# Use of RFID in Supply Chain Data Processing

**Jan Owens**
*University of Wisconsin-Parkside, USA*

**Suresh Chalasani**
*University of Wisconsin-Parkside, USA*

**Jayavel Sounderpandian**
*University of Wisconsin-Parkside, USA*

## INTRODUCTION

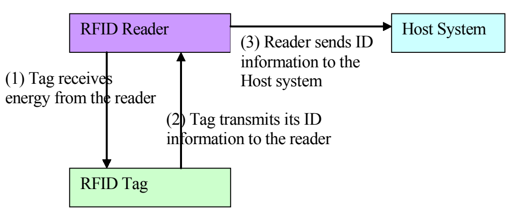
The use of Radio Frequency Identification (RFID) is becoming prevalent in supply chains, with large corporations such as Wal-Mart, Tesco, and the Department of Defense phasing in RFID requirements on their suppliers. The implementation of RFID can necessitate changes in the existing data models and will add to the demand for processing and storage capacities. This article discusses the implications of the RFID technology on data processing in supply chains.

## BACKGROUND

RFID is defined as the use of radio frequencies to read information on a small device known as a tag (Rush, 2003). A tag is a radio frequency device that can be read by an RFID reader from a distance, when there is no obstruction or misorientation. A tag affixed to a product flowing through a supply chain will contain pertinent information about that product.

There are two types of tags: passive and active. An active tag is powered by its own battery, and it can transmit its ID and related information continuously. If desired, an active tag can be programmed to be turned off after a predetermined period of inactivity. Passive tags receive energy from the RFID reader and use it to transmit their ID to the reader. The reader then may send the data to a host system for processing. Figure 1 depicts the activity of reading the ID from a passive tag by an RFID reader (Microlise, 2003).

*Figure 1. Reading ID information from an RFID tag*




The ID in the above discussion is a unique ID that identifies the product, together with its manufacturer. MIT's Auto-ID Center proposed the Electronic Product Code (EPC) that serves as the ID on these tags (Auto-ID Technology Guide, 2002). EPC can be 64 bits or 96 bits long. However, EPC formats allow the length of the EPC to be extended in future. Auto-ID center envisions RFID tags constituting an Internet of things.

RFID tag information is generated based on events such as a product leaving a shelf or being checked out by a customer at a (perhaps automatic) checkout counter. Such events or activities generate data for the host system shown in Figure 1. The host system, when it processes these data, in turn may generate more data for other partners in the supply chain. Our focus in this article is to study the use of RFID in supply chains.

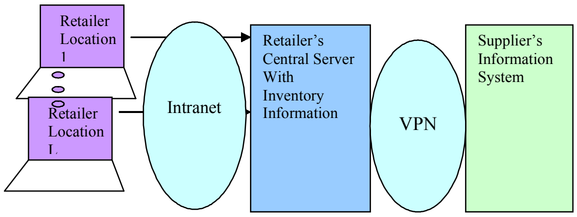
## MAIN THRUST

This article explores the data generated by RFID tags in a supply chain and where this data may be placed in the data warehouse. In addition, this article explores the acceptance issues of RFID tags to businesses along the supply chain and to consumers.

### Types of Data Generated by RFID Tags

The widespread use of the Internet has prompted companies to manage their supply chains using the Internet as the enabling technology (Gunasekaran, 2001). Internet-based supply chains can reduce the overall cost of managing the supply chains, thus allowing the partners to spend more money and effort on innovative research and product development (Grosvenor & Austin, 2001; Hewitt, 2001). Internet-based supply chains also allow smaller companies to thrive without massive physical

*Figure 2. Interaction between a retailer and a supplier in a supply chain*




infrastructures. The impact of RFID on a retailer supplier interaction in the supply chain is discussed below.

The information system model for communication between a retailer and a supplier is shown in Figure 2. The retailer is assumed to have several locations, each equipped with RFID readers and RFID-tagged items. Each location has its own computer system comprising a local database of its inventory and application programs that process data from the RFID readings. The complete inventory information for the retailer is maintained at a central location comprising high-end database and application servers (Chalasani & Sounderpandian, 2005).

Computer systems at retail locations are interconnected to the central inventory server of the retailer by the company's intranet. Reordering of inventory from the supplier, once inventory levels fall below the reorder points, takes place by communication of specific messages between the retailer's information systems and the supplier's information system (Ranganathan, 2003). Any such communication is facilitated by a virtual private network (VPN), to which the retailer and the supplier subscribe (Weisberg, 2002).

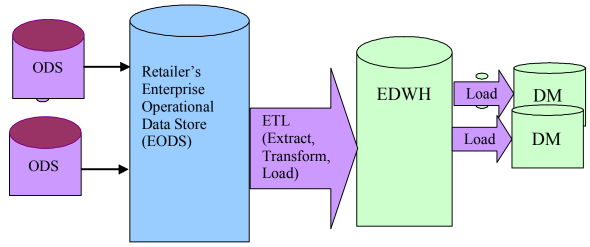
For large retailers, such as Wal-Mart, each location communicating with one central server is impractical. In such cases, a hierarchical model of interconnected servers, where each server serves a regional group of locations, is more practical (Prasad & Sounderpandian, 2003). In this article, for the sake of simplicity, we assume a flat hierarchy. The ideas and developed in this article can be extended and applied to hierarchical models as well.

RFID readings and the transactions that may be triggered upon processing the readings are classified by Chalasani and Sounderpandian (2004).

## Placing RFID Data in an Enterprise Data Warehouse System

Data warehouse systems at the retailer and the supplier should be able to handle the information generated by the transactions described previously. Figure 3 presents

*Figure 3. Processing information from operational data stores (ODS) to an enterprise data warehouse (EDWH) and to data marts (DM)*




a typical data warehouse system at the retailer's central location.

The operational data store (ODS) at each retailer's location stores the data relevant to that location. The data from different retailer ODSs is combined together to obtain an enterprise operational data store (EODS). The process commonly referred to as ETL (extract → transform → load) is applied to the EODS data, and the resulting data is loaded into the enterprise data warehouse (EDWH). The data from EDWH are then sliced along several dimensions to produce data for the data marts.

The transactions described in the previous section are handled by several tables in the ODS and the EODS databases. These tables are depicted in Figure 4. The reader table contains the Reader_ID for each RFID reader. This reader ID is the primary key in this table. In addition, it contains the location of the reader. Reader_Location often is a composite attribute containing the aisle and shelf and other data that precisely identify the location of the reader. The product table has several attributes pertaining to the product, such as the product description. The primary key in the product table is the Product_EPC, which is the electronic product code (EPC) that uniquely identifies each product and is embedded in the RFID tag.

Transaction type table is a lookup table that assigns transaction codes to each type of transaction (e.g., point of sale or shelf replenishment). Each of the tables—Reader, Product, Transaction Type—have a one-to-many relationship with the transactions table, with the many sides of the relationship ending on the transactions table.

The amount of transaction data generated by RFID transactions can be estimated using a simple model. Let $N$ be the total number of items and $f$ be the average number of tag-reads per hour. The total number of RFID transactions are $N * f$ per hour. If $B$ is the number of bytes required for each entry in the transactions table, the total storage requirements in the transactions table per hour is given by $N * f * B$. For example, if there are