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LEADING THE FUTURE OF GOODS MOVEMENT

Drivers of Change, Transformations, and Opportunities

OCE
Where Next Happens

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INTRODUCTION

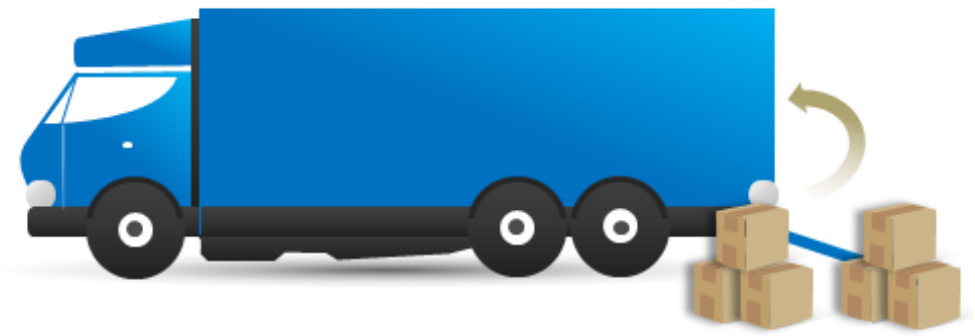
The ways in which goods move today are changing rapidly and radically due to a number of different trends. Technological advances and market dynamics experienced in the last decade have started to revamp every stage of a product's delivery journey. The rise of the Internet of Things and artificial intelligence technologies have brought major opportunities to both the operational and economic aspects of the logistics, freight, and warehousing industries. The rise of e-commerce and the pressing consumer demands for fast and convenient shipping have imposed serious expectations on the goods movement logistics, especially the last-mile delivery services. The current and further anticipated shortage of labour in trucking and warehousing has pushed players in these industries to look for solutions. As a result, all industries that take part in goods movement have been experiencing substantial transformations and are anticipated to further revolutionize the sector.

In this report, we delineate the various trends driving change in how goods move. We also focus on discussing the major transformations and innovative opportunities that we are seeing in all industries related to goods movement including logistics, freight, trucking, warehousing, and last-mile delivery. These transformations include new delivery concepts that have great potential for boosting operational capacity and solving the workforce shortage challenges. They also incorporate tracking and connectivity technologies that bring transparency and

visibility with ease to the entire journey of goods movement, as well as advances in data analytics that efficiently facilitate data-driven decision-making. Trending transformations also include new operational concepts such as asset sharing that has started to change the dynamics of fleet and warehouse ownership. We conclude the report by discussing some insights for leading the future of goods movement.

We anticipate that the discussed transformations and their corresponding opportunities will be experienced in incremental waves over the coming years. Logistics providers, carriers, and retailers have already started to adapt and converge into integrated and intelligent supply chains that are capable of quickly and transparently delivering more goods to everyone everywhere at anytime.

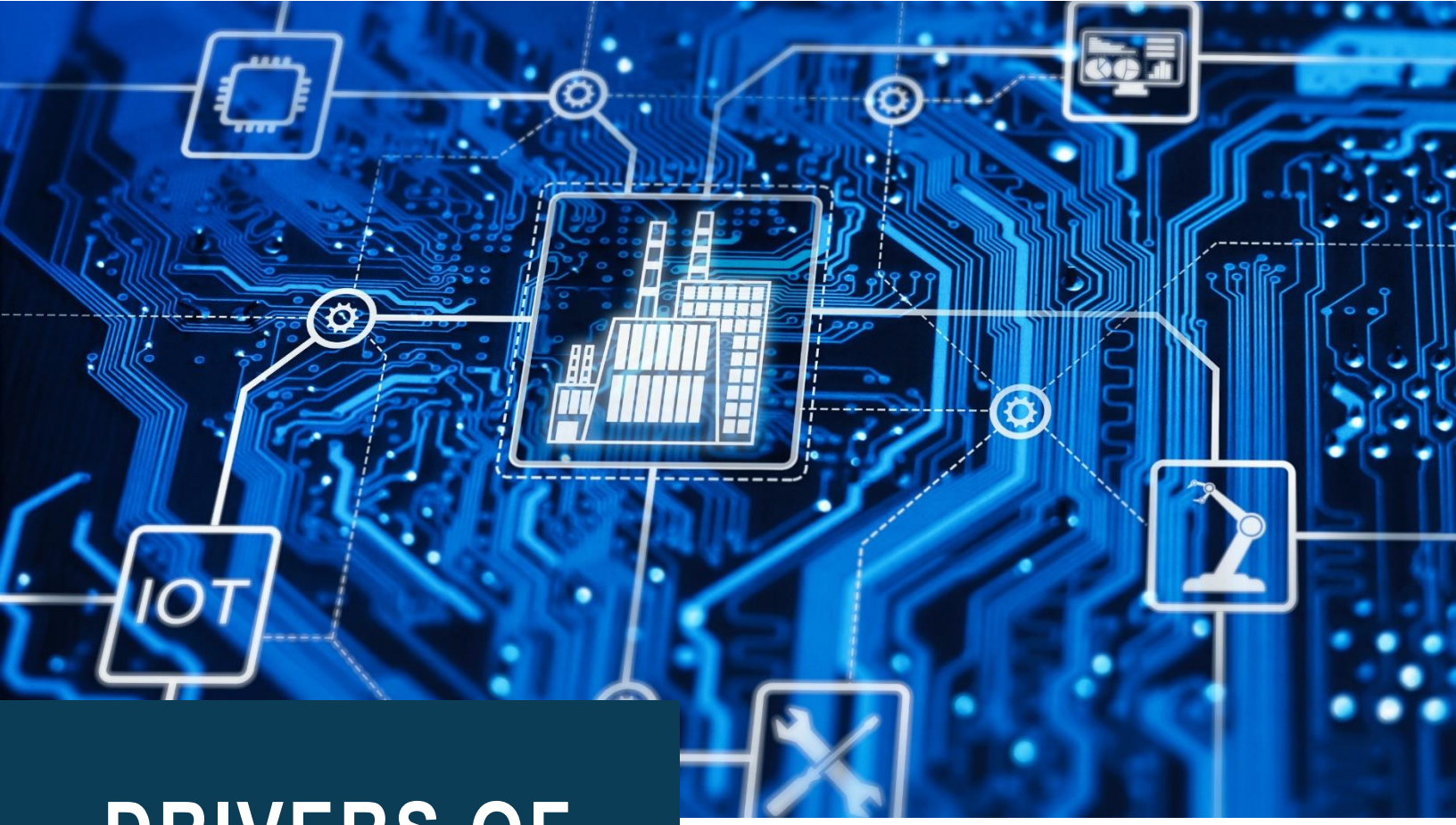
The Goods Movement Journey



First-mile Delivery
refers to the first phase of the delivery journey where goods are moved from production facilities to warehouses.

Middle-mile Delivery
refers to the middle phase of the delivery journey where goods are moved from warehouses to distribution stores.

Last-mile Delivery
refers to the last phase of the delivery journey where goods are delivered to their final shipping address.



DRIVERS OF CHANGE

The movement of goods industry continues to evolve in response to trends in technologies and market demands. In the last decade, the industry has experienced disruption from various trends that have driven it to go through changes in every stage of the goods movement journey. In this section, we shed light on these drivers of change, spanning across disruptive technological advances and market dynamics.

Technological Advances

Goods movement has always been linked to digitization and information technologies. Identification, communication, and computing technologies have found their way into the entire journey of consumer products. Barcode identification has been in use for decades and basic connectivity has been at the core of freight operations for many years. But today, advances in these enabling technologies are all coming together with a transformational power.

The emergence of the **Internet of Things** (IoT) has disrupted all industries. It has brought unprecedented

opportunities to the freight, logistics, and warehousing industries, in particular, due to the ability to connect to and track every single object using radio-frequency identification (RFID) and low-energy wireless communication technologies. This brings capabilities for real-time object tracking, improved environment sensing, and enhanced fleet management, to name a few[1]. These opportunities have been amplified over time as IoT enabling products become less expensive and more widely available, allowing for large-scale deployments. As an example, the Danish shipping giant, Maersk, uses IoT technologies to track, monitor, and control 380,000 refrigerated containers as they move around the planet[2]. In 2018, DHL announced the launch of DHL SmarTrucking aiming to build a fleet of 10,000 IoT-enabled trucks in India by 2028 to deliver products more safely, securely, and transparently[3].

Artificial Intelligence (AI) technologies continue to radically transform all industries. AI is commonly used so machines can perform tasks that humans perform. Through AI algorithms, machines can process large amounts of data to learn how to mimic human behavior, make informed predictions, and optimize performance. In freight and logistics, AI offers significant opportunities towards operational efficiency through bringing these automation, prediction, and optimization capabilities to the various stages of supply chain.

Blockchain is another emerging technology that is anticipated to enable more efficiency and security in the logistics of goods movement. For instance, blockchain enables the use of smart contracts that can be used to digitize and enable secure information exchange between the entire partners of a supply chain. Using blockchain, companies can create a decentralized repository of all transactions, making it possible to securely track assets from production to delivery[4].

[1] **Internet of Business. Delivering the goods: 8 examples of IoT transforming supply chain. Retrieved from** https://internetofbusiness.com/8-real-life-examples-iot-supply-chain/
[2] **Microsoft. (2019). Maersk safely transports goods around the globe with Microsoft Azure and IoT. Retrieved from** https://customers.microsoft.com/en-us/story/757564-maersk-transportation-azure-iot
[3] **DHL International. (2018). DHL launches innovative road transportation across India. Retrieved from** https://www.dhl.com/global-en/home/press/press-archive/2018/dhl-launches-innovative-road-transportation-across-india.html
[4] **Deloitte. (2017). Using blockchain to drive supply chain transparency. Retrieved from** https://www2.deloitte.com/us/en/pages/operations/articles/blockchain-supply-chain-innovation.html

The introduction of **hyperloop** technologies and the advances in **3-D printing** are other prominent examples of disruptive trends that continue to play a role in reshaping the movement of goods.

Market Dynamics

In addition to the technological advances discussed above, drivers of change in the movement of goods come as well from changes being experienced in market capacity and consumer demands.

According to a research study by Deloitte[5], Canadian e-commerce sales reached nearly $43 billion in 2018, and they are expected to reach $55.4 billion by 2023. **As e-commerce grows, consumers' preferences and expectations for delivery also rise**. Consumers have started to expect two-day, free shipping as the norm. Demands for same-day delivery are also on the rise. Consumers also want to have complete transparency on the movement of their shipments. The ability to track the status, location, and delivery time of their goods is under increasing demand. These demands have imposed pressure on retailers and logistics companies to meet these customer expectations. These companies have been forced to adopt fast, trackable, and efficient means of delivery from production facilities all the way to consumers' homes.

Another force of change is the shortage of workers in the freight, trucking, and warehousing industries. The American Trucking Associations (ATA) estimated a truck driver shortage in 2018 to be roughly 60,800 drivers[6], with predictions that this shortage will increase to 160,000 by 2028. One of the reasons is that when truck drivers retire, carriers and fleet owners find it very challenging to replace them as this career has become less appealing to younger generations. This workforce capacity crunch is not only being experienced in freight and trucking; it has been reflected in warehousing worker capacity as well. With the shift in consumer

[5] **Deloitte. (2019). The last-mile challenge in Canada. Retrieved from** https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/consumer-industrial-products/ca-final-mile-challengesIn-canada-report-2-aoda-en.pdf

[6] **American Trucking Associations. (2019). Truck driver shortage analysis 2019. Retrieved from** https://www.trucking.org/sites/default/files/2020-01/ATAs%20Driver%20Shortage%20Report%202019%20with%20cover.pdf

preferences towards online shopping, there is a demand for warehouses to grow in size and labour capacity to accommodate more goods and meet the demands of the shift from brick-and-mortar shopping to e-commerce. This demand for more workers has been met with insufficient supply of warehousing workforce. These dynamics have resulted in increasing adoption of automation in distribution, delivery, and warehousing operations. This confirms that adopting automation is driven by the shortage in workforce and not a replacement of existing workers, as many of the jobs that will be filled by automated vehicles and robots in goods movement logistics are currently, and will continue to be, unoccupied. Automation still involves collaboration with and maintenance by human labour as well.

LOGISTICS, FREIGHT, AND TRUCKING

The logistics, freight, and trucking industries have been experiencing major transformations in the past decade thanks to the technological advances and market dynamics discussed above. New technologies and opportunities have been introduced to these industries, altering operations at every stage of moving goods. In the following, we discuss some of these major transformations that are reshaping the present and future of logistics, freight, and trucking.

Autonomous Trucking

Autonomous vehicles are reshaping the future of many industries. The trucking industry is one that is being massively transformed with the advances in automated driving. Autonomous trucks are likely to gain widespread adoption quicker than the other types of vehicles. This is mainly attributed to the fact that driving on highways is much more straightforward than in cities. Also, the benefits and cost advantage of deploying autonomous trucking is much greater than those of

personal vehicles[7]. For instance, autonomous trucking has been recognized as an opportunity to solve the shortage in truck drivers faced nowadays in the industry and a means for boosting the operational capacity.

The route to having fully autonomous trucks on roads is quite long, but it is not supposed to happen all at once. The McKinsey Center for Future Mobility has envisioned that the deployment of autonomous trucks will happen in four waves[8]:

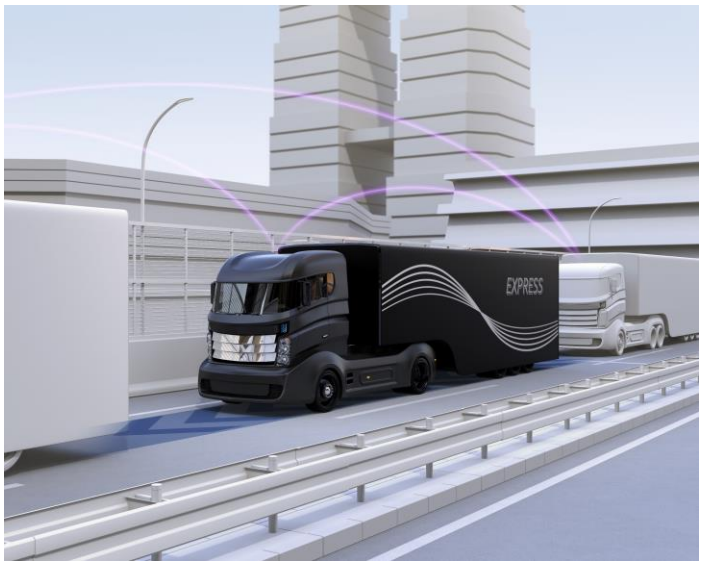
Wave 1 [2018-2020] – Automated trucks driving in geo-fenced areas

Wave 2 [2022-2025] – Platooning on select highways with a driver in the leading truck

Wave 3 [2025-2027] – Automated trucks on select highways with drivers needed only to drive the trucks to and from these highways

Wave 4 [2027+] – Fully autonomous trucks on all highways

Platooning is a technology that utilizes collision avoidance systems with vehicle-to-vehicle communication to enable two or more trucks to travel in close proximity. The truck at the front serves as the leader, while the other trucks follow the head truck's movements via technology.



[7] **Boston Consulting Group. (2019). The Future of Commercial Vehicles. Retrieved from** https://www.bcg.com/publications/2019/future-commercial-vehicles

[8] **McKinsey Center for Future Mobility. (2018). Route 2030: The fast track to the future of the commercial vehicle industry. Retrieved from** https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/route-2030-the-fast-track-to-the-future-of-the-commercial-vehicle-industry

In 2018-2020, we have also seen many companies testing automated trucks on highways with at least one safety driver on board. Some initial use cases that will eventually lead to fully autonomous trucks on roads have already been introduced and explored by the trucking providers and original equipment manufacturers (OEMs). Companies are either building their own technologies, partnering with the leaders in the space, or making other arrangements to acquire them. Startups such as TuSimple and Embark have managed to raise millions of dollars to develop and test their own autonomous truck technologies on highways in the U.S. and China. They have also partnered with many other companies to widen the scope of their operation and use cases. For example, Embark's autonomous trucks have been spotted moving cargo for Amazon and Frigidaire[9,10]. TuSimple has recently announced plans for autonomous freight network with UPS, U.S. Xpress, and others as inaugural partners[11].

Big automotive and mobility companies have also joined the race towards autonomous trucking early on. In 2014, Daimler unveiled the Mercedes-Benz Future Truck 2025 with a Highway Pilot system[12]. Daimler has also been running platooning trials in the U.S., Europe, and Japan[13]. Volvo has also been conducting successful platooning and autonomous trucking trials in partnership with giant carrier and freight companies. In 2018, Volvo Trucks and FedEx successfully demonstrated truck platooning on public highways in North Carolina[14]. Volvo Trucks has also developed an electric, autonomous truck called Vera, that it started testing in 2019 in partnership with the ferry and logistics company DFDS to transport goods in Sweden[15]. Waymo, one

[9] **Kolodny, L. (2019). Amazon is hauling cargo in self-driving trucks developed by Embark. Retrieved from** https://www.cnbc.com/2019/01/30/amazon-is-hauling-cargo-in-self-driving-trucks-developed-by-embark.html

[10] **Business Wire, Inc. (2017). Embark, Frigidaire®, and Ryder Partner to Pilot Automated Driving Technology. Retrieved from** https://www.businesswire.com/news/home/20171112005077/en/Embark-Frigidaire%C2%AE-Ryder-Partner-Pilot-Automated-Driving

[11] **Korosec, K. (2020). TuSimple kicks off plan for a nationwide self-driving truck network with partners UPS, Xpress and McLane. Retrieved from** https://techcrunch.com/2020/07/01/tusimple-kicks-off-plan-for-a-nationwide-self-driving-truck-network-with-partners-ups-xpress-and-mclane/

[12] **Mercedes-Benz AG. The long-haul truck of the future. Retrieved from** https://www.mercedes-benz.com/en/innovation/autonomous/the-long-haul-truck-of-the-future/

[13] **Daimler AG. (2018). Daimler now testing platooning technology for more truck efficiency also in Japan. Retrieved from** https://media.daimler.com/marsMediaSite/en/instance/ko/Daimler-now-testing-platooning-technology-for-more-truck-efficiency-also-in-Japan.xhtml?oid=32920883

[14] **FedEx. (2018). Volvo Trucks and FedEx Successfully Demonstrate Truck Platooning on N.C. 540 (Triangle Expressway). Retrieved from** https://newsroom.fedex.com/newsroom/volvo-trucks-and-fedex-successfully-demonstrate-truck-platooning-on-n-c-540-triangle-expressway/

[15] **DFDS. (2019). Volvo and DFDS present autonomous solution. Retrieved from** https://www.dfds.com/en/about/insights/newsletters/volvo-presents-autonomous-transport-solution-with-dfds

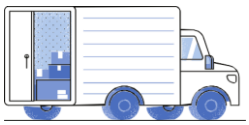
of the world leaders in autonomous driving, integrated its self-driving system into Class 8 trucks and began testing them in Arizona in 2017. The company has been testing trucks in the San Francisco area and Atlanta. Early this year, Waymo started mapping highways in Texas and New Mexico, preparing for testing autonomous trucks on those roads as well[16].

Many other companies[17] have been investing in autonomous trucking to capture the opportunities brought by these technologies both on the efficiency and cost reduction aspects. According to McKinsey[18], with the adoption of fully autonomous trucks, operating costs in the logistics and freight industries would decline by about 45 percent as those trucks would fill in the shortage in truck drivers and operate 24/7.

Autonomous Vehicles for Middle-Mile Delivery

The freight industry expands beyond the long-haul part of goods movement. Another major part is the middle-mile phase where goods are moved from warehouses to distribution centres. Some companies have found an opportunity in automating goods movement and bringing autonomous vehicles into play in this part of the journey.

A prominent example is Gatik's autonomous vans that are used to deliver online orders from Walmart's main warehouse to its neighborhood stores in Arkansas[19]. Gatik has recently added box trucks to its fleet to boost capacity amid surging demand from consumers ordering goods online[20].



[16] **Korosec, k. (2020). Waymo's self-driving trucks and minivans are headed to New Mexico and Texas. Retrieved from** https://techcrunch.com/2020/01/23/waymos-self-driving-trucks-and-minivans-are-headed-to-new-mexico-and-texas/

[17] **GearBrain, Inc. (2020). These 8 companies are making the self-driving truck a reality. Retrieved from** https://www.gearbrain.com/autonomous-truck-startup-companies-2587305809.html

[18] **McKinsey & Company. (2018). Distraction or disruption? Autonomous trucks gain ground in US logistics. Retrieved from** https://www.mckinsey.com/industries/travel-logistics-and-transport-infrastructure/our-insights/distraction-or-disruption-autonomous-trucks-gain-ground-in-us-logistics

[19] **Davies, A. (2019). This robo-van startup will handle Walmart's 'middle mile'. Retrieved from** https://www.wired.com/story/robo-van-startup-handle-walmarts-middle-mile/

[20] **Korosec, K. (2020). Gatik adds autonomous box trucks to its 'middle mile' game plan. Retrieved from** https://techcrunch.com/2020/05/06/gatik-adds-autonomous-box-trucks-to-its-middle-mile-game-plan/

Connectivity and Transparency

One emerging trend in the logistics and freight industries is acquiring full system transparency through end-to-end inter-connectivity. This is mainly enabled through deploying IoT monitoring and connectivity solutions in all parts of the supply chain to facilitate tracking products in real-time from production facilities all the way to consumers. This real-time visibility is a key for boosting efficiency, reducing risk, and maintaining end-to-end transparency. It is also critical for tracing damaged/lost goods and identifying equipment malfunction for prompt maintenance. IoT could also enhance the fleet management services by offering fleet companies real-time visibility over their entire fleet, so that they know the location and status of each vehicle in their fleet.

Amazon, for example, has built on the IoT opportunities and leveraged real-time visibility on goods throughout its entire ecosystem. This has been helping the company guarantee its two-day shipping offerings on millions of different items for its Prime customers. Capitalizing on its success, the company offers Amazon Web Services (AWS) IoT cloud and data management solutions as a vendor as well[21].

Amazon is not the only company offering IoT solutions to logistics and freight companies. Other examples include Sigfox, a leading service provider for IoT, that partnered with Michelin and DHL to build solutions to locate shipments and track their transport conditions in real time[22]. The benefits of IoT in logistics and freight and the advances in IoT technologies that keep making its devices more affordable and available are anticipated to make end-to-end transparency and connectivity the norm in the near future and will continue to make scaling solutions easier and faster.

Data-Driven Decision-Making

Success in data-led industries is not only about collecting a plethora of data; it is all about using this data as a differentiator. The value of the collected data is maximized when data is analyzed in real-time and used to inform decision-making.

[21] **Amazon Web Services - AWS IoT. Accessed through** https://aws.amazon.com/iot/

[22] **Sigfox Canada. A Smarter Supply Chain: IoT and Logistics. Retrieved from** https://www.sigfoxcanada.com/a-smarter-supply-chain-iot-and-logistics/

" We can invest selectively because we have more perfect information. We know where our demand is, we know where we're moving things between warehouses and sort centers[23]. "

Brian Olsavsky, CFO, Amazon

Analyzing data and making relevant decisions over days or weeks is becoming very obsolete. The major differentiator today is all about deploying algorithms that analyze data and make decisions in "real-time". Dealing with dynamic environments and changing consumer demands require agility and ability for prompt adaptation and reacting to dynamic decisions. A perfect use case in the freight industry is deciding on the best routes that the goods-carrying vehicles should follow. Analyzing traffic and road condition data along with shipment status and delivery data in real-time can be utilized to adapt and optimize these routes on the go to move goods faster and safer. UPS's dynamic routing system, ORION, is an example of such a use case of data-guided decision-making. ORION uses customer, driver, and vehicle data to reduce miles driven on delivery route by calculating the most efficient driving path taking into consideration all scheduled package delivery and pick-up stops[24].

Advanced data analytics, such as predictive analytics, can be leveraged as well to drive

[23] **Deloitte. (2019). How are global shippers evolving to meet tomorrow's demand? Retrieved from** https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/future-of-freight-connected-data-intelligent-automation.html

[24] **United Parcel Service of America, Inc. (2015). UPS Accelerates Use of Routing Optimization Software to Reduce 100 Million Miles Driven. Retrieved from** https://www.pressroom.ups.com/pressroom/ContentDetailsViewer.page?ConceptType=PressReleases&id=1426329559785-791#

smarter decision-making. Predictive analytics can be a tool for demand forecasting and inventory planning. Amazon's "anticipatory shipping" concept can be a good example of leveraging this in logistics and freight[25]. Predictive analytics is also essential for risk reduction and proactive maintenance. For instance, if a system can proactively predict that the freezer in a cold chain truck carrying temperature-controlled goods is about to fail, the truck driver can be informed in real-time if he can continue to the destination or make a quick stop to mitigate the risk.

As data collection and analytics technologies evolve, it is anticipated that data-driven decision-making in logistics and freights will get much broader and richer. It can eventually be combined with large-scale data from smart city sensors and other data sources such as traffic control centres[23].

Asset Sharing

The sharing economy model has been disrupting many industries. Airbnb, for example, has been transforming the vacation rental industry with people sharing unused capacity in their own homes with others in temporary need for competitive pricing. The same business model has been brought to the logistics, freight, and trucking industries to monetize and share underutilized, capital-intensive assets such as carrier fleets.

Sharing of commercial vehicles has been transforming how carriers operate. It is a means for expanding the operational capacity for carriers in need of more trucks to move their loads at peak times, and helping small companies that do not have capital budget to own a fleet utilize on-demand truck loads on a "pay per use" basis. It also helps companies that often have unused fleet capacity utilize it as a major revenue stream. Freight companies can also utilize this business model to expand their geographical scale of operation by leveraging offered moving capacity to deliver outside of their typical region of operation.

Some technology enablers, such as expanded connectivity and data analytics, help facilitate such coordination and connection among companies and broaden

[25] **Forbes On Marketing. (2014). Why Amazon's Anticipatory Shipping is Pure Genius. Retrieved from** https://www.forbes.com/sites/onmarketing/2014/01/28/why-amazons-anticipatory-shipping-is-pure-genius/#24e53b0a4605

their asset sharing scale. A transparent, fully connected platform that offers shippers and carriers real-time visibility into asset capacity and demand can facilitate asset utilization and help set up dynamic pricing that reflects the market status at the moment. Some start-ups, such as Convoy[26] and NEXT Trucking[27], have taken advantage of this idea and been offering platforms for matching shippers with carrier loads in real-time.

The concept of "freight on-demand" has also ignited big companies' interest and driven them to offer this business model as a part of their services. Uber Freight[28] is a good example of this service expansion by the giant ride-hailing company. As truck prices get higher due to adopted technological advances, it is anticipated that the adoption of this asset sharing model will continue to rise and that fleet outsourcing will become a trend in freight and logistics.

[26] **Convoy: Future of Freight. Accessed through** https://convoy.com/
[27] **The NEXT revolution in trucking is here. Accessed through** https://www.nexttrucking.com/
[28] **Uber Freight: Hassle-free load boards and freight shipping. Accessed through** https://www.uber.com/ca/en/freight/

WAREHOUSING

Warehousing is an essential part of the movement of goods journey that has also been affected by the technological advances and market dynamics discussed earlier. Warehouses are no longer dumb storage sites with minimal technology intervention. They have been experiencing major digital transformations in many aspects of the warehousing process[29], including goods sorting and pickup, inventory tracking and maintenance, and decision-making. Below, we walk through some of these transformations.

Automation

When it comes to boosting the operational capacity and efficiency of warehouses, automation is the key. Having automated machines that mimic human actions and reasoning is a means to tackle the shortage in workforce challenge warehouses are experiencing today and to expand their capacity further during peak times. It is also a crucial means for automated inventory management. From an efficiency standpoint, automation has a lot to bring.

Although automation in warehouses has been around for years, many companies

[29] **Nestlé. (2018). Nestlé and XPO Logistics building digital warehouse of the future in the East Midlands. Read more** https://www.nestle.co.uk/en-gb/media/pressreleases/nestle-and-xpo-logistics-building-digital-warehouse-of-the-future-in-the-east-midlands

have recently been considering adopting it in a wider scale and different forms. Automation, for example, is expansively incorporated today in warehouses in the form of robotic pickers, packers, and sorters[30]. Amazon, for instance, has deployed more than 200,000 robots in its warehouses and fulfillment sites[31]. Ocado has also deployed thousands of robots in its automated warehouses[32].

Automated machines are also being used to scan and monitor the inventory, providing real-time information on goods status and location. Amazon's robots, for example, can identify goods by reading QR codes using built-in scanners.

These scanning machines are not only in the form of ground robots, they have been also introduced in the form of drones flying up and down aisles to scan goods and read their information tags autonomously, saving retailers billions of dollars and thousands of hours consumed in traditional inventory control[33].

[30] **McKinsey & Company. (2019). Automation in logistics: Big opportunity, bigger uncertainty. Retrieved from** https://www.mckinsey.com/industries/travel-logistics-and-transport-infrastructure/our-insights/automation-in-logistics-big-opportunity-bigger-uncertainty

[31] **Heater, B. (2019). Amazon says it has deployed more than 200,000 robotic drives globally. Retrieved from** https://techcrunch.com/2019/06/05/amazon-says-it-has-deployed-more-than-200000-robotic-drives-globally/

[32] **Vincent, J. (2018). Welcome to the automated warehouse of the future. Retrieved from** https://www.theverge.com/2018/5/8/17331250/automated-warehouses-jobs-ocado-andover-amazon

[33] **MIT. (2017). Drones relay RFID signals for inventory control. Retrieved from** https://news.mit.edu/2017/drones-relay-rfid-signals-inventory-control-0825

Tracking and Visibility

Thanks to the advances in the IoT technologies, smart warehouses are benefiting from monitoring and connectivity capabilities that ease locating and tracking stored goods. Through sensors and RFID scanners connected to an IoT network, warehouse workers – either human or robots – can easily know the location of every single item for faster pickup and track their status as they move through their delivery journey. The IoT monitoring and connectivity capabilities in warehouses can also improve inventory management and planning and help identify damaged and lost goods. They can also be very helpful with site maintenance through monitoring equipment operation and triggering proactive maintenance early enough to avoid equipment breakdown.

Tracking and visibility in warehouses are not only restricted to the on-site use. The data collected from IoT devices is accessible through the Internet and can be used to provide tracking and visibility options to remote managers and to the other partners of the supply chain.

These wide benefits of IoT are all augmented with the proliferation of mobile devices, such as smartphones and tablets, that are able to provide powerful and user-friendly accessibility tools of the IoT data and management platforms. IoT applications and adoption in warehousing will continue to grow as the IoT monitoring and connectivity devices, as well as the access mobile devices get less expensive, more widely available, and easier to use.

Advanced Analytics

For the automation and IoT platforms to run efficiently and achieve effective results, they need to be backed up and complemented with advanced analytics to process the collected data, guide the automation, and drive informed decisions. With Amazon's robots, for example, AI data analytics are run to prioritize locating products for Amazon Prime members, then directions are passed to the robots to assist human workers picking and packaging these products.

Advanced analytics are also needed for prediction and forecasting. Predictive analytics based on AI algorithms can drive smarter decision-making and help identify risks and problems before they happen. This includes analysis of the IoT data collected on the status of the equipment

and tools on site that helps run predictive maintenance.

Advanced analytics are also critical for digesting actionable insights from complex raw data by helping create user-friendly data summaries and visualizations.

Augmented and Virtual Reality

As AI is digging its way deeper into warehousing operations, it is bringing more advanced technologies into action. Another emerging use case of AI in warehouses is the adoption of augmented reality (AR) and virtual reality (VR) technologies.

AR can significantly reduce cost in warehousing by improving the picking process. It can also help with staff training and warehouse planning. An AR vision system can assist warehouse workers with goods scanning, object recognition, and indoor navigation, all connected with the warehouse management system in real-time[34]. Warehouse managers using AR glasses can also oversee the entire warehousing operation and coordinate both human and robotic workers, accordingly.

With the help of VR systems, managers can handle the warehouse management and planning processes remotely, exactly as they do when they are physically at the warehouse. VR can also be used to train new hires virtually before starting their on-site jobs.

[34] **DHL Trend Research. (2014). Augmented Reality in Logistics. Retrieved from** https://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/csi_augmented_reality_report_290414.pdf

Warehousing On-Demand

The sharing economy model that is currently disrupting many sectors is also finding its way in industrial warehousing. Many companies have already built their warehouses with capacity to handle their peak season demands. During their off-peak times, non-negligible parts of their warehousing capacity are left idle. This inspired exploring the sharing economy model and monetizing this unused capacity as "warehousing on-demand" offerings for other seasonal companies that do not need or have the capacity to own private warehouses. Companies with the ability to have their own warehouses can also leverage this business model. They can build warehouses that meet their regular demand and account for the peak demand externally through this warehousing on-demand model.

Companies such as Stowga[35] and Flexe[36] have recognized the feasibility of this business model and have provided platforms for running warehousing on-demand services. Through these platforms and this business model, unused warehousing capacity can become a commercial asset[37].

[35] **Stowga - The world's warehousing marketplace. Accessed through** https://www.stowga.com/

[36] **FLEXE - Free and fast, promoted. Accessed through** https://www.flexe.com/

[37] **Middleton, C. (2019). Five predictions on the future of smart warehousing. Retrieved from** https://www.experfy.com/blog/five-predictions-on-the-future-of-smart-warehousing/

LAST-MILE AND CURBSIDE DELIVERY

How cargo arrives at the customer's door has been experiencing tremendous transformations. As e-commerce continues to rise, customers demand higher levels of service and convenience in getting their shipments to their homes. It is no longer enough for retailers to compete on price and quality; today it is more important to also compete on the convenience and seamlessness of the delivery experience.

Being a major part of goods movement logistics, last-mile delivery is also taking advantage of all the transformations and technological opportunities discussed earlier for the logistics and freight industries. **Connectivity** among carriers, shippers, and the other parts of the supply chain is a key for transparency and visibility of the order status all the way to its final destination. **Data-driven decision making** is currently an integral part of the last-mile delivery services for reaching optimized decisions in real-time, such as dynamically adapting delivery routes. In addition to these trends that are affecting the whole logistics industry, including last-mile delivery, in the following we focus on more transformations touching this last stage of goods movement.

Last-mile delivery services have been experiencing major changes and opportunities through the initial deployment of both **ground and aerial autonomous vehicles**. According to a study by KPMG[38], autonomy manages to enable cheaper, faster, and more convenient delivery services. McKinsey predicts that semi and fully autonomous last-mile delivery will reduce delivery costs by approximately 10-40%.[39] This is mainly attributed to eliminating the dependency on human labour, which will result in reducing shipping costs and expanding availability of delivery facilities for overnight and weekend pickups.

These opportunities are facilitated by the introduction of new concepts and technologies for curbside delivery. Delivery **droids**, also referred to as **bots**, are examples of such technologies. These droids are autonomous ground vehicles specially designed for driverless delivery. They come in different sizes to accommodate different types of packages. Some droids can offer the possibility of delivering multiple packages at once by, for example, being partitioned into many secured lockers. This offering has promoted the concept of **mobile lockers** that allow carriers to deliver more parcels in less time.

[38] **KPMG LLP. (2018). Autonomy delivers: An oncoming revolution in the movement of goods. Retrieved from** http://tiny.cc/l2c7az

[39] **McKinsey & Company. (2018). Fast forwarding last-mile delivery – implications for the ecosystem. Retrieved from** http://tiny.cc/l0c7az

Realizing the need for leveraging these new delivery technologies, some retailers have started to make use of bots in last-mile delivery, and some of them have introduced their own ones. In the U.S., Amazon has officially rolled out autonomous delivery bots, called "Scouts", on the streets of California[40]. The bots autonomously follow their last-mile delivery route from urban distribution points to Amazon Prime customers and are initially accompanied by an Amazon Scout Ambassador. In China, the e-commerce companies JD[41] and Alibaba[42] have started to test driverless delivery bots to help ship goods purchased online. Alibaba's bots can also deliver fresh food that can be kept warm or cool, depending on the temperature adjusted remotely by the customer. In February 2019, FedEx unveiled its "SameDay Bot", an autonomous robot that is designed to deliver small shipments to customers' homes and businesses on the same business day[43].

To bring delivered packages to customers' doorstep and fill the gap of autonomous home delivery, Ford has released its vision of a **two-legged delivery robot** called "Digit." This robot will be able to climb steps and is equipped with lidar and stereo cameras to navigate its pathway to customers' front doors[44].

As they bring opportunities, these new delivery vehicles bring a challenge as well. Curbside delivery would require adjustments in the public infrastructure either through arrangements to accommodate it on sidewalks or through the creation of dedicated lanes and parking zones for drop-off.

The use of **drones** for last-mile delivery has also been receiving more popularity in the past few years, with more than forty countries now permitting or planning to permit drone delivery services[45]. Drones can

[40] **Scott, S. (2019). What's next for Amazon Scout? Retrieved from** https://tinyurl.com/yxsfnadx

[41] **Matsuda, N. (2018). JD.com rolls out fleet of AI-equipped delivery robots. Retrieved from** https://asia.nikkei.com/Business/China-tech/JD.com-rolls-out-fleet-of-AI-equipped-delivery-robots2

[42] **Liao, S. (2018). Alibaba made a driverless robot that runs 9 mph to deliver packages. Retrieved from** https://tinyurl.com/ybzpqhs6

[43] **FedEx. (2019). Delivering the future: FedEx unveils autonomous delivery robot. Retrieved from** https://about.van.fedex.com/newsroom/thefuturefedex

[44] **Naughton, K. (2019). Ford's way to finish driverless deliveries: package-carrying robots. Retrieved from** https://tinyurl.com/yyx5knau

[45] **Urban Air Mobility News. (2019). Drone delivery services growing at extraordinary rate – new Unmanned Airspace survey. Retrieved from** https://www.urbanairmobilitynews.com/express-delivery/drone-delivery-services-growing-at-extraordinary-rate-new-unmanned-airspace-survey/

take part in goods movement by taking on deliveries to the shipments' final destination. Drones also bring delivery opportunities to areas with limited reach by ground delivery vehicles such as rural and remote areas. For example, in 2017, an online retailer in Iceland started to trial drone delivery services. A year later, the company expanded these services offering regular deliveries to almost half of Iceland's capital[46]. Moose Cree First Nation, an Indigenous community in northeastern Ontario, teamed up with the Ontario-based Drone Delivery Canada in 2017 to bring food, medicine, and other supplies to the remote community[47].

Some big retailers and carriers have also been using drones to expand their delivery services. For example, UPS launched a drone delivery subsidiary called UPS Flight Forward. The company managed to get government approval in the U.S. to operate a nationwide fleet of drones, expanding deliveries to campus settings such as hospitals and universities and moving closer to making deliveries to consumer homes[48]. In 2019, Canada Post, in partnership with London Drugs and InDro Robotics, successfully started testing drone delivery via carrying pharmaceuticals from a London Drugs pharmacy to remote Salt Spring Island in British Columbia[49].

Some companies have also started to test having drones complement a truck's journey and take off with shipments directly from trucks for the last leg of delivery. The Workhorse Group's HorseFly is an example of such an integration between drones and trucks. In this system, a drone takes off from the roof of a truck to fly autonomously to a customer's home to deliver a package then return to the vehicle, while the

[46] **BBC. (2018). Iceland expands food delivery by drone in Reykjavik. Retrieved from** https://www.bbc.com/news/technology-44466353

[47] **McQuigge, M. (2017). First Nation in Ontario using drones to help lower costs, create jobs. Retrieved from** https://www.thestar.com/news/canada/2017/10/18/first-nation-in-ontario-using-drones-to-help-lower-costs-create-jobs.html

[48] **Baertlein, L. (2019). Big drone on campus: UPS gets U.S. government okay for drone airline. Retrieved from** https://www.reuters.com/article/us-ups-drones/big-drone-on-campus-ups-gets-u-s-government-okay-for-drone-airline-idUSKBN1WG475

[49] **GlobeNewswire. (2019). London Drugs, Canada Post and InDro Robotics successfully test Drone delivery of emergency medications over Pacific Ocean. Retrieved from** https://tinyurl.com/y37scyc9

delivery driver continue along the route to make another delivery[50].

With the health concerns brought up by COVID-19, some last-mile delivery technologies have been supplemented with features of **contactless delivery**. For example, amid the pandemic, the Michigan-based Refraction AI complemented its fleet of three-wheeled delivery robots with contactless access authorization. These contactless delivery services from Refraction AI have seen demand increase by four times since the beginning of the COVID-19 lockdown [51]. Recently in Ontario, Tiny Mile, a Toronto-based start-up developing sidewalk delivery robots announced a partnership with foodora to provide on-demand contactless delivery in Canada. Initial plans are to pilot these contactless delivery robots in Toronto and expand later to other locations in Canada[52].

These innovative last-mile delivery technologies have the potential to further boost consumer confidence and convenience, especially in critical times as during the COVID-19 pandemic[53]. Meanwhile, carriers and logistics companies can benefit from increased operational capacity and reduced delivery costs. With these two-fold opportunities, it is anticipated that investments in these technologies will continue to grow and pilots will continue to expand.

[50] **Workhorse - The HorseFly™ UAV. Accessed through** https://workhorse.com/horsefly.html

[51] **Payne, H. (2020). Robots on the rise in the COVID-19 economy. Retrieved from** https://tinyurl.com/yd34zrr4

[52] **The Robot Report. (2020). Tiny Mile teams with foodora for robotic food delivery in Toronto. Retrieved from** https://www.therobotreport.com/tiny-mile-teams-with-foodora-for-robotic-food-delivery-in-toronto/

[53] **Autonomous Vehicle Innovation Network. (2020). The auto sector and the COVID-19 pandemic: Recovery support and opportunities. Retrieved from** https://tinyurl.com/y4l754dz

HIGHLIGHTS FROM ONTARIO

FLEETOPS

FleetOps is a freight matching company based in Toronto. The company started out as a telematics company called FleetRover, with a mission to "move truckload freight without friction." With applied AI, the company uses telematics data to learn carrier needs and match them with the perfect shipment at the perfect time, saving clients hours searching through loadboards and negotiating terms.

Link: https://www.fleetops.ai/

CLOUDHAWK

CloudHawk is an innovation-focused telematics and Internet of Things solution provider. Based in Waterloo, the company offers a full suite of customizable IoT fleet and asset tracking solutions that include real-time GPS tracking, temperature and humidity condition monitoring, engine hours reporting, among others.

Link: https://www.cloudhawk.com/

ROSE ROCKET

Rose Rocket is software company based in Toronto. The company offers a transportation management software that helps manage the unique needs of today's transportation companies through improving communications with systems, customers, and the people who move freight.

Link: https://www.roserocket.com/

NUPORT ROBOTICS

NuPort Robotics is an autonomous trucking company focused on middle-mile automation for supply chain operations. Based in Toronto, the company applies its proprietary platooning and autonomous driving technology to create autonomous supply chains.

Link: https://www.nuport.ai/

Note: The companies highlighted above are only a few examples of the success stories in Ontario in the context of goods movement innovation.

CONCLUSIONS

In this report, we have discussed the current trends that are driving disruptive changes in the movement of goods. These include technological advances that are bringing opportunities to the goods movement journey, and market dynamics that are affecting the operational and economic side of the industry. We have also discussed the major transformations that have started to be seen and adopted in the various industries that take part in moving goods, including innovative transformations in logistics, freight, trucking, warehousing, and last-mile delivery. These transformations span across innovative delivery and automation solutions and technologies, connectivity and monitoring solutions that enable transparency and visibility, data analytics solutions that enable efficient and effective operations and decision making, and asset sharing solutions that change the notion of fleet and warehouse ownership. We have also highlighted some of the substantial opportunities that are brought to the industry players and consumers by these various transformations.

Some companies have already started to reap these opportunities through joining the race and investing in these transformations either through solution development or deployment. To be able to win the race and lead the future of goods movement, companies need to grasp the industry disruptions and evolving transformations, understand their strengths and priorities, and act accordingly. They need to balance their investments between expanding their operational capacity and securing the innovative transformations that are winners in their markets and key to building their competitive position in today's and tomorrow's ecosystem.

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ABOUT AVIN

The **Autonomous Vehicle Innovation Network (AVIN)** is a key component of Driving Prosperity, the Government of Ontario's initiative to ensure that the automotive sector remains competitive and continues to thrive. The Government of Ontario has committed $85 million in innovative programming to support research and development (R&D) funding, talent development, technology acceleration, business and technical support, and testing and demonstration sites. AVIN programs support small- and medium-sized enterprises (SMEs) to develop, test, and commercialize new automotive and transportation products and technologies, and cultivate the capacity of a province-wide network to drive future mobility solutions, reinforcing Ontario's position as a global leader.

AVIN, led by OCE, is supported by the Government of Ontario's Ministry of Economic Development, Job Creation and Trade (MEDJCT) and Ministry of Transportation (MTO). The initiative comprises five distinct programs and a central hub. The AVIN programs are:

- AV Research and Development Partnership Fund
- WinterTech
- Talent Development
- Demonstration Zone
- Regional Technology Development Sites

The AVIN Central Hub is the driving force behind the programming, province-wide coordination of activities and resources, and Ontario's push to lead in the future of the automotive and mobility sector globally. Led by a dedicated team, the Central Hub provides the following key functions:

- A focal point for all stakeholders across the province;
- A bridge for collaborative partnerships between industry, post-secondary institutions, broader public sector agencies, municipalities, and the government;
- A concierge for new entrants into Ontario's thriving ecosystem; and
- A hub that drives public education and thought leadership activities and raises awareness around the potential of automotive and mobility technologies and the opportunities for Ontario and for its partners.

AVIN has five objectives:

We would like to thank the Government of Ontario for supporting AVIN programs and activities.

We would also like to thank the partner organizations that work with OCE to deliver AVIN programs, including the Regional Technology Development Sites and the Demonstration Zone.