A Low-Cost ERP Solution for Manufacturers and Distributors needing Materials Traceability

A White Paper by Peter and Eric Green

Introduction

This white paper is intended for small and mid-sized manufacturers of food, pharmaceutical, and medical supplies, as well as other industrial organizations that are required to maintain materials traceability history records.

These organizations are increasingly being required by their customers to electronically exchange materials traceability data, often in complex formats such as GS1 EPCIS, with upstream and downstream supply chain partners. As a result, many of these organizations are looking to transition from capturing their materials traceability records on paper forms and Excel spreadsheets to buying an “ERP” system.

What they find (hopefully before they buy or subscribe) is that ERP systems do not support materials traceability beyond rudimentary lot number traceability. The reason for this is that all these systems (even those costing a million dollars or more) track the quantity of inventory at a location, rather than tracking containers of material or individually serialized items, along with their lot numbers and expiration dates.

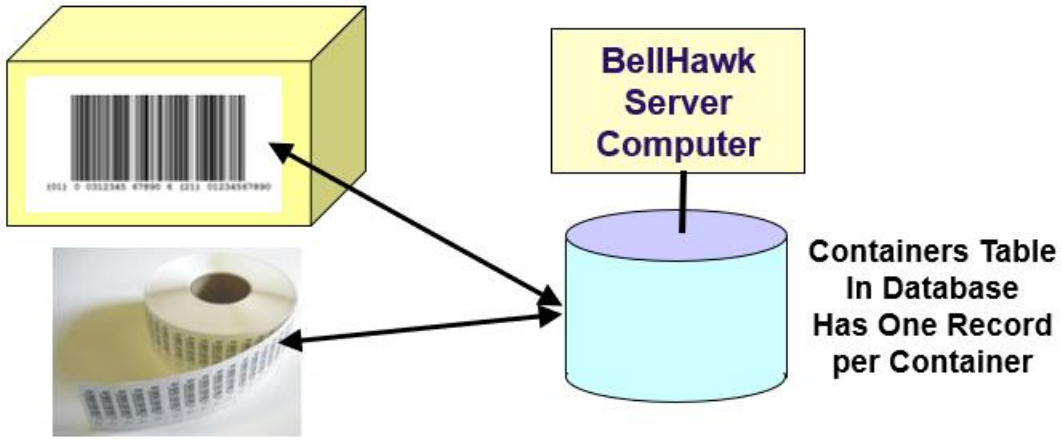
The reason for this is that ERP systems are basically accounting systems at their core which, for financial purposes, require tracking the quantity of materials and their unit value, rather than tracking containers of material. Here we will refer to these systems (along with their associated traditional inventory tracking and warehouse management systems) as Item Locator Systems to differentiate them from Container-based tracking systems.

Container-based traceability is what is used by FedEx, UPS, and Amazon. It is what is required by the GS1 standard for tracking materials in the supply chain and is the basis of materials traceability standards of US Government agencies such as the FDA, USDA, DOT, and the DOD as well as ISO standards, where appropriate.

In this white paper we look at using a container-based materials traceability software, such as KnarrTek's BellHawk with accounting systems such as QuickBooks Enterprise or ERP systems, such as NetSuite, to achieve an integrated "ERP" environment that supports capturing materials traceability data without the need to perform duplicate data entry into both systems.

Translating between Container-Based and ERP Inventory Tracking

In container-based tracking, we track materials by lot and serial number, as well as expiration date. We do this by attaching a unique tracking barcode, often to GS1 standards, to each container of material or individual part and then recording the Item, quantity lot, serial, and expiration data for each tracking barcode in a containers table in the materials tracking database.



For each container and part, we track the item number along with its unique GS1 GTIN or UPC code (now a subset of GTIN) and the quantity in each container (which is one for individually barcoded items). We also track the location of each container and the facility within which it is located (along with the GS1 GLN global location code of that facility).

In addition, we may be required to track temperature profile data for each container, as well as data such as hardness and PH and HAZMAT status for liquids and explosives.

Whenever we receive or ship a container of materials, we need to update the quantity and value of the inventory of that item, as well as the accounts receivable or accounts payable, in the accounting or ERP system. We also need to update the inventory when materials are added-to or withdrawn from each container in production, kitting and repacking operations.

Inventory updates can be done on a real-time basis, whenever a change is recorded to any container in the materials tracking system, or on a nightly snapshot basis, where we add up the quantities of each item in all the containers being tracked by the container tracking system and compute the average value before updating the inventory quantity and value in the accounting system.

Please note that it is not possible to go the other way. That is, to compute the quantities in each container of materials from the total inventory of each item in an ERP or accounting system.

Accounts Payable

In a materials traceability situation, containers of material (or individually tracked parts) are received in a container-based material tracking system, such as BellHawk, where individual tracking barcodes are attached to each container (or part) and all the relevant lot, serial, expiration and other relevant data is recorded into the tracking system's containers table for each container (or individually tracked part).

This may be facilitated by having the supplier pre-attach the tracking barcodes and then sending all the tracking data, for each container, related to its tracking barcode, ahead of time in the form of an advanced shipment notice. Then the tracking barcodes can simply be scanned, upon receipt to activate the container records in the tracking systems container's table.

Please note that a UPC code on materials only contains the part number for the materials in the container and cannot be used as a unique tracking barcode for each container, as many containers may have the same UPC code.

To update the accounts payable records in an ERP or accounting system, we typically require the purchase order number, as well as the line number, against which the materials were received.

This PO data can be keyed in when the materials are received but, to avoid mistakes, is either entered previously into the tracking system, or imported from an ERP or accounting system, enabling the PO number and line to be selected, thereby helping prevent mistakes.

Supplier data for purchase orders, whether entered directly or imported into the material tracking system, always starts in the ERP or accounting system and then has to be entered or imported into the tracking system prior to entering or importing the purchase orders.

This is complicated by the fact that there may be multiple suppliers for the same part, each of which uses a different part number. Please see our white paper "Part Number Mayhem in a Fractured Supply Chain" for details.

Also, supplier units of measure may be different from those used for materials tracking and traceability, all requiring significant translation between supplier data, materials tracking data, and accounts payable records entered into the accounting or ERP system.

Purchase Orders may originate in the ERP system, as a result of traditional Materials Requirements Planning (MRP) algorithms, or in the materials tracking system as a result of dynamic materials planning decision support mechanisms, or may be manually entered in both/either.

In addition, most ERP/accounting systems require that the quantity of materials received on a line item not exceed that on the PO (which requires changing the PO line before entering the receipt into the ERP/accounting system). This causes issues with "run of the mill" PO shipments, as does under-shipments, which can cause automatic back-order generation.

This makes manual duplicate data entry in both an ERP/accounting and a material tracking system a very complex and error prone process.

Work Orders

An important part of materials traceability is tracking what materials were used to make which products. We are seeing increasing specificity required for both pedigree and EPCIS reporting as to exactly which containers of material were used to make which work-in-process materials, which in turn were used to make which intermediate materials. Then we need to track all products which were made from each batch of intermediate materials and which customers they were shipped to.

This data recording is done using work orders. In a system like BellHawk this consists of a work order number, a route of operations to make the product, and for each step the materials to be consumed and produced.

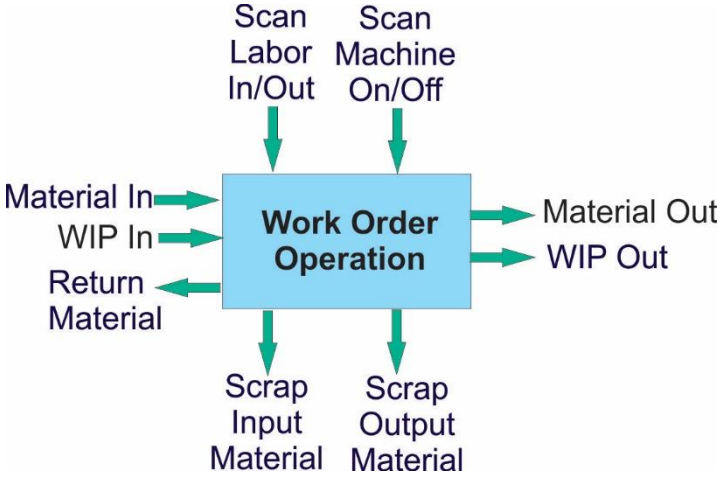
Work orders may be directly entered into the tracking system or created from an item mater part record set, which provides the route steps and materials required to make a unit quantity of the product. They may also be imported from an ERP system in the form of a Route of Operations and a BOM (Bill of Materials) for the finished product. Alternately, in the case of a system like QuickBooks Enterprise, there is no route.

In a system like BellHawk, work orders are often printed out on a Work Order sheet, like that shown above, with barcodes that can be scanned as part of the materials tracking and traceability process.

Work Orders are used in the tracking system to record the materials consumed (by container) as input to the step and materials produced (by container) as a result of the route step. They may also be used to record when an operator starts and finishes work on an operation and the setup, run, and cleanup time for any equipment involved. In a system like BellHawk, they are also used to warn the operator if they are using the wrong materials for an operation and if the materials have not passed quality inspection.

Inventory changes that occur at each step can be exported to the ERP/accounting system, except for work-in-process, as ERP and accounting systems have no concept of work-in-process (WIP) inventory.

This lack of WIP accounting can result in a “Black Hole” in inventory value. Please see our white paper ‘Solving the Work-in-Progress "Black-Hole" Problem’.



Instead, we can transfer the value of real inventory as it occurs and then update a “WIP Value” general ledger account in the ERP/accounting system every time the WIP value changes.

Because, if done manually, all of this can require a large amount of error prone manual data entry many companies do not update raw materials inventory until the finished products are made or shipped, using a technique known as back-flushing. As described in our white paper “Why is the Inventory in my ERP System Always Wrong?” this can result in substantial inventory valuation errors.

Labor and machine time recorded on a work order operation may also need to be entered into an ERP system so that it can report on the cost of each job.

Again, this makes manual duplicate data entry in both an ERP/accounting and a material tracking system a very complex and error prone process.

Accounts Receivable

Customer orders, along with customer data, may be manually entered into an ERP/accounting system, or may come from E-Commerce systems, or by EDI from customers, or from many other sources. These then have to be converted into Ship Orders and exported or manually entered into the materials tracking system.

In the materials tracking system, the ship orders are used to record the picking, packing and shipping of materials. In the case of “blanket” customer orders there may be multiple shipments, often on a periodic basis. Also “run of the mill” quantities differing from order quantities and different customer part numbers and units of measure add to the complexity of updating accounts receivable in the ERP/accounting system.

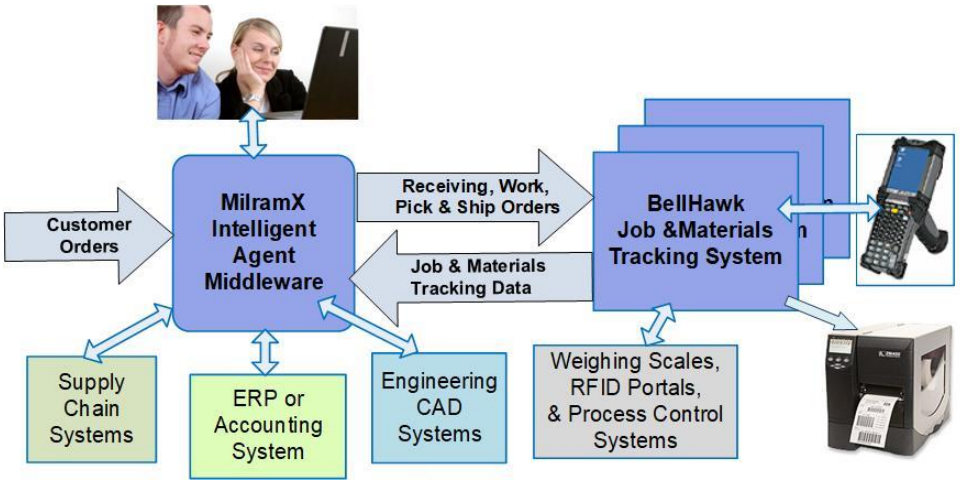
Handling order quantities can also become complex. For example, the customer orders 7 of a part and you only make and sell them in packs of 10. Or the customer orders 2 quarts of a made-to-order coating material and the minimum batch size for the coating machine is one gallon. This not only requires adjusting order quantities but needs interaction between the sales department and the customer, always assuming that the order was not placed via E-Commerce with no human interaction.

Because of the complexities of handling payment terms, shipments are entered as such into most ERP systems. However, accounting systems such as QuickBooks have no notion of shipments and required the invoices to be entered directly or imported.

Again, this makes manual duplicate data entry in both an ERP/accounting and a material tracking system a very complex and error prone process.

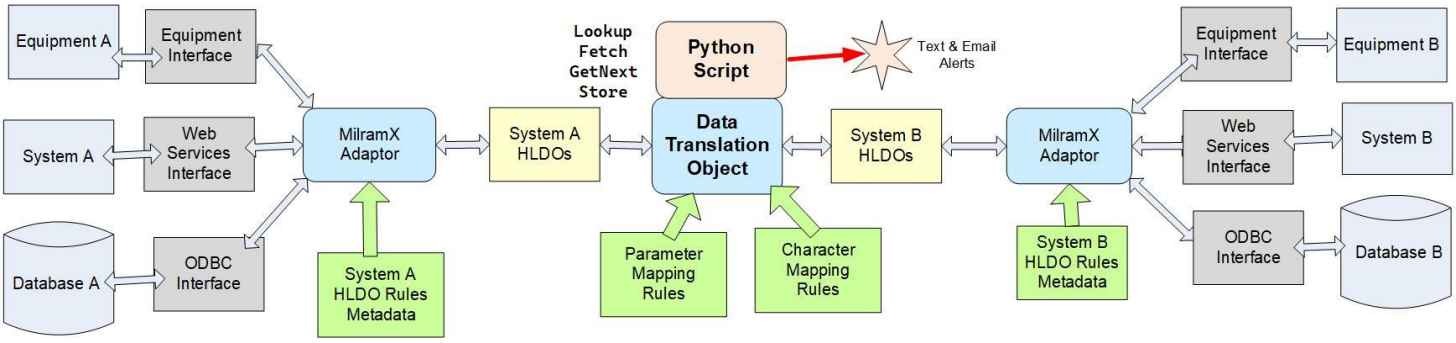
The Solution

For both an ERP/accounting system and a material tracking and traceability system to correctly perform their specific functions they need to exchange information, where the information is derived from, but not identical to, data entered into both systems. This can be done by duplicate data entry with manual translation of data from one system to information for the other. Or we can use an intelligent agent software platform, such as MilramX, to do this for us.



MilramX uses the paradigm of cooperating intelligent agents to periodically look for new data in source systems and then translate this into information updates that it sends to other systems.

In the materials traceability scenarios described above, MilramX uses data from the ERP/accounting system to generate receiving, work, pick, pack and ship information which it sends to the BellHawk tracking system. In response MilramX picks up changes to material quantities in containers due to receiving, manufacturing, and shipping operations and converts this data into information that is useful to the ERP or accounting system.

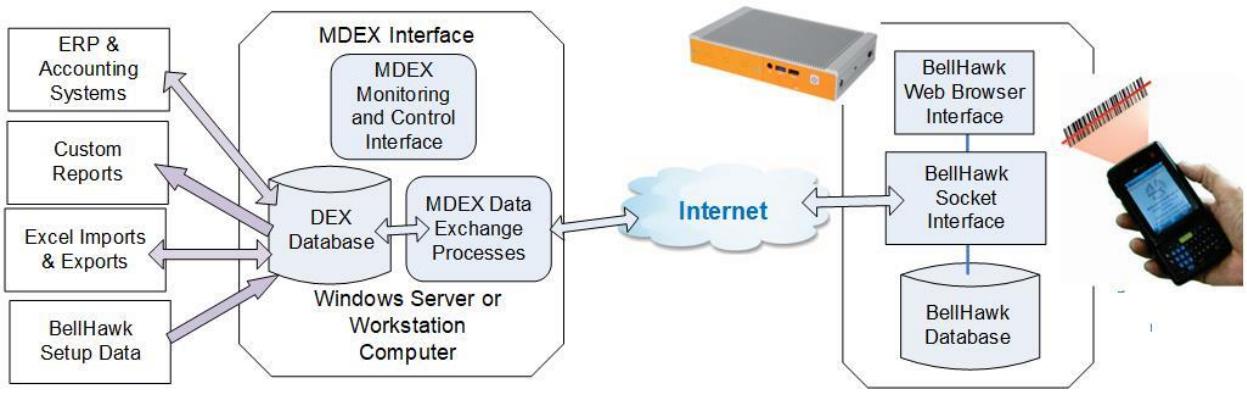


MilramX makes this task much easier by providing expert-systems based adaptors between databases, web and equipment interfaces, and the reading and writing high-level data objects (HLDOs), which are essentially JSON name-value pair, strings. The translation of data into information is done by Data Translation Objects (DTOs) which output HLDOs to be sent to one or more systems, using another set of adaptors. Alternately the results of the translation can be sent directly to people in the form of text or email messages.

DTOs are typically written as Python scripts (although more complex ones can be written in .Net) using just four highly abstracted data access calls (Lookup, Fetch, GetNext, and Store) to make writing these DTOs as easy as possible for business analysts. The rules for interface adaptors are typically written in the form of Excel spread sheets and then imported into MilramX, where they are stored in a compressed form ready for use.

MilramX includes a web-browser interface through which DTOs can be scheduled and monitored. It can execute and monitor multiple DTOs to be run as separate processes, thus enabling many different transfers to be run at the same time, especially on computers with CPUs supporting many parallel threads of execution.

By providing over 90% of the needed code pre-created or automatically generated, MilramX can substantially reduce the amount of interface code development required. This is especially true in the case of a system like QuickBooks Enterprise desktop, where a standard set of DTOs and interface rules exists and can be easily adapted to the specific needs of individual organizations.



MilramX is also used as the basis of the BellHawk MDEX interface to create a simplified automatically-updating “mirror” of the BellHawk tracking database, which can be used to create remote interfaces to BellHawk without needing to learn how to code Python DTOs.

MilramX can also be used to link both the ERP/Accounting system and the materials tracking system to the supplier and customer supply chain systems, exchanging appropriately formatted data automatically to with supplier and customer systems.

Commentary

By using an intelligent-agent middleware software platform like MilramX, we can integrate materials tracking and traceability with the other functions performed by an ERP system without needing to perform manual data translation or data entry, thereby avoiding a major potential source of errors.

This can be relatively inexpensive, such as when using the existing interface between BellHawk and QuickBooks Enterprise desktop or more complex, and therefore expensive, when using an ERP system such as Oracle’s NetSuite. In either case, the complexity and therefore the time and cost of implementing or customizing the interface is substantially reduced, by the use of a software platform such as MilramX.

Authors

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Dr. Peter Green serves as the Technical Director of KnarrTek Inc. Dr Green obtained his BSC (Hons) in Electrical Engineering and his Ph.D. Degrees in Electronics and Computer Science from Leeds University in England. Subsequently Dr. Green was a senior member of technical staff at Massachusetts Institute of Technology and a Professor of Computer Engineering at Worcester Polytechnic Institute.

Dr Green is a Systems Architect who is an expert in using real-time artificial intelligence methods to implement real-time Inventory Tracking and Operations Management systems for Industrial Organizations. He has led the implementation of over 100 such systems over the past decade. Dr Green also led the team which developed the BellHawk job and materials tracking software, the MilramX intelligent information integration software platform, and the KnarrOps EDS software platform.

Eric Green

Eric Green serves as the Director of Support of KnarrTek Inc. Eric Green obtained is bachelor's degree from UMASS Dartmouth in Operations Management and Management Information Systems. Eric has been a part of 40 plus implementations of operations management systems over his 8 years of experience in this field. This includes receiving, production, inventory management, shipping, order management, as well as integrations with a number of ERP systems and a range of different manufacturing equipment.

For further discussion, or to send comments, please contact peter.green@KnarrTek.com or eric.green@KnarrTek.com.

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