RFID-Based
Production Process Monitoring Solutions

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Abstract

The keys to success in the implementation of RFID are the utilization of the data collected using the RFID technology and the establishment of an RFID implementation strategy for the future. These two issues necessitate a step-by-step implementation of RFID with a firm future perspective as well as of the technologies that supports it. As a practical means for enabling the above proposals NEC offers an RFID-Based Production Process Monitoring Solution backed by the RFID implementation and pilot expertise of the NEC Group.

This paper introduces the RFID technologies backing the solution and its future deployment perspectives.

1. Introduction

RFID (Radio Frequency Identification) is now a worldwide target for attention, and its applications are expanding in supply chains covering multiple businesses. In Asia including in Japan, the utilization of RFID is expected to advance in the upstream supply chains, i.e., in the manufacturing industries. At the NEC Group, we have been promoting piloting and implementation of RFID at a couple of production sites and now offer an RFID-Based Production Process Monitoring Solution based on the expertise in RFID applications that has been obtained as a result of this experience. The following sections will discuss the details of the solution and its future deployment.

2. RFID-Based Production Process Monitoring Solutions

The keys to a successful implementation of RFID are the utilization of data collected with the RFID technology and the establishment of an RFID implementation strategy for the future. Nevertheless, since the RFID application technology has not been matured, there remain hurdles to overcome before any RFID system can be confidently implemented. In some RFID projects RFID systems were implemented but did not meet ultimate goals, such as the further use of RFID data and RFID deployment strategies. To solve the above problems, the solution offers the know-how of RFID implementation that has been cultivated in the NEC Group in order to lower the hurdles for RFID implementation at production sites and sup-

port the acquisition of the best possible benefits of the implementation. The goals of the Production Process Monitoring Solution are; 1) to visualize the production process in real time, and; 2) to support the utilization of data collected by RFID and efficient operational improvements. Specifically, its functions enable the possibility of identifying the progress of each process in the production lines in real time using RFID and displaying the analysis results of the collected information on a monitor. The system is designed as scalable in order to meet the deployment of the RFID system or the future expansion of the RFID application fields.

The outline, expected benefits, configuration and the course of the implementation of the system will be described in the following.

2.1 RFID Applications

The progress of each operation in the production process can be acquired in real time using RFID tags carrying unique IDs and the RFID read devices for reading information written in the RFID tags. The RFID tags are attached to parts and products in the process of manufacture and the RFID readers for reading them are installed between the process operation steps so that the process time and duration of each process operation can be collected automatically in real time. In general, one of the hurdles before RFID implementation is the inadequacy of the RFID tag reading accuracy.

In order to overcome this hurdle, the present solution proposes a method of RFID reader installation for the production process, RFID attachment to parts and products in the process of manufacture and evaluation of the reading accuracy reliability by

making use of previous experience; e.g. such as that obtained in the RFID implementation at the Yonezawa Plant, NEC Personal Products, Ltd.[1] and the RFID demonstration experiment at NEC Computertechno, Ltd.[2] The expertise is given in the form of implementation procedures and serves as a tool for the efficient installation of RFID equipment.

2.2 Efficient Operational Improvement

One of the major effects of RFID implementation is the efficient operational improvement. The operations that have been used using bar codes, visually or manually, such as recognition of parts and processes and information input into the system can be automated with RFID. The automation not only reduces the work time requirement but also tends to improve the efficiency of the workers. From the viewpoint of management, the information on the actual achievement of transit and process time that is input in the field becomes the management information representing the achievement of tasks and the progress of work. In general, however, when the requirement for management information is more detailed, the management accuracy can improve but the burden of work in the field for providing information will increase and affect the work that is primarily most important. When the information collection is automated using RFID, it will be possible to collect more detailed information efficiently and without obstructing the work.

In this way, the application of RFID at the production site can bring about favorable effects to the managers as well as the workers. In addition, the effects of RFID implementation can be further enhanced by fully utilizing the information collected with RFID as described below.

2.3 Visualization and Data Utilization

The utilization of the process time and the actual achievement of transit data enhances the effects of the RFID implementation. The Production Process Monitoring Solution enhances the RFID implementation effects by displaying the analysis results of information collected with RFID on the terminal and thereby visualizing the entire production process. This supports efficient operational improvement because the visualization of the process time and progress of each operation helps identify and extract problems quantitatively and at an early stage.

For instance, when there is a variance in process time between operations, the appropriateness of work time can be identified quantitatively and in real time online, such information can be used to improve the job by balancing the process operations and reviewing the process in good time. It may also

tend to enhance the capabilities of the process to deal with possible condition changes. This can be counted as one of the major effects of RFID implementation. In addition, when the information obtained with RFID is applied to operational applications (such as ERP, MES or SCM), it will also be possible to collect more accurate achievement information more efficiently and improve the thoroughness of management.

The support for job improvement by means of data visualization and the appropriate utilization of data are the key issues of RFID implementation and also some of the biggest features of the Production Process Monitoring Solution.

2.4 System Configuration

The implementation effects described above are not practical unless there is a system that can put them into effect. The Production Process Monitoring Solution provides already-proven RFID system configurations to ensure effective system implementations at any production site. The system configuration features an extendibility that allows it to deal with the development of the system or expansion of the RFID application area at a future time.

The RFID system is composed roughly of the RFID tags/reader, the RFID middleware and the RFID server (see **Fig.**).
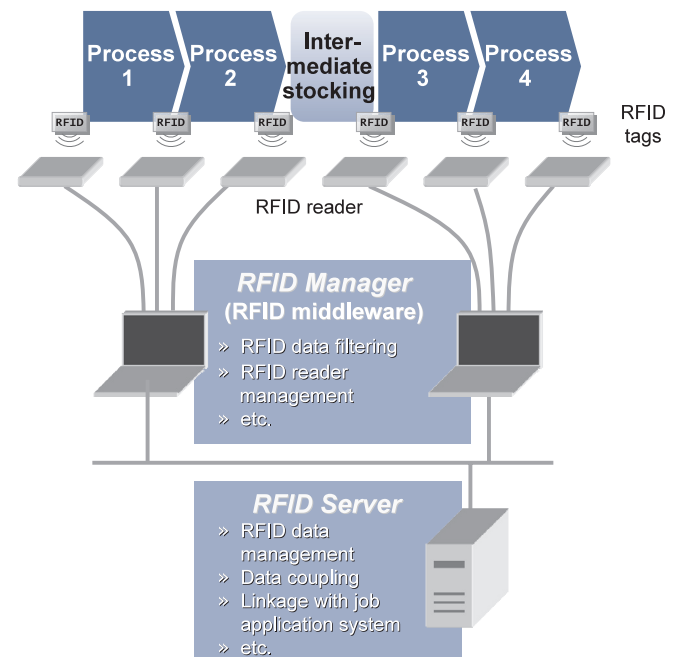
Fig. Configuration image of RFID-based Production Process Monitoring System.

The system components are as detailed below.

(1) RFID Tags/Reader

The RFID tags are attached to the articles, including parts and products as well as the workbench on which they are placed. Each RFID tag records an ID, which identifies a part/product as well as the associated jobs. Each article is identified based on its ID, and the job process is monitored by capturing the movements of the IDs.

The system associates the ID recorded in each RFID tag with other associated operational data. It is this association that makes it possible to inquire the part/product attribute information and sundry other operational information and to record the production history by using the IDs recorded in the RFID tags as the search keys. It is also possible to record the associated information in RFID tags. However, from the viewpoint of data integrity the system records only the IDs in the RFID tags and the associated information is managed from a higher level. This design also makes it possible to implement the RFID system by making use of the existing process management system.

The RFID reader reads the ID recorded in an RFID tag and transfers it to the RFID middleware together with the ID of the RFID reader and the time that the RFID tag is read. The transferred data is referred to as the RFID data. The present Production Process Monitoring Solution provides several types of proven, recommended RFID readers and selects the optimum ones according to the environment and conditions of actual use. This makes it possible to design an RFID system independent of the specific RFID equipment and to introduce the system based only on the job requirements of each site.

(2) RFID Middleware

The RFID middleware interfaces with the RFID readers and receives RFID data from them. The RFID readers usually incorporate several RFID reader interfaces so that the RFID system can be built independently from specific RFID equipment. The RFID middleware incorporates a filtering function, which filters RFID data to extract only the required RFID data items. By eliminating unnecessary RFID data, the filtering function reduces the load to the network and also facilitates later utilization of data.

The RFID middleware product of NEC is called the RFID Manager (see page 97 of this issue). The RFID Manager is a practical package software product for supporting improvement of RFID systems development efficiency. It has already been applied in actual RFID implementations including the implementation in the Yonezawa Plant, NEC Personal Products, Ltd. The RFID data filtered by the RFID middleware is then transferred to the RFID server for use in supporting the management operations and job improvements.

(3) RFID Server

The RFID server interfaces with the RFID middleware and receives RFID data from it. The RFID server performs centralize the management of the received RFID data and utilize it to enable linkages with the information managed by job application systems at a higher level, etc. It is also the RFID server's job to link the information associated with the part/product carrying the RFID tag and the ID recorded in the RFID. The RFID server also interfaces with other operational application systems and transfer information collected with RFID to them. In other words, the RFID server performs the role of "hub" in the entire RFID system.

The Production Process Monitoring Solution chooses an RFID server for use in operation verification based on the past experience of the NEC Group in order to enable construction of simplified test systems at actual production sites. This strategy enables more practical verification of operations and assists the implementation of the actual systems.

The hardware and software components of the RFID system are as described above. The next section will describe the procedure for building an RFID system by integrating the system components and also the implementation procedure in order to achieve the desired RFID implementation effects.

2.5 System Implementation Procedure

The Production Process Monitoring Solution has completed the assessment and onsite verification stages and is now being applied to real production lines. The assessment consists of considering the current status of each customer by collating their needs and related issues and drawing up an overall print of the implemented RFID system that also plots its projected future development. The creation of the RFID implementation roadmap covering progress from the initial installation to the future system development and extensions is a very important step for obtaining the maximum effects from the RFID implementation. It can also serve as the guidelines for showing the orientation of each RFID implementation project.

The next step is the study of the RFID implementation policy based on the results of the assessment. This step also includes the creation of the RFID implementation model and the identification of the effects of such an implementation. Specifically, it includes setting up the points for reading the RFIDs to be used in support of the targeted efficient operational improvement and data utilization, drawing up images of the operation including the data readout method and assessment of the system configuration. The subsequent step is the application de-

sign for the demonstration tools for operation verification, actual verification and the effects of measurements. The tools and systems described above are used in this series of processes; e.g., using the RFID implementation equipment and implementation procedure in the operation verification step. After the on-the-spot verification has been completed and the RFID implementation models have been reviewed and finalized, the design and fabrication steps are performed just as in any other system implementation procedures.

The tools, systems and RFID implementation procedures based on the expertise gained in RFID implementations of the NEC Group are systematized and provided as the present RFID-Based Production Process Monitoring Solution.

3. Future Development

The Production Process Monitoring Solution targets the "closed" (in-house) RFID systems because it applies RFID in production sites that are located in closed areas. Since the scope of application of a closed RFID system is limited within a single business, such a system features a lower risk than the implementation of an "open" RFID system covering multiple businesses. The Production Process Monitoring Solution enables future system extensions and developments in addition to ensuring the application of RFID by lowering the hurdles that challenge it. This implies that the present solution can also be regarded as being optimized as the first step for the businesses that need a step-by-step implementation of RFID.

At present, the method for the implementation of an open RFID system that aims at application of RFID to an entire supply chain is under study. This system is expected to provide an overall optimization by visualizing the entire supply chain. However, as the RFID application technology is still in large part, under development, the implementation of an open RFID system by a "big bang" like method is still accompanied by a significant risk. This is why the step-by-step implementation of a secure first step is regarded as being so important for the present.

In addition to the improvement in the level of the current RFID application technology, the standardization is also an important issue for the implementation of an open RFID system that covers the entire supply chain. Research into standardization of the utilization of RFID in the supply chain domain is under way by a standardization organization called EPCglobal. NEC is not only actively cooperating with the activities of EPCglobal but also handles the verification as well as the actual packaging of EPCglobal standard technologies

(see page 106 of this issue).

4. Conclusion

In this paper, we introduced the configuration, components, system implementation procedures, expected effects and future development perspectives of the RFID-Based Production Process Monitoring Solution. The present solution has the objective of maximally visualizing the production process and utilizing the collected data. Its features include practicality based on actual experience and compatibility with system developments.

The RFID has existed since the phase in which it was handled as a new topic and is now entering the phase of implementation at actual sites, the deployment of RFID systems and the expansion of fields of application. At NEC, we rank the present solution as a first step in continuing the development of practical RFID solutions that can realize the challenging concepts of RFID application and support important implementation effects.

References

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   URL (in Japanese): http://www.sw.nec.co.jp/library/jirei/necp/gaiyo.html
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   URL (in Japanese): http://www.sw.nec.co.jp/library/jirei/nct/gaiyo.html

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