AI in supply chains:
Helping businesses respond to change

DELIVERY 24/7

There is always another crisis — but artificial intelligence can help predict and prevent disruption

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AI helps navigate supply chain challenges

There is no respite in sight for global supply chains, after a year of disruption caused by the COVID-19 pandemic. Faced with an onslaught of demand fluctuations, border shutdowns, and stay-at-home orders, most suppliers have been judged on their resiliency amid unprecedented pressure.

Today's globalized supply chains must navigate a whole gamut of operational, financial, and ethical risks – everything from averting delivery chargebacks to monitoring forced labor watchlists.

Experts believe many of the structural vulnerabilities that plague supply chains will persist well beyond the conclusion of the pandemic. And nowhere are the fault-lines more apparent than in the semiconductor industry, where shortages continue to derail automotive production – an issue that required the intervention of the US president Joe Biden.

To succeed in this new era of global disruption, supply chains must take full advantage of emerging technologies – and this includes artificial intelligence. AI-driven software and geotracking can massively improve supply chain visibility and unlock operational efficiencies, helping businesses predict and respond to change.

In this eBook, sponsored by supply chain software specialist Blue Yonder (formerly JDA), we explore the role of AI in supply chain management and optimization. We discuss popular use cases and feature perspectives from companies including Microsoft, DHL, Morrisons and a multinational beverage producer.

We hope that this publication will equip you with the knowledge required to build more resilient supply chains, enabling your business to thrive in years ahead.

Callum Cyrus | Associate Editor | AI Business

eBook in collaboration with:

✤ BlueYonder   ⊞ Microsoft

AI is going mainstream

Looking at the potential of the AI software market over the next five years

Analyst firm Omdia suggests that the COVID-19 pandemic has accelerated the adoption of AI software in a wide variety of use cases. In the wake of the pandemic, almost 70% of respondents to a recent Omdia survey indicated that intelligent automation and AI were becoming "significantly more important" or "more important" to operations.

More than 20% of the 4,961 respondents said computer vision was already deployed in their organizations, and a further 60-70% were either trialing or developing new computer vision apps. A similar proportion said they would be looking to capture operational gains from the next wave of AI applications such as natural language processing, reinforcement learning, and knowledge graphs.

The post-pandemic trajectory is aligned with anticipated growth in AI software revenue, as the market looks to embed the technology for cost-cutting and revenue generation. Omdia expects the global AI software market to balloon from $17 billion in 2019 to $99 billion in 2026.

The analytics category in particular is expected to grow from $6bn in 2019 to $41bn in 2025, when it will represent 41% of all AI software revenue. By this point, supply chain and inventory management will emerge as one of the three most popular use cases for AI-driven analytics, alongside IT management, and personalized learning.

Some of the benefits afforded by applying ML to the supply chain include identifying and predicting demand for products and components, as well as managing historical data and mixing it with current and future demand figures to create optimized delivery schedules.

Over the next few years, Omdia anticipates traditional machine learning will gradually be supplanted by deep learning techniques, or a combination of the two. Deep learning models can process more data, from more sources – think Internet of Things (IoT) devices, or user feedback pools. By 2026, this trajectory will have reduced the share of traditional machine learning to just 19% of the total.

In terms of geography, North America will account for an estimated $213 billion of cumulative AI software revenue from 2019 to 2026, equating to 42% of global activity. Omdia believes the region will remain a powerhouse of artificial intelligence, largely due to indirect revenue sources, such as internal AI budgets at hyper-scalers like Facebook, Netflix, and Google.

Elsewhere, China is driving revenue growth in Asia and Oceania; Omdia projects the region will account for 32% of global AI software revenue by 2026.

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Five applications for AI in supply chain management and optimization

Warehouses, factories, freight operators, and legions of employees across the globe are already calling on machine learning-driven analysis to unlock efficiencies. Gartner indicates that by 2023, around 50% of product-centric enterprises will have invested in real-time transportation visibility systems. By 2024, roughly 50% of all supply chain organizations will have put money into some form of AI or advanced analytics platforms.

The question facing vendors is how to bring AI to the next wave of supply chain clients. This isn't a one-size-fits-all sector. Global logistics giants coexist with modest, family-run warehouses. This raises the question: where are the quickest wins for AI in fulfilling supply chain objectives?

Demand forecasting

Predicting how much product needs to be shipped is a core objective of logistics operations. Deep within a distributor's data flows lie forecasting patterns indiscernible to the human eye, but which AI can teach itself to scrutinize. External data sources like weather forecasts or social media

reactions can also be incorporated. By deploying machine learning algorithms, the distributor can aggregate and evaluate a holistic spectrum of demand factors. Since conventional forecasts can be off by as much as 30%, improving demand forecasting is paramount to helping avert delays and chargebacks.

Resolve disruptions

Fully-fledged ML-powered platforms such as Blue Yonder's Luminate™ Control Tower build on demand forecasting by also highlighting any disruptions in the client's distribution network. The software is then able to suggest potential solutions, like switching up the distribution schedule to front-load cargo and stay ahead of any issues. As with most enterprise AI technologies, it will be the manager who makes the final decision. Still, a helping hand is always welcome

Robotic experts

Artificial intelligence equips supply chain robots with advanced motor and navigation skills. These are particularly suited for tasks requiring adroit mobility, such as moving boxes around

the facility. Robots can be expensive to implement, however, so clients might need to embark on a trial before making a large financial commitment; for this reason, increasing numbers of robotics vendors are now offering their products as-a-service. When done right, the next-generation robots can limit the burden on manual laborers, reducing injuries and fatigue.

Predictive maintenance

Supply facilities equipped with state-of-the-art IoT networks might want to look at advanced AI applications such as predictive maintenance. In predictive maintenance, AI models are used to monitor equipment and inform decisions on when repairs should be made. This empowers maintenance staff by freeing up their capacity and could also reduce wage expenditure by limiting the need for temporary contractors. A big caveat is that predictive maintenance may need robust IoT sensors to aggregate data from the ground – but artificial intelligence can also be used to secure distributed IoT networks from cyber-attacks and system failures.

Visibility into customer orders

There's a substantial market for solutions that help track shipments after dispatch. Real-time visibility helps keep all parts of the chain in sync while also making sure that the end-recipient is informed of potential disruptions. Ultimately, this can help build transparency and trust across the entire ecosystem. According to Gartner, dispatch visibility is a highly fragmented sector, and due diligence is needed to ensure products play well with the client's existing operational technologies.

Order Pick Time

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From sensors to insights

Discussing customer expectations, the potential of IoT, and autonomous supply chains with Blue Yonder's Puneet Saxena and Microsoft's Indranil Sircar

Today's consumers are spoiled when it comes to product delivery time frames, and much of this is down to supply chain innovations. If there is a single development that changed our expectations, most would point to the introduction of same day or next-day delivery services – such as Amazon Prime in the West – that have made traditional distribution networks seem sluggish by comparison.

This didn't happen overnight: supply chains have been transforming gradually over the past 20 years. First the microprocessor enabled better data collection. More recently, the advent of artificial intelligence, edge computing, and Internet of Things (IoT) sensors have helped take operational efficiencies to another level. The Internet-enabled distribution chain can know where products are at any time and track them as they move around the globe. Any operational risks can be identified, while the status of workers and deliveries can be relayed directly to management and other parts of the workforce.

The race to the customer's premises has turned what was once a routine management decision into a strategic priority for executives in the boardroom, Puneet Saxena, group vice-president for supply chain at Blue Yonder, told AI Business.

COVID-19 has further expedited this trajectory, by prompting wide-scale supply chain disruption around the world. Now, more than ever, manufacturers and distributors want software tools that help them identify operational risks faster, and more accurately.

Saxena said: "We need to be able to see the nature of operations in real time. If so much information is arriving at supply chains, then the industry needs to be able to automate more of the decision-making process."

Bear in mind it's not just consumers who are demanding more; businesses also expect service to be prompt and reliable. Depicting the supply chain as a cohesive unit underplays the vast complexity. It is a labyrinth of distinct material suppliers, manufacturing plants, shipping ports, warehouse processes and trucking routes. All require visibility to allocate capacity effectively.

50%
of enterprises to invest in real-time transportation visibility systems by 2023
Gartner

Blue Yonder pivoted toward AI-enabled software products for its supply chain clients in 2018, and the move has paid off, with the company set to be acquired by electronics giant Panasonic in a proposed deal worth $7.1 billion. The acquisition would see Blue Yonder integrated into the Panasonic Connected Solutions unit, while maintaining its brand.

Saxena told AI Business that Panasonic already markets a range of IoT devices such as sensors to assist workers on what the company calls the 'front-line' of production, including those on assembly lines, warehouse floors, and in transportation facilities. There are plenty of potential synergies between Blue Yonder software and Panasonic's IoT device offering for logistics. The latter purchased a 20% stake in Blue Yonder in 2020, and the two have collaborated ever since.

Saxena said: "In many ways this is simply going to accelerate Blue Yonder's vision of helping supply chains see right across operations in real time. Panasonic has long believed we need to enable better decisions on the front-line.

"It's Panasonic's desire to serve its customers by connecting them to the world around them. And its IoT devices and connected products are well aligned with Blue Yonder's central vision, about connecting to the real world and allowing [the supply chain] to access real-time information.

"There are now all these IoT sensors around us. We're used to seeing them in our smartphones, but now all these sensors pick up information in the factory, and can tell us how each specific machine is operating in a manufacturing network.

"These transponders are providing signals about where we are in the logistics context. Embedded transponders are providing signals about where we are in the logistics context."

Blue Yonder's vision involves automating the supply chain, in the sense that static estimates that underpin the schedule of core

manufacturing and logistics operations can be replaced by automated decisions made by software, based on real-time data.

Its flagship Luminate platform employs machine learning for a holistic overview of production, warehouse, labor, and transportation management.

One notable application of the software, on behalf of a leading automotive supplier, resulted in a wholesale implementation of dynamic customer segmentation, with machine learning used to systematically identify clusters of product demand.

Blue Yonder's solution was able to identify different customer and product segments automatically, which allowed the client to devise new supply chain postures for specific areas of its customer base. This in turn helped reduce the cost-to-serve ratio for each differentiated segment. The client's planners were also able to deliver differentiated customer services levels across different segments, profitably, in line with the company's strategic objectives.

Saxena said: "We tend to think of the world as deterministic, that everything is fixed. The supply cycle times are fixed, the production yields are fixed, demand is fixed.

"In fact, none of these things are fixed, because they're all probabilistic. Everything is a distribution. There is risk in everything that we deal with because the numbers are not exact.

"'Autonomous supply chains means that the supply chains of tomorrow will be driven by real-time information, with much higher levels of automation. We will not be operating in a world where the supply chain is depending on a demand plan created once a month."

Real-time data insights can help reduce the burden on hard-pressed logistics workforce. It's a pertinent point, particularly in the US, where there's a shortage of interest in warehouse positions. In March 2021, Amazon said it would seek to tempt new starters into its US warehouses with higher wages and a bonus payment of up to $1,000 in certain locations.

Given the complexity of the supply chain, standardization is crucial wherever possible. Blue Yonder's Luminate platform achieves this through a collaboration with Microsoft around the Azure development platform, which has provided a full range of machine learning and cloud-to-edge tools to build from.

Azure's Digital Twin feature sits on top of Blue Yonder's supply chain data analysis to communicate with IoT devices installed in the client's network. It works by condensing IoT output into visualized graphs through Blue Yonder's software, providing key insights to warehouse managers at a glance. Simulation modeling, performance management, process control, asset management and configuration overviews can all be activated using the Digital Twin interface.

Microsoft's partnership with Blue Yonder reflects the common interest in supply chain intelligence. The software giant has dedicated a part of its development vision to forging ecosystems that encourage the industry to modernize its processes.

Indranil Sircar, CTO for manufacturing industry at Microsoft, said: "Our vision is that we will be able to help the customer and enterprise, through joint conversations with companies such as Blue Yonder, to bring the whole ecosystem's data together and drive level-up insights and integration.

"It's about creating those Digital Twins and being able to look into the risks that impact the movement of materials."

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Keeping the shelves full

> "*Our new automated ordering system is now fully operational in all stores across all food categories, and we expect it to continue to improve availability and save time for colleagues in the important period over Christmas and New Year.*

British grocery giant Morrisons our using automation and AI to stay on top of some 29,000 distinct SKUs

Restocking is one of the biggest differentiators of the modern supermarket. Grocery aisles must replenish every stock-keeping unit (SKU) as soon as possible after they've run out – but it's a delicate balance between minimizing food waste on one side and retaining the customer's confidence on the other.

This was the challenge facing British grocery giant Morrisons: its store replenishment procedures still depended on manual ordering processes, which failed to incorporate any real analysis of consumer behavior.

Blue Yonder's Luminate Planning software has made a vital difference in driving stock replenishment efficiencies at Morrisons. The predictive scenario platform was tailored to add visibility, automation, and orchestration features to transform restocking and ordering across the chain's 500 retail stores. It was a tall order: Morrisons' warehouses must keep track of some 29,000 distinct SKUs, stocked across 130 categories.

Having originally deployed the software as part of a three-month pilot program, Morrisons subsequently rolled out Luminate Planning to retail outlets across the country. Following full implementation, it was able to reduce missing product disappointments by 30% and slash average store inventory times by two-to-three days. The net effect was a 2.6% uptick in sales revenue on a per-store basis.

UK trade body Institute of Grocery Distribution selected Morrisons' implementation of Luminate Planning as its Supply Chain Innovation of the Year in 2017.

In terms of granularity, Blue Yonder's machine learning tech has enabled the supermarket chain to optimize demand forecasts right down to a store-by-store overview. And, thanks to the ongoing refinements of Luminate's decision-making AI engine, Morrisons has been able to account more accurately for fluctuating supply and demand patterns, factoring in evolving influences like shelf sizes, weather, and promotions.

David Potts, CEO of Morrisons, said: "Our new automated ordering system is now fully operational in all stores across all food categories, and we expect it to continue to improve availability and save time for colleagues in the important period over Christmas and New Year."

"The system is capital-light, utilizing cloud technology and store specific historic sales data to forecast stock requirements. It is reducing costs and stock levels, while also saving time for colleagues and providing a better offer for customers."
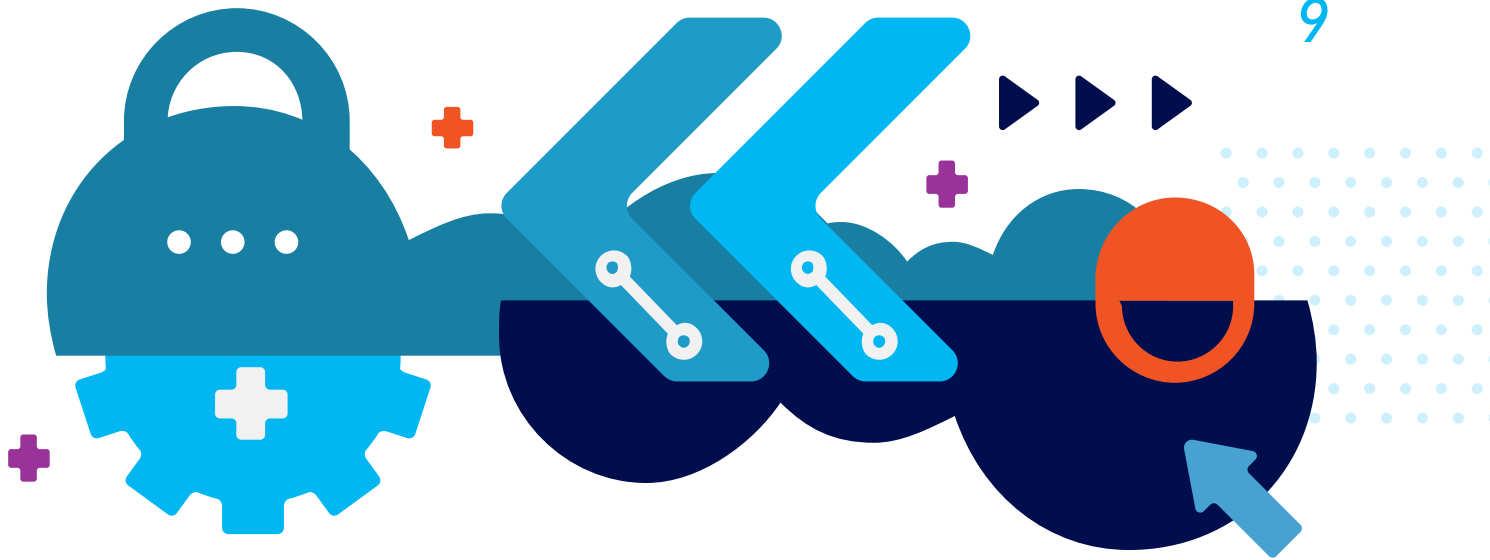
What we can learn from the Great Chip Shortage

Origins of the current chip supply chain crisis, and potential remedies

The world might be getting closer to the end of this pandemic, but there is no sign of the great chip shortage subsiding. The supply chain disruption made especially dire headlines for the automotive industry. GM expects it to wipe between $1.5 billion and $2 billion from its operating profit this year, while earnings at Ford could be down anywhere from $1 billion to $2.5 billion. Employees at many assembly points across the world have been put on ice until the chip supply improves.

Unfortunately, the predicament has no quick answers. Producing microprocessors is highly time-intensive: by some estimates it can take 11-13 weeks to meld seven, ten or 14 nanometer chips, the brackets into which most modern chipsets fall. Lead times were extended for around three-quarters of semiconductor output in February 2021, according to IHS Markit, with around 11% delayed for more than 10 weeks.

Chuck Robbins, chief executive of networking hardware producer Cisco, told the BBC he expected the crunch to last at least until October.

No less pessimistic were TSMC's chief executive C.C. Wei and Intel's Pat Gelsinger. Both are working to deliver new US-based chip fabrication capacity, but this won't be ready until 2023 at the earliest. There is also a conundrum to resolve: new 'fabs' will need enough semiconductor parts to operate.

Of course, businesses that provide goods and services to semiconductor makers are reaping the benefits. On April 21, Dutch chip-making equipment supplier ASML said it expected annual revenues to come in 30% higher than in 2020, with projected 49% gross margins for the second quarter.

ASML's offering includes lithography machines which imprint minute circuit patterns onto silicon wafers, using light projection templates. The company expanded its customized lithography systems for owners of mature fab installations in the early 2000s – and it was this division that created most of the extra revenue. For national policymakers, the lesson is that chip manufacturing can no longer be left to global market forces. In a world where advanced silicon powers everything from military fighter jets to medical equipment, a semiconductor shortage is not merely an inconvenience. It's a potential national health and security crisis.

US President Joe Biden has committed $50 billion to enhancing domestic chip manufacturing capacity but will be expected to provide more. Even more pressing is his executive order to resolve gaps in the domestic supply chain. With unemployment in the US remaining high, in part due to factory shutdowns, the crisis is serving a stern test of Biden's economic mettle. Intel is among those to have answered the President's call, having pledged extra chips for American car plants within the next six-to-nine months, according to Reuters.

Fabless chip models may have done wonders for innovation and competitiveness, but the concentration of manufacturing in East Asia – home to almost 80% of chip foundries and assembly points, according to the Semiconductor ❯

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❯ Industry Association – means there's a sharper brake on capacity when conditions get tough.

Fabs in the US were responsible for 12.5% of global chip manufacturing capacity in 2020, down from a far healthier 37% share in 1990. And yet, the US-based chip vendors control almost half of global semiconductor sales, having accounted for 47% in 2019.

East Asia's formidable supply engine fell completely out of sync during the pandemic. When the virus spread across the Chinese mainland in early 2020, it forced shutdowns at most of the region's electronics factories. Fewer items needing chips were being produced, so East Asian foundries responded by slashing output.

Western chip purchases began to fall in anticipation of the pandemic only for demand to then spike when other countries followed China into lockdown. Stay-at-home workers suddenly needed new PCs, keyboards, and headsets. Families bought new game consoles.

Then, there were completely unexpected consumer behaviors. Soaring cryptocurrency values incentivized countless speculators to mine tokens using hi-end graphics processing units, which began selling out in droves.

While the crisis has affected the latest generation of game consoles and smartphones, the consumer electronics sector, on average, stockpiled more than automotive producers. In supply chains, there's a delicate trade-off between just-in-time inventory management and building stock for contingencies. It appears most automakers got caught on the wrong side of the equation.

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US fabs responsible for
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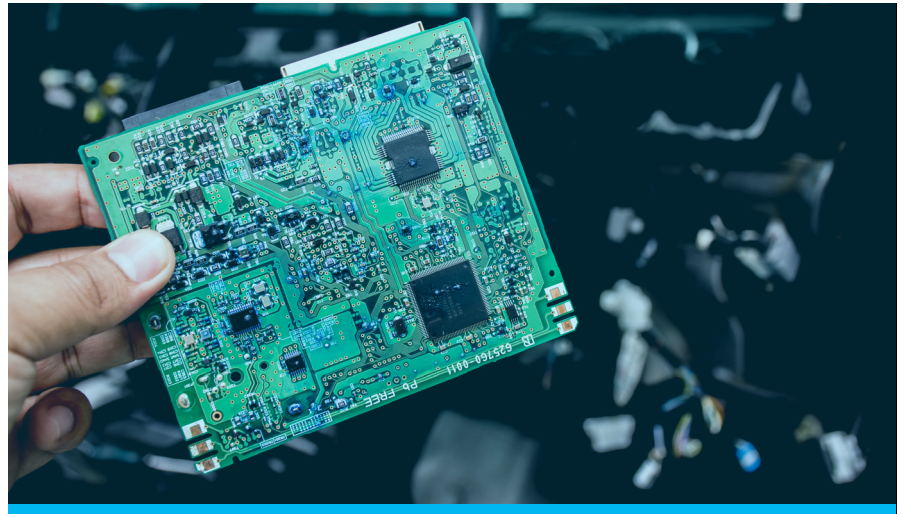
Car makers that slashed chip orders when demand for new vehicles fell in the initial stages of the pandemic were then unable to locate fresh stock in sufficient quantities. Fabs running at full tilt can do little to help, as they already have extensive backlogs to service.

There's a high price to pay for miscalculation at such a scale. Automotive revenues this year could plunge by as much as $60.6 billion due to the shortages, according to consulting firm AlixPartners.

In the midst of the crisis, it has also become clear that semiconductors underpin the modern car's value proposition. Automakers purchase around $37bn worth of chips each year globally, with around 40% of the cost in producing new car models going toward electronics-driven systems, according to some reports.

The average modern car is thought to execute 100 million lines of software code. Core functions like braking and power-steering which historically relied on hydraulics are now augmented by semiconductors.

One of the few automakers to stockpile enough chips to cope in the crisis was Toyota, but then the company has already been in this position once before, following the Tohoku tsunami in 2011. The crunch in Toyota's local chip supply chain forced the company to re-examine its strategy. Ahead of the current shortage, it had reportedly built a stockpile for around one-to-four months, putting it well ahead of many of its competitors.

As the industry veers toward electric and autonomous vehicles, the amount of chips carmakers need is likely to increase. For Toyota's rivals, better contingency planning and supply chain visibility will surely have moved toward the top of the agenda.

Just one boat

One of the most surreal events of recent times was the shipwreck of hulking container Ever Given, which slammed into the side of one of the world's busiest shipping canals in March.

Thankfully no one was injured, but it was almost a week before the vessel was finally dislodged from the Suez Canal by tugboats and dredgers. By that point, many freight containers had already embarked on a nine-day detour toward South Africa's Cape of Good Hope. In the following weeks, Shoei Kisen Kaisha, the owner of Ever Given, refused to pony up the reported $900m compensation, and the vessel was impounded by Egyptian authorities.

The debacle was but the latest in a string of supply chain disruptions that have exacerbated the ongoing chip shortage. A cold snap in the US state of Texas interrupted semiconductor deliveries and was followed by a blaze at a chip factory owned by Japan's Renesas Electronics.

Nikkei Asia has predicted that automakers will be forced to pare back 2.4 million vehicles, or around 3%, from anticipated output this year as a result of the disruptions. The situation is expected to deteriorate even further due to water shortages affecting Taiwan's west coast.

Incidentally, automation was cited as one of the contributing factors in the 400-meter long Ever Green's crash. The shipping industry has increasingly opted for computerized systems to keep down crew numbers. This has enabled shipyards to limit costs despite expanding the size of many newly-built container ships.

With the autonomous shipping market expected to grow from $90 billion at present to above $130 billion by 2030, the accident is a stark reminder that adequate manual resources must be deployed to back maritime AI systems.

Doing so will only become more crucial as AI-based systems become more advanced. In the same month that Ever Green was shipwrecked, IBM and marine research organization Promare announced they would trial an AI-driven navigation system aboard a transatlantic autonomous ship called The Mayflower. At the time of this eBook going to press, the ship's autonomous journey had been derailed by a fault, although project managers hoped it could be assessed and repaired.

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How DHL made robotics a key component of its strategy

With over 1.6 billion parcels delivered across 220 countries, DHL has been one of the industry's biggest beneficiaries of robotic orchestration software

Robots and supply chains have always been perfect companions. When it comes to implementing automation, the industry is a great fit for machines that thrive on routines and protocol.

Today's industrial robots are a world away from the early robotic arms pioneered by heavy manufacturing plants in the 1960s. They have been supplanted by nimble and intelligent devices, expertly navigating the maze of their surroundings. The orchestration of picking, sorting, and storage is optimized thanks to systems capable of interpreting visual data, enabling human workers to increase productivity and switch to higher-level tasks. Recent advances in artificial intelligence software have enabled automation across an ever-growing number of supply chain processes.

Often the robotics software is sold alongside the hardware as part of a single commercial license. But, as Boston Dynamics' CEO Marc Raibert has observed, robotics could one day make a bigger impact on society than even the Internet did. The hardware side is already a highly diverse, rich ecosystem. So it follows that developers want to look beyond the existing commercial software model, to improve cross-compatibility across different robotic operating systems.

Such versatility is particularly important in logistics, where each package requires prioritization and assignment according to the unique data labels that determine delivery. Aggregating the various robotic software outputs can help make the integration less time-

consuming, while improving visibility into the sorting process.

Blue Yonder is among the pioneers in this area with its cloud-native Robotics Hub, designed to accelerate the process of integrating robots from different vendors. The artificial intelligence-driven platform is built on Microsoft Azure, and is currently used by logistics giant DHL to manage its robot fleet.

Robotics Hub serves as a plug-and-play intermediary to DHL's various robotic management systems. It works by translating each logistics task into a common automation language that a robot can use to fulfill orders by transferring items from the warehouse.

Operators can quickly determine their robot fleet's current status and check which tasks are currently being performed, as well as provide estimates on how much of the daily workload has been completed. Because the software is language-agnostic, the burden on DHL's programmers has been massively reduced – there's no longer a need to manually code for each individual vendor's operating system.

With over 1.6 billion parcels delivered across 220 countries, DHL has been one of the industry's biggest beneficiaries of robotic orchestration

software, which has helped the company navigate through the disruption of the global pandemic. Its distribution center in Madrid has seen integration times for its robot fleet reduced by 60% since it started using the platform, and the firm expects reduced friction from redeploying robots across its global logistics sites.

The upshot is that emerging e-commerce start-ups seeking a foothold with today's ever-impatient consumers can hit the ground running, as DHL can build customized delivery services to get them the goods quicker.
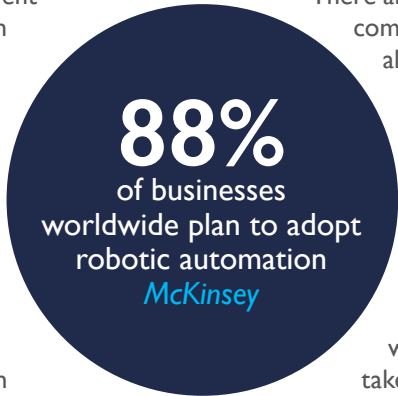
Markus Voss, CIO and COO for supply chain at Deutsche Post DHL Group, said: "The robotics hub is a key component of our strategy, as part of our centralized digitalization initiative. There are 700 projects already completed, with 200 already on the go. With this we will make the digital supply chain a reality."

Girish Rishi, chief executive at Blue Yonder, said: "Every once in a while, a development takes place that changes the future of the industry for the better. Our co-innovation partnership around the robotics hub is one such example.

"We are incredibly honored and privileged to be partnering with DHL to take this formidable step forward in the world of logistics."

88%
of businesses worldwide plan to adopt robotic automation
McKinsey
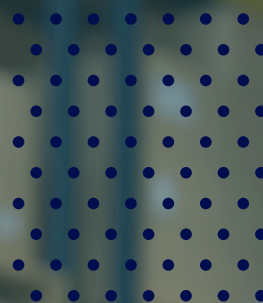
A sense of place

As well as better fleet orchestration, there's a market opportunity for common software systems that can run on all sorts of robotic hardware. SLAMcore, a five-year old start-up in the UK, is one of the leading players in this area. Its AI-driven technology aims to mirror the visual systems of humans and animals, utilizing the concept of parallax, whereby objects closer to the eye appear to move quicker than objects further away. This helps build a 3D estimate of where the robot's camera is in space, relative to the world around it.

Owen Nicholson, chief executive at SLAMcore, said: "We can use this to calculate the amount of movement that [the vision software] sees within each frame. Because all distances of each feature from the robot's camera differ, we can use these natural points to calculate the amount the camera has moved."

SLAMcore's software acts as the positioning system for robots, also known as simultaneous localization and mapping (SLAM). The company has won its share of plaudits, and Nicholson claims it has the only technology to intrinsically mesh all parts of the autonomous perception process – from positioning to object recognition.

SLAMcore's software suite launched earlier this year, and Nicholson pointed out there are significant lead times for building robotic positioning that actually works. The system takes images of the robot's surroundings at 30 frames per second and must rapidly scour each for information before loading up the next one.

Nicholson added: "One of the most important and challenging parts of building an affordable robotic system using vision is there's no point of knowing five seconds or even half a second late what the position is, or if you're about to crash into something, because you need to be able to adjust that in real-time."

"It's a constant iteration of position-move-position-move-position. You need to know there and then, so you can adjust the amount of movement or power you give to the wheels or legs, to navigate effectively."

Optimizing the cloud to the edge: The infrastructure requirements of modern supply chains

Investigating software and hardware for edge computing with George Moore, Edge AI Devices at Microsoft

The last decade in corporate computing was characterized by the big public clouds wiping away the disparate virtualization fabric that once serviced most enterprise requirements. Easy access to cloud resources has enabled corporations to modernize IT at their convenience, while emerging start-ups have gained an affordable path to scaling their technology.

With public cloud, massive data centers in key locations simultaneously serve thousands of customers, enabling data processing and storage – whether the data originates from a dashboard, sensor, or wristband. However, as the information is arriving over the Internet, it is subject to increased latency when the networking conditions are poor.

The next ten years will put an end to the cloud-only trajectory. We are now at "peak cloud". Everything else in the future will be increasingly decentralized, with the edge eventually being far larger than the cloud. Video analytics, natural language processing, and real-time forecasting are poised to revolutionize the supply chain, but they will increase the burden on cloud communication channels. Not only do networking logjams hinder the reliability of applications, but the offshoring of data may also raise privacy concerns, as the service provider would hold the keys to potentially sensitive information.

In response, IT managers are looking to move more of their computational load to servers or intermediary units situated near the end-user – a concept known as the edge of the network. It marks a direct reversal of the centralization trend, but the transition remains in its early stages.

Currently, some believe there's not even a firm definition of what constitutes an edge location. Analyst firm Omdia suggests it should include any machines capable of data transfer to and from the end-user within 20 milliseconds. The supply chain – especially manufacturing – was one of the earliest adopters of IoT technologies and has been under pressure to meet evolving customer expectations.

So it's not really a surprise that the sector is also moving fastest to implementing edge computing systems. Around 94% of decision-makers surveyed by Omdia cited the supply chain as the biggest edge computing use case, compared with 67% for the next-leading application (immersive experiences in venues).

But bringing intelligence to the edge is a colossal undertaking. For one, the embedded processors within supply chain endpoints must be able to shoulder the burden of compute, without excessively increasing energy consumption and therefore undermining sustainability aims. Energy consumption, in turn, drives heat, which drives increased HVAC requirements at the edge. That is why

sub-10 watt AI devices with passive cooling will continue to proliferate. Network architectures must evolve too, to offer more capacity for 'near-edge' or 'cloud-edge' stacks. These can be situated within enterprises themselves, along with regional CSPs, and industry and co-location data centers.

Another Omdia survey, conducted late last year, found that 56% of enterprise decision-makers depended on existing data center management tools to implement edge computing systems. A significant number (36%) were resigned to deploying processes manually. Presumably, the software ecosystem isn't considered to be robust enough.

Today, public cloud providers such as Microsoft Azure are changing the paradigm by offering edge products with standardized functionality, fully compatible with their core cloud technology. Cloud and communications providers are anticipated to account for 30% of overall physical edge infrastructure spend by 2024, up from 19% three years ago, according to Omdia.

Microsoft has outfitted the Azure cloud development ecosystem with per-built AI models, documentation packages, and devices that should make it simpler to implement automated supply chains. Azure Percept, one of the many Azure services available to any organization, encompasses two lightweight AI compute modules for executing end-to-end video or audio analysis at the edge. A third edge device serves as the hardware root of trust to anchor the client's data security, integrity, and privacy.

Percept hardware is manufactured by Asus and enables the user to build and test AI models for their intended use case. The modules are available for purchase online, though currently on a public preview basis. "The initial set of devices includes a camera designed
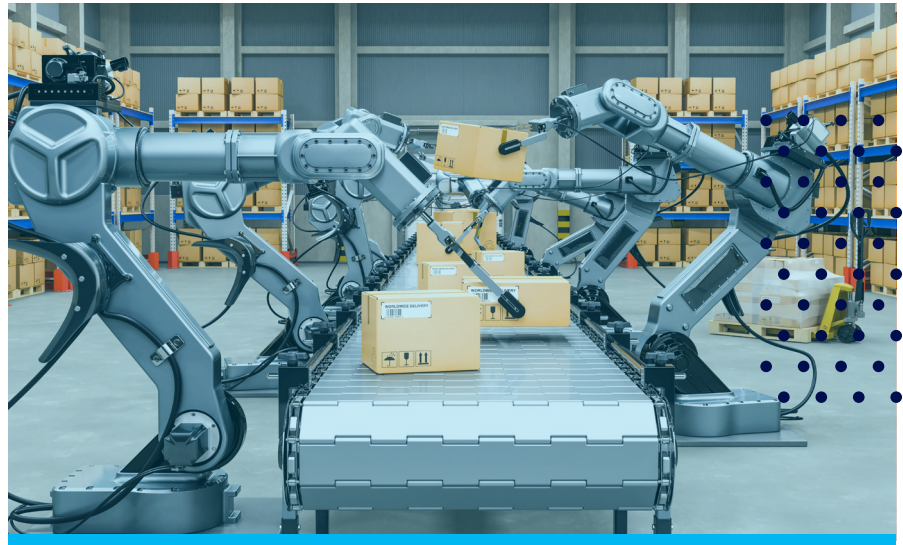
for rapid prototyping, and so that you can quickly take it to a pilot setting if you chose," explained George Moore, Azure Edge Devices at Microsoft. "It features an RGB sensor connected to a GPU mounted under a heat sink. The camera lens is mounted to a 180-degree locking hinge, the sensor itself is attached to a magnetic plate so you can pick it up and move it around. The GPU consumes just 3.5 watts of power and is entirely passively cooled. That means you can install it almost anywhere, and securely, because it is connected to the Azure Trust module." For supply chains, the module offers a way to rapidly deploy computer vision for logistics tracking, stock refilling, and quality control (*web link*).

The Azure Percept audio unit packs similar firepower. It sports a four-field array microphone, along with access to Microsoft's entire text-to-speech tagging repository, which can be queried in 91 languages and dialects.

For a logistics client large enough, the Percept could be installed in many separate instances to provide departure updates on freight vehicles and even real-time monitoring of their contents. Moore said: "If you have boxes going down the conveyor belt, the AI model can be trained up to recognize a normal box in terms of

shape and size. If something abnormal comes along, say because the box has been crushed or damaged in some manner, then an alert can be raised. A pusher mechanism might then be actuated, for example, to push the box off the conveyor belt."

Additionally, as customers address sustainability into their supply chain, an Azure Digital Twin can be quickly built to show a visualization on the optimal way to architect the cloud to edge solution. Doing this will provide insights, estimated savings and potential roadblocks before a system is launched.

"The whole point of what we're doing with Percept is to provide the client with management of all different lifecycles," Moore said. "So we manage the device, operating system, the firmware, and keeping it up-to-date.

"We supply all the infrastructure that really doesn't exist today: the AI data, models and the connections to Azure machine learning in the public cloud for training and downloading new models. At the moment, everybody is rolling their own. Every time, they have to reinvent the wheel. And what we're doing is providing the platform so businesses can focus more on problem-solving rather than working out how to build infrastructure."

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Innovation starts with science

Exploring the origins of Blue Yonder technology in experimental physics

Felix Wick, Blue Yonder's group vice-president for data science, was there during the AI platform's inception at CERN, before it was acquired by digital supply chain company JDA Software in 2018.

Wick recalled that the team had been relying on all kinds of computational statistics wizardry as it crunched its way through rare and transient particles, however it was machine learning that proved especially useful. Classifying signals of interest from what he described as background noise soon led to a commission for ML-driven supply chain optimization in retail, where Blue Yonder capitalized on the pressure from e-commerce companies like Amazon.

Wick said: "Initially, what we used with neural networks involved a lot of statistical pre-processing tricks. For example, this first package that we used had contained a lot of Bayesian statistics modeling, but it had a neural network for performing the final classification. We found we could also use it quite nicely outside of science, in the world of business."

Demand forecasting was one of the first supply chain applications to evolve from this transition and has remained key since JDA took over Blue Yonder. Another important utility was price setting, which let retailers integrate real demand elasticities for individual products.

"That means the minimization of cost function, for example, it comes on top of the demand forecasting," Wick said. "So it can enable probabilistic optimization by means of having probabilistic demand forecasts and some form of output probability distribution."

He hopes future tools in the Blue Yonder armory will be similarly transformative. One function the company is currently working on is stock-out predictions: supply chain forecasts that would be presented alongside root cause analysis to help explain what's actually driving them. Blue Yonder's approach is no black-box solution; there's an overriding intention in the design to categorize the factors behind each machine learning judgment. It's a key

consideration for user experience, giving the client maximum confidence as they retrieve insights from the system.

Another tool highlighted by Wick is called probabilistic perpetual inventory – using machine learning to estimate product quantities that the client actually holds. The entire product roadmap marks a shift for Blue Yonder, from optimization toward more predictive abilities – identifying the risk of carrier delay, for instance.

And as the team looks ahead to its second transition through acquisition – this time coming under Panasonic's Connected Solutions umbrella – Wick is ready to welcome new opportunities. Many more warehouses affix IoT devices to machinery compared with a decade ago, while others issue devices to track employee performance. While the internet of things is by no means universal, it is becoming far more common, and Blue Yonder wants to keep abreast of this trend.

"When we look back to the beginning of the project, I guess we were early in the market. And this is always the question – either you are too late for the train, or a bit too early," Wick said. "And then it's difficult to convince early customers that the technology is useful, but then we came back a few years later, and tried again, and were successful. If you think of IoT, when we started, the field was not really developed enough for us to monetize. Now it's beginning to get there - I think IoT is definitely something that will be a hot topic in the coming years."

Multinational drinks producer trusts Luminate™ Control Tower to revamp global supply chain

Within an hour of learning the Suez Canal was obstructed by a container ship, the drinks producer had received accurate intelligence on how many of its containers were affected

The distribution ecosystem behind this large drinks producer stands out as a feat of logistics, when you consider it must consistently satisfy soft drink and alcohol purchasers in more than 180 countries. The company's supply chain is a truly intercontinental operation. Perhaps unsurprisingly, Europe remains a nexus for alcohol production, thanks to global brands like an internationally renowned whiskey.

But the drinks company's suppliers face escalating demand from developing countries. It operates 50 manufacturing plants across India and has a foothold in both Latin America and Africa. Supervising goods making their way from production centers to customers in emerging markets is a major pain point. And yet, the custom is too lucrative to ignore – this particular whiskey, for example, has reportedly emerged as India's leading Scotch whiskey brand.

Faced with 40 different supply chain carriers, the drinks producer's existing processes for tracking the status of each shipment were exhausting and inconsistent. Its personnel spent hours continually checking carrier websites. Sometimes, when a delivery wasn't quite going to plan, they would have to jump on a call with the carrier directly.

The decision to implement Blue Yonder's Luminate Control Tower as part of a strategic partnership

agreement came after the producer had undertaken 4,950 hours of operations testing. The improvement has been easy to see. Imagine climbing the apex of a tall hill and being able to follow traffic hurtling down the urban grid – such is the visibility the drinks company now has into all if its geo-tracked shipments.

A simple click through the interface is enough to bring up information on specific orders, with personnel able to log any transit problems as they arise. Meanwhile, Luminate Control Tower's machine learning capabilities provide the drinks manufacturer with forecasting capacity for time periods ranging up to three months in advance.

Already, containers jammed due to reduced capacity at one of the many shipping ports the producer depends on have been promptly reached and diverted. "We've been able to get containers moving that historically we wouldn't have known there was even an issue with. We now get alerts when containers are stuck in port, when we know that they shouldn't be," the drinks company's global procurement director for packaging and logistics, said in a recent webinar. "There's been a couple of scenarios where we've ended up informing carriers of delays before they've even been aware."

On the performance side, the drinks producer has access to concrete

metrics that can be used to hold distribution partners to account. All transit lanes are now reviewed through Luminate Control Tower, in some cases leading to a decision to switch carriers.

At a time when coronavirus and Brexit-driven volatility has loomed large over operations, the strategic value the drinks producer has gained from additional visibility cannot be understated. Out-of-stock predicaments at numerous retailers have been avoided, ultimately protecting the reputation of its brands.

Within an hour of learning the Suez Canal was obstructed by a container ship, the drinks multinational had received accurate intelligence on how many of its containers were affected (). Customers and partners were then informed of the potential disruption. "That kind of activity would have taken days at a minimum for us to quantify [previously]," Griffiths said.

The introduction of Luminate Control Tower has been successful enough to warrant plans to extend the platform to the drinks company's own customers. Starting sometime in 2021, alcohol shops, supermarkets and hospitality venues around the globe will have end-to-end visibility across the company's shipments.

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Common supply chain terms and concepts

Autonomous supply chains
Blue Yonder's vision of distribution networks that have access to real-time data insights to enable automatic decision-making across the ecosystem.

Azure Digital Twin
A data visualization plugin delivered from Microsoft's cloud computing service used to visualize output from IoT devices such as sensors.

Bayesian statistics
A probability-based approach to solving statistical problems and producing related forecasts based on evolving data and evidence.

Cloud-to-edge architecture
A networking architecture intended to divide compute tasks between public cloud servers and edge systems, without hindering the performance of the application.

Computer vision
AI models that are trained to automatically recognize patterns in images and video, for purposes such as medical diagnostics or detection on CCTV cameras.

Deep learning
A subset of machine learning in which neural net algorithms imitate the processing structure of the human brain to intelligently absorb data and make decisions.

Deterministic planning procedures
Standard estimates of logistics operations based on all external causes known to be potential influences at the time.

Demand forecasting
Blue Yonder's machine learning-driven software can be applied to supply chain data to return estimates of likely demand fluctuations, at far greater accuracy than conventional methods.

Edge computing
Distributed computing architectures in which software platforms execute functions from data gateways closer to the end-user, or even from end-user devices.

Future stock-out predictions
A forthcoming Blue Yonder feature that would present supply chain forecasts alongside root cause analysis to help explain what's actually driving them.

Graphics Processing Units
Processing chips often favored for training AI applications because they can perform multiplex calculations across thousands of cores.

JDA Software
The supply chain software company that purchased AI-focused startup Blue Yonder in 2018, before taking on the latter's name last February.

Luminate Control Tower
Blue Yonder software-as-a-service interface that provides real-time visibility, orchestration, and prescriptive resolutions across the supply chain.

Microsoft Azure Percept
A series of lightweight hardware modules designed to allow enterprises to securely execute real-time video and audio analysis models from the edge.

Natural language processing
AI models trained to automatically recognize and respond to patterns in speech and text.

Private cloud
A form of cloud computing deployed in a corporate or co-location data center.

Probabilistic perpetual inventory
A forthcoming Blue Yonder project intended to forecast future product quantities at a given point in time.

Public cloud
A platform that offers remote access to computing resources and services located in a large, centralized data center managed by a third party.

Robotics Hub
A Blue Yonder software suite built in tandem with Microsoft Azure to fulfill robot orchestration requirements across global organizations.

Robotic Orchestration Software
A software package designed to manage the various robotic processes employed across the organization.

Virtualization
The process of running a virtual instance of a computer system in a layer abstracted from the actual hardware.

BlueYonder

Why Blue Yonder for AI?

Now you can translate real-time data into faster, smarter, more profitable business decisions. With access to the power of artificial intelligence (AI), you can focus on the real exceptions in your supply chain. Blue Yonder leverages industry-leading AI and machine learning (ML) to see deviations automatically and identify risks early. This combination gives you complete supply chain visibility and precise recommendations that enable more accurate decisions.

Microsoft

Why Microsoft Azure for AI?

Get proven, secure, and responsible AI capabilities on your terms with Microsoft Azure AI. Build mission-critical solutions that can analyze images, comprehend speech, make predictions using data, and imitate other intelligent human behaviors—all using Azure AI.

More info here