Whitepaper PTC / Kepware

Next-Gen IT/OT Convergence: Capitalizing on Determinism, Data Flow & Containerization to Boost Operational Resiliency

The idea of incorporating information technology (IT) into operational technology (OT) systems is not a new idea, but it is a concept that is constantly evolving. It's no longer about plugging in IT features into a couple areas of an assembly line. In order to gain the full advantage of what IT has to offer and to keep our operations resilient as we emerge from the pandemic, we need to shift our application from supplementing OT systems, to fully integrating IT and OT technologies.

In short: IT is the future of OT, and OT and the future of IT. And the tools, techniques, and technologies that are increasingly used by each side are evolving from optional to mandatory.

However, the values for each type of technology is not one-to-one. For example, determinism is not a critical component in IT architectures. But when it comes to the OT sphere, determining how many parts you can manufacture per minute is absolutely critical for efficient OT systems.

When considering the best way to introduce Industry 4.0 to the factory floor, decision-makers need to remember that technology must drive value. Implementing technology without updating the current processes and workflows will not deliver the desired business benefit. Otherwise, the return on investment will be slim to none.

Effectually, it's a top-down decision that must be driven from the bottom up. When streamlining your workflow, you need to know: what kind of data helps the operators on the factory floor; what context is required for a particular datapoint; when and how this data should be delivered; and whether the environment is conducive to cloud-based systems or if it requires an on-premise server.

What to Capture and Why

An important part of a digital transformation journey is determining what data you want to capture. There are three categories of data:

- Demand: this indicates incoming work, expressed as a quantity per unit of time. For example, 50 clients per day, or 1000 orders per week.
- Status: this indicates the current work underway, or rather the progress of work in the queue. For example, 4 of 5 production lines are operational, or the project is in Phase 2.

- Outcome: this indicates performance over time, typically against a target. For example, $3.1 million in sales, or 9.8% product returns.

All three categories together can inform team performance at a glance. In other words:

There is X volume of work to be done, the work is in Y stage, and the work performance is Z.

This is also known as the Input-Process-Output (IPO) model, which provides a framework for conceptualizing how teams perform, and how to maximize their performance. IT can routinely capture this information so teams can make informed decisions on improving outputs, workflows, or OT structures.

The Edge is Ahead of the Curve

If there is one absolute truth about technology, it is that it is constantly evolving. Simple machines became more complex, then they were computerized. Even robots evolved from simple commands to collaborating with other machines, and physical servers became virtual environments.

But when new technologies arrive, so do the skeptics. When the programmable logic controller (PLC) came on the scene, not everyone was convinced that it was the path forward. Some even doubled down on relay logic instead of investing in PLCs – because it was easier to continue with their current technology then to adapt a new one. Now that PLCs are everywhere, it would be fair to say that PLC skeptics backed the wrong horse.

The remarkable thing about technology today is the rate at which it is evolving. Nowadays we don't have to change current production set-ups to apply IT innovation – instead we can add edge computing to a PLC, SCADA, or MES/MOM and deliver data to an IIoT platform. Users can get data in one spot instead of checking the workloads at all levels of production. With digital transformation, we are supplementing OT systems with IT, not replacing one for the other.

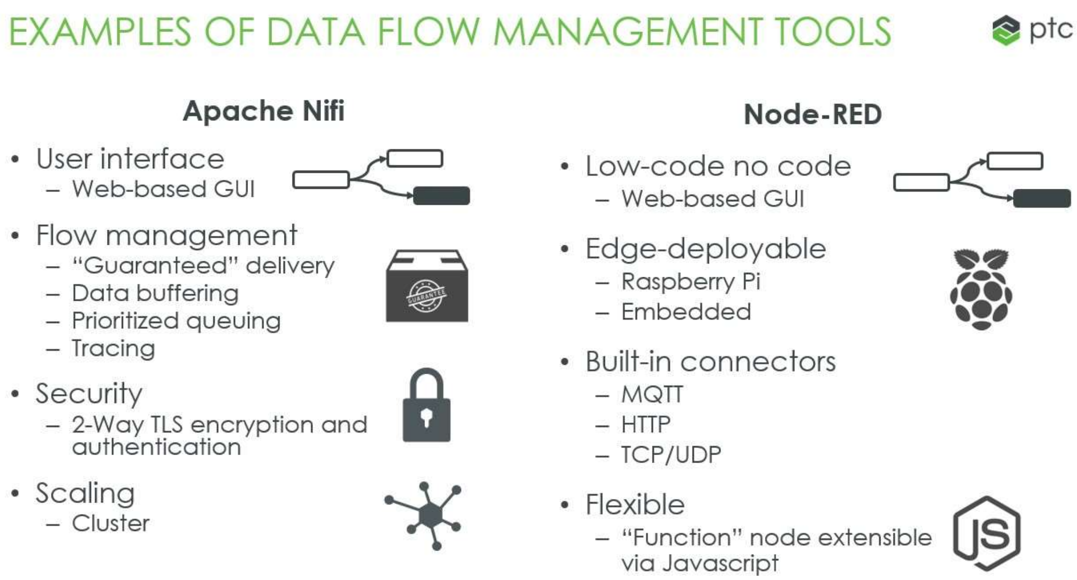
However, there is an ebb and flow to bringing OT and IT systems together. In some cases, crucial manufacturing data can only be shared across the larger enterprise system by leveraging existing IT infrastructure and resources (centralized servers, security resources, etc.). Conversely, it can be very difficult for those IT infrastructures and tools to interpret industrial data directly – that is where edge analytics come in.

Edge analytics can be interpreted in several ways: protocol conversion, simple interpretation of data (calculating values), or even machine learning. Regardless, data from field devices will need to be manipulated in a way that higher level systems can understand. In other words, when your field devices deliver data such as %yield or total output, edge analytics will translate it into a format compatible with a higher-level IT system (e.g. MQTT, REST, DDS or even OPC UA).

Data Flow Management

Transforming an OT operation into the digital space requires some understanding of data flow management. This means we can get data from one source, process and possibly transform that data, and then send it via a new channel or protocol. (Remember the IPO model?) This also allows for data from multiple sources to be delivered to a single solution, whether that is a database or a cloud platform.

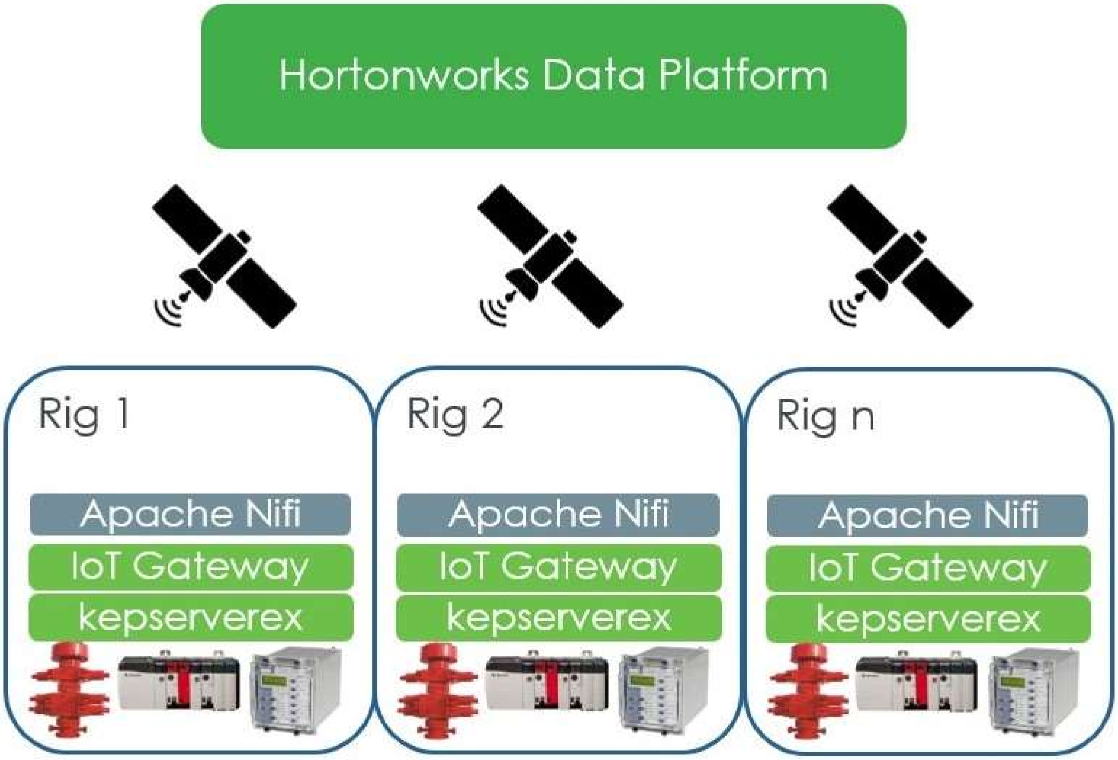
There are a variety of data flow management tools. Apache Nifi and Node-RED are two examples of data flow management tools commonly found in production environments. Apache Nifi is a complex tool that requires more configuration than other tools but allows for more granular control of the data. On the other hand, Node-RED is a user-friendly and very flexible solution that is easy to set-up with less refined data controls.



Example from the field

Rowan is an oil and gas offshore drilling company. Due to a new legal requirement, Rowan needed to transmit and store their safety data onshore. For their offshore operations, their only communication medium was via satellite – which is known to be a spotty and expensive connection with low bandwidth and high latency. New regulations for onshore transmission and storage applied to data from the blow-out preventers, manage drilling systems, and electrical systems on their rigs – which is where Kepware came in.

On each rig, Rowan installed KEPServerEX® to aggregate data from the required sources into a single application. With the use of the IoT Gateway advanced plugin, they were able to convert all of that data into the MQTT protocol and send it to their Apache Nifi data management system.



To reduce the amount of data transmitted via satellite (a medium with limited bandwidth), Rowan configured their data management system to downsample the data. Additionally, they leveraged the Apache Nifi fault tolerance and guaranteed delivery tools to ensure their critical data was safely delivered and stored in their Hortonworks Data Platform – even in the case of a temporary communication failure.

This solution not only met the legal requirements for their operations, but also established an architecture for Rowan to employ predictive analytics for maintenance forecasting and performance improvement. By integrating IT innovations with their existing OT operation, Rowan was able to able to comply with industry regulations and gain valuable insights from reliable and focused data points.

Data in Motion

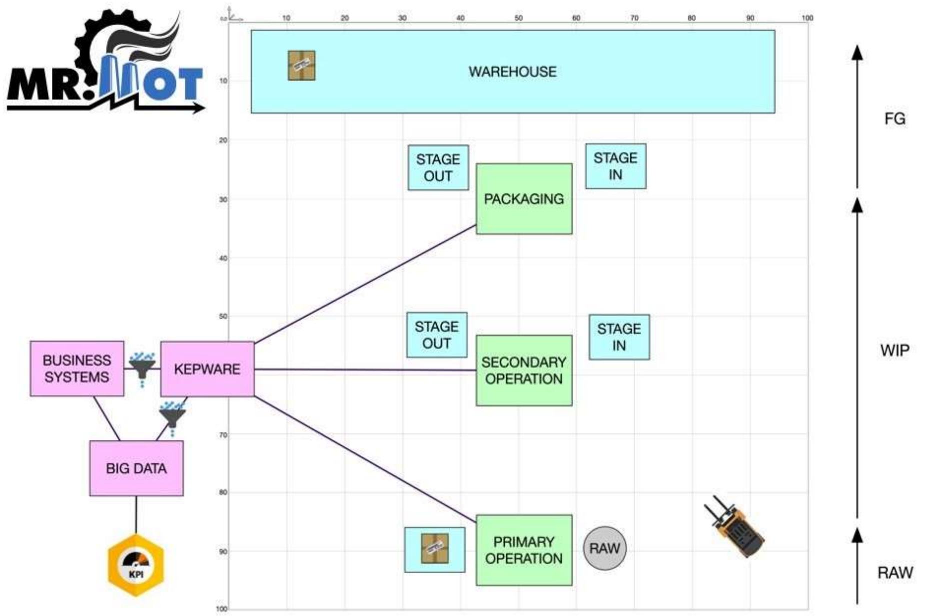
As interest in IoT applications has grown, so have connected systems, and from there so has the IoT's relationship to Big Data. With IoT, organizations can process such quantities of data in real time and reliably store it in the cloud, to a server, etc. This provides a more complete picture, since it follows the product as it moves from each data point in the process.

IoT Big Data processing can be broken down into three steps:

1. Network assets, collect machine data, and visualize machine availability.
2. Combine transactional data, automate data reporting, and refine PLC logic.
3. Collect data at the edge and focus on product rather than process.

Example from the Field

Several consolidation warehouses wanted to increase their overall equipment effectiveness (OEE) by leveraging IoT and Big Data, and they already used KEPServerEX to send their data to the cloud. In typical manufacturing scenarios, especially batch manufacturers that need high volume production or a high variety, it starts with networking the assets, collecting machine data, and visualizing machine availability. In this example, the machine data was broken down into three events: raw materials, work in progress, and delivery or storage of the final good.



Chris Misztur, owner of Mr. IIoT, provided the above diagram to depict a manufacturing warehouse workflow (bottom to top), with data collected and delivered to the cloud via KEPServerEX.

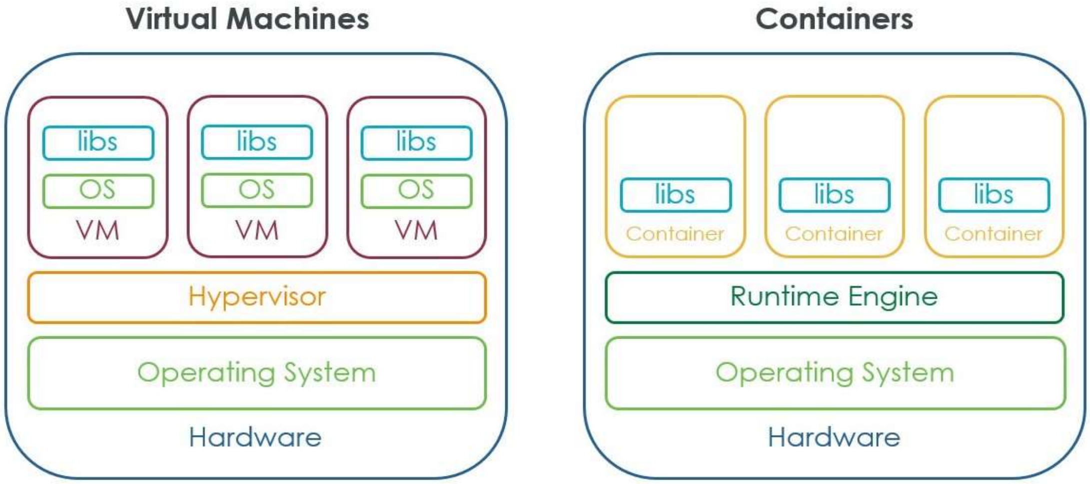
Next, they combined transactional data from the existing data collection system. Since their data collection was not timely or accurate, they automated their data reporting and fine-tuned their PLC logic.

Once they had reliable and consistent data, they identified any points where additional context should be added. To resolve these blind spots, they applied geofencing which incorporated any equipment that moved the product around (forklifts). By collaborating with operators, they gained visibility for the product across the factory floor in real-time and dissolved operation siloes by making data available on all levels.

As a result, they gained real-time inventory traceability from the factory floor to the boardroom, reduced operational expenses, enabled 365-day production, and saw a return on their investment within six months.

Containers

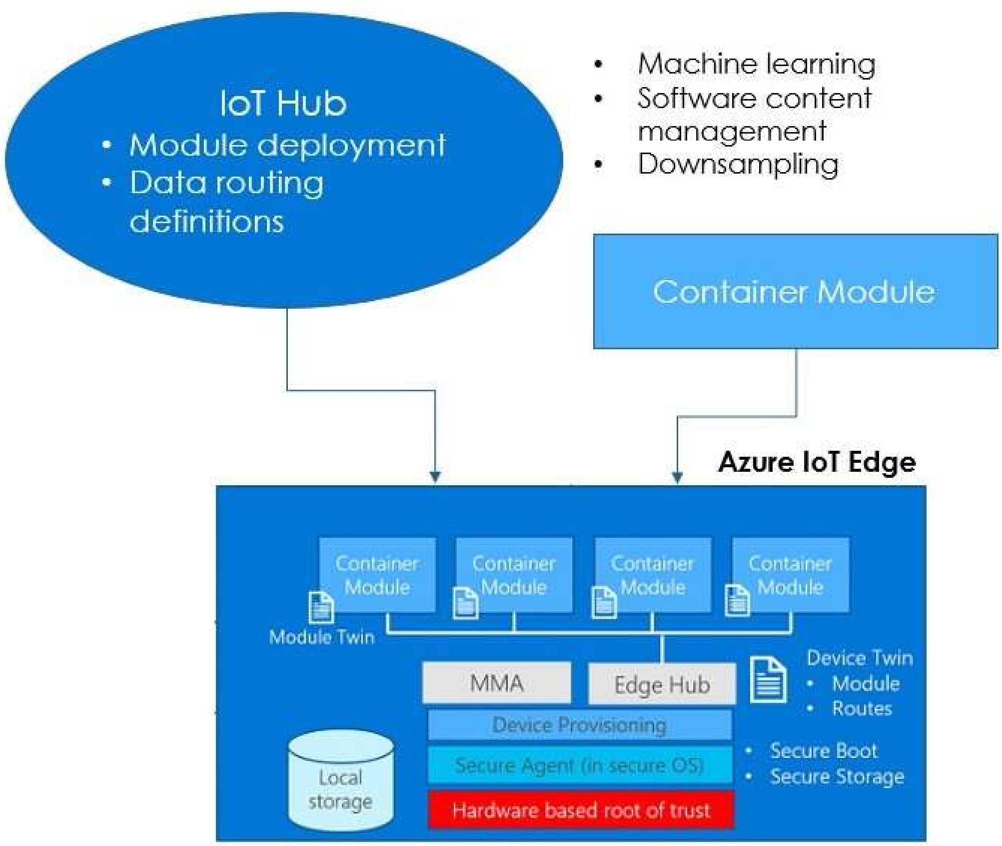
A container is similar to a virtual machine (VM), which allows an organization to run multiple operating systems on a single piece of hardware. Containers isolate applications and libraries like a VM, but each container uses the host's single operating system.



Since each operating system requires significant memory, containers are a less resource-intensive solution whilst mitigating interference between different applications. Furthermore, containers are portable and versatile because of their modular architecture, and provide security by isolating applications and their dependencies.

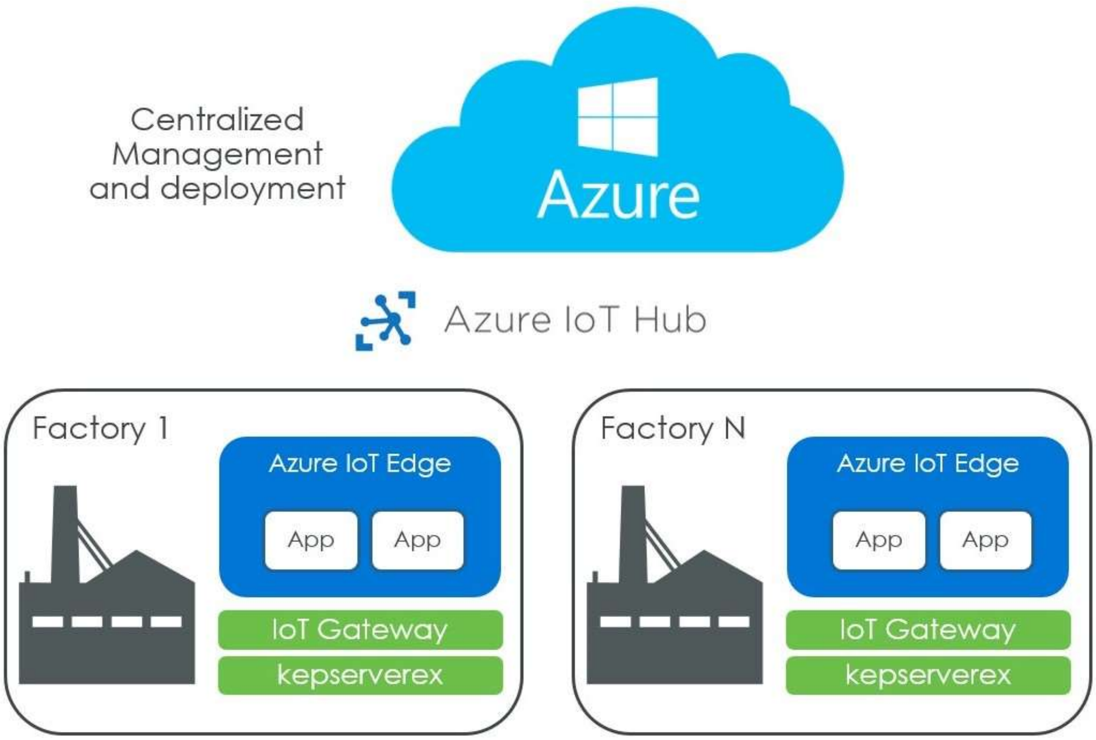
Example in IT

Microsoft Azure IoT Edge is a great example of containerization in technology. This product is designed to take workloads that would typically run on the cloud and instead run them on edge based or on-premises hardware. According to Microsoft, "by moving certain workloads to the edge of the network, your devices spend less time communicating with the cloud, react more quickly to local changes, and operate reliably even in extended offline periods."



Microsoft uses containers in order to efficiently send workloads to Azure, which is on the edge of the network (on prem server or IoT gateway). This enables users to quickly define a workload in the cloud, bundle it into a container, and push it to the edge. From then on, the workload can be updated or edited easily from a central point.

Example from the Field



One textile manufacturer chose Microsoft and PTC to connect with multiple factories around the globe. One of their primary objectives was to track time on winding machines across multiple factories. KEPServerEX was already installed on these machines for connectivity, and they wanted to deploy Azure IoT Edge to their factory sites instead of sending data directly to the Azure IoT Hub.

The Azure IoT Edge solution allowed for data aggregation and reformatting – plus downsampling can limit the amount of data sent to the cloud (which is typically priced on a consumption-based model). This architecture also enabled the manufacturer to manage the entire data collection system from one central location – thus standardizing connectivity and mitigating the security risks that come with remote connections and manual on-site updates.

Conclusion

The goal of a successful digital transformation is integrating IT and OT to drive business value, but it also comes down to the people and workflows involved. People are a key data source in the decision-making process, but their buy-in is also crucial for a smooth and successful digital transformation.

Not to mention the effort it takes to overhaul or reconfigure an existing workflow. Every process is subject to analysis and adjustments as physical and digital technologies are merged in order to optimize equipment efficiency and business efficacy.

These trends from the field are great indicators of the evolution of IIoT and the role of digital transformation in modern manufacturing. Just as technology advances with each shift in the manufacturing industry, so must the industry adapt to technological improvements.