The transportation industry experiences an increase in the interconnectedness of people and goods that can be optimized through technologies and data analysis. CIOs and IT leaders can reference this Hype Cycle for innovations and trends to evaluate and implement.
Analysis

What You Need to Know

The innovations, technologies and concepts contained within this Hype Cycle have the potential to significantly change how companies plan, operate and deliver new products and services.
Therefore, decision makers, innovation team members and other stakeholders should use the Hype Cycle to underpin an investment strategy based not on industry hype, but on a clear understanding of the potential impact of the innovation profiles described.

This Hype Cycle is for CIOs, CTOs and other digital business leaders from the following subsectors within the transportation industry:

- Air transport
- Rail transport
- Maritime
- Road transportation
- Warehousing/couriers

The Hype Cycle

Figure 1. Hype Cycle for Transportation Industry, 2020

Hype Cycle for Transportation Industry, 2020

![Hype Cycle Diagram]

As of August 2020

Plateau will be reached:
- less than 2 years
- 2 to 5 years
- 5 to 10 years
- more than 10 years
- obsolete before plateau

Source: Gartner
ID: 467939
The Priority Matrix

Organizations that typically seek competitive advantage in their industries via technology-driven innovation should focus on those that will have transformational or high impact on their operational capabilities and business models. These are all listed on the upper half of the Priority Matrix.

CIOs need to be preparing for the transformational impact of innovations critical for their transportation organizations that are two to five years away from reaching mainstream adoption in the marketplace, specifically:

- Internet of Things (IoT)

For CIOs in organizations that typically seek competitive advantage in their industries via technology-driven innovation, business cases for various usage scenarios of the IoT, as applied to their companies, should already be prepared. And proofs of concept should be completed or nearing completion soon. Plans for conducting pilots within a roadmap for ramping up to full-scale production environments should be starting within the next 12 to 18 months. Organizations with less appetite for taking technology risks and first-mover rewards, should plan to be “fast followers,” with proof of concepts (POCs) and business case(s) under preparation for it. Because of the transformational nature of IoT technologies, every organization — regardless of its risk reward profile — should be actively preparing to adopt this technology innovation. Falling too far behind the curve of technology diffusion in these areas could be damaging to the business in the long term. The selection of “most important” should always be done in the context of your own business strategy and goals.

Another tranche of innovations is expected to deliver significantly high benefits within two to five years:

- Advanced self-service technologies — now reinvigorated with touchless capabilities
- Commercial UAVs — a good alternative for touchless deliveries
- Last-mile delivery solutions — several capabilities that allow e-commerce companies to deliver when and where needed
- 5G — as it will allow for greater information granularity and remote operations capabilities

While not considered transformational in nature, the high benefits that these innovations are expected to bring to mainstream technology adopters within five years make them investment priorities over the short term. CIOs must ensure that their business leaders are armed with these technologies as they compete in an industry where even small differences matter, given the scale of operations.

There are several innovation profiles that are estimated to take more than 10 years to reach the Plateau of Productivity due to the speculative nature of their impact on the industry. Autonomous vehicles is one such innovation where there are some solid use cases in controlled environments, but widespread usage is still being hampered by several obstacles. On the other hand, we have changed the expected time to plateau from over 10 years to between five to 10 years for two
innovations this year: intelligent traffic management systems and zero-emission vehicles. The latter is due to an increase in regulations requiring their adoption, in areas like Europe and the U.S.

Although many innovations (such as autonomous mobile robots and artificial intelligence [AI] in transportation) have a somewhat long time to plateau of five to 10 years, this shouldn’t be viewed as an indication that they’re not to be used. The underlying technologies are mature and have many viable providers. However, the high-budget outlay and entrenched legacy systems mean that it will take several years for these new technologies to replace legacy systems, despite a strong business case. In addition, these solutions are continuing to evolve and expand, which is extending the time to plateau.

Traditionally risk-averse transportation providers, shippers and carriers should focus on the left half of the Priority Matrix (see Figure 2) to determine which technologies are mature and proven. Experimenting with and around these innovation profiles is worthy of consideration as upgrades to, or replacements for, solutions and extensions to new concepts such as intelligent connected infrastructure.

Figure 2. Priority Matrix for Transportation Industry, 2020

<table>
<thead>
<tr>
<th>benefit</th>
<th>years to mainstream adoption</th>
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<tbody>
<tr>
<td></td>
<td>less than two years</td>
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<tr>
<td>transformational</td>
<td>Internet of Things</td>
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<td>high</td>
<td>5G</td>
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<td>Advanced Self-Service</td>
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<td></td>
<td>Technologies</td>
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<td>Commercial UAVs</td>
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<td>(Drones)</td>
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<td>Last-Mile Delivery</td>
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<td>Solutions</td>
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<td>moderate</td>
<td>Biometrics in Aviation</td>
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<td></td>
<td>Global Logistics Visibility</td>
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<td></td>
<td>Micromobility</td>
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<td>Real-Time</td>
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<td>low</td>
<td>Transportation Visibility</td>
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<td></td>
<td>Platforms</td>
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<td>Digitized Freight</td>
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<td>Networks (Road)</td>
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<td>Intelligent Traffic</td>
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<td>Management Systems</td>
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<td>Flying Autonomous</td>
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<td>Vehicles</td>
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<td>Immersive Experience in</td>
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<td>Logistics</td>
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<td></td>
<td>Platooning</td>
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<td>Swarming Robotics</td>
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</table>

As of August 2020
Off the Hype Cycle

- SCM BPaaS was replaced with supply chain as a service.
- 5G for transportation was substituted with 5G for communications services providers.
- Autonomous robots was renamed to autonomous mobile robots.
- AI was renamed to AI in transportation.
- Real-time visibility platforms was renamed to real-time transportation visibility platforms.
- RFID for logistics and transportation is now a mature technology and has come off the Hype Cycle this year.

On the Rise

Quantum Computing

**Analysis By:** Pedro Pacheco

**Definition:** Quantum computing is a type of nonclassical computing that operates on the quantum state of subatomic particles. The particles represent information as elements denoted as quantum bits (qubits). A qubit can represent all possible values simultaneously (superposition) until read. Qubits can be linked with other qubits, a property known as entanglement. Quantum algorithms manipulate linked qubits in their undetermined, entangled state, a process that can address problems with vast combinatorial complexity.

**Position and Adoption Speed Justification:** Quantum computers are not general-purpose computers. Rather, they are accelerators, capable of running a limited number of algorithms with speeds that are orders of magnitude faster than conventional computers. The problems that quantum computers solve fall into a broad category of optimization, where a traditional algorithm would take impossibly long to find a solution. Quantum computers are superior for solving problems with enormous combinatorial complexity, such as route or traffic optimization. This was previously a technology limited to research laboratories, due to its high price and exclusivity. However, vendors like Amazon, IBM and Microsoft have started to offer quantum computing as a service (QCaaS), something that made the technology and its capabilities more accessible to a broad list of organizations.

Quantum computing has strong potential in transportation by allowing companies to tackle problems that were previously seen as unsolvable or too time-consuming. This includes modeling or forecasting of complex ecosystems like a traffic environment and urban planning. Often, it also addresses needs for structural optimization of components at molecular level. Several companies in the area of transportation are already using it. Volkswagen has started the world’s first pilot for traffic optimization using a quantum computer from D-Wave. Ford is working with Microsoft on a use case that utilizes quantum computing to optimize vehicle navigation route guidance. Besides making use of swarming effect information, the model uses quantum computing to run frequent optimizations
that take into consideration thousands of other vehicles on the road. Delta Airlines is also working with Microsoft on applications for quantum computing.

Quantum computing poses a threat to existing encryption processes due to its advanced computing power. For that reason, a number of companies have started to look at quantum-save encryption systems as a way to protect against a possible cybersecurity threat posed by quantum computing.

Use cases for quantum computing keep growing in transportation, which shows a clear ascending adoption curve.

**User Advice:** Although quantum computing is becoming more commercially accessible, it is still in a nascent phase. As such, transportation CIOs should plan their quantum computing initiatives thoroughly and with a future mindset. First, it’s important to find the right use cases to justify the investment. Usually this entails working with R&D and other internal parties to find high-value, highly complex problems that were previously set aside. In addition, it is imperative to promote your quantum computing initiative to the board of the company to get support for what should be a long-term initiative. Due to its infancy, quantum computing tends to be seen in some organizations as a distant technology, which is the reason why you should set up the right governance and competences around the project for the sake of its success.

**Business Impact:** The United Nations has projected that 68% of the population will live in urban cities by 2050. Transport authorities have been looking to optimize public transportation, including improving routing, maximizing passenger rides, and reducing commute times and traffic congestion, while seeking a better quality of life and experience for the residents. Quantum computing promises to be an accelerator for several technologies that are paramount to transportation like calculation of superior chemistry combinations for batteries.

The quantum approach holds the promise of doing faster calculations and predicting demand and supply better.

**Benefit Rating:** High

**Market Penetration:** Less than 1% of target audience

**Maturity:** Emerging

**Sample Vendors:** Alibaba Cloud; Amazon; D-Wave; Fujitsu; Google; Hitachi

**Recommended Reading:** “Quantum Computing Planning for Technology General Managers”

**Autonomous Trucks**

**Analysis By:** Bart De Muynck

**Definition:** Autonomous trucks are commercial trucks that use a combination of lidar, radar, sensors and cameras as well as machine learning to drive autonomously, meaning without the assistance of
a driver. There are several scenarios planned in which trucks can have drivers in the cabs while being autonomous. They can be fully autonomous vehicles without drivers or participate in truck platooning, where the lead vehicle has a driver and the following vehicles follow the lead truck fully autonomously.

**Position and Adoption Speed Justification:** The logistics industry sees autonomous trucks as an opportunity to improve safety and operational efficiencies. Autonomous trucks could also help lessen the challenges around shortage of drivers. Estimates for deploying autonomous trucks vary, with rollouts estimated to occur as quickly as three to five years in China. The U.S., by comparison, is closer to a decade away. In most cases, amending existing regulations will determine which regions adopt first.

**User Advice:** Although the current market for autonomous vehicles is quite limited, many companies with truck fleets should begin to look into autonomous vehicles to understand if, where and how this technology might impact their supply chains. Companies should look for parts of the world where regulations favor autonomous innovation, but today very few regions support this. Risk-tolerant companies should allocate a small, technically competent team to research and evaluate government regulations and emerging autonomous capabilities being added to current vehicles. Shippers should also talk to their third-party logistics providers to see how they are embracing autonomous vehicles. Some firms may want to partner with shippers initially to pilot the new capability while sharing some risks.

**Business Impact:** Autonomous driving technology is maturing rapidly but adoption will be constrained by other factors such as regulatory restrictions. Several successful pilots have shown the technology to be nearly ready for the open road. The trucking industry’s appetite to embrace autonomous vehicles is fueled by the belief that early adopters will gain market share and secure a more profitable operating model. However, despite having the potential for addressing industry’s most severe challenges, growth will be delayed by long-running and sometimes contentious regulatory debates and low public acceptance as well as due to economic factors such as the current COVID-19 crisis. Driver pay is one of the largest operating costs for fleets associated with a commercial truck. Safety regulations limit the amount of time a driver can operate behind the wheel. Together with the current driver shortage, autonomous trucks will provide additional capability on top of the current trucking capacity. Autonomous vehicles also reduce transit time substantially which affects the decreasing lead times customers put on orders and also reduces the need to have the inventory placed within close proximity to the end customer markets.

Autonomous trucks have already been used successfully in closed environments within vertical industries like mining and agriculture. They will be further tested on the road in the U.S., Europe and Asia/Pacific.

**Benefit Rating:** Transformational

**Market Penetration:** Less than 1% of target audience

**Maturity:** Emerging
Intelligent Connected Infrastructure

**Analysis By:** Ivar Berntz; Venecia Liu; Thierry Kuperman Le Bihan

**Definition:** Intelligent connected infrastructure (ICI) is an integrated “mesh” that enables transport infrastructure to exchange data with surrounding entities. The mesh is made up of elements such as artificial intelligence (AI), Internet of Things (IoT), cloud, analytics, telecommunications and autonomous technologies. The transport infrastructure can include ports, bridges, roads, airports and airways, and highways. And surrounding entities may include vehicles, technicians, equipment and other assets to transport authorities.

**Position and Adoption Speed Justification:** ICI kept gaining traction in 2020 among transport authorities that have a vision for pulling all technologies together to communicate, provide insight and enable decision making to take action. Enclosed campus environments, such as port authorities or airport authorities, have taken steps to implement intelligent connected infrastructures using 5G and Long Term Evolution (LTE) infrastructures.

Some of the enablers of ICI, such as IoT and vehicle to vehicle (V2V) communications, are at the Trough of Disillusionment. Others are already mature, (for example, electronic tolls, in-vehicle telematics or sensor-based charging stations), whereas some may have different standards or not exist yet. ICI combines these diverse data sources to create an intelligent infrastructure that can provide insight and initiate appropriate action(s). Example ICI use cases include:

- Notifying drivers about different road conditions (such ice or obstacles)
- Monitoring vehicles going into, or currently inside, tunnels, parking lots, facilities and restricted access areas/roads to organize assistance or evacuation in case of fire or accidents
- Orchestrating cargo prioritization at the port yard for rail and trucks
- Pulling in diverse data points from ground operations to air traffic control and airlines to decrease airplane gate turnaround time

ICI is still an emerging area since it requires a digital mesh infrastructure across various technology touchpoints and entities in the ecosystem for an orchestration and collaboration to realize this vision.

**User Advice:** CIOs seeking to advise COOs and operations managers on how to optimize the operations of leading should consider the following:
Governmental and private transport agencies or concessionaires should examine ICI to obtain multiple sources of data for a holistic view of infrastructure maintenance, planning, forecasting, safety and traffic flow.

Port authorities and operators need to look into ICI as a means to improve the orchestration of multiple stakeholders, (such as truck drivers waiting for unloaded cargo, pilots, tugboats, crane operators, rail cargo, shipyard equipment, shipper and emergency services).

Airports, passenger and cargo airlines, catering and ground handling ought to consider ICI to meet higher asset utilization and reduced greenhouse gas emission targets through the sharing of infrastructure.

**Business Impact:** ICI combines diverse, transport-related data sources, coalesces the data and provides an amalgamated view to produce actionable, intelligent insights back into the transportation ecosystem to deliver a seamless and optimized network. ICI can improve traffic flows, safety, infrastructure maintenance and road condition notifications such as hazardous conditions, accidents and collisions, roadblocks and vehicle usage. It can supplement vehicle sensor capabilities with information from other vehicles on the road and from the surrounding infrastructure. ICI could also enable a charging mechanism built into the infrastructure.

ICI can play a crucial role in the viability of autonomous vehicles. It can also provide economic savings and environmental benefits by improving transportation efficiency, which could offset the required investments. For example, with ICI, an autonomous ship could monitor itself and navigate the water conditions using sensors and algorithms that reduce required staff, as envisioned by Rolls-Royce.

The connected intelligent infrastructure will be able to communicate the status of the asset condition and if any maintenance is required. Smart motorways will be able to share which toll booths are open, which route is optimal, avoid hazards, inform users of road conditions and usage levels/patterns, and suggest speeds and fuel stops. A partial example is some tunnels that already control the heat of truck engines before allowing entrance, as this could be automated and eventually avoid huge queues and delays in case of fires. Smart ports would benefit from ICI in optimizing operations and improving terminal management by communicating with cranes, rails, port authorities and trucks on the loading and off-loading of cargo, cargo weight, size, location, hazardous materials and customs documentation and processes. The use of 5G as a ubiquitous network for IoT connectivity could provide the tissue for further extension of such capabilities. Smart airports would benefit from an increased capacity enabled through the better orchestration and coordination of members in the airport ecosystem including assets and ground service equipment. ICI in the sky partially exist today with direct plane-to-plane communication and air traffic control managing exceptions.

The risk level is high. New technologies offer new possibilities, but also come with unknown risks. For example, absence of standards and immature technologies can lead to unintended consequences and facilitate hacking. These will need to be considered in the design, development, implementation and operation of resilient ICI components.

**Benefit Rating:** High
**Market Penetration:** 1% to 5% of target audience

**Maturity:** Embryonic

**Sample Vendors:** Alibaba Cloud; Bosch Group; Cisco; Ford Motor Company; IBM; Mercedes-Benz; Qualcomm; Rolls-Royce; Siemens

**Recommended Reading:**
- “Market Guide for Vehicle Routing and Scheduling”
- “Market Insight: Roadmap for V2X Technologies for Autonomous Driving — When to Invest”
- “Hype Cycle for the Internet of Things, 2020”
- “Hype Cycle for the Future of CSP Wireless Networks Infrastructure, 2019”
- “Hype Cycle for Connected Vehicles and Smart Mobility, 2020”
- “Market Guide for Transportation Mobility Technology”
- “Market Trends: Monetizing Connected and Autonomous Vehicle Data”

**Hyperloop**

**Analysis By:** Venecia Liu

**Definition:** Hyperloop is a mode of transport using low-pressure vacuum tubes to propel transport pods at an ultra-high speed in a virtually friction-free environment from one point to another. Hyperloop technology can be used to transport people or goods.

**Position and Adoption Speed Justification:** In this past year, we haven’t seen enough progress to warrant the Hyperloop innovation profile to move up the curve. Its progress has been significantly impacted by the COVID-19 pandemic, which has led to project activity being postponed and government funds being shifted toward health and human services.

There has been much hype around this new mode of transport and interest in its feasibility to transport people. Elon Musk has driven the concept forward from the original Hyperloop Alpha paper published in 2013 to the annual SpaceX sponsored competitions which has resulted in prototypes and signed development agreements with nations around the world, including the United Arab Emirates (UAE), France, India and Indonesia. But, concerns have been raised about how pods are developed, oxygen requirements and the necessary safety equipment and emergency exit considerations. In July, 2020 Hyperloop Transportation Technologies and TÜV SÜD announced the first completed certification guidelines for hyperloop systems.

Theoretically, Hyperloop is said to achieve speeds of 1,200 km per hour or 760 mph. However, super maglev trains in Japan and China have already been recorded breaking 600 km per hour. While this is half of the projected speed of hyperloop, it is still a significant improvement on today’s highspeed rail initiatives which means that this competing technology may hamper future hyperloop consideration.
**User Advice:** Transport authorities and CIOs should wait to see the developments of a working commercial system and the subsequent issues that will arise before making investments. There has been a lot of promise and hype with the benefits of Hyperloop technologies, but a commercial deployment in use remains to be developed.

Consider alternative modes of transport, such as maglev technology and high speed rail or even flying autonomous vehicles if seeking faster transport in congested urban traffic.

Government entities and transport agencies should also examine Hyperloop’s impact with regard to the environment, society, safety, insurance, above-ground and below-ground implementation.

**Business Impact:** Transport authorities around the world seek cleaner, faster transport systems at lower costs. Some studies suggest Hyperloop technologies could be one-half to two-thirds the cost of a high-speed train and more than double or triple the speed of the fastest train. Hyperloop technology requires less energy consumption than a conventional train, and it is positioned as safer and quieter, as well as can move on demand. Munich RE, an insurance firm, recently partnered with Hyperloop Transportation Technologies to do a risk study and concluded Hyperloop technology is feasible and insurable in the medium term.

The use cases for Hyperloop technology have been point to point in congested areas. Also, specific use cases include moving cargo from shipping ports and connecting one airport to another. If there are commercial deployments of Hyperloop, then this fast mode of transport could increase demand to live in satellite cities and reduce road traffic congestion for commuters.

**Benefit Rating:** Transformational

**Market Penetration:** Less than 1% of target audience

**Maturity:** Embryonic

**Sample Vendors:** Delft Hyperloop; Hyperloop Transportation Technologies; The Boring Company; TransPod; Virgin Hyperloop One

**Recommended Reading:** “Digitopia 2035: All Stories Collected”
“Digital Society Infrastructure Will Set the Enterprise’s Business Context”
“Market Guide for Collaborative Work Management”

**Supply Chain Control Tower**

**Analysis By:** Christian Titze

**Definition:** The control tower is a concept combining the capabilities of people, process, data, and organization, facilitated and supported by appropriately combined technology elements, for transparency and coordination. It is about developing a set of playbooks of appropriate actions and reactions: (1) see — enabling visibility into current and projected situations; (2) process —
understanding impacts; and (3) act — providing means to suitably resolutions within a business ecosystem.

**Position and Adoption Speed Justification:** The term “control tower” still means many things to many people, creating a recipe for confusion in the marketplace and making it difficult for buyers to select appropriate control-tower-type capabilities for their needs. Fundamental control-tower-type technology-enabled capabilities, such as exception alerts and interactive dashboards to support areas such as capacity shortage, inventory shortage or late shipments, are now foundational and fairly standard to modern SCM solutions. However, advanced capabilities such as impact analysis, scenario simulation or a collaborative resolution/response room are lagging behind.

Most current available solutions are domain-specific, serving a specific role in supply chain planning or supply chain execution (like logistics control tower) rather than being supply chain end-to-end in support of supply chain convergence. They are also less actionable and mostly provide visualization capabilities (end-to-end data-driven insights) but not related to collaborative resolution (end-to-end intelligent decision making). We positioned control tower just around trigger/peak midpoint, as we refer to end-to-end, yet domain-specific control towers are more mature (around peak/trough midpoint). What you need is end-to-end insights and orchestration, a digital twin in order to allow impact analysis and scenario modeling, and collaboration for intelligent issue resolution.

**User Advice:** What hasn’t changed is this: There are no standards for control-tower-type application requirements or capabilities, making it increasingly challenging for buyers to evaluate vendor offerings and identify potential needs. Therefore, it is essential for supply chain technology leaders to build a comprehensive understanding of the underlying capabilities in parallel — regardless of the terminology — helping remove any confusion and misconceptions. There are different types of offerings marketed as control tower solutions. These are control-tower-type capabilities as an integrated part of a broader SCM platform (either serving supply chain planning [SCP] or supply chain execution [SCE]), or a stand-alone tool that leverages intelligence on top of a data lake.

In order to gain full visibility that is marketed by most of the solutions, companies need to be mindful that they need to map out in their journey an end-to-end control tower versus a more functional supply chain approach. They also need to improve nontechnical capabilities like process management and decision-making capabilities to support a control tower environment.

**Recommendations:**

- Familiarize yourself with the concept, building blocks and anticipated benefits of control towers so you can properly communicate the value to your peers.
- Invest in control tower capabilities when maturing supply chain processes, scope or technology.
- Pick the right solution offering based on your use case.

**Business Impact:** Control towers have gained popularity because they are marketed as stitching together complex and siloed supply chains, and they are gaining visibility and insights into the supply chain performance. It is all about getting more transparency (what’s happening in my highly
volatile supply chain) and coordination (linking to the different layers that will not be replaced by the control tower). Hereby, control towers act as entry points to make better and faster decisions.

A control tower captures end-to-end, data-driven insights for designing and optimizing the supply chain, as well as managing end-to-end exceptions, enabling intelligent end-to-end decisions within the business ecosystem. This can be mapped toward the following detailed activities required:

- **Sense (see):** Get real-time, end-to-end supply chain visibility
- **Analyze (process):** Understand and leverage signals from the digital ecosystem
- **Predict (project):** Utilize advanced analytics for predictions and prescriptions
- **Solve (act):** Do exception management and scenario modeling
- **Execute (respond):** Leverage a collaborative intelligent response framework
- **Learn (learn):** Continuously learn, sense and respond.

**Benefit Rating:** High

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Adolescent

**Sample Vendors:** Blue Yonder; E2open; Elemica; Infor; One Network Enterprises; SAP

**Recommended Reading:**

- “Research Brief: Remove the Clouds of Confusion When Shopping for a Supply Chain Control Tower”
- “High-Tech Supply Chainnovator Finalists 2020: Automated Contracts, Planning and Fulfillment”
- “Video: Electrolux — Logistics and Customer Service With End-to-End Vision”
- “Video: Logitech — Control Tower Evolution”

**Platooning**

**Analysis By:** Ivar Berntz

**Definition:** Convoying vehicles into platoons is a method to optimize overall fuel consumption and increase road capacity via cooperative, adaptive cruise control. Platoons decrease the distance between vehicles, making them travel at specified gaps, using electronic, vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and possibly mechanical, coupling. This allows trucks, buses and cars to join or leave platoons simultaneously while maintaining the close proximity required to reduce wind resistance and drag.

**Position and Adoption Speed Justification:** Platooning is still at an emerging stage. The technology for platooning with trucks of the same brand (so-called “monobrand platooning”) is already available, but the regulatory landscape constrains its use. At the same time, customers will want to be able to platoon with vehicles of different brands. The next step would be to introduce
multibrand platooning (up to automation Level 2 as defined by the Society of Automotive Engineers [SAE]) with the driver ready to intervene. This might require totally new vehicles, or it may be something that can be retrofitted, but for both to happen the regulatory environment will need to evolve at the same time. Eventually, autonomous or smart vehicles with artificial intelligence could automatically join and leave platoons.

Right up until 2019, the appetite for platooning seemed strong following successful real-world trials with MAN Truck and Bus in partnership with DB Schenker and Hochschule Fresenius University of Applied Sciences in Germany. This trial concluded that platooning is not only possible but “safe, technically and easily applicable in the routine of a logistics company.” Despite that, In early 2019, Daimler Trucks North America announced that it was pulling back its truck platooning investment citing “less than expected fuel savings,” even in perfect platooning conditions.

Since then, the platooning juggernaut seems to have slowed somewhat, particularly given the impact of COVID-19.

**User Advice:** The benefits of platooning have thus far shown to be elusive and hard to achieve. There are other technologies that can yield good results with less effort, sooner. For instance, **Daimler claims that it can achieve 3% fuel savings** with predictive powertrain control, basically an autonomous Level 2 system with HD maps.

Like autonomous driving, platooning has had its fair share of technical and legal challenges. Although platooning per se is not prohibited by law in most places, several locations have laws that dictate a minimum distance between vehicles. That distance is typically bigger than the aerodynamic following distance, which negates the fuel-saving advantage of platooning. In February of 2020, the European ENabling SafE Multi-Brand pLatooning for Europe (ENSEMBLE) research program published their multibrand platooning project scope and three-year plan, its ambition to:

- Realize prestandards for interoperability between trucks, platoons and logistics solution providers.
- Speed up actual market pickup of (sub)system development and implementation.
- Enable harmonization of legal frameworks in the member states.

Transportation CIOs with no platooning initiative should keep monitoring its evolution, because the technology and regulatory landscape may change in a discontinuous manner. CIOs in the transportation business that do road cargo should:

- **If monobrand vehicle fleet:** Investigate whether the vehicle make offers a retrofit or if you have models that are already platooning-enabled. Invest in limited-scale testing to understand eventual use cases, advantages and limitations. If you detect a promising use case, consider participating in the U.S. DoT or the EU programs to understand the impact of it on your business, and determine data streams and system integration requirements.
- **If multibrand vehicle fleet:** Wait for the technology and regulations to evolve.
**Business Impact:** Companies in the trucking and cargo business stand to benefit the most from this innovation. Platooning can improve safety while reducing CO2 emissions (as in, consumption) by up to 16% from the trailing vehicles and by up to 8% from the lead vehicle (according to the recent ITS4CV study by ERTICO).

Buses are now also being targeted for platooning experiments under the U.S. Department of Transportation (USDOT) Federal Transit Authority (FTA) Integrated Mobility Innovation (IMI) Program. The next frontier in truck platooning will be connecting vehicle-to-everything (V2X) communications to the cloud.

**Benefit Rating:** Moderate

**Market Penetration:** 1% to 5% of target audience

**Maturity:** Emerging

**Sample Vendors:** Continental; HINO; Navistar; PACCAR; Peloton; Tesla; TRATON; Volvo Group

**Recommended Reading:**

“The 2020 Top Strategic Transportation Technology Trends”

“Market Insight: Roadmap for V2X Technologies for Autonomous Driving — When to Invest”

“Tech CEOs Should Reprioritize Their Strategies as Robotaxi Deployment Expectations Cool”

“Supply Chain Brief: All Aboard the Transport Fuel Surcharge Roller Coaster”

“Hype Cycle for Automotive Electronics, 2019”

“Hype Cycle for Connected Vehicles and Smart Mobility, 2019”

Swarming Robotics

**Analysis By:** Ivar Berntz

**Definition:** Swarming robotics is an attempt to control both physically and behaviorally a set of communicating robots, e.g., drones, creating a feedback loop between them. With that, self-propelled individual robots aggregate together to move as a group and modify their movements to attain the goal of multirobot coverage or exploration of an area or situation. This can be done for commercial and military uses.

**Position and Adoption Speed Justification:** In 2020, swarming progressed closer to the peak. The innovation is approaching its adolescence. While several use cases still need to be extensively tested/developed/expanded upon before they can mature, others, like warehousing and drone swarms have progressed considerably. While there is still a need to simplify the individual robot communication, in an effort to isolate and understand swarm behavior and intelligence, group sizes of up to a thousand are increasingly being field tested, instead of only simulated on computers.
More recent, emerging use cases, involve **autonomous vehicles** and **human-robot coordination**. We should thus expect continued evolution for swarming robotics.

**User Advice:** Swarming was initially focused on miniaturization and principally on the idea that for certain types of problems, many small, low-cost robots would yield similar if not better results performing a task than a larger more expensive robot. The advantage relied on the age-old truism of strength in numbers: A swarm can take on casualties and failures, and just keep going.

Emerging and developing use cases include:

- **Military**, the swarming technology benefits are intuitive. The idea of using a set of affordable, replaceable devices appeals to a number of applications, e.g., having a swarm of drones protect a group of soldiers. Several vendors are active in this market.

- **Warehouse logistics**, vehicle platoons and even multiplatoons can work collaboratively to alleviate congestion, increase throughput and reduce accidents. This is already in development by several vendors and clients.

- **Entertainment**, several large-scale demonstrations using dancing robots or drones have been done by various vendors.

- **Social media bot swarms** might evolve to simulate societal mood swings in order to drive voting or even broader societal outcomes, with considerable ethical implications.

- **Healthcare**, swarms of nanobots might one day perform preventative surgery without an incision made to the body, or repair physical damage. This requires working with universities in order to direct research.

- **Maintenance areas**, microbots could work inside machinery, monitoring and correcting eventual deviations, but this needs to be further developed.

- **Farmers** interested in covering wide swaths 24/7 can start getting acquainted with autonomous vehicles and unmanned aerial vehicles for mowing and harvesting, or crop protection.

- **IT**, server, storage and even AI farms that adapt themselves to nonprogrammed use cases. Several announcements have been made in the area of edge computing. Test where appropriate.

- **Autonomous vehicle communication**, with a moving grid of available slots to fit into or move to, could allow for different makes and sizes to share roads with regular vehicles in the future.

**Business Impact:** The most immediate business impact is at this moment being developed and tested in warehousing, entertainment and warfare contexts. Outside of these, it is still at an experimental level and thus more difficult to assess.

In principle, swarming complements aerial, naval, terrestrial and micro/nanotechnology autonomous thing technologies, as an assigned task could be done in less time, and for lesser cost, if a set of robots is deployed to the task or tasks.
In contrast to biological swarms, the digital embodiment has the advantage that the program of individual swarm members can be quickly updated based on information gathered by individual members. The whole swarm can learn from the mistakes of individual members.

**Benefit Rating:** Moderate

**Market Penetration:** 1% to 5% of target audience

**Maturity:** Emerging

**Sample Vendors:** Apium; China Electronics Technology Group; DJI; EHang; Intel; Kronstadt; Northrop Grumman; Raytheon Technologies; Siemens

**Recommended Reading:**
- “Hype Cycle for Drones and Mobile Robots, 2019”
- “Top 10 Strategic Technology Trends for 2020: Autonomous Things”
- “Deploy Leaner AI at the Edge: Comparing Three Architecture Patterns to Enable Edge AI”

**Supply Chain as a Service**

**Analysis By:** Michael Dominy

**Definition:** Supply chain as a service (SCaaS) is an externally focused commercial digital service that delivers ongoing management of one or more supply chain functions to other enterprises. These business process services leverage technologies and supply chain professionals. Processes are standardized, configurable and exploit cloud technologies.

We have combined supply chain (SC) business process as a service (BPaaS), business process outsourcing (BPO) and digital SC services into SCaaS to better align with how the market describes the innovation.

**Position and Adoption Speed Justification:** Cost-effective availability of cloud computing infrastructure services, multitenant SaaS applications, open-source software and analytics tools have enabled service providers and some enterprises to create, launch and sustain SCaaS offerings. Adoption will vary by maturity and current application portfolio. Organizations with limited or outdated supply chain applications will be more open to using SCaaS. Access to master data and transaction systems, such as ERP, will be critical enablers for the service.

Adoption varies by process area:

- Transportation management, customs clearance process and tracking are mature examples. In the area of tracking, basic tracking is not charged separately.
- Postsale or postdelivery services are less mature.
- Supply chain planning and analytics as a service are less mature, but are being offered and hyped by many providers.
- Sourcing and procurement, like logistics, is mature overall with differences between direct and indirect categories. Indirect sourcing and procurement is very mature, while direct materials or parts is immature.

**User Advice:** If you are considering launching your own SCaaS, evaluate your ability to compete. Use, “Take Four Steps to Develop Your Supply-Chain-as-a-Service Strategy” to help assess your capabilities, the competitive landscape and solution requirements.

If you are considering using SCaaS, prioritize processes and functions with lagging capabilities or those spanning multiple organizations. For example, if you have poor supply chain planning capabilities and constrained budgets or insufficient planning professionals, you should consider a SCaaS offering for supply chain planning. An example SCaaS targeting processes spanning multiple organizations would be those enabling a digital business model for a product company that requires integration and coordination of forward fulfillment and aftermarket or delivery services.

Continually monitor the market for new SCaaS offerings. As software functionality becomes more advanced, and as integration capabilities utilizing cloud services improve and expand, service providers will bring new and broader services to the market. Digital tools, such as artificial intelligence, robotic process automation and machine learning, are enabling providers to create, deploy and scale services faster than traditional license, design and implementation approaches using packaged applications.

**Business Impact:** SCaaS will continue to impact the logistics function, especially as logistics service providers look to leverage technology to offer more differentiated services to shippers. Aftermarket services, such as returns and reverse logistics, will be impacted as companies expand digital offerings or embrace circular business models. SCaaS will also impact planning and optimization, including demand forecasting, supply planning and inventory optimization. Manufacturing operations processes that involve regulatory and compliance activities, such as environmental, health and safety (EH&S) reporting, material safety data sheet (MSDS) processing and reporting, will be impacted. The demand-sensing and demand-shaping functions within supply chain management (SCM) will also be impacted as existing and new service providers capture and analyze consumer data from social networks and combine it with other sources of demand data, such as POS scan data.

**Benefit Rating:** High

**Market Penetration:** 1% to 5% of target audience

**Maturity:** Emerging

**Sample Vendors:** Arrow Electronics; Celestica; DHL; Entercoms; Genpact; Jabil; KPMG; Mayo Clinic; Tata Consultancy Services; UPS Supply Chain Solutions

**Recommended Reading:** “Take Four Steps to Develop Your Supply-Chain-as-a-Service Strategy”

“Market Guide for Supply Chain Strategy and Operations Consulting”
Flying Autonomous Vehicles

**Analysis By:** Michael Ramsey

**Definition:** Flying autonomous vehicles encompass self-operating aircraft that sometimes are referred to as “flying cars” or personal drones and are designed to operate without a human pilot either in the vehicle or remotely operating. These vehicles include air taxi services, primarily, but do not include commercial delivery drones. They are distinguished by their ability to complete complex decision making in addition to handling normal vehicle operations as an “autopilot” function might do in a standard aircraft.

**Position and Adoption Speed Justification:** More than a dozen companies are working on new aircraft that are piloted by artificial intelligence and designed to create a more agile, less expensive and quicker way to execute air travel, primarily in congested areas. The goals of the projects include:

- Faster travel in densely populated areas
- Economical air travel over short distances
- Travel to difficult-to-reach locations or with poor infrastructure

The ambitions around these vehicles have primarily expressed themselves in the form of advanced air taxis that would fly over congested megacities, reducing transit time. There are efforts underway by companies such as Airbus and Uber to develop self-flying vehicles. In many cases, the designs are multiple-rotor, vertical-takeoff-and-landing (VTOL) devices. They are similar in capability to traditional helicopters, but look similar to much smaller drones. Increasingly, firms are using hybrid VTOL and horizontal wing designs to take advantage of the agility of a VTOL vehicle with the fuel efficiency and speed of a horizontal wing aircraft.

While the prospect of direct flights over congested areas is tantalizing, these vehicles face significant challenges to implementation. The technology is not currently validated by federal authorities and ensuring safety of such a system could take years. In addition, regulations are such that distances of a mile or more may be required between the vehicles over urban areas, limiting the usefulness. Infrastructure in cities is not currently available for landing areas to accommodate large numbers of vehicles and the vehicles produce significant noise. Finally, many versions of the vehicles are battery-powered, limiting their range significantly when compared with standard helicopters or planes. All that said, the prospect of fast, economical and, ideally, safe flight, point-to-point, in urban areas is certain to attract significant interest and investment. Additionally, the U.S.
Air Force took an interest in developing this industry further and is planning to invest in the technology and hold competitions for vendors to create working vehicles.

**User Advice:** For CIOs in organizations dependent on transportation and logistics, add these vehicles to the long-term technologies that may need to be obtained or used in your processes. While it may be decades before these vehicles proliferate, they are nearly certain to grace the skies at some point. Assess what problems in logistics, both for moving people and for cargo, that might be solved by using these vehicles. Consider how systems might need to be altered internally to allow for use of the vehicles.

**Business Impact:** The business impact of flying autonomous vehicles is likely to be moderate for most companies, though it could be quite high in a limited set of businesses around mobility services and logistics. For most people, these vehicles will be an extra convenience and not the primary way they will travel. In the end, they are mostly going to be the equivalent of robot-piloted helicopters, which lowers the cost and perhaps increases the availability of a service that already exists. It is likely that special use cases in remote areas or difficult topography will lead to much faster adoption on a regional or special use basis, as helicopters already serve locations like this in special circumstances.

**Benefit Rating:** Moderate

**Market Penetration:** Less than 1% of target audience

**Maturity:** Embryonic

**Sample Vendors:** Airbus; Bell; Lilium; Terrafugia; Uber; Volocopter

**Recommended Reading:** “Why Autonomous Flying Drones Must Be on the Radar of Mobility Sector CIOs”

“Hype Cycle for Drones and Mobile Robots, 2019”

**AI in Transportation**

**Analysis By:** Venecia Liu; Pedro Pacheco

**Definition:** Artificial intelligence is a discipline that applies advanced analysis and logic-based techniques, including machine learning, to interpret events, support and automate decisions, and take actions.

**Position and Adoption Speed Justification:** AI has a number of applications and use cases in transportation from chatbots for travel planning, baggage support in aviation to autonomous robots and autonomous vehicles. Machine learning is one form of AI techniques to identify patterns and make predictions. AI solutions make sense of structured and unstructured data and can interact with humans through various means, for example via written or conversational natural language.
Amid COVID-19, several companies have used AI such as autonomous vehicles to deliver goods and medical supplies to cities under lockdown as well as use autonomous vehicles to shuttle people to COVID-19 testing locations. With the risk of COVID-19 infection through contact, many transport authorities are evaluating touchless interfaces to engage with passengers and reexamining AI for facial recognition. Several years ago, biometric boarding trials took place among many airports and airlines using facial recognition and several are reconsidering facial recognition to eliminate the touch interfaces.

AI is being utilized to compute IoT data in areas of predictive analytics in the maintenance, repair and overhaul (MRO), transport infrastructure and transport operations space. Other AI applications in transportation include advanced urban traffic optimization and routing, forecast planning, load planning and demand modeling. There are already several use cases for AI pertaining the optimization of mobility as a service (MaaS) and shared mobility ecosystems. These can be used for improving public transport schedules, traffic around cities or even where to place shared vehicles and how many to allocate using AI techniques.

The position of AI in transportation is nearing the peak as more transportation companies experience the benefit and business value of AI. AI helps to drive operational efficiencies in network operations, routing, scheduling, planning, monitoring and to optimize cost in both cargo transport and passenger transport.

**User Advice:** We recommend:

- Transportation CIOs should consider AI to be leveraged holistically across the organization to build an AI strategy. Gather requirements from business unit leaders to identify how AI can optimize operations as well as how it can be used to improve and enhance passenger engagement.

- Retrain internal IT skill sets to build AI capabilities depending on your AI application such as robotics engineer, data scientist, RPA expert, computer vision programmer, etc. Several e-learning course platforms offer training services such as data science and machine learning to upskill your team.

- Seek technology partners such as IT services firms, startups or software providers to help fill the short-term internal gaps in AI skill sets and resources. In some cases, these third-party providers may be willing to share costs if it is considered a leading edge solution that will get them recognition and future business.

- Bear in mind the legal constraints or public opinion when implementing AI. While AI surveillance was considered a method to identify people of threat, there have been concerns of mass surveillance and government tracking people. Due to this, some cities such as San Francisco and the EU have banned the use of facial recognition in public places.

**Business Impact:** AI impacts the transportation industry across many facets of the operations from transportation planning, design, forecasting, passenger engagement, operations and maintenance, surveillance systems, biometrics and facial recognition, to autonomous vehicles. By augmenting the ability to synthesize data, identify patterns and arrive at conclusions, AI provides quicker analysis for
decision making and efficiencies. Autonomous vehicles, drones and robots can provide efficient and reliable operations to optimize transit.

AI in surveillance cameras and baggage/container scanning machines would be able to quickly identify a suspicious person or dangerous item in the baggage/container, thus its impact on safety is significant.

**Benefit Rating:** Transformational

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Emerging

**Sample Vendors:** Alibaba Cloud; Google; IBM Watson; KONUX; LexX Technologies; Local Motors; Noodle.ai

**Recommended Reading:**
- “Introduce the Machine Learning Architect — An Emerging Technical Professional Role in AI Initiatives”
- “Top 10 Strategic Technology Trends for 2019: AI-Driven Development”
- “2020 CIO Agenda: Global Perspectives for Transportation”
- “Cool Vendors in AI in Automotive and Smart Mobility”
- “Market Insight: How to Increase the Business Value of AI in Transportation”

**Digitized Freight Networks (Road)**

**Analysis By:** Bart De Muynck

**Definition:** Digitized freight networks (also often referred to as digital freight brokerage platforms), provide shippers real-time access to capacity and rates, and allows them to instantly book freight. These platforms publish transportation supply and demand information to a broad online community of shippers and carriers across extensive networks of carriers leveraging modern integration techniques and technologies.

**Position and Adoption Speed Justification:** A growing number of digitized freight networks for commercial domestic transportation are entering the U.S., European markets as well as Asia (mainly India and China). These platforms are becoming more interesting to and necessary for shippers, especially in times of disruption and/or tight capacity. The models differ from traditional brokerage in that the capacity offered is available rather than booking the load with the shipper and finding capacity later. Customer demand is typically driven by increases in transportation costs (both full and less than truckload), need for automation and access to real-time freight capacity combined with a transportation industry in flux. This forces shippers to seek other sources for capacity outside of their traditional contracted carriers, brokers and spot markets. Where a company’s existing transportation systems might be directly connected to a small number of preselected carriers, the current business climate necessitates that they communicate with a far larger ecosystem of
partners. This offers a win-win for carriers as it fills empty miles and can increase the utilization of the carrier’s fleet. Many of these platforms have partnered with existing TMS vendors to provide an integration for loads where contracted rates cannot be found or honored.

**User Advice:** Shippers that have a focus on reducing transportation costs, have a dependency on the spot market or struggle with capacity, can source their transportation needs via these networks to increase their options when it comes to transportation. These platforms, although still relatively small, offer opportunities for shippers that are looking to find capacity and lower costs while providing better delivery services to their customers.

**Business Impact:** Although most shippers still use contracted common carriers and private fleets for the biggest part of their business, growing capacity constraints, increasing omnichannel orders and increasingly selective carriers will continue to drive demand for ad hoc capacity. These platforms will provide shippers with available capacity while increasing carriers’ load percentage and decreasing empty backhauls and empty miles.

**Benefit Rating:** Moderate

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Adolescent

**Sample Vendors:** BlackBuck; Convoy; Emerge; Everoad; Fretlink; InstaFreight; Loadsmart; NEXT; Transfix; Uber Freight

**Recommended Reading:**

- “How Digitized Freight Platforms and Other Transportation Technologies Can Help With Current Domestic Transportation Capacity Challenges”
- “Digitization of Transportation Networks Provides an Option for Companies to Tackle Transportation Capacity”
- “Video: Converging Physical and Digital Transportation Through Visibility and Digital Procurement of Freight — Land O’ Lakes Use Case”

**Intelligent Traffic Management Systems**

**Analysis By:** Venecia Liu

**Definition:** Intelligent traffic management systems are advanced systems to manage traffic flow. They incorporate infrastructure sensor data, camera data and vehicle data, together with traffic light and the surrounding environment in real time, to automatically adjust traffic flow based on the road condition and context of the traffic situation. Intelligent traffic management systems also take into consideration safety, efficiency, vehicle speed, air quality, congestion and vehicle routes.

**Position and Adoption Speed Justification:** Intelligent traffic management systems pull in data from various sources in real time to dynamically adjust traffic lights to improve the flow of traffic or enable emergency vehicles to quickly have a clear route to the destination. In the past, GPS data, radar sensors and digital cameras were used to measure traffic flow and some transport authorities
were pulling in historical data, such as weather, time of day and traffic patterns, to adjust signal lights. With edge computing, intelligence is now embedded in the camera and traffic lights incorporating AI, IoT sensor data and real-time data to do the analysis. Aspects of intelligent traffic management systems are being pulled into the larger intelligent connected infrastructure technology.

Some intelligent traffic management systems also include payment infrastructure for tolling as well as electric vehicles (EVs) priority lanes. Several highway authorities have been implementing express lanes for not only EVs and high-occupancy vehicles (HOVs) but also charging drivers who wish to drive in these express lanes to get to their destination faster. This payment mechanism enables new revenue streams for the government. Some of these intelligent traffic management systems have better design configurations utilizing technologies to eliminate the electronic toll infrastructure and gantry with infrastructure of the side of the road to further reduce setup costs.

**User Advice:** Edge computing can be utilized to do processing of data at the edge. For traffic management, edge computing done at the traffic light intersections can analyze patterns of driving violations and send the relevant information to central operations. Faster processing and lower cost have enabled smaller boxes to do powerful calculations to enable traffic management systems to become more advanced and sophisticated. Traffic light synchronization has been implemented for many years, but intelligent traffic management systems avail multiple sources of data to analyze and automatically take action in real time.

This means first responders would be able to enter an intersection with traffic lights synchronized to their direction. However, the ideal state of adjusting traffic lights to enable emergency vehicles to quickly maneuver the city streets would only be possible if different municipal government agencies work together to enable data to be pulled together into the traffic management systems. This would require coordination of and participation across multiple agencies and other entities in the wider ecosystem, such as transport agencies working with public safety, health and human services, and hospitals/emergency vehicles. Municipalities working toward smart cities recognize this vision and the benefits that can be achieved, such as better traffic flow and reduction in the loss of productivity as people won’t be stuck in traffic congestion. In addition, paid express lanes can be an added revenue stream using intelligent traffic management systems.

**Business Impact:** While traffic congestion has subsided given the shelter-in-place and remote work strategies employed by many companies around the world, the priorities for government CIOs have shifted. As governments face capital constraints, from stimulus packages and the minimal expected tax revenue for this year to fund next year’s budget, there may be a way to utilize intelligent traffic management systems as a new source of revenue. Fines issued for traffic violations (from talking on mobile devices while driving to stopping over the crosswalk) using intelligence from the intersection cameras could be a way forward. Maintaining public safety by ensuring drivers comply with regulations has conventionally required personnel to issue tickets to violators. Now technology can play a role. Optimizing traffic flow with the use of intelligent traffic systems may also reduce the commute time, subtly enhancing drivers’ emotional well-being and perceived quality of life.

**Benefit Rating:** Moderate
**Market Penetration:** 1% to 5% of target audience

**Maturity:** Emerging

**Sample Vendors:** Advantech; Alibaba Cloud; Hazen.ai; Huawei; Indra; Kapsch Group; Panasonic

**Recommended Reading:** “2020 CIO Agenda: Global Perspectives for Transportation”

“Cool Vendors in AI in Automotive and Smart Mobility”

“Market Guide for Transportation Mobility Technology”

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**Blockchain in Logistics and Transportation**

**Analysis By:** Andrew Stevens; Dwight Klappich

**Definition:** A blockchain is one architectural design of the broader concept of distributed ledgers. In logistics and transportation, blockchain is an expanding list of cryptographically signed, irrevocable transactional records shared by a network of participating supply chain trading partners (including manufacturers).

**Position and Adoption Speed Justification:** Across manufacturing, logistics, and transportation providers, blockchain can potentially be applied in areas such as automating/digitalizing transactional contracts, source-to-store goods authentication, event tracking, and shipper-to-carrier capacity matching and optimization. It’s position reflects continued but decelerated momentum for blockchain initiatives across the logistics and transportation sectors. Solution adoption and cadence could be dependent on how manufacturers of finished goods demand interdependent process steps and verifications across digital and physical transactions during high-risk or critical stages of transportation and distribution. Technology solutions supporting blockchain must adapt to bridge physical levels of authentication and interoperable data exchange across responsible trading partners.

Blockchain technology adoption challenges will also be impacted by a lack of robust protocols for governance across transactions, limited resources for establishing core blockchain expertise in-house and creating zones of trust in dynamic and interoperable operating environments. This is especially true for smaller and local logistics and transportation partners. Challenges largely centered around ecosystem enablement include:

- Governance
- Standards
- Interoperability
- Integration

Increasingly expectations and demands from retailers, distributors, and consumers paralleled with the increasing need for future digitalized networks will shape and influence future applications for
blockchain in logistics and transportation. This will likely occur through more collaborative and orchestrated trials and pilots for product supply across key products, assets, and services.

**User Advice:** Manufacturing, transportation, and logistics business leaders should consider joining or establishing a dedicated working group and consortium to accelerate their potential for being able to position blockchain accurately in their logistics and transportation operations. Recognize that terminology surrounding blockchain across logistics and transportation is in flux and often needs more granular and broader interpretation when it is applied in the context across the full supply chain. Uncertainty and applicability across supply chains (especially in physical transactions) often masks the potential suitability of technology solutions to meet business use cases. Be sure to:

- Assess the solution’s ability to map and execute across specific logistics and transportation use-case criteria and risks — such as location, status and ownership — and its planned timing and positioning across your strategy technology roadmaps.
- Identify specific high-risk logistics and transportation routes or markets that exhibit transactional complexity or have exhibited variable or low levels of service. These are prime candidates for blockchain.

**Business Impact:** Multiple business use cases for blockchain across logistics and transportation are yet to be proven. Although early hype has been focused on the financial services industry, it is likely that supply chain management will see increasingly higher volumes of adoption, but at slower rates.

Consider the following areas and levels of impact:

- **Risk: High** — Tools are still nascent and unproven, and resources and expertise to develop, maintain and govern these systems are lacking. However, in supply chain logistics and transportation, blockchain continues to have momentum.
- **Strategic policy change: High** — Certain supply chain blockchain use cases deployed as part of a strategic technology roadmap across many areas of the supply chain, such as global trade finance, product pedigree and security, could realize significant business improvements.
- **Organization change: High** — Groups of trading partners will need to address new collaborative and interoperable working practices and logistics organizations are normally risk averse.
- **Culture change: High** — Blockchain execution will require cultural shifts focused on shared value creation, trust and consensus across all levels of the business.
- **Process change: High** — Protocols must be established for secure transactions and governance mechanisms for the blockchain ecosystems.
- **Competitive value: High** — Early collaborators and adopters will gain a competitive advantage. However, because of the multienterprise nature of supply chain management blockchain use cases, logistics and transportation may get wrapped up into broader initiatives across the extended supply chain.
**Benefit Rating:** Transformational

**Market Penetration:** 1% to 5% of target audience

**Maturity:** Emerging

**Sample Vendors:** Blockshipping; Chainworks; Inxeption; Modum; Morpheus.Network; ShipChain; TMW Systems; TradeLens

**Recommended Reading:**
- “Supply Chain Brief: Industry Consortia to Drive Education and Standardization of Blockchain in Transportation”
- “Toolkit: Accelerate Your Blockchain Technology Competency Across the Supply Chain”
- “Top 10 Strategic Technology Trends for 2020: Practical Blockchain”
- “Blockchain Technology Spectrum: A Gartner Theme Insight Report”

**Immersive Experience in Logistics**

**Analysis By:** Dwight Klappich

**Definition:** The immersive experience (formerly wearables) in logistics spans several technologies. Conversational systems are where user and machine interactions occur mainly in natural language. Virtual reality is where computer-generated 3D environments are provided that surround a user and can respond to the individual’s actions in a natural way. Augmented reality is where users are presented with real-time visual information in the form of text, graphics, video and other virtual enhancements integrated with real-world objects.

**Position and Adoption Speed Justification:** In logistics, most businesses still consider the immersive experience a novelty. Only a small number of companies have progressed beyond pilots, notably with smartglasses. Also for example, while transactional voice is quite mature in logistics, conversational platforms, or chatbots, while interesting to users, are nascent. Although interest is increasing, there remain few examples of widespread adoption in production environments. Some of the initial wearable prototypes are new slants on solutions prevalent in warehouses, such as using smartglasses to replace scanning and voice solutions. However, technologies like virtual reality (VR) have yet to find appropriate use cases, even though interest is growing. Early indications are that augmented reality (AR) and VR are following an adoption pattern similar to traditional industrial/transactional voice (e.g., vendors like Honeywell’s Vocollect), so as the cost and performance of hardware improves, adoption will increase. Over time, we anticipate the emergence of new solutions that will provide capabilities not currently available. For example, virtualized cart picking, where the smartglasses function like a head-up display.

**User Advice:** Consider pilots for wearable user interfaces, especially smartglasses. Start with wearables for mobile workers who cannot conveniently or safely put aside what they have in their hands to use a phone or tablet. Examples include employees using tools or equipment, or who need to keep their heads up or hands free for safety. Evaluate solutions for all-day comfort to avoid issues such as headaches, eye fatigue and skin irritation from wearable devices.
Engage with software developers now on use cases specific to your business needs, and integrate solutions for logistics with the warehouse management system. Robust software solutions fully exploiting advanced AR will take an additional two to five years of development, but initial solutions are ready for basic use cases today.

The ROI for implementing wearables will be greater in countries where worker wages are relatively high. Where time-motion efficiency is essential to productivity, such as call centers and logistics organizations, employers are investigating wearables, such as gaze tracking through audio headsets and location tracking through badges. Explore solutions that lead to recommendations to increase worker productivity, or to monitor employees in physically demanding work environments.

**Business Impact:** Logistics’ use of immersive technologies will bifurcate into solutions for workers in the warehouse and in transportation, and the nature, types and value of solutions will segment likewise. For example, the use of head-mounted displays (HMDs) in warehousing has already garnered interest, and productive pilots indicate some improvements in worker efficiency versus existing methods. In transportation, there is potential for solutions targeted at productivity, such as HMDs or the equivalent, that support drivers’ mission, navigation and safety. Wearable solutions could monitor driver fatigue, for example. AR solutions have the potential to increase productivity by providing part labels, checklists, maps and instructions superimposed on real-world views. Companies should monitor government mandates (e.g., from OSHA, EPA, NTSB) that could require wearable technology for logistics operations for safety or compliance reasons.

**Benefit Rating:** Moderate

**Market Penetration:** Less than 1% of target audience

**Maturity:** Emerging

**Sample Vendors:** Accelogix; Honeywell; Ubimax; Upskill; Vuzix; Zebra

### 5G

**Analysis By:** Sylvain Fabre

**Definition:** 5G is the next-generation cellular standard by the 3rd Generation Partnership Project (3GPP). The standard targets maximum downlink and uplink throughputs of 20 Gbps and 10 Gbps respectively, latency below 5 milliseconds and massive scalability. New system architecture includes core slicing as well as wireless edge.

**Position and Adoption Speed Justification:** Seventy-three operators have announced 5G rollouts (Source: Global mobile Suppliers Association [GSA], April 2020), just under 9% (up from 5% one year ago) of mobile networks.

3GPP Release 16 freeze date has been postponed due to the COVID-19 pandemic, with a freeze target date of mid-2020.

5G encompasses a range of 3GPP standards focused on different functionality:
R15: Extreme broadband (5G NSA and then 5G SA)
R16: Augmentations for Industrial IoT (massive IoT, slicing and security improvements)
R17: Augmentations for wider ecosystem expansion (freeze target date end of 2021)
R18: Additional augmentations (e.g., extra territorial 5G systems, railway smart station services)

Due to this phased introduction, and the time required from the vendors’ ecosystem to build standard compliant networks and grow silicon and device availability, Gartner expects the full potential for 5G use cases to materialize first in 2022.

Use of higher frequencies and massive capacity, will require very dense deployments with higher frequency reuse. Here we see regional differences, whereby mmWave will be leveraged in the U.S. and South Korea, but may not see initial adoption elsewhere.

Gartner expects many 5G deployments to initially focus on islands of deployment, without continuous national coverage.

Less than 45% of CSPs globally will have launched a commercial 5G network by 2025. Uncertainty about the nature of the use cases and business models that may drive 5G is currently a source of uncertainty for many CSPs, enterprises, and technology and service providers (TSPs). Gartner estimates that 5G capable handset penetration will reach 50% in 2023 in Western Europe, and could be a little faster in North America.

We are seeing different dynamics by regions, where in many parts of Africa for example, 5G would not be the next step to lower bandwidth services, and handset cost may be an inhibitor for lower income subscribers. Adoption is more aggressive in APAC and NAR, with Europe cautiously enthusiastic — and the developing world lagging.

**User Advice:** TSP product managers should:

- Focus mobile infrastructure planning on LTE, LTE-A, LTE-A Pro, small cells and heterogeneous networks (HetNets), as part of a planned transition toward 5G.
- Ensure backward compatibility to preceding generation (LTE) devices and networks. This is necessary because 5G coverage may be limited, so new 5G devices need to be able to seamlessly transition to 4G fallback infrastructure for uninterrupted service.
- Focus on related architecture initiatives — such as software-defined network (SDN), network function virtualization (NFV), CSP edge computing, distributed cloud architectures and cloud native containerization, as well as end-to-end security in preparation for 5G.
- Provide solutions where new frequency allocations (preferably) should be used for the latest technology — 5G — to benefit from lower cost per byte, higher bandwidth and more capacity.
- Help CSPs refine generic services to vertical-focused solutions (B2B) for 5G.
- Have a clear understanding of specific verticals and their use cases for more effective consultative selling of their 5G solutions.
- Build their ecosystem of partners to target verticals more effectively with 5G.

Enterprise business leaders should:

- Identify use cases that definitely require the high-end performance of 5G; these may be few or even nonexistent for many verticals.
- Evaluate the multiple IoT alternatives available that may prove adequate, more available and more cost-effective than 5G for many use cases (e.g., low-power wide-area [LPWA] such as NarrowBand Internet of Things [NB-IoT], long-range [LoRa], Wireless Smart Ubiquitous Networks [Wi-SUN]).
- Clarify the level of complexity involved in operating a private 5G network.
- Evaluate options for CSPs or other providers to be involved in running the 5G network.

**Business Impact:** Gartner Enterprise 5G Surveys indicate that vertical use cases with 5G would be first motivated by operational cost savings. Another driver is agility — in particular, in oil and gas and manufacturing.

In addition, the vertical users for 5G appear to value lower latency from ultrareliable and low-latency communications (URLLC) and expect 5G to outperform rivals in this area.

With massive machine-type communications (mMTC), scenarios of very dense deployments can occur, supported by the 5G target of 1 million connected sensors per square kilometer.

5G enables, principally, three technology deployment and business scenarios, which each support distinct new services, and possibly new business models (such as latency as a service):

- Enhanced mobile broadband (eMBB) supports high-definition video.
- mMTC supports large sensor and IoT deployments.
- URLLC covers high availability and very low latency use cases, such as remote vehicle/drone operations.

URLLC and mMTC will be implemented after eMBB. Only eMBB addresses the traditional mobile handset requirement of ever higher throughput. URLLC addresses time critical industrial applications such as automation, with latency around 1ms over a limited range for a limited number of connections — where reliability and latency requirements surpass bandwidth needs. Finally, mMTC addresses the scale requirements of IoT. Apart from some smart city scenarios, mMTC may not be required in most locations for some years, with NB-IoT and other LPWA such as LoRa being sufficient for a while.

**Benefit Rating:** High

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Early mainstream
Sample Vendors: Cisco; Ericsson; Huawei; NEC; Nokia; Samsung; ZTE

Recommended Reading: “Market Guide for 5G New Radio Infrastructure”
“How Assessing 5G Mobile Technology for Organizations”
“How to Select 5G NSA/SA Migration Paths”
“Forecast: Communications Service Provider Operational Technology, 1Q20 Update”
“Market Trends: Strategies Communications Service Providers Can Use to Address Key 5G Security Challenges”
“Reduce Privacy Risks When Using 5G Products and Services”

Autonomous Mobile Robots

Analysis By: Dwight Klappich

Definition: Autonomous mobile robots (AMRs), formerly called smart automated guided vehicles (AGVs) in previous Gartner Supply Chain Execution Hype Cycles, add intelligence, guidance and sensory awareness to conventional AGVs, allowing them to operate independently and around humans. These new types of AGVs address the historic limitations of traditional AGVs, making them better suited to, and more cost-effective for, complex warehouses and collaborative activities.

Position and Adoption Speed Justification: AMRs will continue to gain traction in complex distribution centers and AMRs will increasingly develop to take over functions historically performed by humans on lift trucks such as product put-away or forward-picking replenishment with little to no human intervention. As computing power has multiplied and the cost of sensors has declined, the power, flexibility and use cases for AMRs have grown while prices have come down leading to significant AMR market demand growth. However, while customer demand strengthens, resource availability to deploy AMRs is poised to become a barrier to growth. Gartner tracks over 50 AMR vendors that perform various warehouse tasks from simple transport moving goods from point A to B to more complex and sophisticated collaborative picking robots where the AMR supplement human labor. Market penetration is low overall with under 20,000 AMRs deployed commercially today, which when contrasted to the well over a million of lift trucks is a small market so far.

User Advice: Next-generation AMRs have become more autonomous and intelligent. They will transform warehouse operations over the coming decades. Costs and complexities will also come down, which will open up the market to more companies. Labor reductions seem the most likely drivers, but improvements in overall throughput and productivity will be the primary value, regardless of whether labor is reduced or not. Warehouse operations with a high volume of bulk (i.e., palette) product moves should consider some of the current generations of AMRs as an alternative or to supplement existing automation. Companies looking to build new automated facilities also should explore the potential value of these smart machines.

Business Impact: AMRs will continue to gain traction in complex distribution centers. The same technologies will emerge and also have applications outside warehouses as the technology
matures. For example, in retail stores there is the potential that an AMR could unload trucks and deliver palettes of goods to specific departments in a store without human intervention. Smart AGVs will increasingly develop to take over functions such as product put-away or forward-picking replenishment with little to no human intervention. AMRs could also have a positive environmental impact as they reduce costs such as lighting, heating and air conditioning, because robots don’t need any of that.

**Benefit Rating:** Transformational

**Market Penetration:** 1% to 5% of target audience

**Maturity:** Emerging

**Sample Vendors:** 6 River Systems; Clearpath Robotics; Fetch Robotics; GreyOrange; Locus Technologies; Seegrid; Vecna

**Recommended Reading:** “Predicts 2020: Supply Chain Technology”

“Cool Vendors in Supply Chain”

“Innovation Insight for Autonomous Mobile Robots”

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**Biometrics in Aviation**

**Analysis By:** Venecia Liu; Ivar Berntz

**Definition:** Biometrics in aviation use unique biological or behavioral traits to corroborate a person’s claim to an identity previously established to obtain access to an electronic or digital asset, e.g., curb to gate access or immigration status.

Typically used in one-to-one comparison mode (biometric verification) to support an implicit or explicit identity claim. Rarely used in one-to-many search mode (biometric identification) — where a person simply presents a biometric trait and the system determines the identity from a range of candidates.

**Position and Adoption Speed Justification:** With COVID-19, transport authorities are revisiting biometrics. In the past biometric methods were used for immigration e-gates, self-service baggage drop, airline lounge access, airport security access and boarding of aircraft using facial recognition, fingerprints and even retinal scan. Several of these biometric boarding trials were paused given privacy concerns but now with the proliferation of COVID-19 many transport authorities are revisiting the notion of facial recognition and gesture-based technologies as a way to eliminate all of the touch surfaces. Outside of aviation, the adoption of biometrics in transportation is nonexistent except for the few pilots of facial recognition to board trains in China. Because of this we have limited the scope of this technology profile.
Biometrics is a viable method to verify a person's identity. Its benefits include faster processing, reduced wait times, reduced queue lengths and crowds, and reduced staff to verify which result in a more efficient process. Some citizens have raised concerns about privacy, personal data usage, cross-border collaboration, surveillance and monitoring. These obstacles move the profile into the Trough of Disillusionment.

**User Advice:** Given COVID-19, transportation CIOs should reevaluate the use of biometrics facial recognition from a touchless standpoint while balancing data privacy.

Data and analytics leaders should consider how biometric data should be handled and stored. Architectures differ in privacy-relevant data security concerns, but the architectural choices cannot avoid general regulatory requirements set out in the EU General Data Protection Regulation (GDPR) and similar privacy mandates. Biometric data under GDPR is another form of sensitive data.

**Business Impact:** Eliminating another touch interface or exchanging documentation from one to another can be achieved using biometric techniques such as facial recognition although it raises many privacy concerns. Biometric techniques have demonstrated the ability for a more efficient and faster processing to verify a person’s identity. There is a balance between creating a seamless passenger experience, by eliminating bottlenecks where passengers would have to queue for a long time, and privacy regulations. Aviation companies need to monitor societal sentiment around it closely, as it may shift, while adopting additional security measures that observe applicable regulations on data ownership, data storage, data retention, data security and data vulnerability.

**Benefit Rating:** Moderate

**Market Penetration:** 20% to 50% of target audience

**Maturity:** Adolescent

**Sample Vendors:** Cognitec Systems; Materna IPS; NEC; Safran; SenseTime; SITA; Thales (Gemalto); Vision-Box

**Recommended Reading:** “Technology Insight for Biometric Authentication”

“Market Guide for Speech-to-Text Solutions”

“Biometric Verification: An Opportunity and a Regulatory Risk”

**Zero-Emission Vehicles**

**Analysis By:** Pedro Pacheco

**Definition:** Zero-emission vehicles (ZEVs) are those that do not emit harmful gases during operation. ZEVs are usually powered by batteries, fuel cells, photovoltaic cells or a combination of these, which are used to propel one or several electric motors. ZEVs includes all modes of passenger and cargo transport from cars to trucks, airplanes, ground transport vehicles, motorcycles, trains and ships.
**Position and Adoption Speed Justification:** ZEVs are past the Peak of Inflated Expectations as transportation companies keep expanding their ZEV offer in response to legislation echoing the drive for emission reduction in cities around the world.

This trend for emissions reduction is strongly present, for instance, in legislation and targets put forward by China and the European Union. The Chinese government has said that 25% of cars sold by 2025 should be new-energy vehicles, which includes ZEVs. The European Union has set stringent targets in terms of the CO2 emissions for the average sales of passenger cars for each manufacturer. Not only will this target become ever-more stringent, but it also has recently been expanded to commercial vehicles and trucks. Trucks will be required to lower their CO2 emissions by 30% by 2030. Moreover, EU’s Recovery Plan, as a response to the impact of COVID-19, has defined strong investment in the production of green hydrogen and the development of charging infrastructure for EVs and fuel cell vehicles. Adding to this, California regulators have mandated that at least half of all trucks sold in the state are zero-emission by 2035. As such, these points put strong pressure on vehicle manufacturers to rapidly deploy ZEVs in the market.

Some transport authorities have set their own targets. The MTA in New York has stated it will replace its diesel busses to an all-electric fleet by 2040, and Los Angeles Metro is committing to an all-electric fleet by 2030. In China, Shenzhen City has already converted its entire city bus fleet of 16,000 vehicles to electric, thanks to subsidies from the government. The city also recently announced that 21,000 taxi cabs are now electric. The city has a number of charging stations owned by the municipal government, the private sector and Shenzhen Bus Group. Shenzhen Bus Group has 136 bus depots, of which 20 have electric charging facilities. Most of its buses are charged overnight and can run about 200 km per charge. The Government of India has launched a Green Urban Transport Scheme (GUTS) to push electric vehicle public transportation and has proposed an INR 250 billion grant for its development.

On the trucking side, the Tesla Semi has produced a lot of hype in the industry, raising awareness toward the concept of electric mobility, even in long-haul trucks. Nikola Motor has also made significant progress with its electric and fuel cell trucks, securing further investors and growth. This, in turn, has led established truck makers to push forward their electrification roadmap, with the likes of Volvo and Mercedes, for instance, putting several electric variants on the market.

**User Advice:** CIOs in transportation agencies should examine the political, environmental, social, financial and regulatory impact on decisions to migrate to ZEVs. Follow the development of the underlying technology of the ZEV and evaluate the limitations, challenges and long-term benefits.

Assess the required supporting infrastructure, access location, maintenance infrastructure and skill sets required to maintain the ZEV. For example, work with utility companies and municipalities to install charging stations, as there has been concern over the limited infrastructure for charging vehicles. At the same time, carefully evaluate aspects related to the performance of these vehicles, and make sure they do not impact your demands for features like driving-range limitations.

Fleet operators can tap into funding sources such as municipal bonds, federal funding programs, grants or transport taxes to finance ZEV purchases. The recently announced EU Green Recovery Deal will provide a boost to ZEVs within EU countries. For electric vehicles, there may also be an
additional possibility to offset costs with the vehicle to grid technology, where you can sell back electricity to the grid at peak times. Some transport agencies may consider installing their own charging infrastructure and to use these charging locations for a new business models such as charging as a service or a rental service to others. Moreover, ZEVs also offer lower running costs than combustion-engine vehicles — this is an additional argument to justify the transition.

**Business Impact:** ZEVs’ impact on passenger and cargo transport is significant. Not only will they be directly or indirectly mandated by legislation in several regions, but they also are crucial for organizations that want to demonstrate their commitment to carbon neutrality and sustainability. Furthermore, ZEVs’ advantage in terms of total cost of ownership is an additional argument of major importance.

**Benefit Rating:** Transformational

**Market Penetration:** 1% to 5% of target audience

**Maturity:** Adolescent

**Sample Vendors:** Alstom; BYD; Eviation; H3 Dynamics (HES Energy Systems); Nikola Motor; Proterra; Tesla; Zunum Aero

**Recommended Reading:** “What a CIO Needs to Know About the Rise of Electric Vehicles”

“Use Scenarios to Plan for the Future of Mobility 2025: The Driving Forces”

“Why All the Investor Buzz Around Silicon Carbide and Gallium Nitride?”

“The Impacts of the Emerging Smart Mobility Value Model”

**Micromobility**

**Analysis By:** Michael Ramsey

**Definition:** Micromobility is the use of single-person vehicles or transportation modes, primarily within urban and suburban areas. Although the term is not specific to any technology, the use of the term became common with the proliferation of dockless bike-sharing services and electric scooters.

**Position and Adoption Speed Justification:** Scooters, bikes, Segways and other single-person transportation modes that are accessible for short-term rental exploded in popularity in 2019, but have retracted somewhat as the challenging economics of the business models associated with them have collided with the COVID-19 pandemic. Micromobility startups rocketed around the globe in the past few years as the use of smartphone-enabled activation and mobile payments in a dockless environment led to a fast-paced spread of bikes, e-bikes and, particularly, e-scooters. For example, Bird, one of the leading e-scooter companies, has spread to more than 100 cities. However, the same company laid off 30% of its workers in April 2020 as a result of economic conditions.
These services have been very popular and provide quick and inexpensive transportation offerings inside cities, though they have also been somewhat controversial. Dockless vehicles have been left in spots that sometimes clutter sidewalks or other rights of way. Users of e-scooters sometimes ride on the sidewalks, creating a dangerous situation for pedestrians. Still, the new options have created a way to travel very quickly in the city and not get in any other vehicle. As cities contemplate closing off sections of city centers to vehicle traffic, rental options like these could be attractive.

The micromobility trend is so fast paced that it has the chance of burning out before it changes the city environment. In many places, cities are opting for restricted usage or issuing special deployment licenses. Many of these services are deeply unprofitable and, in light of the global economic conditions, could cease to operate. However, fears of virus exposure associated with public transportation could push some users into biking and e-scooters, creating a small refuge for the businesses.

**User Advice:** Look for ways to connect these services into a holistic transportation strategy, enabling payment or scheduling options that complement public and private transportation options. Be wary of investing in, or connecting with, services that skirt or avoid city regulation, because the services could quickly be frozen out for an individual town. Create transportation plans for a region with a consideration of micromobility as a means to solve some traffic congestion, to address pollution concerns and to even provide low-cost transit.

CIOs in local governments should assess the impact of single-user mobility given urban street and walkability aspects, as well as within the strategies for healthier and greener communities. Align routing and geospatial data to user journeys and map it through accidents and capacity data for street designs. As the steep increase of usage will challenge existing patterns on traffic velocity, decisions on use of micromobility on streets versus pedestrian walkways versus bike lanes will change the algorithms on speed of movement in cities.

Ensure that micromobility providers are now implementing some kind of sanitation regimen to prevent vehicle contamination.

Look for ways to use micromobility to provide transportation options for people who feel uncomfortable in public transportation as a result of the COVID-19 pandemic.

For CIOs working for industrial and commercial clusters and real estate development, set up data exchanges for mobility and related ecosystem datasets that can be combined to use for new services on last-mile logistics, as well as adjacent service potentials in touristic, health and insurance business sectors.

**Business Impact:** Micromobility could have a significant impact inside large cities where traffic is challenging and where pollution and congestion are concerns. Micromobility businesses could be damaged or made irrelevant by strict regulation that would render implementation expensive or cumbersome. Today, the business is mixed in nature, being both positive and negative, absent a cohesive strategy to integrate this type of mobility into a city. In the long term, micromobility could help reduce pollution and provide low-cost transportation within cities. But there are risks to safety and of added congestion if cities and service providers fail to coordinate.
**Benefit Rating**: Moderate

**Market Penetration**: 5% to 20% of target audience

**Maturity**: Adolescent

**Sample Vendors**: Bird; JUMP; Lime; Skip

**Recommended Reading**: “Smart City Funding Models: It’s Time to Be Creative”

“Turning Smart Cities Into Intelligent Urban Ecosystems”

“What CIOs Need to Know About Micromobility”

“3 Ways Transportation CIOs Can Shape a Mobility-as-a-Service Ecosystem Effectively”

**Mobility as a Service**

**Analysis By**: Pedro Pacheco

**Definition**: Mobility as a service (MaaS) is a platform that provides users seamless planning and booking of different means of transportation — vehicles, planes, boats, bikes, scooters and other transport modes — to go from A to B. Supporting systems enable providers to deliver services to the customer efficiently. This is done by providing intelligent, real-time, context-aware data exchange and service offerings between conveyances, operators, passengers, assets, routes, timing and traffic patterns for the customer.

**Position and Adoption Speed Justification**: MaaS is falling toward the Trough of Disillusionment. Its adoption has been growing, with several cities embracing MaaS solutions — either through the hands of private companies like MaaS Global or through initiatives of local transport authorities. One good example is Jelbi, launched last year by Berlin’s transport authority (BVG), which claimed that Jelbi was the world’s largest MaaS app due to the diversity of mobility solutions offered. MaaS is a key solution for large city planning and transport authorities by helping move people more efficiently and with less dependence on personal cars. The impact on smart cities is substantial, particularly to transportation. Benefits can also be derived by leverage of contextual information about residents, businesses and mobility needs mapped against real-time data such as time of day, number of vehicles and travelers, pricing of road traffic per time of day and user, and environmental impacts (for example, pollution, noise, productivity and environmental quality). These services are also being integrated with public transportation, providing subsidized, on-demand rides in areas where regular service is not practical.

However, COVID-19 is heavily impacting passenger volume on public transport and taxi or ride hailing. This factor can slow down the adoption of MaaS solutions in the near future.

**User Advice**: CIOs in transportation should invest in MaaS as an important component of future city planning and an enabler for further reduction in urban emissions. However, CIOs in MaaS and city transport authorities should pivot their strategy to adapt to the postpandemic world. As travelers
may be less keen to adopt public transport due to fear of infection, MaaS developers should strengthen their offer in the field of shared mobility, including shared cars, e-scooters and bicycles.

In order to fight possible headwinds, MaaS developers should consider new ways to monetize their solutions. MaaS for goods delivery and advertising may be good ways to achieve that. For instance, public transport could also be used to deliver packages in urban areas in parallel. In addition, policymakers need to be cognizant of implications on regulations to ensure openness, interoperability, fair competition, safety and privacy. CIOs across both the private and public sectors will have to discuss the issue of data ownership and privacy when systems tap into data from the various transport modes. While those datasets are critical to creating more contextualized service offerings, there should also be enough focus on ensuring a high level of data protection.

City planners should also adopt MaaS models to further benefit the urban environment in terms of reduction of traffic and emissions but favoring the most effective solution for each situation. For instance, evidence today suggests companies like Uber and Lyft have reduced use of public transportation and increased the number of miles driven on city streets. Such situations undermine some of the advantages brought by MaaS, hence demanding a more holistic management of the overall efficiency of MaaS.

**Business Impact:** MaaS impacts numerous markets, ranging from smart cities to core transportation producers (for example, cars, trucks, trains, planes, ships and bikes). With technologies ranging from wireless communications (LPWA to 5G) to virtual reality and shared economy trends leading to further innovation and operational optimization, we will continue to see usage models changing. MaaS will broadly impact efficiency and effectiveness, mobility options, economic development, safety, security, population urbanization, proximity of people’s homes to work and climate change initiatives. The innovation behind MaaS in terms of technology and business models will both benefit and challenge public transportation. For example, MaaS can improve the appeal of public transportation by making it more efficient, yet draw demand away from it — referring again to the examples of Uber or Lyft. It can also have the effect of enhancing and lowering the cost of private options (such as private ride-sharing and car-sharing services). When this happens, citizens may forgo public transport and, thereby, reduce city revenue and increase traffic congestion (as observed in Massachusetts in the U.S.). This could be offset by productivity gains from city assets and cost savings from reduced infrastructure wear and tear; however, cities must carefully consider the overall implications of MaaS. MaaS will also have an impact on other areas of government, such as human services, where MaaS will offer alternative transportation options that will require adjustments on how funding can be used for paratransit.

**Benefit Rating:** High

**Market Penetration:** 20% to 50% of target audience

**Maturity:** Early mainstream

**Sample Vendors:** DiDi Chuxing; Lyft; MaaS Global; Mobike; Ola; Uber; Zipcar

**Recommended Reading:** “3 Ways Transportation CIOs Can Shape a Mobility-as-a-Service Ecosystem Effectively”
Real-Time Transportation Visibility Platforms

**Analysis By:** Bart De Muynck;

**Definition:** Real-time transportation visibility platforms complement the planning and executional capabilities of TMSs by providing real-time order and shipment visibility. These platforms are a core part of logistics technology and play a complementary function that supports transportation management, warehouse management, yard management and fleet management.

**Position and Adoption Speed Justification:** Supply chain visibility is no longer a “nice to have” for any organization, no matter the size, and now spans a multitude of vertical industries, use-case segments and geographies. When it comes to domestic transportation, customers are demanding more real-time visibility into in-transit shipments. This visibility existed in last-mile delivery scenarios for a number of years but for-hire transportation has struggled with a lack of proper visibility for loads once they leave the shipper or third-party logistics (3PL) provider’s warehouse.

In the past few years, a growing number of companies that specialize in providing real-time carrier information to the shipper and the 3PL community have entered the market. These companies can be labeled as third-party real-time transportation visibility platforms. They provide real-time information on shipments from the carriers based on integration with the in-cab telematics systems, interaction via the carrier’s back-end systems or a driver smartphone app. These vendors have expanded their solutions to cover more modes of transportation as well as more regions. Supply chain leaders have visibility as a key priority on their investment agenda and have been executing on it with a variety of initiatives. Many Gartner clients from all types of industries have implemented these solutions in the past 12 months.

**User Advice:** End users should look into transportation visibility to create internal efficiencies especially given the recent disruptions. You should also provide real-time transportation visibility for your internal and external customers by identifying the best platforms for connecting to your carriers. End users should differentiate their selection based on the modes of transportation, regional coverage and size of the carrier network, as capabilities and vendors are different.

**Business Impact:** These real-time transportation visibility solutions can provide shippers, 3PL providers, brokers and carriers with a multitude of benefits in the areas of carrier management and transportation processes, as well as warehouse and yard efficiencies. They can also provide higher customer satisfaction and delivery service through proactive action when deviations occur from the plan (e.g., ability to update dock appointments) and updated ETAs to customers, allowing them to assess whether changes are needed. Shippers and 3PL providers can reduce costs by shortening detention/waiting times and/or fines for missing dock appointments, improve utilization of labor, warehouse and yard resources. They can provide real-time visibility provisioning to customers online rather than needing customer service representatives, reducing inventory through a reduction in safety stock based on greater trust in reliability of deliveries and creating backhauls through improved alignment of load timing. Shippers and 3PLs transportation teams can gain productivity to
focus on value-add activities for the business instead of check calls, tracking and carrier communication activities to provide status updates.

Carriers can increase driving time and reduced detention times due to dynamic and more accurate dock scheduling (tighter windows) and avoid costs as services are mainly free for carriers versus EDI setup costs and ongoing charges.

**Benefit Rating:** Moderate

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Adolescent

**Sample Vendors:** Blume Global; C.H. Robinson (TMC); Descartes; FourKites; project44; RateLinx; Shippeo; Sixfold; Tive; Trimble

**Recommended Reading:**
- “Market Guide for Real-Time Transportation Visibility Platforms”
- “Smart Insights for the Real-Time Transportation Visibility and Monitoring Solution Market”
- “Role of Real-Time Transportation Visibility Technology in Handling Logistics Challenges Created by COVID-19”
- “Toolkit: RFP for Real-Time Transportation Visibility Platforms”

**Last-Mile Delivery Solutions**

**Analysis By:** Bart De Muynck

**Definition:** Last-mile delivery solutions enable the execution of the last mile, providing real-time communication between routing applications and drivers/vehicles to track their activities and locations and, when necessary, to reroute them in transit while on the go. These solutions are the next generation of delivery solutions, and mainly focused on last-mile deliveries to businesses and consumers, adding additional capabilities such as customer experience management.

**Position and Adoption Speed Justification:** Last-mile delivery solutions are an evolution of the more traditional dynamic and even batch-oriented fleet routing and scheduling (FR&S) grown due to the huge increase in e-commerce and last-mile deliveries. Whereas traditional routing solutions focused primarily on over-the-road fleets and movements for first mile, middle mile and last-mile to businesses, these new last-mile delivery solutions mainly focus on deliveries to consumer homes. Rudimentary real-time routing solutions are dispatcher-centric, having limited communication with drivers. These more robust last mile delivery solutions are emerging that can automatically and proactively adapt to unforeseen events. For example, as traffic-monitoring solutions emerge and become pervasive, routing systems could receive notifications of traffic congestion that will delay drivers and may warrant rerouting. The system could dynamically recalculate the route and communicate the new route to drivers in real time. The goal is not only to make the fleets more efficient, but also to communicate updated ETAs with the consumer who is increasingly focused on
the delivery experience when selecting an e-commerce or online retail vendor. It seems simple to just calculate new arrival times by indexing schedules based on the time of the delay (e.g., if one hour late leaving the previous stop, then just add one hour to the anticipated arrival time). However, this is overly simplistic, and leading vendors are working on algorithms that will recalculate the new arrival time based on other factors, such as time of day and current traffic patterns.

As businesses have become more dynamic and customers more demanding, companies need to balance the trade-offs between optimal and feasible routes that consider changes throughout the day as variables of change continue to increase and click to door times continue to decrease. As consumerism takes hold, meeting on-time appointment windows for delivery to home or office is becoming not only more important, but more plentiful and difficult. Consumers are seeking flexibility in delivery slots and are increasingly prone to changing the date and time of delivery according to their changing needs. E-commerce for certain products (e.g., grocery, meals, electronics and furniture) continues to grow rapidly, and companies' ability to deliver to consumer time frames is challenged, adding stress to the capabilities of traditional solutions to plan (and deliver) within narrower time frames. Missed appointments require more dynamic updating of both routes and notification to customers of changed appointments. The solution also needs to manage the customer experience providing insights into the whole delivery cycle and use these insights to improve future deliveries.

Last-mile delivery solutions are increasing. These solutions are adaptations of traditional routing and scheduling, wherein a route could be replanned and a dispatcher would control the process. Many of these solutions use AI and machine learning to speed up the optimization process and predict occurrences and impacts based on real-time information. Support for pieces of this technology, such as automated vehicle locating, is becoming more mature and commonplace.

**User Advice:** Not all users will need last mile delivery solutions, and traditional vehicle routing and scheduling solutions will suffice. Users that have high levels of change over the course of a delivery horizon or have a large focus on last-mile delivery to the consumer, are the best candidates for last mile delivery solutions. Users should define their specific use cases before investigating solutions to ensure the solutions they consider fit the needs of their operations.

**Business Impact:** Last-mile delivery solutions will not only provide benefits to e-commerce companies and other shippers focused on last mile, but can also add incremental benefits to mature users of routing and scheduling, further reducing costs and improving customer service in dynamic environments. Less mature users and more traditional industries that do not focus on the last mile should start with traditional vehicle routing and scheduling tools that are mature and proven.

**Benefit Rating:** High

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Adolescent

**Sample Vendors:** Bringg; Descartes; FarEye; Locus; LogiNext; Onfleet; ORTEC; Paragon; Quintiq; Wise Systems

**Recommended Reading:** “Market Guide for Vehicle Routing and Scheduling”
Autonomous Vehicles

Analysis By: Jonathan Davenport

Definition: Autonomous vehicles use various onboard sensing and localization technologies, such as lidar, radar, cameras, GPS and map data, in combination with AI-based decision making, to drive without human intervention. This Innovation Profile does not cover ADAS features that require humans to supervise vehicle operations. While self-driving cars are getting most of the attention at present, the technology can also be applied to nonpassenger vehicles for transportation of goods.

Position and Adoption Speed Justification: There have been a number of signs of autonomous driving moving into the Trough of Disillusionment during the past year. Drive.ai and Starsky Robotics failed, Cruise cut 8% of its workforce, and Zoox is looking for a buyer, Continental has delayed AV investments after Q120 earnings plummeted and Audi has abandoned its plans to introduce the Level 3 traffic jam pilot feature into its A8 vehicles, which it had originally announced back in 2017. Likewise, Ford Motor Company made the decision to shift the launch of its self-driving services to 2022 to evaluate the long-term impact of COVID-19 on customer behaviors.

But there has been increased investment too. For example, Intel’s Mobileye has acquired Moovit and is developing an autonomous mobility as a service (MaaS) solution for the emerging robotaxi market. This plan shifts Intel from being a supplier of chips and self-driving systems for the automotive industry and places it in direct competition with automakers’ own mobility ambitions and the likes of Waymo, Baidu and Yandex. Likewise, autonomous vehicle pilots and trials have continued to be undertaken, though most continue to be supported by safety drivers. To overcome regulatory issues, many autonomous shuttle buses have been demonstrated on private road networks, such as at airports.

The efforts of automobile manufacturers and technology companies to develop autonomous vehicles have been prominently featured by mainstream media, leading to unrealistic and inflated expectations for the technology. Artificial intelligence (AI) is a critical technology for enabling autonomous vehicles, and development of machine learning algorithms for autonomous vehicles has accelerated. Key challenges for the realization of autonomous vehicles continue to be centered on cost reductions for the technology and industrialization. However, the challenges increasingly include regulatory, legal and societal considerations, such as permits for operation, liability, insurance and the effects of human interaction.

Continued advancements in sensing, positioning, imaging, guidance, mapping and communications technologies, combined with AI algorithms and high-performance computing capabilities, are converging to bring the autonomous vehicle closer to reality. However, in 2020, complexity and cost challenges remain high, which is impacting reliability and affordability requirements, as well as hindering the ability for companies to get regulatory approval.
**User Advice:** The adoption of autonomous vehicle technology will require increasing levels of technical sophistication and reliability that rely less and less on human driving intervention. Automotive companies, service providers, governments and technology vendors (for example, software, hardware, sensor, map data and network providers) should collaborate on joint research and investments to advance the required technologies, as well as work on legislative frameworks for self-driving cars.

Furthermore, consumer education is critical to ensure that demand meets expectations once autonomous vehicle technology is ready for broad deployment. Specific focus must be applied to the transitional phase, where autonomous or semiautonomous vehicles will coexist with an older fleet of nonautonomous vehicles.

Look for use cases, such as mining, agriculture or airports, where autonomous vehicles can operate in restricted areas safely without regulatory restrictions. Use these implementations to drive early revenue and gather data and insights to improve the performance of self-driving systems.

Autonomous vehicles will have a disruptive impact on some jobs, such as bus, taxi and truck drivers. Develop policies and programs to train and migrate employees who will be affected by automation to other roles.

**Business Impact:** The main implications of self-driving vehicles will be in the economic, business and societal dimensions. Automotive and technology companies will be able to market autonomous vehicles as having innovative driver assistance, safety and convenience features, as well as being an option to reduce vehicle fuel consumption and improve traffic management. The interest of nonmobility companies (such as Intel, Waymo, Apple and Baidu) highlights the opportunity to turn self-driving cars into mobile computing systems. These systems offer an ideal platform for the consumption and creation of digital content, including location-based services, vehicle-centric information and communications technologies.

Autonomous vehicles are also a part of mobility innovations and new transportation services that have the potential to disrupt established business models. For example, autonomous vehicles will eventually lead to new offerings that highlight mobility-on-demand access over vehicle ownership by having driverless vehicles pick up occupants when needed. Autonomous vehicles will deliver significant societal benefits, including reduced accidents, injuries and fatalities, as well as improved traffic management, which could impact other socioeconomic trends.

When autonomous driving enters the Trough of Disillusionment, it might be a good opportunity for new market entrants.

**Benefit Rating:** Transformational

**Market Penetration:** Less than 1% of target audience

**Maturity:** Emerging

**Sample Vendors:** Audi; AutoX; Daimler Group; General Motors; Mobileye; Pony.ai; Tesla; Uber; Waymo
Recommended Reading: “Market Trends: Monetizing Connected and Autonomous Vehicle Data”


“Utilize Partnerships to Secure a Winning Position in the Autonomous Driving Ecosystem”

“Market Insight: Use Situationally Aware Platforms to Enable Safe Autonomous Vehicle Handovers”

“Maverick* Research: Autonomous Mobile Structures Will Fuel the Sharing Economy”

Commercial UAVs (Drones)

Analysis By: Aapo Markkanen

**Definition:** Commercial unmanned aerial vehicles (UAVs, also known as drones) are small helicopters, fixed-wing airplanes, multirotors and hybrid aircrafts that have no human pilot on board. They are either remotely controlled by human pilots on the ground or outfitted for autonomous navigation. This analysis relates to UAVs used for commercial purposes — excluding consumer and military drones.

**Position and Adoption Speed Justification:** In 2020, commercial UAVs have nearly reached the bottom of the Trough of Disillusionment. In the technical sense, drones are a relatively mature technology and capable of increasingly sophisticated tasks. However, their wider adoption is often held back by national regulations that restrict or even outright prevent many use cases. In particular, flying drones beyond visual line of sight (BVLOS), above people or in restricted airspace, such as close to airports, are types of operations that are heavily regulated, if not entirely unpermitted, in most countries. Additionally, the scarcity of trained and licensed drone pilots, as well as the high cost of vertically specialized end-to-end drone solutions — which cover the devices, the supporting software and the flight operations — hold back large-scale adoption among end users. Autonomous flights would represent a major boost to the market, but their enablement for routine usage requires both further regulatory changes and technology advancements.

**User Advice:** Overall, a corporate drone program should have both short-term and long-term objectives. This is because commercial UAVs can deliver major operational benefits on a routine basis already today, but future technological or regulatory developments can significantly increase their applicability. For instance, once a major market introduces less restrictive regulation on BVLOS flights, the potential of drones in its territory can shoot up practically overnight. Meanwhile, permitting routine BVLOS operations will trigger substantial near-term investment and innovation among the affected technology and service providers. Organizations considering drones, therefore, should not solely plan on the basis of available technology, but also factor in the local regulatory outlook. It makes sense to proactively identify relevant regulatory and technological changes and take advantage of them as early as possible.

The Low Altitude Authorization and Notification Capability (LAANC) initiative in the U.S., facilitating flights in restricted airspace, is one such example users should be aware of. Today, the leading use cases include aerial photography, mapping and surveying, volume measurement, and remote inspection. All of these can be considerably enhanced by the right analytics, so as part of their UAV
planning, the adopters should also take into account how they can exploit the captured data in the best possible way. Use cases involving physical tasks — such as delivering cargo or repairing assets — are currently largely in their nascency, but they can be expected to become gradually more viable over the medium term. However, benefits of commercial UAVs in applications that rely on completion of physical tasks will take longer to materialize than in the ones that focus on data capture and analysis.

**Business Impact:** Most of all, commercial UAVs represent a technology to enhance the capabilities of the roles such as land surveyors, insurance inspectors, and camera operators who traditionally perform labor-intensive tasks in potentially unsafe conditions. As such, drones offer productivity improvements by reducing and/or redeploying headcount, while enabling real-time data capture and improving employee safety. Examples of industry verticals where commercial UAVs can particularly add value include agriculture, construction, emergency services, extractive industries, media and entertainment, as well as utilities. In most of the verticals, the value of commercial UAVs is in reducing operating expenditure and improving safety, but there are also revenue-generating opportunities in industries such as cinematography, surveying and logistics. In 2020, the COVID-19 crisis is set to speed up drone adoption across various use cases such as public safety and traffic monitoring. Also, use of autonomous delivery drones may accelerate during the crisis.

**Benefit Rating:** High

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Early mainstream

**Sample Vendors:** Cyberhawk; Delair; DJI; DroneDeploy; Kespry; Nightingale Security; PrecisionHawk; Sky-Futures; Unmanned Life; Zipline

**Recommended Reading:**
- “Top 10 Strategic Technology Trends for 2020: Autonomous Things”
- “Why Autonomous Flying Drones Must Be on the Radar of Mobility Sector CIOs”

**Internet of Things**

**Analysis By:** Alfonso Velosa; Benoit Lheureux

**Definition:** The Internet of Things (IoT) is a core building block for digital business and digital platforms. IoT is the network of dedicated physical objects that contains embedded technology to communicate and sense or interact with their internal states and/or the external environment. IoT comprises an ecosystem that includes assets and products, communication protocols, applications, and data and analytics.

**Position and Adoption Speed Justification:** Gartner’s CIO Survey 2020 shows that IoT is regarded by CIOs as one of the top five game-changing technologies, with enterprises vary widely on their IoT adoption depth and maturity. Enterprises on a global basis have ongoing IoT-enabled initiatives for use cases ranging from incremental benefits (for example, asset optimization or compliance
reporting) to transformative benefits (for example, product as a service or guaranteed asset uptime). The more developed use cases center on fleet management and industrial equipment maintenance, where ROI is calculated from cost optimization such as reducing maintenance and fuel costs. Many enterprises are now exploring employee and citizen safety solutions using IoT enabled capabilities. Finally, Gartner’s 2019 IoT Survey indicates that while enterprises expect a 3-year payback on average for their IoT projects, 42% expect payback in less than 2 years. In the 2020 economic downturn, many clients are pushing for even shorter project paybacks.

The hype has decreased from the highs in 2016 through 2019; we reflect this by moving the profile’s position into the trough. Enterprises continue to address cost, complexity and scaling challenges implementing IoT-enabled business solutions, as well as increased adoption of contact-less monitoring solutions, drone inspections, etc. driven by the 2020 pandemic. Challenges include end-to-end integration complexity, the need to bridge cultural divides between IT and operations, confusing vendor marketing, especially as they increasingly shift to IoT-enabled business solutions, security concerns, and the 2020 pandemic disruption on IoT project schedules.

**User Advice:** CIOs should take action to address IoT concerns across the following areas:

- **Business:** Measure and deliver IoT value based on digital and strategic business objectives. If you are still experimenting, use a proof of business value approach. Build business cases with project payback of less than 18 months to account for implementation challenges and cultural resistance. Add employee and customer safety to your priority list of IoT projects and capabilities.

- **Management:** Build or contribute to an IoT center of excellence (COE) composed of IT, operational and business personnel. Use the COE to drive global alignment on best practices, alignment to business objectives, budgeting and people allocation. Remember that IoT is really about business process transformation, so focus on culture change first and technology second to ensure success.

- **Architecture:** Ensure the architecture teams focuses on both the IT and operational technology portfolio as well as the need to manage a multi-IoT platform approach. Ensure analytics and applications are part of the conversation.

- **Skills:** Invest in business and architecture skills to support project ideation and prioritization, as well as technical skills for IoT platforms, integration, analytics and security. Drive learning via projects with short-term outcomes, and include business leaders, IT leaders, and front-line workers.

- **Vendors:** Assess and select providers on how they lower project risk for your enterprise via their vertical market expertise, technical capabilities (including best-of-breed partners) and trained professional services partners. Ensure your vendors integrate into your IT infrastructure.

- **Governance:** Establish accountability, participation, predictability and transparency policies for IoT — addressing sponsorship, budgets, digital ethics, data ownership and rights to monetize IoT data, etc...
- Risk: Scan for threats from enterprises in your ecosystem who may use IoT capabilities to damage or limit your differentiation and competitiveness.

**Business Impact:** As an evolutionary business impact, IoT will impact most enterprises’ internal operations, differentiation, competitive position, and product strategies. Connected things will help lower costs, drive revenue, and improve enterprise processes in these types of usage scenarios:

**Optimization of a range of business processes:**

- Cost optimization: Lower operating costs for energy reduction, maintenance minimization, minimizing inventory spoilage, lowering theft
- Operations optimization: Better productivity, increased efficiency, logistics and coordination
- Optimize assets: Asset utilization, health monitoring, reliability, predictive maintenance
- Conserve resources: Energy efficiency and pollution reduction

**New revenue strategies:**

- Generate revenue via improved products, contractual services, usage-based pricing, and monetizing IoT data
- Increase engagement: Improved experiences of consumers, citizens and others in order to improve loyalty and increase customer lifetime value

**Safety focus:**

- Drive employee and citizen safety by monitoring and checking people’s health, shifting to over-the-air updates to avoid in person visits, fall monitoring for the elderly and remote workers.

**Benefit Rating:** Transformational

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Adolescent

**Sample Vendors:** ABB; Alibaba Cloud; Altizon; GE Digital; Hitachi Vantara; Tencent; Vodafone

**Recommended Reading:**

- “Predicts 2020: As IoT Use Proliferates, So Do Signs of Its Increasing Maturity and Growing Pains”
- “Toolkit: Enterprise Internet of Things Maturity”
- “Survey: Manufacturers See Quick Return on IoT Projects”
- “Forecast: Enterprise and Automotive IoT, Worldwide”
Climbing the Slope

Global Logistics Visibility

**Analysis By:** Oscar Sanchez Duran; C. Klappich

**Definition:** Global logistics visibility improves the connectivity, interoperability and visibility of events across facilities, multiple transportation modes, suppliers, customers and logistics service providers. This technology enables companies to monitor international logistics events throughout an entire multileg shipment itinerary to detect event-driven problems early enough to notify recipients and address possible threats.

**Position and Adoption Speed Justification:** Global logistics visibility applications are maturing, and while data quality has improved over the past years, there are still areas in which visibility and connectivity remain poor — specially around ports and terminals. Newer visibility platforms and the integration of different systems such as GTM and TMS are making it easier to correlate the information received through the different parties. However, connecting to carriers and other constituencies — such as suppliers, forwarders, brokers and third-party logistics (3PL) companies — remains difficult. EDI continues to be the dominant way for companies to connect with trading partners. The use of API technology within global logistics visibility is increasing, with many already having this technology in their products and others considering in its roadmap. Additionally, initiatives like IATA’s ONE Record, which promotes the concept of a virtual shipment record accessible through API technology and which moves away from the peer-to-peer messaging model, should further facilitate connectivity between parties involved in global trade in a near future.

**User Advice:** Midsize and large international shippers (those with 1,000 or more containers per year) in dynamic international logistics environments will benefit from improved visibility. Early adopters of stand-alone solutions should consider on-demand global logistics visibility solutions, where upfront costs are minimized. Transportation management system (TMS) users should first consider the visibility solutions offered by their providers, only considering stand-alone solutions when their TMS vendors lack a visibility offering or when their offerings are inadequate. Users looking for true end-to-end visibility across locations, processes and data types should look for generic tools that can support this breadth of use. Users looking for real-time visibility beyond event-driven visibility should look for specialized real-time visibility applications that can connect to vessel AIS satellite systems, airline systems and IoT devices. However, they should plan multiphase roll outs to ensure they address the numerous potential hurdles that will crop up for engagements of this size and scope.

**Business Impact:** Given the increased risk of managing a global supply chain, the visibility of potential problems is critical to managing global logistics operations effectively. Sensing and responding to events are critical aspects of supply chain visibility, but visibility alone provides only incremental value. Although visibility can identify and diagnose problems, it cannot resolve them. The value of visibility increases when it is integrated with other applications, such as TMS, warehouse management system (WMS), order management, supply chain planning and ERP, where problems can be identified, diagnosed and resolved in a single environment. However, true end-to-end visibility that spans transportation, inventory, orders, multiple modes of transport (such as land...
and ocean) or multiple functions (such as transportation and trade compliance) is less mature. End-to-end visibility also often requires multiple applications to be “stitched together” or, at the very least, disparate data sources are pulled into one visibility application.

**Benefit Rating:** Moderate

**Market Penetration:** 5% to 20% of target audience

**Maturity:** Early mainstream

**Sample Vendors:** Blume Global; Descartes; E2open; FarEye; Infor; LOG-NET; TransVoyant

**Recommended Reading:**
- “Magic Quadrant for Transportation Management Systems”
- “Plan for and Use Supply Chain Visibility Capabilities in Close Alignment With Maturity Stages”
- “Supply Chain Operational Visibility Vendor Guide”
- “Supply Chain Brief: Getting Ready for Multienterprise Business Network”
- “How to Use Technology to Increase International Visibility in Times of Crisis”
- “Market Guide for Global Trade Management”

**Advanced Self-Service Technologies**

**Analysis By:** Ivar Berntz

**Definition:** Advanced self-service technologies encompass interactive computer terminals, such as kiosks, featuring specialized hardware and software that access information and perform tasks. They are typically located in either high-traffic areas, such as airports, hotels, rent-a-car stations, malls or restaurants, to expedite processes or where having personnel isn’t economically justified.

**Position and Adoption Speed Justification:** 2020 has thus far been an exceptional year for this innovation. Although self-service technologies have been widely deployed globally and should be at a mature stage by now, they are still evolving fast to meet the new demand for touchless interactions, which soared as a result of the COVID-19 pandemic. We see this innovation as vital in regaining the public trust in transportation by making travelers feel more secure.

The very first self-service kiosk was developed in 1977 at the University of Illinois. They were initially simple interactive terminals that accessed static information. Network connectivity gave the newer versions even greater capabilities through online access. Today’s smartphones have largely replaced the older kiosks in terms of functionality. However, newer versions have added new capabilities, like vital sign detection, facial recognition and touchless interaction, even via head movement. Recent examples include passports being read by holding them open in front of a camera, rather than by inserting them into a passport slot (see “Avalon Airport to Implement Touchless Self-Service Technology,” Future Travel Experience) and also portable, battery-driven check-ins and bag drops for train stations, hotels, convention centers and so on. (See “Passenger
Touchless Check In & Bag Drop Experience — Tagomat — Improve Social Distancing," British Aviation Group).

**User Advice:** Self-service technologies were already a winning proposition for customers and companies for many years. They transfer the burden, and thus the cost, of executing various tasks from the company offering a service or good to their customers.

Now, because of extended sanitary precautions that include the requirement of social distancing and for thorough cleansing, this innovation evolved to also offer a touchless user interaction. By virtue of being touchless, these new self-service stations have the added economic benefit of requiring less maintenance. They have no high-contact surfaces that need to be cleaned, so they do not get dirty in the same way, nor do they need to be substituted as often, as there is less abrasion.

While human machine interfaces (HMI) will be able to react to smell and emotions in the future, at their current stage, they are able to leverage virtual, augmented and mixed reality. Thanks to which, it allows customers to avoid touching physical elements, such as a touchscreen. These touchless stations, while in themselves a customer touchpoint, need to be seen as part of a broader trend that transcends previous channel thinking, such as multichannel or omnichannel. These stations are becoming touchpoints that allow for multiple modalities of interaction, like touch, voice, vision or gesture — in effect, a “multiexperience” journey for customers.

Transportation company CIOs should promote an extensive use of these latest self-service technologies that reduce the need for contact via touchscreens and other surfaces, and for on-site or remote personnel performing repetitive, difficult-to-optimize, low-value-added tasks. Start by studying the various customer journeys to understand touchpoints and excessive wait times. Gauge optimal deployment of self-service stations, possibly augmented with smartphone-enabled services, to gain cost reduction and customer satisfaction benefits. Consider a balance between the use of common use self-service (CUSS) kiosks with solutions that multiple transportation companies can use to reduce both operating costs and space requirements, versus the specific needs of their companies’ business model and customers. The CUSS of tomorrow will most likely also be touchless and incorporate biometrics, gesture control, voice recognition and additional thermal and even humidity sensors.

**Business Impact:** This year, we raised the benefit rating of this innovation from moderate — that is, incremental improvements to established projects — to high, due to it now being able to carry out transactions in a touchless manner.

Given the current travel slump, we see touchless self-service as an important way to reduce traveler’s fear of infection.

Current examples of touchless self-service channels include enabling customers to retrieve data (e.g., schedules), interact with sales (e.g., seat/room selection or check-in), be offered upsells and cross-sales of services (e.g., upgrades) or goods (e.g., cars, fresh food), verify identity (e.g., biometrics or facial scanning), check for potential signs of illness (temperature, respiration, heartbeat), print out documents (e.g., boarding passes), and also dispatch luggage or parcels.
There will always be instances when a customer needs to speak to a real person about a real issue. Knowing which types of issues require a live interaction and which do not — and quickly routing customers accordingly to the channel in which they can gain the most rapid resolution — is key. Increasingly, many customers want to help themselves. By making it easy for them to do so — when their specific needs can be resolved in the self-service channel — while at the same time enabling a healthy environment that removes the fear of contamination from their list of travel objections, seems to be a win-win proposition for all sides.

**Benefit Rating:** High

**Market Penetration:** 20% to 50% of target audience

**Maturity:** Mature mainstream

**Sample Vendors:** Diebold Nixdorf; KIOSK Information Systems; NCR; Olea Kiosks; SITA

**Recommended Reading:**
“Adjusting Omnichannel Strategies in Uncertain Business Environments”

“Transcend Omnichannel Thinking and Embrace Multiexperience for Improved CX”

“Create a Low-Effort Omnichannel Customer Service Experience”

“AI Multisensory Tech in Automotive HMI”
Appendixes

Figure 3. Hype Cycle for Transportation Industry, 2019

Hype Cycle for Transportation Industry, 2019

Source: Gartner
ID: 39369
Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 1. Hype Cycle Phases

<table>
<thead>
<tr>
<th>Phase</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Innovation Trigger</strong></td>
<td>A breakthrough, public demonstration, product launch or other event generates significant press and industry interest.</td>
</tr>
<tr>
<td><strong>Peak of Inflated Expectations</strong></td>
<td>During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the technology is pushed to its limits. The only enterprises making money are conference organizers and magazine publishers.</td>
</tr>
<tr>
<td><strong>Trough of Disillusionment</strong></td>
<td>Because the technology does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.</td>
</tr>
<tr>
<td><strong>Slope of Enlightenment</strong></td>
<td>Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the technology’s applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.</td>
</tr>
<tr>
<td><strong>Plateau of Productivity</strong></td>
<td>The real-world benefits of the technology are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology’s target audience has adopted or is adopting the technology as it enters this phase.</td>
</tr>
<tr>
<td><strong>Years to Mainstream Adoption</strong></td>
<td>The time required for the technology to reach the Plateau of Productivity.</td>
</tr>
</tbody>
</table>

Source: Gartner (August 2020)

Table 2. Benefit Ratings

<table>
<thead>
<tr>
<th>Benefit Rating</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformational</td>
<td>Enables new ways of doing business across industries that will result in major shifts in industry dynamics</td>
</tr>
<tr>
<td>High</td>
<td>Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise</td>
</tr>
<tr>
<td>Moderate</td>
<td>Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise</td>
</tr>
<tr>
<td>Low</td>
<td>Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings</td>
</tr>
</tbody>
</table>

Source: Gartner (August 2020)
### Table 3. Maturity Levels

<table>
<thead>
<tr>
<th>Maturity Level</th>
<th>Status</th>
<th>Products/Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embryonic</td>
<td>■ In labs</td>
<td>■ None</td>
</tr>
<tr>
<td>Emerging</td>
<td>■ Commercialization by vendors</td>
<td>■ First generation</td>
</tr>
<tr>
<td></td>
<td>■ Pilots and deployments by industry leaders</td>
<td>■ High price</td>
</tr>
<tr>
<td></td>
<td>■ Maturing technology capabilities and process</td>
<td>■ Much customization</td>
</tr>
<tr>
<td></td>
<td>■ Uptake beyond early adopters</td>
<td></td>
</tr>
<tr>
<td>Adolescent</td>
<td>■ Proven technology</td>
<td>■ Second generation</td>
</tr>
<tr>
<td></td>
<td>■ Vendors, technology and adoption rapidly evolving</td>
<td>■ Less customization</td>
</tr>
<tr>
<td></td>
<td>■ Maturing technology capabilities and process</td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ Uptake beyond early adopters</td>
<td></td>
</tr>
<tr>
<td>Early mainstream</td>
<td>■ Robust technology</td>
<td>■ Third generation</td>
</tr>
<tr>
<td></td>
<td>■ Not much evolution in vendors or technology</td>
<td>■ More out of box</td>
</tr>
<tr>
<td></td>
<td>■ Several dominant vendors</td>
<td>■ Methodologies</td>
</tr>
<tr>
<td>Mature mainstream</td>
<td>■ Proven technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ Vendors, technology and adoption rapidly evolving</td>
<td></td>
</tr>
<tr>
<td>Legacy</td>
<td>■ Not appropriate for new developments</td>
<td>■ Maintenance revenue focus</td>
</tr>
<tr>
<td></td>
<td>■ Cost of migration constrains replacement</td>
<td></td>
</tr>
<tr>
<td>Obsolete</td>
<td>■ Rarely used</td>
<td>■ Used/resale market only</td>
</tr>
</tbody>
</table>

Source: Gartner (August 2020)

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**Gartner Recommended Reading**

*Some documents may not be available as part of your current Gartner subscription.*

Understanding Gartner’s Hype Cycles

Research Roundup for Transportation Technology

The 2020 Top Strategic Transportation Technology Trends

How to Ensure Your Supply Chain Visibility Initiative Succeeds

Digitization of Transportation Networks Provides an Option for Companies to Tackle Transportation Capacity

Supply Chain Transformation Guide

Create Your Own Hype Cycle With Gartner’s Hype Cycle Builder

To Innovate More, Define Failure, Not Success