.4 Advancement of AGVs through Coordinated Control

There are many cases in which automated transport equipment are introduced for unmanned material transportation in factories and logistics warehouses. However, once automated transport equipment is installed, it is hard to modify the layout, making flexibility impossible with respect to changes in production line layout that would be required on account of improvement activities at the production site or changes in production items. This issue may be solved by adopting the trackless automatic guided vehicle (AGV) that features the capability to change the transport path in response to changes in the surrounding conditions (**Fig. 9**).

The typical use of AGV is to let several AGVs run simultaneously. However, when each AGV runs under individual control, traffic congestion occurs and the availability of AGVs is reduced. This problem can be solved by the features of 5G, the ultralow latency and the simultaneous multi-connections, namely, the Multi-Robot Controller (MRC), which can serve as the centralized AGV control system to collect real-time information on the running conditions of AGVs and give real-time instructions of the optimum path to be taken for each AGV. This eliminates traffic congestion of AGVs, increases AGV availability and ensures that goods arrive at the right place at the right time (**Photo**).

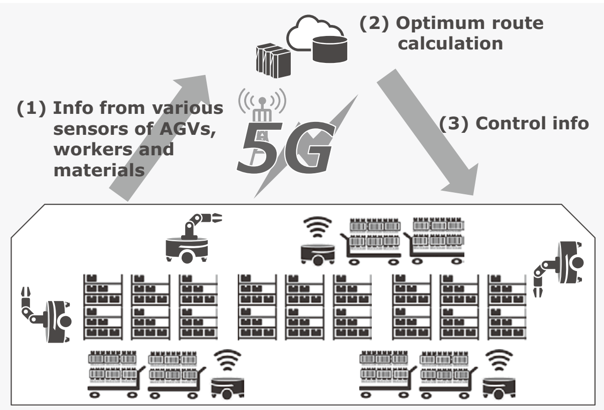

Fig. 9 Usage scenario: Factory goods warehouse.

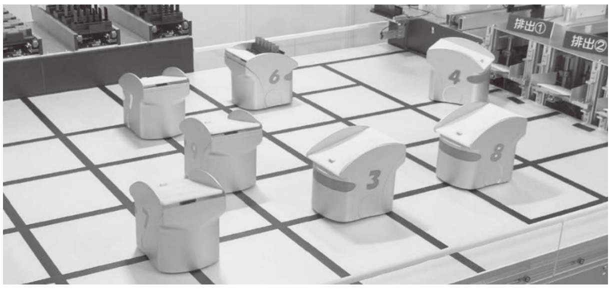

Photo Demonstration: Real-time simultaneous control of several mini-AGVs

4. The Future of the Smart Factory with 5G

It is expected that the use of 5G will go beyond factories and expand to between factories and between enterprises. Local 5G will be used inside factories while carrier 5G will be used between factories or between enterprises. When local 5G inside a factory is linked with carrier 5G connecting factories or enterprises, this will accelerate the development of smarter value chains.

One of the examples of usages is the remote maintenance by the factory equipment management department. The equipment manager inspects the customer's equipment by operating a drone through the carrier 5G. The manager shares the image of the inspection with the on-site workers in real time and, gives work instructions if human intervention is required. If the equipment can be operated remotely, it can also be operated through the local 5G in the factory.

In this way, the Smart Factory that NEC aims at can be implemented by expanding the use of local 5G and carrier 5G in the entire value chain (**Fig. 10**).

5. Conclusion

For the implementation of the Smart Factory, NEC models the use cases of local 5G introduced here and

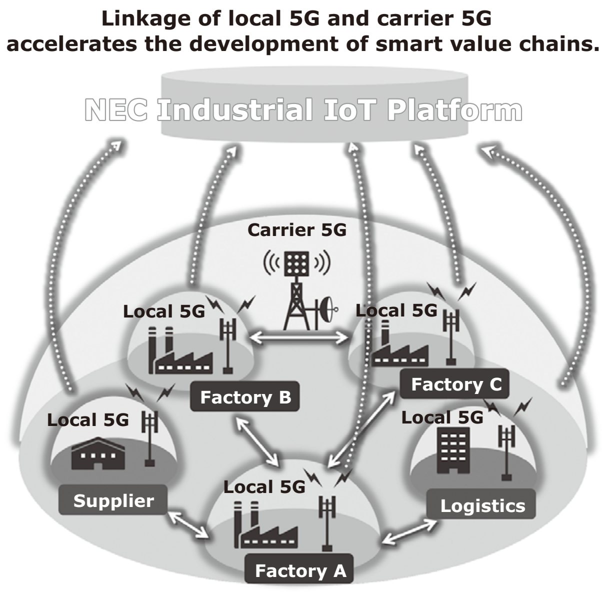

Fig. 10 Linkage between local 5G and carrier 5G.

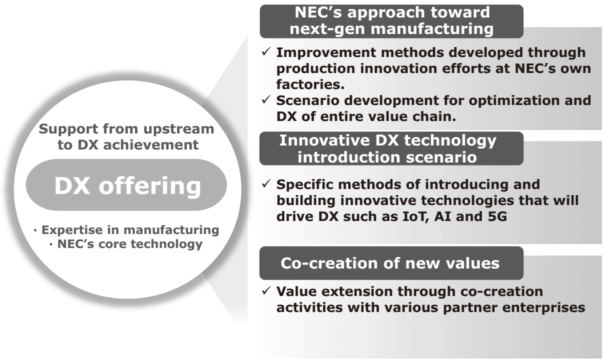

Fig. 11 Provision of DX offering model for implementation of Smart Factory.

creates an end-to-end DX offering model from IT to network to OT. First, to realize advanced AGVs through coordinated control, we provide it as an AGV utilization improvement offering model (**Fig. 11**).

As a facility where customers can experience the reality of the Smart Factory and manifest their creativity, the NEC DX Factory Co-creation Space has been established at the NEC Tamagawa Office in Kawasaki city, Kanagawa prefecture. In addition, we will accelerate the establishment of the Local 5G Lab and the demonstration of a "Smart Factory using Local 5G" in fiscal 2020.

Looking ahead ten years from now, NEC is determined to realize each and every value for customers aiming at implementation of the Smart Factory where people can work with vigor and enthusiasm.

Reference

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