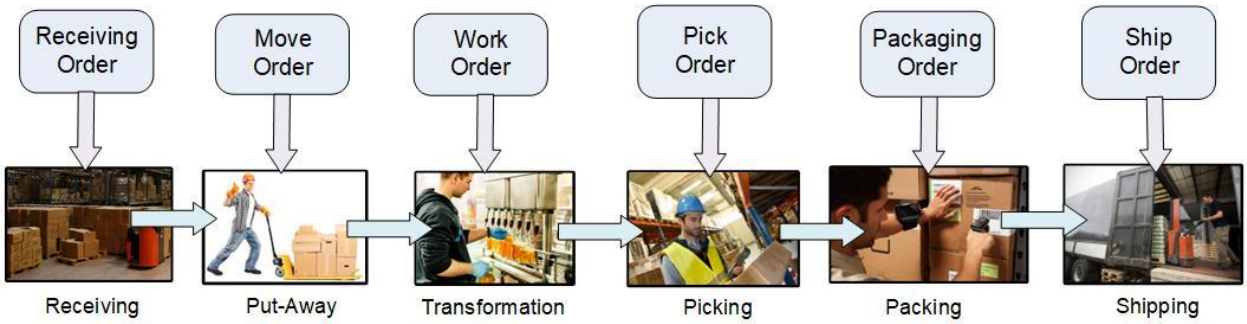
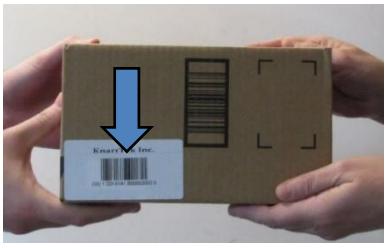
BellHawk Software Technical Overview



Introduction

The purpose of the BellHawk software is to solve those tough inventory and work-in-process tracking problems that cannot be readily solved using conventional inventory tracking systems, including ERP and warehouse management systems. Such systems use item locator methods, in which they simply track the quantity of each item number at each location, in each warehouse or other industrial location.

BellHawk, by contrast, tracks the flow of containers through of material through manufacturing plants, warehouses, and other industrial organizations by putting a unique tracking barcode and/or RFID tag on each container and then scanning these tags whenever materials are received, put-away, transformed into products, packed, packed and shipped.



Information such as part number, quantity in container, lot and serial numbers, expiration date, project code and owner, length, width and other parameters for the materials in each container are associated with the tracking barcode, which is attached to each container, when the container of materials is first received or entered into inventory.

BellHawk can track dimensioned materials, such as rolls and reels, by treating each roll or reel as a separate container of material, with each roll or reel of like materials having a common part number but different lengths and/or widths.

BellHawk can also track serialized items, such as motors and controllers, as well as assemblies and kits, each with their own tracking barcode. BellHawk can also track a mixture of items without tracking barcodes, in a barcoded container.

Tracking Inventory and Work-in-Process

When containers are put-away, the barcode on each container is scanned along with the rack or shelf location barcode where the container is placed.

Thereafter all that is necessary is to scan the tracking barcode on the container, along with the new destination location barcode, whenever the container is moved to a new location. This greatly reduces the quantity of data entry required and, as a result, significantly reduces inventory errors.

This is similar to how Amazon, UPS, and FedEx track the containers in their supply chains. It also forms the basis of the GS1 standard for tracking materials in the Global Supply Chain.

Note that there is no need to enter all the information about the contents of each container again, when it is moved, if this has been entered at time of receiving or production. The same applies when BellHawk records the consumption of materials to make intermediate or finished products

If materials are entered into a container or withdrawn from a container then all that is needed is to scan the tracking barcode on the container and record the quantity entered or withdrawn.

Also, many other attributes can be tracked for each asset or container, such as size and color, including user defined parameters, and, in the case of rolls, reels or sheets of material the length and width dimensions

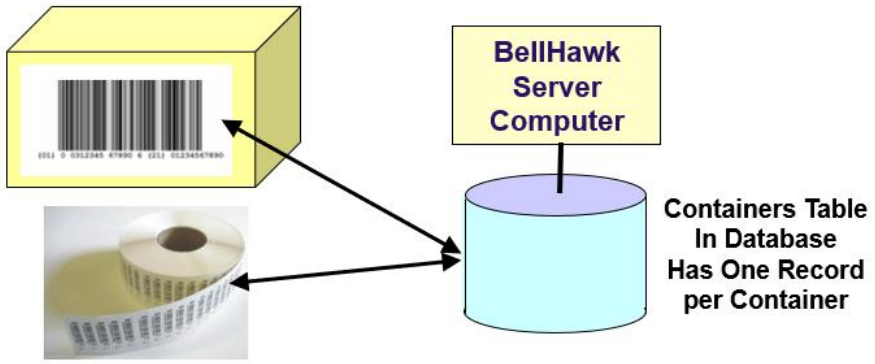
The tracking barcode label that is applied to each container can be as simple as a uniquely numbered barcode peeled off a roll of pre-printed barcodes, such as shown at right, for use within your own plant, or as complex as a GS1 standard SSCC barcode to uniquely identify a pallet or other shipping container in the global supply chain.

This use of unique tracking barcodes is sometimes known as License-Plate-Number (LPN) tracking, which gets its name from the registry of motor vehicles, where they issue you with a license-plate for your new car or truck. This license-plate has a state of issue and a set of letters and numbers that uniquely identify the vehicle, but otherwise do not contain any information about the vehicle.

All the information about your vehicle is stored in an electronic database, where it is readily available, irrespective of whether the license-plate is on a car, truck, or motorcycle or who or what is in the vehicle at a specific time.

Similarly, BellHawk enables tracking of materials in containers with LPN tracking barcodes to be handled in a uniform manner through the use of the Containers table in its database.

Here a unique LPN tracking barcode and/or RFID tag is applied to each container, or individual part, or asset that is to be tracked and all the details about the contents of the container, part or asset are captured when the container is first entered into inventory.



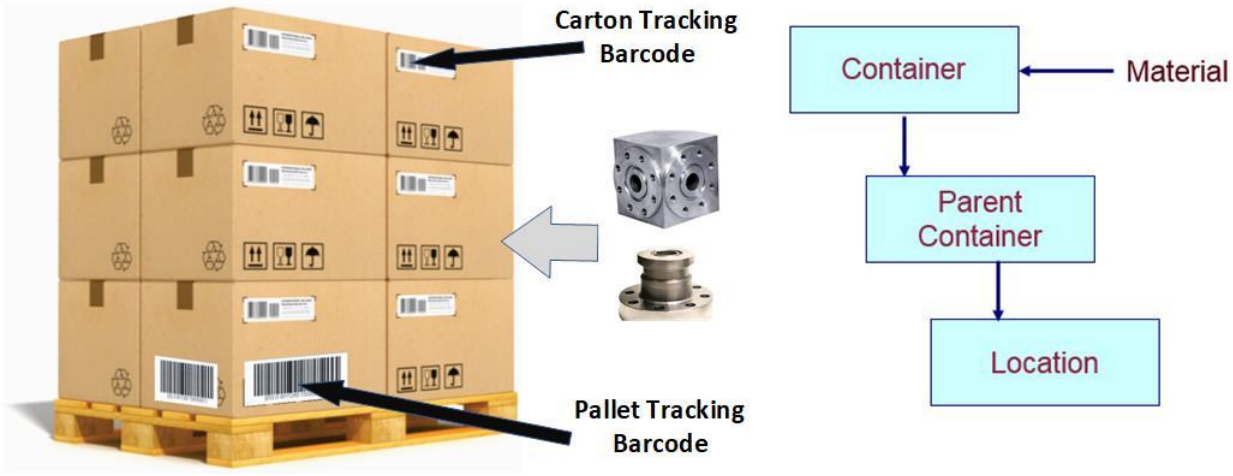
This data may include: part number, quantity, lot number, serial number, expiration date, supplier, location, assigned project, and owner, as well as user defined parameters such as size and color and, where appropriate, dimensions such as length or width.

Please note that the contents of the database record describing each container is dynamic, so that the barcode label does not need to be changed whenever the quantity of materials in the container is changed. Also, the current location of the container can be changed simply by scanning the tracking barcode and recording the new location.

Work-in-Process (WIP) can be tracked, by simply scanning the operations on a barcoded Work Order (WO) traveler, whenever work is started or completed on each step.

Alternately, or in addition, WIP materials can be tracked by scanning a permanently attached LPN barcode on each tote, cart, or other container, whenever WIP is produced from one step, moved, and consumed on another operation.

BellHawk also tracks mixed materials on pallets, or in totes, or in cartons, as nested containers.



Here, as shown in this example, we have mixed parts, each of which can have their own serial numbers, in cartons, which have their own license-plate tracking barcodes. These cartons are then placed on pallets, which have their own license-plate tracking barcodes.

Inside BellHawk, these are recorded in the Containers table, with a parent-child relationship, as shown above. There can be multiple layers of nested parent-child relationships, in our example, records for the mechanical parts having their carton as a parent container record, each of which has the pallet as a parent container record.

The first benefit of this is that if a pallet is moved, picked, or shipped then it is not necessary to break-down the pallet and record the quantity of each part moved to the new location. All that is necessary is to scan the pallet barcode. The system knows what is on the pallet and can use this data to generate ASN (Advanced Shipment Notice) data, for delivery by EDI software, describing the nested relationship of all the containers and materials on the pallet. This ASN data can then be sent to a recipient (by EDI software) who will use the information to receive the contents of the pallet simply by scanning the tracking barcode on the pallet.

Where supply chain materials tracking and traceability is required, the nested container data about the contents of each carton or pallet shipped can be used to generate EPCIS files for sending to downstream supply chain partners.

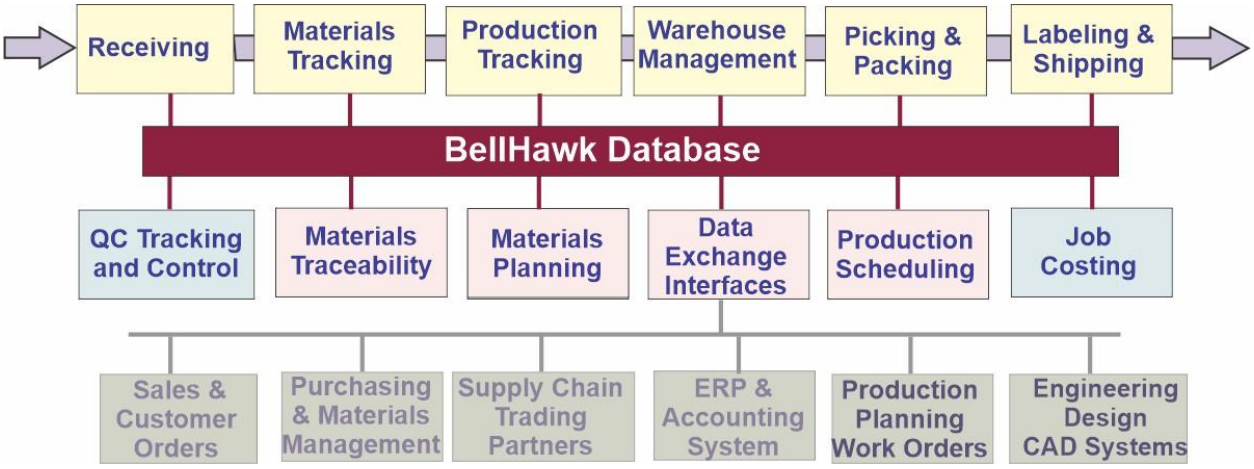
Another advantage is that cartons can be removed from the pallet and materials removed from the cartons and BellHawk still knows what materials are on the pallet and where the carton now is and which items it still contains, which is necessary for efficient operations tracking and management.

BellHawk also tracks untagged materials directly at locations without these being in containers. Untagged items have no license-plate tracking barcodes on them. Untagged materials might be a a stack of boxes (without license-plate tracking barcodes) on a shelf.

As we might have multiple untagged items at a location with different item numbers, lot numbers, and attributes such as size and color, we have to track them separately. To do this we use the concept of virtual containers, which are tracked the same as real containers except that they do not have tracking barcodes; instead, they have internal reference numbers

In this way BellHawk knows where every container of materials is at all times and is able to provide this information in real-time to users of the BellHawk system. Also, when total quantities of inventory in stock can be quickly reported by simply adding up the quantity of materials in all the containers of each part, wherever they are located.

The BellHawk Software Product Line



BellHawk® is an affordable, modular Barcode and RFID based Data Collection System that can integrates Work-in-Processing Tracking, Inventory Management, FDA Compliant Materials Tracking and Traceability, Materials Execution System and Warehouse Management Systems capabilities into one comprehensive system.

BellHawk is comprised of three base systems plus a number of optional modules. The base systems are:

- BellHawk Materials Tracking System (MTS) - tracks raw, intermediate and finished materials at all stages of manufacture and distribution using license-plate-number (LPN) container tracking methods but does not track the conversion of materials.
- BellHawk Simple Production Tracking System (JTS) - tracks work orders through a sequence of work-order operations. It can optionally capture the labor required for each operation as well as the piecework quantity produced. Also includes real-time scheduling of work order operations to be performed, based on wanted delivery dates.
- BellHawk Real-Time Job and Materials Tracking System (JMTS) which combines the features of JTS and MTS and adds in the ability to track the materials consumed and produced by each work order operation. JMTS also includes the ability to track WIP materials as they move from one operation to another.

Both JTS and JMTS support the import or creation of work orders, whereas MTS does not.

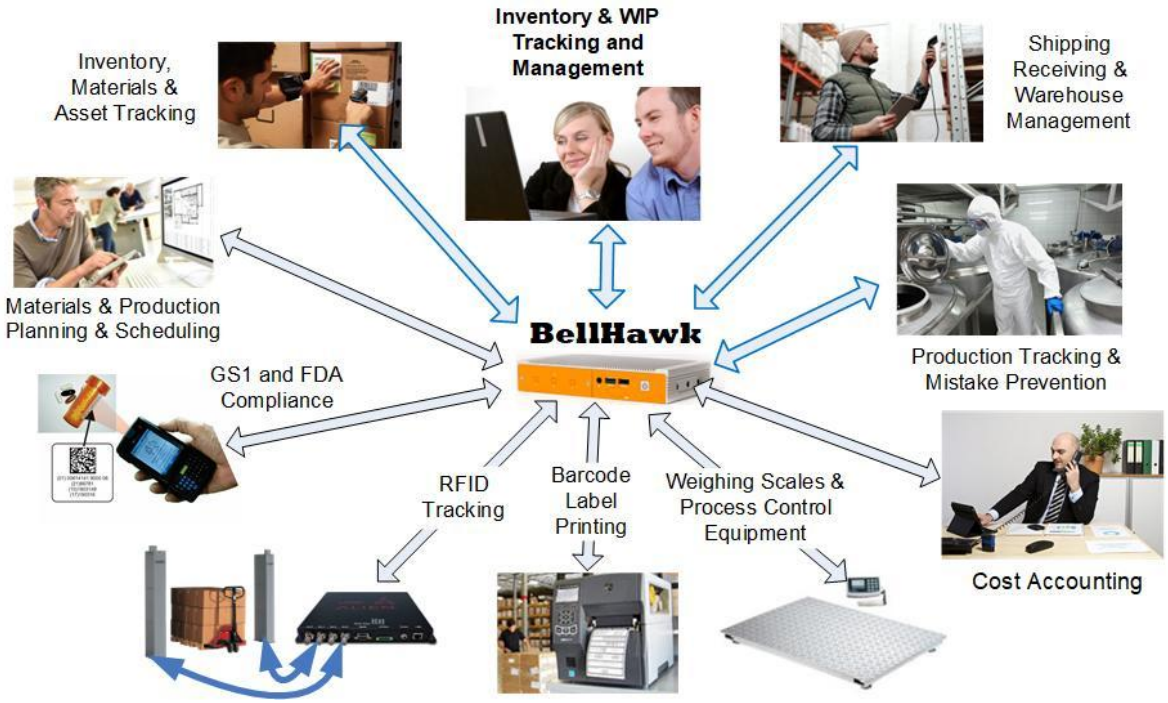
In addition, JMTS supports the use of BOMs (Bills of Materials) to prevent mistakes by warning operators if they attempt to use the wrong materials. JMTS can also capture the cost of making products as well as capturing materials traceability history data.

Where warehousing operations are involved, then the BellHawk WMS option is used with MTS or JMTS to track receiving, picking, packing, and shipping operations as well as tracking the loading of trucks/trailers at loading docks. This option also enables periodic cycle counting and auditing of materials without shutting down the warehouse.

Other options are available to support special applications without the need for customization. This includes the ability to turn on features to make BellHawk compliant with the requirements of CFR 21 Part 11, which is required for certain FDA compliant applications such as the manufacture of pharmaceuticals and medical devices.

With BellHawk, organizations can start with a simple job, inventory, or asset tracking system and build upon that, as their need and experience grow, until they may have a full, possibly multi-site, manufacturing execution and warehouse management system, with decision support capabilities. This can be done without the need to change operational procedures or disrupt factory or warehouse operations, even when a change is made to the ERP system.

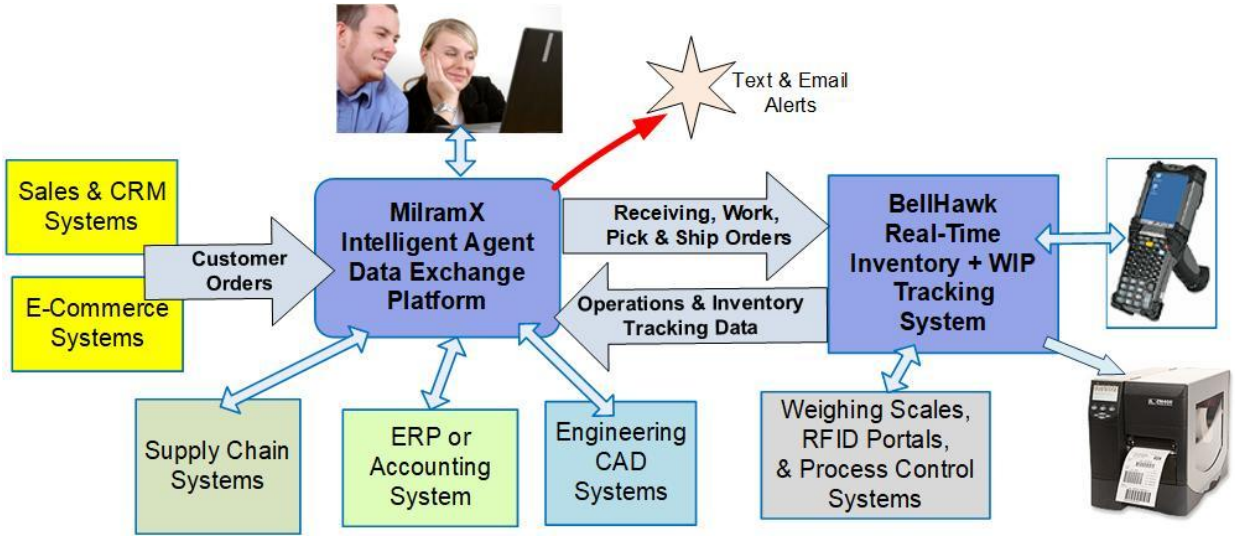
BellHawk Technology Overview



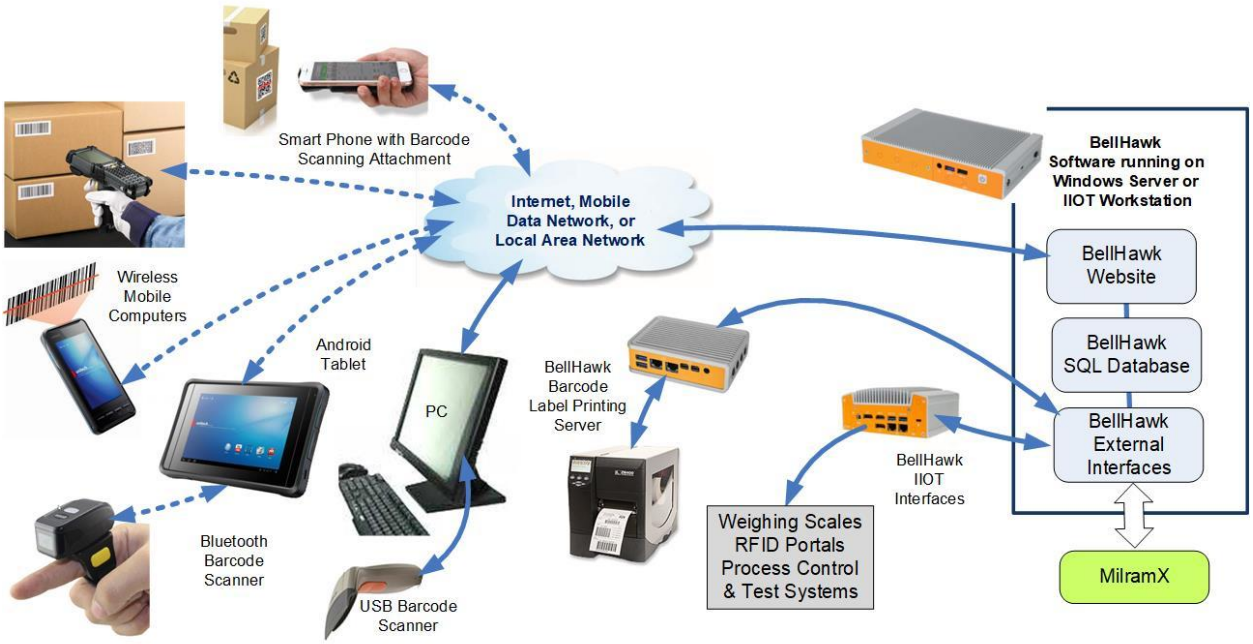
BellHawk consists of a specialized Windows IIS-based web-browser interface, for data collection and interrogation, plus a SQL Server database in which inventory and WIP tracking data is stored. In addition, BellHawk has a variety of interfaces, which support data exchange with other systems.

BellHawk can be used on a Windows Server in the Cloud or run in a Windows IIOT Enterprise based ruggedized computer in each warehouse or manufacturing plant, for higher reliability.

BellHawk can be run stand-alone or, when used with the MilramX intelligent-agent based data-exchange and decision-support software platform, also automatically exchange information with a wide-range of ERP, accounting, and supply-chain systems.



BellHawk Data Collection Architecture



A BellHawk data collection system consists of a specialized website and a SQL Server database that run on a dedicated Windows Server or IIOT Enterprise based computer.

BellHawk has a variety of interfaces, including a secure web-services interface and a data exchange interface with the MilramX software. MilramX is used to exchange information with ERP and other enterprise systems, as well as with systems belonging to supply chain trading partners.

All user interaction is performed using web-browser based devices thereby avoiding the need to install custom software in each data collection or viewing device.

Data collection and viewing can take place over the local area network, over an Internet connection, or over a mobile phone data network, anywhere there is an Internet or internal network connection to the server computer, using encrypted data links.

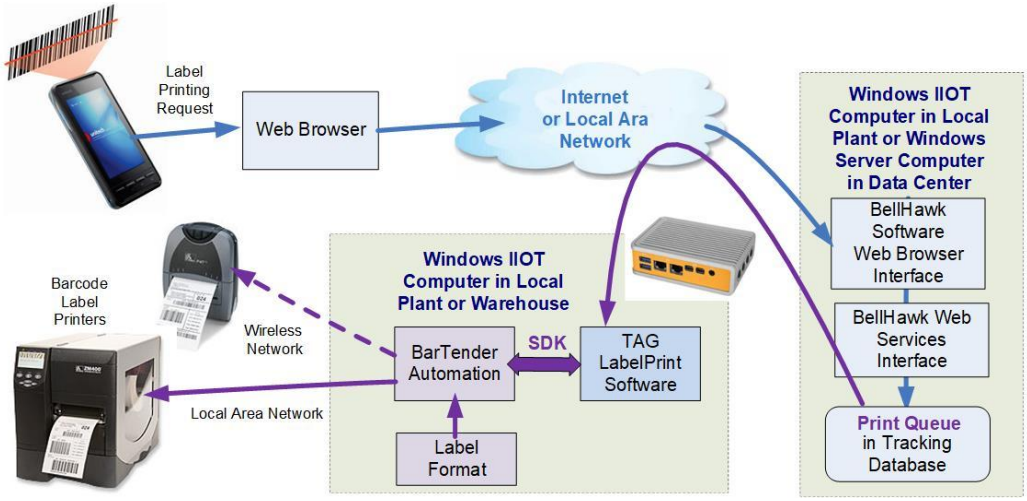
Barcode data collection can be performed using devices such as PCs or Android tablets that have external corded or cordless barcode scanners which are used for data capture. Data capture devices can also include ruggedized PDAs with integral barcode scanners as well gun-style units equipped with long-range scanners, which are suitable for scanning from the seat of a fork-lift truck.

Data viewing over a secure internet link can be done using these same devices as well as by using smart phones, preferably with external barcode scanning “sleds”.

BellHawk is based on a rules-based expert system concept that enables each organization using BellHawk to rapidly configure BellHawk for their own specific data collection requirements.

This same rules-based concept is used to make it easy for people such as material handlers and machine operators to use BellHawk to capture data, even if they are not very computer literate or English is a second language.

Barcode Label Printing



While BellHawk can perform all of its inventory and operations tracking functions using pre-printed rolls of license-plate tracking barcodes, it is sometimes required that the system quickly and efficiently print barcode labels for incoming materials, finished products and the packing materials used to ship these products to customers.

This is especially true when GS1 compliant standard supply chain barcode labels have to be individually printed.

It is essential that this labeling be performed without a lot of manual data entry, which takes time and can cause mistakes.

In BellHawk, with the BellHawk Barcode Labeling option, when a user is entering materials into inventory using a PC or a mobile computer, they can request that labels can be printed out as part of the data entry transaction. The label is then printed out automatically on the designated barcode printer. This can be on a desktop printer or on a wireless printer attached to the belt of a mobile worker or located in cradle on his fork-lift truck.

Alternately users can pre-print a set of labels, ready to attach to a set of items or containers. The information about these items, such as part numbers and lot numbers, is entered when the set of labels is requested, so that this information can be printed on the label in human readable format. These labels do not become active until the tracking barcode on them is scanned to record the items or containers into inventory. At this time the previously entered data is picked up from the database for each label and transferred to the item or container record in inventory.

BellHawk uses Artificial Intelligence rules to prevent employees from making mistakes by choosing the wrong label to print or of entering the wrong data into that label. When a user requests a label to be printed, the BellHawk rules use information such as the Customer, Item, Container Type, and Quality Control status to automatically select the correct label and quantity of duplicate labels to be printed out.

In this mechanism, a mobile device user typically sends a label printing request to the server, as part of their normal data entry. Rules set up in BellHawk then gather the needed data for the label from the BellHawk database and the label printing request is placed in a print queue on the server.

This label printing request is then picked up by software running on a Windows IIOT (Industrial Internet of Things) or Workstation computer in the designated facility and printed out at high speed on a barcode label printer located near to where the label printing request was made (which can be to a wireless connected printer mounted on the requesting user's belt).

The benefit of this is that the label printing request and the printing of the label can take place at a location that is remote from the computer running BellHawk. Also, it does not require any inbound "holes" in any internet firewall, which otherwise could cause a security risk.

The selection of the label format, data to be printed, and the printer on which the label is to be printed are made by a rules-based expert system, to avoid users needing to select the format or printer or manually enter the data, which can help prevent many costly mistakes.

BellHawk's label printing works in conjunction with BarTender Automation from Seagull Scientific, which provides printer drivers for a wide-range of barcode printers and RFID labelers. BellHawk also uses BarTender's label layout capabilities to allow its users to create labels in a wide variety of formats for a wide variety of media.

BarTender Automation can only efficiently drive barcode printers connected to PCs, or connected directly to the LAN, in the manufacturing plant or other facility in which BarTender is used. The BellHawk label printing server is able to rapidly fetch a small amount of data for each label, from the label printing queue on the BellHawk server and to call BarTender which translates this to a much larger amount of data that can be sent to the designated printer over the high-speed local area network.

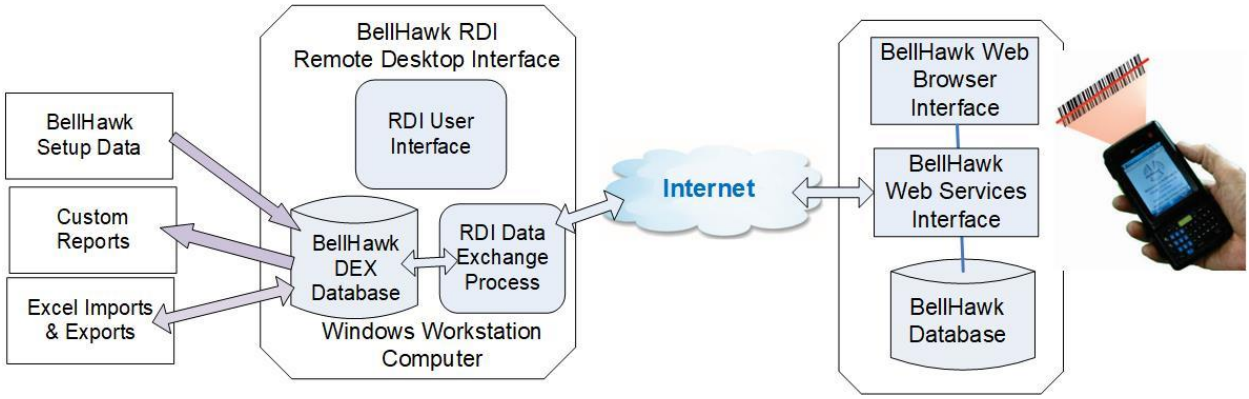
Remote Desktop Interface and MDEX

Because all the barcode data capture is performed using web-browser-based devices, all the processing of each scan or data entry item has to be performed by the computer on which BellHawk is running. This includes accessing the BellHawk database in real-time to check the entered data for operational or data entry errors and proving real-time point-of-action warnings when mistakes are about to be made.

Users get very unhappy, if the time to respond to barcode scans or test data entry, through a mobile computer, exceeds a second or two. For this reason, it is critical to run BellHawk on a dedicated computer and not on a virtual computer, such as a Hypervisor partition on a shared computer.

It is also important to restrict reporting from BellHawk to relatively small amounts of data, such as needed for immediate operational use, as the running of large reports can interfere with barcode scanning response times. Also, it is important to recognize that the BellHawk database is organized for rapid response to barcode scans and not for ease of reporting or data exchange with other systems.

The BellHawk RDI, Remote Desktop Interface, however, provides a convenient way of creating custom reports as well as exchanging data between software running in a local plant or warehouse and BellHawk running in the Cloud.



The DEX interface consists of a SQL Server database and a DEX data exchange process, which is based on the use of the MilramX software.

Data written into tables in the DEX database are automatically transferred to the corresponding tables in the BellHawk database by the DEX data exchange process. Similarly, data entered into BellHawk is automatically transferred to corresponding tables in the DEX database.

The tables in the DEX database are structured in a well-documented tabular format (think Excel spreadsheet), with a set of self-contained records and no indirect references. This makes it easy for users to develop their own custom reports, using the contents of the DEX database. It also makes the development of interfaces to exchange data with ERP, accounting, CAD, and other systems very straightforward.

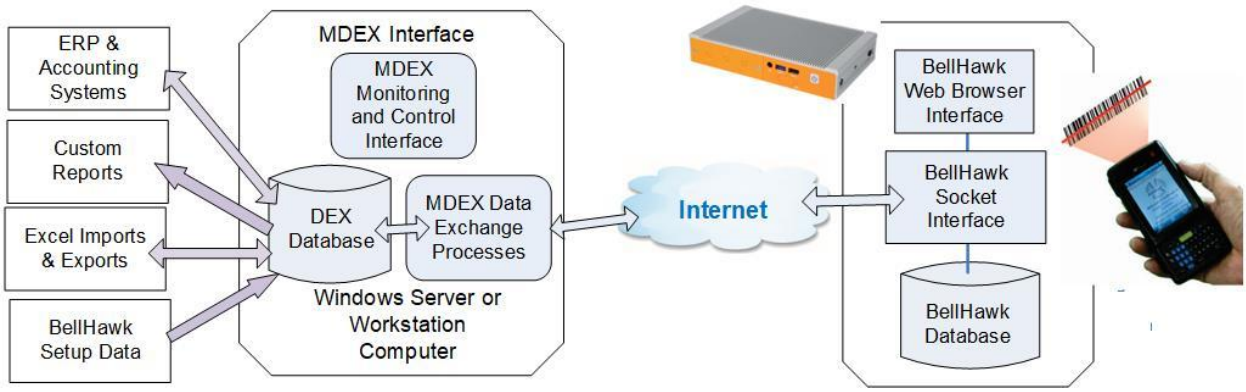
This is in contrast to the BellHawk database itself, which is designed for rapid transactional processing of barcode scanning data from a large number of mobile computers. This requires a

complex database organization with many indirect references, which makes using the BellHawk database itself for reporting or data exchange interfaces much more complex than using the DEX interface.

The Remote Desktop Interface (RDI) can be installed by end users on their Windows PCs, along with a copy of the Microsoft SQL Server Express database. This enables users to extract data from BellHawk and send data to BellHawk under user control. Note that while multiple users can be using the RDI, however, if multiple users attempt to update the BellHawk database at the same time, unexpected results can occur.

Please also note that the RDI is designed to have transfers of data controlled by the user. While these will take place automatically once initiated, it should be noted that the RDI is not intended to continuously maintain the state of the DEX database for use in data exchange with other systems.

Instead, if there are to be multiple users of the DEX database or it will be updated from multiple sources, such as ERP and CAD systems, then the MilramX based version of the RDI, called MDEX should be used.



MDEX runs as a service on a Windows Server or Workstation and is designed to run unattended and reliably exchange data 24x7 for long periods of time. It has a separate web-browser interface for remote monitoring and control.

Users can start out using the RDI to develop custom reports and/or interfaces and then transition to using MDEX for operational use. This is especially valuable when implementing shared reports using business intelligence software which requires the DEX database to be continuously updated without human intervention. It is also essential when implementing automated data exchange interfaces with ERP, accounting, CAD and other systems.

Both versions of DEX can communicate with BellHawk over the Internet, using the BellHawk web-services interface. This enables the DEX database to be located in a manufacturing plant or warehouse that can be thousands of miles away from the data center in which the BellHawk software and database is running.

MDEX can also be run on a Windows Server in the same data center as BellHawk along with the ERP or other system with which BellHawk will automatically exchange data. In this case MDEX

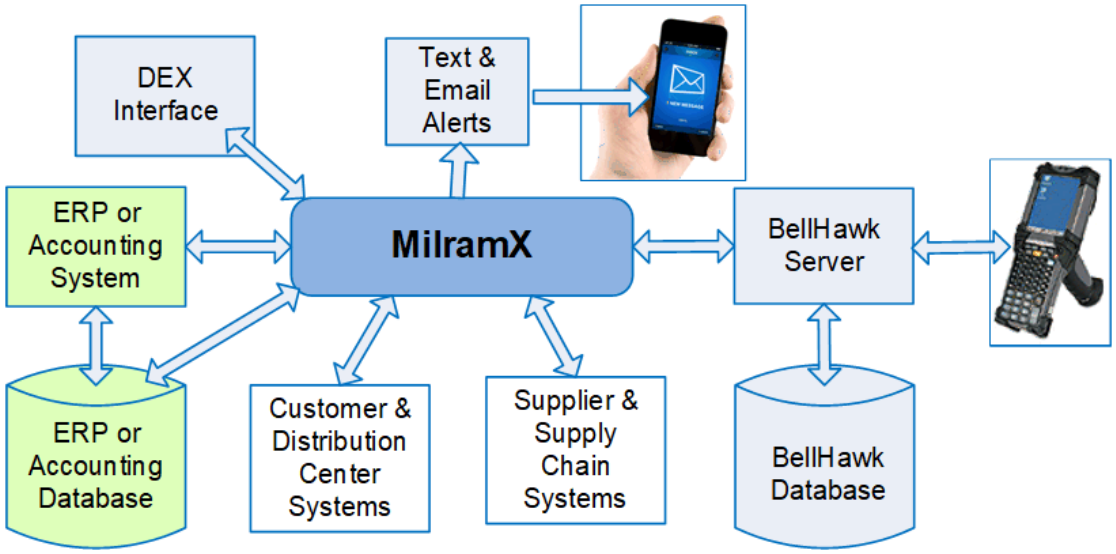
will exchange data directly with the BellHawk database, which is more efficient than communication over the Internet.

Multiple versions of MDEX and the RDI can be in operation at the same time. This enables data exchange and reporting to be taking place simultaneously with a single version of BellHawk at multiple different geographic locations.

One major advantage of the DEX database interface is that it isolates and protects the BellHawk database from possible damage from reporting and data exchange software which would be possible if they directly interacted with the BellHawk database. This also helps ensure compliance with requirements such as CFR 21 Part 11, which require that users not be able to modify data once it is captured without an audit trail being present.

MilramX

MilramX™ is a software platform, which can also be used to implement high reliability data exchange interfaces that run 24x7 with a wide-range of accounting and ERP systems. In this case, instead of communicating through an intermediate DEX database with the ERP system, MilramX communicates directly with the ERP or accounting system. This is especially useful if the ERP system is itself running in the Cloud and data exchange has to be performed through its web-services interface.



MilramX is typically run on a separate Windows Server, which can be virtual, at a remote data center in the Cloud so that it can easily interact with other Cloud-based systems, such as ERP or accounting systems, at another data center.

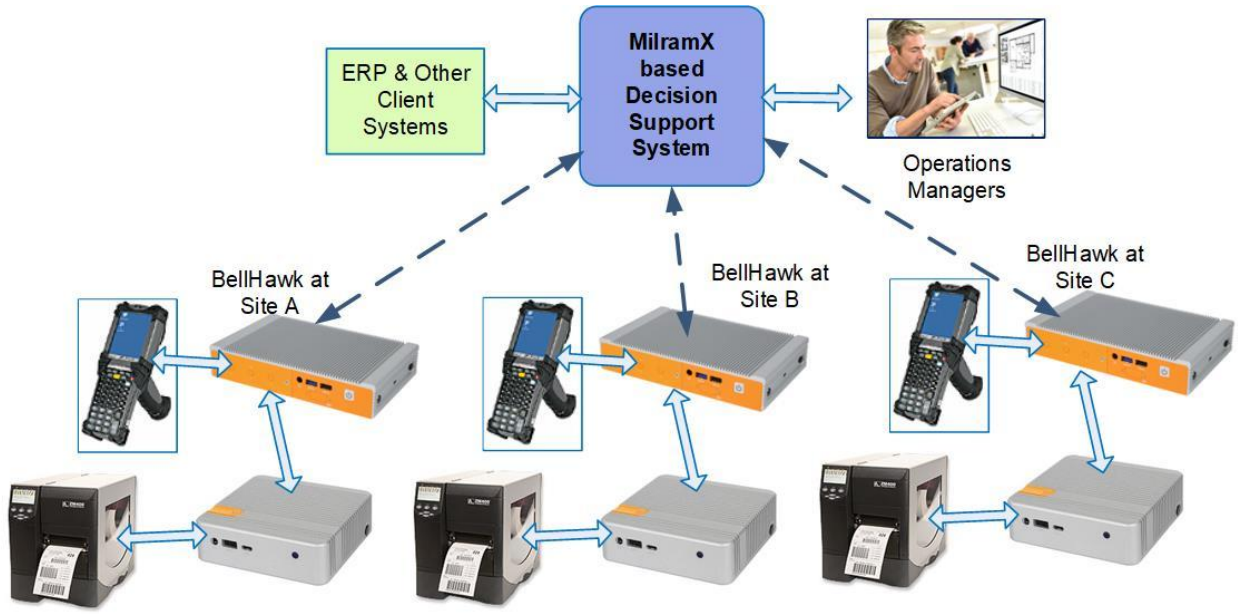
MilramX is also used to exchange data between upstream and downstream supply chain systems, as well as to generate text and Email alerts to specified users when events occur that they need to pay attention to.

In this role, MilramX examines data as it is captured by BellHawk, as well as possibly by an ERP or accounting system, and automatically analyzes this data looking for operational

situations that are potentially problematic. If a potential problem is detected then MilramX sends an alert Email or Text Message to a designated list of recipients, for that event.

This can avoid the need for managers to "walk the production floor" looking for problems or for staff members to sit glued to a computer screen or wading through reports looking for problems which have already occurred. Instead, MilramX can often predict future problems and enable managers to head off the problems before they occur.

MilramX can also be used to integrate data from multiple BellHawk sites as well as to provide decision support capabilities, such as dynamically routing customer orders to the best plant or warehouse to fulfill that order at that time.



MilramX can also provide operations managers with an overview of operations at multiple sites as they occur in near real-time.

At a single site, a version of MilramX, called MilramX Lite, can be run on the same IIOT box as BellHawk. In this case, the BellHawk web-browser Sys Admin interface is used to control and monitor its data transfers.

MilramX Lite can also push data to an Enterprise version of MilramX running in the Cloud, thereby avoiding the need for enabling inbound internet service to each site, which could cause a security risk, and also providing for store-and-forward transfers of the data for those times the Internet goes down.

For More Information

Please see www.BellHawk.com.

