

The background image shows a massive cargo ship sailing on the ocean during sunset. The ship's hull is dark grey, and its deck is filled with numerous shipping containers stacked in long rows. The sky is a warm orange and yellow, transitioning into a darker blue at the top. The water reflects the colors of the sky.

intel®

A Supply Chain Renaissance

Navigating Supply Chain in a Post-Pandemic World

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The COVID-19 Pandemic is an evolving situation.
All information here was accurate as of the date of publication.

EXECUTIVE
SUMMARY

SUPPLY CHAINS
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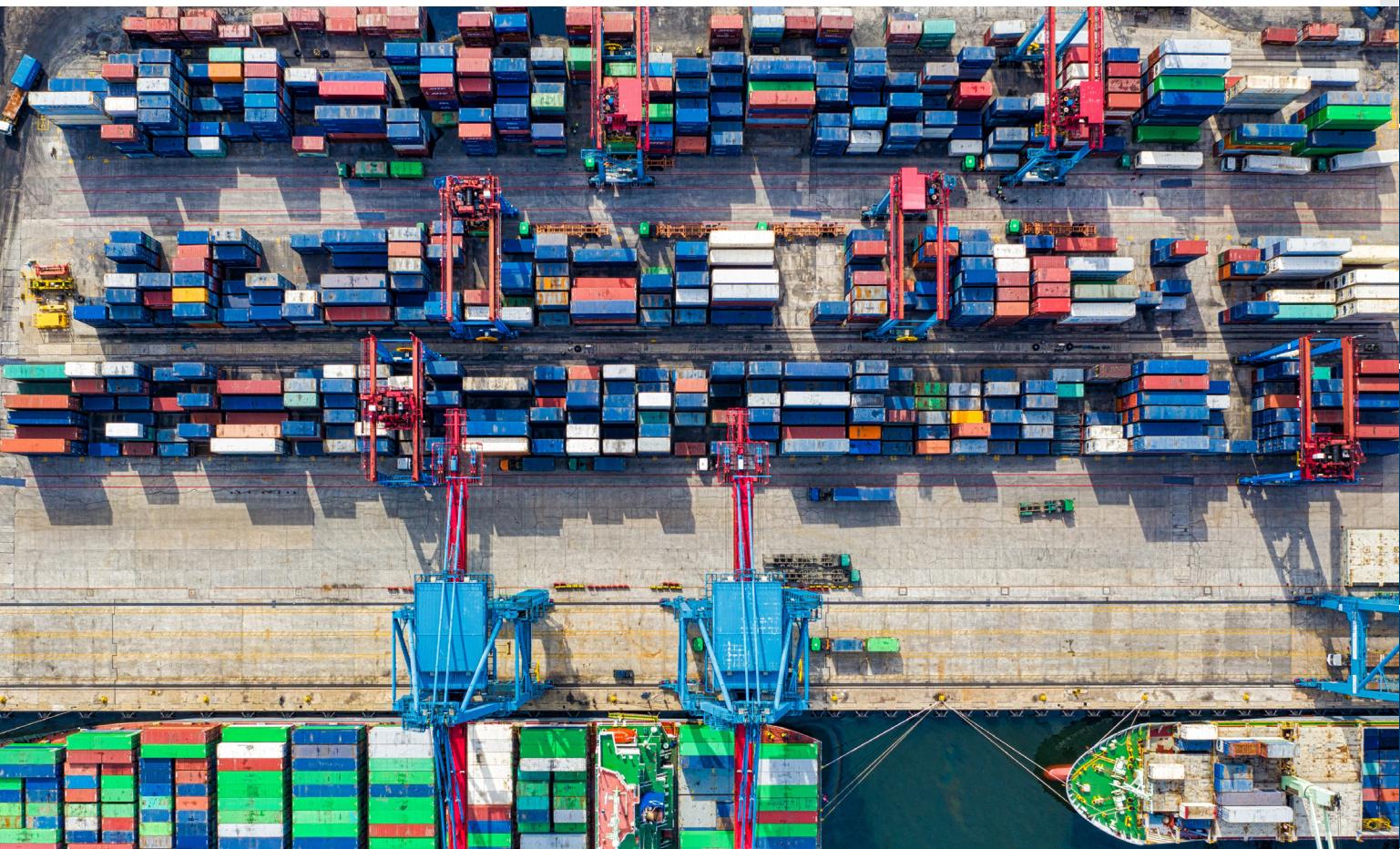
Executive Summary

Supply chains – as a topic of the global economy - are receiving plenty of attention these days. Various disruptions, and particularly the COVID-19 pandemic, are exposing the fragile nature of today's global supply chain ecosystems. With record backlogs at ports and rail yards, a major shortage of truck drivers and consumer pressure mounting for an on-demand e-commerce economy, some of today's supply chain issues are likely to persist for the foreseeable future.

The COVID-19 pandemic has been unrivaled in its ability to disrupt operations across the entire supply chain. Every link in the global supply chain has been exposed to disruption, from upstream manufacturing, where factory shutdowns have delayed the production of goods, to downstream retail, where unprecedented demand has seen the creation of new channels and the expansion of existing ones.

This eBook will illustrate the current state and ongoing evolution of supply chains, outline the key challenges and pain points, and describe the digital supply chains of the future. It will showcase the innovative technological developments Intel is helping to drive and the Intel strategic alliance solutions that can address customer needs.

Readers will not only learn about the current state of supply chains, but also how supply chains have reached a state of disarray, they will also learn about the technology solutions that can help solve key operational issues and increase efficiency across all stages of supply chain operations. This e-book will serve as a guide on how to implement changes and utilize Intel solutions to reach a more stream-lined and resilient global supply chain.



Section 1

Supply Chains in Flux

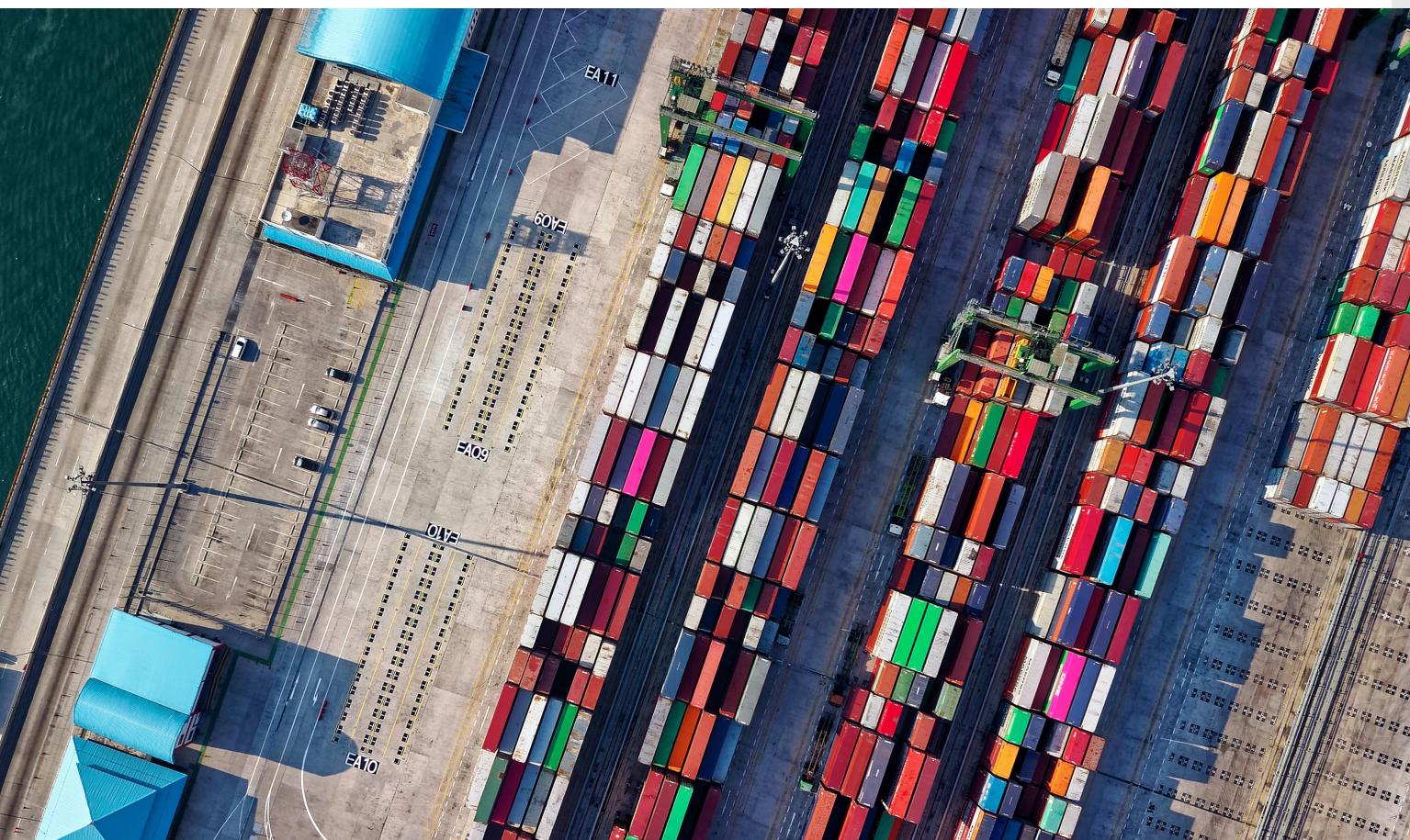
1.1 SUPPLY CHAINS UNDER PRESSURE
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1.1

Supply Chains Under Pressure

Supply chains are receiving plenty of attention these days. Various disruptions, and particularly the COVID-19 pandemic, are exposing the fragile nature of today's global supply chain ecosystems. With record backlogs at ports and rail yards, a major shortage of truck drivers and consumer pressure mounting for an on-demand e-commerce economy, some of today's supply chain issues are likely to persist for the foreseeable future.

The COVID-19 pandemic has been unrivaled in its ability to disrupt operations across the entire supply chain. Every link in the global supply chain has been exposed to disruption, from upstream manufacturing, where factory shutdowns have delayed the production of goods, to downstream retail, where unprecedented demand has seen the creation of new channels & the expansion of existing ones (ex: spike in eCommerce, new pickup-at-store options [ex: pickup at curb, delivery to vehicle]) retailers into new channels.

The pandemic created rippling impacts across every stage of the supply chain, from labor shortages to disruptions to in-store retail traffic, with some disruptions having long-standing impacts. Consumer shopping preferences, with limited access to retail stores, began relying more on eCommerce and delivery services (ex: DoorDash, UberEats, grocery & meal kit delivery services). As the pandemic subsided in late 2021 (as of May 2022) many consumers returned to stores, but it has

become clear that online shopping and home delivery are not going anywhere. As retail foot traffic returns to pre-pandemic levels customers are still buying more of their goods online every year.

The disruptions caused by the pandemic began at the furthest point upstream: sourcing raw materials. Outbreaks halted the operations of key raw material facilities, such as farms and mines, delaying their shipments to manufacturers. This, in turn, created production delays and impacted retailers' ability to replenish inventory. The cascading effects stemming from closures and delays caused by the pandemic are still

being felt, even as much of society reemerges from government regulated shutdowns. And with the geopolitical situation occurring in Ukraine, who provides 7% of the world's wheat supply², a new threat looms on the horizon in the form of a wheat shortage, cutting into supplies of goods from Rice Krispy treats to baby formula.³

Supply Chain:
not a vertical market,
but more so a series
of exchanges and
interactions enabled
by technology that
support a variety of
vertical markets

Sourcing and inventory issues are forcing supply chains to evolve, but there are customer-driven factors putting pressure on supply chains as well. One major and potentially long-term effect of the COVID-19 pandemic is its impact on customer purchasing preferences. Eighty-three percent of customers believe convenience is more important now than it has ever been in the past, according to a 2020 Smart Insights

1 https://www.census.gov/retail/mrts/www/data/pdf/ec_current.pdf

2 <https://www.aljazeera.com/news/2022/2/17/infographic-russia-ukraine-and-the-global-wheat-supply-interactive>

3 <https://www.delish.com/food-news/a39096722/rice-krispies-shortage-a-brief-investigation/>

survey. When the pandemic made in-store shopping risky or unavailable due to closures, many customers moved to purchasing everything, including groceries, online and getting them delivered. Others utilized newly created curbside pickup services. Many customers have found these new purchasing options highly convenient, especially within the grocery market. U.S. grocery pickup sales hit \$4 billion in January of 2022, up \$100 million from 2021 figures, while grocery delivery fell from its 2021 height of \$3.2 billion to \$3 billion in 2022⁴.

This rapid and unexpected change in consumer shopping preferences is resulting in a new wave of competition for retailers and e-commerce vendors around factors like delivery times, service consistency, product customization capabilities and customer experience personalization. Tracking downstream retail and sales data has become increasingly important for retailers and e-tailers, enabling improved demand forecasting and end-to-end supply chain visibility.

Retailers who may have had extremely efficient brick and mortar operations are now suddenly competing with companies who have years of e-commerce and online order fulfillment experience. These e-commerce companies in turn are now competing with seasoned brick and mortar retailers who have physical presence throughout their shared markets. In order to effectively compete with e-commerce vendors, brick and mortar retailers must offer comparable services and customer service. For retailers, this means offering package tracking, accurate ETAs, simple returns and more. With this transition and its associated increase in competition, consumers may benefit, but retailers – both omnichannel & pure e-commerce retailers - are experiencing new competitive pressure. The trend toward online shopping had already begun, but the pandemic accelerated the consumer shift to online shopping by roughly five years.⁵

Captive Supply Chains:

Value chain participants with robust & far-reaching supply chain operations (ex: trucking, warehousing and distribution) that leverage assets that are either directly owned by the company for specific purposes (ex: Best Buy using a Best Buy delivery truck is an example of captive supply chain operations)

The expansion of retailers into business strategies that combine both brick and

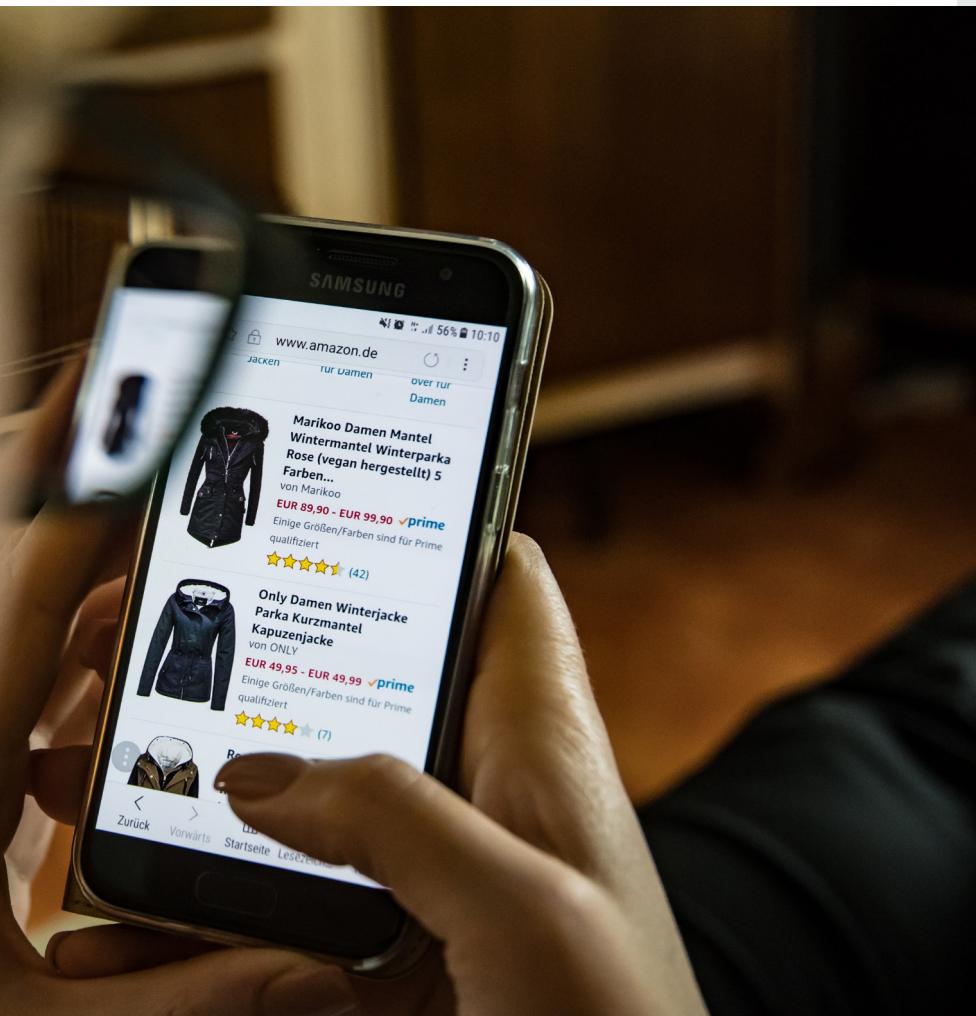
4 <https://qz.com/2132628/why-grocery-curbside-pickup-will-outlast-delivery/>

5 <https://www.ibm.com/thought-leadership/institute-business-value/report/consumer-2020>

mortar and online operations, otherwise known as omnichannel, carries with it fundamental changes to their core business models and the structure of their supply chains. To support the delivery of goods directly to end customers, retailers must roll out last-mile delivery plans by leveraging their captive supply chain capabilities or partnering with new companies to complete the final delivery stage of the supply chain. Last-mile delivery can vary in form, whether delivered directly to a consumer's home or to a package locker. The method of last-mile delivery also varies widely, from gig economy style delivery services like DoorDash, to commercial fleets, bikes, drones and Autonomous Mobile Robots (AMRs). Regardless of form or modality, last-mile delivery will always carry a significant cost, forcing retailers to carefully consider their options. Last-mile delivery accounts for roughly 53% of total logistics costs,⁶ emphasizing the importance of creating a sustainable and cost-conscious last-mile delivery system.

Shifts in consumer shopping preferences have necessitated immediate changes for retailers, who are now offering e-commerce and delivery options, but this shift carries significant implications for midstream and upstream participants as well. Before diving into all the effects on midstream and upstream supply chain, let's define who the key players are.

⁶ <https://www.businessinsider.com/last-mile-delivery-shipping-explained?r=US&IR=T>





1.2

The Four Key Actors Within Supply Chains

Supply chains require the close collaboration of a diverse range of stakeholders. From a company sourcing rubber in Thailand to a retailer selling sneakers in Germany, the supply chain of a single good can be incredibly complex and include dozens of interactions, exchanges, vendors and service providers.

Despite this complexity, there are just four core segments that carry out the bulk of supply chain operations, from upstream to downstream: Manufacturers, Transportation and Logistics Providers, Warehouses, and Retailers. Between the activities of these four customer segments, raw materials can be molded into final goods, the goods can be moved where they need to go, and retailers can sell and distribute the goods to customers.

SUPPLY CHAIN PROCESS

SOURCE → MAKE → DELIVER → SELL → RETURN

PLAN

ENABLE

SOURCE & MAKE | Manufacturing is part of the upstream supply chain, where raw materials are processed into their final form. These goods are packaged and transported to their secondary destination, which could be a retail store, a warehouse, or even the home of an end customer. Manufacturers crave data from midstream and downstream operations, such as sales data from a retailer or a notification from a warehouse that a shipment has been damaged. This data helps improve the accuracy of a manufacturer's production and materials planning.

DELIVER & RETURN | Transportation and Logistics is part of the midstream supply chain, where finished goods are transported from factories, warehouses, or points of entry (e.g. airports, rail yards, ports) to their end delivery location (e.g. retail stores, package lockers, homes of customers). In the context of the supply chain, transportation and logistics is carried out by either captive supply chain operators or a combination of transportation and warehousing providers. Companies that own their own fleets and warehouses, like Walmart, are good examples of a captive supply chain operator. Meanwhile, smaller retailers typically rely on the services of third-party logistics companies (3PLs) to transport goods within their supply chain.

DELIVER & RETURN | Warehouses are another critical piece of the midstream supply chain. Traditionally, warehouses store inventory and offer some services, but warehousing providers have begun to diversify and grow their capabilities. This has led to the creation of new kinds of warehouses and business models. New types of warehouses, like micro-fulfillment centers, are being created specifically to assist with order fulfillment, often by retrofitting unused areas in retail stores or warehouses. Warehousing providers are also diversifying their business models, with some offering an OpEx model alongside the traditional CapEx model.

SELL & RETURN | Retail performs the bulk of downstream supply chain operations, where goods are presented and sold to customers in retail environments and online. Customer purchasing behaviors have shifted to purchasing online and to a preference for convenience over price. These shifting behaviors are putting pressure on retailers in many different areas. Retailers are being pushed by their customers to expand into new channels, exposing them to new forms of competition. For example, brick and mortar retailers expanding into e-commerce will have to create a last-mile delivery strategy. This can be as straightforward as outsourcing last-mile delivery to traditional transportation providers like UPS or partnering with a gig economy player like DoorDash to execute last-mile delivery. In addition, brick and mortar retail locations now have significantly less in-store traffic where employees can gauge customer behavior and interests. This is forcing retailers to find new, innovative ways to track customer behavior.

SUPPLY CHAIN FLOWCHART

RAW MATERIALS EXTRACTION



Raw Materials Transport

POINTS OF ENTRY



RAW MATERIALS PROCESSING & GOODS PRODUCTION



Bulk Freight Transport



POINTS OF ENTRY

WAREHOUSING & DISTRIBUTION



ONLINE SALES



RETAIL SALES



ORDER FULFILLMENT

CONSUMPTION OF GOODS

Last-Mile Delivery



Retail Distribution



Returns

The increasing density of technology across supply chains has enabled the potential to tap into an unprecedented volume of data and information.

The increasing density of technology across supply chains has enabled the potential to tap into an unprecedented volume of data and information. While supply chains have deployed strategies and systems to realize value from these new digital networks, the future of supply chains promises to close the gap across untapped data and information networks. To access this valuable data, supply chains must continually integrate upstream, midstream and downstream operations.

The upstream stage of supply chains, dominated by manufacturers and raw material suppliers, benefits from insights into consumer behavior from downstream retailers. This data enables better production and materials planning. Midstream supply chain players, like warehousing, transportation and logistics providers, need to understand where goods in transit are, where they are moving to, and how to most efficiently move the goods to keep their customers informed and their transportation costs to a minimum. Downstream supply chain participants, such as retailers and last-mile delivery providers, leverage in-store sales data and online order data to manage inventory effectively and execute efficient deliveries to end customers.

This vast amount of data being collected is often siloed into point systems, like Transportation Management Systems (TMS). With siloed data, supply chain operators must use multiple systems to manage their supply chain, rather than a “single pane of glass” view into all operations.

The linear and dependent nature of today’s supply chains was not capable of handling the various disruptions introduced by the COVID-19 pandemic. Having described the key players within the supply chain, as well as how they have individually responded to the post-pandemic “new normal”, it is critical to understand the forces driving the ongoing evolution of supply chains, from now into the future.

SUPPLY CHAIN KEY STATISTICS

OVERALL TREND



Every

3.7 YEARS

Frequency of supply chain disruptions lasting a month or longer

**172%**

increase in out-of-stock scenarios compared to pre-pandemic levels



Only

6%

of companies have full visibility into their supply chain

UPSTREAM



A record high –

92 DAYS

Lead Time for Production Materials



A record high –

45 DAYS

Lead Time for Repairs on Production Equipment



Longest since 1989 –

154 DAYS

Lead Time for New Production Equipment



MIDSTREAM



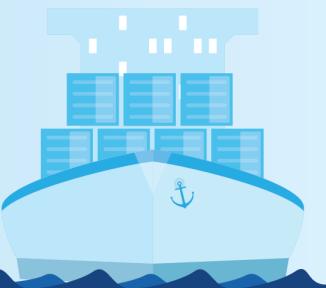
Current Truck Driver shortage

80,000

of all goods transported by sea

80%+

increase in the cost of containers coming from China to US West Coast



BACKLOGS AT POINTS OF ENTRY

**AIRPORTS** 14-day wait times at LAX & JFK airports**RAIL YARDS**

16-day wait times in the Port of LA's rail yard

PORTSA record **105 ships** were waiting to offload at the Ports of LA and Long Beach in January of 2022

DOWNSTREAM

CONSUMER DEMAND SHOCKS

24% Average Consumer Good Demand Shock

TOILET PAPER
845%
Demand ShockEXERCISE EQUIPMENT
170%
Demand Shock

COVID-19 Pandemic accelerated retailers' shift to omnichannel strategies by

5 YEARS

Last-mile delivery accounts for 53% of overall logistics costs

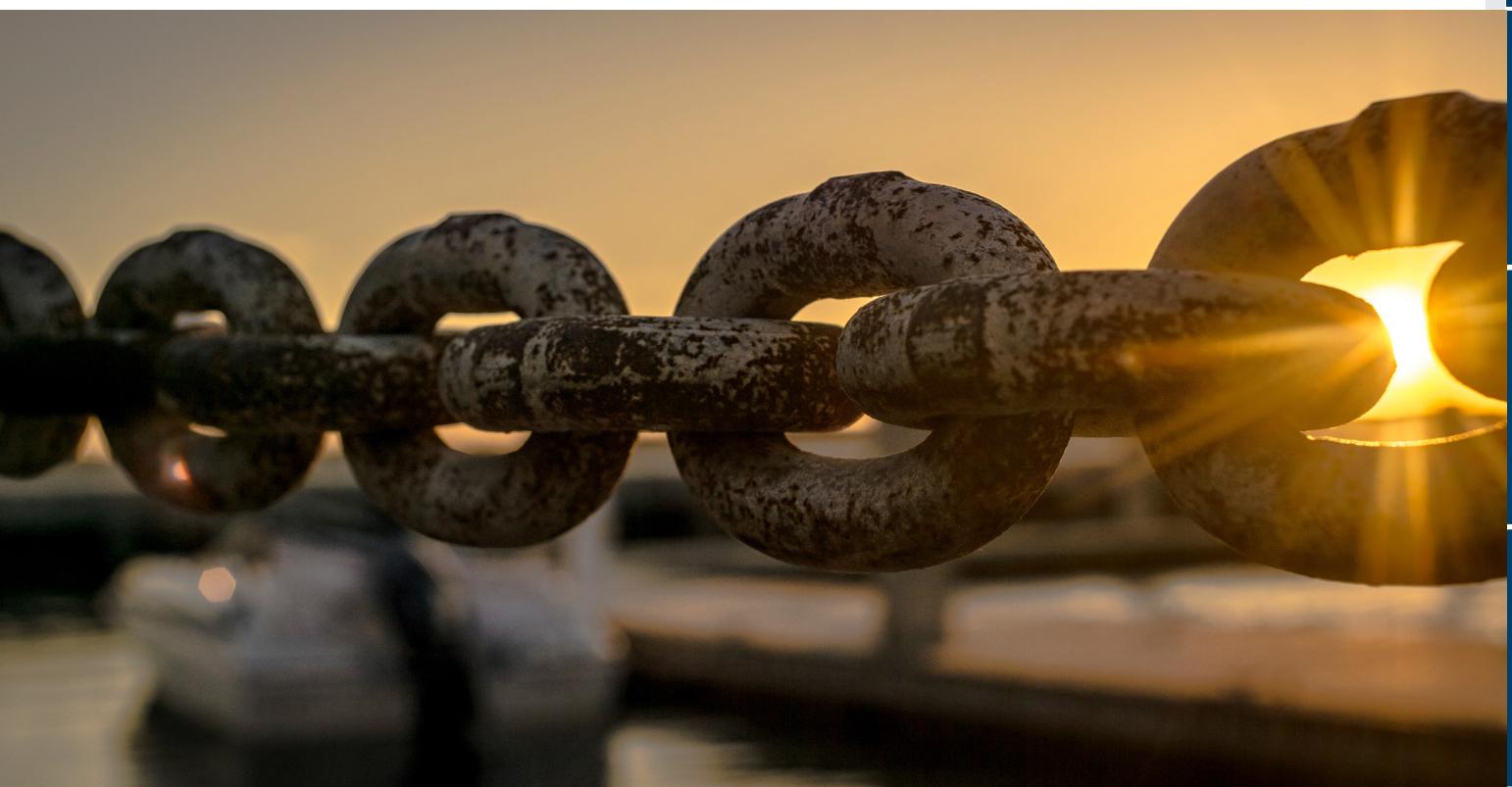


1.3

Forces on Upstream, Midstream and Downstream Operations

In the midstream supply chain, warehouses and transportation providers are having to tailor operations and business models to account for the growth in e-commerce. Warehouses are experimenting with OpEx business models alongside the traditional CapEx model, allowing growing retailers to leverage a mature logistics network. Transportation providers are offering a range of transportation and logistics services to customers, from first to fourth party logistics.

Despite being a large expenditure for many businesses, supply chain processes and ecosystems can be quite messy. Supply chains have historically been defined by disconnected manual processes, handwritten forms, and intensive, manual labor across multiple venues, including warehouses, airports and rail yards. This has changed significantly over the last 15 years, as the introduction of key technologies like Artificial Intelligence (AI), Machine Learning (ML), the Internet of Things (IoT) and advanced, ubiquitous networking, such as 5G, has created a path forward for supply chain operations. Combining these technologies has led to a new generation of integrated devices and systems that are reducing the amount of human labor required. For example, Machine Vision leverages AI, IoT and advanced camera systems. These new, complex systems are increasing the amount of data collected within specific supply chain activities, leaving the door open for process optimization and data sharing. Today's forward-thinking supply chains have begun to adopt these new devices and systems, leading to both promise and problems.



1st Party Logistics:

Captive supply chain operations where one firm or individual has their own cargo and freight and can transport goods and merchandise from one point to another.

2nd Party Logistics:

Businesses work with an asset-based carrier that provides them access to marine vessels, planes or trains to enact the long-distance or international transportation of heavy and wholesale goods.

3rd Party Logistics:

Providers are primarily concerned with transportation and delivery of products, but offer additional services to their client, including warehousing, terminal operations, customs brokerage, supply chain management and more.

4th Party Logistics:

This nascent logistics model involves an external company overseeing the entire supply chain operations of a company. Often functioning as a consultant to the company in question, they act as a head administrator and handle all aspects of their client's supply chain.

The midstream supply chain, while not directly contributing to making or selling goods, acts as a critical touchpoint that connects upstream and downstream processes. The data generated by midstream operations, includes location data, estimated time of arrival (ETA) and damage reports. All this data enables increased end-to-end visibility and equips manufacturers and retailers to plan more effectively. Without access to this data, manufacturers and retailers are reacting to problems in real-time as opposed to planning for and around them.

In the upstream supply chain, manufacturers are also falling victim to changing consumer preferences. The growing prevalence of e-commerce and the innovations brick and mortar retailers have made in re-imagining the in-store customer experience has led to a growing

expectation of, and demand for, personalized goods and services, such as offering multiple pickup options. In response, manufacturers must make changes of their own. Production lines must change, new equipment may be required, and new processes must be created to account for custom goods and an increasing SKU count. With the current state of the supply chain, upstream players, including raw materials suppliers, are subject to the volatility of demand shocks. This can leave them unable to effectively access sales and inventory data. Without this data, upstream players are left guessing at their manufacturing and materials planning.

SUPPLY CHAIN OVERVIEW:

UPSTREAM, MIDSTREAM & DOWNSTREAM

	KEY PLAYERS	RESPONSIBILITIES	PAIN POINTS
UP STREAM	Raw Materials Suppliers	<ul style="list-style-type: none">  Raw materials sourcing  Labor planning 	<ul style="list-style-type: none">  Labor shortages  Reactionary planning
	Manufacturers	<ul style="list-style-type: none">  Production planning  Goods production 	<ul style="list-style-type: none">  Material lead times  On-demand economy
MID STREAM	Transportation Providers	<ul style="list-style-type: none">  Goods & materials transport  Route planning 	<ul style="list-style-type: none">  Backlogs at points of entry  Increasing fuel & labor costs
	Warehouses	<ul style="list-style-type: none">  Goods storage  Retail & wholesale distribution 	<ul style="list-style-type: none">  Growing parcel volume  Inefficient manual processes
DOWN STREAM	Retailers	<ul style="list-style-type: none">  Goods sales  Inventory planning 	<ul style="list-style-type: none">  Shifting consumer preferences  Inventory management
	Last-Mile Delivery Providers	<ul style="list-style-type: none">  Online order fulfillment  Goods delivery 	<ul style="list-style-type: none">  Fuel efficiency  Route & load optimization
	End Customers	<ul style="list-style-type: none">  Consumption or return 	<ul style="list-style-type: none">  Immature online return processes

1.4

The Supply Chain Evolution: Responding to Globalization and the Rise of E-Commerce & Shifting Consumer Preferences

Like many other industries, supply chains are feeling the effect of the digital revolution and trends around on-demand consumption and e-commerce.

Considering that supply chains are vulnerable to changes in consumer shopping preferences, the introduction of new technologies, competitors and regulatory changes, it's no surprise that supply chains are currently undergoing a large evolution. Major disruptions like the COVID-19 pandemic, along with the socioeconomic changes that it brought, have driven supply chains into a state of accelerated change. There are three key factors driving the ongoing evolution of today's supply chains: **globalization**, the **rise of e-commerce** and **shifting consumer expectations**.

Globalization:

The expansion of a supply chain from domestic operations to international operations.

As the internet and improved transportation infrastructure connected the world, it opened the door for many companies to broaden their operations to the global level. This introduced many new customers and markets, but it introduced problems as well, including increased supply chain complexity, risks in sourcing materials, increased competition and data collection challenges.

One example of the downside of globalization is the impact that the Tohoku Earthquake in Japan had on various global supply chains. Due to crippled infrastructure, the export of electronic components was halted. This created significant slowdowns in the supply chains of many dependent industries across the globe, like automotive manufacturing.

Recently, there have been several signs indicating that some companies may be walking back on globalization. This recent trend, coined "near-shoring," involves moving key supply chain activities, like manufacturing and sourcing of raw materials, to countries or areas that have significant demand for that product. Bringing key activities close to the product's end destination reduces reliance on global transportation networks.

The Rise of e-Commerce

The continued rise of e-commerce is a critical driver in the recent changes in consumer shopping preferences and will continue to impact the way that consumers interact with products and make purchases. This is particularly disruptive for retailers, forcing them to reconsider their channel strategy. It also carries significant implications for transportation, logistics and warehousing providers. As e-commerce continues to grow, so will the volume of parcels that require transportation and logistics support. Both transportation and warehousing providers must dramatically increase their throughput to account for the growing number of parcels demanding last-mile delivery service.

Last-Mile Delivery:

The final stage of the supply chain, where goods are delivered to an end customer. Last-mile delivery is not exclusive to home delivery and can come in various forms, including package lockers, curbside or in-store pick-up and even drone or AMR delivery. Last-mile delivery is the most expensive stage of the supply chain, representing 53% of overall logistics costs while other last-mile fulfillment options, like in-store pickup, are cheaper for both customers & retailers.

| <https://www.businessinsider.com/last-mile-delivery-shipping-explained>

Shifting Consumer Expectations

Expectations are changing relative to product, delivery and customer service. Customers are increasingly demanding personalized goods to better express their identities. These personalized products range from NikeID custom footwear to KitchenAid's product customizer. This plethora of new, custom products introduces new SKUs and complexity in manufacturing and distribution. Thanks to popular services like Amazon Prime's two-day delivery, customers now expect goods to be delivered quickly, consistently and with communication throughout the fulfillment process. Along with high-speed and consistent delivery, customers expect additional services like tracking, estimated time of arrival and return services. All these customer expectations make a quick and successful expansion into e-commerce difficult for inexperienced retailers.

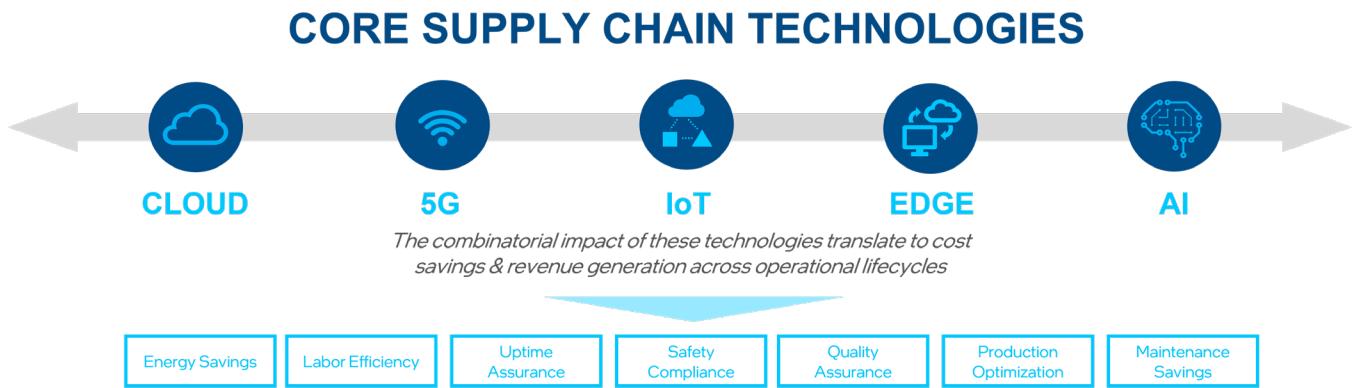
Supply chain operators can mitigate their exposure to these three key trends by bolstering the agility and responsiveness of their supply chains. To do so effectively, operators must collect data from all stages of their supply chain, from upstream manufacturing to downstream retail.

1.5

Why Supply Chain Data Matters

The current state of the supply chains can be seen as a jumble of disparate information and software systems, to which untapped value for stakeholders is left on the table. It's through highly coordinated, end-to-end solution design and ecosystem collaboration that supply chain stakeholders can realize the potential value of open data and supply chain visibility. For example, retailers are constantly challenged with determining an optimal strategy to achieve integrated product and sales personalization, inventory optimization and supply chain scheduling. The integration of real-time fleet and asset data, consumer preferences, and inventory levels, leads to highly valuable demand forecasting. Better forecasting helps optimize product placement, reduce inventory and achieve greater delivery efficiency.

Over the last two decades, the world has seen the introduction of incredibly powerful software, such as Artificial Intelligence, Machine Learning and Supply Chain Management platforms. The world has also seen dramatic reductions in the cost of advanced equipment like robotics and autonomous vehicles. Socioeconomic changes have accelerated the adoption of technology as a replacement for labor-intensive processes. The combinatorial impact of advanced analytics, AI, ML, open data management and exchange, high-performance networking and agile cloud resources is creating an unprecedented ability to integrate disparate data and information systems. Integrated, accessible data helps establish end-to-end visibility across supply chain operations.



These technologies have enabled increased visibility of goods across a supply chain through applications like track and trace, which allows supply chain operators to track their goods from their manufacturing facility to delivery at the retail store. Some companies are integrating blockchain into their procurement and fulfillment processes, enabling new services for their

customers like authenticity verification. Fashion conglomerate LVMH (known for Louis Vuitton and Hublot, among other brands) recently partnered with Richemont's Cartier and Prada SpA to create a blockchain solution designed to validate the authenticity of purchased goods via encrypted digital certifications of authenticity. The consortium ultimately intends to offer this solution, Aura Blockchain, to other luxury brands.

Connected devices like Autonomous Mobile Robots (AMRs) are being integrated into supply chain activities. When combined with diverse sensing, connectivity, computing technologies and platforms, a massive amount of asset data is being generated. This data includes position, status, temperature, vibration and more. As forklifts, commercial trucks and even shipping vessels are connected to the invisible, digital fabric of a supply chain, their data is often being collected and aggregated for standalone systems. For example, the connection of a commercial truck involves the collection and aggregation of fleet-level data for use in a Transportation Management System (TMS). Software creates both a solution and a burden in these cases, helping manage one part of supply chains (e.g. Supplier Management) while requiring the use of multiple systems to manage other aspects of a supply chain.

It's through a highly coordinated, end-to-end solution design and ecosystem collaboration that supply chain stakeholders can realize the potential value of open data and supply chain visibility

Supply chain stakeholders are making progress toward this future state of interoperability and open data exchange across the supply chain. As both the volume of data being collected across supply chain activities and the demand for accessible open data increases, so does the underlying need for a strong data management and analytics solution. One provider at the forefront of open data exchange platforms is [Snowflake](#), who offers a scalable, flexible platform that can host, manage and visualize internal and external supply chain data.

The success of end-to-end supply chain visibility is contingent on the engagement of stakeholders to re-imagine their current role as a contributor to an open data ecosystem versus a bystander of supply chain activities. This is much easier said than done, and by no means should be done in isolation. Ultimately, the collective buy-in of supply chain stakeholders and technology providers is required to advance digital solutions and introduce new business models. It is also

necessary to address the myriad of highly variable external forces that impact the continuity and efficiency of supply chain business operations. To fully appreciate the scope of challenges that supply chains are up against, it is important to understand the impacts that external events have on supply chain processes, as well as identify what form these disruptions will take.

¹ <https://www.yahoo.com/video/fashion-brands-using-blockchain-combat-182607353.html?guccounter=1>

SUPPLY CHAINS ARE SHIFTING FROM SILOED LINEAR PROCESSES TOWARDS COMPLEX ADAPTIVE SMART SYSTEMS

CURRENT STATE OF SUPPLY CHAIN

Today's supply chains are highly linear and are defined by interdependent processes as well as a low level of data sharing & data interoperability across the value chain.

PLAN → SOURCE → MAKE → DELIVER → RETURN → ENABLE

FUTURE STATE OF SUPPLY CHAIN

Supply Chains, empowered by interoperable tech stacks and free-flowing, real-time data sharing across value chain participants, will be able to evolve into resilient, agile & dynamic Supply Networks.

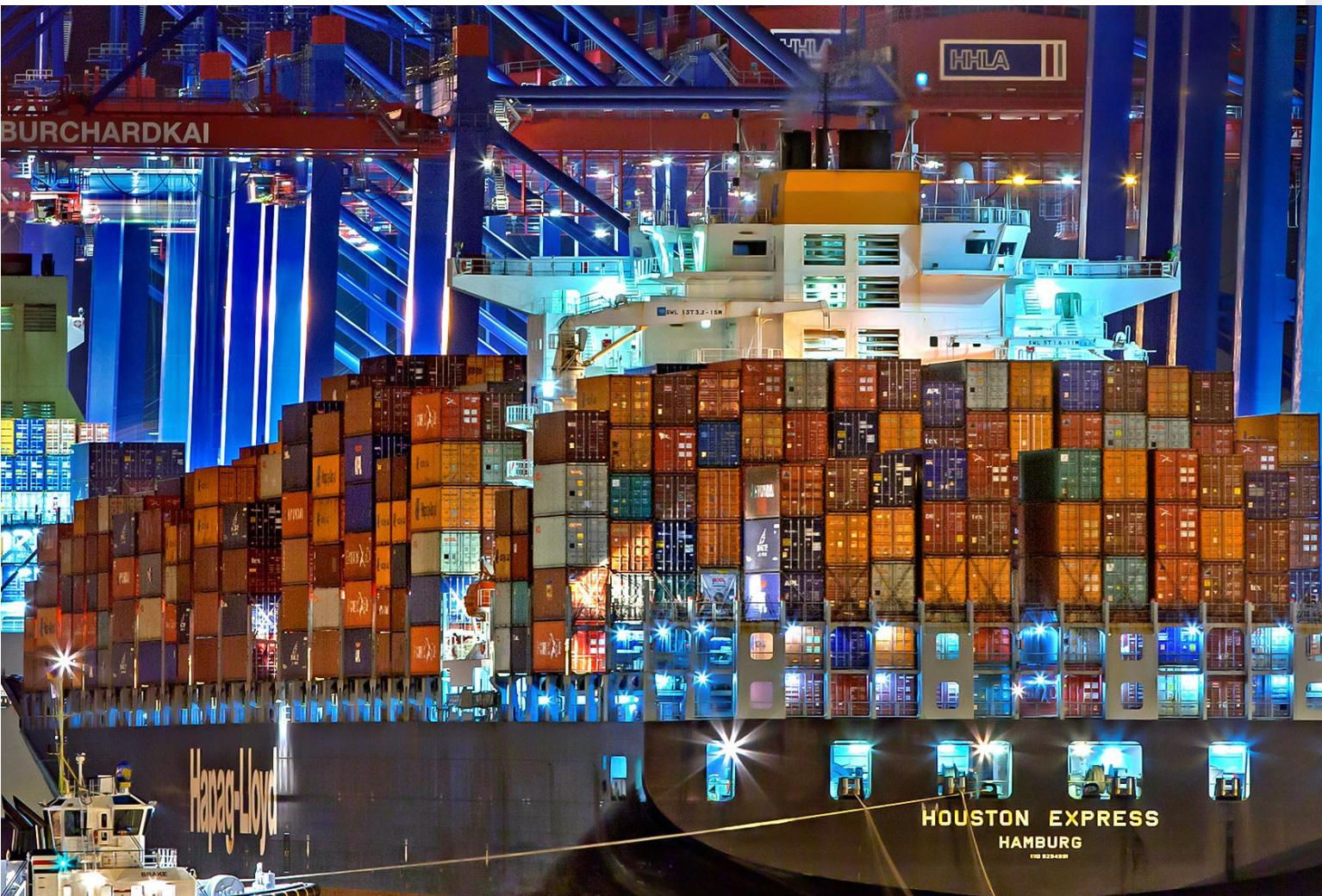


Section 2

Challenges and Disruptions to Today's Supply Chains

2.1 THE MANY FORMS OF SUPPLY CHAIN DISRUPTION

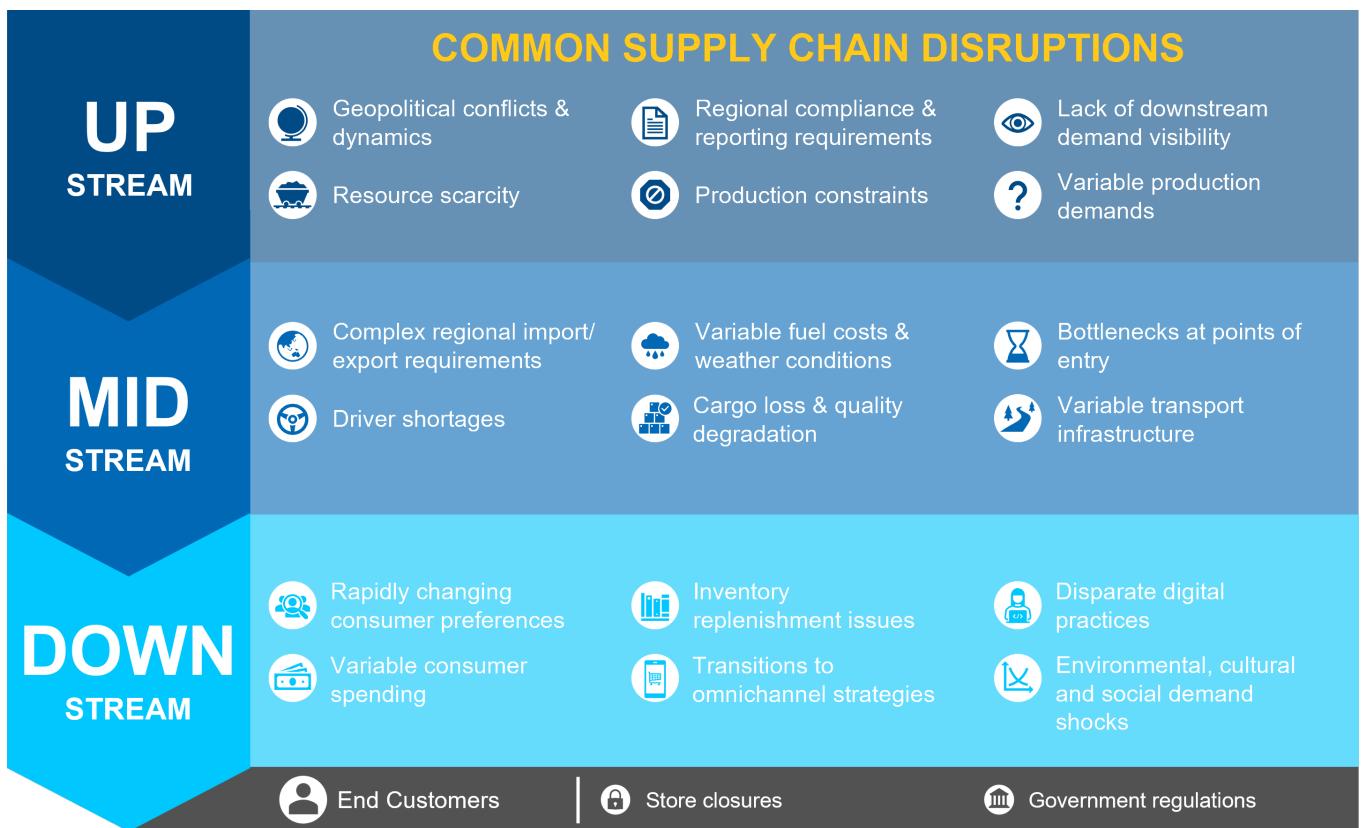
2.2 TRENDS CREATING NEW SUPPLY CHAIN CHALLENGES



2.1

The Many Forms of Supply Chain Disruption

There are myriad forces that introduce massive challenges for supply chains. From resource and raw material constraints to driver shortages and geopolitical dynamics, global supply chains are highly susceptible to world events happening outside of the internal decisions, strategies and operational activities of stakeholders. These challenges will be ever-present, leading to the core question supply chain stakeholders must ask: how can integrated technology and business strategies mitigate the impacts of external forces to maintain operational efficiency and continuity?



Prevalent Upstream Disruptions & Challenges

- Geopolitical Conflict & Dynamics
- Responsible Sourcing
- Resource Scarcity
- Distinct Regional Compliance & Reporting Requirements
- Production Constraints & Variable Production Demands
- Lack Of Visibility to Downstream Demand & Available Resources

Starting at the most upstream point of supply chains – where raw materials are sourced from the earth – we can begin to see the impact that COVID-19 has had. Government regulations, like quarantines, stay-at-home orders and shutdowns of key infrastructure, like airports and rail systems, have created labor disruptions that have impeded or prevented the extraction and export of raw materials. This has created record-high lead times for production materials¹ which causes a significant ripple effect for downstream players in manufacturing and retail.

Manufacturing, another member of the upstream supply chain, has become a direct victim of slowdowns in materials sourcing. Unable to produce sufficient levels of goods because of slowdowns in materials supply, Manufacturers are experiencing significant production delays, leading to long lead times for ordered goods. This slowdown continues its ripple effect downstream, impacting the midstream players in charge of transporting and storing these promised goods, as well as the retailers who expected to be able to sell them.

¹ <https://www.supplychaindive.com/news/lead-time-record-highs-ism-supplier-labor-congestion/602923/#::text=The%20lead%20time%20for%20production,began%20collecting%20data%20in%201987.>



Prevalent Midstream Disruptions & Challenges

- Complex & Regionally Specific Import/Export Regulations
- Driver Shortages & Variable Transport Infrastructure
- Variable Fuel Costs & Weather Disruptions
- Cargo Loss & Product Quality Degradation
- Port Bottlenecks Driven by Cargo Throughput Inefficiencies

As goods are manufactured and packaged, they face a new set of challenges in terms of getting those goods to their appropriate location. Record-high backlogs at various points of entry, from ports to airports to railyards, have created significant difficulty and increased logistics costs for goods moving across international borders (airport¹, railyard²). As COVID-19 outbreaks halted operations in key facilities like ports, the impact of closures, as well as the threat of delays, led to a massive increase in the cost of overseas shipping containers. For example, the cost of a container traveling through one of the world's busiest shipping lanes, the China-U.S. East Coast route, rose over 500% between July of 2020 and 2021³.

Compounding the problems seen in transportation is the scarcity of human labor. A growing lack of truck drivers, along with a decrease of new commercial vehicles due to the semiconductor shortage⁴, have created significant friction when it comes to moving goods out of points of entry. Ports are an example of this phenomenon, for while vessels are still able to successfully navigate to their point of entry, there are not enough trucks and truck drivers to move these goods off vessels and to their destination. This has created significant friction for maritime freight, as vessels are often stuck at ports waiting to offload their cargo. Sometimes these vessels must wait off the coast and return to port to drop off containers⁵. In early 2022, container ships had to wait at American ports for an average of seven days before unloading⁶. Since 90% of world trade flows through maritime, delays here cascade throughout the supply chain. Airports and railyards are not immune to this phenomenon either. Airports have been shutting down air freight due to lack of on-site storage and railyard container stacks are climbing higher and higher⁷.

1 https://www.scdigest.com/ontarget/21-11-17_Air_Cargo_Delays_Congestion.php?cid=19281

2 <https://www.wsj.com/articles/supply-chain-backlogs-turn-chicago-into-new-chokepoint-11627064719>

3 <https://www.cnbc.com/2021/08/05/china-us-container-shipping-rates-sail-past-20000-to-a-record.html>

4 <https://www.smart-trucking.com/truck-driver-shortage/>

5 <https://www.bbc.com/news/58926842>

6 <https://www.nytimes.com/2022/02/01/business/supply-chain-disruption.html?auth=link-dismiss-googleltap>

7 <https://gomotive.com/blog/state-of-the-supply-chain-railroads/>

Prevalent Downstream Disruptions & Challenges

- Rapidly Changing Consumer Preferences
- Macroeconomic Dynamics & Variable Consumer Spending
- Disparate Digital Practices Limiting Inventory & Supply Chain Management Efficiency
- Environmental, Social & Cultural Demand Shocks
- Inefficient, Undefined Omnichannel Strategies

A few unique forms of disruption exist in the downstream supply chain, where goods are sold and delivered to end customers. A victim of the trickle-down impacts from the midstream and upstream supply chains, players in downstream supply chains, such as retailers and last-mile delivery providers, must mitigate shipping delays, increased logistics costs and poor inventory replenishment, along with their own unique pain points.

COVID-19 has led to a massive shift in consumer shopping preferences, including a large-scale migration to purchasing goods online. In some cases, this has been a short-term solution where in-store shopping was prohibited or risky, but for many shoppers, this change is here to stay. Retailers who typically benefited from in-store consumer analytics and behavioral analysis must now find new ways to track customer preferences.

Demand shocks have also plagued the downstream supply chain. A prime example of this is the rush on toilet paper at the start of the COVID-19 pandemic. Despite retailers' best efforts to accurately forecast demand and stock inventory accordingly, it would have been nearly impossible to predict consumers' reactions to the pandemic. This demand spike led to weeks of panic-buying, as consumers snapped up any toilet paper they could find on store shelves, whether or not they truly needed it¹. These out-of-stock scenarios are dangerous for retailers, as not only do they lose out on a sale, but lack of inventory can erode customer trust over time.

¹ <https://cnr.ncsu.edu/news/2020/05/coronavirus-toilet-paper-shortage/>





Recent Examples of Supply Chain Disruptions

The impact of the COVID-19 pandemic on global supply chains has been well documented. But what are some other ways that supply chains can be disrupted? And who is to blame for these disruptions?

Research has indicated that on average, supply chain disruptions lasting a month or longer occur every 3.7 years¹. These come in two forms: man-made and natural disruptions. These disruptions also vary in severity, ranging between disturbances at the low end and catastrophes at the high end.

More than anything else, these various forms of disruptions turn business plans - including inventory procurement, production schedules and material deliveries – upside down. With enough foresight, businesses can plan effectively and avoid the major slowdowns stemming from these disruptions.

¹ <https://www.mckinsey.com/business-functions/operations/our-insights/risk-resilience-and-rebalancing-in-global-value-chains>

Man-Made Supply Chain Disruptions

Man-made disruptions occur far more frequently than natural disruptions, but are typically much smaller in their impact, with the most common forms of man-made disruptions being common events such as theft and accidents that lead to damaged goods and equipment. There are significant forms of man-made disruptions as well, which can cause trillions of dollars in economic damage. Some examples include terrorist attacks, military conflicts, trade disputes, counterfeiting schemes and cyberattacks. An example of an enormously disruptive cyberattack occurred in 2017 when the port of Rotterdam was infected with ransomware, completely paralyzing container terminals and eventually leading to \$10 billion of damage globally¹.

A recent example of a significant man-made supply chain disruption can be found in the ongoing US-China trade war, which has forced American companies to search for suppliers exempt from new tariffs. This has cost the American economy an estimated 300,000 jobs and a resulting \$1.7 trillion dollar loss in overall stock values².

1 <https://www.wired.com/story/notpetya-cyberattack-ukraine-russia-code-crashed-the-world/>

2 <https://www.brookings.edu/blog/order-from-chaos/2020/08/07/more-pain-than-gain-how-the-us-china-trade-war-hurt-america/>



Natural Supply Chain Disruptions

In some cases, natural supply chain disruptions can be predicted, such as with volcanic eruptions or hurricanes. However, natural disasters often happen without much warning, like typhoons or tornadoes. These disruptions are nearly impossible to protect supply chains against, highlighting the importance of flexibility, agility and risk management in supply chain operations.

Additional examples of natural disasters that can dramatically impact global supply chains include pandemics, floods, tsunamis, blizzards, earthquakes, and rare events such as large super-volcano eruptions, meteor strikes and solar storms.

The case study of how COVID-19 impacted supply chains throughout its lifespan is still being written, but there are plenty of examples of natural disasters rocking the global supply chain. From earthquakes in Japan to hurricanes in New York, it is clear that no country, city or supply chain is immune to the forces of nature – or humanity. For more examples of man-made and natural supply chain disruptions, see the [Appendix \(pages 55-57\)](#).



2.2

Trends Creating New Supply Chain Challenges

Focusing on supply chain in its current state, there are several nascent trends that are beginning to create new challenges and exacerbate existing problems across various supply chain activities.



Product Personalization

A growing trend within retail is product customization, driven by the increasing prevalence of e-commerce and coming as a response by brick-and-mortar retailers to re-imagine the in-store customer experience. Consumers are increasingly demanding personalization options for goods, especially for high-ticket items like consumer electronics, designer apparel and jewelry. Customization leads to an increase in SKU counts, and can require changes to production processes, as well as their own fulfillment process outside that of traditional retail operations.

Increasing Diversity of Transportation Modalities

As various forms of modalities and equipment decline in cost and human labor becomes increasingly scarce and costly, supply chain participants are relying on new forms of transportation to enact processes like last-mile delivery. Fast-growing supply chain transportation modalities include delivery AMRs, such as Nuro for Dominos Pizza, and delivery drones, such as Zipline for Magellan Health medications.

Warehouses Evolving in Response to Urban Environments

As e-commerce grows, so does the need to fulfill and deliver online orders. Order fulfillment for e-commerce purchases is largely done in warehouses, which were traditionally kept to the outskirts of urban centers. Increasing delivery needs are pushing warehouses to operate closer to urban centers to decrease fuel costs and delivery times. This leads to an increase in the cost per square footage for warehouse operators. In response to increased costs, warehouses are expanding vertically to maximize storage space. They are also increasingly leveraging robotics like AMRs to increase the efficiency of their operations.

As brick and mortar retailers expand their operations to include e-commerce, retail stores are increasingly functioning as hybrid locations. While retaining their ability to serve customers and display goods, retail stores have begun expanding into the role of the fulfillment center, reducing the impact of growing e-commerce fulfillment needs by creating additional bandwidth for online order fulfillment. While e-commerce boomed during the pandemic, with at-home-delivery being the standard model at the time, retailers have evolved into more cost-effective forms of online order fulfillment such as curbside pick-up, deliver-to-vehicle and other nascent fulfillment models like package lockers.

Reverse Logistics & Circular Economy

Two more trends stemming from the growth of e-commerce are the growing need for reverse logistics and the consideration of the circular economy. Reverse logistics is the process of returning unwanted goods back to their source. It is becoming increasingly important as customers continue to buy more delivered goods. With the return rate for goods purchased online nearly 21% as of January 2022, there is a growing need for an efficient return system¹.

¹ <https://www.cnbc.com/2022/01/25/retailers-average-return-rate-jumps-to-16point6percent-as-online-sales-grow-.html#:~:text=The%20average%20rate%20of%20returns,professor%20at%20George%20Mason%20University>.

Circular economies are economies that are based on the principles of minimizing waste and pollution, keeping products and materials in use, and regenerating natural systems². This concept has become increasingly important as carbon footprints from supply chain operations continue to rise. Both circular economies and reverse logistics aim to mitigate waste, pollution and unsold goods. They create multiple channels of value through reducing negative externalities associated with waste and emissions, improving brand perception and reducing storage and distribution costs of unsold inventory.

One area that would see a significant impact from circular economy and reverse logistics is the fast fashion industry, which is notorious for the amount of waste that it creates on an annual basis. A shocking 10% of global emissions come from fast fashion leaders like Topshop, Forever 21 and Shein³. The fashion industry as a whole creates more carbon emissions than maritime shipping and international flights combined⁴. With that in mind, the impact that circular economies and improved reverse logistics processes can have in terms of supply chain sustainability is enormous. Considering that many goods bought online today often end up as trash⁵, there is still plenty of room for improvement in the current process of applying both reverse logistics and implementing a circular economy.

Increasing Emphasis on Sustainability Across Supply Chain Operations

In an effort to reduce the impact that supply chains have on the environment, many operators are instituting environmental policies. One major form of supply chain sustainability is carbon offset.

Fortunately for supply chain operators and the value chains supporting those supply chains, there is a plethora of hardware, software and service providers racing to provide solutions to current and future pain points. Only through the adoption of digital tools, streamlined processes and efficiency-boosting equipment can supply chains evolve into a more reactive, agile, and dynamic state.

² <https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>

³ <https://www.theguardian.com/fashion/2021/aug/29/fast-fashion-retailer-shein-design-reality-show>

⁴ <https://www.bloomberg.com/graphics/2022-fashion-industry-environmental-impact/>

⁵ <https://www.cnbc.com/2022/01/28/amazon-returns-what-really-happens-to-them.html>

Carbon Offset:

Purchasing credits associated with environmental projects that reduce emissions of carbon dioxide or other greenhouse gases as a way of offsetting the carbon emissions associated with a company's supply chain¹

¹ <https://www.greenworldwide.com/green-sustainability/green-carbon-mission/>

Section 3

Supply Chain Transformation with Intel

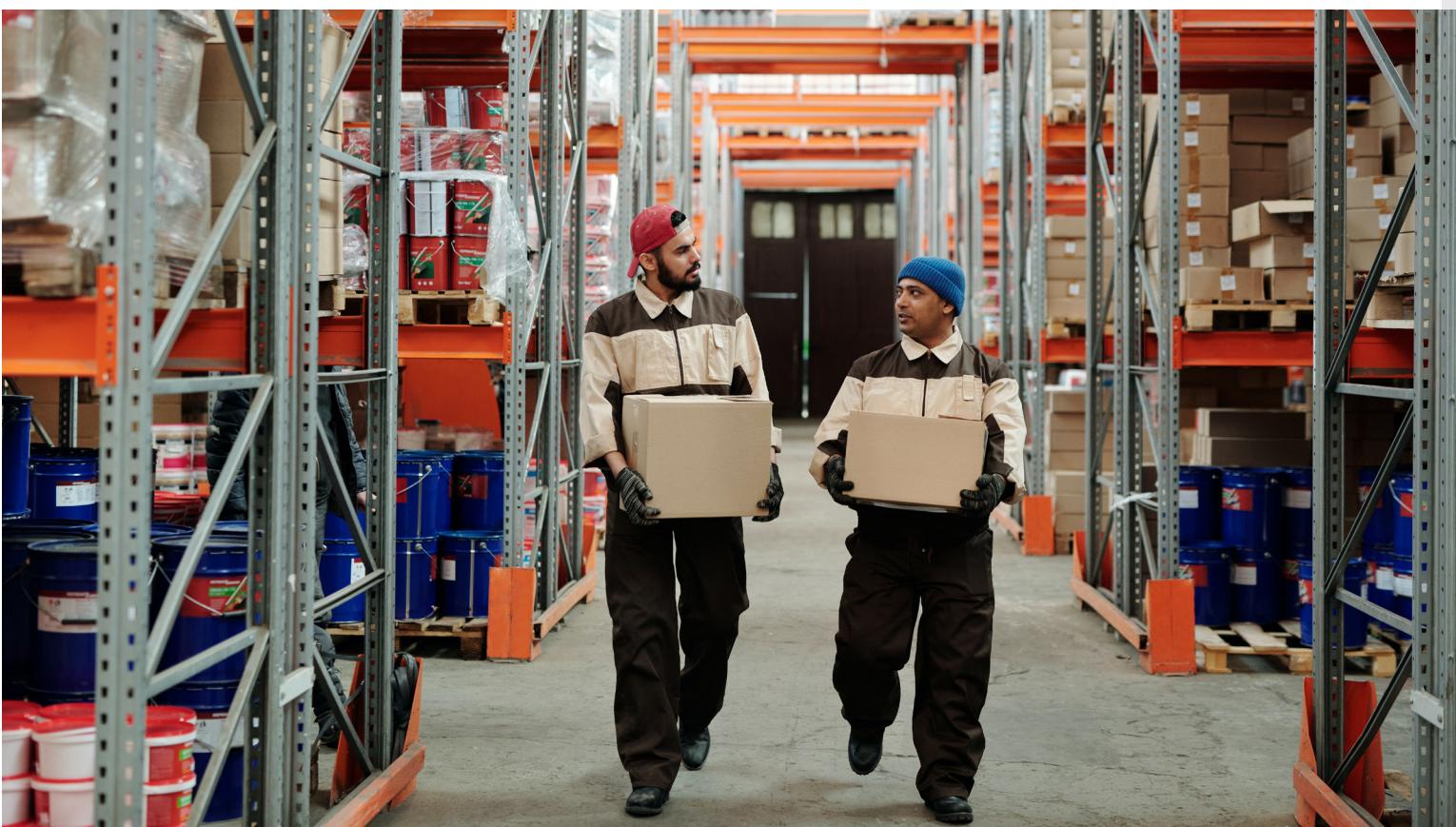
3.1 A GROWING NEED FOR CHANGE

3.2 WHY INTEL FOR SUPPLY CHAIN TRANSFORMATION

3.3 CUSTOMER SUCCESS STORIES

3.4 INTEL TECHNOLOGIES & INTEL STRATEGIC ALLIANCE SOLUTIONS

3.5 INTEL AS A DIGITAL ORCHESTRATOR OF SUPPLY CHAIN SOLUTIONS



3.1

A Growing Need for Change

The last few years have shown how sensitive the global supply chain is to disruption, whether from pandemics, political unrest or natural disasters. With recent disruptions top of mind, businesses around the globe are looking to mitigate the impacts of external events on their operations. The task is complex as they look to protect against future natural disruptions, like floods, hurricanes and pandemics, or to create the agility and elasticity required to effectively navigate the constantly changing, global geopolitical landscape. Businesses involved with all aspects of supply chains need new ways to improve efficiency and increase the flexibility and agility of their operations to better handle future disruptions. Potential efficiencies can be found at all stages of the supply chain. Examples include deploying Automated Storage & Retrieval Systems (ASRS) to

increase warehouse efficiency or leveraging Machine Vision for quality inspection in manufacturing.

When considering how to improve overall supply chain efficiency, changes are most beneficial when scaled across all operations, from upstream to downstream, but small changes in even one environment can create value across the supply chain. For example, a warehouse operator can deploy Autonomous Mobile Robots (AMRs) and ASRS systems in their warehouses to increase throughput.

These systems also help reduce human errors that can arise from simple tasks such as incorrectly copying a written form into a typed form. However, the full value of these solutions cannot be realized without a strong data management strategy. In the



warehouse, equipment and supply chain related data, such as product damage, delivery status and inventory levels, create value for the warehouse operator but remain siloed in a single data platform. Significantly more value can be created from an open data platform shared across supply chain strategic alliances.

Organizations like the GS1 Standards Group have already created a path to create more transparency and accessibility in supply chain data systems. Interoperable data formats give all participants in a supply chain massive efficiency gains. Empowered with data from upstream or downstream participants, supply chain actors, like retail stores, can more accurately forecast demand and stock inventory accordingly. This eliminates out-of-stock products that can cause lost revenue and damage reputations for retailers.

Small changes
in even one
environment
can create value
across the
supply chain



3.2

Why Intel for Supply Chain Solutions

Intel is one of the most trusted global names in technology, offering a wide range of solutions, with processing and software products spanning edge, core and cloud technologies. With its unique position as both a technology supplier and data management systems solution expert, Intel is uniquely qualified to help organizations that sit anywhere in the end-to-end supply chain. Intel solutions provide support to players from upstream manufacturing to downstream retail, as well as all of the stages in-between, including warehouses, transportation and logistics. Combining this position with a robust strategic alliances portfolio showcasing hundreds of ready-to-deploy strategic alliance solutions, Intel can help companies strengthen their supply chain operations. With Intel, companies are able to deploy new technology, orchestrate end-to-end supply chain solutions, scale to reach more customers and deployments, and integrate open-source, interoperable data management systems.

Intel's transparent supply chain and Integrated Data Platform (IDP), has led to an estimated \$208 million return on investment

Intel works from experience, having gone through its own internal supply chain transformation in 2017. Through a combination of AI-powered analytics and Intel® Xeon® processors, Intel simplified their supply chain and data pipelines, improved data quality by eliminating the reconciliation of data sets and enabled real-time analytics to sense and respond to emerging supply chain challenges (Intel's Supply Chain Transformation Link). This shift allowed Intel to develop a "glass pipeline" around its core supply chain data, creating value for stakeholders in the form of improved decision-making capabilities and business agility. Since its deployment, this new data platform, named the Intel Integrated Data Platform (IDP), has led to an estimated \$208 million return on investment¹.

¹ <https://www.intel.com/content/dam/www/public/us/en/documents/white-papers/transforming-supply-chain-with-real-time-analytics-whitepaper.pdf>

WHY INTEL FOR SUPPLY CHAIN SOLUTIONS?

Intel is unique in its ability to orchestrate solutions of varying scope and focus & deploy these solutions around the globe

DIGITAL ORCHESTRATOR FOR SUPPLY CHAIN SOLUTIONS



Intel helps identify **best-in-class solutions and partners**



Intel can act as a **liaison between technology suppliers & customers**

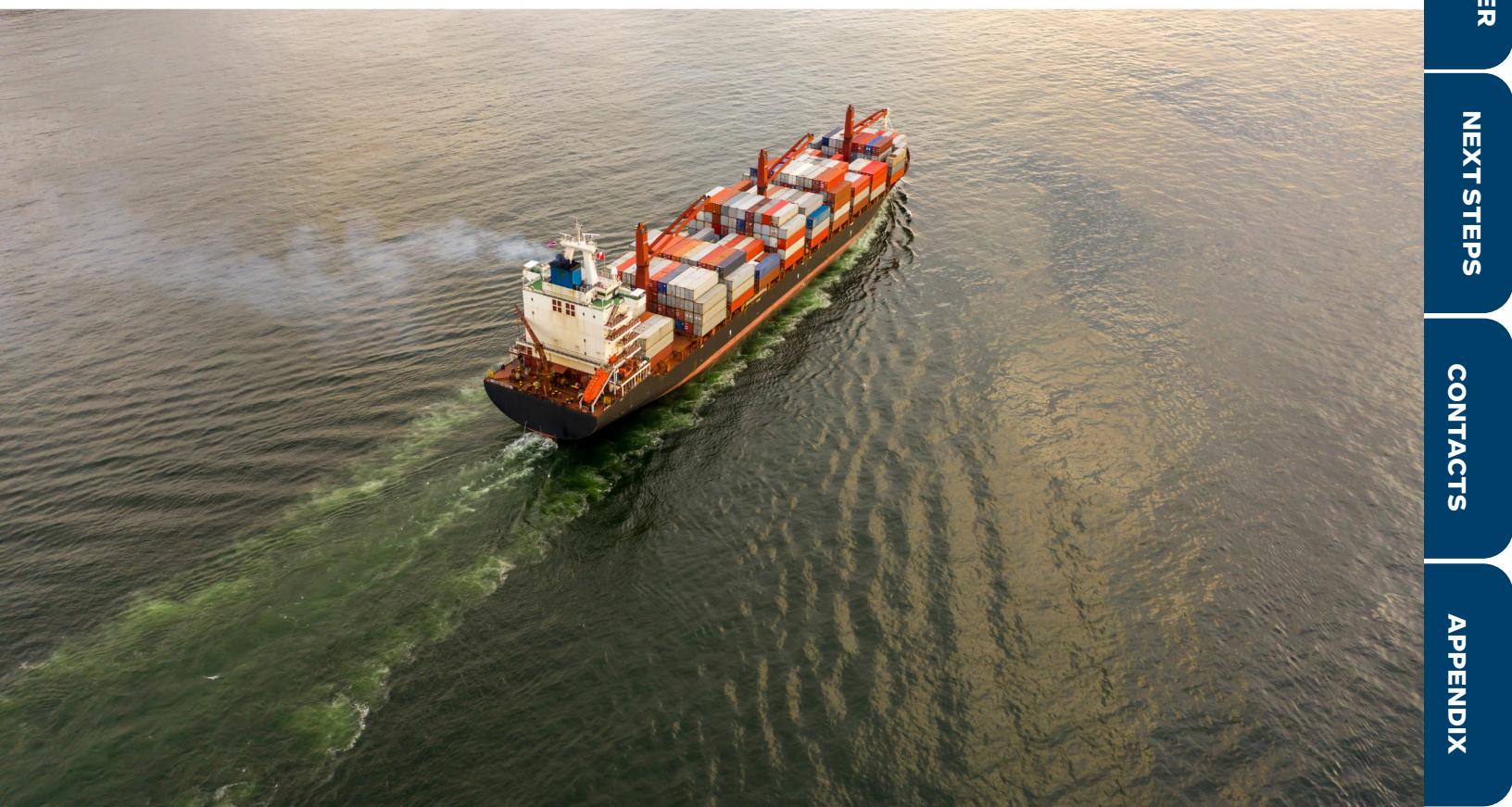
GLOBAL LEADER IN SUPPLY CHAIN



Intel has a robust, global partner network that has **deployed solutions around the world**



Intel offers **end-to-end, vertical-specific & process-specific supply chain solutions** to meet your needs



3.3

Customer Success Stories

INTEL-POWERED SOLUTIONS

Manufacturing:

Automated Factory

- Customer: Audi
- Key Results:
30-50% reduction in factory labor costs
- [Link to case study](#)

Greener Manufacturing

- Customer: Weifang Special Steel Group
- Key Results:
50% reduction in IT operational & maintenance costs
50% reduction in data center carbon footprint
- [Link to case study](#)

Retail:

AI for Shopper Insights

- Customer: Town Talk Foods
- Key Results:
Actionable data and insights from shopper demographic, inventory, journey maps and footfall projections to optimize operations, marketing and merchandising
- [Link to case study](#)

Smarter POS System

- Customer: Ace Hardware
- Key Results:
71% reduction in tech visits
47% reduction in time to resolution
- [Link to case study](#)

AI for Product Management

- Customer: Harris Farm Markets
- Key Results:
~10x resource capacity improvement
- [Link to case study](#)



Transportation & Logistics:

AI Vision for Delivery Logistics

- Customer: Viso.ai
- Key Results:
Decreased costs by providing accident avoidance, people safeguard functionality, automated workflows & theft detection
- [Link to case study](#)

Big Data & AI for Delivery Logistics

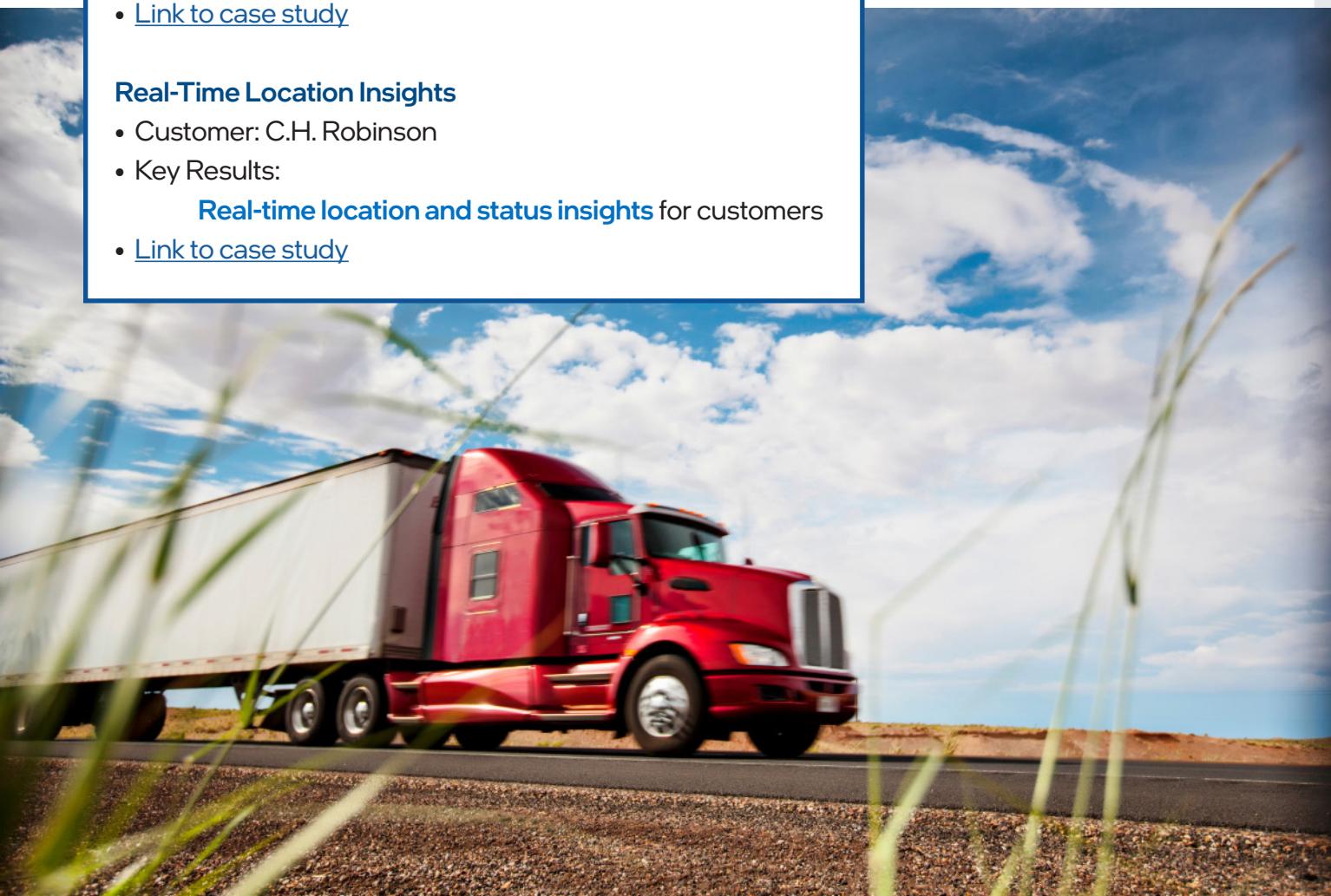
- Customer: Yunda Express
- Key Results:
Improved efficiency of delivery logistics system
- [Link to case study](#)

Blockchain for Traceability of Pharmaceuticals

- Customer: Nippon Express
- Key Results:
Time and cost savings from decreased reliance on manual checks
- [Link to case study](#)

Real-Time Location Insights

- Customer: C.H. Robinson
- Key Results:
Real-time location and status insights for customers
- [Link to case study](#)



3.4

Intel & Intel Strategic Alliance Solutions

Manufacturing:

- Quality Inspection
- Defect Detection
- Worker Safety
- Packaging & Load Inspection
- Inventory & Production Management
- Vision-Guided Robots
- Improved Quality Control
- Predictive Maintenance
- Increased Worker Safety
- Time-Deterministic Compute
- Workload Convergence
- Application & Platform Management
- Infrastructure Management
- Controls Application
- Industrial Connectivity

Warehouses:

- Order Accuracy
- Facility Security
- Theft Detection
- Employee Tracking
- Vision-Guided Robots
- Improved Product Visibility
- Improved Operational Efficiency
- Increased Worker Safety
- Automated Picking
- Time-Deterministic Compute
- Workload Convergence
- Application & Platform Management
- Infrastructure Management
- Controls Application
- Industrial Connectivity

Transportation & Logistics:

- Driver Analytics
- Point of Entry Security
- Driver Safety
- Predictive Maintenance
- Tracking & ETAs
- Cold Chain

Retail:

- Improved Employee Productivity
- In-Store Inventory Management
- Facial Recognition
- Anonymous Tracking
- Theft Detection
- Facility Security
- Package Inspection
- Visual Inspection Platform
- Improved Inventory Management
- Customer Behavior Analysis
- Cold Chain
- Digital Signage
- Automated Picking
- POS Systems
- Retail AMRs

3.5

Intel as a Digital Orchestrator of Supply Chain Solutions

Intel's robust portfolio of market-ready solutions, RFP-ready kits and strategic alliance solutions, allow them to act as a Digital Orchestrator of supply chain transformations, working in partnership with organizations to help identify best-in-class solutions and suppliers to accelerate their business. Intel works with hand-vetted suppliers to deliver streamlined end-user experiences, helping ensure that all new technology integrates well with existing systems while also aiming at creating value-add efficiency gains and increased data access and visibility. Through an integrated strategy of leading technology development and ecosystem programs, Intel drives a culture of innovation and community of transformative solutions. The technology opportunities Intel offers will help transform supply chains to their required future state of interoperability and end-to-end visibility.

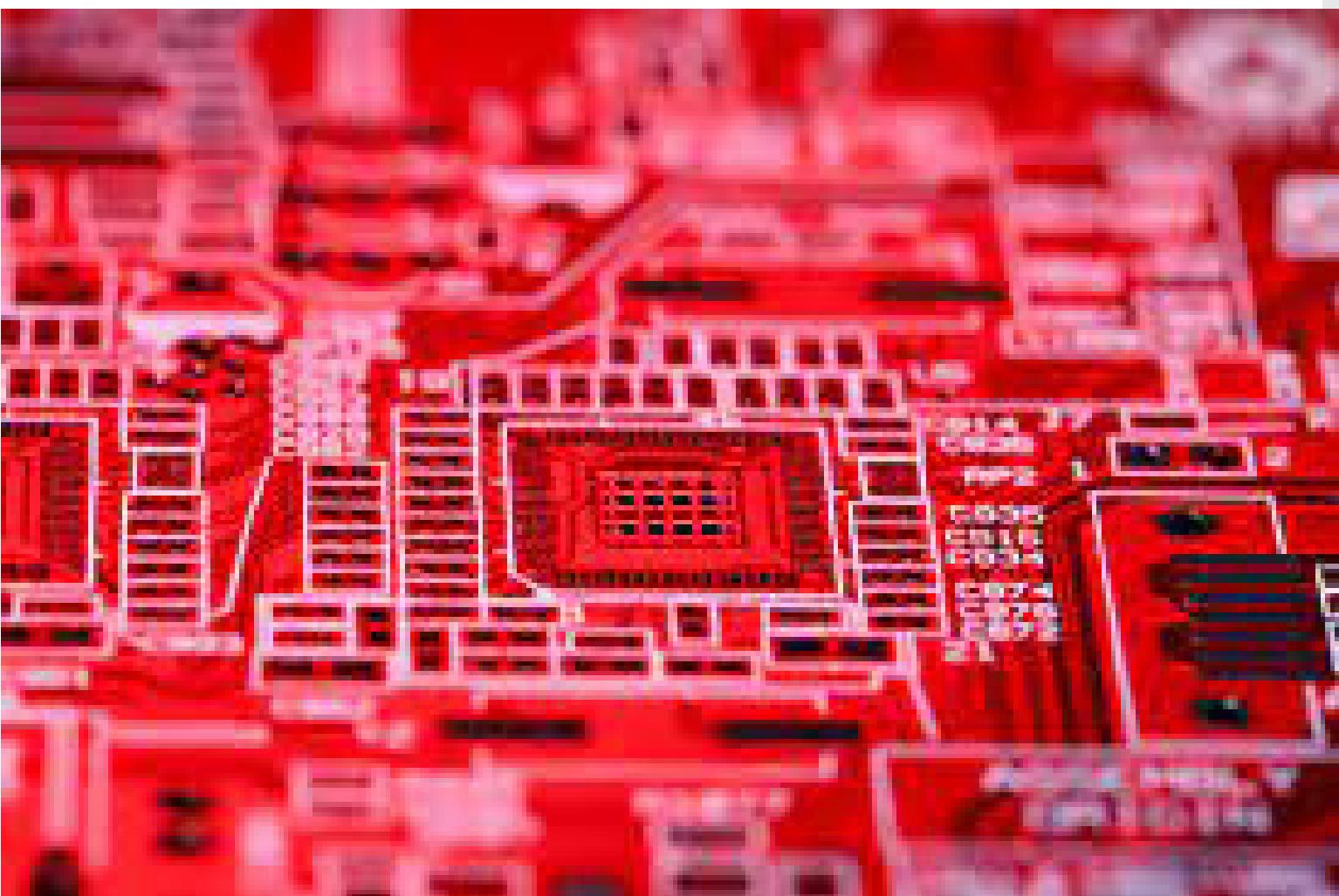


Section 4

The Silver Lining: Technology Opportunities Within Supply Chains

4.1 THE FUTURE STATE OF SUPPLY CHAIN

4.2 REACHING THE FUTURE STATE OF SUPPLY CHAIN



3.1

The Future State of Supply Chain

Fundamentally, supply chains are a succession of discrete processes that integrate data and information from marketing, product development, manufacturing, distribution and delivery to customers. Each stage of supply chains -- planning, sourcing, making, delivering and returning

- are complex, highly interrelated and dependent on diverse interactions.

Historically, there has been significant knowledge and collaboration gaps between those who are responsible for the financial performance of the organization and those responsible for operations and supply chains. These gaps are caused by incompatible performance measures, poor data sharing between functions and rigid and brittle IT systems.

For all of their sophistication, most of today's supply chain systems are really a patchwork of processes, data and interactions.

The "technical" cultures that develop the systems to support each stage of a supply chain are relatively "siloed" and autonomous. They add up to a huge collection of information-islands--whether

on IT servers, cloud service provider servers, in an embedded control system's servers, or anywhere else. Assuming the islands remain in existence reliably, they are still fundamentally incapable of truly interoperating with other information-islands.

Most of today's supply chain systems are really a patchwork of processes, data and interactions. A unified intelligent "system of systems" approach will enable increased visibility, collaboration and effective decision making.

The inability of today's evolving enterprise systems to interoperate and perform well with distributed supply chain processes and workflows is a significant obstacle. The discrete stages within a supply chain may not be very "smart" in themselves, but if they are networked in a way that allows them to collaborate and share data effortlessly and interoperate seamlessly, they begin to give rise to complex, system-wide behavior. This allows an entirely new order of intelligence to emerge from the system as a whole—an intelligence that could not have been predicted by looking at any discrete supply chain stage individually.

What's required is to shift the focus from upgrading the aging siloed systems that support each individual stage to a new supply chain model based on an open and interoperable data platform and ecosystem.

This unified intelligent “system of systems” approach will enable increased visibility, collaboration and effective decision making.

So how should manufacturers be thinking about the future state of supply chains? What’s really required to drive open data sharing and supply chain model innovation?

The answer involves three interrelated elements:

1.

A vision for how organizations can create data ecosystems, inclusive of external organizations, that leverage real-time data sharing for interoperability and collaboration

2.

A data architecture and platform that organizes and provides a unified, open and shared set of tools for data aggregation, management and analytics across the supply chain data ecosystem

3.

Relationship enablers and economic incentives for data ecosystem participants that enable improved supply chain visibility, new value creation and services opportunities



In the conservative culture of most manufacturing-based businesses, competitive advantage is usually perceived to lie in ownership, secrecy, control, and sometimes adversarial relationships with suppliers and partners. It goes without saying that such a culture does not blend well with the notions of openness, transparency and trust.

The technical roadmap required for a truly open data ecosystem encompasses substantial challenges, from fragmented data governance, security and integration strategies to varying skill levels and available IT resources. There are cultural challenges in bringing the various players in a supply chain data ecosystem together. An incentive structure will be critical to ensure the success of future supply chains.

While the objectives, business case and key performance indicators vary relative to different stakeholders across the supply chain, the pursuit to establish an open data ecosystem ultimately points to the same goal: to create and optimize **end-to-end supply chain visibility**. Open and fluid data ecosystems that combine and integrate diverse data and data sources will soon become the very air that business breathes.

3.2

Reaching the Future State of Supply Chain

It goes without saying, future supply chains will increasingly be driven by the interrelatedness of data, collaboration and automation. These three core elements build on one another. Consequently, a digital supply chain strategy needs to consider all of them to leverage the full benefits of digitization.

TECHNOLOGY NEEDS



Data

Organizations will benefit from upgrading and revitalizing their existing software, IT systems and digital infrastructure (e.g. networks, cloud resources and security) that support critical supply chain systems including integrated planning and execution, as well as end-to-end supply chain visibility.

With so many data sources across a supply chain, from vendors to vehicles, it is becoming increasingly important to find tools capable of managing the diverse interactions within supply chains. The complexity and diversity of supply chain data, along with the challenges associated with using multiple tools to manage diverse data sources, data types, governance and more, is leading to a growing demand for **data management platforms**. These platforms will increase the ease of managing the many variables involved with supply chains.

Data sharing is quickly becoming a critical enabler for supply chains. For a retailer to share data with a transportation and logistics provider, or a warehouse to share data with a production facility, there needs to be **data standards** that underly information exchange. These disparate parties must align on governance and security standards to ensure the safety of supply chain data, while being confident in the benefit of sharing data with their ecosystem partners.

To provide access to data and enable collaboration, organizations will need to establish a data management architecture that addresses data transformation, management and modeling tools, including innovations to support data brokering and data exchange. These systems are setting the stage for provisioning diverse data sources as well as data repositories and exchanges. Collectively these tools are sometimes referred to as a **common data plane** providing a real and tangible means for everyone to think about how supply chain data ecosystems in the real-world might work.

Once data standards are set and a common data plane has been created, there will be a greater opportunity for **supply chain visibility software** to sort, organize and visualize key supply chain data. This software exists today, but its capabilities are only as strong as the data feeding into it. By collecting data from across the supply chain, this visibility software will become more valuable and insightful for its users.

Automation and AI

Organizations will benefit from upgrading and revitalizing their existing “physical” systems, including manufacturing automation, smart warehousing, efficient spare parts management, autonomous logistics and more.

Continuing investments in automation will drive many new values for industry participants. **Automated material handling equipment** such as Automated Guided Vehicles (AGVs) and Autonomous Mobile Robots (AMRs) have become more affordable with many new capabilities. These new innovations have become considerably more “horizontal” and can

enable new automated capabilities across applications in manufacturing, warehousing, transportation and retail environments. Their adoption will help companies leverage their skills and investments on a larger scale.

Supply chain system developers have begun to see the benefits of **autonomous goods and materials transport** from diverse pilot projects utilizing self-driving commercial trucks. Commercial trucks, much like material handling equipment, are used in many supply chain applications to automate the movement of raw materials as well as finished goods. By adopting autonomous self-driving commercial trucks, supply chain operators will eliminate the looming threat caused by a growing scarcity of vehicle drivers. It will also increase safety levels by eliminating human errors and optimizing fleet utilization.

Another way that organizations are making their supply chains more efficient is by deploying **AI-powered machine vision for inbound and outbound quality inspection**. Companies like Intel first deployed machine vision for manufacturing use cases like quality inspection and defect detection. Intel has since expanded its use into supply chain, allowing them to identify returned products via camera systems and ensure that returns are accurate.

Beyond the physical equipment systems that are becoming more automated, there is significant demand for advanced automated capabilities such as **AI-driven applications**, including machine vision and predictive analytics for use cases focused on modeling and forecasting demand, optimizing vehicle routing, managing inventories, and defect and theft detection. AI technologies will play a critical role in enabling diverse applications and use cases across global supply chain operations.

New robotic automation, autonomous vehicle systems and AI-enabled sensor-based systems can help organizations take the next step into the future by bolstering their transportation and logistics processes and by expanding their last-mile delivery options.

Machine Vision:
A combinatory technology leveraging AI, smart cameras and a vision platform that enables various machines to 'see', allowing them to perform autonomous and/or complex operations from autonomous driving to cargo load optimization.

New robotic automation, autonomous vehicle systems and AI-enabled sensor-based systems can help organizations take the next step into the future by bolstering their transportation and logistics processes and by expanding their last-mile delivery options.

Collaboration

As the complexity of supply chains increases, the number and diversity of stakeholders expands and the volume and nature of their interactions grows. The systems or “technology architecture” will become more and more tightly coupled to the relationship or “ecosystem architecture.” Therefore, the required technologies to inform new collaborative data and information-sharing services must be aligned and these two “architectures” must be viewed in close proximity. The two thrusts need to be mutually supportive without inhibiting one or the other. Success in either increasingly goes to the company that effectively utilizes the combined potential of both.

Orchestrating Future Supply Chains

Even though no one can predict precisely when new supply chain innovations will mature, the process by which they will be delivered is now clear. Leveraging data and software innovations is creating the potential for visionary players like Intel to step into the important role of “data orchestrator”—that is, to become the facilitators of the orchestration process. Data orchestrators who facilitate and leverage digital platforms and shared data will enable new alliances based upon co-creation, and these partnerships will become increasingly important. Standards bodies, or groups of organizations that attempt to establish industry guidelines, rules and regulations have begun paving a path towards a digital supply chain. Organizations like GS1 have [already released detailed reports](#) on how organizations can and will collaborate in the future.



Section 5

Next Steps

5.1 CONCLUSION

5.2 WHERE SHOULD YOU START?

5.3 WHY INTEL AND ITS ECOSYSTEM?

5.4 CONTACT & RESOURCES



5.1

Conclusion

Although it has been over two years since the start of the COVID-19 pandemic, supply chains across many industries are still suffering from long lead times for raw materials and finished products, increased logistics costs and growing levels of complexity. The pandemic was a strong – if unfortunate – example of a major supply chain disruption.

As the short-term impacts of the pandemic, such as production stoppages due to disease outbreaks, slowly fade, the importance of having a resilient and agile supply chain will not. With major supply chain disruptions that last a month or longer occurring every 3.7 years¹, it is only a matter of time until the next natural or man-made disaster shatters the complacency of impacted industries.

¹ <https://www.mckinsey.com/business-functions/operations/our-insights/risk-resilience-and-rebalancing-in-global-value-chains>



5.2

Where Should You Start?

With so many avenues for potential supply chain or logistics investments and an ocean of solution providers to choose from, picking which changes to implement can be a difficult process.

The below recommendations reflect a safe and high-level approach to supply chain transformation:

1. Take Inventory of Your Pain Points & Define Your Desired Future State

- a. Determine the current status of your organization. Ask yourself, "What is and what isn't working? What are your most impactful KPIs?" Discuss where you want you to be in the future and define key performance indicators that will help you quantify success.

2. Focus on Solutions that Create Horizontal Value

- a. With so many individual stages across a supply chain – from upstream manufacturing to downstream retail sales, picking horizontal solutions that can scale across all of these environments, transactions and interactions is a fast way to gain efficiency in multiple areas of your supply chain.
- b. Horizontal Solutions: Automated Material Handling | AI Machine Vision | Edge Computing | Controls-Based Solutions

3. Start Building a Culture of Transparency

- a. Transitioning your supply chain into a more resilient and agile state, will require the integration of both upstream and downstream supply chain data into a single system. Getting to a state where key data is shared in real-time across the value chain will not be an overnight process for any party but can be accomplished through a combination of data sharing and data soliciting.

4. Build End-to-End Visibility

- a. Build end-to-end visibility of supply chain operations and goods-in-transit by integrating upstream and downstream data. After establishing a collaborative culture of data sharing, work with your partners to create the data infrastructure required to manage disparate types of supply chain data.

5.3

Why Intel and its Ecosystem?

Considering the many processes, interactions and environments in which supply chain activities take place, in most cases working with one provider will not solve an organization's supply chain pain points. Picking point solutions may be a quick way to create value, but creating a piecemeal supply chain strategy is risky. It can lead to an increasingly complex web of data and monitoring platforms and supply chain systems.

To increase supply chain resiliency, operators should seek end-to-end solutions that create horizontal value and liberate supply chain data for the value chain. With needs ranging from automated material handling solutions to digital tools that assist in the management of various supply chain processes, operators should seek partners that can solve their problems across every step of a supply chain journey.

The future of supply chains is highly dependent on the ability to collect, organize and distribute data in a unified, standardized manner. This all starts at the edge, whether monitoring inventory levels, predicting consumer demand, or forecasting the availability and pricing of raw materials for manufacturing. Intel's state-of-the-art solutions and strategic alliance ecosystem provides that level of edge intelligence across each stage of the supply chain.

However, end-to-end supply chain visibility is not just an edge story – it requires a corresponding set of full stack solutions and services. Intel's network and cloud strategic alliance solutions permeate the value of edge intelligence throughout every layer of the supply chain technology landscape. Intel helps to unify the diverse ecosystem of digital assets, systems and stakeholders.

Intel acts as the **digital orchestrator** of supply chain transformations, arming stakeholders with the most amazing possible strategic alliances and solutions to drive new value and ensure operational excellence. Intel's strategic alliance programs are structured to directly address the core needs of any given organization and coordinate a custom optimal combination of partners and solutions. Whether an organization needs an automated storage system in their warehouses or the installation of quality inspection cameras across various stages of the supply chain, Intel can help.

The future of supply chains is highly dependent on the ability to collect, organize and distribute data in a unified, standardized manner.

Intel is armed with the solutions and strategic alliances necessary to not only enhance current operational needs, but to catalyze change in the pursuit of redefining the future of supply chain operations.

5.4

Get In Touch

The following industry experts are available to help you identify Intel technology solution strategic alliances for your specific situation and needs.

Global Transportation:

Syamak Nazary - Syamak.Nazary@Intel.com

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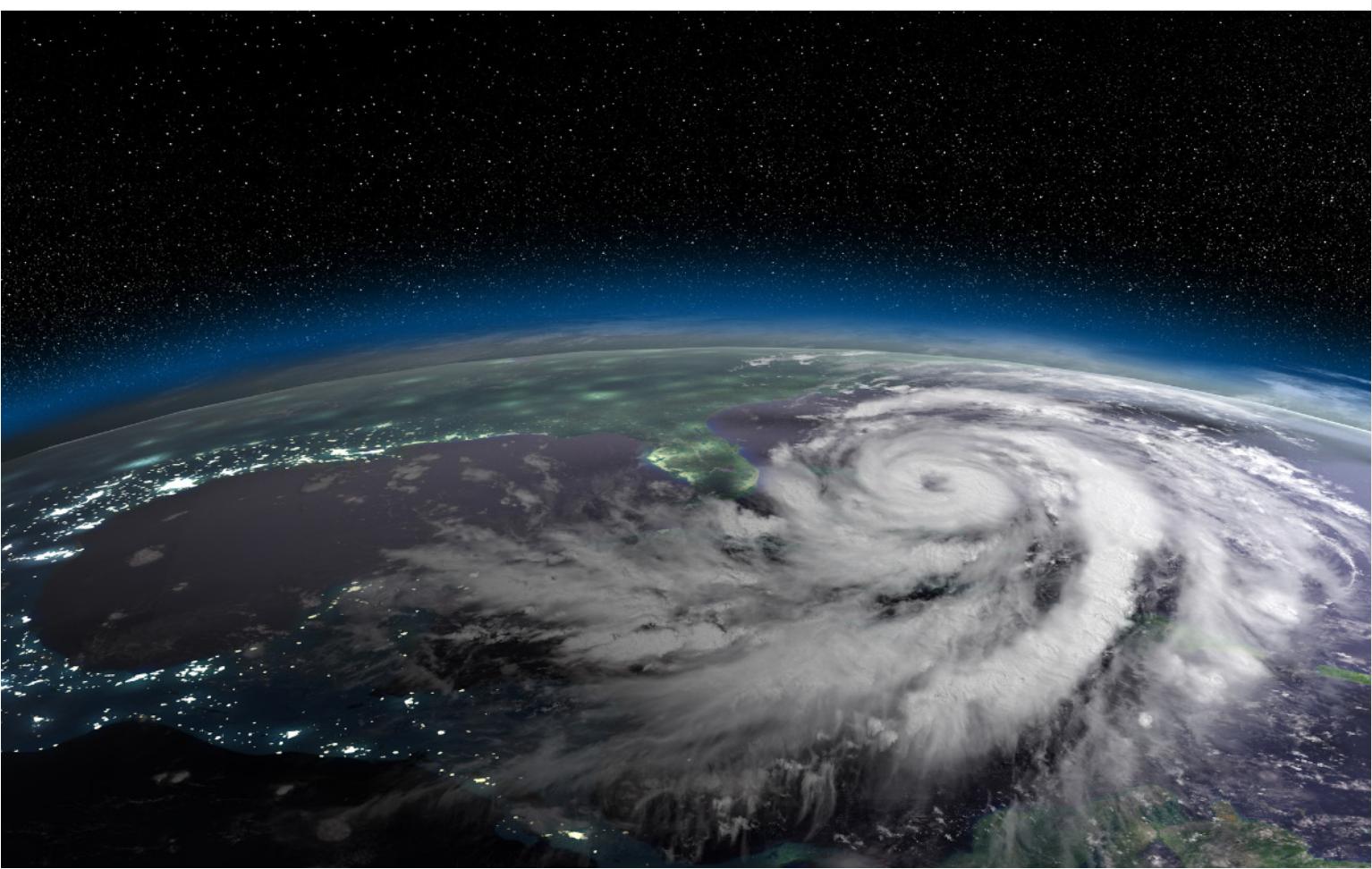
Unsure where or how to start? Please reach out and we will be happy to help!

Section 6

Appendix

6.1 REAL-WORLD EXAMPLES OF SUPPLY CHAIN DISRUPTIONS

(Man-Made & Natural Disruptions)



Man-Made Supply Chain Disruptions

The US-China Trade War (2018 - 2019)

During former American president Donald Trump's 2016 election campaign, he repeatedly criticized American trade policies with China, blaming China for the loss of American manufacturing jobs and theft of intellectual property. Once elected, Trump imposed tariffs on roughly \$550 billion worth of Chinese goods, with China responding by imposing more than \$185 billion in tariffs on American goods¹.

These tariffs had significant implications for both countries' economies and dramatically impacted companies operating in the technology, automotive and consumer industries. Participants in these industries were forced to explore new suppliers and consider relocating manufacturing facilities, with many companies being forced to shift these additional costs onto consumers. In 2021, some time after the trade dispute began in 2018, a U.N. report stated that these unilateral tariffs had undone three to five year's worth of growth among global value chains in affected countries².

Garment Factory Strike (Cambodia, 2014)

The garment sector makes up more than 80% of Cambodian exports, with the sector employing 600,000 workers across the country, many of whom are members of various labor unions. In 2014, workers demanded a wage increase from a monthly rate of \$80 a month to \$160 a month. When this request was rejected in favor of a raise to \$95 a month, a coalition of labor unions organized a strike on garment factories across the country³.



image courtesy Wikipedia

The fallout of the month-long strike cost the lives of four union protesters and a one-month production delay for those garment factories. It also cast a spotlight onto the supply chains of the garment industry. Major companies like Puma, Adidas and H&M were critiqued by customers for their role in the conflict, opening the floodgates for years of scrutiny on the unethical practices of the garment industry, with companies ultimately changing suppliers and consumers shifting brand alliances as a result.

1 <https://www.brookings.edu/blog/order-from-chaos/2020/08/07/more-pain-than-gain-how-the-us-china-trade-war-hurt-america/>

2 <https://www.bloomberg.com/news/articles/2021-06-17/trade-war-costs-global-value-chains-3-5-years-of-growth-un-says>

3 <https://www.aljazeera.com/features/2014/1/8/cambodia-garment-worker-strike-unravels>

Natural Supply Chain Disruptions

Tohoku Earthquake & Tsunami (Honshu, Japan - 2011)

In March of 2011, a magnitude 9.1 earthquake was measured off the coast of Honshu, Japan – the third-strongest earthquake measured since 1900. The powerful earthquake generated a tsunami that reached the coast of Honshu in less than 30 minutes, submerging seawalls and disabling three nuclear reactors¹.

The damage to the city was catastrophic, including over 123,000 destroyed homes². Damaged infrastructure, including ports, created massive issues for some of Japan's biggest OEMs, as they were unable to ship or receive parts. This blockage led Toyota, General Motors and Nissan to temporarily suspend operations in both the U.S. and Japan, with other businesses reliant on Japan's just-in-time manufacturing left reeling. All in all, the 2011 Tohoku Earthquake is now the most expensive natural disaster in history, costing Japan \$220 billion and the U.S. roughly \$131 million³.

Hurricane Maria (Puerto Rico - 2017)

Caribbean islands are no strangers to the power of hurricanes, but when Hurricane Maria hit Puerto Rico in September of 2017, it disrupted the island's two biggest industries: pharmaceuticals and medical devices⁴.

Puerto Rico, who manufactures a significant percentage of sterile saline bags used in the United States, suddenly had to shut down its manufacturing facilities. Unable to open due to damaged infrastructure across the island, the U.S. was left without a major source of key medical supplies, eventually being forced to ration saline for patients across the U.S.⁵

Hurricane Sandy (New York, USA - 2012)

In October of 2012, Hurricane Sandy touched the beaches of New York, bringing with it 80+ mile per hour winds and a significant storm surge. The New York coastline had done some preparation for the storm, including raising critical tables and tanks high above sea level, which mostly proved futile. The storm crippled the state's fuel supply chain — foreign oil tankers were blocked by debris, refineries, warehouses and stores closed due to flooding, and pipelines were halted due to power cuts⁶.



Image by Brian Birkes

1,2,3 <https://www.ncei.noaa.gov/news/day-2011-japan-earthquake-and-tsunami>

4 <https://www.scientificamerican.com/article/hurricane-maria-takes-a-toll-on-global-medical-supplies/>

5 <https://www.scientificamerican.com/article/hurricane-maria-takes-a-toll-on-global-medical-supplies/>

6 https://www.nytimes.com/2012/11/05/business/a-storm-battered-supply-chain-threatens-the-holiday-shopping-season.html?ref=business&_r=0

ABOUT HARBOR RESEARCH

Harbor Research

Harbor Research has over thirty years of experience working with clients on growth strategy and new business creation. At the core of Harbor's approach is a deep understanding of the core technologies, markets and business characteristics, as well as the management and organizational challenges that companies face when adopting and developing digital and smart systems technologies. We strive to generate deep insight into how emergent technologies drive value creation and competitive advantage in our clients' businesses and the economy as a whole.

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