Empowering the Mobility Fleet of Tomorrow

Developing innovative, meaningful, and long-lasting mobility solutions through technology.

intel.

AUTHORS
Andrea Thomas
Senior Product Marketing Engineer, Cities and Transportation, Intel Corporation
Miao Wei
Solution Architect, Cities and Transportation, Intel Corporation

RESEARCH CONSULTANT
Bridge Partners

For more information, please visit intel.com/fleet

Overview

The internet of things plays a key role in the future of urban mobility. As cities grow in size and complexity, transportation solutions require a more strategic approach. Increasingly, public transportation companies, as well as freight/cargo companies and operators of heavy equipment fleets, are looking for IoT technology systems to produce actionable insights from vehicle data. Companies need to provide their fleets with new capabilities that will transform the transportation experience—and that is just the start of mobility's evolution.

Demand for urban mobility

Growing demand in urban mobility and mass transit—which includes freight/cargo transportation, public transit, and heavy equipment—is driving the need for innovative approaches to operations. Every day, millions of connected things within smart cities generate large amounts of data. Making sense of that data in an economical way to transform municipalities and the many segments that operate within them. These analytics-based insights enable organizations to make better decisions in near real-time that deliver more value for customers and employees.

Urban mobility includes a broad scope of road vehicles—trucks, buses, and cars, as well as heavy equipment—each of which plays an integral role in personal and commercial transportation. In this context, road vehicles are crucial in areas such as last-mile transport and delivery, the reduction of

infrastructure costs, and minimizing environmental impact. Here, the concept of urban mobility deals with both public transit as well as commercial applications, from global logistics to heavy equipment in fields like agriculture, construction, and mining.

The growth in population of metropolitan areas, especially larger ones, continues unabated and will ultimately influence mobility's evolution. Large metropolitan areas that feature populations of 1 million-plus inhabitants have increased by over 400 million since 2000, with the most rapid growth seen in metropolitan areas with populations above 5 million.

Smaller metropolitan areas have also seen unprecedented growth. Additionally, the number of urban areas with more than 5 million inhabitants has doubled in just 25 years.[1] According to the UN World Urbanization Prospects, urban shares globally are projected to increase in the coming decades. By 2050, as much as 68 percent of the global population will call an urban area home, up from 54 percent as recently as 2016.[2]

The resulting global demand for passenger mobility in urban areas is expected to double by 2050.[3] Transport operators continue to face increasing challenges with their existing systems in e-commerce, ticketing, route planning logistics, as well as overseeing vehicle and internal bus maintenance purposes. New complications such as evolving public health measures, non-traditional traveling schedules, and other accessibility needs present even more challenges. Even with decreased

The Evolving Transportation Experience

What's driving growth and the need for innovative technological solutions?

Heavy equipment

Increasing investment in construction around the globe due to population shifts

Cargo

Significant growth in commercial transport as buying habits shift to e-commerce

Public transit

Global demand for passenger mobility in urban areas expected to double by 2050

ridership during the COVID-19 pandemic, the number of daily individual journeys is poised for historic growth, further increasing pressure on urban mobility systems. Requisite upgrades and expansion often fail to keep pace with the most used systems. As of 2021, Rio de Janeiro was the most used bus rapid transit system in the world, with just over one trillion passengers.[4] New York City remains the largest bus system in the U.S., and expects to be all-electric by 2040, a plan that keeps pace with California's statewide goal for public transit to be zero-emissions by that same year.

China—the global leader in the adoption of electric buses—is home to cities like Shenzen, which hosts and operates the world's largest electric fleet.[5] Adoption of electric vehicles in the mass transit systems of Europe has been dramatically rising as well, with e-bus deliveries growing 48% in 2021 in Western Europe as compared to the previous year. As of 2021, nearly 60% of city buses in the region had an alternative driveline.[6]

The Organisation for Economic Co-operation and Development (OECD) outlines ways that environmental concerns can be folded into transport policies. These include moving toward zero-emissions road passenger transport, autonomous car development, mitigating non-exhaust elements from road transport, and promoting more sustainable mobility patterns in passenger transport.[7] Customer demand for convenient, fast, reliable, and individualized mobility solutions are increasing. Globally, the smart transportation market is projected to reach USD 121,220 Million by 2026, from USD 74,990 Million in 2020, at a CAGR of 8.3% during the forecast period 2021-2026.[8]

The total number of public buses in operation in the U.S. alone amount to nearly 900,000, including commercial and school vehicles.[9] With China and India leading the way in terms of projected growth on the horizon for public transportation vehicles, nearly every region around the globe is predicted to increase their fleet size of heavy-duty transit buses in the coming years. Further, it should come as no surprise that with this expected growth in fleets around the world, a significant portion of all new buses will be running on some alternative fuel.[10]

Cargo transport

Compounding matters further, goods mobility and commercial transport is facing even larger growth, as consumers shift their buying habits, e-commerce skyrockets, and last-mile delivery demand booms.[11] The global Transportation Management System market size is projected to reach USD 6.6 billion by 2026, from USD 2.9 billion in 2020, at a CAGR of 15.1% during 2021-2026.[12] The commercial vehicle market is expected to grow from $634.3 billion in 2021 to $990.5 billion by 2028 at a CAGR of 6.5% during forecast period.[13]

Improvements in production techniques, evolving consumer demand, the rise of e-commerce, and more are all putting pressure on businesses and governments alike to continue transforming through digital adoption and

Country	Commercial Vehicle Sales
USA	12,764,999
China	4,324,497
Canada	1,479,252
Japan	894,125
India	854,839
Mexico	597,951
Thailand	538,914
Brazil	525,781
France	479,698
Germany	409,801

Commercial Vehicle Sales
Demand by Country 2019

Commercial Vehicle Sales/Demand by Country 2019

innovation. Meaningful and lasting change in mobility solutions and within the global supply chain requires all parties involved to adopt and deploy digital technologies in an effective way, with visibility, intelligence, and efficiency guiding the process.[14]

Heavy equipment

In the heavy equipment vehicle market (agriculture, construction, and mining), growth of global fleets is also on the rise. For example, the global farm machinery and equipment market is expected to grow from $183.85 billion in 2020 to $201.83 billion in 2021 at a compound annual growth rate (CAGR) of 9.8%. The growth is mainly due to the companies rearranging their operations and recovering from the COVID-19 impact, which had earlier led to restrictive containment measures involving social distancing, remote working, and the closure of commercial activities that resulted in operational challenges. The market is expected to reach $276.85 billion in 2025 at a CAGR of 8.2%.[15]

One key trend driving projected growth is related to the expected increase in demand for autonomous tractors, which will likely hold significant market share in the next few years. Developments in the autonomous tractor market, including sensors, more safety, productivity, and fuel efficiency, are expected to boost demand in the coming years. Among the many reasons supporting this growth, favorable government schemes and policies play a central role in countries around the world.

Several factors impacting the heavy equipment, construction vehicle market is supporting projected growth. These factors include rapid urbanization, increasing investment in construction around the globe, rising demand for infrastructure development in developing economies, population increase, and the resulting increase in spending.

The earthmoving equipment segment held the major share in 2020, garnering more than half of the total market.[16] In the heavy equipment sector, heavy construction vehicles includes earthmoving, material-handling, heavy construction, and mining vehicles. The global construction equipment market size was valued at $201.9 billion in 2021, and is projected to reach $322.0 billion by 2031, growing at a CAGR of 4.8% from 2022 to 2031. Construction equipment are specially designed machinery used to perform construction operations. These equipment are used for different functions such as drilling, hauling, excavating, paving, and grading. The global market covers different industries such as construction & infrastructure, manufacturing, and oil & gas.

Although the construction sector is facing a slow-down, which is affecting new construction equipment sales, the construction equipment market is expected to recover during the forecast period. One of the reasons for the growth is anticipated to be the rise in focus on public-"private partnerships (PPP). These partnerships are characterized as a joint venture between government and private sector companies for construction of public infrastructure systems. In this type of partnership, a private company handles a project and lends technical & operational expertise to government projects. The growth in public private partnerships in different countries such as India, Africa, and China is expected to fuel the growth of the construction equipment end-user segment.[17]

Today, many logistic providers rely on disaggregated data platforms and independent point solutions for their fleet management systems, making it difficult to manage large fleets without expending significant time and resources. New fleet solutions can provide a smoother transportation experience, actionable insights from mass data, and greater value for customers and employees with improved efficiency and manageability—regardless of the industry within which they are operating.
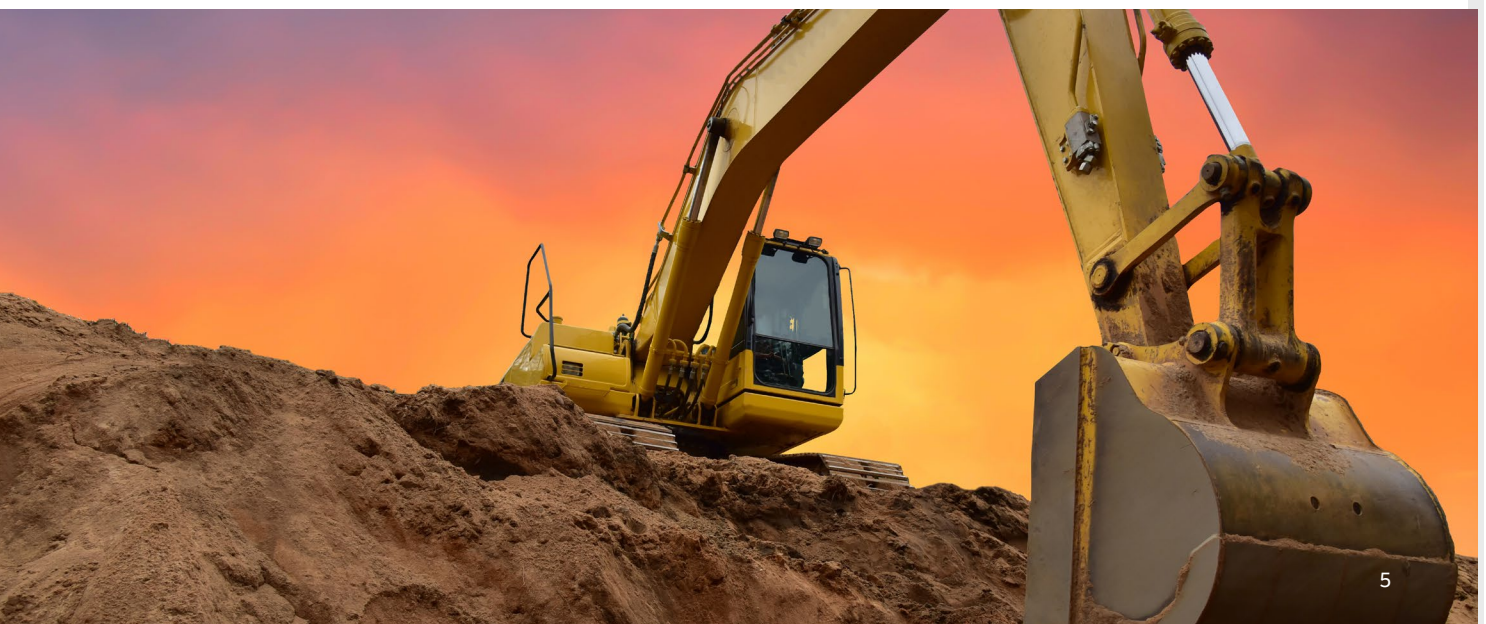
Challenges

Ongoing developments in the increasing sophistication of consumers, continued obstacles in the wake of the global pandemic, and growing populations in the world's urban centers will continue to pose significant and meaningful challenges for operators across several industries. Infrastructure modernization, yet another challenge currently unfolding in cities across the globe, is connected to the need for smarter fleet solutions. Part of this transformation requires legacy infrastructure to be modernized, which in turn can bring additional costs to already strained budgets.

Increased demand for mass transit

In many countries around the world, government investment is inextricably linked with public transit development and modernization. Customers want their goods delivered faster, consumers are demanding greater sustainability, and citizens desire improvements in public infrastructure, urban mobility, and mass transit, using technology implemented by governments. To keep pace with citizen demand, many governments are setting new goals for improving mass transportation. This will help accelerate the delivery of goods, mitigate congestion, and increase environmental sustainability efforts.[18]

Operational performance oversight

To focus on one specific example, within public transportation, fleet managers face many challenges with their current systems when it comes to organizing fleets, overseeing vehicles for performance, maintenance, and route planning. Many logistics providers today rely on disaggregated data platforms and independent point solutions for their fleet management systems. Disaggregated systems have significant disadvantages compared to a single, connected system, such as decreased efficiency and performance of fleet operations. This results in major competitive disadvantages for a customer's first choice of fleet delivery. Fleet operators with disaggregated systems are left to manually track each vehicle's systems separately, making it difficult to manage large fleets and expending lots of time and resources.

Inability to adapt quickly to near real-time data

Fleet operators need greater flexibility to meet the changing demands of customers and to adapt in near real-time to weather conditions, traffic disruptions, and other events. For fleet managers, using technology, connecting devices, and harnessing the power of captured data in an economical way, can transform the business. Information based in near real-time analytics allows organizations to make better decisions, delivering greater value for passengers, customers, and employees.[19]

Smarter solutions needed

COVID-19's impact on consumer behavior and the global supply chain cannot be underestimated, resulting in greater demand for technology to solve budgetary and growth issues. For example, the global market for Mass Transit Smart Solutions, estimated at USD 38.3 billion in 2020, is projected to reach USD 63.4 billion by 2027, growing at a CAGR of 7.5% over the analysis period 2020–2027.[20]

Opportunity

Globally, public transport is rapidly being adopted by consumers as a viable mode of transportation. Governments all over the world are continuing to invest in infrastructure, such as roads, rail, and forms of mass transit, in part because public mobility systems offer both short and long-distance solutions, while reducing congestion, transport expenses, and environmental pollution.[21] The U.S. government is awarding nearly $1.5 billion in grants in 2022 to modernize bus fleets and facilities across the country. Of the money allocated, $1.1 billion will go to the Low or No Emission (Low-No) program this year alone.[22]

Another trend worth noting is the commercial trucking industry's growth. [23] Technology will continue to play a substantial role in how municipal governments provide services for citizens, as evidenced by fleet management applications such as smart navigation, that allows comprehensive asset allocation for snowplows, road salting, and tree removals after heavy storms.[24] Digital twin ecosystem development will likely see greater adoption by municipalities around the globe, offering near real-time 3D city modeling and the ability to simulate the impact of natural disasters and new development while optimizing sustainability efforts and saving costs.[25]

Trends that will impact the increased need for heavy duty machinery include large-scale efforts toward urbanization in countries like China, India, and elsewhere. Due to ongoing consumption of base and precious metals in Mexico and Canada, the mining equipment market alone is projected to grow to USD 284.93 billion by 2025.[26] To improve safety, mining companies worldwide are swiftly leveraging technological developments to better use their equipment and human resources. Considerable increases in safety processes and procedures are helping mitigate risks. Using automated equipment, which can be maneuvered into unsafe areas and challenging locations, the mining companies can send fewer miners underground, with lower risk to their employees.[27] Driverless vehicles, automatic power crusher technology, and auto-tunable robotic tactile loading (ARTL) sensors represent just a few more of the innovations driving growth in the industry.

Within the agriculture industry, increased demand for more sustainability, interest in regional produce, and the resultant growth in equipment sales are driving the need for new technology and safety. Machine learning-enabled solutions, for example, are being adopted by agricultural organizations and farmers worldwide to enhance their productivity and to gain a competitive edge in business operations.

In the coming years, the application of machine learning in various agricultural practices is expected to rise exponentially.[28] Robotic devices that can perform under adverse conditions, common data sharing initiatives, and autonomous workforce and other remote solutions are among the many other tech innovations being adopted by agricultural companies.[29]

In this market, increases in efficiency of methods employed for cargo and commercial delivery have led to faster delivery times, resulting in more widespread adoption of e-commerce as a primary way of acquiring goods. This growth is expected to continue, as e-commerce further becomes the preferred mode of consumers around the globe in the wake of the pandemic—a trend that most experts expect to become more permanent in the future. Concerned consumers have turned to shopping online in a massive wave, with e-commerce sales in the U.S. increasing 14.2% over 2020 and 50.5% over 2019.[30]

In the construction industry, increased building of megastructures and high-quality infrastructure has highlighted the need for connected construction technology to counter the shortage of skilled labor that exists in many markets. Predictive data can enable preemptive maintenance that allows components to be replaced before they malfunction or fail. These solutions can also track information such as idle time and fuel consumption, enabling managers of building sites and public-works projects to make better decisions about the use of their fleets. These machines can carry out much of their work automatically, while an operator can be dedicated to higher value, decision-making tasks. Operators will also be able to better coordinate groups of machines and facilitate scheduling and fueling, potentially speeding up each project phase.[31]

Demand for commercial vehicles will be driven by digitization, along with increasing infrastructure spending. A few important factors currently driving growth in the commercial vehicles market include an increase in integration of telematics services, a rise in consumer demand for individualized transport solutions, and the growth of fleet sharing.

Another byproduct of the global pandemic has been the dramatic rise in consumer awareness of the necessity to reduce food waste. Concurrently, the need for investment in the cold chain has been bolstered by pharmaceutical delivery for worldwide administration of vaccines to combat the spread of COVID-19. To cite a recent pertinent example, billions of lives depend on the reliability of something like cold chain integrity and

pharmaceutical asset management, a topic that few people likely consider when receiving vaccination shots. Here, IoT and technology solutions allow for careful, ongoing monitoring and protection of perishable assets at every stage of transport, ensuring temperature and handling issues don't jeopardize successful delivery. Governments around the world have increased infrastructure investment of the cold chain as a result, with a projected value in the cold chain market size estimated to reach USD 340.3 billion by 2025, with a CAGR of 7.8 percent.[32]

Government leaders at all levels, together with private and public companies, are aware of the growing need for smarter, safer, and more ably managed urban mobility systems that provide dramatic and much-needed improvements for both commerce and citizens everywhere. With the world's population continuing to shift rapidly to urban areas—expected to grow from the current figure, 56%, to as much as 70% by 2050.[33] Massive investment will be required to meet the challenges that cities and leaders face. Providing a way for passengers to navigate urban environments with convenience, speed, and safety while minimizing the impact on the environment, for example, is one key example of the opportunity that lies ahead.

Technology development is poised to make a significant impact on the overall growth in mobility systems, with the Mass Transit Smart Solutions market in the U.S. alone estimated at USD 11.3 billion in the year 2020. China, the world's second largest economy, is forecast to reach a projected market size of USD 11.1 billion by the year 2027 trailing a CAGR of 7% over the analysis period 2020–2027. Among the other noteworthy geographic markets are Japan and Canada, each forecast to grow at 7% and 6% respectively over the 2020–2027 period. Within Europe, Germany is forecast to grow at approximately 6.1% CAGR.[34]

The opportunities to increase overall efficiency and performance are abundant and include improvements in fuel efficiency via the enabling of automated and optimized routing, braking, acceleration, and on/off (instead of idling). The value of predictive maintenance cannot be understated, as innovative maintenance technologies allow for the integration of diverse sets of equipment, systems, and platforms, with behavioral indicators being sent from each vehicle or asset to be analyzed at the edge, thereby helping improve operational efficiency.

Country	Global Parcel Shipping Volume (in million parcels)
China	63,500
USA	14,700
Japan	9,000
UK	3,800
Germany	3,700
India	2,800
France	1,300
Canada	1,100
Italy	990
Australia	934
Brazil	850

Global Parcel Shipping Volume
(in million parcels)

2019 Global Parcel Shipping Volume (in million parcels) via Statista
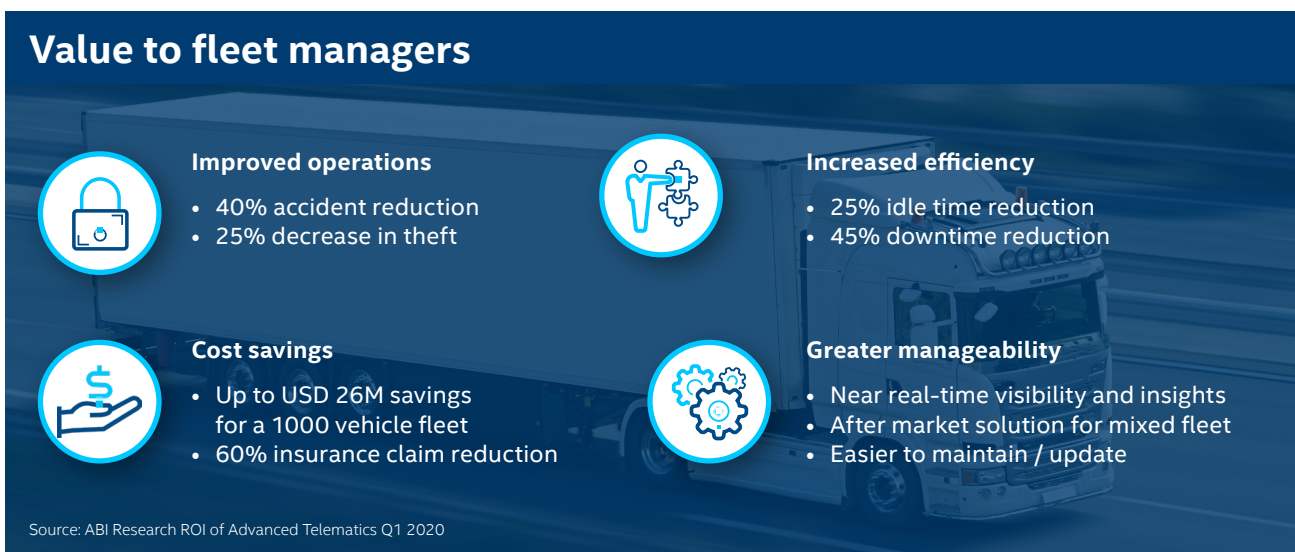
Use Cases

This section focuses on use cases within three major categories: heavy equipment, cargo, and public transit. While much of the information featured below showcases solutions that allow for great complexity in terms of features, it is important to note that these solutions are also exceedingly flexible in terms of usability. Because of this, they can often be implemented within other municipal or city vehicles (i.e., taxis, police cars), and use cases (i.e., public asset management, which is often a point of data collection onboard buses).

Fleet managers can help improve operations, connectivity, security, efficiency, and management while keeping costs low with Intel-powered fleet management solutions, designed and built by ecosystem partners.

Fleet management telematics solutions collect, store, and analyze vehicle data, allowing fleet managers to access analytics and mass fleet data in one location remotely through the cloud.

Fleet management solutions create a greater experience for stakeholders

Bus Company Administrators
Route logistics Coaching opportunities

Fleet Manager
Route Route logistics
Managerial opportunities
Cargo management

Heavy Equipment
Waste reduction
Predictive maintenance

Driver
Insights
View of surroundings

Insurance
Policy handling
Evidence

Passenger
Convenience
Connected ticketing system

Service Shops
Maintenance predictions
Vehicle health

Advertisers
Integrated digital marketing
Sponsored-travel opportunities

Shippers
Space optimization
Cargo management

The Fleet ecosystem requires consideration of multiple user experiences to drive efficiency, scalability, and cost-effectiveness

Value to fleet managers

Improved operations
- 40% accident reduction
- 25% decrease in theft

Increased efficiency
- 25% idle time reduction
- 45% downtime reduction

Cost savings
- Up to USD 26M savings for a 1000 vehicle fleet
- 60% insurance claim reduction

Greater manageability
- Near real-time visibility and insights
- After market solution for mixed fleet
- Easier to maintain / update

Source: ABI Research ROI of Advanced Telematics Q1 2020

Heavy Equipment Fleet Management Solutions

Heavy equipment, including yellow iron, utility vehicles, agriculture, and mining, can leverage increased safety and value through state-of-the-art automation technologies. Customers can take advantage of high-performance computing platforms for the processing power to capture, monitor, and use data from technology-equipped machines for greater insight into equipment operations. Customers can manage their operations from a single, remote location, translating into even larger productivity gains and return on investment (ROI).

Smart equipment can help provide a safer environment to conduct remote operations, leading to improved equipment availability, operational consistency, and lower overall costs. Operators can also use sophisticated onboard intelligence to achieve continuous improvement and innovation.

Organizations can count on sturdy, dependable heavy mobile equipment solutions that are designed for flexibility and durability. Powerful modules, available in different sizes, provide flexibility for any embedded device, while system platform architecture is designed for maximum flexibility to meet today's demands and future needs for in-vehicle AI, deep learning, and High-Performance Edge Computing.

Ruggedized, industrial-grade devices perform well under challenging conditions, including shock, vibration, and thermal extremes. Built-in artificial intelligence (AI) and machine learning (ML) help them capture and analyze relevant data and develop new processes. Predictive maintenance can increase uptime and diminish potential outages.

Because many solutions are compatible with a manufacturer's existing systems, organizations will be able to retrofit connected machinery. Customers can take advantage of cloud services to enable machine-to-cloud and machine-to-machine communications. They can synchronize workflow among machinery using the cloud. Predictable costs, such as fuel and insurance, give greater control over expenses and can improve total cost of ownership (TCO). With greater efficiency in place, organizations can free operators to focus on higher-value tasks and put their insights and judgment to uses beyond basic equipment operations. Mechanical data analysis enables customers to reduce fuel consumption.

For more improved operator safety, our solution delivers increased automation in compliance with safety regulations. Kontron and Intel offer a safety mezzanine option, collaborating with manufacturers to implement functional safety to ISO specifications.

Waste reduction, service efficiency, uptime

Internal Video Event Recording

External Video Event Recording

Vehicle and driver monitoring

Predictive maintenance

Driver Management

Fuel Management

Event Monitoring

Idle Monitoring

360° View

Cargo Fleet Management Solutions

Cargo Fleet Management includes everything from tractor trailers to delivery vans and vehicles. IoT technology in cargo fleets is playing a pivotal role in helping transform business operations. Cargo fleet vehicles are a major driving force behind commerce and play a key role in the supply chain. As the number of commercial vehicles grows worldwide, the management of larger fleets becomes more complex and costly, raising a need for IoT technology to help manage them.

These insights enable managers to optimize vehicle maintenance schedules by predicting and spotting maintenance needs that allow vehicle performance and runtime to be maximized. Additionally, metadata helps managers plan routes and schedules to increase delivery efficiency. Further, artificial intelligence (AI) and vision technologies monitor cargo and empower drivers with insights for a more secure delivery experience. Advanced Telematics drives near real-time analyses and valuable insights to help businesses make key decisions in improving their fleet operations.

The latest telematics solutions powered by Intel® technologies support a range of use cases to meet the needs of all fleet managers helping instill confidence by providing deeper insights on how their fleet is performing and operating.

Cargo Management (Measurement and Location)

Geospatial Asset Management

Vehicle and Driver Monitoring

Internal Video Event Recording

Navigation/Route Planning

Driver Management

Predictive Maintenance

Event Monitoring

Idle Monitoring

External Video Event Recording

Cargo Location and Condition

Cargo Optimization

Cold Chain

360° View

Public Transit Fleet Solutions

As cities grow in size and complexity, public transportation solutions like buses and paratransit-type vehicles require a more strategic approach. Transport operators continue to face increasing risks with their existing systems in e-commerce, ticketing, and route planning logistics, as well as overseeing vehicle and internal bus maintenance. And new complications like evolving public health measures, non-traditional traveling schedules, and other accessibility needs present even further challenges. Increasingly, public transportation companies are looking for IoT technology systems to produce actionable insights from vehicle data to empower their fleets with new capabilities that will transform the transportation experience.[36]

The Internet of Things plays a key role in the future of public transportation. Many logistics providers today rely on disaggregated data platforms and independent point solutions for their fleet management systems, making it difficult to manage large fleets without expending significant time and resources. New fleet solutions can provide a smoother transportation experience, actionable insights from mass data, and greater value for customers and employees via improved efficiency and manageability.

To address their challenges, fleet organizations are looking for solutions that can:
- Improve operations with tools that allow transport operators to monitor vehicles, passengers, and driver behavior for coaching opportunities; and to monitor goods as part of cold chain quality assurance or theft protection
- Improve fleet manageability with near real-time visibility and insights of the entire fleet
- Enhance the passenger experience with streamlined ticketing systems, automated policy enforcement, back-end analysis on customer demands, and public transport infotainment

- Reduce costs with improved efficiencies and optimized maintenance scheduling for max vehicle runtime
- Increase awareness for heavy duty vehicles and operators, allowing data collection for light pole maintenance needs, pothole location and severity, or on construction sites to monitor effective use of safety equipment

Public transportation companies can help improve operations, efficiency, and manageability while keeping costs low with fleet management systems that provide a more connected and enhanced transportation experience.

Fleet systems collect, store, and analyze vehicle data providing transport operators with actionable insights that help manage their entire fleet. These insights enable transport operators to optimize vehicle maintenance schedules by predicting and spotting maintenance needs for the vehicle and passenger seating areas. Additionally, metadata can help operators with route planning to maximize transportation efficiency.

Features such as 360° view, driver management, and passenger monitoring provide key insights for drivers and transport operators that can help improve operations. To streamline onboarding, fleets can take advantage of e-ticketing systems, contactless payments, occupancy control, and automated compliance notifications. Lastly, passenger communication systems notify customers of policies, stops, transfers, and other routes to create a smoother travel experience for new and experienced customers.

The latest public transport fleet management solutions, powered by Intel® technologies, supports a range of use cases that meet the needs of all transport operators helping instill confidence with deeper insights on how their fleet is performing and operating.

Passenger Monitoring, Security Compliance, and Accessibility Assistance

Driver Management

E-Ticketing/Contactless Travel and Automated Fare Detection

Passenger Count

Road Asset Management and Data Collection

360° View

Passenger Communication Systems

Internal Video Event Recording

Vehicle and Driver Monitoring

Navigation/Route Planning

Predictive Maintenance

Event Monitoring

360° View

Use Cases for Fleet Management Solutions Powered by Intel® Technologies

	Heavy Equipment	Cargo	Public Transportation
360° View	●	●	●
Cargo Location and Condition		●	
Cargo Management (Measurement and Location)		●	
Cargo Optimization		●	
Cold Chain		●	
Driver Management	●	●	●
E-Ticketing/Contactless Travel and Automated Fare Detection			●
Event Monitoring	●		
External Video Event Recording	●	●	●
Fuel Management	●	●	●
Geospatial Asset Management		●	
Idle Monitoring	●	●	
Internal Video Event Recording	●	●	●
Navigation/Route Planning		●	●
Passenger Communication Systems			●
Passenger Count			●
Passenger Monitoring, Security Compliance, and Accessibility Assistance			●
Predictive Maintenance	●	●	●
Road Asset Management and Data Collection			●
Vehicle and Driver Monitoring	●	●	●
Waste Reduction, Service Efficiency, Uptime	●		

Fleet Management Solutions Powered by Intel® Technologies

360° View

360° View cameras allow vehicles to record the external environment, detect specific events during the drive, and upload and save the videos online. Fleet owners can use the video for coaching opportunities to train drivers, as well as for evidence to potentially reduce the costs of litigation.

Cargo Location and Condition

Telematics plays a large role in supply chain and logistics. Temperature control, surveillance, and vibration sensors ensure that cargo is secure during transportation. By monitoring and keeping a vehicle's cargo hold at a set temperature, items such as food, medications, and other perishables stay fresh and consumable. With cameras and sensors surveying cargo—inside and outside of the vehicle—operators can help ensure exactly what should be on the truck, and in what order. This also confirms if any cargo is lost or stolen. Vibration sensors can ensure that fragile goods are secure and will not break during transportation. In-vehicle and edge-based solutions offer visibility inside and around the vehicle. Video feeds can be stored when needed for driver coaching or in case of an accident or litigation. Drivers are also more aware of cargo conditions during transit.[37]

In the warehouse, 3D cameras can be used to scan barcodes quickly and measure the dimension of packages to capture the overall volume of the shipment, helping track cargo and maximize cargo capacity. Additionally, lighting tags can be used to localize packages. All data and insights generated can be accessed by fleet managers through a dashboard hosted on the cloud. The insights generated can be used to help optimize transportation and handling efficiency for a better delivery service to customers.[38]

Cargo Management (Measurement and Location)

Sensors and cameras within the cargo compartment inform drivers of how much cargo space is utilized to maximize capacity. Additionally, they help ensure that cargo is secure and that the appropriate temperature for perishable cargo is maintained. By remaining connected to the entire fleet solution system, drivers are provided alerts that help detect when cargo is compromised.

Cargo Optimization

Telematics solutions collect, store, and analyze data that can be sent to fleet managers. This data helps fleet owners and managers evaluate vehicle maintenance, driver operation, and cargo management. IoT in fleet monitoring can help improve savings, manageability, and visibility in passenger-load and cargo vehicles. Managers can increase savings with improved route efficiency and cargo utilization management. Additionally, they can reduce fuel costs and decrease idle time when telematics is used to provide optimized routes. Managers can also see a decrease in accidents and theft, which can reduce costs associated with vehicle downtime and repairs.[39]

Cold Chain

Enabling a supply-chain network that connects suppliers, customers, original device manufacturers (ODMs), third-party logistics (3PL) transport agents, retailers, and end-consumers: the network will enable sensors to directly and seamlessly connect with any potential partner and will drive supply-chain efficiency. Developed to offer near real-time asset tracking solutions for the logistics industry, Intel® Connected Logistics Platform (Intel® CLP) is an IoT platform that uses battery operated smart wireless sensor devices to provide greater visibility into location, condition, and security of packages. By providing this improved insight into all points of the shipping process, companies can save time and money, as well as greater control over inventory levels. Live tracking of multiple elements such as temperature, humidity, and GPS at the pallet level with the Intel® Connected Logistics Platform means that companies can make real-time adjustments when the unexpected occurs.

Driver Management
Driver monitoring systems keep drivers and others on the road safe with driver fatigue and distraction detection. Using visual and audio alerts, drivers are notified when they exhibit unsafe behavior or driving manners to help bring their focus back on the road, helping prevent accidents. Telemetry also provides insights on driving behavior by capturing speed, acceleration habits, and more, providing opportunities for coaching.

**E-Ticketing/Contactless Travel
and Automated Fare Detection**
Contactless ticketing options can provide customers with a streamlined onboarding experience, including paying with a card via NFC or connecting an online ticketing site to allow customers to prepay for tickets and scan during onboarding. This allows customers to skip ticket lines and allows buses to deliver transportation services efficiently, mitigating the risk of delays. For fleet operators and passengers alike, increased safety and reduced virus transmission result from delivering a contactless experience for all.

Smart ticketing systems using sensor beacons could eventually result in the removal of ticket barriers and signal an end to queues at the ticket machine in metro railway and public transportation stations. Sensors on station platforms or onboard public transit fleet vehicles will be able to detect an app on passengers' smartphones as they enter the station or board, automatically charging the correct fare and eliminating passenger overcharges. Public transit fleet operators and will be able to streamline backend billing and revenue management, while better understanding public transit vehicle usage behavior through near real-time data.

Event Monitoring
Intel® AI Builders member viso.ai helps vehicles provide a clear view of surroundings with exterior monitoring. Cameras can also record video clips that can be used in case of an accident or for driving coaching.

External Video Event Recording
Operators can apply AI to monitor the exterior of fleet vehicles to detect, record, and send events to the cloud dashboard. Heavy equipment external video monitoring allows for compliance, human object detection, proximity detection, PPE/safety equipment detection, and breach detection. Distributed edge and cloud-based Computer Vision/AI solution provides visibility in a variety of conditions.

Fuel Management
Organizations can increase fuel efficiency by enabling automated and optimized routing, braking, acceleration, and on/off, instead of idling.

Geospatial Asset Management
Intel® Geospatial fuses remote sensor data collected from satellites, planes, drones, and Mobileye-equipped vehicles together with AI-powered analytics and high-performance data processing and management. Designed to meet the unique challenges of processing, storing, and streaming multisource geovisual data, our cloud-based data management platform enables a wide range of cost-effective solutions. Through the use of Intel® Geospatial, operators can utilize onboard AI compute from their in-vehicle PC to detect PPE

compliance from workers on the worksite, geo-locations of construction assets such as power generators, and more. Powerful AI-powered analytics capabilities include object detection and classification, 3D reconstruction, and spatial analysis.

Idle Monitoring
Idle monitoring helps minimize fuel waste by detecting unnecessary idling when on standby. An alert notifies the driver when the vehicle should be turned off, saving fuel and decreasing carbon emissions. Combined with GPS tracking and navigation, fleet solutions can help enhance the efficiency of the load and unload times, as well as waiting times in warehousing.

Internal Video Event Recording
Use computer vision, deep learning, and edge networking to develop a solution for managing drive behavior and alertness. Public transit security solutions provide video monitoring, centralized evident storage, GPS bus location, and prepared police response. A recent deployment with MBTA in Boston resulted in a solution that could be easily and securely transferred and addresses future need for video analytics inside and outside buses.

Navigation/Route Planning
GPS tracking and navigation not only helps drivers get to their destination, but it also helps managers oversee the entire fleet in near real-time, remotely through the cloud, as well as plan route logistics and improve both truck and hazardous cargo routing, especially in light of the fact that in some city road segments, trucks and hazardous cargo freights are not allowed. Optimizing delivery routes can save on fuel, speed up delivery, and improve customer service for a more efficient fleet.

Passenger Communication Systems
To enhance the customer experience for new and seasoned travelers, passenger communication systems can help inform passengers of bus arrival and departure times, upcoming bus stops, transfers to their travel destination, out-of-service buses, and more. With digital displays inside and outside the bus, passengers can stay informed on details regarding their travel agenda. At the fleet management level, near real-time, fleet-wide visibility leads to increased productivity and performance, based on routes, trips, and events.

Passenger Count
Telematics helps fleet managers monitor drivers, vehicle usage, and maintenance needs. Aftermarket solutions can capture telematics data across a diverse fleet of vehicle types and models. With passenger-load vehicle fleets, managers can see a more accurate passenger count. They can also easily maintain surveillance and ticketing systems inside the vehicles.

Passenger Monitoring, Security Compliance, and Accessibility Assistance
The new normal for citizens traveling in public transportation means taking necessary measures to prevent the spread of illnesses to the driver and other passengers onboard. During onboarding, passenger monitoring systems can detect if passengers do not have a face mask and display an automated compliance message. Smart vision cameras can further detect social distancing between passengers, count the number of

passengers for occupancy control, and even help the driver detect passengers who need help with lifts, special seating, or other special accessibility needs to ensure that everyone has a great travel experience.

Passenger information systems in buses or other passenger load vehicles can provide access to Wi-Fi or deliver helpful information about routes and services. They can notify passengers if there are social distancing guidelines they must follow while aboard and if there are accommodating seats for people with disabilities. Video surveillance systems can provide statistics for bus operators about the number of riders and other protocols like social distancing and face mask usage. Touchless ticketing can connect to buses to improve the passenger experience.

Predictive Maintenance

In-vehicle sensors (or alternately, CAN bus or ODB2 readings) detect performance status of components across the entire vehicle, indicating to fleet managers when maintenance needs occur early so that vehicle runtime and performance can be maximized. This ensures maintenance schedules are optimized to save fleet organizations major costs in maintenance and downtime.

Road Asset Management and Data Collection

Intel's ecosystem partners have developed market-ready solutions to solve challenges in fleet maintenance and road asset management. For example, by using 360° sensors and cameras that provide high-resolution streams, the solutions help vehicles avoid accidents and prevent theft by automatically recording anomalies around the vehicle. Telematics plays a large role in fleet management.

Temperature control, surveillance, and vibration sensors ensure that passengers and cargo remain secure during transportation. By monitoring and keeping a fleet vehicle's passenger cabin and cargo hold at a set temperature, items such as food, medications, and other perishables stay fresh and consumable. With cameras and sensors surveying cargo—inside and outside of the vehicle—operators can ensure exactly what should be on the fleet vehicle. This also confirms if any cargo is lost or stolen.

External and Driver Monitoring

External cameras that can detect objects, pedestrians, and other vehicles provide clear views of the surrounding area. Cameras can also record video clips that can be used in case of an accident or for driving coaching. In-cabin cameras can alert drivers and recommend that they stop and rest when needed. Video data can be stored for use in case of an accident.

Driver monitoring is able to detect behaviors while using or interacting with the vehicle. The application monitors the driver's attentiveness and alertness, and feedback can be given to improve the conditions under which a vehicle is operated. It functions using video analytics and AI models.

IEI Integration Corporation uses the Intel® Atom® processor to power driver management solutions like its ITG-100AI embedded PC, which uses computer vision to monitor drivers for drowsiness and distraction. These applications notify control center operators of a driver's condition in near real-time.

Waste Reduction, Service Efficiency, Uptime

Operators can reduce waste by helping to maximize payload and identify bottlenecks, measure the volume of material cut and filled, and ensure machines move the right amount of material with every load. Standardizing common parts for equipment enables successful inventory management with much less variety.

With a single unique platform in use across a customer fleet, the team will not need specialized knowledge about multiple solutions. Service and repairs will be more consistent from vehicle to vehicle. With near real-time performance data and contextual analytics, organizations can anticipate potential outages or equipment failures and accurately measure volume or weight moved, in order to avoid downtime and reduce bottlenecks. Predictive maintenance enables customers to prevent interruptions from breakdowns, and keep equipment running reliably.

The Digital Truck

Intel delivers power-efficient performance and intelligence optimized for transportation use cases, like fleet, cargo and warehouse management to fleet management solutions. Intel is partnering up with its ecosystem partners to support new models for intelligent, connected logistics with powerful computing, vision technology, and edge/cloud computing that cover fleet manager's use cases of today and in the future. From the edge to the cloud, Intel helps turn data into actionable insights that help fleet managers continue providing a high-quality delivery service.

Fleet managers can help improve operations, security, efficiency, and management while keeping costs low for a more connected fleet with Intel®-powered fleet management solutions, designed and built by ecosystem partners.

Fleet management telematics solutions collect, store, and analyze vehicle data, allowing fleet managers to access analyses and mass fleet data in one location remotely through the cloud. These insights empower managers to optimize vehicle maintenance schedules by predicting and spotting maintenance needs to maximize vehicle performance and runtime. Additionally, metadata helps managers with routes and schedules to increase delivery efficiency. Further, artificial intelligence (AI) and vision technologies monitor cargo and empower drivers with insights for a more secure delivery experience. Advanced Telematics drives near real-time analyses and valuable insights to help businesses make key decisions in improving their fleet operations.

The latest telematics solutions powered by Intel® technologies supports a range of use cases to meet the needs of all fleet managers, helping instill confidence with deeper insights on how their fleet is performing and operating.

Predictive Maintenance
In-vehicle sensors detect performance status of components across the entire vehicle, indicating to fleet managers when maintenance needs occur early so that vehicle runtime and performance can be maximized. This ensures maintenance schedules are optimized to save fleet organizations major costs in maintenance and downtime.

Navigation and Route Planning
GPS tracking and navigation not only help drivers get to their destination; it also helps managers oversee the entire fleet in near real-time remotely through the cloud, as well as plan route logistics. Optimizing delivery routes can save on fuel, speed up delivery, and improve customer service for a more efficient fleet.

Driver Management
Driver monitoring systems identify drivers when interacting with the vehicle. Visual and audio alerts notify drivers when they are behaving in and unsafe manner, such as distracted driving or driving while drowsy, helping to prevent accidents. Telemetry also provides insights on driving behavior by capturing speed, acceleration habits, and more for coaching opportunities.

Cargo Management
Sensors and cameras within the cargo compartment informs drivers of how much cargo space is utilized to maximize capacity. Additionally, they help ensure that cargo is secure and that the appropriate temperature for perishable cargo is maintained. By remaining connected to the entire fleet solution system, drivers are provided alerts that help detect when cargo is compromised or infiltrated in.

Idle Monitoring
Idle Monitoring helps minimize fuel waste by detecting unnecessary idling when on standby. An alert notifies the driver when the vehicle should be turned off, saving fuel and decreasing carbon emissions. Combined with GPS tracking and navigation, fleet solutions can help enhance the efficiency of the load and unload times, as well as waiting times in warehousing.

360° View
360° View cameras allow vehicles to record the external environment, detect specific events during the drive, and upload and save the videos online. Fleet owners can use the video for coaching opportunities to train drivers, as well as for evidence to potentially reduce the costs of litigation.[48]

Technology Summary

Technology Solutions from Intel

For fleet management needs, Intel and partners are providing solutions that maximize performance in a singular, connected system accessible through the cloud, helping reduce infrastructure costs, simplifying integration, and making it easier to manage entire fleets.

Intel's partner solutions can accelerate time to market with proven solutions with adaptable offerings that can help transform business operations and the overall transportation experience to help meet today's needs, enabling fleet managers to make better decisions and create more value for end customers with Intel's cutting-edge solutions.

Intel delivers power-efficient performance and intelligence optimized for transportation use cases, like fleet, cargo and warehouse management to fleet management solutions. Intel is partnering up with its ecosystem partners to support new models for intelligent, connected logistics with powerful computing, vision technology, and edge/cloud computing that cover fleet manager's use cases of today and in the future. From the edge to the cloud, Intel helps turn data into actionable insights that help fleet managers continue providing a high-quality delivery service[35].

ODM	Regions Available	Country	Solutions	Solution Type	Products
ADLink	APJ	Taiwan	ADLink MXE-5500 Series		6th Generation Intel® Core™ i7/i5/i3 Processor-Based Fanless Embedded Computer
Advantech	APJ/ASMO	Taiwan/ USA	ADVANTECH TREK-60		• Intel® Core™ i7-7600U dual-core, 3.9 GHz • Intel® Core™ i5-7300U dual-core, 3.5 GHz • Intel® Atom™ X5-E3940 quad-core, 1.8 GHz
			TREK-60		Intel® Atom™ X5-E3940 quad-core, 1.8 GHz Intel® Core™ i7-7600U dual-core, 3.9 GHz Intel® Core™ i5-7300U dual-core, 3.5 GHz Memory 1 x SODIMM, up to 8 GB DDR3L 1866 non-ECC memory 2 x SODIMM, up to 32 GB DDR4 2133 non-ECC
Aeeon	APJ	Taiwan	Aaeon BOXER-6839		Fanless Embedded Box PC with 6th/ 7th Generation Intel® Core™ Desktop Processor and PCIe [x4] & PCI Expansion
DFI		Taiwan/ USA	VC300-CS		DFI's VC300-CS is a fanless and AI-enabled in-vehicle computer.
			VC230-AL		DFI VC230-AL is a fanless in-vehicle system powered by Intel Atom® E3900 series, featuring reliability, real-time data transmission, and SWap (small, lightweight, and low power consumption) with complete in-vehicle I/O and communication interfaces.
			VC-500-EHL		The VC500-CMS from DFI is a fanless in-vehicle System powered by Intel 10th Gen Intel® Core™ processor.
Everfocus		Taiwan	eIVP-KBU-IV-V0004		In-vehicle network video recorder platform Mobile in-vehicle NVR platform system with Intel® 7th gen. processor.
			eIVP-TGU-IV-V0000		Fanless in-vehicle edge system, empowered by 11th Gen. Intel® Core™ i7/i5/i3/Celeron® U-series, with dual video outputs up to 4K and one 2.5GbE LAN supporting Intel® Time Sensitive Networking (TSN)
Kontron	ASMO	Germany	Kontron TRACe -V40x-TR		Fanless Box Computer for rolling stock applications Intel® Core™i7-6600U or Core™i3-6100UKontron TRACe V40x-TR is an EN50155 fanless Transportation Computer, specifically designed for rolling stock application where video processing and real time analysis, video streaming, video storage are requested to match your system requirements, like IP video surveillance.

ODM	Regions Available	Country	Solutions	Solution Type	Products
Nexcom	APJ/ASMO	Taiwan/ USA	VTC 1030 VTC 7251 VTC 7252	General Fleet, Bus, Heavy Equipment	Fanless Rolling Stock Computer • Intel® Coffee Lake-S Refresh Desktop, i7-9700TE, 35W, 8 Core • 4 x 10/100/1000 Mbps M12 X-coded, PoE 802.3af/at, total 60W2 x mini-PCIe (USB 2.0, PCIe 3.0/SATA 3.0) and 1 x mini-PCIe (USB 2.0) for LTE • 2 x M.2 3042/3050/3052 Key B (USB 2.0, USB 3.1 Gen2) for LTE/5G for Video Surveillance Applications
			VTC 7251-7C4 VTC 6222	Buses, Patrol Vehicles	VTC 6222, based on Intel Atom® quad core processor E3950 (up to 2.0GHz), is specifically comply with stringent E mark standard in rugged, fanless and compact mechanism.
			VTC 7260		Fanless AI-aided Vehicle Computer with Intel® Core™ 11th Gen CPU
Onlogic			Karbon 800		Karbon 801 packs 12th Gen Intel Core power and versatile industrial connectivity into a rugged platform.
Sintrones	APJ	Taiwan	VBOX-3611-4L VBOX-3611-4L-D5G		• Intel® Gen 6 Core i7-6600U CPU with 4 x GbE LAN On-Board Computer • Intel Gen 6 Core i7-6600U CPU with 4 x GbE LAN On-Board Computer with Dual 5G Modem Capability

Intel® Edge Software Hub

The Intel® Edge Software Hub is making it easier to optimize edge solutions, including computer vision and deep learning applications for Intel® architecture. Set your objectives and ramp up quickly—much less prework is needed. Choose the architecture type, then select Intel, third-party, or open-source software. Use containers and run multiple workloads on a single converged edge system, managing the data flow between sensors and applications. Whether building from scratch or customizing an implementation, Intel® Edge Software Hub accelerates business development. The Intel® Edge Software Hub makes it easy for developers to benefit from edge-to-cloud workflow integration, too. The Intel® Distribution of OpenVINO™ toolkit and marquee cloud service provider (CSP) offerings allow developers to extend their cloud applications to seamlessly develop and deploy solutions at the edge.

Partner Spotlights

Advantech, Harman (LATAM), Cittati (ISV)

Advantech, whose mission is to enable an intelligent planet, works with partners to co-create business ecosystems that accelerate the goal of industrial intelligence. HARMAN designs connected products and solutions for automobile manufacturers, consumers, and businesses. Cittati is a leading provider of Intelligent Transportation Systems (ITS) in Brazil, with over 10 years of industry experience and almost 30,000 buses monitored in real time.

Fulfilling key requirements for new connected buses, CittaGeo embedded technology transforms the common bus into an intelligent vehicle, capturing data so that private operators and public authorities can understand and apply continuous improvements to urban mobility. By transforming common buses into smart vehicles, the solution's technology connects passengers and on-board crew, improving user experience. With the technologies already in use around the world, passengers gain predictability through self-managed driving, improved punctuality, a constant detail of buses on the line, and increased accessibility for people with visual impairments.

The CittaGeo solution enabled by these partners has become the first choice of bus companies that want to use data to apply continuous improvements in the efficiency of urban transport, increasing passenger safety and the quality of their experience.

Advantech AIoT Heavy Duty Construction Equipment

Advantech provided its rugged and trusted TREK in-vehicle platform for a major APJ HME manufacturer's semi-automated construction equipment, realizing features such as 3D modeling manipulation and graphical user interfaces. Also, Advantech provided ultra-rugged DLT computers to Modular Mining, a Komatsu subsidiary providing operation optimization systems for the mining industry, and to Komatsu's Autonomous Haulage System, the world's first autonomous driving system for large mining dump trucks.

Besides the ruggedness and stability of its TREK in-vehicle platform, Advantech's application-oriented middleware and software also made Komatsu's application development more productive. With the assistance of semi-automated equipment, management has been able to lower criteria for operators and recruit digital generation staff with less experience for jobs that in the past required decades of experience.

Autonomous heavy equipment will revolutionize the construction and mining industries by solving personnel shortage issues, eliminating human errors, creating a safer work environment, executing tasks with impeccable precision, increasing productivity, and lowering operational costs. Komatsu continues to collaborate with Advantech to realize an autonomous environment for equipment and systems used in the construction and mining industries.

KOMTRAX" greatly increased Komatsu's competitiveness in the industry, monitoring the status of equipment, facilitating arrangements for maintenance, and predicting the occurrence of malfunctions, thereby minimizing equipment downtime and maximizing equipment productivity.

Advantech Cold Chain

Advantech's cold chain management solution spans temperature and humidity sensors, gateways, an Android APP for configuring the sensors, and a backend dashboard to monitor cold-chain logistics in different stores simultaneously in near-real time.

For most current cold chain solutions, installation of wired sensors presents a challenge for operators and maintenance personnel. With Advantech's temperature sensors, a wireless transmission design makes things convenient for installation and maintenance. 24/7 uninterrupted temperature detection and recording, coupled with big data analysis, can effectively assist the owners of cold chain goods in identifying blind spots in inventory management, while improving the quality of foods and medication. The core of Advantech's cold chain solution is TREK IoT gateway that is an open platform architecture based on Intel® CPU.

This solution can be used in many places, such as within a factory, fleet, warehouse, hospital, clinic, pharmacy and retail store, delivering uninterrupted cold chain management from collection to sale.

Advantech/VinBus

VinBus, a subsidiary of Vietnam's largest conglomerate VinGroup, specializes in intelligent electric buses. They have launched a large-scale electric bus project aimed at improving environmental stability.

VinGroup decided to improve rider experiences by building safe, comfortable electric buses that provide various smart services. Accordingly, VinFast, a subsidiary of VinGroup that builds vehicles, partnered with Advantech. Their superior hardware and software integrated solutions for electric buses and extensive experience implementing similar projects in Taiwan made them a logical partner. VinBus opted to collaborate with Advantech and use their TREK Intelligent Electric Bus Management System.The TREK Intelligent Bus Management System provides advanced driver assistance systems (ADAS) and driver behavior management, passenger Wi-Fi service, and advertisement systems. The TREK system improves bus safety, comfort, and convenience — eliminating the discomfort passengers previously endured on diesel buses and transforming public transportation in Vietnamese cities. The intelligent electric buses deliver a comparatively safer, more convenient, and comfortable public transportation experience for Vietnamese commuters.

Electric buses also help address air pollution problems. VinBus is deploying 2~3 thousand electric buses in major Vietnamese cities. Their comfort, plus intelligent features, are expected to attract previously reluctant people. The project will also reduce the amount of time people spend on motorcycles, further reducing air pollution.

Aervision

AerVision, established in 2013 in Australia, develops innovative solutions for enhanced monitoring, safety, and security using state-of-the-art AI, computer vision, biometrics, IoT, and video analytics. AerVision provides one of the world's most advanced Real-time Situational Awareness and Secure Access Control solutions available.

AerVision's AerAccess® solution incorporates AI/ML at the edge, Intel's OpenVINO™ software platform and processors, and touchless biometric technology in one comprehensive technology. Using an easily integrated kiosk, AerAccess® technology improves safety, production, and work management and integrates with ease into a variety of workflows while complying with existing regulatory measures.

AerAccess® delivers multiple biometrics access control options and identification capabilities, suitable for use in both high throughput environments and highly secure facilities. AerAccess® units can be configured to operate based on any configuration of identification modalities to support increased functionality and ease of use.

DFI

Founded in 1981, DFI America, LLC is a global leading embedded solution provider. DFI specializes in Edge AI computing technology, industrial motherboards, and custom products across a wide range of industries, including Transportation, Automation, Medical, Banking, and Energy industries. DFI's In-Vehicle Systems contributes Smart Transportation a reliable, intelligent solution for public transit, fleet management, law enforcement and autonomous driving.

Due to government regulations and stringent verification processes, electronic systems of this nature, used within public transportation vehicles, must meet standards of high reliability without compromise. DFI's In-Vehicle Computer maintains an "always connected to the Internet" status and offers "precise positioning" functionality, without network interruption or location errors.

DFI's In-Vehicle Computers' design centers on reliability, MIL-STD anti-vibration, and SWap - small, lightweight, and low power consumption. The systems are certificated by E-Mark (E-13) to guarantee the quality level of electromagnetic. DFI's In-Vehicle systems are built-in with Mini PCIe and M.2 expansions for additional connectivity such as 3G/4G, Wi-Fi, GNSS, and CAN-Bus to provide real-time data analysis. Wide temperature, wide-voltage, and in-vehicle power management jointly ensure stability and astonishing endurance even in harsh environments.

EverFocus

EverFocus's comprehensive intelligent vehicle management solution, under the guidance of the Intel® Cities and Transportation special project team, has continued to show good results in the past few years. The flagship industrial computer product eIVP-KBU-IV-V0004 (eIVP5600) has not only won Taiwanese Excellence Award affirmation, but also won the favor of customers to use in the high-level community electronic fence project in Taipei City. In addition, it has also launched a number of mid-to-high-end AI Box products that meet different market needs (eIVP-TGU-AI-D0000, eIVP-CFS-AI- D0000, eIVP-WHU-AI-D0000, etc.), not only can be used for smart transportation, but also can be used in different business scenarios according to customer needs. One of the those is the "Autonomous Self-Driving Bus" project which was jointly developed with Taiwanese self-driving car manufacturers. It has now entered the third phase by opening up for public test rides. This phase has turned a new page in Taiwan's self-driving car industry.

EverFocus plays the role of "transmitter of image analysis of the outside field environment" during the operation of self-driving cars, the images are captured by the new MIT network camera EZN1250-SG with its industrial computer edge in the roadside unit (RSU), this helps link analyzed images to the project in real-time. Computing (Edge Computing) technology (eIVP-TGU-IV-V0000), the collected images are transmitted to the industrial computer in real time and accurately for edge computing. With the help of AI identification technology (Vehicle to Everything, V2X), it can effectively judge various emergencies for Autonomous Self-driving Cars. Road conditions are a very important part of the current vehicle networking technology.

Genetec/City Tech/CTA

Genetec is a provider of public safety, operations, and business intelligence solutions that help businesses protect, understand, and enhance the world around them. City Tech Collaborative, an urban solutions accelerator, tackles multi-organization problems using IoT sensing networks, advanced analytics, and urban design to create scalable, market ready solutions. The Chicago Transit Authority (CTA) operates the U.S.' second largest public transportation system and covers the City of Chicago and 35 surrounding suburbs.

Enhanced monitoring, management, and operations capabilities can improve customer experience and increase transit agency resilience. Building on the Chicago Transit Authority's (CTA's) existing measures to keep bus and train service timely, efficient, and safe, City Tech Collaborative (City Tech), together with the Chicago Transit Authority, Genetec, Intel, and Microsoft, developed new tools to provide near real-time insights on bus occupancy across multiple vehicles. Pilot implementation on CTA's 79th street bus line allowed CTA to proactively meet route ridership demand; reduce both passenger crowding and wait times; and provide a safe, socially distanced rider experience.

This effort demonstrates how existing assets and advanced technologies can improve short-term operations while also building a foundation for continued innovation.

Genetec/MBTA

Genetec™ is an industry leader in Internet Protocol (IP)-based security, delivering future-proof, scalable vision solutions that improve operational efficiencies for public and private fleets, leveraging the Intel® Distribution of OpenVINO™ Toolkit and Intel® Core™ Processors. The Massachusetts Bay Transportation Authority (MTBA, or "T"), is one of the oldest public transit systems in the U.S., providing subway, bus, Commuter Rail, ferry, and paratransit service to commuters.

A recent case study with the MTBA involved proprietary video recording systems used for stations and bus depots, and legacy, outdated components that had become time-consuming to operate. Genetec provided an open-architecture fleet monitoring solution using most of its existing hardware by just adding Intel® Core® Processors inside the recorders. The new open-architecture system provided a superior fleet management solution that allowed the customer to transfer the data of all vehicles securely through Wi-Fi to the wayside system. Genetec's Fleet Monitoring solution includes Security Center Omnicast™, an open, scalable IP video management solution that integrates with existing infrastructure and enables operators to rapidly respond to incidents.

The solution also included future-proof capabilities to address future objectives, using video analytics inside and outside the buses to give fleet managers the ability to view live and playback data.

Getac

Getac Video Solutions is a distinct subsidiary of Getac Technology Corporation, manufacturer of rugged computing solutions. Getac remains one of the largest global manufacturers of military-grade, rugged computing solutions. Since 2018, Getac Video Solutions offers robust software and rugged hardware solutions to help law enforcement and other industries acquire and manage video and digital evidence.

Getac's Video Mobile Edge Solution delivers a Mobile Data Terminal (MDT) and in-car video monitoring system, all-in-one. For in-vehicle placement, the VRX-20 DVR can be mounted in the trunk or on the center console, the display and keyboard are positioned above the center console for ease-of-use, and the 5" touch display is mounted on a visor bracket. The cameras leverage the same mount as the display (or can be fastened to the windshield), and an additional camera is typically mounted in the vehicle cab. This all-in-one solution alleviates the need for two separate devices that may be required to operate similar systems (i.e., a laptop or tablet, as well as in-car video), leading to significant cost-savings and reduced need for ongoing IT support.

The solution delivers the ability to run all applications on an MDT while also operating in-vehicle video items, through the use of a single piece of hardware powered by Intel's i7 chip and Windows 10 software, as well as a host of other key benefits.

GPC

GPC Systems, founded in 2010, is an innovative 3D dimensioning software house built on a history of working with 3D camera technology across a range of sectors, including Transport and Logistics as represented by councils across the UK.

For example, GPC's Highways Measure software can capture instant 3-dimensional measurements to detect and calculate the length, width, depth, and volume of road defects such as potholes, rutting, and cracks. This allows engineers to effectively plan for maintenance and repairs, offering multiple customizable functions, including GPS tracking, PDF Costings, and 3D Toggling for a complete understanding of any road defect.

Now, our 3D dimensioning software has been turned toward another area of Transport and Logistics, pallet-focused environments. GPC has developed Palletways ID, the most sophisticated forklift truck-mounted sensor technology. By combining four key measurements in one—pallet imaging, barcode scanning, accurate weight reading, and cubing/dimensioning—without interrupting process flow, Palletways ID delivers important real-time data to improve health and safety.

Incluit

IncluIT, a leader in software design and development based in Cordoba, Argentina, has partnered with Intel to address the risks attendant to changing transportation demands. IncluIT saw the opportunity for Internet of Things (IoT) solutions to transform the way trucking businesses operate. The benefits include enhanced efficiency, reduced costs, and decreased risks.

IncluIT turned to new and emerging tools spanning edge computing, artificial intelligence (AI), computer vision, and an open-source Intel solution designed to help bring it all together, the Intel® distribution of OpenVINO™ toolkit. Intel and IncluIT use the toolkit for non-ADAS solutions that aid truck drivers and meet transportation needs through driver training. The toolkit also allows driver monitoring to prevent and reduce risks by identifying and inferencing potentially dangerous situations.

IncluIT's Driver Management System, deployed inside a vehicle, monitors driver behavior, alerting the driver of potentially dangerous situations.

LivNSense

Intel and ecosystem partners LivNSense, Velociti, and Austin Bridge & Road are jointly developing a Vision-Based Intelligent Collision Avoidance System (ViCAS). ViCAS is an external monitoring solution that helps enable commercial and industrial construction firms to reduce workplace accidents. ViCAS leverages the Intel® Distribution of OpenVINO™ toolkit and Intel® Movidius™ Vision Processing Units (VPUs) to power deep learning inferencing models that can alert workers in near-real time about their surroundings, reducing workplace incidences and work stoppages. This solution provides an analytics dashboard visualization that includes a fully detailed report of all key metrics, as well as any non-safety compliance events that happen in the workplace."

ViCAS offers three key elements leverage AI vision at the edge: proximity detection, breach detection, and worker productivity. ViCAS senses humans with dangerous proximity to a vehicle, triggering audio and visual alerts that can allow drivers to prevent injuries. The solution can also detect physical breaches and issue real-time warnings to avoid unwanted intrusions and unauthorized visitors. It can also perceive driver behavior characteristics such as posture, position, and even the driver's emotional state. The ViCAS edge-to-cloud solution comprises an IP camera, a speaker, and an in-vehicle display connected the the AI Gateway, with an Intel® Atom® processor and an Intel® Movidius™ VPU configuration. It supports a Web/Mobile-Based Real-Time Dashboard in cloud with a safety proximity incident, safety compliance incident, cognitive safety insights, and configuration management.

MooVita MooBox

Founded 2016, Singapore headquartered MooVita is a high-tech provider of smart mobility solutions for urban environments. With offices in Singapore, Malaysia, and India, the high-tech startup offers vehicle-agnostic, driverless software capabilities for applications such as first and last-mile transportation, logistics transportation, and utility solutions. MooVita's solutions can be deployed across multiple industries such as hospitality service providers (hotels and resorts), industrial parks, commercial offices, and residential estates.

The MooBox is a Driver Behavior Monitoring Analysis System, providing a flexible cost-effective vehicular data acquisition and analytics system, increasing driver's safety by improving driving behavior. The enhanced capabilities in MooBox facilitate operational efficiency in public transportation, private-owned vehicles, and fleet management. MooBox combines ADAS and Fleet Management System (FMS) with vehicle health monitoring diagnostics in a fan-less compact design.

The largest MooBox deployment to date was successfully installed on a prominent public transport operators which owns buses and taxis in Singapore. The additional features to obtain vehicle health data (onboard diagnostics and vehicle geolocation using the GPS) were enabled through the upgrade of Nexcom hardware.

Passengera Infotainment Solution

Passengera digitizes mobility through innovative solutions for transport companies, designed to boost business performance and enhance passengers' digital experience. One of these solutions provides passengers with access to real-time trip updates and entertainment content while engaged with travel.

As the number of travelers rises across the world, transportation services of all kinds are struggling to keep up with customer demands and travel standards while also achieving scalable infrastructure to support new technologies. Passengera and Advantech teamed up to create an Infotainment solution that enables railways and buses with in-vehicle Wi-Fi, integrated GPS, and an on-board infotainment platform, offering: travel information (interactive map, notifications, points of interest, station services); onboard services (e-commerce enabled food ordering, surveys, feedback); entertainment (movies, TV, music, games, books, magazines); and advertising and monetization opportunities.

With this solution, customers discover the information they need at their fingertips, while leveraging the resources required to stay entertained, thus creating a more positive travel experience.

VectoLabs

VectoLabs is a Malaysia-based Internet of Things (IoT) company engaged in designing and developing a variety of Smart City and Enterprise IoT solutions that can power sustainable cities and provide residents with better places to live and work as we move into a brighter tomorrow. The Adionex Edge AI-enabled Transport Safety System is a solution that uses AI (artificial intelligence) and IoT to monitor driver behavior and send real-time audio alerts for increased safety, efficiency, and fleet performance benefit.

The solution was sparked by the need to address safety issues related to heavy vehicles while sharing the roads and highways with the public. It is deployed with collaboration of PETRONAS to address safety issues related to heavy vehicles while sharing the roads and highways with the public and to adhere to the PETRONAS Health, Safety & Environment (HSE) policy. Vectolabs leveraged advanced Intel® technology to sense dangerous situations and attempt to prevent damage or injury altogether.

Drivers' behavior is the main contributing factor in accidents. AI technology provides a proactive approach by immediately detecting and correcting unsafe behaviors. The Edge AI-enabled Transport Safety System catches safety violations such as drowsiness, use of mobile phones, failure to check mirrors, distracted driving (eating, drinking, or smoking), and not wearing seat belts. The system also detects violations using telematics data via the vehicle's highly accurate Controller Area Network (CANBUS). Unlike a GPS system, CANBUS contributes towards detection at the time when GPS may have no signal, such when the vehicles go under a bridge, overpass or tunnels. Once the AI models catch any safety violations, the drivers are immediately alerted audibly and a report is sent to the HQ for further action towards the drivers.

Solutions

Intel Go to Market Strategy

The deployment of IoT for fleet management can help boost efficiency, visibility, and manageability, while helping lower costs. The latest telematics solutions powered by Intel® technologies can enable predictive fleet maintenance, help improve driver operation, and monitor cargo.

Fleet vehicles are the driving force behind commerce and public mobility. Fleet managers have the important role of organizing and overseeing vehicles for performance, maintenance, and tracking purposes. Telematics solutions collect, store, and analyze data that can be sent to fleet managers. This data helps fleet owners and managers evaluate vehicle maintenance, driver operation, and cargo management. IoT is transforming fleet management with the ability to connect vehicles and capture a wide range of data about vehicle performance, route, passengers, and cargo.

Intel's go to market solution involves first working with the Fleet C&T team to define specific use cases related to the company and the industry. Second, we review MRSs/RRKs, or find an option that can be customized to meet the partner company's needs, allowing them to scale as needed. Next, we "matchmake" in order to complete the value chain, or to complete a proof of concept of pilot project. Last, we go to market and scale business through collaboration.

Intel® Partner Alliance (link)

Fleet authorities can also find optimized solutions through the Intel Partner Alliance, one of the world's most trusted ecosystems for hardware, software, systems, and services. The Intel IoT Solutions Alliance helps providers deliver first-in-market IoT solutions. A global ecosystem of more than 800 industry leaders, the Alliance offers its members unique access to Intel technology, expertise, and go-to-market support. By accelerating the design and deployment of intelligent devices and analytics, technology providers can win greater market share. With more than 6,000 solutions, from hardware and software to systems and services, Intel helps fulfill nearly every requirement in a range of markets. Early access to Intel road maps and design support enables Alliance members to stay ahead of the competition, as well as help reduce risk and development costs.

Intel® IoT Market Ready Solutions

The Intel® IoT Market Ready Solutions program is designed to help members of our broad ecosystem of partners strengthen their delivery of solutions through unique support and scaling opportunities. These solutions give Fleet authorities scalable, repeatable, end-to-end solutions. That means less time, cost, and risk. These solutions are made up of sensors, edge hardware, software, cloud, and analytics from across the IoT ecosystem. By choosing Intel IoT Market Ready Solutions, fleet authorities get scalable, repeatable solutions designed to solve key challenges in vision technology, mobility, traffic management, and more. Intel has already vetted these solutions, so fleet authorities can move forward with the assurance of intelligent connectivity, exceptional performance, and easy manageability.

Intel® IoT RFP Ready Kits

Intel® IoT RFP Ready Kits are focused technology offerings that solve a class of market problems, have been deployed and tested in the field, and provide bundled hardware, software, and support. The technology is scalable and designed to grow with customer requirements, enabling accelerated development and time to market.

Next Steps

Come **Ride** With Us!

| Work with the Fleet C&T team to define your use cases | Review MRSs/RRKs, or find option that can be customized to meet your needs so you can scale | We "matchmake" to complete the value chain, or complete a proof of concept or pilot | Go to Market and Scale Business through collaboration |

Leading transportation and urban mobility organizations through strategic innovation and transformation is a continual journey. Many fleet management teams plan their intelligent initiatives across three action areas to:

1. Transform data into new insights in how their systems and fleets work with intelligence from edge to cloud.
2. Leverage proven intelligent mobility solutions to support stakeholder goals.
3. Consolidate systems at the edge for greater efficiency and value.

Initially, leaders should examine which services may have the most impactful outcomes. Stakeholder identification, participation, and clear priorities are essential foundation points for building a plan. Leveraging experience working with many governments and transportation authorities worldwide, Intel is bringing together the right stakeholder organizations and companies to deliver building blocks that transportation leaders can use to create and implement an appropriate plan. Here are the major steps to enable the fleet transformation journey:

Identify Stakeholders

Within the complex structure of your transportation organization, identify who the major stakeholders in any digital transformation project would be. Depending on the project, this can include government representatives, members of the transportation management or fleet management team, employee representatives, concessionaires, urban mobility IT team, transportation security team, and passenger advocates.

Assess Current State

Determine where your fleet system or transportation system is now, using the same key performance indicators you will use to quantify success. What works? What needs work? How can you improve satisfaction, security, safety, and success for all stakeholders?

Create A Shared Vision

Establish your ultimate outcomes, expressed in terms of stakeholder benefits. The vision should not be expressed solely as technical achievements but also as experiential improvements that technology can make possible. It is essential to build that vision with stakeholder involvement to achieve better and more diverse suggestions, consensus, and commitment.

Build Blueprints

Develop a priority list and "blueprints" for the most important projects in your technical modernization plan. Possibilities include master plans for:

- Better utilization of current mobility and urban transportation space and/or the addition of new space
- Modernization of the current technical infrastructure (communications and computing resources)
- Data collection
- Improvements to all interacting urban mobility systems

Mark Milestones

Identify waypoints at which you measure progress, share lessons learned, discuss course corrections, and strengthen stakeholder commitment to your shared vision.
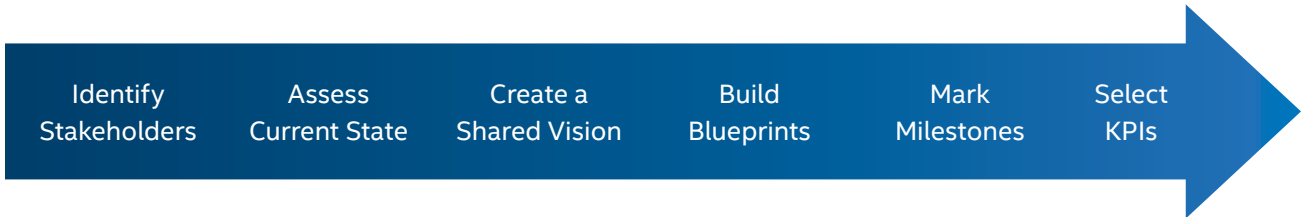
Select KPIs

Decide on key performance indicators that quantify success and align with your vision.

Explore Financing and Partnerships

Implementing a comprehensive digitization vision requires committed funding. Committed funding is a critical component that should be thoughtfully planned. Innovative funding and financing alternatives can accelerate your projects. Exploring multiple funding sources such as regional economic development; state and federal agency funding for transportation, public safety, environment; and private developer and industry partnerships are a few examples of broadening sources. Developing partnerships to embrace industry knowledge, best practices, plus key solutions and technologies, provides insight from planning to implementation.

Defining and executing a digitization strategy is not straightforward or without risks—but the benefits can be significant. Intel believes that a successful urban transportation transformation requires certain key components: the right level of stakeholder participation, clear priorities, and methodical planning of technology infrastructure.

Identify Stakeholders	Assess Current State	Create a Shared Vision	Build Blueprints	Mark Milestones	Select KPIs

Endnotes

1   OECD iLibrary
2   UN World Urbanization Prospects estimates of urban shares across the world through 2050
3   AD Little
4   Statista
5   WE Forum
6   Sustainable Bus
7   OECD
8   PR Newswire
9   U.S. Federal Highway Administration
10 Venson.com
11 AD Little
12 PR Newswire
13 Fortune Business Insights
14 Mobility Report 2021
15 Global News Wire
16 Global News Wire
17 Heavy Construction Equipment Market, Global Forecast to 2031
18 On Track to the Future With Smart Railways
19 Fleet Management Cargo Business Brief 2020 09 30 - Final
20 Mobility Report 2021

21 World Atlas
22 US Government Invests in Electric Bus Fleets
23 International Climate Initiative
24 Smart Planet Software
25 PR Newswire
26 MAI-Group
27 Automated Mining Equipment Market – Growth, Trends, and Forecast (2021–2026)
28 Artificial Intelligence in Agriculture Market
29 Frontu
30 Forbes.com
31 Intel – Intelligent Mobile Heavy Equipment for Industry
32 Cold Chain Market - Global Forecast to 2025
33 Urban Development, The World Bank
34 Market Research
35 Fleet Management Cargo Business Brief 2020 09 30 - Final
36 Fleet Management Public Transport Business Brief 2020 09 30 Final
37 Ibid.
38 Intel Solution Brief: Intel-based fleet management solutions are transforming the supply chain
39 Intel: IoT Drives the Future of Fleet Management

Relevant Links

IoT-Based Fleet Management and Telematics (intel.com)
Accelerate your Growth with Intel® Partner Alliance
Intel® IoT Market Ready Solutions (Intel® IMRS)
Intel® IoT RFP Ready Kits

intel.

Notices & Disclaimers

Think big

Assess all the ways technology can facilitate meaningful change

Start small

Get going with projects and opportunities

Move fast

Learn, adjust, iterate

intel.