DELL Technologies

CONNECTED MOBILITY

The New Mobility Industry

Index

A ONCE-IN-A-LIFETIME SHIFT

Developing connected autonomous vehicles and services is the biggest challenge today's suppliers, automakers and mobility providers will face in their lifetime. Closely behind that challenge will be the funding, design and build-out of the supporting technology infrastructure vital to supporting these future vehicles and services. The technology road map to the future is still fluid. Companies continue to join forces, create joint ventures and forge new paths to protect their differentiation.

Today, a fully-functional platform to support vehicle fleets and services does not exist — but many of the components for it do. What should you as the CTO or CIO of your organization do now? This report outlines the current state, key issues and recommendations for such a platform — all based on Dell Technologies experts, leaders in the transportation industry and analyst firm Frost & Sullivan.

The Disruption of an Entire Industry

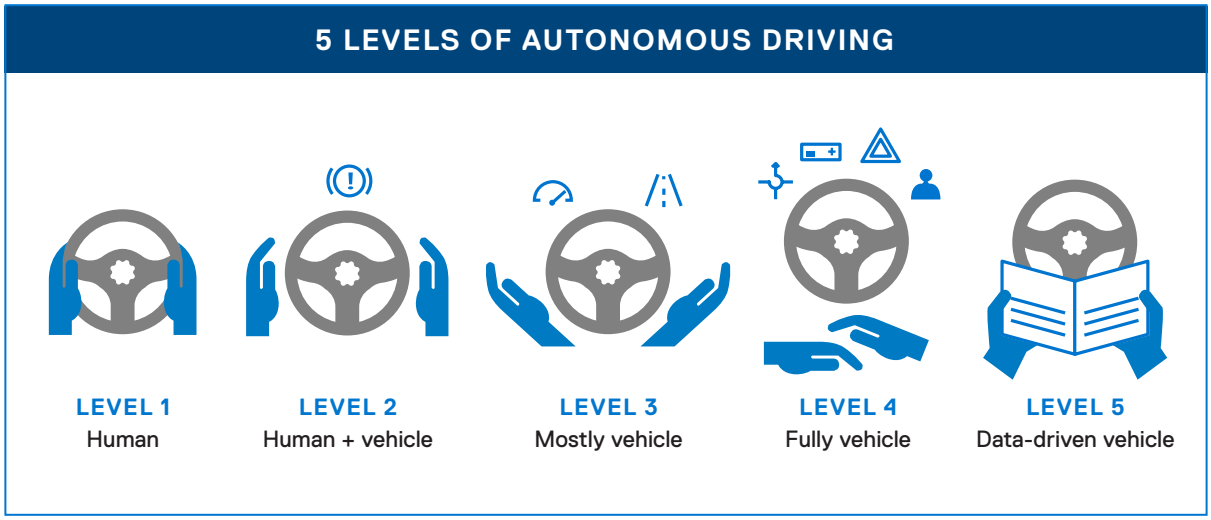
There's no doubt about it. The world has gone digital, and the same is true for the mobility and transportation industry. From smarter vehicles to autonomous ones, it's going to take new partnerships and processes driven by technology to power it all. Technology has helped define the human experience for centuries and we are now at a moment in history where the pace of change takes a dramatic leap forward.

While vehicles are not fully autonomous at scale yet, we've seen a great deal of change in this human-machine partnership. There are now connected cars equipped with internet access — sharing data to devices both inside and outside the vehicle. And the value of this data is important to almost everyone across the industry ecosystem. In fact, in a Dell Technologies study of 4,600 business leaders around the world, 50% believe they will travel in a self-driving car by 2030.[1]

So, the chain reactions begin; new technologies are created and harnessed, manufacturing partnerships are made and processes undergo transformation as industries converge. Amid this change, there are digital innovators who are quite literally upending the transport industry in their development of advanced driver assistance systems (ADAS), all eager to take driving to the next level.

THE CHANGE OF A LIFETIME

For the first time in over a century, transportation and mobility are undergoing massive change. It begins at the very crux of the business: Do we deliver products, or do we deliver a service? This isn't about preparing for a new business model, it's about preparing for an entirely new industry.



Forward-thinking companies are completely revising their strategy to run the business, their business model and the role that technology plays in the process. These leaders are rethinking their mission, transitioning from a manufacturing company to one that delivers transportation and delivery in a data-driven ecosystem. The pivot is to be truly digital, with technology bringing data to life in new ways; not to just be a producer of things.

To get there will be no small task. You'll have to think about how you:

- Deliver new connected experiences to customers, constituents and employees.
- Deploy and consume software, infrastructure and apps.

Leading organizations are already embracing the opportunity that emerging technologies present.

A LOOK TO THE FUTURE: WHAT'S DRIVING CHANGE?

- **New ways to travel**
  Connected, electric, autonomous, pay-per-use and mobility as-a-service.
- **Mobility changes**
  Increased urbanization, reduce congestion and enhance livability.
- **Shift toward sustainability**
  Clean emissions, sustainable supply chain and disposal.
- **Changing buyer demands**
  Consumers want experiences, convenience, safety and lower emissions.
- **New market disrupters**
  New entrants into the market have the luxury of starting from scratch.
- **Industry consolidation**
  Non-traditional partnerships between manufacturers and technology providers.

THE EVOLUTION CONTINUES

Dell Technologies, the Institute for the Future and global business leaders set out to forecast the future. Our experts believe the following shifts will occur by 2030:

Vehicles will continue to become more sentient: The ultimate merger of human and machine continues to evolve across the transport industry and will continue to do so.

Safety will eventually intersect with scale: Given the critical need for autonomous vehicles to protect human life, the industry is embracing artificial intelligence while being cautious about progressing safely.

The vehicles of tomorrow will essentially be mobile computers, traversing the arteries of our digital cities.

Vehicles will be increasingly connected while fully autonomous, self-driving vehicles develop. Some have called this the 'Internet of Vehicles'.

50% of 4,600 global business leaders believe they will travel in a self-driving car by 2030.[1]

Amid Disruption, There is Opportunity

How and when fully autonomous vehicles will be available is still being discussed. However, there is one trend that doesn't see as much controversy: future revenue streams. These will come from new delivery models such as intelligent and autonomous vehicles, rather than old ones.

Currently, it's estimated that the industry generates approximately $226 billion in sales per year worldwide. By 2035, the traditional part of the industry is expected to only grow 1%, to about $229 billion. The real growth will come from new sources: new types of vehicles, components, software, sales, uses of data and the services that can be delivered to mobile platforms. While these emerging revenue streams only amount to about $2 billion per year today, they are expected to grow to **$151 billion — a 7,500% increase — by 2035.**[2]

Clearly traditional profit pools will shrink, and revenue from new options — transportation options, new models of delivery and data services — will grow exponentially.

BY 2023[3]

Mobility-as-a-Service will account for 30% of auto industry profit.

Smart factories and operations could add $160 billion in productivity gains.

BY 2030[3]

100% of new cars will be connected by 2030, up from 25% today.

50% of vehicle value will be from electronics and software.

Dell Technologies Capital, our venture investing and corporate development practice continues to invest resources and expertise in R&D around connected and autonomous transportation. Ongoing discussions with industry experts have uncovered priorities between now through 2030. The following list is a combination of where these organizations see revenue opportunities and what they can address given their current state.

MOBILITY PRIORITIES AND USE CASES THROUGH 2030

- ADAS/AI training and testing
- Mobility-as-a-Service
- Vehicle cybersecurity
- Smart manufacturing
- Predictive maintenance
- Extracting value from data
- Asset management
- Over-the-air updates
- In-car infotainment
- Telematics navigation
- Vehicle-to-anything connectivity
- Smart City integration

*Based on Dell Technologies research, customer insight and use cases.

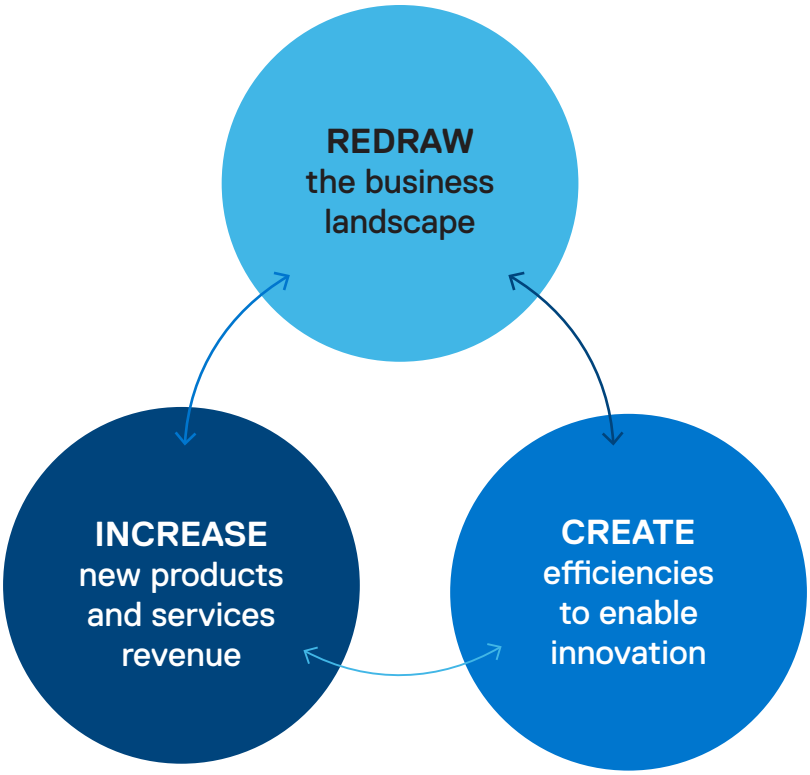
"We want to put (self-driving) robots into the world's dullest, deadliest and dirtiest jobs."

— MATT RENDALL, CEO AND CO-FOUNDER, OTTO MOTORS[4]

Traditional suppliers, OEMs and manufacturers are in the midst of turning their need to grow their own investments into profitability to mitigate disruption. All of this of course has a cascading impact on the entire value chain. For example, companies with high market share of conventional cars could lose substantial production volume to manufacturers of electric components.

Furthermore, OEMs face the challenge of integrating new suppliers into their existing supply chains while still maintaining current industry standards. This is the perfect storm of supply, demand and capability. The choices are simple: innovate, follow or wait.

AGILITY FEEDS INNOVATION: THE OPPORTUNITY



While driverless cars, or at least driver assistance, consumes the attention of the general public, the opportunity is so much larger. Imagine delivery vehicles that can run 24 hours a day, with only minutes needed for predictive maintenance and fuel. Or warehouses with internal workings that are completely automated by autonomous robotic forklifts. Farms, road construction and heavy delivery machinery that do their jobs in any condition, at any time, nonstop until the job is done. Or how about truck swarming, where ten trucks all drive in a line, one foot apart?

On the other side of the equation are the manufacturers and suppliers. They will be able to generate new revenue streams for the delivery of connected experiences like infotainment to drivers — news, streaming content, movies and online shopping. They'll deliver value and loyalty by identifying maintenance or repair issues in real time, and even make the appointment to have it fixed. Think of vehicles as a means to deliver connected experiences, applications and services.

> Caterpillar Resource Industries uses autonomous mining trucks that don't need to stop for lunch breaks or shift changes, and it doesn't need a backup operator for weeks when it is on vacation. Growing numbers of companies are capitalizing on Caterpillar's autonomous mining trucks and the system that runs them.[5]

The CIO as the "Digital Orchestrator"

The CIO is at the center of the universe of this industry transformation. You are the one who can blend technical and business expertise. You have a disruptive mindset with the know-how to merge old and new technologies, and physical and virtual worlds. This all starts by transforming into a software organization, extracting value from the data deluge all while harnessing emerging technologies such as AI, IoT and 5G.

This industry and its diverse players are far reaching and complex. The challenges are immense. However, you can be the digital orchestrator. You can identify the overarching strategy and connect disparate projects and technologies — from intelligent connected transport functions to smart manufacturing.

DIGITAL CHALLENGES

Any change is disruptive. The common notion is that people resist change, but companies do too. Inertia is the enemy of transformative change. Our research uncovered six technical challenges to the industry that must be solved in the near future:

1. **Creation of new business, app ecosystems** and the platforms and skills required to run them.

2. **The ZetaScale challenge:** Because of the scale of data, new solutions are needed for object, image management, metadata management, reduction, compression and deep learning.

3. **Enabling real-time, always-on connectivity** to create a new mobility businesses based on big data uploads/downloads only possible with 5G. networks.

4. **Management of everything:** Management will be a big issue, so solutions will be needed particularly for high-performance workloads, data, vehicular control, automation, learning, in-car compute/computer vision and vehicle-to-X communications.

5. **Data privacy, security, risk and compliance:** Connected vehicles will represent a valuable target for cybercriminals — perimeter security just won't work.

6. **Connection to, and insightful use of, external data:** The industry will need to create solutions and standards for data from maps, apps, traffic, urban data and maintenance.

"I'm most excited about the opportunity to redefine the automotive industry, and really make it the mobility industry."

— MARCY KLEVORN, PRESIDENT, FORD MOBILITY[6]

By embracing a startup and software development mentality, Ford's Mobility division is banking hard on transportation services — a $5.4 trillion market. They're looking long-term and bringing the best tools possible to their workforce for rapid, continuous development and testing. With a Pivotal Labs partnership in place, they're leveraging a world-class platform to democratize mobility — and bring it to market.[7]

Suffice it to say, to innovate, your organization needs to think like a software company — managing massive amounts of data and an integrated architecture that can perform with agility. But don't put all the weight on yourself. As the CIO, focus on being the digital orchestrator, the overarching strategist, the bold leader and the connector of disparate projects and technologies.

A Formula for Change

EXECUTING TOWARD A MOBILITY STRATEGY

In this new era of the vehicle industry, leaders will adapt, take action and lead. New entrants and leaders are certainly getting the most attention by the media and analysts. And catching the eye of customers, too. Leaders — the adaptable and agile — will be the ones to reap the most profit from this change.

We've done comprehensive research on the needs of this industry, with manufacturers and suppliers. From interviews and research with executives across the Intelligent Connected Transport community, we see three imperatives and patterns that surface. These patterns helped define a formula for change that includes creating value via a data-centric organization, driving agility with a platform solutions mindset and focusing on the workforce of the future.

1. **Adopt a data-centric strategy.**

   The sources of data are only increasing: travel information, logistics planning, advanced IT systems for matching supply and demand, big data solutions and much more. Executives in today's transportation industry — suppliers, production, automakers and mobility providers — are keenly aware of the partnership and collaborations required to outrun the current pace of change. So, the complexity of the data-centric technology infrastructure and processes must be addressed. To do that, organizations must create a map for the future to navigate and successfully transition their businesses. Some of the components to address this strategy include:

   - *Becoming data-value centric:* Most data strategies remain focused on data ingest. Help and guidance is needed from the technology industry to better manage and extract insight from the volumes of data generated by connected and autonomous vehicles. This way, organizations can monetize data.

   - *Considering the convergence of artificial intelligence/machine learning and data management:* Solutions are required to safely and securely operate the new modes of transport while implementing AI and ML across the organization.

   - *Creating a multi-cloud strategy for agility and cost savings:* Companies must develop expertise to implement an effective and scalable infrastructure, as well as a multi-cloud strategy to manage and orchestrate the data.

"The faster we get data, the faster we can design and engineer components. As a result, we can deliver changes trackside, optimize the cars and get the best racing results."

— PAUL BRIMACOMBE, HEAD OF ENTERPRISE ARCHITECTURE, MCLAREN TECHNOLOGY GROUP[8]

It's critical to group technologies as a base for developing competitive software and applications. This facilitates running your current business while innovating and managing risk.

2. Create a platform-centric organization.

New digital technologies enormously expand the reach, speed, convenience and efficiency of traditional infrastructural platforms. This new system of platforms changes and overturns the traditional value chain in the industry. Yet, additional disparate and disconnected infrastructures — can increase complexity and hinder competitiveness. A platform solution approach looks holistically and creates unity through standardization and automation. New technologies can facilitate and accelerate communication and the exchange of data between participants in the network. This way, the more a company attracts new participants to a more unified platform (owners, providers, producers and consumers), the greater the network becomes and the more transactions between demand and supply increase. The larger the scale, the more value it generates via enriched data and insights.

- *Innovators understand this:* The capacity of certain companies to take advantage of sentient platform development poses a significant threat for incumbents. New competitors quickly entered the market, proposing a new kind of crowd-based public-private partnership, including Uber, Lyft and others. The emergence of Tesla is also a clear example of a threat for incumbents.

- *The focus should be on data ingest and storage:* Frost & Sullivan confirms that federated data ingest and storage is a key issue to solve. The cost will increase as the amount of data generated increases. Along with a strategic approach to data, to achieve application and dev ops agility, mobility leaders will require data administration. This enables their scope to include innovative solutions for orchestration, movement and compute, based on the dynamic access needs of the future. This future requires robust placement strategies to support Edge and in-vehicle data movement to the cloud and back.

- *Think about scale:* The current industry approach of improving and adding service platforms via top-down and bottom-up integration will inevitably restrict scale. Especially as workload management is implemented at a foundational platform level. Managing these future intelligent fleets will require a smart and agile architecture

along with the capability to manage the massive data sets being generated. But by doing so, you'll be rewarded with additional business value and new revenue for your ever-accelerating volumes of data.

"We realize that we must be effective with the data that we generate and handle — AI is really transforming the way we use that data and, therefore, how we operate software."

— DENNIS NOBELIUS, CHIEF EXECUTIVE OF ZENUITY[9]

McLaren successfully moved to an infrastructure-as-code approach to support its expanding hybrid cloud operating model.[10]

Now can upgrade key applications in ***2 days*** *instead of* ***2 weeks***

3. Address the workforce of the future now.

Many of the challenges of making autonomous vehicles a reality are known — disruptive technologies, massive data sets, communications and the foundational changes required in business processes, technology and strategy. There are certainly many unknowns too, yet a great reminder came from Frost & Sullivan interviews.

- *Talent and skills:* Your people, functional talent and workforce strategy must be able to create change through software and differentiating algorithms to re-orient business models.
- *Leverage partnerships to fill voids in skills:* Suppliers, production, automakers and mobility providers are keenly aware of the skills (technical and functional) that partnerships offer to keep pace during disruption.

We believe that success lies in working with a partner that has a long tradition in data management and cutting-edge technologies. One that possesses the end-to-end capabilities to address 'the now'; balancing connectedness of things with the driverless future that lies ahead.

HOW TO GAIN A COMPETITIVE ADVANTAGE TODAY

Are You Prepared for Change?

Any IT project, and any transformation, follows a few standard steps. We know, however, in the real world, digital change does not happen overnight — it is an ongoing and and long term process.

Since 2016, Dell Technologies and Intel have studied thousands of business leaders to measure the global state of digital transformation. These studies included organizations from 12 industries in 40 countries, taken from key levels within these organizations — from Director to C-Suite, mid-sized to large enterprises. The results show that **just 5% of organizations fall into the 'Digital Leaders'** category, where digital is ingrained in the DNA of the business. What is even more surprising is that **73% of organizations have not started** or are simply evaluating what they should do next.[11]

"The problem is that few of today's transport vehicle makers, mobility providers and suppliers have complete understanding of the complexity of the technology infrastructure and processes to make the transition."

— FROST & SULLIVAN[3]

The Road Ahead

Volvo's 360c concept car used a 360-degree band of light and speakers to signal intention like acceleration or imminent lane changes. The aim was to create an autonomous vehicle universal standard for visually and aurally communicating on the road.[12]

INDUSTRY PREDICTIONS

No one organization or body has clear insight into the future. But in cooperation with analysts, industry experts and from our own research, we see five important trends:

CONVERGENCE

Industries will continue to converge: Vehicle companies will begin to merge with other non-vehicle industries. OEMs will converge with software or tools companies. OEMs will join delivery and transportation companies. And, OEMs will connect with data providers such as cities and map companies.

EXPERIENCES

Connectivity will create new customer experiences (CX) and revenue streams fueled by rich data.

AUTONOMY

Autonomous vehicles will dominate the narrative: Manufacturers and OEMs are acting now, leaving the laggards behind.

COMPLEXITY

Current complexity — technologies, processes and organizational structure — will impair development: Innovation is needed, especially in data management and AI sensory technologies.

PARTNERSHIPS

Partnerships will prevail: Manufacturers will partner with providers for mapping, driver assistance, mobility, autonomous driving, onboard infrastructure, back-end processing, analytics, consulting and services.

TECHNICAL CONSIDERATIONS

There are several key accelerators that must be solved to pave the way to the future state of Connected Mobility:

- **Information management of the autonomous vehicle platform:** We believe that less than 5% of the data[13] created by the vehicle will ever leave the vehicle. So, most of the data — steering, stopping, safety, etc. — needs to be consumed onboard. Data of Interest, that 5%, is the part that will be of great value to manufacturers to understand driving patterns, accident rates, maintenance needs and for avenues of engagement (sales, marketing, etc.).
- **Management of scale AI workloads:** The training of vehicles is very complex, requiring compute-intensive inferencing and reasoning workloads. These workloads will need to be located in core and edge data centers. Imagine a vehicle sensing a person on a bike carrying a stop sign. What does the vehicle do?
- **Vehicle communications:** One of the anchor tenets for autonomous vehicles will be 5G networks. But our view is that the heavy data transfer to and from the vehicles will be uploads, as opposed to downloads. So, we must develop communication platforms that are not latency impaired.
- **Simulation/modeling of training datasets:** A study by the Rand Corporation[14] estimated that to make autonomous vehicles 20% better than a human with 80% precision, it would require data from 11 billion miles of driving. This, of course, isn't feasible. So, simulation is required in a complex computational environment that comprehends a myriad of factors: roadway type and conditions, vehicle type, weather, region, etc.
- **The standardization of scalable compute platforms:** We call this the "point solution paradox." Many organizations, both inside the industry and out, are tackling components of the overall compute platforms. Edge, cloud, traditional data center, in-vehicle, security and data management platforms are all in differing stages of development. As a company built on the value of efficiencies through standardization, we believe that scaffolding common, tested platforms for these workloads will bring costs down and simplify the integration of disparate systems.
- **Emerging technologies will play a role in the future:** Edge and 5G networks will be essential for computational efficiency and connectivity. But so too will others: Blockchain for secure data transport, Internet of Things to move analytics to the Edge and AI to turn insights into action.

"It is our ambition to have a car that can drive fully autonomously on the highway by 2021. The technology, however, is something as a carmaker you cannot develop yourself."

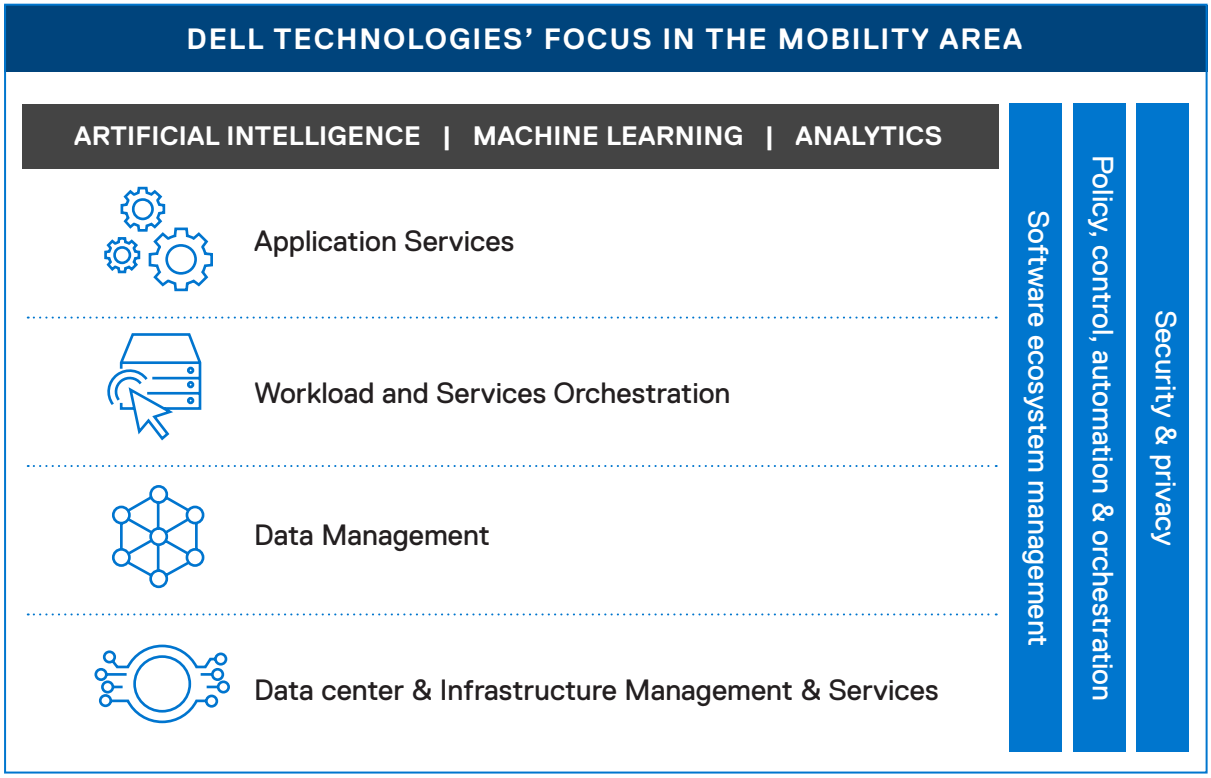
— HAKAN SAMUELSSON, CEO, VOLVO[15]

What is Dell Technologies Doing to Address These Challenges?

CONSTANT INNOVATION

The once-in-a-lifetime change in the mobility industry requires constant innovation. The technology business is no different. And while Dell Technologies itself continues to transform and change, we intend to keep our innovation and transformation engine moving.

Working with OEMs worldwide, as well as suppliers across the transport value chain and industry, Dell Technologies and the Office of its CTO is laser focused on several key projects. These include projects that create scalable infrastructures, standardized architectures, platforms and solutions to support our mobility customers' needs.



Dell Technologies continues to invest resources and expertise in R&D and technology roadmaps to determine which initiatives will make a more connected and autonomous future real for cars, trucks and all forms of transportation.

INVESTING IN THE FUTURE FOR OUR CUSTOMERS

- *Co-innovating with our customers and partners on new technologies:* In Dell Technologies Centers of Excellence, we partner to design solutions and test drive cutting edge technologies. Through these collaborations, we support customers in every step of their digital transformation to become a data and value-driven business. Our executive briefing specialists, solution centers and laboratories are staffed by world-class experts from their fields that help take innovative ideas and make them real.
- *Investing in the disrupters of the future:* Dell Technologies Capital (DTC) invests in innovative early-stage companies, providing crucial business guidance and access to the power of the Dell Technologies brand and channel. The group develops and furthers new technologies that help manage the deluge of data our customers might encounter. Over the past six years, this commitment has resulted in DTC investing over $600 million in startups across the tech industry. For example, one of these companies is Otonomo, a company that delivers automotive data services platforms.

WE DELIVER TRANSFORMATION IN WAYS NO OTHER PARTNER CAN

We created Dell Technologies to provide not only the products and solutions, but also the services and expertise to help make business transformation happen. We make it real for you: one partner, purpose-built for your digital future.

Contact your Dell Technologies account team to arrange an executive briefing or follow up conversation with consulting services.

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Read how McLaren are using data to improve their racing success:
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