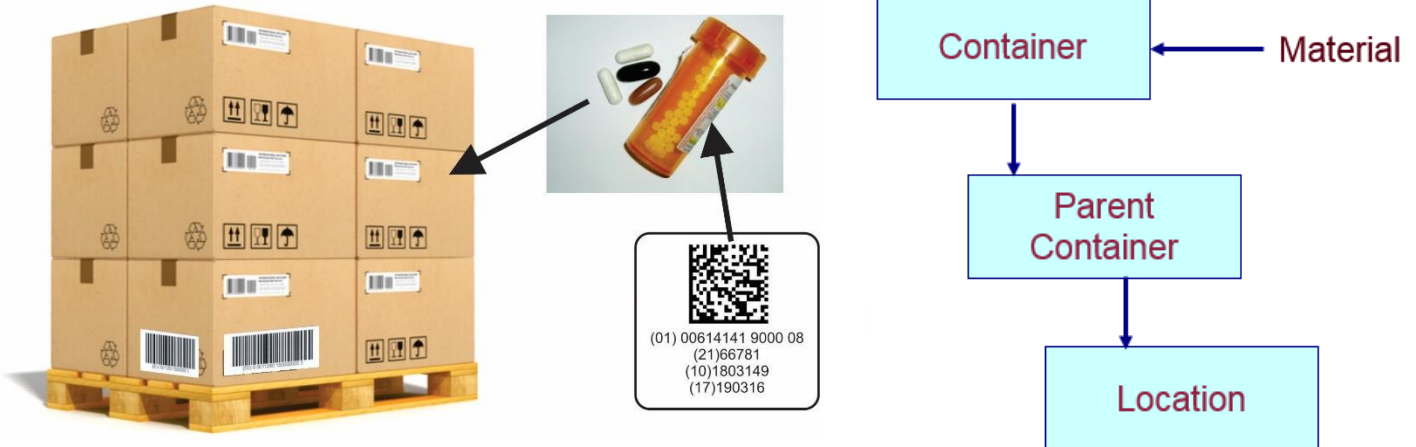## How BellHawk uses a Containers Table to Track Materials

Concepts

Unlike accounting systems, which track the quantity of material in stock, BellHawk tracks material in containers. At its core it is tracking the quantity of each item in or on each container, such as a box, barrel, or pallet. To compute the inventory of a specific item, BellHawk adds up the quantities of the item in all the containers.

This is also different from ERP (Enterprise Resource Planning) systems, which track the quantity of an item at a location. BellHawk tracks the quantity in a container, which has a location. Each container may move from location to location and, as a result, the inventory at a location changes.

BellHawk has a very fine grained, physical view of locations. To BellHawk, a location is a shelf, a rack, or a floor location. A location can also be a subcontractor or installation site. This is different from many ERP systems, for which locations are typically warehouses or production areas. In BellHawk, warehouses and production areas are referred to as Facilities, which are supersets of its physical locations.

In many cases, with ERP systems, "locations" are used to give properties to the inventory stored there, such as waiting for QC inspection, even though the materials in this "location" may be in many different physical locations.

BellHawk tracks "physical" containers which have a license-plate-number (LPN) tracking barcode and "virtual" containers which do not. As a result, we can have a set of widgets in a barcoded box at a location or we can have these "loose" in a virtual container at a location.

They could be in a physical box without a tracking barcode, which is still treated as a virtual container. Or we could have a mix of different parts, each in their own virtual container, in or on a physical container, such as a pallet, with its own LPN tracking barcode.

BellHawk also tracks individually barcoded parts, which have an LPN tracking barcode applied directly to each part. These parts are represented by a container with a quantity count of 1. These containers also typically have a serial number which is tracked by BellHawk.

BellHawk tracks the lot number and expiration date of the material in each real or virtual container. It can also track the quality control status of this material.

BellHawk can also track nested containers. As a result, we can have a parent container, such as a pallet with its own LPN tracking barcode, which has a set of cartons on it, each with their own LPN tracking barcodes, with each carton having individually barcoded parts within it. The benefit of this representation is that, when the parent container is recorded as being moved to a new location, then all the contents of the pallet are recorded as being moved to the new location.

This also enables BellHawk to keep track of what is left when a carton is removed from the pallet or a part is removed from a box. The removed cartons and parts can then be tracked individually.

BellHawk distinguishes between a Type 1 single use container that is restricted to containing a single part and lot number at the same time and a Type 2 multi-use container which can contain multiple Type 1 and virtual containers, as well as other Type 2 containers. In physical terms, Type 2 containers are things like pallets and shipping containers, whereas examples of Type 1 containers are boxes of bolts, cans of liquid, and reels of wire.

The use of Type 1 containers can prevent the accidental mixing of different products, or similar products having different lot numbers or expiration dates in a container that is supposed to contain identical products.

This fine-grained container and physical location view of the world enables materials managers to track their inventory in real-time and to be aware of its multiple physical locations at all times.

Container Database Records

BellHawk stores its inventory data in a containers table Some of the important fields in this table include:

1. A unique LPN tracking barcode – this is how material handlers uniquely identify a physical container. This is required for all Real containers. A pseudo tracking barcode is generated for virtual containers in the form BBBBB>NN where BBBBB is the LPN barcode of the immediate parent container or location and NN is the sequence number of the virtual container within that parent container or location. This is used for selecting virtual containers for transactional purposes.

2. Real or Virtual flag. A Real container has a tracking barcode and is physically tracked by its barcode. A Virtual container is how we track material without a tracking barcode that exists at a location or as one of a number of different materials in a Real container that has a tracking barcode.

3. Container type - (box, roll, reel etc.,) record which also relates to whether the container can be used to hold only a single part number or can hold multiple different part numbers.

4. Parent Container – this is the LPN of the parent Real-Container, if it exists

5. Location – this is the physical location of the material.

6. Item Number – this is the part number for the material stored in the Real or Virtual container. This will be absent if the record simply represents a Parent container, such as a pallet that has a number of Real or Virtual containers of different material stacked on it.

7. Quantity – this is the quantity of material in the Real or Virtual container.

8. Lot Number

9. Expiration Date

10. Serial Number

11. Quality Control Status

12. Unit Cost for materials in the container.

13. UDP - which contains user defined parameters for the container, such as length, width and color.

14. IsDeleted - this is normally set to 0. It is set to 1 to indicate that this record is not part of current physical inventory. Note that records in the containers table are never physically deleted, for referential integrity. When the materials in a virtual or real container are withdrawn from inventory then the IsDeleted flag is set to yes.

15. IsWIP - this is set to No for "normal" inventory and Yes for Work-in-Progress inventory, which is material in process of being converted to the end product of a work order.

16. IsPending - this is normally set to zero unless this is for a container for which a pre-printed label has been printed or for which an Advanced Shipment Notice has been received but the container has not yet been received in the plant. This is set to 255 if a preprinted label has been destroyed

BellHawk not only tracks active containers but also tracks containers of material that have been consumed or shipped. It marks these inactive containers with the IsDeleted flag so they do not appear in inventory. But it keeps them in its database so that the data is still available for shipping and similar reports that may refer to them, even if they are not in inventory.

This also enables easier handling of returned material that has a tracking barcode.

Container Types

Each container record, which relates to a physical container, references the container type in the container type table Some of the useful fields in this table, which impact on the way BellHawk tracks its inventory, include:

1. ContainerType - an alphanumeric string, such as Box or Bag, that identifies the container type

2. IsMultiUse - if this is No then this container type is a Type 1 (single use) container with its own tracking barcode, or an individually barcoded item (as set on the Item master record), or a virtual container. If this is set to Yes then this is a Type 2 parent container.

3. IsResusable - if this is No then the container is assumed to be discarded when empty. If this is set to Yes then the container record is retained when it becomes empty so that it can be reused. For example a box may be considered to be non-reusable whereas a tote would be reusable.

4. Tare weight - assumed weight of empty container of this type.

5. Tare weight UOM - unit of measure nomenclature (such as Kg) for this type of container

Usage Examples

There are several special cases that we use all the time in tracking materials:

1. A Type 1 container. This is a real container with an LPN tracking barcode that contains a quantity of a single part number of a specific material that has a single lot number, quality control status and expiration date. This is most commonly used for tracking raw materials and work-in-process. Here the containers type is set to be single use.

2. A Type 2 container. This is a parent barcoded container that has one or more virtual or real containers with this container as its parent. This is typically used to represent shipping cartons and pallets that hold multiple different part numbers. Here the container type is set to multi-use.

3. An empty container. This is a barcoded container that does not yet have any materials picked or moved into it. It is typically recorded into the system using a Tag Container transaction, ready for picking materials into.

4. An individually barcoded item. This is a part, such as a circuit card or an electric motor that is tracked independent of a physical container. It has its own tracking barcode and always has a quantity of 1 each. This is different from a roll of material, which will also have its own tracking barcode, but will have a weight or length that will vary with the amount of material on the roll.

5. A serialized item is an individually barcoded item that also has a serial number that needs to be recorded when it is entered unto inventory.

6. Loose material at a location. This is where the material is stacked directly on shelves or racks or is stored in Silos. Here there is no container barcode. Instead these materials are tracked in Virtual containers at the location. There may be several materials in Virtual containers at a specific location.

7. Loose material of different types in a parent container. Here we have multiple virtual containers in a Type 2 container. When new materials are added to the Type 2 container a new virtual container is created unless the Item, Lot Number, Expiration Date, and UDP parameters match an existing entry in the Type 2 container. In this latter case the quantities in the two virtual containers are added.

8. When new materials are added to a Type 1 container that already has material in it then the material can only be added if the Item, Lot Number, Expiration Date, and UDP Parameters match, when the quantities are added, otherwise the entry is rejected. The materials added must also be for the same project or customer as the other materials in the container or come from common or company owned stock.

In the illustration, at the beginning of this paper, the printed circuit cards are serialized items with their own individual tracking barcode. They are placed inside a Type 2 container. These Type 2 containers are stacked on a Type 2 pallet. If the items placed in the cartons were not individually barcoded, then they would be placed in Type 1 containers (same part and lot number) which would be placed on the Type 2 pallet.

It should be noted that BellHawk only tracks quality control status, lot numbers, and expiration dates for material in Type 1 containers, for individually barcoded items, and for virtual containers. It does not track these values for Type 2 parent containers.

BellHawk is setup to make it easy to track materials in Type 1 containers or to track individually barcoded items, as these are the most commonly tracked items in manufacturing and other similar industrial operations.

Type 2 containers are also easy to track or ship as an entity by simply scanning the barcode on the outermost parent container. But it requires more data entry to select which of multiple materials or lot numbers you wish to withdraw from a Type 2 parent container or directly from a physical location.

Supply Chain Integration

When a set of containers is recorded as being shipped in BellHawk, they are written into a Shipped Containers table in BellHawk, which is essentially a copy of the container records in BellHawk. This includes all the nested container information, such as which boxes, with which serialized parts in them, were placed on which pallets shipped to the customer. These shipped container records include links to the shipment to which they belonged, which itself may contain data as to the truck on which it was shipped.

As the materials are picked and packed for the shipment the BellHawk barcode labeling software (TAG) can be used to print out barcode labels with GS1 (Global Standards One) compatible SSCC (Serialized Shipment Container Code) barcodes for the boxes and pallets. This data is recorded in BellHawk, as the pallets are picked and packed, and then copied to the Shipped Containers table when the pallets are shipped.

This shipped containers data can then be exported for use by an EDI (Electronic Data Exchange) system to send Advanced Shipment Notice (ASN) data to the customer and/or distribution center which will receive the pallets or other containers.

When containers are shipped, they are marked as IsDeleted, so they no longer appear in BellHawk's Inventory of containers. But the records are retained. This is so that, if containers or individually barcoded items are returned, then their license-plate tracking barcodes can be scanned and the container record "resurrected" back into the BellHawk container inventory.

When this happens, a full record is kept in the Inventory Transactions history table. This enables, for example, the repair of an instrument, to be tracked over multiple times that it is returned from a customer and shipped back to a customer after repair.

Checking in materials received from suppliers can be time consuming, with the need to attach a tracking barcode on each item, or container of parts and to enter all the data about the received parts, as well as recording the receipts into an ERP or accounting system so suppliers can get paid.

The time to receive materials can be minimized if the suppliers attach GS1 compliant tracking barcodes to their items and the containers in which they are packed, and then send an ASN for the shipment, as soon as it has left their plant. That ASN can be sent via EDI and then transferred to BellHawk, or sent directly to BellHawk as a web-services message, using the DEX interface, or dropped as a comma delimited file by FTP into a web-accessible FTP site from which BellHawk can retrieve the data.

BellHawk can then import this data as a set of pending containers in its containers table. These are not visible as part of the BellHawk containers inventory until the SSCC barcodes on the outside of the pallets are scanned, when the nested container records are activated, and made visible as part of BellHawk inventory.

This receipt data can also be automatically exported to an ERP or accounting system so as to avoid the need to manually enter the receipt data in one these systems.

As a result, the total data recording can be reduced to scanning the barcodes on the pallets as they are offloaded from the truck/trailer. This not only speeds receiving but significantly reduces the probability of data entry errors.

Because BellHawk is recording events such as receiving, transforming, labeling, packing, and shipping containers of material, it can also send these events to materials supply chain traceability repositories, using GS1 standards such as EPCIS.

Commentary

The container representation that BellHawk uses is a very powerful and concise way of storing data about materials. It allows for a wide variety of storage configurations from loose material on a shelf to complex nested container representations. It is designed to make it as simple as possible for material handlers to record the receipt, usage, transformation, picking, packing and shipping of materials. It also enables automated exchange of data with customer and supplier systems and the global supply chain.

BellHawk keeps historical track of every transaction on containers (real and virtual) in its Inventory Transaction database table. It does not, however, have the ability to easily recall the total inventory of a part on a specific date in the past. If this historical record keeping is required then nightly snapshots of the inventory should be taken and these should be transferred to an accounting or ERP system that is setup to provide historical inventory reporting.