Full Circle – to the Cloud and back again

Dr Peter Green

Introduction

Were you one of those people who lost their Internet connection when Amazon Web Services (AWS) went down? Or do you get frustrated when your Internet slows to a crawl?

Or even worse, are you like one of my clients who, against my advice, decided to run all of the operations tracking and process flow management software for three manufacturing plants using one server, located at their remote data center, over the Internet. These were three very high volume, rapid response, make-to-order plants which produced custom business forms.

All went well with the start of the work-week at all three plants, with production just getting into its stride when at 9 in the morning a junior IT person decided to apply a patch to the server's operating system. As soon as the patch was applied, the server crashed and production immediately ceased at all three plants. This is similar to what happened to AWS, except that they had the good sense to do this at 3 O'clock in the middle of the night.

With my client, it took three days to restore the server, during which time three plants, which would have run 24x7 were shut down, at an enormous cost in lost productivity and customer dissatisfaction in orders shipped late. It is not recorded what happened to the hapless IT person who caused the crash but I have got to believe that this was not a career enhancing move!

When we first started to transition our tracking systems from on-premises client-server systems to Cloud-based system, a wise plant manager from a prospective client took me to the window of their conference room. He then pointed to a wire strung between utility poles and informed me that this was their Internet connection.

Then he said “If you think that I am going to risk my plant operations on that thin wire keeping working, you had better think again. Why, last winter, some idiot in a snow-plough truck took down three utility poles and our Internet connection with it. And the winter before, a tree fell on it.” Needless to say, he did not sign up for our BellHawk Online Cloud-based tracking system.

In this white paper, we examine the progress of operations tracking systems from on-premises client-server-based systems to Cloud-based systems and, then increasingly back to hybrid on-premises systems. For this, we use, as an example, two bodies of software:

1. BellHawk, which is an operations tracking software platform, which performs barcode and RFID data capture, barcode labeling, inventory, asset, and work-in-process materials tracking and traceability.
2. MilramX, which is an intelligent-agent based solution that is primarily used to exchange data with ERP and other systems, as well as to provide decision support for managing the flow of materials through manufacturing plants and warehouses.

Early History

BellHawk started out as a client-server desktop application, with an Access front-end, running on a Windows desktop PC, communicating over the local area network with a SQL Server database running on an in-premises Windows Server computer, such as that shown here.

Barcode data capture was performed using corded barcode scanners plugged into each PC. Barcode label printing was performed directly from each PC, by the Access front end directly calling the BarTender barcode labeling software, on each PC, to print out specific barcode labels on demand.

Back then, we could not run the BellHawk front-end directly on mobile computers as the Microsoft Windows Compact Edition, which the data collection mobile computers of the time supported, did not support Access. Instead, we developed a store-and-forward thick client in Visual Basic, which would run in disconnected mode until the mobile computer came into wireless communications range of the server, when it would update the server about data it had captured, as well as well as update its database from the server.

This version of BellHawk was beloved by many IT people and manufacturing engineers as they could modify the Access front-end to fit their specific requirements. And, until recently, a few organizations were still running this 25 year old version of BellHawk.

Transition to the Cloud

This version was, however, doomed by three factors:

1. Microsoft in wanting to move to the Cloud, stopped supporting many of the features of Access that made the client-server version work. This was, in my opinion, so that Microsoft could dumb down Access in order to integrate it into their Cloud-based offerings.

2. The decline in IT and manufacturing staff at most small and mid-sized enterprises. When we first developed BellHawk, our typical client has 5 or more IT and Manufacturing Engineering staff on site. Today we are lucky if our mid-size clients have one IT person on site and the smaller organizations have none.

3. Microsoft's planned obsolescence for earlier versions of its software, including the operating systems on which the client-server version of BellHawk ran. Now largely solved by the Long-Term Support Contract (LTSC) versions of Windows designed to run on Internet of Things (IOT) based computers.

The lack of IT staff also doomed the store-and-forward technology that we used in mobile computers, as it took a lot of IT staff time to keep it working and make sure that the separate databases in each device remained in a self-consistent state.

As a result, we rewrote BellHawk as a web-based application with a web-browser front-end, as shown here.

This enabled BellHawk to be run in the Cloud on a remote Windows Server. Most importantly, it enabled the use of a web-browser on a wide range of fixed station and mobile devices, without the need for an IT person at each site to install and maintain custom software on each device.

With this shift, it was also possible to support data collection on a wide-range of mobile devices over the wireless local area network in each building as well as in the field over, the mobile phone data network.

With this configuration we were able to support multiple small clients running BellHawk on a shared computer, as well as larger organizations running a dedicated version of BellHawk on a Windows Server computer in their own data center.

Storm Clouds Brewing

Having BellHawk run in the Cloud worked reasonably well at first, but then problems started to appear for the following reasons:

1. Internet speed and reliability. The vast increase in use of video sharing in all its forms during and after the Covid pandemic resulted in a substantial increase in dropped internet messages. While a dropped frame or two may not matter when watching a video, they can have a very negative effect on the speed and accuracy of real-time data collection.

2. Security vulnerability of Cloud-based enterprise systems, witness the recent ATT and the car dealer system hacks that shut down businesses for days, if not weeks.

3. Physical infrastructure vulnerabilities. Recently we had a cement truck take out 800 feet of Internet cable to our offices which resulted in our offices being off-line for over 24 hours. Think what would have happened if we had been a busy manufacturing or distribution facility.

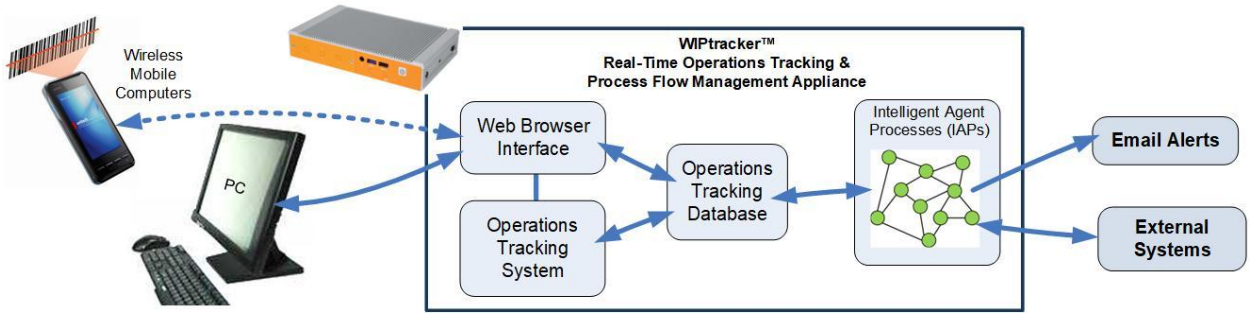
4. Microsoft updates. Microsoft is performing ever increasing updates which are increasingly buggy. I just spent over 4 hours last night diagnosing and fixing a Microsoft update that brought my PC to its knees. Fortunately, an industrial site did not depend on my computer; but one client that we had made the mistake of applying a Microsoft patch at 9 AM and shut down 3 plants running on a shared internet server for 3 days.

As a result, for those clients who want high reliability and up-time, we have switched to running BellHawk on a Windows IOT Enterprise based industrial ruggedized computer in each plant.

These computers are highly reliable, provided they are plugged into an uninterruptable power supply (UPS). Most important, they are not automatically updated by Microsoft and are designed to run for many years without maintenance, which is what you need for an operations tracking system.

We have found, however, that clients with limited operations tracking needs, who are not so concerned about the Internet occasionally going down or running really slow, are willing to trade-off reliable access against the ease of simply using a production or inventory tracking system in the Cloud without having to worry about any IT issues.

WIPtracker



The latest iteration in our operations tracking saga is WIPtracker™ which integrates a BellHawk operations tracking system and a MilramX intelligent agent system in a ruggedized industrial internet of things (IOT) computer, the size of a college textbook, that runs on-premises in each manufacturing plant or warehouse.

Here, BellHawk acts as a barcode tracking system that provides work-in-process tracking, job and materials tracking, warehouse management, materials traceability, and manufacturing execution system capabilities. Also, MilramX enables data exchange with a wide range of ERP and other systems through their REST interfaces. MilramX intelligent agents can also periodically monitor the BellHawk operations management database and send alert Emails, such as when inventory gets low, to operation managers and their staff.

Some of the benefits of WIPtracker system are:

1. We can ship a WIPtracker system to each plant or warehouse, in a plug-and-play configuration, with all the needed software pre-loaded. All that is needed is to plug the box into the site's local area network (LAN) and to an uninterruptable power supply to start collecting data. This avoids the need for any IT people on-site to install the software and potentially long delays to get IT to provision and setup a suitable computer.

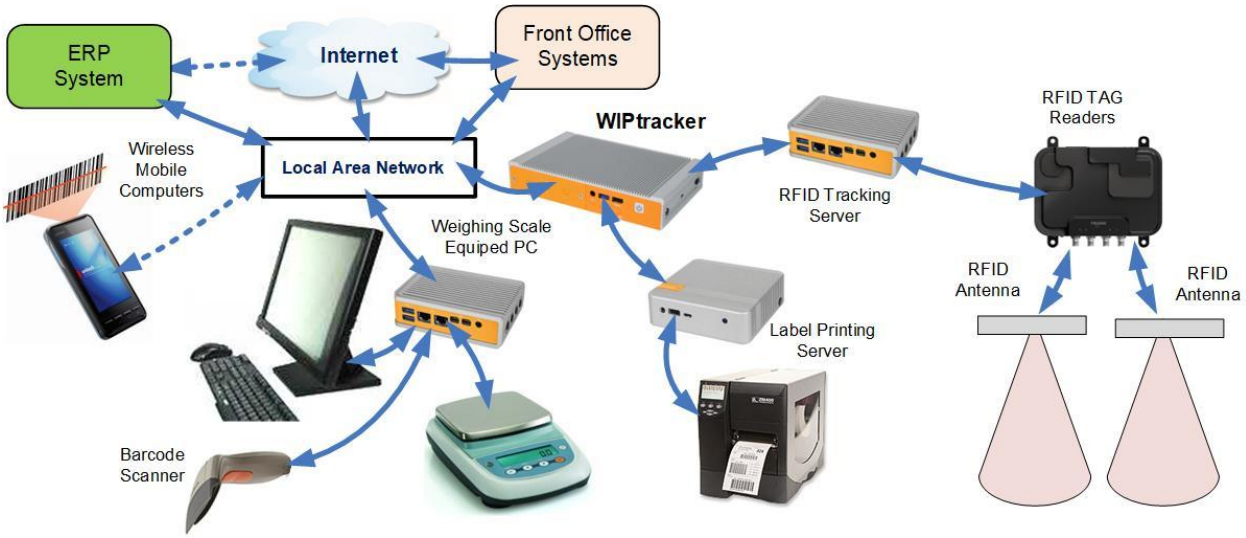
2. WIPtracker is secure and reliable in that it does not need any external connection to the Internet to operate. It uses encrypted communications with mobile devices in the plant or warehouse. Also, any communications with external systems are done using an outbound Internet connection, just like any PC plugged into the site's LAN. There is no need for IT to create "holes" in the site's security firewall.

3. WIPtracker is reliable, in that operations in the plant can continue if the Internet goes down. Also, WIPtracker runs on an LTSC IOT version of Windows 11, for which Microsoft guarantees at least 10 years of support and also, and most important, guarantees that they will not automatically update the operating system. This avoids the risk of Microsoft bringing operations to a halt by automatically patching and crashing the operating system.

4. WIPtracker is configurable by manufacturing engineers and business analysts using a mix of rules and Python scripts thus enabling the system's data collection, reporting, and data exchange interfaces to be modified locally, without the need for on-site IT people.

5. Because it uses a web-browser interface WIPtracker will work with a wide-variety of data collection devices, without the need to load any special software. Also, because communication with WIPtracker works over the site's high-speed wireless or wired LAN and the WIPtracker computer is dedicated to data collection, response time for barcode scanning is much faster than relying on a much lower speed Internet connection and a time-slice on a shared computer.

Connection to the Shop Floor



While WIPtracker is an excellent, stand-alone barcode tracking system, we quickly found that, especially with the availability of a WIPtracker box in the plant, that there was a need for extensions to this to support shop-floor operations, such as interfaces to weighing scales and RFID sensors as well as the printing of custom barcode labels on demand.

So as not to interfere with barcode scanning time, we use external IOT boxes to automatically perform these functions using software that extends BellHawk capabilities. We also use MilramX running in one or more IOT boxes to automatically exchange data between BellHawk and process control lines and test stands.

Multi-Plant Issues

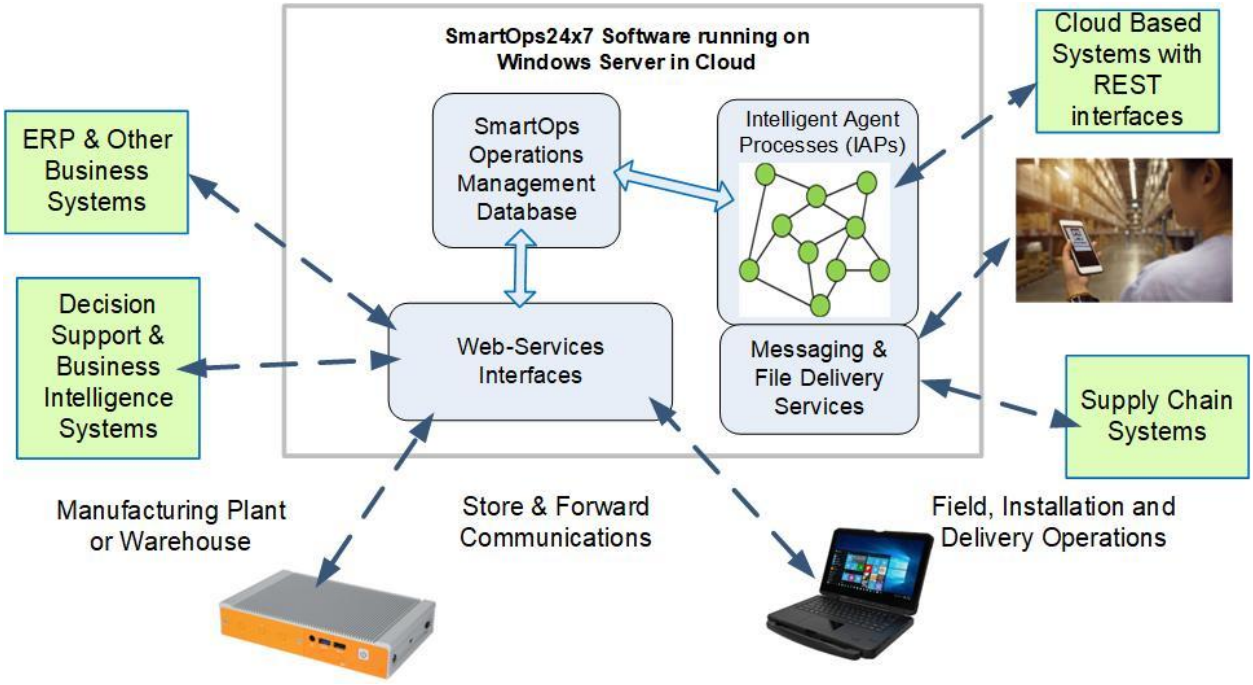
The WIPtracker approach enables us to do a great job of reliably collecting and processing operational data in individual manufacturing plants and warehouses. But then the question arises as to what to do when our clients have multiple manufacturing plants and warehouses but have single ERP or accounting system, which they want to use to run all their plants.

The simple answer to this is to have each WIPtracker interact with the ERP system, which typically is in the Cloud, to get the data that each WIPtracker box needs, such as work/manufacturing orders, and for WIPtracker to send back data about inventory received, processed, produced, and shipped.

But then the question arises, how do we take advantage of the latest AI technology to assist in making management decisions and to control the flow of materials through multiple manufacturing plants and warehouses.

One answer is to use multiple WIPtrackers in a SmartOps24x7 configuration.

SmartOps24x7



Here we have MilramX intelligent agents, running on a Windows Server in the Cloud, combined with an Operations Management Database, containing integrated data from all the WIPtracker sites. This database also contains work orders and ship orders destined for each WIPtracker site.

Each WIPtracker communicates with the Smart Operations Database using a store and forward technology which helps ensure reliable data exchange, even if communications with the SmartOps24x7 server over the Internet is unreliable.

SmartOps24x7 also takes advantage of this store and forward technology to support disconnected operation at field and construction sites, as well as mobile delivery applications where there is no internet connection. Here the SmartOps24x7 software is run on a ruggedized laptop or tablet, running the Windows IOT operating system.

With the store and forward technology, communications are automatically established whenever the laptop or tablet has an Internet connection and then this enables the WIPtracker database to exchange data with the SmartOps24x7 database.

The SmartOps24x7 Operations Management database is accessible, through a variety of web-services interfaces to AI based business intelligence systems as well as to other systems. Data can also be exchanged by the intelligent agents with centralized ERP and CRM systems, as well as with supply chain management systems.

Summary

We started with client-server operations tracking systems in each plant and then moved to Cloud-based systems to eliminate the need for an IT support staff in each plant and to, theoretically, reduce costs. But this caused problems due to the unreliability of the Internet, poor response times, difficulty of communicating with shop-floor systems, and security concerns.

As a result, we now have transitioned back to a hybrid solution with on-premises data collection systems but with the ability to communicate with Cloud-based ERP and other systems, as well as the ability to interact with Cloud-based regenerative AI systems for decision support.

For more information

For prospective clients in the Americas interested in deploying WIPtracker and possibly SmartOps24x7, please contact Sales@KnarrTek.com or see www.KnarrTek.com.

For prospective partners interested in licensing WIPtracker and SmartOps24x7 for integration into their own solutions, please contact Marketing-Support@SmartOpsMgt.com.

Author

Peter Green

Dr. Peter Green serves as the Technical Director of KnarrTek Inc. and Smart Operations Management LLC. 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 technology solutions for materials tracking and traceability in the food, medical, industrial, construction and defense supply chains. He has led the implementation of over 100 such systems over the past decade. Dr Green also led the team which developed the BellHawk barcode tracking, labeling, materials tracking and traceability software as well as the MilramX decision support and supply chain information integration software platform.

For further discussion, or to send comments, please contact pgreen@SmartOpsMgt.com.

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