

# RFID-ready Master Data Management for Reverse Logistics

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**Abstract**—Sharing consistent and correct master data among disparate applications in a reverse-logistics chain has long been recognized as an intricate problem. Although a master data management (MDM) system can surely assume that responsibility, applications that need to co-operate with it must comply with proprietary query interfaces provided by the specific MDM system. In this paper, we present a RFID-ready MDM system which makes master data readily available for any participating applications in a reverse-logistics chain. We propose a RFID-wrapper as a part of our MDM. It acts as a gateway between any data retrieval request and query interfaces that process it. With the RFID-wrapper, any participating applications in a reverse-logistics chain can easily retrieve master data in a way that is analogous to retrieval of any other RFID-based logistics transactional data.

**Keywords**—Reverse Logistics, Master Data Management, RFID.

## I. INTRODUCTION

MASTER data management has become more and more important in most business application areas. The area of logistics and supply chain management is a good example area in which sharing single consistent master data across overall logistics chain is inevitably critical. Especially, in the area of reverse logistics, it is very important to sustainably provide consistent master data needed for reuse, repair, recycle and disposal of products and materials. More companies have started to realize that many well-equipped supply chain systems had failed because of the lack of sufficient master data sharing.

RFID is not an emerging technology any longer. Many solid research and development results have already been published. RFID tags are believed to be, by many people in the logistics research community at least, the most efficient way to uniquely identify products and services. There is no doubt that any operations related to logistics and supply chain management could benefit from the use of RFID technology [1]-[3].

EPCglobal [4] develops industry-driven standards for the Electronic Product Code (EPC) to support the use of RFID. EPCIS (EPC Information Services) is a part of standards developed by EPCglobal, which enables disparate applications in a logistics chain to leverage a single consistent shared view of information relevant to business context. In other words,

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any application that demands access to information such as track and trace of a product, authentication, and others needs to use standard query interfaces provided by EPCIS. However, in reality, information needed for reverse-logistics often goes far beyond what EPCIS is capable of providing. For example, in support of service parts logistics, information on relationships between products and service parts, may not be provided by standard EPCIS query interface. In the field of reverse logistics, the focus is on all activities associated with goods and services after the point of sales. The goal is to repair, reuse, recycle products and materials to save money and reduce natural resources. Applications supporting these activities need more information than standard EPCIS can provide. We believe that master data management system has to play this complementary role to participating applications by providing necessary additional information.

There are lots of commercial master data management solutions out in the market, but none of them is readily available for direct integration with RFID-based supply chain management. Most of them have proprietary Web APIs (web application programming interfaces) for integration purposes. This means that any application that needs information from master data management system has to be able to communicate through a set of additional Web APIs other than standard EPCIS query interfaces which it might already be very well aware of.

In this paper, we propose a RFID-ready MDM, master data management system integrated with RFID technology. With a RFID-ready MDM, any master data that needs to be shared among disparate applications can be retrieved efficiently and effectively. RFID-ready MDM system can process data exchange request in a way that conforms to the standard EPCIS query interface. This makes the MDM readily available to the environment where each supply chain partner is required to conform to the EPCglobal standards.

This paper presents preliminary results from an on-going research project funded by ministry of Knowledge and Economy of Korean government. Section 2 introduces fundamental concepts of master data and their management. Section 3 describes different alternatives to integrate master data management system in the standard EPCglobal RFID-based supply chain management environment. We propose to introduce a RFID-enabled wrapper to bridge the gap between a MDM and external accessing applications. Section 4 concludes with summary of our work and presents further studies.

## II. MASTER DATA MANAGEMENT

### A. Master Data

Master data are defined as a key information needed to the operation of business. This key business information may include data about products, customers, financials, materials, suppliers, employees, and etc. Master data are generally non-transient and often non-transactional in nature. Master data are usually cleansed, standardized, and integrated as a single reference point for various business processes in a supply chain management. Any other data, that has tendency to change as time passes by, are considered as transactional data. For example, 'Product\_Name' for product master does not change often, whereas 'Qty\_in\_stock' and 'Sales\_date' would either change a lot or differ by a single instance of a product. Thus 'Qty\_in\_stock' and 'Sales\_date' would not be included as a part of master data attributes whereas 'Product\_Name' would be. Apparently this type of modeling decision is utterly subjective and it is up to the subject matter expert to provide adequate information to let the modeler make rational decision making [5], [6].

Master data are typically needed by multiple business units and maintained in heterogeneous systems in dispersed locations within a supply chain. Master data may not be maintained in a single central repository; therefore, the possibility exists for duplicated, inconsistent, and inaccurate master data. Thus master data are that persistent, non-transactional data that defines core business entities for which there is an agreed view among business partners across the supply chain.

Table 1 lists example master data needed for operations in reverse logistics activities.

TABLE I  
 MASTER DATA NEEDED FOR REVERSE-LOGISTICS ACTIVITIES

Reverse-Logistics Activities	Associated Master Data
Return	Product, Customer, Vendor, Supplier, Part, Material
Repair/Refurbishing	Product, Supplier, Part, Material, BOM, (Dis)assembly Manual, Design Specification
Recycle	Product, Part, Material, BOM, (Dis)assembly Manual, Environmental Regulatory Compliances
Disposal	Product, Part, Material, BOM, (Dis)assembly Manual, Environmental Regulatory Compliances

### B. Master Data Management System Architecture

Fig. 1 is an architectural diagram of our RFID-ready master data management system. It consists of three layers. The interface layer is for data and operation interface to external users and systems. Personalization module provides personalized departmental data view per user. It allows intelligent personalization of master data to be published to multiple recipients with custom business rule declaration capability to reflect various business policies. Workspace provides workbench for data sponsors and stewards to perform administrative work needed for daily master data operations. Data integrator is the one that is responsible for consolidating

data from outside databases as well as publishing master data to synchronize with departmental copy of master data. RFID-Wrapper is an essentially data service interface which exposes itself as an EPCIS conformed data service APIs to accessing applications outside. Without RFID-Wrapper, participating applications in the supply chain had to go through proprietary APIs provided by individual master management systems to access master data.

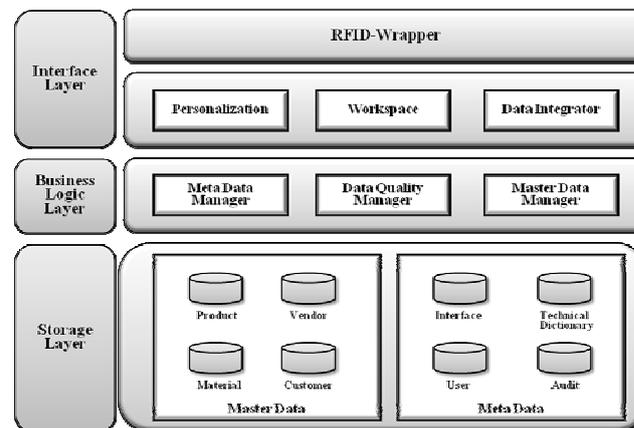


Fig. 1 Master Data Management System Architecture

The business layer is for main functionalities of master data management including overall life cycle management of master data, metadata, and their quality management. Master data management module in the business layer performs registration/modification/deletion of master data. Metadata management module is mainly for manipulation of metadata such as classification hierarchy, attribute metadata, UOM (Unit of Measure) values, and information for audit trailing. Data quality management module maintains quality of master data by utilizing the information provided by metadata. For example, if attribute metadata enumerates standard values for a particular field of master data, such information can be used to check the validity of new entry. Data quality module also incorporates data profiler which may be used to check the current status of master data as well as auto-classifier which may be used to automatically classify master data into categories according to pre-trained classifier. The storage layer is the main repository for storing and maintaining master data, metadata, and others needed for administrative purposes.

### C. RFID-Wrapper

RFID-Wrapper fundamentally serves two folds; first it receives a query from accessing applications and it passes the query to the appropriate system, second it gathers executed query results from EPCIS and/or MDM and passes the results back to the original accessing applications. It may forward the query to the MDM if the query to be answered is about master data maintained by the MDM, or else it will simply pass the query to the EPCIS for further processing. The latter case RFID-Wrapper merely passes the query to the EPCIS, while the former case it would transform the query into the appropriate

combination of Web APIs of the MDM.

Fig. 2 depicts logical structure of the RFID-Wrapper. For brevity, we omit descriptions of implementation details of each module.

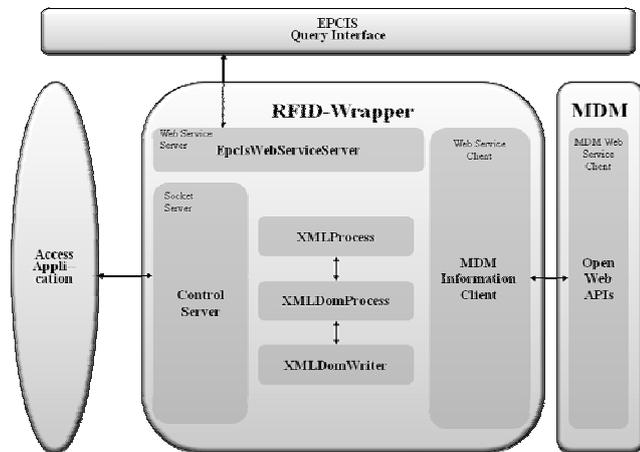


Fig. 2 Modular Structure of RFID-Wrapper

### III. MASTER DATA MANAGEMENT SYSTEM INTEGRATION

EPCglobal is if not *de facto*, surely one of the most promising standards in the field of RFID-based logistics. Any applications that conform to EPCglobal standard are to apparently use EPCIS query interface which is a standard query interface developed by EPCglobal. In reality as listed in table 1, many reverse-logistics applications including return, repair, recycle, and disposal management systems require more information than the standard EPCIS is capable of providing. It is because that EPCIS is focused on traceability of goods and services rather than a specific service task on a reverse-logistics chain. However, it is easy to imagine the conveniences of all information being readily available to repair a product by a simple scan of RFID tag attached to the product.

Although it sounded like a simple requirement, it is not easy to dynamically deliver some of the missing master data to the point of repair. To do so, the repair application must directly use proprietary access method of the master data management system separately – it would usually be Web application program interfaces - to get that necessary master data, in a way that is shown in Fig. 3. This means that the application developer of the repair management system must be able to distinguish master from transactional data so that she can write a code to access appropriate data based on her own prejudice. In addition she must be capable of dealing with both standard EPCIS query interface as well as proprietary application program interfaces provided by individual master data management systems.

In addition, access application is also responsible for combining query results together to return meaningful information back to users. Query results returned from heterogeneous systems are not only hard to combine but it is also not a good idea to delegate this responsibility up to individual application developer. In any cases, severe change

is incurred due to the integration of master data management system.

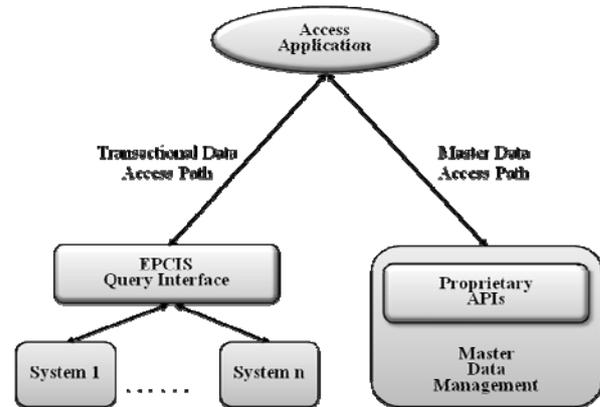


Fig. 3 Traditional MDM Integration

Fig. 4 shows a better way to integrate master data management system within EPCglobal conformed logistics environment. Every access application is to be connected via RFID-Wrapper. RFID-Wrapper will act as a gateway between access application and data whether the requested service is about master data or not. RFID-Wrapper will simply pass submitted data service to standard EPCIS query interface if it is about transactional data. And any legacy system (e.g., warehouse management system) working behind the scene will get that query and process it and gives the result back to the RFID-Wrapper. RFID-Wrapper will then present the results to original accessing application.

RFID-Wrapper will transform the query submitted by accessing application and call Web APIs of master data management system if submitted data service is about master data. RFID-Wrapper will be very well capable of transforming queries into the form of proprietary APIs of master data management system accordingly, since it had originally been designed as a part of it. From accessing application's point of view, it can submit query conforming to standard EPCIS query interface. There is no need to know whether the query is about master data or not. Query results returned by the master data management system will again be wrapped by RFID-Wrapper in a way that accessing application could comprehend.

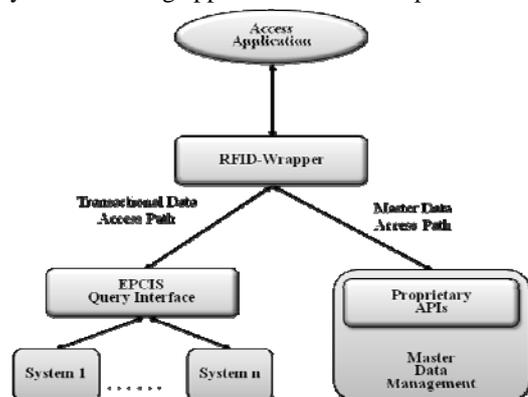


Fig. 4 RFID-ready MDM Integration

There could be queries that have to be answered only by combining access to both transactional and master data at the same time. If that is the case, RFID-Wrapper first decompose the query then send the decomposed queries to both systems and merge the results back together as a single query result. Again, the result has to be wrapped in the form that access application can understand. In comparison to integration method shown in Fig. 3, it still is better in a sense that we no longer leave the query decomposition/composition task to the hands of application developer.

#### IV. eCLIX™ MDM

*eCLIX™ MDM* is a commercial implementation of the master data management system offered by Prompt Inc., Seoul, Korea, [7], [8]. It is developed primarily based on the architecture presented in Fig. 1. In addition to the functionalities described in section 2, it has a unique ability to handle properties of master data independently from master data table. In other words, a user can define a property by naming it, giving it a unique code, and maybe enumerating values that specific property can take without having to define the table beforehand. This unique feature is very beneficial when it comes to maintain data quality since by using property manager any authorized user can make changes to properties of master data any time without a help from database experts. Other functionalities of *eCLIX™ MDM* are omitted for brevity, instead we show some of the user interfaces in Fig. 5.

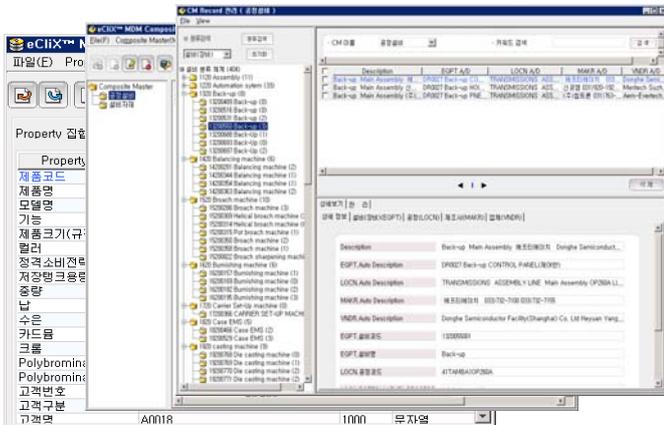


Fig. 5 eCLIX™ MDM User Interfaces

#### V. CONCLUSION

We believe that our RFID-ready master data management system can help to improve the level of master data visibility throughout the entire supply chain. With RFID-Wrapper, any information regardless of its characteristics – whether it is master or not - and its location, can be delivered by a simple scan of RFID tag. Our approach is especially significant in many reverse-logistics activities such as repair, refurbish, and recycling management, since it is critical to have that consistent master data available from the beginning to the end of product life cycle. The non-intrusive nature of RFID-Wrapper makes

integration with others relatively easy, which in turn can help speed up reverse activities effectively and efficiently.

Implementation is still in progress, primarily in the module where dynamic decomposition and composition of complex queries are carried out. In addition, we hope to further extend our system to completely transform it to a SaaS (Software as a Service) by improving it to cope with multitenant environment as well as ensuring scalability and configuration capability [9].

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