New Mexico Mobility Strategy

June 30, 2020

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Introduction and Background

The New Mexico Mobility Strategy project's objective is to develop the foundation for an overall mobility business strategy for the State of New Mexico. To the extent possible, the project's scope is to position the State as a leading player in the rapidly growing new global mobility sector. By advancing New Mexico's mobility strategy, the State's goal is to support industry to bring practical and safe mobility solutions to its communities, and to create the opportunity for investment attraction and economic development. A core assumption for this project is that the pace of change and growth in the mobility sector will create significant new research and development, production and supply chain investment projects and that an integrated strategy can establish New Mexico as a realistic competitor.

The automotive technology environment is extremely dynamic with rapid advances in technology and business model deployment. Extremely intense research and development has led to extraordinary product development in areas such as energy storage and propulsion systems, optical systems, computational processing, active safety systems and connected vehicle technology. Parallel to this, there have also been substantial developments in matching new technological capabilities to business or public services – in areas such as public transit and public safety.

To date, the State of New Mexico has largely lagged in the US in regard to developing regulation, policy and investment strategy to support research and development and to accommodate the requirements of the sector. Other states have devised and implemented specialized regulations to support testing on public roads and clarified licensing and permitting requirements. Some states have issued executive orders pertaining to these issues, in all 44 states have devised some standards or policy. Fairly few states though have structured initiatives to support investment attraction from the mobility sector.

For the purposes of this project, it is important to note the definition of the term "mobility sector". At the very basic level, the term shall include the range of technologies and services that enable people and goods to move around more freely. This will include the traditional automotive sector, but it will also include the vast range of new technologies that are shaping most forms of ground (and air) transportation. This analysis will focus on the automotive industry, which is one of the largest, most complex industries in the world and is supported by a truly global supply chain. The automotive industry includes passenger vehicles and light trucks, but also a wide range of other products including farm equipment, heavy trucks, mining equipment, transit vehicles and cargo handling equipment. As noted below, there are some crossover technology relationships with the aerospace industry.

The automotive sector is now being fully redefined and is undergoing a fundamental transformation. The

traditional commodity-dominated industry that has existed for approximately 100 years has given way to an industry that is largely driven by advanced technological innovation. No longer is the sector defined by low-cost commodity production and access to low-cost labor. Historically these factors have been the influences that have shaped the industry and is also why the industry has experienced rapid growth over the past 40 years in the US South and in Mexico in North America, and globally in Eastern Europe and in Southeast Asia.

In North America, what had been largely three major automakers and a handful of Japanese, Korean, Swedish and German automakers is now changing. New entrant player are assuming prominent roles 1) new automakers that have not had a presence in the US before (China), and 2) pure technology companies. Clearly new entrants will be making supply chain investments. In the Western US there is a large opportunity to capture investment and this can be seen by investments in California, Arizona and Nevada To date, companies such as Tesla, BYD, Lucid, Faraday Future, Nikola, have made major manufacturing investments, while others have made investments in R&D: NIO, Toyota Research Institute, Bosch, Nissan, BMW, Mercedes Benz, Daimler, Google/Waymo, etc.

The underlying structure of the industry is changing – new players are emerging as important elements of the sector. The largest and most complex equipment manufacturing supply chain in the world is being redefined by its proximity and integration with the factors that produce a thriving research and product development environment. This includes a clear connection to skilled labor and research and testing/development centers. As well, due to the point in time considerations the industry has gravitated to undertake business and research in settings where government understands the needs of this evolving industry.

These issues are so large that many companies, even the largest in the world, do not think that they can go alone in developing and commercializing product. Over the past several years, a myriad of joint venture research and development partnerships have been created where companies are hopeful to exploit individual strengths.

- In this way, combinations like ARGO Ai have been formed between Ford and the Volkswagen Group to work on joint autonomous solutions. That integration is in the form of a new start-up which has received almost $4B in investment from the two companies and has over 1,000 employees. Argo has offices in Detroit, Palo Alto and New York and has fleets of autonomous vehicles mapping and testing in the Austin, Miami and Washington, D.C regions. Argo Ai is developing the virtual driver system and high-definition maps designed for Ford and Volkswagen vehicles.

- In 2016, General Motors acquired a small company called Cruise that was a leading-edge autonomous car company. They spent approximately $1B to acquire Cruise with plans to establish it as GM's autonomous vehicle subsidiary. Industry observers have noted, and GM CEO Mary Barra has stated, that GM allowed Cruise to remain responsible for both technology and commercialization, giving Cruise independence in order to avoid the pitfalls common when a large company acquires a technology startup. Last year the company announced a $2.25B investment from the SoftBank Vision Fund and since then GM said it would partner with Honda to design a purpose-built self-driving car. The Japanese automaker said it would invest $2B to the joint venture.

- Amazon is entering the space with speed, via a myriad of investments in robotics, autonomous vehicle platforms for ride-hailing and electric vehicles. The company is heavily investing in technologies that support their core package delivery and logistics management mission, and with these investments come secondary and important benefits. By investing in a new ground-up autonomous vehicle platform designed for

developing the robo-taxi segment, the company will be developing autonomous small vehicle delivery capabilities. Amazon is a $700M equity investor in the start-up Rivian which is now developing a state-of-the-art factory in Illinois to build 100,000 delivery vans. Rivian had also announced a joint venture with Ford through its Lincoln division but due to current economic conditions that has been delayed.

- Toyota and Uber have joined to build self-driving cars in a deal which included a $500M investment. Following that, Uber secured another $1B from SoftBank, Toyota, and Denso to develop their autonomous ride-hailing technology.
- The Chinese internet giant Baidu (and Google rival) has recently completed development of its Apollo Park testing center for self-driving vehicles. Located in Beijing, Apollo Park is promoted as the world's largest research-and-development center for self-driving vehicles. The Apollo platform was launched by Baidu in 2017 as an open AV platform is intending to be the "Android" of the AV industry. Partners in this project include BMW, Ford, Toyota, Volkswagen and Honda.

Due to all of these dynamics, mobility sectors are developing new supply chain concentrations today in Asia, in North America and Europe. Today, the automotive industry is concentrated in Michigan and California in many regards due to its research and labor, the San Francisco Bay region is now the global automotive mobility industry. The western states that have seen new investment have not developed a strategy to support and attract investment from this sector. This project was created to establish New Mexico as a hub for the mobility technology sectors.

It is also important to consider that the broader definition of the mobility sector includes aerospace applications. The technologies that are shaping how automotive products navigate, communicate and move are largely the same technologies that are utilized in the aerospace sector. Though the applications are quite different, many of the optical systems, sensor technologies and advanced propulsion systems used in the aerospace sector are derivatives of the automotive sector. This intersection is important and especially so in New Mexico, with the substantial base of primary and applied research and development in aerospace.

In order to harness the advantages of doing business in New Mexico and deliver a product of value to industry, the State and its partners would need to develop and deliver a product that uniquely stands out versus the competition. New Mexico must create an especially compelling business proposition that meets the needs of industry in a manner that is different, better and more durable than its competition.

There are no states in the US that have prepared and brought to market an end-to-end business proposition that truly satisfies the sector's research, development, production and logistics requirements. For obvious reasons, the State of Michigan has invested substantial resources to development global-standard testing and development infrastructure, but even this is fairly limited in scope.

In terms of economic investment attraction, what was simply not realistic for New Mexico or the Western US states ten or fifteen years ago is realistic now. There are a myriad of factors that point to a highly competitive business proposition for the Western US states, this having to do with proximity to the massive research and development center of Silicon Valley and the logistics advantages of having access to Asian market supply chains, and in the case of New Mexico access to the Mexican auto sector supply chain. Many but not all of the Western US states are seen by industry as business-friendly with low overall costs. Throughout the region there is diversity in terms of weather and topographical conditions, issues that are vital for testing and development. With that said, none of these states has taken steps to offer a comprehensive product to this burgeoning industry. There have been a number of major mobility sector investment projects announced in California, Nevada and Arizona over the last 36 months, driven by a combination of factors including global supply chain connectivity (Asia), low costs, proximity to the California technology centers – and in some cases an overt welcome by Governors and state governments. Still though, it is important to restate that none of these states has developed a structured comprehensive strategy to support the range of needs for the sector to include policy, infrastructure, testing and development, local government partnerships, etc.

The next decade will be a pivotal period in the development and maturity of the mobility sector. During the next 10-year period of rapid innovation and product commercialization, most companies in the sector will be highly reliant on access to various testing and development facilities. Supporting their evolutionary engineering and product development, companies are generally researching and innovating inside their labs and then testing in the field. From the results of field tests, iterative recalibrations are done to hardware and changes to software are made – then quickly back to field testing, and this cycle repeats many times until satisfaction with the product and its performance is reached. This process goes on for months and in some cases for years and creates a frenetic pace of lab-to-field work, then back to lab for technical adjustments and then the process repeats over again.

Product research and development is defined around three different kinds of testing facility requirements. The first level of core research and product development is conducted in the technology lab, the second level of testing is done in the field but in a controlled, purpose-designed closed course environment, and the third level of testing and product development is carried out on public roads in a real world environment. Most companies have two significant needs in trying to efficiently and seamlessly carrying out their work:

1) Access to course time at a special-purpose testing development complex where they can carry out confidential testing and product development; this requires technically appropriate infrastructure, testing equipment and support expertise,

including certifications. Companies are quite willing to pay for the use and are generally most anxious to gain blocks of time at such facilities as there are few such centers.

2) Access to a range of public road environments for testing and development; including urban, suburban, highway settings. This typically requires working with State and local governments and navigating permissions, in many cases on an ad hoc basis.

New Mexico Mobility Strategy

The New Mexico Mobility Strategy project has been launched by the State of New Mexico at an opportune time. The extraordinarily rapid pace of technological advancement in the space of human mobility has driven fundamental changes to the core function of the automotive industry's supply chain structure. These changes have created a window of opportunity for regions that can offer new entrants and some established in-market technology companies and manufacturers support for developing new products and bringing new products to market. Due to this fundamental transformation, this represents a generational opportunity for New Mexico, but the window of opportunity will reduce over the next several years as the new technology structure becomes more mature and better established.

This project has been designed to support the State of New Mexico to understand how well it could compete for new investment and define a tactical business plan that would elevate the State to be recognized as a national leader in the mobility sector. Toward this, the project set out to define a business pathway where it and its local government allies could collaborate to develop a distinctive business product to capture investment in this rapidly expanding sector.

The project's scope included focus on the following areas:

- Regulatory
  - Broad assessment of regulatory issues associated with testing & development needs of the industry
  - Definition of areas where the State should focus adjustments of existing regulation
- NM Mobility Technology Partnerships
  - Create a New Mexico Mobility Advisory Committee
  - Identify the potential for collaboration with the federal laboratories present in New Mexico
  - Review with economic development agencies and councils of governments
- Facilities and Infrastructure
  - Create the infrastructure framework to support mobility technology testing and development
- Market Development
  - Define the potential for business interaction between Detroit and Silicon Valley, and New Mexico
  - Review New Mexico as a mobility product with global OEMs, technology companies and global Tier 1 industry suppliers
  - Examine the specific opportunity for Southern New Mexico's role in an overall State strategy
  - Produce overarching New Mexico Mobility Business Proposition

An advisory structure was developed to help vet the market reaction to the project proposal. The New Mexico Mobility Advisory Committee was assembled and comprised of industry experts in the sector from New Mexico and from outside the state. A blend of national and international companies were selected on the basis of their advanced technology development across a spectrum of technology areas.

New Mexico Mobility Advisory Committee

Company	Business Sector	Relationships	Location
Luminar Technologies	LiDAR	Geely/Volvo, OEMs	Silicon Valley
Intel/Mobileye	Computational	OEMs	Silicon Valley/NM
Pajarito Powder	Propulsion/Hydrogen	Asian OEMs	New Mexico
Trilumina	LiDAR	DENSO	New Mexico
Ford Mobility/Smart City	Automotive OEMs	ARGO/Volkswagen	Silicon Valley/Detroit
UC Berkeley PATH	Research Institute	OEMs	Silicon Valley
Apex Ai	Software Systems	OEMs/Suppliers	Silicon Valley
WiTricity	Propulsion/Electric		Silicon Valley/Boston
Rosenbauer	Heavy Truck OEM		Austria/Minnesota
First Group	Automated Transit		UK/Ohio
Zayo	Telecom Infra	ATT, Verizon	Colorado
NM Assoc C/I			New Mexico

Additionally, several representative economic development organizations were included to participate in the development of the project, including organizations from Albuquerque, Southern New Mexico and the greater Gallup region. These regions were chosen as the best places for hub elements for an overall strategy: all on an interstate highway, one as the large-region metropolitan area, and others representing medium-sized and small-size regions. Two regions offer close proximity to an adjacent state.

Local Government and Economic Development

City of Albuquerque
Bernalillo County
Greater Gallup Economic Development
Northwest New Mexico Council of Governments
Mesilla Valley Economic Development
Dona Ana County
New Mexico Trade Development Alliance

State of Mobility and Technology

There is a broad range of mobility technologies that are powering the evolution of the automotive sector. These technologies can be characterized into the following categories

Autonomy
the suite of technologies that are required for non-driver directed movement of vehicles

Propulsion
powertrain or system of propulsion that are an alternative to the legacy internal combustion engine

Connected Vehicle
technologies for allowing vehicles to communicate with each other or with the overall infrastructure system

Taken together, these technologies are defining the automotive industry. Whereas in the past, the industry was largely oriented around the design and technical specifications of a small number of manufacturers (OEMs), the current industry is really a composite of technologies many of which are really developed independently of the OEM. Traditionally, the industry managed a highly complex global supply chain that was largely built around lowest-cost production and transportation. This is the underlying reason why in this hemisphere auto assembly plants for the past 30 years have generally been built in the US South or in Mexico. During this period, Mexico has vaulted to become the 6th largest automotive producer in the world with automakers from the US, Asia and Europe all with major production investments in the country. For automakers, the model has been fairly simple, with access to low-cost semi-skilled labor being the main contributing competitiveness factor, and to assure cost competitiveness and to satisfy the cost oriented just-in-time supply chain systems with clusters of commodity suppliers built around the assembly plants.

These core cost efficiency factors will remain but will be diluted as today, there are significant new supply chain factors in the automotive supply chain system. As a baseline and for example, in the tomorrow's electric-powered autonomous vehicle there will be approximately 8,000 parts required for whole-vehicle assembly as compared to approximately 30,000 components in the traditional vehicle. In the end, the proportional importance of the economics around low-cost commodity production is reduced and replaced by far more sophisticated components. These components are high-value and require higher-skills to develop and install. These kinds of components also require an enhanced and very efficient supply chain system.

Different from the current system where commodity parts manufacturers would build supplier factories near to the main assembly plants, we are seeing that production of high-value electronics and optical systems associated with future vehicles will not be distributed in the same way. Instead, due to the very direct requirements connected with high levels of ongoing research and development and by extension concentrations of skilled technical staff, production of these component are clustering in several regions that have these kinds of competencies. With that, there are currently several incumbent regions that are core concentrations for automotive technology, as expected this includes the Detroit region which is still largely regarded as the primary global center for automotive engineering. Over the past ten years, Silicon Valley has emerged as the global center for mobility technology research and development and is now seen as the main global innovation hub for mobility. The technology world now gathers in Silicon Valley at events like AV19, or at CES which has to an extent become an automotive technology showcase. Following the sector and technology concentrations in other global automotive production hubs, there are other mobility technology concentrations emerging in China, Japan, Korea, the UK, France and Germany. In North America, beyond Michigan and Silicon Valley, there are no real mobility technology concentrations of any scale. Increasingly it will become more important to bridge research, testing, development, and production – and Michigan and especially California do not display the core competitiveness factors to support that eco-system. This creates a window of opportunity for regions that: 1) have core R&D depth that provide a foundation for industry,

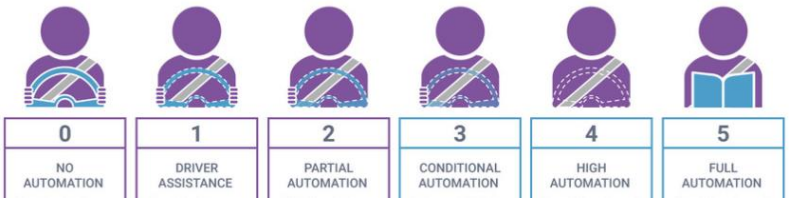
2) have government policy and investment plan that supports sector innovation and production growth, and 3) represent a competitive setting for production and supply chain management.

For the purpose of this project, the focus of analysis was on the three areas described above, 1) autonomy, 2) propulsion and 3) connected vehicle technologies. Here is summary review of each of these areas.

Autonomy

The area of vehicle autonomy is rapidly evolving and has been undergoing a full transformation of the operational aspects of the vehicle. The technology has made rapid advances over the past decade with specialist automotive suppliers like Bosch, Continental, APTIV and Waymo making great strides in developing the technology and integrated systems that can operate a vehicle without a human driver. Particularly over the past 5-7 years, the first stage of the technology has begun to find its way into the consumer market, with companies like Tesla leading the way in delivering up through Level 3 autonomy. A myriad of other companies (both automotive technology suppliers and OEMs, and also new entrant pure technology companies) have also made great strides in bringing technology to market or near-market readiness. A range of partnerships have been formed to pursue joint or complimentary research and product innovation – teams such as such as ARGO ai (Ford and Volkswagen) and Luminar Technologies and Geely/Volvo.

The Society of Automotive Engineers (SAE) defines 6 levels of driving automation ranging from 0 (fully manual) to 5 (fully autonomous). These levels have been adopted by the US Department of Transportation.



Level 0 (No Driving Automation) Most vehicles on the road today are Level 0: manually controlled. The human provides the "dynamic driving task" although there may be systems in place to help the driver. An example would be the emergency braking system—since it technically doesn't "drive" the vehicle, it does not qualify as automation.

Level 1 (Driver Assistance) This is the lowest level of automation. The vehicle features a single automated system for driver assistance, such as steering or accelerating (cruise control). Adaptive cruise control, where the vehicle can be kept at a safe distance behind the next car, qualifies as Level 1 because the human driver monitors the other aspects of driving such as steering and braking.

Level 2 (Partial Driving Automation) This means advanced driver assistance systems or ADAS. The vehicle can control both steering and accelerating/decelerating. Here the automation falls short of self-driving because a human occupies the driver's seat and can take control of the car at any time. Tesla Autopilot and Cadillac (General Motors) Super Cruise systems both qualify as Level 2.

Level 3 (Conditional Driving Automation) The jump from Level 2 to Level 3 is substantial from a technological perspective, but subtle if not negligible from a human perspective. Level 3 vehicles have "environmental detection" capabilities and can make informed decisions for themselves, such as accelerating past a slow-moving vehicle. But—they still require human override. The driver must remain alert and ready to take control if the system is unable to execute the task. In 2019 the world's first production Level 3 vehicle was produced by Audi. During this period, the regulatory process in the US shifted from federal guidance to state-by-state mandates for autonomous vehicles, meaning for the time being, this level of autonomy will be used in several countries in Europe and not in the US.

Level 4 (High Driving Automation) The key difference between Level 3 and Level 4 automation is that Level 4 vehicles can intervene if things go wrong or there is a system failure. In this sense, these cars do not require human interaction in most circumstances. However, a human still has the option to manually override. Level 4 vehicles can operate in self-driving mode. But until legislation and infrastructure evolves, they can only do so within a limited area (usually an urban environment where top speeds reach an average of 30 mph). This is known as geofencing. As such, most Level 4 vehicles in existence are geared toward ridesharing. NAVYA, a French company is now selling Level 4 shuttles and cabs in the US that run fully on electric power and can reach a top speed of 55 mph. Alphabet's Waymo is operating a Level 4 self-driving taxi service in Arizona, where they had been testing driverless cars for more than a year and over 10 million miles. Canadian automotive supplier Magna is working with Lyft in Level 4 capabilities in both urban and highway environments. Volvo and Baidu have announced a strategic partnership to jointly develop Level 4 electric vehicles that will serve the robotaxi market in China.

Level 5 (Full Driving Automation) Level 5 vehicles do not require human attention—the "dynamic driving task" is eliminated. Level 5 cars won't even have steering wheels or acceleration/braking pedals. They will be free from geofencing, able to go anywhere and do anything that an experienced human driver can do. Fully autonomous cars are undergoing testing in several pockets of the world, but none are yet available to the general public.

In the autonomy technology area, the core technologies include the following:

- LIDAR (Light Detection and Ranging) is a method for measuring distances by illuminating the target with laser light and measuring the reflection with a sensor. Differences in laser return times and wavelengths can then be used to make digital 3-D representations of the target. LIDAR has terrestrial, airborne and mobile applications.
- Optical Systems are used to capture data from the vehicle's external environment and also the internal environment. There may be multiple camera systems utilized in a vehicle, for:
    - Seeing the roadway ahead, for monitoring other vehicles and road signs
    - For monitoring the driver for determining unsafe conditions
    - As replacement for traditional mirrors for sideview and rearview
    - For creating a stereo image of the vehicle's immediate environment
- Radar Systems are used to augment alongside other optical systems for the following applications:
    - For driver vital sign monitoring

    - For detecting critical conditions over both ultra-short distances and longer-ranges
- Sensor Fusion systems
    - ADAS domain controller
    - Conditionally automated drive controller
    - Drive assist ECU

In application, Advanced Driver Assistance Systems (ADAS) are new automotive electronic safety systems that provide a level of automatic driver and vehicle protection. ADAS enhances the driver's experience while providing an increased level of safety. ADAS systems and technologies will significantly reduce automotive accidents. These systems provide drivers with enhanced safety features such as blind spot detection, lane departure warning, collision warning, and tire pressure monitoring. ADAS also provides for limited autonomous driving features such as adaptive cruise control, parking assistance, traffic sign recognition, lane change assistance, and collision avoidance. These systems are based on various detection mechanisms for sensing the vehicle's immediate environment. While present ADAS environments use different sensing systems such as ultrasonic, radar, video, infrared, and laser, the most common sensing solutions are based on radar and optical system technology.

Propulsion

In the context of this project and around the space of advanced mobility technology, alternative powertrains describe propulsion systems that are not based on the internal combustion engine. This technology includes a range of propulsion systems including gasoline/electric hybrid engines, all-electric powertrains, and hydrogen-powered vehicles via fuel cells.

Presently, vehicles with internal combustion engines are by far the most popular choice of powertrain. However, concern for the environment has led to policy targets on carbon emissions both globally and at the domestic US level. In the US, there are directives to reduce vehicle emissions by requiring automakers to produce vehicles that increase fuel economy performance. Previously referred to as the Corporate Average Fuel Economy (CAFE) standards, the current Administration has relaxed those standards for passenger cars and light trucks. Called the Safer Affordable Fuel-Efficient (SAFE) vehicles, the current requirements call for the average fuel economy to increase to 40 miles per gallon by the year 2025. Previously under CAFE, that standard was 54 miles per gallon. Twenty-three states are currently suing the federal government to restore the earlier standards.

For a number of states and local governments, this coincides with the objective of improving air quality. In transport, the strategy has been built to increase efficiency with refinement of traditional technologies. Since automobiles were first introduced, propulsion systems have relied on spark-ignited internal combustion engines (ICEs). These types of gasoline and diesel-based engines have been improved over time, however, are likely to become obsolete in the next few decades as new disruptive electric technologies are introduced. This trend and pattern is not limited to light-duty vehicles; electric and hydrogen-powered freight truck technology is now a reality.

To ensure that they can remain competitive in this electric-powered future, manufacturers are currently investing in a wide range of propulsion technologies. For the medium-to-long term corporate planning cycle, there will be a mix of ICEs, electrics, hybrids, and other propulsion systems on the market.

Internal combustion engines (ICEs) are still leading all other propulsion technologies, but a significant shift towards partial or complete electrification is expected in the next 10 years. Five classes of ICE technology will further develop.

- Gasoline Direct Injection: Highly pressurized gasoline is injected directly into the combustion chamber of each cylinder, as opposed to the intake tract or cylinder port. This improves efficiency, since conventional injection methods require fuel to be mixed with air and flow around intake valves to be used.
- Turbocharging: Turbocharged engines have a forced induction device to increase the engine's efficiency and power output by forcing extra air into the combustion chamber.

- Atkinson Cycle: The Atkinson cycle delays the fuel intake valve's closing until the piston has completed 20-30% of its upward travel on the compression stroke. As a result, some of the fresh charge is driven back into the intake manifold by the rising piston and less fuel is used to create ignition. Despite less fuel, the cylinder's expansion ratio increases greatly and produces a similar or greater power output.
- Variable Compression Ratio: Since faster driving speeds require lower compression ratios to be efficient (and vice versa), variable compression ratios adjust the compression levels of an internal combustion engine while the engine is in operation.
- Homogenous Charge Compression Ignition: This engine uses a mix of both conventional spark-ignition and diesel compression-ignition technology. To work, small amounts of gasoline are mixed with a large amount of air in the engine's combustion chambers. Pistons compress this mixture under intense pressure to ignite the fuel without sparking it. This provides the benefit of both gasoline and diesel-based engines – low emissions and fuel efficiency.

- 12 Volt Stop/Start: In ICEs, stop/start systems will switch off the vehicle's engine when it has slowed to speeds of a few kilometers per hour. While in idle (up to 25% of average travel time), the engine remains off and does not consume fuel or produce emissions. When it's time to start the vehicle again, the vehicle's alternator starts the vehicle back up.

Electric Vehicle Engines

A variety of factors are emerging to develop the electric vehicle marketplace. The core factors for this evolution include (generally) more stringent fuel economy standards, more capable energy, storage/batteries, higher fuel costs and increased public environmental awareness.

Current (or soon to be released) electric vehicle technologies include:

- 48 Volt Stop/Start Mild Hybrid: Since electric vehicles will continue integrating new electrical components, a 48-volt battery will be needed in the future. Stop/start functionality would mean that upon slowing down, regenerative braking systems could shut off and recharge the battery, then restart it when the vehicle accelerates again.
- Hybrid Electric Vehicle (HEV) Power Split: Power split hybrids contain both an internal combustion engine and an electric engine which can be used to power the vehicle. At faster speeds, the ICE is

dominant while at slower speeds the electric engine is dominant. As the ICE is used, it recharges the electric engine.

- Plug-in Electric Vehicle (PEV): Plug-in EVs do not have hybrid capabilities and therefore cannot be recharged through the running of an ICE. As such, batteries must be recharged through connection to the electrical grid.

- Battery Electric Vehicle (BEV): Battery electric vehicles are similar to plug-in electric vehicles; however, some have the option of interchanging battery packs for extra range. As opposed to PEVs, battery systems are accessible and can be changed in/out relatively easily.

Hydrogen Vehicle Engines

- Fuel Cell Electric Vehicle (FCEV): Fuel cells use oxygen from the air and compressed hydrogen from a fuel tank to produce electricity within the vehicle. This electricity can then be used to support driving functions.

Comparing the market challenges for transitioning to alternative propulsion systems, it is impotent to recognize that there are still meaningful cost considerations. The current manufacturing cost gap between battery electric vehicles and internal combustion engine vehicles is approximately $10,000 per vehicle for similarly sized models with a travel range of more than 200 miles.

Based on analysis of the cost structure of the battery supply chain, from materials extraction and synthesis to battery cell and pack production, estimates suggest that the price of lithium-ion battery packs are expected to drop by approximately 50% between now and 2030. Battery price projections beyond 2030 are highly uncertain and are likely to be disrupted by the development and commercialization of new battery chemistries. This reduction would mean that a mid-sized battery electric vehicle with a range of 200-plus miles will likely remain about $5,000 more expensive to manufacture than a similar internal combustion vehicle through 2030. Although the manufacturing cost differential between electric and conventional vehicles is expected to persist beyond 2030, lower operating costs help to offset the ongoing higher production cost of battery electric vehicles.

Connected Vehicle Technology

By its widest definition, a connected vehicle has access to the internet and other sensors which allow it to communicate and interact with other vehicles and its environment. Connected technology has experienced significant technological advances over the past several years. Fifth-generation wireless connectivity has created new possibilities with the promise of highly reliable supporting networks. The speed in which devices operate has accelerated to the point where it provides required safety for deployment planning. The sensors that are needed for communication are becoming more widely produced and inexpensive as new technology companies enter the space with new competition.

By having vehicles interact with each other over full network deployments, a smart transportation system can manage traffic speeds or divert traffic to lessen or avoid congestion, can remove traffic from needed emergency vehicle access pathways and detect traffic safety issues well in advance of an impending dangerous situation.

The US Department of Transportation's (USDOT) Connected Vehicle program is working with state and local transportation agencies, vehicle and device makers and the public to test and evaluate technology

that will enable cars, buses, trucks, trains, roads and other infrastructure to “talk” to one another. Cars on the highway, for example, would use short-range radio signals to communicate with each other so every vehicle on the road would be aware of where other nearby vehicles are. Drivers would receive notifications and alerts of dangerous situations, such as someone about to run a red light as they’re nearing an intersection or an oncoming car, out of sight beyond a curve, swerving into their lane to avoid an object on the road.

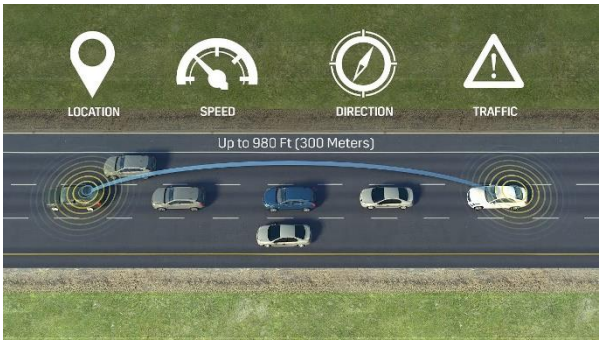
When in deployment, vehicles on the road will likely be using some wireless technology and GPS to create a full 360-degree awareness of nearby vehicles and conditions. This equipment will continually transmit your position, direction, and speed to other vehicles around you. This technology will also empower vehicles to "talk" to equipment installed in the road itself and other infrastructure, such as traffic signals, stop signs, toll booths, work or school zones, and railroad crossings.

Connected vehicles can send and receive immediate warnings or guidance based on road conditions. For instance, a connected vehicle could send data to roadside sensors when it rapidly changes speed, which would then communicate to traffic operators that an abnormal situation might be occurring. Operators could then dispatch emergency personnel if necessary, depending on data shared by other vehicles in the vicinity.

As connected cars spread across the driving fleet, machine-learning platforms can develop models from the data over time and begin predicting conditions and incidents. Such platforms, managed by traffic administration agencies, could suggest improvements to road infrastructure at points on the road that can be particularly hazardous, such as sudden sharp turns on rural freeways or slick pavement due to poor weather.

Safety

Connected vehicles could dramatically reduce the number of fatalities and serious injuries caused by accidents on our roads and highways. While the number of people surviving crashes has increased significantly thanks to passive and now active safety technologies (airbags, anti-lock brakes, automatic emergency braking systems), USDOT is seeking to advance the focus from helping people survive on US accidents to preventing crashes from occurring. Every year, there are over 5M accidents on US roadways, resulting in over 30,000 deaths according to the National Highway Traffic Safety Administration (NHTSA).



A recent NHTSA study has shown that connected vehicle technology could reduce accidents by up to 80% where drivers are not impaired.

The potential for connected vehicle technology could create safety conditions above and beyond that of other technologies now appearing in automobiles, such as radar, lidar, cameras, etc. Connected vehicle technologies and applications have a greater range than on-board vehicle equipment, which will allow the vehicle to receive alerts of hazardous situations much earlier, providing additional reaction time. Connected vehicle technology doesn't depend on “line of sight” communications to be effective allowing a vehicle to understand a problem well before a camera system might detect a threat. Connected vehicle technology is fairly inexpensive to install as compared to onboard radar and camera systems.

Traffic Congestion

Beyond the significant increase in safety, connected technology also promises to increase transportation options and reduce travel times. Traffic managers will be able to control the flow of traffic more easily with the advanced communications data available and prevent or lessen developing congestion. This could have a significant impact on the environment by helping to cut fuel consumption and reduce emissions.

In addition to costing the US economy an estimated $87B in 2018, per INRIX data, congestion also reduces the productivity of workers idling in traffic, adds costs and length of time for transporting goods, and increases air pollution.

EMERGING TECH

Utah Grows Connected Vehicle Work with Panasonic Partnership

The Utah Department of Transportation has outlined a five-year, $50 million partnership with Panasonic Corp. of North America to develop what state officials are calling "the most advanced transportation data network."

Sharing real-time traffic data can prevent jams before they impede traffic flow. The state of Utah has built one of the first operational connected-vehicle corridors in the US in Salt Lake City and Provo. Buses there that are equipped with equipment can "talk" to traffic signals and if the bus is running behind schedule, the signal can extend the length of the green light without any action taken by the bus driver.

Data Security and Telecommunications System

To function, a connected vehicle system needs to ensure the trustworthiness of communication between vehicles. The source of each message needs to be trusted and message content needs to be protected from outside interference. The system will likely have several layers of security and privacy protection to ensure that vehicles can rely on messages sent from other vehicles. USDOT's Intelligent Transportation System Joint Program Office (ITS JPO) is working with the industry to develop tight controls to prevent tampering with connected vehicle hardware and software.

As of this point, there are initial connected car services available over 4G LTE networks such as telematics, infotainment (passenger entertainment) and remote-control functions to start the car or unlock doors. Looking ahead to far more sophisticated connected technology deployment, connected autonomous cars will generate an enormous amount of data and 5G-enabled data transmission volumes are expected to grow exponentially in the coming years.

The first 5G standards were agreed upon in 2017 by the 3rd Generation Partnership Project (3GPP). 3GPP is a consortium with seven national or regional telecommunication standards organizations as primary members and has been responsible for the development of standards for GSM/2G, UMTS/3G, LTE/4G and 5G.

For telecom operators, the process of updating core network to 5G will be an evolution. One way that networks will evolve is using Network Functions Virtualization (NFV), which replaces physical network functions with Software Defined Networking (SDN). NFV allows network functions to

be distributed, focusing computational power where and when it is needed most. In relation to connected autonomous cars (CAVs), NFV will allow 5G connectivity for connected vehicles to be focused on the services and locations that need it most.

NFV will helps enable network slicing, which allows multiple logical networks to be created on top of a common shared physical infrastructure. This means a dedicated and secure "slice" of a 5G network can be created for a specific function. Network slicing will be essential to ensure self-driving vehicles get access to the critical data they need to operate safely.

Using predictive mobility, CAVs services and applications will be able to adapt to predicted network performance. For example, big data transfers from the cloud such as over the air (OTA) security updates, mission-critical data, and even the kids' videos can be anticipated or delayed depending on predicted network performance. This way, CAVs can still take long journeys, leveraging 5G whenever available and providing a uniform and smooth user experience

Connected vehicles work by collecting information from their surroundings and communicating it to each other, as well as intelligent transportation infrastructure that uses sensors installed alongside roads, on utility poles, on large gantries along highways, and on poles dedicated for traffic cameras or lights. This vehicle-to-everything, or "V2X," communication, as it's called, delivers practical information to drivers and workers coordinating road traffic.

Some states have already begun deploying connected car technology in roadway infrastructure. In addition to the aforementioned Utah program, states like Colorado, New York, and Wyoming are using connected vehicle technology to gather and send vital safety information directly to roadway infrastructure users.

Auto manufacturers are also embracing this innovation. Ford, for example, announced that all 2022 models in the US will be equipped with an advanced V2X system. Cadillac is working to enable its cars with V2X capabilities by 2023. A large percentage of European production is equipped with V2X.

The Importance of Advanced Truck Technologies to New Mexico

With New Mexico's location on two of the country's most trafficked cross-country interstates, I-10 and I-40, trucking will remain the dominant mode of freight transport to, through and from the state. Trucks carry over 70% of the nation's freight on a tonnage basis and virtually all goods consumed in the United States are shipped by truck for at least part of their trip to the consumer. Because of the issues of driver shortages, time in service restrictions and most importantly trucking's impact on the environment, the goods movement sector is the logistics sector that is moving most rapidly to adopt new technologies. Heavy-duty freight trucks are disproportionate contributors to pollution. Most are powered by diesel engines that, especially in older models, can emit high levels of particulates, nitrogen oxides, and other pollutants.

All future freight transportation solutions will need to be more affordable, efficient, clean, and safe to meet customer needs and broader societal demands. Technology and fuel choices will be essential for meeting the varying needs of commercial truck customers. Multiple fuel options, including natural gas, propane, electricity, hydrogen and diesel, will all play a role in future commercial truck markets. Research work in areas such as high efficiency engines, advanced domestically sourced fuels, connected and automated vehicle systems, electrified

drivetrains, and hydrogen fuel cells will lay the groundwork to create these future transportation solutions.

The Spectrum of Truck Technologies - There is a full spectrum of truck technologies being both used and tested in the truck industry today. Impressive improvements are being made to the engine efficiency of the traditional combustion engine as well as new technologies that are leading to a zero emissions product. The market demand for autonomous vehicle technologies of low and high levels of automation is quite strong, and both OEMs and technology companies are active in the space and are aggressively developing products

To meet the zero emissions goal, electric vehicle technologies will be essential to decarbonize the heavy-duty freight sector. Even though current advances have been made in diesel technologies to reduce carbon emissions by over 40%, the US Department of Energy projects that electric vehicle technologies powered by renewable sources can achieve over an 80% reduction in fuel life-cycle emissions. Many vehicle OEMs both established and new are developing zero-emissions vehicles both for testing and limited production. Daimler, Tesla, Toyota, BYD, Renault Trucks, Nikola, Volvo are all companies who have announced vehicles under development.

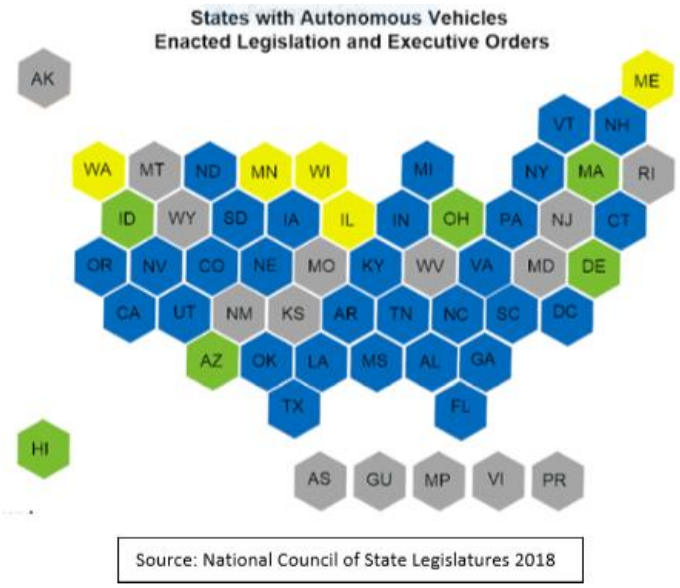
Another freight movement innovation being tested on US highways is platooning which is using the improved driving systems that are currently employed in trucks to allow for trucking rigs to arrange in formations. These formations, which are controlled by computers, communicate with one another, and follow closely behind other trucks in their fleet. It is all made possible through telematics: the sending, receiving and storing of information via telecommunication devices to the trucks. The result is a line of heavy vehicles heading in the same direction, one after the other.

Platooning is a real cost-saver in terms of fuel consumption and emissions. The combined line of trucks works to combat wind resistance and traffic congestion. It also works as a safety feature for the public as well. Instead of many trucks dotted all over the roads, this method creates a single, predictable file of large vehicles. A good example of this in practice is the work done by Pelton. The company is specializing in platoon technology and has proven fuel savings of 4.5% for the lead truck, and 10% for the following truck. The US Department of Transportation estimates that congestion on our highways costs the freight industry $60B annually. Exploiting connected vehicle platooning should have an impact on lowering these costs. For several years, truck manufacturers have been testing platooning on the I-10 corridor in New Mexico.

Regulatory Environment

The rapid development and adoption of connected and autonomous vehicles will transform the U.S. transportation system over the next 30 years. Although the widespread use of fully connected and autonomous vehicles is still several years away, it is nonetheless critical that legislators, policymakers, and regulators understand how the presence of these vehicles will restructure the operation of roadway networks. Without a doubt, lawmakers and policymakers will need to develop new laws — and revise existing ones — to account for the presence of connected and autonomous vehicles.

The United States has no formal statutes permitting or prohibiting automated vehicles. The federal government – through the National Highway Traffic Safety Administration – regulates vehicle design, construction, and performance while the States are responsible for licensing, vehicle registration,



insurance regulation, and similar matters. Without federal regulations, states and cities have been acting on their own. Since 2012, 44 states and Washington, DC have discussed legislation for AVs, and many have passed frameworks for testing and use. Some of these laws define terms differently, and some always require a human driver in the vehicle while others do not. These and other differences, such as differing regulations on the performance of vehicles, could complicate the eventual deployment of autonomous vehicles across state lines. Since this diagram was published by the National Council of State Legislatures, Wyoming, Missouri, Maryland and New Jersey have all passed enabling legislation leaving only six states without some sort of formal initiative.

Experts in the field and autonomous industry reps have expressed urgency in the need for federal legislation to avoid varied regulation from state to state. However, there has been some reticence at the state level to have the federal government regulate this new technology which will have an impact on safety on state highways. But as the technology grows, the differences between different sets of rules could become a major inconvenience for car manufacturers.

Since 2016, DOT has released four guidance documents. They have stated the department's principles for automated vehicles across modes of transportation. The principles include promoting safety, updating regulations, and remaining unbiased toward different technologies. The guidance offers recommendations for states and localities, such as to assess whether their road markings and signs are ready to support safe autonomous vehicle use and to adopt common terms and definitions that the industry has developed. They are encouraging states to initially use rules and regulations in permitting the industry as opposed to laws as the technology is changing rapidly and constant updates and changes laws will be required as the industry becomes more mature. On March 2019, Secretary Chao also started a multi-modal council at the department to address regulatory barriers to new transportation technologies, including autonomous vehicles.

The most recent action by the federal government was announced on Monday, June 15th, 2020 by NHTSA which unveiled a new online log that will be used to indicate the ongoing status of nationwide Autonomous Vehicles public roadway efforts, including those of self-driving cars. Known as the AV TEST initiative, a catchy acronym for Automated Vehicle Transparency and Engagement for Safe Testing, the public will be able to see the log online and sign-up to be emailed whenever the latest info is posted.

As stated at the AV TEST website: "You'll be able to see if testing has been reported in your community and learn more about the types of activities happening, including testing of various types of motor vehicles — cars, low-speed shuttles, trucks, and driverless electric delivery vehicles."

Meanwhile, attempts to pass federal legislation about regulating self-driving cars has continued to be stalled in Congress, partially due to differing viewpoints across political lines and most recently as a result of the pandemic and a focus on other legislative matters. It would seem unlikely that any such legislation will be completed soon, especially with the national election this year.
There are some arguing fervently that more laws and regulations are needed to keep the self-driving industry on point and ensure that the mobility-for-all aspiration will be achieved, along with attempting to implement stronger safety measures than otherwise might be chosen by the industry. At the same time, some want to change the existing laws that are seen as hampering progress in self-driving cars, thus proclaimed to be delaying the mobility-for-all hopes and impeding the presumed reduction in highway deaths.

Just like the technology, the regulations surrounding AVs continue to evolve. As the reality of driverless vehicles creeps closer, states and federal agencies will become even more invested in drafting and clarifying laws that both empower the industry and protect consumers.

The following is a synopsis of the existing rules and regulation governing autonomous vehicles in New Mexico and the competitor states.
New Mexico

- Chapter 18, Section G of MVD New Mexico's Vehicle Procedures Manual was revised in 2017 to include information on AVs, including defining AV per the definition provided on Wikipedia. However, Chapter G specifically provides that "there is no statutory authority at this time to title or register autonomous vehicles for use on New Mexico roads or highways."
- In February 2018, New Mexico's Legislature adopted a Joint Memorial (SJM-3) requesting the New Mexico Department of Transportation (NMDOT) to create a committee that includes relevant state agencies and private entities to review the current and developing state of AV technology and develop a proposal to allow AV use in New Mexico. NMDOT held a summit to discuss AVs in 2018 in response to the Memorial. The Joint Memorial called for the submission of a report to the Legislature by the end of 2018.
- The Intelligent Transportation Systems program is run under the direction of NMDOT. The ITS program seeks to improve transportation safety and mobility through the use of advanced communications technologies and data collection.
- In January 2019, SB No. 332 was introduced to authorize the use of AVs and platooning vehicles using AV technology within New Mexico. Although the Corporation and Transportation Committee recommended the Bill be passed, it died in session.

Pennsylvania

- Pennsylvania passed SB No. 1267 in 2016 allowing for the allocation of up to $40 million in state funds to local governments for upgrading and implementing intelligent transportation system applications.
- Pennsylvania created an Autonomous Vehicle Policy Task Force in 2016 which issued a report on an AV Policy. The Report made recommendations including:
    - Testers of highly automated vehicles (HAVs) must submit testing proposals to the Pennsylvania DOT (PennDOT) and enter contracts attesting that the vehicles meet all federal and state safety standards and meet the policies adopted by PennDOT

- PennDOT and the Pennsylvania Turnpike Commission may temporarily restrict HAVs from certain routes
- Platooning of HAVs will be restricted to two commercial or three passenger vehicles; the HAVs must be able to record data that can be used to investigate crashes involving the HAVs and PennDOT will have access to the data
- Testers must certify that cybersecurity protections are in place for the HAVs
- PennDOT and State Police are required to make annual reports on HAV testing to the Legislature

- In July 2018, after discussions with the AV Policy Task Force and a dozen AV technology companies, PennDOT issued Automated Vehicle Testing Guidance. Taking the guidance into consideration, in order for an entity to test a HAV in Pennsylvania, the entity must:
  - Complete a Notice of Testing Form and if necessary, a Notice of Testing Supplement. Testers are also required to supply PennDOT with semi-annual collections of data gathered during the testing
- PennDOT also released the Joint Statewide Connected and Automated Vehicles Strategic Plan (CAV Strategic Plan) in 2018. The CAV Strategic Plan serves as a road map for organizational change as CAV technology advances.
- In 2018, Pennsylvania passed HB No. 1958, (Act 117), which establishes a number of guidelines and practices for the use of AV in work zones and allowing certain vehicle platoons to operate in the Commonwealth. The Act defines platoon as A group of buses, military vehicles or motor carrier vehicles traveling in a unified manner at electronically coordinated speeds at following distances that are closer than would be reasonable and prudent without the coordination. The term does not include a school bus or a school vehicle.

Michigan

- In 2013 Michigan permitted testing of automated vehicles under certain conditions and addressed the liability of the vehicle manufacturer.
- In 2014 Michigan limited the liability of manufacturer for damages resulting from modifications made to an automated vehicle.
- In 2016 Michigan was one of the first states to pass comprehensive AV legislation including, SB No. 997 (Act 334) and SB No. 998 (Act 335). These Michigan laws set forth requirements for AVs to operate in the state, allows AVs to operate without a driver present and sets forth a structure for liability should an accident occur.
- SB No. 996 (Act 333) created the SAVE project, an initiative that authorizes eligible motor vehicle manufacturers to make available to the public on demand AV networks.
- Michigan law also allows for the operation of vehicle platoons. By HB No. 5749 (Act 377) enacted in December 2018, vehicle platooning operations are exempt from the requirement that trucks and truck tractors leave sufficient space between themselves and other trucks.
- In 2017 Michigan made mechanics and repair shops exempt from liability when fixing automated vehicles.
- SB No. 995 (Act 322) created the Michigan Council on Future Mobility within the Michigan DOT, to provide annual recommendations on AV technology.
  - The Council's 2019 Report provided a list of issues the Council would review throughout 2019 in order to provide future recommendations including:
    - mobility on demand;
    - electric vehicle charging infrastructure development;
    - automobile insurance;
    - transportation infrastructure funding;

- talent attraction, retention and education;
- public acceptance of HAVs;
- state law revision; and
- cross-border mobility

Arizona

- In 2015, Arizona Governor Doug Ducey, signed Executive Order No. 2015-09, directing various agencies to: undertake any necessary steps to support the testing and operation of self-driving vehicles on public roads within Arizona
- In 2018, Governor Ducey signed Executive Order No. 2018-04, which served as a general update to the 2015 Executive Order. Notably, Executive Order 2018-04 requires any entity wishing to test an AV with or without a driver to first submit a written statement to ADOT. An AV without a driver must certify:
  - Compliance with all federal laws and FMVSS
  - Achievement of a reasonably safe state, such as bringing the vehicle to a complete stop, upon experiencing a failure of the vehicle's ADS
  - Compliance with all Arizona traffic and safety laws
  - Compliance with all applicable certificate, title registration, and licensing and insurance requirements
- In 2018, Governor Ducey also signed Executive Order No. 2018-09, creating the Institute of Automated Mobility (IAM). The IAM seeks to unite global companies and Arizona universities with partners from the public and private sectors by providing AV testing facilities and resources
- ADOT issued the Law Enforcement Protocol for Fully Autonomous Vehicles. The directive is intended to provide procedural guidance and information as officers have more contact with AVs. Officers are instructed to follow the procedures outlined in the policy when investigating a collision, traffic or criminal violation, or incident involving a fully AV with no operator present

Florida

- The first legislation regarding AVs in Florida was HB No. 1207, enacted in 2012 declaring legislative intent to encourage the development, testing, and operation of autonomous vehicles on Florida roadways
- In 2014, the Florida Department of Transportation (FDOT) created the Florida Automated Vehicles program to educate the public by engaging stakeholders, developing research and pilot programs, and creating awareness of AV technologies. FDOT has also created the Florida Connected Vehicle Initiative. The Initiative uses leading edge technologies to quickly identify roadway hazards and alert drivers
- The Florida Department of Highway Safety and Motor Vehicles issued an Autonomous Vehicle Report in 2014, which discussed the impact of AV technology in Florida
- The Legislature subsequently enacted HB No. 7027 and companion HB No. 7061 in 2016, allowing for AVs to be driven on roadways for purposes other than just testing. It also directed FDOT to study the operation of driver-assistive truck platooning technology; authorized FDOT to conduct a pilot project to test such operation (Driver Assisted Truck Platooning Pilot); and required a report from FDOT to the Governor and Legislature regarding same
- In 2019, the Florida Legislature passed numerous bills pertaining to AVs. In June 2019, with passage of HB No. 311, Florida became one of the few states to allow a fully AV to operate without a person

present in the vehicle. The bill provides that the automated driving system, rather than a person, is deemed the operator of an AV when operating with the ADS engaged

- HB No. 311 also authorized the Florida Turnpike Enterprise to fund, construct, and operate facilities for the advancement of autonomous and connected innovative transportation technologies
- Starsky Robotics was the first company to test its fully unmanned autonomous truck in Florida on June of 2019. However, in the Spring of 2020, Starsky terminated its operations due to the lack of funding and has subsequently sold its technology
- HB No. 107, relating to wireless communications while driving, was also enacted in 2019 and provides an exception for AVs from the statutory ban on texting while driving
- FDOT has selected HDR to help ensure Florida remains a leader in the integration of CAVs. General engineering consultant, HDR will develop, implement, deploy and evaluate a statewide investment in CAV technology that's touted as being among the most robust in the nation

California

- California passed SB No. 1298 in 2012 authorizing AV testing on public roads if a certificate is filed which provides that the AV complies with the following:
- The autonomous technology satisfies all of the following requirements:
    - A mechanism to engage and disengage the autonomous technology that is easily accessible to the operator;
    - A visual indicator inside the cabin to indicate when the autonomous technology is engaged;
    - A system to safely alert the operator if an autonomous technology failure is detected while the autonomous technology is engaged, and the system shall:
        - Require the operator to take control or
        - If the operator does not take control, the AV shall be capable of coming to a complete stop
        - Allow the operator to take control in multiple manners, and tells the operator that the autonomous technology has been disengaged
        - Meets FMVSS for the vehicle's model year and all other applicable safety standards;
        - The autonomous technology does not make inoperative any FMVSS and performance requirements set forth in state and federal law and the regulations promulgated pursuant to those laws
        - Has a separate mechanism, to capture and store the autonomous technology sensor data for at least 30 seconds before a collision occurs while the vehicle is operating in autonomous mode
- California passed SB 719 (in 2015) and an almost identical Assembly Bill No. 669 (in 2017) to allow vehicle platoon testing in the State. The law provides that Caltrans, in coordination with the Department of the California Highway Patrol: "may conduct testing on technologies that enable drivers to safely operate motor vehicles with less than 100 feet between each vehicle or combination of those vehicles". The Assembly Bill amendment to the Government Code to allow for this testing will remain in effect until January 1, 2020, at which time it will be automatically repealed.
- The Governor released the Automated Vehicle Principles for Healthy and Sustainable Communities in 2018 in an effort to summarize key principles for maximizing alignment between California's AV policy and goals for climate, air quality, health, environment, land use, quality of life and equity.
- The California Department of Motor Vehicles (DMV) passed Driverless Testing Regulations as required by SB 1298. The regulations provide, among other things, specific requirements in order to gain a permit for testing an AV with and without a human driver. Currently, 64 companies have

valid permits to test 29 AVs with a safety driver on California public roadways. One company has a permit for driverless testing

- California also passed Assembly Bill No. 87 in 2018, to direct peace officers in their interaction with AVs regarding traffic or parking violations
- In 2018, California's General Assembly passed Assembly Bill No. 1184, authorizing San Francisco, by voter approval, to tax trips that occur in AVs that originate in the City
- In August 2019, the California Public Utilities Commission (CPUC) granted approval to Waymo's application to not just test self-driving vehicles on public roads, but to also be able to transport passengers in them.
- In December 2019, California approved regulation that will allowing the testing and commercial use of light-duty autonomous delivery vehicles weighing less than 10,001 pounds on the state's public roads with an approved permit from the DMV. Qualifying vehicles include autonomous passenger cars, midsized pickup trucks and cargo vans carrying goods such as pizza or groceries. Autonomous delivery vehicles will be required to comply with the same application requirements currently in place for testing and deployment of autonomous passenger vehicles. Depending on the permit, companies can test their autonomous delivery service with or without a safety driver.
- Currently pending in the Senate are the following AV related bills proposed in 2019:
    - SB 59: creation of an AV advisory committee known as the California Council on the Future of Transportation; and
    - SB 336: requires fully automated transit vehicles be staffed by at least one employee who has had specified training, while the vehicle is in service.

Recommendations for New Mexico Regulatory Action

Based upon a thorough review of current AV legislation and Executive Orders in the US and discussions with the New Mexico Department of Transportation, a recommendation is being made to establish a program for the testing and development of automated vehicle technologies on public roads within the State of New Mexico to be administered by the New Mexico Department of Taxation and Revenue's Division of Motor Vehicles The intent of this process is to create a collaborative, constructive, and expedient pathway for the testing of automated vehicles in New Mexico while maintaining a safe environment for all who use New Mexico's transportation systems and facilities.

In 2018 NMDOT formed an Autonomous Vehicle Committee which created an excellent overview of the industry as well as recommendations for establishing a testing program. To take advantage of the previous work that has been done it is recommended:

- Through Executive action, reengage the Autonomous Vehicle Committee that was established through SJM3 to adopt rules and regulations for the testing and development of automated vehicle technologies on public roads within the State
- Enable the New Mexico Motor Vehicles Division to administer the program
- Recommend that regulations should include:
    - An application process for permission to test on public roads
        A. Identification of each vehicle to be used for testing, with VIN or serial number, vehicle type, and other unique identifiers such as the year, make, and model
        B. Identification of each test operator, their driver's license number, and the jurisdiction in which the operator is licensed
        C. Agreement that test operators are to be responsible for following all traffic rules of the road, and responsibility of all traffic violations in the HAVs being tested on roadways open to public travel, are that of the permit holder

D. Self-certification that AV safety training has been provided to the employees, contractors, or other persons designated by the manufacturer or other entity as operators of the test vehicles
E. Self-certification that each vehicle meets all applicable Federal Motor Vehicle Safety Standards or equivalent; or is the subject to an exemption from such standards by National Highway Traffic Safety Administration (NHTSA)
F. Self-certification of a reasonable measure of previous testing of the technology in the test vehicles under controlled conditions that simulate the real-world conditions (various weather, types of roads, times of the day and night, etc.) to which the applicant intends to subject the vehicle on public roadways, prior to testing on roadways open to public travel
G. Assurances from the manufacturer or entity of the safety and compliance plan for testing vehicles on roadways open to public travel, to include a copy of the Safety Assessment Letter (SAL) submitted to National Highway Traffic Safety Administration (NHTSA) for the vehicle(s) being tested
H. Proposed test location(s) (areas or corridors)

- All testing vehicles must carry the standard New Mexico motor vehicle insurance. The manufacturer or other entity permitted to test is the liable party for any of their vehicles and drivers / operators of their vehicles
- Proof of an umbrella liability insurance policy for no less than $5M per occurrence for damages from bodily injury, death, or property damage. This would not require $5M to be paid to obtain and maintain the insurance, pay out would only occur in the case of an applicable incident. The experimental nature of AV testing and deployment at this stage helps justify a higher umbrella liability insurance requirement. The amount can be changed later when AVs mature
- Plan for accident notification to the New Mexico Department of Public Safety
- Preempt any local regulation of the AV industry to prevent unnecessary roadblocks to deployment of AVs
- Provide guidance, information, and training to prepare the transportation workforce and the general public for the advent of autonomous vehicles

Competitiveness

States and cities are increasingly looking for ways to attract the emerging mobility/autonomous vehicle (AV) industry as they are becoming aware of the economic development opportunities that these technologies can offer. Even though the acceptance, cost and regulation of AV technology and infrastructure makes it unlikely that this technology will be implemented simultaneously across the U.S. in the near future, communities that understand and embrace this new industry and technology will have an opportunity to be early implementers of programs for the industry investment. As autonomous technologies become a staple of the global economy, there is the potential for broad-based employment opportunities for New Mexico. The regions that understand this new industry and welcome the testing and development of the industry will have the ability to create new tech clusters and eco-systems, which will anchor these jobs to their area for decades to come. Additionally, the next generation workforce is likely to view the new technology as an amenity when choosing a city in which to live, therefore providing a steady influx of an educated workforce.

The autonomous vehicle ecosystem is both complex and rapidly changing. Each day there are new entrants and partnerships being announced. In recent discussions with the industry, we have found numerous categories of manufacturers, operators and integrators that are being significantly impacted by the advent of vehicle autonomy. Adding to the complexity of the situation, traditional auto OEMs are investing in service opportunities to the mobility industry while technology firms who are not a part of the traditional automobile community have begun to be the automotive software component suppliers.

Each of the following stakeholders play a role in the autonomous vehicle ecosystem:
Automotive and freight system vendors:

- These are the subsystem integrators (Bosch, Continental, Magna International, Denso, etc.) that combine their hardware and software to provide functionality to the OEM's (Ford, GM, BMW, PACCAR, etc.) vehicles

Component suppliers:

- These companies provide the sub-components that are used by the system vendors or in some cases the OEMs in their subsystems

Telecommunication companies:

- These are the companies that manage the wireless communication networks that transmit information to and from the vehicles

Data aggregators:

- These are the companies that collect the driving environment data from a variety of sources and then process that data into information that is sent back to the vehicles

Public sector:

- Controls and manages the physical transportation network assets such as roads, signs and signals and works to optimize travel within that network

This entire ecosystem is an economic development target. The traditional original equipment manufacturer (OEM) supply chain is being altered, and AV technology (software and hardware) will play an increasingly important role in the automotive supply chain even though it is not currently linked to OEM supply hubs. On the hardware side, the growth segments are batteries; electric motors; semi-conductor chips; cameras, radar, laser, lidar, and other sensors; and advanced materials such as high-strength steels. On the software side, as the auto industry moves to a software-based digital car, regions with strong software talent will attract new economic opportunities. IBM has noted that a new vehicle produces almost 25GB of data every hour. This has the potential to create an array of new digital services, new economic value, and new business opportunities.

The new supply chains have not yet been formed but suppliers are watching those states and locations where testing is accepted and welcomed. This regulatory landscape will be the driving force that will alter the existing OEM supply chains as software and hardware begins to play an increasing important role in the AV auto supply chains.

A customized competitiveness/core competency assessment model has been developed to illustrate how New Mexico would compete against five of the perceived leading mobility technology regions in the country. This model is based upon the competitiveness of the traditional business climate, an educated technology workforce that understands R&D business practice, universities and community colleges/technical schools with strong STEM curriculums, quality of life with reasonable costs of living,

and a regulatory environment that supports the testing and development of autonomous vehicles. These variables illustrate how various location factors will specifically influence this industry's location decisions for both testing and production and identify New Mexico's location strengths and areas for improvement.

This competitiveness analysis compares the Albuquerque region to San Jose, California (Silicon Valley); Detroit; Pittsburgh; Phoenix and Orlando, five regions that have achieved some success in this industry and compete for leadership in the development of mobility technology. This analysis highlights differences and similarities between the six areas and their mobility assets. It helps identify ways to improve New Mexico's opportunity to become a vibrant ecosystem of companies, academia, test environments, and an engaged public sector at the local, state, and federal levels; a hub for automotive development and manufacturing, all primarily related to innovation in mobility technology. To compare the six regions accurately, GLDPartners Mobility Solutions used the Combined Statistical Area (CSA), as defined by the US Census as the logical geographic unit of comparison. The CSAs for each region are: Detroit-Warren-Ann Arbor; San Jose-San Francisco-Oakland; Pittsburgh-New Castle-Weirton; Phoenix-Mesa; Orlando-Lakeland-Deltona; and Albuquerque-Santa Fe-Las Vegas.

Shown below is a snapshot of key competitiveness factors across the six regions.

Sources: Manufacturing Intensity, BLS 2018; Cost of Living Index, Places 2019; Business Tax Rankings, Tax Foundation, State Business Tax Index 2020, GLDPartners Graphics

The Detroit area has the highest manufacturing intensity relative to the five comparison regions, but this leadership is based upon the traditional auto industry as we know it today. The disruptive trends in the industry will create new opportunities for other regions indicating that Detroit's leadership position might not be secure in the future.

Both the cost of living and the business tax burdens in the Silicon Valley are substantially higher than any of the other regions. Mobility companies will have a difficult time maintaining their competitive advantage and profitability if they try to implement production in California. Albuquerque, Detroit, and Phoenix all offer an attractive cost of living advantage, while business taxes are reasonable in Orlando, Detroit, Albuquerque and Phoenix.

Competitor Regional Analyses and Demographics

Albuquerque, Detroit, Phoenix, Orlando, Pittsburgh, and Silicon Valley all have influential ties to both manufacturing and technology industries, though the specific industries and connections vary.

Detroit

As the original birthplace of the North American automotive industry, the Detroit area remains a global hub for leading-edge research and manufacturing for the automobile industry. Southeast Michigan (Greater Detroit) is an established hub of industrial innovation, including the high-tech, communication

technology arena and its auto manufacturing cluster. Automakers and suppliers have established hundreds of facilities in this area, including manufacturing facilities, headquarters, R&D centers, proving grounds and testing facilities. Many well-known companies, such as Fiat Chrysler Automobiles (FCA), Ford, and General Motors (GM), Daimler, Lear Corp., Delphi Automotive, BorgWarner Inc., and Federal-Mogul Corp,5 have a headquarters, R&D, and a testing presence in this area. Additionally, Toyota, Nissan, Subaru, Mitsubishi, and Hyundai-Kia have R&D and design centers in the region. More recently, tech companies that are developing connected and autonomous vehicle technology, such as Uber and Waymo (Google), have opened facilities in the region.

Increasingly, the Detroit area is looking to become more competitive for connected and autonomous vehicle testing facilities investments and infrastructure deployments. The State of Michigan has actively supported the industry by financing projects relating to the development and adoption of autonomous vehicles in southeast Michigan. The American Center for Mobility, funded by the Michigan Strategic Fund is a 335-acre test facility at the historic Willow Run General Motors plant in Ypsilanti, Michigan. The Center is focused on testing, verification and certification of connected and automated vehicles. Another testing center in this region is MCity, a simulated urban and suburban environment built on a 32-acre site at the University of Michigan which opened in July 2015.

Other academic/industry partnerships include the General Motors creation of the GM Mobility Research Center at Kettering University in Flint. The Center is a vehicle and mobility systems development proving ground and outdoor research facility. Oakland University in Auburn Hills has partnered with Continental and the AV technology company Easy Mile to run a pilot shuttle program on the campus which will be run by students and the data gathered will be used in autonomous engineering courses.

Detroit is also the leading region for testing and deploying infrastructure enabling vehicle communication (vehicle-to-vehicle and vehicle-to-infrastructure communication through Dedicated Short-Range Communication, or DSRC). Over 20 companies have received a state license to test technology on public roads, and the cities of Detroit and Grand Rapids are hosting pilot tests of May Mobility's automated shuttle.

For Detroit to continue its dominance in the auto industry, the attraction of highly skilled talent is crucial. The CSA has a large population, but it is aging with a very anemic growth rate and in fact has been losing population. With the auto industry creating new centers of technology for mobility and autonomy, people have an opportunity to live in other areas of the country and still be involved in the cutting edge of the industry. Maintaining and attracting talent is a critical issue for Michigan.

Pittsburgh

Pittsburgh Like Detroit, is in a region whose economy has long relied on a robust industrial sector but currently is working to move its economy forward by focusing on new technologies, although, manufacturing remains an important part of this region's economy.

Many well-known manufacturing companies are in the region, including Alcoa/Arconic, Bosch, PPG Industries, and U.S. Steel. Several major technology companies, such as Google, Apple, Facebook, IBM, and Uber, have offices in the Pittsburgh area.

Pittsburgh currently enjoys a favorable international reputation in autonomy thanks to Uber's self-driving car service and the Ford investment in Argo AI. The city's advent into the autonomous vehicle industry began in 2015 when Uber hired about 40 researchers and scientists from Carnegie Mellon University, and opened the company's Advanced Technologies Group in Pittsburgh to focus on the development of automated vehicle technology. The following year, Uber announced it was building a test track and testing facility in the city. Pittsburgh is also home to the artificial intelligence startup Argo AI, a company in which Ford invested $1B in 2017 and last year announced a partnership with Volkswagen AG, for a planned investment of $2.6B. Today they are testing their self-driving cars in six U.S. cities: Austin, Detroit, Miami, Palo Alto, Pittsburgh and Washington, D.C.

With the City's global strengths in machine learning, robotics, and artificial intelligence, as well as the presence of a growing cluster of firms such as Argo and Uber, few cities have the academic and research feedstock in autonomous systems as Pittsburgh does. The City clearly has a first mover's advantage, but, as with all transformative technologies, its position is not guaranteed. Other competitor regions such as Silicon Valley and Detroit have strong engineering and computer science universities, greater firm density, and the ability to amass private capital once the technology matures

Due to a long period of deindustrialization, Pittsburgh has struggled to retain a younger workforce which threatens Pittsburgh's ability to create the workforce it needs to compete. Between 2009 and 2014, Pittsburgh's population remained stagnant while peer cities grew by double digits. At the same time, the average worker in Pittsburgh is older than the national average, with a quarter million people expected to retire over the next decade. However, that tide seems to be turning. An increasing number of younger individuals are heading to Pittsburgh due to its growing tech industry and the region's mobility services.

San Jose, California

San Jose is the largest city in the area known as the Silicon Valley in California which is the US center for innovative technology companies. It's located south of San Francisco and is home to over 2,000 tech companies, which makes it the densest technology concentration in the world. Most of these companies are leaders in their industries which include software, social media, and other uses of the internet as well as manufacturers of lasers, fiber optics, robotics, and medical instruments. It can now add to its accolades, the center of global activity in automated driving and in-car computing.

In recent years, automakers such as Ford, Daimler, Nissan, Honda, Volkswagen, and BAIC have opened offices and R&D centers in Silicon Valley to take advantage of its startup culture, hire talented engineers, and work with technology giants such as Apple, Google, and Intel. Currently over 26 automakers have offices in Silicon Valley, up from ten in 2010. Though small compared to the R&D centers that these automakers have in Michigan, Germany, or Japan, these facilities have rapidly risen to prominence.

In addition to being one of the largest mobility development regions, Silicon Valley is also known as a testing location. Waymo first started testing its automated vehicle prototype in Mountain View, California in 2009. Currently, 65 companies are testing automated vehicle technologies on public streets in

California, including automakers (Volkswagen, Mercedes Benz, Tesla, BMW, Honda, Ford, Nissan, Subaru), suppliers (Delphi, Bosch, Valeo), tech companies (Waymo/Google, Apple, NVIDIA Corporation, GM Cruise, Zoox, Drive.ai), and electric car companies (Faraday Future, Wheego Electric Cars, NextEV USA).

There are two testing facilities for connected and automated vehicles in Northern California. GoMentum Station is located at the decommissioned Concord Naval Weapons Station and is owned and operated by the AAA of Northern California, Nevada and Utah. The facility features 20 miles of abandoned roads, bridges, tunnels, railroad crossings, and other infrastructure. The facility has been used by Honda, Apple, and others. Another facility, the California Advanced Technology Development Center (CATDC) is home to Waymo's proprietary global testing center. Throughout the CSA AV testing and pilot programs are being conducted by both the public and private sectors.

- Local Motors is debuting its new Olli self-driving shuttle at a business park in Rancho Cordova.
- In 2019, the San Francisco Metropolitan Transportation Commission (MTC) selected intelligent transportation systems technology company, Iteris, to prepare five cities in the San Francisco Bay Area for future connected and automated vehicle technologies. The three-year project supports the San Francisco MTC's Innovative Deployments to Enhance Arterials program, which seeks to enhance and upgrade the intelligent transportation systems and enable the continuous improvement of arterial operations.
- In 2019, Bosch and Daimler announced they have chosen a city located in the San Francisco Bay in Silicon Valley as the pilot location for a test fleet developing fully automated and driverless capabilities. They will offer customers a shuttle service with AVs on selected routes.

Orlando

Efforts to establish the Orlando region as a top-tier AV innovation hub started in 2011, when NASA and the state's government and industry leaders coalesced around the concept and launched a program to designate the I-4 corridor, which runs through Orlando from Tampa to Daytona Beach, as a test bed for advanced vehicle technologies. Central Florida was reeling at that time as the Federal Government had just announced the discontinuation of the Space Shuttle program. It was estimated that Central Florida would lose approximately 23,000 jobs and the mobility-related strategy was an attempt to file some of the gap from the loss of space jobs. With the strong legacy of the space and defense industry in Central Florida there was an understanding that many of the skill sets in that industry were transferable to the mobility technology.

In 2012, the state's legislature began to pass legislation that would make AV testing, development and deployment companies feel welcome in Florida. In the same year the Florida Automated Vehicles (FAV) program was established to lead the state in developing best safety practices and promote awareness for AVs and relevant technology and legislation was passed in 2016, which cleared the way for all forms of AV testing. State law now permits the testing and operating of AVs on public roads with or without a human driver in the vehicle.

The Florida effort is being led by the Central Florida AV Partnership which includes regional agencies and entities that have demonstrated leadership and significant contributions towards mobility challenges.

Research and simulation is being conducted at some of the area's universities, including the University of Central Florida, Florida Polytechnic University, and Florida A&M University-Florida State University (FAMU-FSU) College of Engineering. The Partnership works closely with numerous entities, including SunTrax, a 475-acre testbed featuring a 2.25-mile-long oval test track for connected-and autonomous-vehicles located between Orlando and Tampa. The multi-lane track will make it the only dedicated high-speed autonomous vehicle (AV) testing facility in the southeastern United States but it has not yet opened.

Several AV developers are taking advantage of Florida's favorable AV laws and are conducting testing in Orlando as well as other areas within the state.

- Voyage Auto, a California-based company, is testing its second-generation cars, in The Village of Virginia Trace, Florida
- Beep is testing its public transit service in a southeast Orlando neighborhood. The shuttles, which can carry 10 passengers and an attendant, will travel at a maximum speed of 15 miles per hour
- Waymo began testing in Florida in 2019. Waymo is especially interested in testing its vehicles in the rain during Florida's hurricane season.
- The Jacksonville Transportation Authority (JTA) established an AV Test and Learn Track in 2017. Since then, the JTA has worked with AV manufactures like NAVYA to test, develop and prepare the technology for public use.
- The Tampa Hillsborough Expressway Authority (THEA)'s Connected Vehicle Pilot is deploying a multimodal project using connected vehicle technology, using both V2I and vehicle-to-vehicle (V2V) and communication. THEA has equipped 10 buses, 8 streetcars and the cars of 1000+ individual volunteers with this new technology.
- Ford Motor Co. intends to start a commercial delivery business underpinned by self-driving technology. Argo AI, the company developing the self-driving system for Ford, has been testing in Miami, and commercial deployment is tentatively set for 2021.

Phoenix

Though it is a relatively young region, Greater Phoenix has a long history of automotive research and development as the major auto manufacturers have located proving grounds in the state for decades. In addition to the long-standing auto testing ecosystem in the region, there is a very strong high-tech industry including Intel's largest manufacturing site in the world with over 12,000 employees in the metro area. Other companies in this sector having a presence include Rogers Corporation and NXP Semiconductors, companies that provide sensors and chips for connected vehicles, and Garmin, which provides GPS. This combination of legacy auto testing and a strong high-tech sector has made Phoenix a logical location outside of California for the presence of connected and autonomous vehicle industry.

Google's Waymo with its fleet of driverless cars, 600 Chrysler Pacifica mini vans, can be seen daily testing on the streets in metro Phoenix. In December 2018, they launched the nation's first commercial self-driving taxi service in Phoenix, and they have also begun to test self-driving tractor trailers in Phoenix. Waymo has partnered with Intel to design, build, and test its autonomous vehicles. OEMs Ford and GM have moved parts of their driverless car operations to the state. GM operates an IT Innovation Center in Chandler and the Cruise Automation facility in Scottsdale and Ford periodically has been testing their cars on Phoenix streets.

Arizona startup Local Motors developed "Ollie," the self-driving bus here. And ride-sharing companies like Lyft and Uber have scaled their operations in Arizona while deploying their own self-driving vehicles. In addition to testing, several auto/truck manufacturers have made major investments in Arizona to manufacture their vehicles. Lucid Motors, an electric car maker, a competitor to Tesla, is building a $700M factory in Arizona while Nikola Motors, a leader in innovative electric long-haul trucks using hydrogen-electric technology, has moved their corporate headquarters to Phoenix and is building a $1B manufacturing facility.

The City of Chandler has become an example of how a community can work with the autonomous car companies. Waymo came to Chandler in 2015 for their original pilot and since then the company has participated regularly in community events. This transparency and willingness to share their work with the public has helped Waymo to establish public trust. Now that AVs have coexisted with Chandler's residents for over five years, they are a common sight throughout the City's neighborhoods. Chandler does not have formal agreements with any AV developers. The City instead focuses on enabling collaborations that promote AV development. For example, the City invited the engineers to test emergency response vehicles on a closed track alongside City employees, so that the City's own responders could become familiar with how their operations in a fully autonomous world might occur. The City also brought its police and fire department representatives to visit company headquarters in the Bay Area to advise on their needs and concerns regarding AV interaction. To continue enabling AV testing and easing the City's transition to larger numbers of AVs on the streets, Chandler officials have modified their zoning development code. The amended code reduces parking requirements by up to 40 percent and encourages passenger loading zones as drop off and pick up locations for autonomous vehicles and ridesharing. The City hopes that AVs will increase shared ridership leading to a decrease in parking needs.

Albuquerque

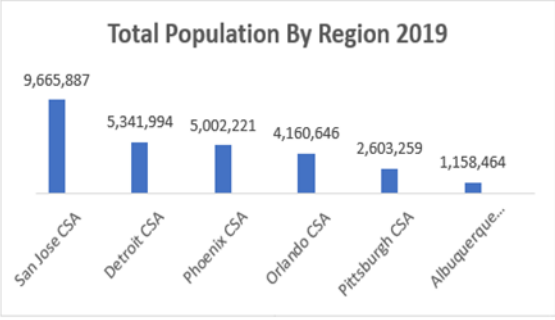
Albuquerque and New Mexico do not have a history of auto industry investment, but they do have a legacy of R&D activity dating back to the late 1930s which grew out of the US effort in World War II to develop the first atomic bomb. After World War II, the federal government took control of millions of acres of New Mexico land, which it has used to build military bases, missile ranges, and R&D facilities. Today, New Mexico has more scientific and technical workers per capita than any other state in the nation with Los Alamos and Sandia laboratories representing just two of the facilities located there.

Throughout the years R&D activities have increased at the federal labs in the foundational technologies of autonomy including cybersecurity, lidar, connected vehicles and propulsion for both the Department of Energy and the Department of Defense. The national labs and the research facilities connected to Kirkland Air Force Base have spawned an ecosystem of institutions and businesses as well as the University of New Mexico, a top tier research university.

In addition to over 24,000 people that work at the national labs, there are scores of companies such as Honeywell, Northrop Grumman, Lockheed Martin, Cabot Corporation, CTS Corporation and Intel that have a major presence in the region. Also, large truck manufacturers such as PACCAR, Daimler and Nikola have been awarded contracts from the labs to conduct research on truck electrification, hydrogen fuel cells and truck autonomy for goods movement. Currently the federal lab system has designated autonomy as a Tech Focus area. Through this program the labs are looking to collaborate and partner with companies that can use the research that the federal government has developed in their operations. The autonomous systems technology research is in the areas of intelligent autonomy, human autonomous systems, sensor systems and networking and communications. This research can be accessed through Sandia and Los Alamos national lab.

The 75-year history of national laboratory presence has created a culture of technology and innovation in New Mexico and has made it a center of R&D in science and technology. The region understands working with R&D companies and has done an excellent job of creating a mid-level tech workforce that can support the research work that is being done throughout the region.

By far Albuquerque has the smallest population of any of the competitive cohort regions. This does not mean that Albuquerque and New Mexico cannot be competitive for the mobility industry but it may need to be surgical and highly targeted in its business attraction planning. New Mexico's combination of a deep research and development culture and the amount and quality of the highly educated people employed in the region, make it a competitive candidate for attracting this industry.

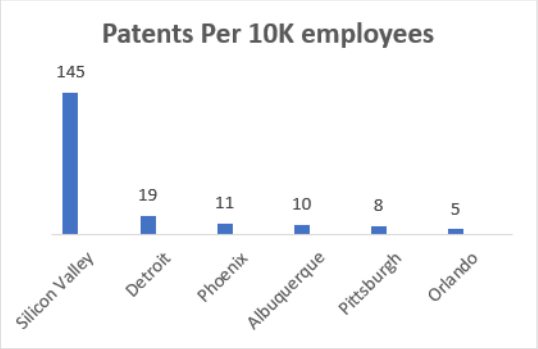


By far Albuquerque has the smallest population of any of the regions. This does not mean that the region cannot be competitive for the mobility industry. Its combination of a deep R&D culture and the amount and quality of the highly educated people employed in the region, make it a prime candidate for this industry.

Patents

Tracking the number of granted patents by technology can provide a measure of a region's innovation activity and its core technology competencies. The technology classes relevant to mobility cross over six different categories: cybersecurity, data management, infrastructure design, intelligent transportation systems, vehicle design and testing, vehicle IT design. Patents from each category have been combined to show the total number of patents issued for each region in mobility technology based upon the number of patents issued per 10,000 employees.

Silicon Valley as expected leads in the number of technology patents issued. However, Albuquerque when compared to the other regions performs well when considering the size of its population and labor base and the fact that there is no mobility technology initiative in the state

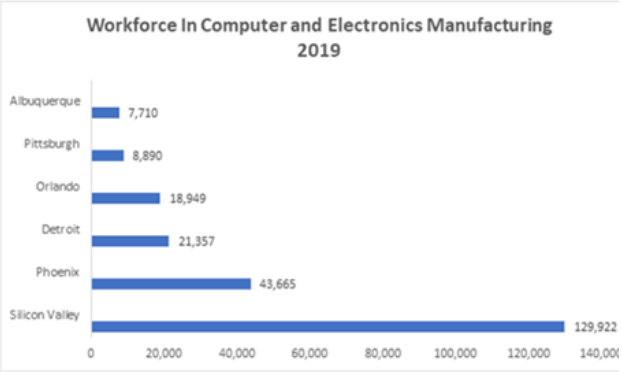


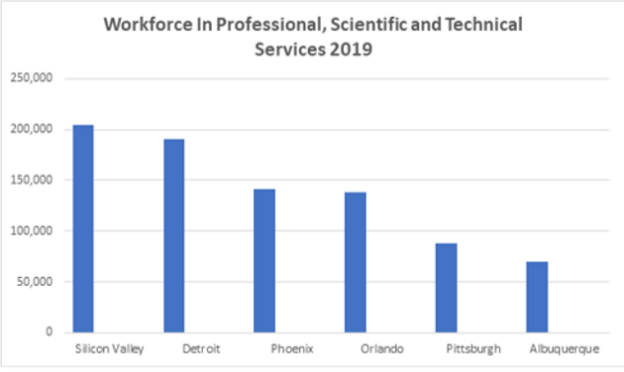
Source: U.S. Patent and Trademark Office, 2015

Talent

Comparing the May 2019 employment levels in Computer and Electronic Product Manufacturing and Professional, Scientific and Technical Services employment reveals very different profiles for each of the regions. These sectors were chosen to illustrate both a production workforce as well as a R&D/professional workforce.

The NAICS code for Computer and Electronic Product Manufacturing, 334, includes establishments that manufacture computers, computer peripherals, communications equipment, and similar electronic products, as well as establishments that manufacture components for such products. The design and use of integrated circuits and the application of highly specialized miniaturization technologies are common elements in the production technologies of the computer and electronic subsector. These are the types of products that will be part of the major systems in autonomous vehicles.



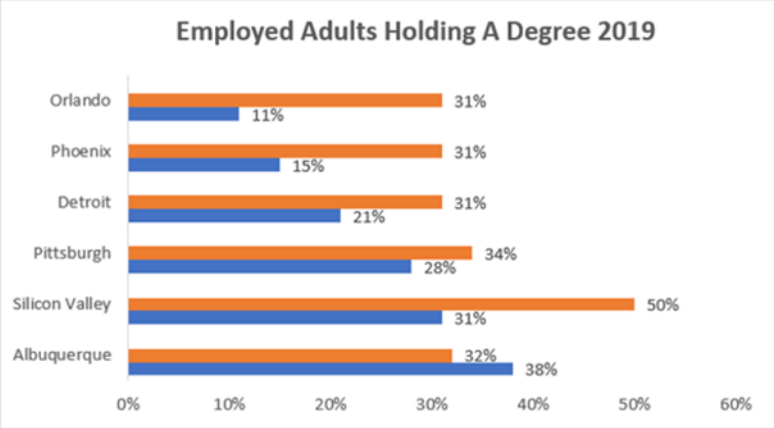


The NAICS code for Professional, Scientific and Technical Services is 54 and includes Computer Systems Design and Related Services. This encompasses programming, software design, computer systems design, and data-processing facilities, among several others. In reviewing the workforce composition for these sectors, Silicon Valley once again dominates the regions, but there is strong legacy investment and workforce base in New Mexico in electronics manufacturing as well as R&D which positions Albuquerque well to compete for component manufacturing for the mobility industry such as radar, lasers, lidar, and other sensors.

Education

As mobility technologies advance, the need for highly skilled individuals becomes critical in the industry. Until about 7 years ago the breakthroughs and advances in AV technology were spawned in the universities. However, as the industry began to grow rapidly, the private sector felt stymied by the red tape at the universities and their inability to respond rapidly to vital research opportunities. OEMs and technology companies began to develop their own R&D units and began to rely less on the universities. Their competitive advantage depended on their ability to rapidly move new technologies from the labs to the test facilities. Obviously, there continue to be many collaborations and joint projects between the industry and universities but because of the rapidly changing technologies, research is now done in-house as well.

To be competitive for investment from the AV industry, a region's educational strengths and diversity of offerings are important factors. The ability to attract highly skilled individuals is a critical element to an AV company's success. The attraction and retention of world class talent exerts a tremendous influence over the performance of the AV operations.



Source: National Science Board, National Science Foundation 2019
Employed Adults Holding an Advanced Degree in Engineering and Science-Related Degrees as a % of population
Employed Adults Completing a bachelor's degree as a % of Population

Universities - All six of the regions that are competitive for mobility technology investment have highly ranked universities. Silicon Valley has 21 universities that offer mobility-related programs. This region is home to Stanford University, one of the institutions at the forefront of automated vehicle development. Stanford has formal research partnerships with Toyota and Volkswagen and in 2005, a team led by Stanford's Artificial Intelligence Laboratory (SAIL) won the DARPA Grand Challenge. The DARPA Grand Challenge is a prize competition for American autonomous vehicles, funded by the Defense Advanced Research Projects Agency, the most prominent research organization of the United States Department of Defense. Another key university is University of California - Berkeley, which is home to eight research institutes in the fields of transportation and engineering. UCB's institutes tackle the technology, human factors, and policy angles of AV development. The majority of programs offered at Silicon Valley-area universities are in engineering, math, and IT/data. In addition, the region hosts significant programs in electrical engineering, computer systems engineering, robotics engineering, information technology, and big data analytics.

The Detroit region has 20 universities, with the University of Michigan in Ann Arbor as the leading institution in academic AV research. Its Transportation Research Institute (UMTRI) has been a key partner with industry several pilot development deployment programs. The UM Mobility Transformation Center (MTC), a partnership with several private companies, supports AV R&D and manages the MCity test bed. The University of Michigan also has a close research partnership with the Toyota Research Institute (TRI). Other Detroit area universities offer a large number of engineering programs including computer, industrial, manufacturing, software, and systems.

In the Pittsburgh area, sixteen universities have programs related to mobility technology. The Pittsburgh region is best known for Carnegie Mellon University (CMU), which has been contributing to AV technology development for the last 30 years through several research labs including the National Robotics Engineering Center (NREC). CMU is considered the birthplace of AV technology. The CMU Robotics Institute is home to the General Motors-Carnegie Mellon Autonomous Driving Collaborative Research Lab. In 2019, CMU and Argo AI announced a five-year, $15M sponsored research partnership. Argo AI and CMU will establish the Carnegie Mellon University Argo

AI Center for Autonomous Vehicle Research, which will pursue advanced research projects to help overcome hurdles to enabling self-driving vehicles to operate in a wide variety of real-world conditions, such as winter weather or construction zones. Overall, the Pittsburgh region has several universities that offer programs related to IT/data, cybersecurity, and software/design, information systems, cyber forensics and information security, coding, and software development.

Arizona State University (ASU) and Central Florida University (CFU)are two of the largest higher education institutions in the country and through their centers of excellence and institutes offer a full array of programs that support the mobility industry. Both institutions are involved in their respective state's mobility strategy. ASU is involved in the Arizona Institute of Automated Mobility, a team that bridges government, innovating companies, and higher education institutions to facilitate the safe development of mobility technologies and UCF is involved with the Central Florida AV partnership.

The University of New Mexico (UNM) is enhanced by the presence of and collaboration with the national labs in New Mexico. Sandia and Los Alamos labs have established relationships with UNM as well as New Mexico State University and New Mexico Tech all of which produce world-class joint R&D in focus areas, educate next-generation employees and help build national visibility for the universities.

Community Colleges - Community Colleges are another important component of the educational foundation for AV companies. STEM skillsets are the most challenging to find and the community college systems can nurture and develop the skills to make a student more prepared to enter a university. Over 76 community colleges with AV-related programs were analyzed across the six regions. The programs reviewed included computer science, cybersecurity, engineering, IT/data, math software/design, and automotive.

Silicon Valley leads in the number of programs offered with the largest number of offerings in automotive, IT/data, and software/design categories. Examples of programs include automotive technology (engine performance, chassis technology, drivetrain technology, and electronics), computer information systems, and computer programming. Obviously both Detroit and Pittsburgh have many engineering programs based upon their strong legacy in manufacturing, but they are weaker in computer science, cybersecurity, IT/data, and software/design. In discussions with community colleges in Florida, Arizona and New Mexico, all three states are offering training programs in cyber-security and Arizona is offering autonomous truck operations. At the present time there is not sufficient demand in the community colleges to provide more mobility specific programs, but the institutions are very confident that as more auto tech companies begin to do business in their regions, they have the ability to very quickly ramp up course offerings.

Skill/Trade/Technical Schools - There are numerous trade and technical schools located in all six regions, and these schools provide basic programs related to the foundations of AV technology. The graduates of these programs are job ready upon graduation and can immediately fill technician positions.

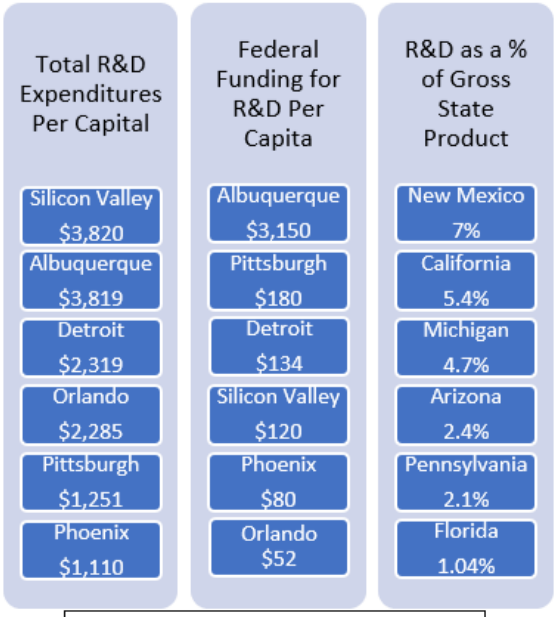
Pittsburgh and Detroit have the highest number of skill trade/technical schools, but the other regions have very comparable offerings. More than half of the programs in Detroit technical schools are in automotive-related programs while Silicon Valley's trade and technical schools lead in program offerings in computer science, cybersecurity, IT/data and software/design. Some frequent programs across most of the regions are computer networking and information systems security,

information technology, some form of engineering (computer, electronics, mechatronics, industrial, and systems), and computer aided drafting. Programs like mechatronics (which blends electrical and mechanical engineering), give students an opportunity to repair and perform maintenance on computer operated machinery and other autonomous systems that will soon be very commonplace.

Investments

Comparing R&D expenditures and venture capital investment in the six regions helps to understand each region's future growth potential, the start-up viability for innovative and new companies in the mobility sector and an overall indication of the understanding and acceptance of R&D as a major component of a growth economy. This includes corporate, university, state, local and federal expenditures.

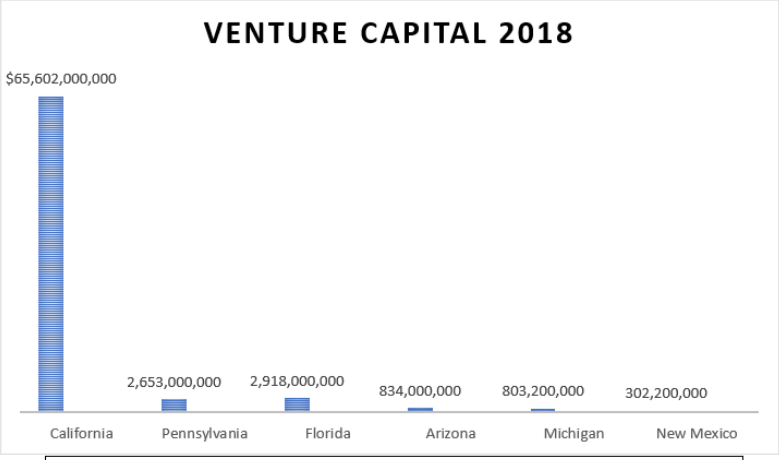
Albuquerque and Silicon Valley are virtually tied for total R&D expenditures per capita but Albuquerque far exceeds the Silicon Valley in Federal R&D funding per capita. Albuquerque's economy is based upon R&D expenditures by both the government and the private sector. By far the largest investment comes from the government but that investment is spread through government facilities and research programs awarded to the private sector operating in Albuquerque. R&D plays a much larger role in the Albuquerque/New Mexico economy than the other competitive regions.



Source: National Science Foundation, 2018

Venture Capital

Venture capital (VC) is often an important source of funding for AV start-ups and small companies that do not have access to equities markets. The chart below displays VC funding at the State level, and Silicon Valley companies by far attract the most venture capital investments across all six regions. In 2018, California firms attracted $65B in VC funding, whereas firms from Pennsylvania received $2.6B, Florida start-ups received $2.9B, businesses in Arizona received $835M, firms in Michigan brought in $803M and New Mexico companies ranked last, receiving only $303M in VC funding in 2018.



Sources: Venture Deal 2018; National Venture Capital Association 2018; National Science Foundation

Legal and Regulatory Framework

Regional and state laws surrounding AVs vary considerably across the six regions studied. California was the leader in implementing regulation but has been more restrictive than the rest of the country in their regulations. On the other hand, Arizona has been one of the most permissive. Regulation will play a major role where companies choose to test and develop their technology and thus will impact where the subsequent spin-off projects such as component manufacturing, office and programming hubs, AV depots, etc. are located. Burdens that can seem mundane — such as the placement, height, and appearance of cell towers or 5G nodes, or excess fees for placement of fiber cables — can have a substantial effect against implementation. New Mexico trails its competitors at this time but has an opportunity to put in place a competitive regulatory package which can position the state for large investments and new jobs from the mobility industry.

Arizona - Arizona has one of the most permissive AV frameworks in the country, thanks to a series of executive orders signed by Gov. Doug Ducey. Automakers need only to notify the Arizona Department of Transportation before testing, if their vehicles comply with state and federal laws governing motor vehicles. The welcoming nature of Arizona's regulatory structure has solidified its standing as a hotbed of AV innovation. Waymo has been testing in the state for years and just recently trialed its "Waymo One" robo-taxi service in the Phoenix area. The company plans to expand the service through a partnership with ridesharing company Lyft in the next several months.

California - California has taken a comprehensive approach to regulating autonomous vehicles, enacting several laws that lay out procedures for the testing and deployment of driverless cars. The state recently expanded its program from requiring backup drivers in all test vehicles to also allowing self-driving car tests without backup drivers. Operators must meet specific requirements and go through a DMV-administered application process. However onerous the burden, these regulations have not deterred AV companies, many of whom have a physical presence in Silicon Valley, from testing in the state. Over 60 companies currently hold permits to test in California, and several plan to introduce robo-taxi services in the coming year.

Florida - In June 2019, Florida passed House Bill 311 to further relax its autonomous vehicle regulations. Under the new law, any driverless vehicle can operate in the state if it can comply with existing state and federal laws and has liability insurance of $1M. San Francisco-based Starsky Robotics was among the first companies to take advantage, and in June 2019 tested a fully unmanned truck on a nine-mile stretch of the Florida Turnpike. Unfortunately, Starsky was unsuccessful in raising funds and has dissolved the company and sold its technology. The company had planned to use autonomous technology to operate its trucks on Florida highways, relying on remote operators in Jacksonville center to guide the trucks from the beginning to the end of their journey. Florida has made inroads in other segments of the AV industry with microelectronics company BRIDG, the State-developed AV-testing track Suntrax and LiDAR manufacturer Luminar all announcing plans to conduct operations in the state.

LUMINAR

Michigan - As the home of the nation's auto manufacturing industry, it's no surprise that Michigan is one of the nation's AV testing hubs. In 2016, the state approved legislation allowing for testing, provided the vehicle is operated by an employee of the manufacturer or a university researcher. Vehicles must operate within predetermined geographic areas and be equipped with crash notification technology. Waymo recently announced plans to locate the nation's first factory dedicated to the manufacture of autonomous vehicles in Detroit. The state is also home

M city
UNIVERSITY OF MICHIGAN

to several large testing facilities including the University of Michigan-owned MCity, a 32-acre mock city and proving ground built for the testing of driverless cars that contains over four miles of roadway fitted out with connected-vehicle infrastructure.

Pennsylvania - Pennsylvania law does not explicitly regulate autonomous vehicle testing, but the state Department of Transportation has created a voluntary registration process. Pittsburgh, due to friendly regulatory climate and local government incentives, has become a hotbed of AV testing. Currently Aptiv, Argo AI, Aurora Innovation and Uber are testing in the city, and Argo recently announced a five-year, $15M research partnership with Carnegie Mellon University to develop autonomous technology.

New Mexico - New Mexico currently has no rules or regulations governing the use of autonomous vehicles for use on New Mexico roads or highways. However, there has been interest in the industry for the past two years. In 2018, the New Mexico Department of Transportation was directed by the legislature to convene an Autonomous Vehicle Committee for the purpose of reviewing the AV industry and developing a series of recommendations for the deployment of the industry in New Mexico. The Committee, composed of relevant state agencies, completed the review and submitted the report to the legislature. Based upon this work, a bill was introduced in the 2019 legislative session, but it died on the floor.

Competitiveness Conclusions

There are two major centers of excellence in the US auto industry, Detroit and the Silicon Valley. Detroit represents the traditional deep auto manufacturing experience while the Silicon Valley represents software and the new frontier of the auto industry. Neither of these regions is going to abdicate its role in the industry, but as autonomy becomes more mainstream, the industry will develop new supply chains based on the new vehicle technology and will expand into geographical areas that have never been considered competitive for the auto industry.

Most auto tech companies based in California are not thinking about moving their headquarters out of California, but they are considering other regions for future growth and expansion. Silicon Valley's cost of living and general business costs are some of the highest in the nation; but what California companies would really like is a location near California but not in California.

In looking for that new location, mobility tech companies are looking for a state that has embraced regulatory policies that allow for the broad utilization of autonomous technologies on its public highways and has not put in place burdensome barriers or taxes. They are looking for a state that is investing in infrastructure that will help facilitate interconnectedness and finally they are looking for a location in a state or community where testing and implementation are widely accepted and supported by the public. They are looking for regions that have a history in electronics manufacturing and an understanding and experience in R&D environments and can supply a highly skilled technology workforce both at the professional and technician level.

All the variables considered in the competitiveness assessment point out, that despite its size relative to the leading mobility technology centers in the country, New Mexico has the attributes to support the mobility technology industry.

- More scientific and technical workers per capita than any other state in the nation
- Strong pool of software and programming talent
- A history of electronics manufacturing supported by a skilled workforce
- Good airport connections
- A deep R&D and innovation culture

- Extremely high levels of R&D investment
- A competitive business climate
- A western US location offering connectivity to the Silicon Valley
- A supportive education system
- Excellent supply chain multi-modal connectivity through rail, road and air

New Mexico's specific competitive niches are:

1. **Product Testing and Development** – On and off-road testing and development programs for connected and autonomous vehicles, trucks


2. **Applied Product Research** - Applied research facilities in conjunction with the testing and development programs


3. **Small and Mid-Scale Production Facilities** – Electronic components, optical systems, sensors, powertrain components, and energy storage systems


4. **Logistics** – Automotive supply chain facilities for product inventory and transportation to onward supply chain points


NM Mobility Product

In order to harness the advantages of doing business in New Mexico and deliver a product of value to industry, the State and its partners will need to develop and deliver a product that uniquely stands out versus the competition. New Mexico must create an especially compelling business proposition that meets the needs of industry in a manner that is different, better and more durable than its competition.

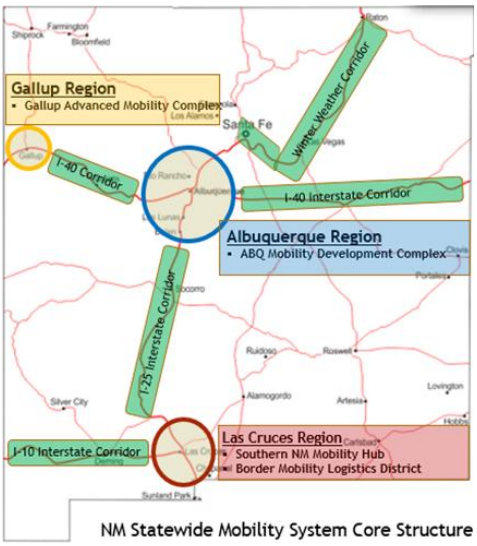
Snapshot: New Mexico Business Proposition

Product Name:	New Mexico Mobility Laboratory
Assumptions:	The automotive industry is undergoing the most significant metamorphosis in its history with a dramatic shift to a complex technology platform. This rapid evolution is producing a period of high intensity product development and creating a fully new paradigm for the sector's end-to-end supply chain. This new reliance on technology research and product development has produced opportunities for places that support the sector's various requirements related to testing, validation and certification, and offer a system policy framework where they can bring new products to life. The key assumption is that companies will likely collocate research and development and some production near to each other and in places that produce a valuable research product.
Concept:	Integrated statewide mobility product offered to automotive OEMs and technology companies to support their testing and product development requirements; with ultimate objective to position New Mexico to become a center for the emerging automotive technology sector, ultimately for production and supply chain investments
Oversight & Management:	Purpose-created entity with Statewide responsibility; skills in the technology/mobility space, formed as a partnership with participating local governments
Business Market:	Manufacturers and licensing developers including OEMs, technology suppliers in autonomy, propulsion, connected vehicles technologies; including component manufacturers, whole-product manufacturers and business model product delivery agents
Business Markets:	Silicon Valley, Michigan, Japan, Korea, China, Germany

NM Mobility Laboratory Components:

The full NM Mobility Laboratory would be comprised of a system of assets that would be variably valuable for companies that are involved in the development of core technology and applied products for the wide mobility industry. The main components of the Laboratory are:

- On and off public road testing – closed-course and public road environments
- Changes to regulatory regulations, one-stop system for multiple road environments
- Dedicated expertise for supporting testing, development and certification
- Special incentives for in-State investments and research presence



NM Statewide Mobility System Core Structure

Capital Investment: Overall investment is broadly estimated at $40-50M. Capital costs would be largely borne by the State, supplemented by funding from local government partners. Private investment will follow public investment for key aspects of the project. Through the Sunport, the City of Albuquerque has committed $5M to this project.

Operating Budget: Managed by the operating entity as a self-sufficient, all operating costs will be borne by revenues generated

Expected Outcomes: At outset – national standing, global recognition; companies testing

2-3 years – establishment of corporate research offices/labs, expanded testing client base (15 companies +/-)

3-10 years – expansion of the number of research facilities, further expansion of testing client base (30 companies +/-); first production facility investments and supply chain logistics investments

<u>NM Mobility Authority</u>

A joint venture should be created to include State, local government partners and automotive/technology industry partners to operate NM Mobility Laboratory. The entity will have the following functions as a central manager for: 1) technology companies and OEMs that are considering testing-development-project investment in New Mexico, 2) define necessary State policy changes and/or investments, 3) develop and operate closed-course testing and development facilities and terminus hubs, 4) develop common product testing zone plan with local government partners, 5) ongoing coordination with local government partners regarding on-road testing zones, 6) develop investment plan and partnerships for missing key telecommunications infrastructure, 7) develop, manage corporate relationships and support marketing for mobility production and supply chain investment. The structure for this Authority should be enabled to plan, develop, finance and operate specialized assets. These assets would operate on a self-sustaining basis by generating private revenues, and careful management of operating expenses.

<u>System of Highway Corridors</u>

State's extensive Interstate Highway system utilized for long-haul, high-speed car and heavy truck testing.

<u>Winter Weather Corridor</u>

Interstate corridor for cold weather conditions/wet surface testing environment.

Albuquerque Mobility Hub

Characteristics: This would be the anchor to the Statewide product offer and function as the main hub. The Albuquerque Mobility Hub would offer the following:

- Access to a complex public road system in a large-sized urban region road system; including a downtown grid, international airport and university district
- Urban transit and transportation routes for senior centers, libraries, local government services centers, passenger rail access points and the Sunport
- Direct urban and extra-urban access to the East-West I-40 transcontinental highway tier and connectivity to Arizona and Texas
- Direct urban and extra-urban access to the North-South I-25 interstate highway and connectivity to Colorado, Texas and Mexico
- A 100-acre purpose-designed closed-course testing complex providing a secure environment and use of customized multi-zone testing and development zones, buildings for onsite product development and collaboration space with federal labs, other companies and universities, secure and high-capacity uplink data transmission infrastructure
- Terminus depot for highway testing
- Albuquerque Mobility Investment District sites for supporting investment in R&D, production and logistics

Albuquerque Mobility Hub Characteristics

City Elevation:	5194‘
Elevation Variation Within 2 Mi:	236’
Elevation Variation Within 10 Mi:	2106’

Temperature

- Coldest: 49/25 F January
- Warmest: 93/66 F July

Wet Weather

- Annual Rainfall: 9”
- Annual Rainfall Days: 61
- Annual Snowfall: 10”
- Annual Snow Days: 10
- Wettest Month: August – 9 Rainfall Days

Sunshine

- Annual Sunshine Days: 310
- Longest Day: 14.5 hours June
- Shortest Day: 9.8 hours December

Gallup Mobility Hub

Characteristics: The Gallup Mobility Hub would provide a specialty product for the New Mexico Mobility Laboratory, providing the following:

- Access to a modest public road system in a small-sized rural urban/region road system
- Direct access to the East-West I-40 transcontinental highway tier and connectivity to Arizona and Texas
- Near access to New Mexico/Arizona border and easy testing in both states
- Terminus depot for I-40 ABQ-Gallup highway testing and for long-run rural route testing
- Secure and high-capacity uplink data transmission infrastructure
- Testing and product proofing cargo mobility zone at Energy Park and Inland Port
- Gallup Cargo and Mobility Investment District sites for supporting investment in R&D, production and logistics

Gallup Mobility Hub Characteristics

City Elevation: 6467’

Elevation Variation Within 2 Mi: 492’

Elevation Variation Within 10 Mi: 1549’

Temperature

- Coldest: 44/17 F January
- Warmest: 88/58 F July

Wet Weather

- Annual Rainfall: 12”
- Annual Rainfall Days: 71
- Annual Snowfall: 34”
- Annual Snow Days: 23
- Wettest Month: August – 10 Rainfall Days

Sunshine

- Annual Sunshine Days:
- Longest Day: 14.5 hours June
- Shortest Day: 9.8 hours December

Southern New Mexico Mobility Hub

Characteristics: The Southern New Mexico Mobility Hub delivers a critical asset for the overall system. The Southern New Mexico Mobility Hub would offer the following:

- Access to a complex public road system in a medium-sized urban/rural region road system; including a downtown grid and university district
- Urban transit and transportation routes for senior centers, libraries, local government services centers and the University
- Direct urban and extra-urban access to the East-West I-10 transcontinental highway tier and connectivity to Texas
- Direct urban and extra-urban access to the North-South I-25 interstate highway and connectivity to Colorado, Texas and Mexico
- Specialty Center: Automated Cargo Handling/International Border
    - 30-acre purpose-designed closed-course New Mexico Cargo Handling Automation Testing Complex at Dona Ana County Airport/UPRR Rail Intermodal facility
    - Border Mobility Test Corridor for cargo transportation from border to nearby warehouse facilities and to Airport/Intermodal
- Secure and high-capacity uplink data transmission infrastructure
- Terminus depot for highway testing
- Southern New Mexico Mobility Investment District sites for supporting investment in R&D, production and logistics

Southern NM Mobility Hub Mobility Hub Characteristics

City Elevation:	3904’
Elevation Variation Within 2 Mi:	272’
Elevation Variation Within 10 Mi:	1903’

Temperature

- Coldest: 58/29 F January/December
- Warmest: 95/68 F July

Wet Weather

- Annual Rainfall: 10”
- Annual Rainfall Days: 52
- Annual Snowfall: 2”
- Annual Snow Days: 10
- Wettest Month: August - 9 Rainfall Days

Sunshine

- Annual Sunshine Days: 310
- Longest Day: 14.2 hours June
- Shortest Day: 10.0 hours December

Market Reaction

This project surveyed a range of businesses that are involved in making vehicles and producing technological components involved in the mobility sector. Including the interaction with the New Mexico Mobility Advisory Committee, the range of companies involved included companies involved in research and manufacturing of automobiles and trucks, sensors, computational processing, optical systems, energy storage electronics, electronics control modules, etc. Companies were located in the US, Europe and Asia, in the US they were largely centered in Silicon Valley and Michigan.

Conversations were held with the promise of confidentiality. This sector operates in an enormously competitive environment. Most companies will not typically share the kind of information that was discussed out of concern about revealing business strategy to the competition.

> "We struggle to find environments to develop our products, it's a major problem"

Companies were queried about their products, technology and business plans, their testing and product development strategy and requirements and the relationship between research, field testing, product refinement. We also reviewed larger corporate planning and the expectations for new product manufacturing.

Overall, in the context of this project the main reactions were these:

- Most companies described a current need for testing facilities and also expectations for needing access to testing facilities for at least 10-15 years.
- Companies talked about a clear need for purpose-built testing infrastructure – currently they simply make-do with using parking lots and other paved surfaces, this being described as fully insufficient for their needs
- To the extent that some companies were conducting tests on public roads, all talked about an imperfect and highly inefficient situation where they were forced to search for the right match for city environment, secure interest and support, and navigate a myriad of constantly changing permitting and operating regulations. In these cases, all of the companies indicated that a one-stop strategy offering a multi-environment product and clear regulations/requirements would be particularly valuable

> "Our world is evolving so quickly, we need to move between research lab and field testing at a frenetic pace"

- Most companies saw a whole-state proposition as unique and of value to a cohort of companies and indicated that they know of nothing similar
- Truck development companies reacted with special interests; open highway, inland port, border and routes to/from Texas and Arizona
- An off-public road closed-course setting was seen as fundamental to the proposition; most participants talked about the need for privacy, special infrastructure design, technical support services, facilities for development, storage and data transmission

> "It's critical for us to work with governments that *get it*"

- Most talked about expectations for clear regulation, and light requirements for reporting, acknowledge need to permit and disclose testing
- Depending on the person and their corporate role, there was some belief that establishing foundational R&D will relate to company requirements for product development and production in some instances
- Some companies were interested in the opportunity to collaborate with the federal government and laboratories

- Overall, the main concerns that most companies talked about were: the distance from Silicon Valley Los Angeles, Detroit and New York (and good connections to Japan, Korea, China, Germany) and the critical need for good business travel air connectivity from these locations to Albuquerque (and in some instances) El Paso
- Since New Mexico operation would require companies to plan multi-day testing to account for travel to site, some could envision placing permanent technical staff onsite to support continue research and testing
- Overall, it was gleaned that the overall value proposition is for multiple, packaged product including: predefined/agreed testing environments, customized closed course infrastructure, reasonable state regulations, agreements/environments in multiple local communities
- Most participants indicated that time is of the essence, as their need is current, but will require this kind of product to support research for many years

> Increasingly, we're finding talent acquisition to be a challenge in Silicon Valley – from both a cost and availability perspective"

Recommendations and Next Steps

Given the sector and technology review, competitiveness analytics, specific needs as indicated by companies, the following is recommended:

Declare New Mexico's Strategy to Develop as National Mobility Leader - Determine that New Mexico should make a determination that with care, it could assume a strong and long-lasting role in the burgeoning technology sectors involved mobility; this would involve the refinement of a clear regulatory structure, public investments in specialty infrastructure and structured use of a range of public roads.

- Issue Executive Order that:
    - Proclaims New Mexico's intentions to become a national leader in mobility with a focus on public safety, air quality improvements, and economic development
    - Calls for the Autonomous Vehicle Committee be reconstituted to consider regulatory actions

Create and Fund Mobility Investment Delivery Structure - Establish a specialized mobility delivery entity that is built around the needs the mobility technology industry. This would be in the form of a joint venture that would be created to include State, local government partners and automotive/technology industry partners to operate the NM Mobility Laboratory. The entity will have the following functions as a central manager for: 1) technology companies and OEMs that are considering testing-development-project investment in New Mexico, 2) define necessary State policy changes and/or investments, 3) develop and operate closed-course testing and development facilities and terminus hubs, 4) develop common product testing zone plan with local government partners, 5) ongoing coordination with local government partners regarding on-road testing zones, 6) develop investment plan and partnerships for missing key telecommunications infrastructure, 7) develop, manage corporate relationships and support marketing for mobility production and supply chain investment and 8) engage with telecom/fiber investors and providers for supporting the complete development of a statewide mobility communications system; pay specific attention to gaps in the current infrastructure.

The structure for this Authority should be enabled to plan, develop, finance and operate specialized assets. These assets would operate on a self-sustaining basis by generating private revenues, and careful management of operating expenses.

The capital costs are expected to be approximately $50M for the development of infrastructure assets for testing, telecommunications, cargo handling projects, roadway, smart signals, uplink broadband, sensor/system installation and fueling/charging infrastructure. Further analysis will be necessary to ascertain the final costs. This investment can be phased if required over a 2-to-3 year period. Short-term improvements and small infrastructure projects such as signage, painting/striping, minor road improvements can be specified and undertaken in the near-term.

New Mexico Regulatory Action - By the actions of the Autonomous Vehicle Committee, establish a program for the testing and development of automated vehicle technologies on public roads within the State of New Mexico to be administered by the New Mexico Department of Taxation and Revenue's Division of Motor Vehicles The intent of this process is to create a collaborative, constructive, and expedient pathway for the testing of automated vehicles in New Mexico while maintaining a safe environment for all who use New Mexico's transportation systems and facilities.

Mobility Investment Infrastructure – Develop hubs for mobility technology investment and support with highly targeted incentives to support economic development versus key competition

- With local government and private investment partners, plan and develop mobility investment sites near to testing hubs to support permanent R&D centers, production and supply chain investment
- Develop applied incentives to support private production investment; some examples:
    - In-state tuition at any New Mexico public higher educational institution to all employees and their families of companies that establish an autonomous vehicle testing and development program at one of the locations of the New Mexico Mobility Laboratory
    - Sales tax exemption for 5 years on equipment and materials used in a research and development operation connected with the testing and development of mobility technologies through the New Mexico Mobility Laboratory
    - Transferable tax credit available to New Mexico VCs making debt or equity capital investments in start-up or young, developing companies testing mobility technologies in New Mexico. The tax credit could be equivalent to 20% of the qualifying investment and carried forward for 5 years.
    - A discretionary grant could be made available to mobility companies that make investments in facilities for research and development, production and assembly, or supply chain management. The grant could provide funding for a portion of the costs related to the development of the facility over 5 years if it is located in one of the New Mexico Mobility Laboratory hub region and if there is appropriate levels of job creation.
    - A special discretionary grant could be offered for mobility companies that undertake crossover technology investment - from ground mobility to aerospace mobility for investments in research and development, production, assembly or supply chain management.

Binational Mobility Zone - Coordinate with Mexican government and State of Chihuahua regarding integrated auto supply chain proposition

- For more targeted investment attraction; specifically, for technology parts and components production, whole-vehicle assembly, logistics
- Explore a joint program for truck/cross border mobility technology testing in both US and Mexico

Develop and Create Specialized National Hub for Aerospace/Ground Mobility – Partner with the Air Force Research Laboratory through their Hyperspace Challenge initiative to pursue investments from

companies with technology and corporate interest to bridge wheeled mobility and aerospace mobility applications.

Strengthen the Automotive Technology-Related Academic Offer – The ability to attract highly skilled individuals is a critical element to a mobility company's success. The attraction and retention of world class talent exerts a tremendous influence over the performance of their operations. Mobility companies judge a region on their skills and educational offering and their commitment and investment in workforce development. New Mexico's continued commitment to the education and workforce development system is a major incentive in competing for a mobility company's investment As New Mexico initiates a mobility strategy, educational institutions at all levels at all levels will need to develop a solid partnership between industry and academia to develop a strength in designing academic programs that meet industry needs. Training and education for the AV industry intersects between math, mechanical engineering and electrical engineering. Educators will need to ensure that curricula are current, and that students are informed about the latest technology developments. The New Mexico Higher Education Department should offer support to the community colleges to be sure that their programs are aligned with industry and to develop programs for computer science, cybersecurity, information technology (IT)/data management, software/design, which are currently disciplines that do not have sufficient offerings. Support should also be offered to K-8th grade students, especially in supporting science, technology, engineering and mathematics (STEM) programs.

Improve Business Travel Connectivity to Important Domestic & Global Automotive Technology Hubs – Develop increased commercial passenger air service to key research and supply chain centers in Silicon Valley, Los Angeles, Detroit and New York, and then for efficient onward connections to Japan, South Korea, China, Taiwan, UK, Germany and France. For domestic service, it is highly important to have a diversity of air service options, with a preference for early morning, early afternoon and early evening flights (depending on destination).

Make Direct Connections to Support Increased Venture Capital Investment - Silicon Valley, New Mexico's prime competitor in the autonomous vehicle space, greatly outpaces all five regions in venture capital (VC) investments. One obvious reason for this disparity is that the New Mexico VC firms maybe unaware of the growing potential for the industry and/or they have not seen opportunities develop in New Mexico. There needs to be a marketing/education effort aimed toward the New Mexico VC so that they can understand the state's strategy in attracting mobility technology companies to test and develop in the state and then ultimately produce products. New Mexico has a very high commercialization gap, or the difference between R&D dollars spent and VC investment. Perhaps, this can actually be a positive attribute when it comes to attracting VC to this industry, as it represents untapped investment opportunities. Autonomy in New Mexico needs to be marketed among VC circles.

Create a National Epicenter for Emerging Mobility Technology Companies – Establish New Mexico as a setting that caters to the growth of small technology companies in the mobility sector.

- Create and support specific program collaboration between federal laboratories and technology small business (e.g. AFRL's Hyperspace Challenge)
- Offer small businesses direct support in understanding the public sector market, purchasing products to showcase to other local/state governments, provide procurement guidance
- Match out-of-state entrepreneurs to venture financing
- Develop collaboration with larger partner companies already involved in the NM Mobility Laboratory