5. Emerging Service & Technology Enhancements

As transportation modes and future means of travel change, six topic areas associated with travel and emerging technology have been identified by the CCMPO as having particular importance in Centre County:

- Transportation Network Companies
- Park-and-Ride
- Electric Vehicles and Bicycles
- Connected and Automated Vehicles
- Bus Rapid Transit
- First-Mile/Last-Mile Mobility

In order to establish a foundation for expanding the discussion of these six topics and inform the LRTP Action Plan, narrative has been prepared for each topic area, comprised of the following subsections:

- Introduction
- State of the Practice
- First Applications in Centre County
- Actions and Planning Implications for Centre County
- Potential Future Developments

Transportation Network Companies

A transportation network company (TNC) matches potential passengers with potential drivers and vehicles, primarily via applications on smart phones and other mobile devices. They are, in part, noteworthy for charging a generally lower per-trip rate than taxi companies. These per-trip rates, however, often fluctuate according to supply and demand—a concept referred to as dynamic or "surge" pricing. Within the United States, the two predominant TNCs are Uber and Lyft, though several smaller and/or regional firms are also in operation, including Fasten, InDriver, Juno, Summon, Via, and Wingz. The TNC concept has also given rise to food and other delivery services to link consumers with business not typically offering direct delivery.

State of the Practice

Proliferation of TNCs is largely a phenomenon of the last decade. Uber—the largest TNC in the U.S. with 69 percent of the market share—was founded in 2009, test-launched in 2010, and officially launched in 2011 in San Francisco. Lyft—the second-largest TNC in the nation with 28 percent of the market share— was officially launched in 2012, superseding a college campus ridesharing service (Zimride) founded at Cornell University in 2009.

In July 2014, after imposing fines on Uber and Lyft, the Pennsylvania Public Utility Commission (PUC) imposed a cease-and-desist order on the companies. Later that year, both Uber and Lyft were granted a two-year experimental license to operate in Pittsburgh, which is home to Uber's Advanced Technology Group (ATG). In November 2016, Pennsylvania Governor Tom Wolf signed Senate Bill 924 (Act 164), which provided statewide authorization for TNCs to operate in all areas, including Philadelphia.

TNC utilization has grown rapidly. As of 2018, Uber completed its 10-billionth trip (including UberEATS deliveries), while that same year, Lyft provided its one-billionth trip. Currently, Uber

provides about 14 million trips per day in 700+ cities, with international markets showing some of the highest growth. Obtaining area-specific data on TNC utilization can present a challenge, as this level of detail does not seem to be made widely available—TNCs seem to know the inherent value of the data they are collecting and hold it tightly, making it available only in larger markets to selected partners.

According to Uber, riders tend to be:

- Split fairly evenly between male (52 percent) and female (48 percent);
- Mostly middle-income (44 percent of riders are within the middle 50 percent of income);
- Younger (65 percent of riders are between the ages of 16 and 34); and
- Overwhelmingly (94 percent) urban and suburban dwellers.

Some noted advantages of TNC service include: potential wider availability than traditional taxi services, greater flexibility than traditional transit services, competitive pricing, and ability to rate both drivers and passengers. Noted disadvantages include: "surge pricing," which can greatly increase rates during busy periods, potential trip cancellations by drivers, safety concerns, vehicle accessibility, uncertain long-term financial sustainability, and impacts of price competition on other modes and providers.

First Applications in Centre County

Preceding the implementation of Act 164, Uber launched service in State College and the surrounding region in February 2015, after securing a two-year experimental agreement from the Pennsylvania PUC. To introduce potential customers to the service and build a base of consumers, Uber employed extensive marketing and promotional activities, and provided up to two free trips to any rider who tried the service within the first two weeks. Lyft followed suit by entering the State College market in September 2016, again to great reception. To promote its services, Lyft enabled a code that allowed new riders to receive $5 off their first trip.

Both Uber and Lyft appear to cover most of Centre County (and some additional territory outside the county), as part of what it deems the State College market. For example, Lyft serves a local area roughly bounded by Clearfield, Orviston, Mifflintown, and Mount Union. Eastern portions of the Penns Valley, however, appear to lie outside of the market area.

None of the other smaller TNCs appear to be operating within Centre County at the present time, although Uber introduced its food delivery service, UberEATS, in October 2017 to compete with other similar entities such as DoorDash and GrubHub.

A significant proportion of local TNC trips seem to be taken to and from venues such as Beaver Stadium, the Bryce Jordan Center, and the Pegula Ice Arena for special events (particularly Penn State home football games). For these events, surge pricing goes into effect, and TNC drivers report a higher level of activity and earnings. Accordingly, Uber entered into a special four-year agreement with the Penn State University Athletics Department in April 2018. This agreement designates Uber as the official rideshare partner of Penn State Athletics, establishes special designated pick-up and drop-off areas near Beaver Stadium, and integrates these special areas into the Uber app to facilitate a more convenient rider experience. Penn State Athletics and Uber, as part of this agreement, have also agreed to engage in cross-promotion. It is not known what specific impacts this agreement has had on Lyft ridership during sporting and other special events.

Local data regarding TNC operations within Centre County is currently impossible to obtain beyond anecdotal reports. The Uber Movement Program promises anonymized speed and travel time data to facilitate transportation planning activities but makes no mention of providing access to volume of

trips, trip times of day, and other elements. Moreover, this program is currently only available in 11 larger U.S. cities: Boston, Cincinnati, Los Angeles, Miami, New York, Orlando, Pittsburgh, San Francisco, Seattle, Tampa, and Washington, DC. The CCMPO staff has submitted a formal request to Uber to include the State College area in the program but given the size of the metropolitan areas currently covered, it is unknown when – or even if – this request may be granted. Lyft currently has no known data offering similar to the Uber Movement Program.

Nevertheless, the continued operation of TNCs within Centre County—coupled with documented TNC growth worldwide—seem to suggest that these operations are enjoying some degree of success within the region over the last several years. Moreover, impacts have been observed with respect to other transportation modes and providers following the launch of Uber, and subsequently Lyft. Established taxi companies—at least one of which made a significant investment in ride scheduling and tracking technology with the impending launch of TNCs within the region—have ceased operations over the last several years. Though Handy Delivery, Inc. and Nittany Express remain in operation, AA Taxi and Happy Valley Ride have closed. The role of TNCs in the closure of these regional taxi services is supported by anecdotal reports of TNC-related traffic congestion at University Park Airport around flight arrival and departure times, where previously taxis were known to provide this service. On the other hand, these same anecdotal reports highlight an increased ease of obtaining transportation to and from the airport area.

In terms of public transportation, CATA has experienced some fixed-route ridership losses since Uber and Lyft entered the State College market in 2015 and 2016, respectively. During that time period, fixed-route ridership figures declined, as follows:

- Fiscal Year 2015-16 – 7,055,328
- Fiscal Year 2016-17 – 6,914,017
- Fiscal Year 2017-18 – 6,504,703
- Fiscal Year 2018-19 – 6,413,239

As of the time of this writing, CATA fixed-route ridership over the previous year has been 6,338,261. These ridership losses correlate with the launch of TNCs within the State College area, though no clear causal relationship can be established. This does not appear to be just a local phenomenon; declines in public transportation ridership nationwide, in a variety of markets, seem to correlate to TNC proliferation, lower fuel prices, more affordable vehicle loan credit, and several other factors combining.

Actions and Planning Implications for Centre County

Potential Increase in Traffic Congestion – Public transportation is a documented, contributing factor in reducing congestion within Centre County, particularly along the North Atherton Street corridor, in downtown State College, and on the campus of Penn State University. To the extent these high-concentration transit trips are replaced with lower-concentration TNC trips, regional congestion may worsen over time. Moreover, the act of TNC vehicles periodically stopping in travel lanes to board and de-board passengers may also have the effect of increasing congestion. This may change the relative priority of transportation projects in future LRTP and TIP cycles. It also may suggest the need for a higher degree of local regulation of TNC services.

Service to Rural Areas – Despite the suggestion of TNC service being a potential answer to low levels of mobility in rural and other less densely-populated areas, over time this has not proven to be the case. According to Uber's own generalized data, only 6 percent of ridership can be characterized as something other than "urban" or "suburban." Though this data is not locally specific, it seems to suggest that TNC-provided mobility in the more rural portions of Centre County

is still lacking. In these less densely populated areas, where automobile ownership and access to mobility options may lag behind the rest of Centre County, it may be incumbent upon policymakers and area transportation providers to come up with new and innovative solutions to meet critical demand.

Accessibility of Vehicles – One vital part of CATA's mission—and the mission of other public transportation providers throughout Pennsylvania and the U.S.—is to meet the transportation needs of persons with disabilities with accessible vehicles and specialized services. These service elements are guaranteed and protected under the Americans with Disabilities Act (ADA) of 1990. To the extent that TNCs can operate free of these "public accommodation" requirements, they are placed at a competitive advantage to traditional transit services. Moreover, as public transportation ridership decreases, and service may be decreased in correlation with TNC utilization, riders having a disability who may require an accessible vehicle or a special accommodation may be placed at a disadvantage that runs counter to the spirit of the ADA.

Availability of Data – As mentioned above, Centre County is not included in the Uber Movement Program, and Lyft has no similar program. Therefore, data related to TNC operation within Centre County is nearly impossible to obtain. If regional decision-makers are to be fully informed and make the best possible choices when it comes to transportation improvements, TNC companies should ideally provide localized information as it relates to origin and destination patterns, travel times, and volume. Similar types of data are already available to generate highway and public transportation performance measures for the benefit of the region.

Potential Future Developments

Additional Regulation at the Local Level – Both Uber and Lyft, as well as other TNCs, have a baseline set of standards for regulation of drivers and vehicles. Nevertheless, a number of well-publicized incidents have taken place in the United States relative to TNC drivers and major property and bodily injury crimes. A key element of TNC service is that it provides—or should theoretically provide—a safety element from impaired driving, public intoxication, and similar phenomena. In order to enhance these safety elements, while also providing protection to the individual patron, local jurisdictions may elect to further regulate TNC service within the bounds of state law. Moreover, additional local regulation may help to mitigate other concerns mentioned above, such as traffic congestion and availability of data.

Microtransit – CATA is current working to pilot test its own microtransit offering (**CATA**GO!) in cooperation with TransLoc. This offering serves the Bellefonte area and provide linkages to certain key destinations in the State College area. While not a TNC by definition, microtransit does borrow heavily from the TNC mode of operation, including flexibility and dynamic scheduling. These elements go beyond traditional fixed-route transit service. At the same time, microtransit provides for a predictable, stable fare to the end user. This eliminates the concern of surge pricing characteristic of TNCs. Should microtransit prove useful and successful within this experimental corridor, it may provide a competitive model that can be replicated in other portions of CATA's service area with low population density, or adjacent to the current service area. While microtransit will only be able to add vehicles into service up to fleet limits, however, pure TNCs can have potentially unlimited fleets.

Public Transportation Partnership – CATA's "Assessment of Alternative Service Models for Areas of Low Population Density" study, completed in 2018, suggested that a partnership between a transit agency and TNCs might be a workable mobility solution in areas where traditional fixed-route transit service is not operationally and/or economically viable. One possible solution would be for the transit agency to subsidize TNC trips where and when fixed-route transit service does not exist.

Though potentially of benefit to both a local transit agency (assuming a role as a mobility integrator) and the TNC companies, this solution would present a number of challenges, including appropriate limits on both the amount of the subsidy and the number of trips subsidized over a given time period, as well as providing a competitive total cost or fare to the user of the service.

Profitability of TNCs – At the current time, the two most widely-available TNCs—Uber and Lyft—are both publicly traded companies. As of May 2019, Uber is traded on the New York Stock Exchange (NYSE) under the symbol "UBER." As of March 1, 2020, Uber's stock was trading at roughly 74 percent of its initial public offering (IPO) price. As of March 2019, Lyft is traded on the NASDAQ stock exchange under the symbol "LYFT." As of March 1, 2020, Lyft's stock was trading at roughly 52 percent of its IPO price. Both companies have yet to turn an annual profit. Though numerous emerging companies have faced difficulties following an IPO, yet managed to turn toward profitability, the current financial condition of both Uber and Lyft does raise some concerns. As publicly traded entities, should either or both companies fail to achieve profitability, it might be reasonable to assume that shareholders could demand a restructuring of operations. In this event, if TNCs pull out of established markets, other existing providers could conceivably be left to fill a mobility void with limited resources.

Park-and-Ride

Park-and-ride facilities help to enable intermodal travel. They allow the use of a low-occupancy mode where travel densities are low, with a transfer to a high-occupancy mode—rail transit, bus, vanpool, or carpool—where travel densities become higher and more supportive of these modes. Worldwide, park-and-ride facilities range widely from multi-story parking garages with an array of customer amenities serving numerous modes, to simple surface parking areas that may not be formally designated as a park-and-ride.

State of the Practice

Based on data obtained from the Southwestern Pennsylvania Commission (SPC), Delaware Valley Regional Planning Commission (DVRPC), and Commuter Services of Pennsylvania, it is estimated that several hundred additional non-PennDOT park-and-ride facilities are owned, operated, and maintained by transit agencies and a variety of other public and private entities throughout Pennsylvania. New facilities are being planned, designed, constructed, and opened on a regular basis. Though most park-and-ride lot facilities throughout Pennsylvania do not charge for parking, some—particularly those located closer to congested and/or heavily urbanized areas—do assess a modest fee for daily use (usually $5 per day or less).

PennDOT owns, operates, and maintains 90 park-and-ride lot locations throughout the state. They range from very small (15-20 spaces) to very large (up to 1,600 spaces), with nearly all located near a major highway. Roughly one-third of these park-and-ride facilities provide access to transit services, with the remainder supporting other ridesharing activities.

Currently, no PennDOT park-and-ride facilities are operated within Engineering District 2, of which Centre County is a part. Longstanding policies at the District level present challenges to formal park-and-ride implementation. The District has historically declined to commit federal and state transportation funding for the purchase of park-and-ride right-of-way, and has not acquired it through condemnation; therefore, property must be acquired from a willing owner entirely using local funds, or through the process of amicable donation. Moreover, the District has historically declined to assume ownership and maintenance responsibilities of a park-and-ride facility; other entities must be identified to take ownership and maintain such facilities over the longer term.

First Applications in Centre County

Old Fort Park-and-Ride Lot – In 1996, a regional park-and-ride lot study identified the intersection of PA 45 and PA 144 as a high-priority location to help meet Penns Valley commuter demand. Between 1997 and 2002, an agreement was reached with the American Legion Post #779 in the village of Old Fort to utilize legion property at this location as a park-and-ride facility, through a proposed lease agreement with Potter Township. During this period, draft cooperation and lease agreements were prepared.

Between 2002 and 2010, cooperation and lease agreements were executed, and a design field view conducted. Preliminary design and cost estimates were completed, although these were subsequently revised to address flooding concerns. An archaeology survey report was submitted to the Pennsylvania Historical and Museum Commission (PHMC), from whom initial concurrence on mitigation measures was obtained. The Federal Highway Administration (FHWA) required an updated lease agreement, which was prepared and executed. Subdivision, land development, and stormwater management plans were submitted to Centre County.

In 2010, the subdivision and land development plans for the lot were approved by Centre County, and a highway occupancy permit (HOP) approved by PennDOT. PHMC, however, made a final determination that the facility would have adverse effects in the project area to culturally and historically significant features, which could not be mitigated. PHMC subsequently declined to reconsider this determination, and as a result, FHWA withheld environmental clearance for the project. In September 2010, the CCMPO Coordinating Committee agreed to select the "No-Build" alternative for the project, based upon the uncertainty of finding a suitable alternative site in the area, and scarcity of additional funds for engineering and construction.

Moshannon Valley Park-and-Ride Lot Study – In 2012, the CCMPO completed the Moshannon Valley Park-and-Ride Lot Study. Preceding this effort, the CCMPO found, through the Coordinated Public Transit – Human Services Transportation Planning process, that the Moshannon Valley was the most transportation-disadvantaged community in Centre County, particularly with respect to alternative modes of transportation. Moreover, staff confirmed that informal park-and-ride activity was taking place at several area locations—a practice that continues to this day.

The overarching purpose of the study was to examine area park-and-ride activity, identify and evaluate potential alternative sites, and attempt to formalize one or more locations in which to consolidate the activity. This was accomplished through stakeholder and public involvement processes, travel demand forecasting, drafting of need and purpose information, site identification and ranking, detailed site investigations, recommendations, and examination of potential funding opportunities.

Although the Cold Stream Dam and adjacent site were identified as supporting need and purpose and meeting demand—endorsed in principle by both Philipsburg Borough and Rush Township—and several potential sources of funding were identified by staff of both the CCMPO and North Central Rural Planning Organization (RPO), ultimately no agreement could be reached on long-term ownership and maintenance of a formal park-and-ride lot.

Actions and Planning Implications for Centre County

Need and Purpose – Based upon prior experiences with the proposed Old Fort Park-and-Ride Lot and the Moshannon Valley Park-and-Ride Lot Study, establishing a robust statement of need and purpose for any future park-and-ride lot development will be critical to funding competitiveness and operational success. The Moshannon Valley Park-and-Ride Lot Study process provides a tested

blueprint for establishing project need and purpose through assessment of current conditions, examination of commute patterns and volumes, and stakeholder and public involvement.

Site Selection – One primary deficiency in the Old Fort Park-and-Ride Lot project was the evaluation of alternative sites. The CCMPO staff worked with an amicable property owner and established arrangements for long-term property lease, construction, and maintenance with the appropriate parties, in a location with significant perceived need. The failure to evaluate alternative sites within the Penns Valley, however, proved detrimental when the selected site was found to have insurmountable historical and environmental impacts, and ultimately resulted in the termination of the project. Here again, the Moshannon Valley Park-and-Ride Lot Study provides a workable example for the identification, evaluation, and selection of sites through assessment of ownership, proximity to travel routes, space available, potential cost, and historical and environmental considerations.

Funding – A phase-out of the CCMPO's eligibility for funding under the Congestion Mitigation and Air Quality (CMAQ) program, based upon air-quality conformity status, places an additional pressure on identifying potential funding sources for the acquisition, construction, operation, and maintenance of park-and-ride lot facilities within the county. Going forward, such projects will face a higher level of competition and scrutiny when measured against other road, bridge, and transit fleet replacement and expansion projects as part of the LRTP and TIP processes. Further, a key consideration will be whether to assess user fees to help defray costs.

Ownership and Maintenance – As demonstrated through the Moshannon Valley Park-and-Ride Lot Study and subsequent actions taken, negotiating agreements for the long-term operations and maintenance of a park-and-ride lot facility can be a challenging process, given limited budgets and required financial and time commitments. Moreover, at the current time, PennDOT District 2 does not currently own, operate, or maintain any state-related park-and-ride facilities. Not only would a formal park-and-ride lot be the first of its kind in Centre County, the resulting operations and maintenance arrangements would be unfamiliar to the CCMPO, local government, and PennDOT staff. User fees could be considered to help defray longer-term costs. Liability concerns would need to be assigned to either lot owners and/or users.

Performance Metrics – As both federal and state governments continue to move toward performance-based planning and programming, both predicted (pre-construction) and actual (post-construction) measures of park-and-ride facility utilization, consistency of utilization, value of shared trips enabled, and the like will be useful in assessing the potential and tangible return on investment, as well as the competitiveness of park-and-ride lot projects when compared to other types of transportation projects.

Potential Future Developments

Moshannon Valley – A significant level of informal park-and-ride activity continues to be present at three key locations: Peebles Plaza, Cold Stream Dam, and the Philipsburg-Osceola high school football field. Moreover, CATA still reports a meaningful level of ridesharing participation from the Moshannon Valley. The potential to formalize park-and-ride activity within the area still exists. It would require updating the findings from the Moshannon Valley Park-and-Ride Lot Study, collaboration among local partners on the issues of long-term operations and maintenance, and securing funding for construction activities.

Nittany Valley – Funding was recently secured for the construction of the I-99 / I-80 / PA-26 high-speed and local access interchanges, which will provide a direct Interstate-to-Interstate connection between the Milesburg and Lamar exits of I-80. Construction is expected to begin in 2020 and take roughly two years. The potential may exist, either through a partnership with PennDOT or through

a public-private partnership, to construct a park-and-ride lot facility in the vicinity of the proposed local access interchange to serve long-distance commuters traveling to the State College area from the Lower Bald Eagle Valley, Mill Hall, Lock Haven, Jersey Shore, and Williamsport.

Penns Valley – Funding was also recently secured for the preliminary engineering phase of the State College Area Connector project, which would link the current Potters Mills Gap project along U.S. 322 to State College with an improved, four-lane, limited-access facility. Construction could begin as early as 2027 and is expected to take three to four years. Again, the potential may exist, either through a partnership with PennDOT or through a public-private partnership, to construct a park-and-ride lot facility along this improved roadway to serve long-distance commuters traveling to the State College area from the Penns Valley, the Seven Mountains area, Lewistown, and the Juniata Valley.

Blair and Cambria Counties – CATA currently facilitates a significant amount of vanpool traffic into the State College area from the Altoona area and beyond, owing in large part to the closure of the State Correctional Institution (SCI) – Cresson and the transfer of those employees to SCI – Rockview and SCI – Benner Township in Centre County. In addition, PennDOT Engineering District 9 owns and operates three park-and-ride lots within the right-of-way of Interstate 99; these lots are located near the Pinecroft, Bellwood, and Tyrone interchanges. Should vanpool traffic grow to, or remain at, the level where additional capacity may be warranted, this will require a complex cooperative effort between CATA, the CCMPO, PennDOT Engineering Districts 2 and 9, and the Blair and Cambria County Planning Commissions.

Electric Vehicles

Electricity was among the preferred early methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by gasoline engines of the period. Though the internal combustion engine has been the dominant propulsion method for passenger vehicles since they became more widespread in society, electric power has remained commonplace—either on its own or as part of a hybrid setup with gasoline or diesel power—in other vehicle types such as trains and trolleys, as well as various purpose-built conveyances such as forklifts and golf carts.

Electric vehicles (EVs) have experienced resurgence in popularity recently due to technological developments, an increased focus on renewable energy, and other related societal preferences. Accordingly, do-it-yourself (DIY) engineers increasingly began sharing technical details for electric vehicle conversions, while major automakers refined EV product offerings, or developed new product lines from the ground up. Government incentives to encourage EV ownership have been deployed, including in the United States and abroad.

An EV uses one or more electric or traction motors for propulsion. EVs may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery, solar panels, or an electric generator to convert fuel to electricity. For the purposes of this document, EVs include road vehicles such as passenger cars, sport utility vehicles (SUVs), and light trucks; freight vehicles such as those that would haul cargo; and transit vehicles that may be utilized to move passengers in a mass transportation context.

As a result of technological advancements, EV ownership cost decreases relative to gasoline and diesel fuel prices, increased availability, and continued shifts in societal preferences, the relative market share of EVs may continue to increase over the planning horizon of the LRTP.

EV State of the Practice

Following decades of stagnant marketplace conditions, interest in EVs started to re-kindle during the 1990s. In 1990, California passed the Zero Emission Vehicles (ZEV) Mandate, which required automakers operating in California to sell a certain percentage of ZEVs each year. As a practical matter, this requirement focused mainly on electric passenger vehicles. A dozen other states later adopted the ZEV Mandate. Though this mandate was subsequently and substantially weakened through court challenges, it produced a new wave of research and development activities among major automakers including Chrysler, Ford, General Motors, Honda, Nissan, and Toyota.

The early 2000s saw a substantial increase in retail gasoline and diesel fuel prices, particularly between 2002 and 2008. Following that trend came increased consumer interest in more fuel-efficient vehicles. Beginning in 2004, from a U.S. market share of about 0.5 percent, sales of hybrid electric vehicles began to increase sharply. Gains were led by the Toyota Prius product line, but also including products from a variety of other automakers. Hybrid electric vehicles represent an incremental step toward pure EVs. Though sales increases started to level off by the middle of the last decade, interest remains significant, and hybrid electric vehicles continue to consistently represent about 2 to 3 percent of all new vehicles sold in the U.S. each year.

The increases that started with hybrid electric vehicles thereafter carried over into the plug-in EV market. In fact, as increases in sales of hybrid electric vehicles have started to level off, more dramatic increases in the sales of plug-in EVs have taken hold. Within the U.S., this movement has largely been led by Tesla Motors, which was incorporated in 2003 and taken public through the NASDAQ stock exchange in 2010. Tesla introduced its first model—the Roadster—in 2008, though early sales increases were driven by the Models S and X, with more recent sales increases attributed to the Models 3 and Y. The Tesla Model 3 is currently the world's leading plug-in EV in terms of sales volume and is the eighth best-selling automobile model overall in the United States.

Beginning in 2011, from a U.S. market share of about 0.1 percent, sales of plug-in EVs started to increase sharply. Though sales declined slightly for 2019, such vehicles continue to account for about 2 percent of all new vehicles sold in the U.S. annually. The overwhelming majority of plug-in EVs in use in the U.S. today are Tesla models.

Recent growth in popularity and sales of EVs in the U.S. and abroad have centered on the following factors:

- Decreasing costs of production and ownership, driven in large part by battery production costs and other efficiencies;
- Increased performance—including range and acceleration—resulting from advancements in motor and lithium-ion battery technology;
- Updates to policy and regulation that continue to favor lower-emission vehicles;
- Corresponding increases in availability and capacity of charging infrastructure;
- Shared learning, research, and development across a wide variety of public and private industry sectors; and
- Other incentives provided for EV ownership, as discussed in more detail below.

In recent years, a wide range of incentives has helped to increase the ownership appeal, reduce total cost of ownership, and expand resulting market share for both pure EVs and hybrid electric vehicles worldwide. Financial incentives include manufacturer rebates, government tax credits, discounts to vehicle registration fees, reduced tolls and parking costs, and discounts for recharging equipment and installation. Non-financial incentives include preferred parking, access to restricted highway lanes such as high-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes, and expedited permitting and installation of charging stations.

For the 2020 model year, most major automakers offer an EV model to the U.S. market, including Audi, BMW, Chevrolet, Honda, Hyundai, Jaguar, Kia, Mini, Nissan, Porsche, Tesla, and Volkswagen. Ford and Fiat Chrysler are working to deploy offerings in the U.S. within the coming years. Hybrid electric vehicles remain substantially more widespread in the U.S. market at the present time, including 2020 model year offerings from Audi, BMW, Chrysler, Ford, Honda, Hyundai, Jeep, Kia, Lincoln, Mini, Mitsubishi, Porsche, Subaru, Toyota, and Volvo. Both types of offerings have greatly increased over the past decade.

Over the planning horizon of the LRTP, EV sales and market share may continue to increase worldwide, accounting for as much as one-third to one-half (depending on the source of the projections) of all new vehicles sold by 2050. The U.S. is expected to adopt EVs somewhat more slowly than the rest of the world, in a continuation of current observed trends.

EV First Applications in Centre County

Growth in Market Share – On a state-by-state basis, Pennsylvania stands at about the middle of the pack in terms of EV adoption, but has recently been climbing the ranks. The majority of PA EV registrations appear to be based in the more populated urban and suburban areas of southeastern and southwestern Pennsylvania. In Centre County, a relatively transient population associated with Penn State University can complicate efforts to identify the precise number of EVs in regular use.

Though it may be difficult to obtain regular, consistent information with respect to the registration and use of EVs on a county-by-county basis, several data sources suggest that Centre County adopted EVs a bit earlier—and is adopting them more rapidly—as compared to the rest of Pennsylvania and the U.S. as a whole. A 2016 study by the International Council on Clean Transportation identified Centre County as one of the few Pennsylvania counties outside the metropolitan Philadelphia area with EVs accounting for more than 1 percent of new vehicle registrations. A 2019 update of this study showed Centre County outpacing nearly every other Pennsylvania county in terms of EV market share. Moreover, the 2019 “Pennsylvania Electric Vehicle Roadmap” identifies Centre County as having a higher per-capita market share of EVs when compared to other Pennsylvania counties.

Proliferation of Charging Stations – Observed trends of comparative early adoption, and high market share, for EVs in Centre County seem to be supported by corresponding growth in access to charging locations within the county. Over the past decade, charging capacity has expanded rapidly in Centre County, with most of this capacity concentrated in the State College vicinity. According to ChargeHub, which maps EV charging capacity for potential users, there are nearly 15 charging locations in the State College area, five in the Bellefonte area, and one in the Pleasant Gap area. While several of these locations are specific to Tesla models, the overwhelming majority accommodate a range of vehicle makes. As access to charging capacity becomes more widespread, both real and perceived barriers to EV ownership and operation can be mitigated.

Connections to Penn State University – As a significant economic, employment, and educational node within Central Pennsylvania, Penn State University both influences and is influenced by its local community. Accordingly, EV development and adoption on the Penn State campus appears to correspond to that of the larger region. The university provides charging stations at both the Nittany Parking Deck and at the Penn Stater Hotel and Conference Center in Innovation Park. In late 2019, Penn State also announced a significant reduction in public charging fees to further encourage the use of EVs.

Penn State’s connection to EV development is also active from an academic standpoint. In 2019, it was announced that university researchers had been successful in developing lithium-ion battery

technology that could potentially greatly reduce charging time. If applied to the larger EV market, such technology could further reduce costs of ownership and increase functionality.

Use in Local Fleets – As market share grows in Centre County, EVs are being added to both public and private fleets within the region. Deployment of EVs in regular, sustained fleet use may accelerate the accrual of environmental and financial benefits. In mid-2019, Ferguson Township was awarded funding under the Alternative Fuels Incentive Grants (AFIG) program to purchase an EV for staff use, and to install a corresponding charging station. During the same funding cycle, Penn State University received capital to add five plug-in EVs and three hybrid electric vehicles to its own fleet. These recent grant awards will augment other EVs and hybrid vehicles that have been placed into fleet service within Centre County. Penn State's Office of the Physical Plant (OPP) currently utilizes EVs, and College Township has one EV in its fleet. Moreover, College and Patton townships have charging stations at their municipal facilities.

EV Actions and Planning Implications for Centre County

Funding – As both federal and state transportation funding programs rely on liquid fuel taxes, a widespread shift to hybrid electric vehicles and plug-in EVs could potentially threaten current funding models, possibly jeopardizing funds for transportation projects. At the state level, a ranking member of Pennsylvania's House Transportation Committee has proposed a $250 annual tax on EVs to make up for transportation funding shortfalls resulting from a shift from gasoline and diesel-powered vehicles to EVs. This measure is still being debated in the Pennsylvania Legislature. There is currently no similar measure being debated at the federal level, which still offers tax credits for EV purchases in some cases. A widespread shift to EV ownership and use, however, might be expected to affect federal fuel tax receipts in a similar manner. This may have the potential to further develop the conversation of how transportation projects are funded in Pennsylvania and nationwide.

Climate Action Plans – Pennsylvania's 2018 Climate Action Plan identifies strategies to implement sustainable transportation planning and practices. According to the Commonwealth's most recent greenhouse gas (GHG) inventory, in 2016 transportation accounted for 23 percent of Pennsylvania's net GHG emissions—63 percent of which were from gasoline-powered vehicles and 24 percent of which were from diesel-powered vehicles. One of the sustainable transportations practices Pennsylvania plans to advance is the implementation of a strategic plan and incentives for increasing EV use in line with the statewide Electric Vehicle Roadmap.

The Centre Region is currently developing a Climate Action and Adaptation Plan that will identify actions to reduce GHG emissions and adapt to a changing climate. The plan is likely to include a strategy to expand electric bicycle options, electric vehicle fleets and charging infrastructure. By making cleaner vehicles more accessible, GHG emissions and air pollution can be reduced even if drivers do not reduce miles traveled.

Ongoing or Additional Incentives – While arguments may be made to assess some form of EV tax or user fee in the face of increasing hybrid and electric vehicle ownership and use, to continue to adequately fund transportation projects at the state and federal levels there may also be an argument made to support growth in hybrid vehicle and EV ownership and use. The latter may play a role in supporting environmental goals and economies of scale within the EV industry, resulting in cost savings and increased revenue from other sources. As discussed previously, federal, state, and local governments employ a wide variety of financial and non-financial incentives to encourage the ownership and use of EVs. One solution may be to focus on non-financial incentives to properly balance the integrity of transportation funding revenues against the benefits of more widespread EV adoption. On the other hand, government entities may continue to invest in EV

purchase subsidies and public charging infrastructure because they perceive the benefits of EV use to be greater than the cost to them.

Performance Metrics for Emissions and Air Quality – Increasing ownership and use of hybrid electric vehicles and plug-in EVs are thought to play a role in decreasing transportation-related emissions and improving air quality, but the specific type of vehicle used is only one contributing factor. In order to meet more ambitious emissions and air quality targets, hybrid vehicle and EV use must be coupled with increased use of public transportation and active transportation modes, and an overall reduction in person-miles traveled, for example. This suggests a continued cooperative role for transportation, regional, and environmental planning disciplines in meeting air quality targets. It also suggests room for further analysis in terms of the environmental impact of electric bicycles and EVs, as potential emissions shift from individual vehicle exhaust systems to coal, oil, and natural gas fired power plants, but also to wind, solar, and perhaps nuclear sources used in powering charging stations.

EV Potential Future Developments

More Widespread Vehicle and Charging Technology – The current network of charging stations in Centre County seems adequate to provide for the number of EVs currently in use within the region. Decreased production and ownership costs, increased performance, policy and regulation, and incentives have driven an increase in EV market share up to this point. If such trends continue, and EV adoption in Centre County continues to grow into a more significant market share, additional public and private charging infrastructure will be needed. For example, the International Code Council (ICC)—the building standards organization that sets voluntary guidelines for new homes—cites research indicating the U.S. will need 9.6 million new electric vehicle charging ports by 2030. Almost 80 percent of those will be in single- and multi-family residential buildings.

This could have cascading planning implications throughout the region. Local and state government entities will need to make the decision to provide additional capacity, or to let the market provide the capacity, depending on available funding and community preferences. New developments and property re-developments may need to make changes to parking configurations if incentives such as priority parking or on-site charging stations are pursued. Developers and other local entities may wish to install conduit, for example, during new development and maintenance projects, even if EV charging stations are planned for the future rather than imminently. For example, in January 2020 the ICC approved changes to building standards that support “EV-capable” infrastructure. These new voluntary guidelines call for installing panels, outlets, and conduits capable of charging at least one full-size EV in a single-family garage overnight. Multi-family buildings will need two spots, along with more that can be easily retrofitted (EV-capable). Moreover, more commercial and residential property owners may begin to opt for solar power to support EV charging and further offset emissions impacts in conjunction with a shift to EVs.

Propulsion of Freight Vehicles – Electric freight vehicles are not yet widely available in North America, although manufacturers and a small number of fleets are currently engaged in cooperative research, development, and limited implementation activities. It is important to note here that the overwhelming majority of freight is transported over shorter distances, which suggests the need for smaller, lighter-duty vehicles that may be more comparable to the passenger-oriented gasoline–electric hybrid vehicles and plug-in EVs already in development and distribution. On the other hand, long-haul freight would likely need to be transported by larger, heavier-duty vehicles that may share a parallel development path with electric transit vehicles, as described later in this section.

Both lighter-duty, short-haul vehicles and heavier-duty, longer-haul vehicles may be expected to have a significant impact on Centre County as a shift is made to electric propulsion. Benefits to air

quality could be assumed to be more meaningful as market share grows. Not only does Centre County support a large commercial presence for an area of its population size, it is also relatively affluent; this suggests significant possible effects through the turnover of local delivery vehicles. Moreover, Centre County is bisected by major freight routes (I-80, I-99, and U.S. Highway 322), which suggests beneficial emissions and air quality effects as through freight traffic is converted to electric propulsion. In both cases, both private and public charging infrastructure would need to be planned, funded, and implemented to accommodate the additional demand.

Propulsion of Transit Vehicles – As an early adopter of compressed natural gas (CNG) propulsion for its fixed-route transit fleet, CATA often fields questions as to its "next step" in vehicle propulsion. During the planning process for CATA's Strategic Plan Update 2016–2026, such considerations did not meet the threshold to be included in one of the five main strategic focus areas. There is good reason for this, given the CNG investments CATA has made—and the economies it has built—in terms of rolling stock, fueling infrastructure, technical competency, and serving as an implementation resource and partner to other private and public entities.

However, much has changed since CATA's Strategic Plan was updated. Hybrid transit vehicle technology has evolved substantially, CATA has administered several limited tests of both hybrid and electric transit vehicles within its fixed-route service area, and sales of electric transit vehicles have increased significantly in Asia and Europe. Electric transit vehicles are slowly being adopted by U.S. transit agencies, most recently by the Orange County Transportation Authority (OCTA) in the Los Angeles metropolitan area, which just approved a plan to bring 10 plug-in electric buses into service by 2021. Electric buses must be further proven in terms of performance and reliability before they are widely adopted in a range of U.S. operating environments.

Because any transition to electric propulsion will take a great deal of time to support—and will undoubtedly require wholesale changes to layover points, fueling infrastructure, rolling stock, and other facilities (including the physical space allocated for these facilities)—this may be a concept that CATA deems appropriate for further examination as U.S. electric bus manufacturers and suppliers ramp up their own economies and production.

Electric Bicycles

Electric bicycles (e-bikes) are growing in popularity nationally and in Centre County. In Pennsylvania e-bikes are defined as "pedalcycles with electric assist". In Pennsylvania e-bikes are required to be under 750 watts, have a maximum speed of 20 mph on a level surface when powered by the motor source only, weigh no more than 100 pounds and have operable pedals. The same rules of the road apply to both e-bikes and human-powered bicycles, and in Pennsylvania e-bikes are not subject to registration, licensing or insurance requirements that apply to motor vehicles and no person under 16 years of age may operate an e-bike.

The emergence of e-bikes presents an opportunity to increase active transportation by minimizing barriers of engaging in physical activity. Commuters may not want to exert the effort required to ride a conventional bicycle, may need to travel a longer distance, or may desire to wear normal clothing without arriving to their destination sweaty. In addition, individuals may have limited time or may not have the stamina to make the trip with a conventional bicycle. In each of these cases, the added assistance of the pedal-assist electric motor in e-bikes may reduce these barriers while still providing some of the health benefits associated with conventional cycling.

E-bikes may help reduce some of the obstacles above, and also have the added benefit of being environmentally friendly, as they do not produce carbon emissions or noise pollution akin to their

motorized vehicle counterparts. In addition, they are not like motorcycles or other motorized scooters in that they can generally be ridden on bike paths and in bike lanes. If adopted widely enough, e-bikes could, therefore, reduce congestion in traffic as well as motor vehicle parking needs, as they can also be parked with traditional bicycles. Other benefits include:

- Increased access to recreation and transportation; older adults are more likely to use e-bikes for recreation and fitness whereas younger adults are more likely to use e-bikes for commuting, utilitarian trips, and to replace car trips.

- The addition of the electric-assist encourages people to take more and longer trips by bike, and offers individual health benefits.

- E-bike users indicate feeling safer on an e-bike than a conventional bike given the ability to travel through an intersection quickly or traverse challenging terrain.

Safety, speed, crowding, and user conflict are common concerns related to bicycles, and even more so for e-bikes. However, e-bike research has shown that people tend to view e-bikes more favorably once they are exposed to or become familiar with e-bikes. Additionally, with the increase of e-bikes and forecasted growth in use, infrastructure may need to be considered related to facilities to accommodate demand and charging needs.

At this time there have not been noticeable issues with the introduction of e-bikes into the community and their usage on the county's bike facilities. Local bicycle shops are offering electric bike conversions kits as well as selling e-bikes. While options may currently be limited, there is potential for growth due to the benefit of cycling and the ride assist that is provided with an e-bike. The availability of electric assist technology allows for a larger population to use e-bikes, especially people who cannot longer ride a traditional bicycle because of physical limitations.

In the Centre Region area of the county, many shared use paths are signed "No Motorized Vehicles" as a condition of the federal funding that was utilized for construction. The Federal Highway Administration (FHWA) provides an exception for electric assist bicycles when state or local regulations permit the use of e-bikes on shared use paths. The elected officials in the Centre Region decided in early 2016 to allow e-bikes to operate on the Region's shared use path system, making e-bikes a more viable transportation option.

E-bike usage, and associated needs and changes in technology, will continue to be monitored for impacts in Centre County.

Connected and Automated Vehicles

Connected and automated vehicles (CAVs) are two distinct but interrelated developments in transportation technology that are rapidly evolving and have the potential to greatly influence both planning and policy in the coming years. CAVs have the potential to impact the design and deployment of passenger, freight, and transit vehicles, as well as multiple non-transportation industries such as construction, hospitality, and law enforcement.

Connected vehicles (CVs) communicate with other vehicles, infrastructure, and devices through wireless network technology, such as WiFi and radio frequencies. Such vehicles can assist in wayfinding and/or alert drivers to nearby incidents, diversions or heavy traffic. Connected vehicle infrastructure can be used for traffic signal control, traffic monitoring, automatic toll collection, traffic congestion detection, and traffic signal priority or preemption.

Automated vehicles (AVs) are equipped with technology that enables them to operate with limited human assistance—in fact the intent is to eventually move to no human intervention whatsoever. Such vehicles are able to "drive" themselves (to various extents) by using cameras, RADAR (radio-based sensing), LIDAR (light-based sensing), global positioning system (GPS) technology, and computer imaging to gather and interpret information on their surroundings. Once an environment has been scanned and relevant objects detected, the vehicle's equipment reacts as the situation dictates—controlling the steering mechanism, accelerator, and brakes as required.

Vehicles can be connected but not automated, automated but not connected, neither, or both—and to varying degrees.

State of the Practice

Connected and automated vehicle technologies are in aggressive stages of research and development in nearly all major automotive markets, including the United States.

Some AV technologies are already in use on vehicles driven today, operating features such as anti-lock braking systems (ABS), adaptive cruise control, electronic stability control (ESC), and blind spot monitoring (BSM) systems. Perhaps the most comprehensive array of AV technologies is currently offered as part of Tesla's Autopilot and Full Self-Driving packages. These include functionality related to automated cruise control, steering, navigation, lane changes, parking, summoning, and traffic signs and controls (however in the U.S. active driver supervision is still required).

As mentioned, AV technologies exist along a continuum, defined by the international Society of Automotive Engineers (SAE) as the following six levels:

- Level 0 – a human driver completes all tasks;
- Level 1 – an advanced driver assistance system (ADAS) can assist a human driver with either steering OR braking and accelerating;
- Level 2 – the same ADAS can control both steering and braking/accelerating under some circumstances;
- Level 3 – an automated driving system (ADS) on the vehicle can perform all aspects of the driving task under some circumstances, but a human driver must be ready to take back control at any time the ADS requests the human driver to do so;
- Level 4 – an ADS on the vehicle can itself perform all driving tasks and monitor the driving environment—essentially, do all the driving—in certain circumstances; and
- Level 5 – an ADS on the vehicle can do all the driving in all circumstances—full automation.

At the current pace of development, Level 4 and 5 passenger vehicles are predicted to enter the marketplace within the next five years, with widespread availability within the next 10 years.

Similar to the gradual implementation of AV technology, several connected vehicle (CV) technologies are already in use on many vehicles. Such capabilities include GPS navigation technology, hands-free cellular phone operation, and proprietary in-vehicle safety and security systems such as General Motors' OnStar system.

CV technologies also exist across several categories, defined by the SAE as follows:

- V2I (vehicle to infrastructure) – capture vehicle-generated traffic data, wirelessly providing information such as advisories from the infrastructure to the vehicle that inform the driver of safety, mobility, or environment-related conditions;

- V2V (vehicle to vehicle) – wireless exchange of information about the speed and position of surrounding vehicles;
- V2C (vehicle to cloud) – help enable connected navigation, social media, music streaming, and in-car WiFi;
- V2P (vehicle to pedestrian) – encompasses a broad set of road users including people walking, using wheelchairs or other mobility devices, embarking and disembarking buses and trains, and riding bicycles; and
- V2X (vehicle to everything) – consists of all of the above functionality.

Research, development, and testing of connected and automated passenger vehicles is taking place on various fronts worldwide. In the U.S., one of the most notable examples is Waymo (formerly the Google self-driving car project), which is testing CAVs in the Phoenix metropolitan area, using a mixed fleet of Toyota, Lexus, Chrysler, Jaguar, and proprietary vehicles. Waymo technology is also in use in partnership with Uber in the Pittsburgh area.

Waymo is further involved in testing of CAV technology for freight vehicles in California, Georgia, and Arizona. Early development of CAV technology for freight trucks has centered on platooning, which couples vehicles together via technology including sensors, GPS, adaptive cruise control, V2V communication, and software and hardware. Platooning can potentially provide fuel economy benefits through tighter vehicle spacing and shared aerodynamics, and improve traffic flow by increasing efficiency and roadway capacity.

CAV technology for public transit vehicles is still in the very early stages, although several U.S. transit agencies have tested, or are in the process of testing, technologies including automated braking and docking, lane-assist technology, and collision avoidance systems. These agencies include the Lane Transit District in Oregon, Minnesota Valley Transit Authority, and Pierce Transit in Washington State. Similar testing is also underway in Europe and Asia.

First Applications in Centre County

Centre County has played an early role in research, testing, and development of CAV technologies in the following ways, and this role is expected to expand in the future:

First Pennsylvania Automated Vehicle Summit – State College hosted the inaugural "Pennsylvania Automated Vehicle Summit" in 2017. Jointly presented by the Intelligent Transportation Society of Pennsylvania (ITS-PA) and the Mid-Atlantic Section of the Institute of Transportation Engineers (MASITE), the summit encompassed all aspects of CAV development, including: safety, workforce changes, planning, policy, and industry implications. Attended by roughly 300 transportation officials, academic and industry experts, public officials, planners, and industry partners, this initial summit has grown into an annual event that rotates location throughout Pennsylvania, and is now described as the largest such conference in the northeastern United States.

Penn State University Test Track – Penn State's Larson Transportation Institute test track played a key role in enabling technology demonstration as part of the 2017 Pennsylvania Automated Vehicle Summit. Earlier that year, the test track (together with the City of Pittsburgh) was designated as one of 10 U.S. Department of Transportation autonomous vehicle proving grounds in the nation. An existing dedicated short-range communications (DSRC) radio network and dedicated differential global positioning system (DGPS) base station on site support CAV testing activities.

Upgrades to the test track associated with the CAV proving ground designation include: perimeter power and communication systems that enable rapid installation and change-outs of V2I hardware, signage, and other signalization elements; a command-and-control center for telemetry collection to enable processing of vehicle data that synchronize roadside measurements (traffic cameras, radio communications, signage, and traffic simulations) with telemetry obtained from vehicles; support of

motion coordination, tracking, and testing of autonomous vehicles to support loading-dock and docking operations for heavy autonomous trucks; collection of vehicle platoon data for evaluation of performance and fuel economy; and a staging area for tele-operated control of automated vehicles for highway testing, in coordination with PennDOT.

Academic Research – Penn State's connection to CAV development is also active from an academic standpoint. University research teams have worked on—or are working on—commercial use predictive control systems that use information shared by CAV technologies for on-vehicle automation systems to reduce the fuel consumption of commercial vehicles; live vehicle driving and driving simulators to study how technology-mediated interactions between a driver and vehicle affect the driver's perception of risk; operation of autonomous vehicles, using tele-operation that is mediated by virtual reality (VR) and augmented reality interfaces; and software that allows interaction between either a simulated or live vehicle interacting with a simulation of virtual traffic elements.

Actions and Planning Implications for Centre County

Interactions with Pedestrian and Bicycle Traffic – Because Centre County features a well-developed network of pedestrian and bicycle facilities, interaction between CAVs and those traveling on foot or by bike may be of particular concern. CAV detection rates for pedestrians and cyclists can be much lower than for other vehicles, owing in part to pedestrians and cyclists not wearing detectable electronic beacons, as well as poor location accuracy of V2X technology—particularly in dense urban areas. In addition, several detection systems partly rely on built environment characteristics (such as crosswalks or bike lanes) to predict the presence of cyclists or pedestrians, while in reality, CAVs may encounter pedestrians in any location. Moreover, current technology has difficulty predicting future movements and intent of pedestrians and cyclists. Finally, CAVs used for commercial ridesharing or deliveries require frequent access to curb space where they may interact with pedestrians and cyclists, traversing bike lanes or even sidewalks to deliver passengers and/or goods.

Vehicle Accessibility – As mentioned, CAVs are engaged in early testing in conjunction with commercial ridesharing entities, most notably transportation network companies (TNCs). To the extent that TNCs can operate free of "public accommodation" requirements, vehicle accessibility in accordance with the Americans with Disabilities Act (ADA) of 1990 may become a concern to the local community. Moreover, automated transit shuttles are being piloted in locations such as Columbus and Las Vegas, though these appear to adhere to ADA requirements. As TNC vehicles (and even public transit vehicles) move further toward full automation, however, a general decline in the availability of personal assistance in boarding and de-boarding a vehicle—as well as in securing mobility devices and personal items—may become an additional concern.

Availability of Data to Local Officials – As with TNCs, increasing connection and automation of vehicles has to the potential to yield a large volume and wide range of data that could prove useful to transportation planning activities. If regional decision-makers are to be fully informed and make the best possible choices when it comes to transportation planning and policy, they must consider a mechanism for accessing data related to origin and destination patterns, travel times, and volume. Similar types of data are already available to generate highway and public transportation performance measures for the benefit of the region. Keys to this effort will include finding a means through which to sort data by relevance and type, identify segment data that is unique to Centre County, and protect data privacy and security. The collection and use of data related to CAV deployment is currently a matter of considerable discussion and debate.

Local Regulations – Local governments throughout the United States are currently taking action to regulate connected and automated vehicles in the areas of on-road testing (Boston, Cincinnati, Las Vegas, Pittsburgh), preparing for the impact of driverless vehicles on parking (Phoenix), and integration of connected and automated vehicles with other existing and planned technologies (Los Angeles). Working under the framework of superseding national and state regulations, jurisdictions within Centre County will need to carefully consider, debate, and implement regulations that will best integrate CAVs with the surrounding context and population.

Infrastructure – As CAV technologies continue to advance, supporting infrastructure will play a critical role, and may guide transportation programming and project development activities well beyond more traditional physical construction projects. AVs may give rise to induced demand and more frequent, shorter trips, while decreasing the need for parking in close proximity. This may effect a shift away from on-street parking and change project planning and design considerations. On major highways, truck platooning may play a role in designing and constructing bridges to a higher weight limit. Moreover, CVs will require development of more widespread technological infrastructure to function effectively. Highway projects might be expected to include the network connectivity necessary to adequately support vehicle operations. In terms of land use and highway construction projects, it is not too early to begin to account for these infrastructure considerations where it makes sense to do so.

Potential Future Developments

Impacts to Parking and Traffic Congestion – Increasing CAV deployment and use may raise concerns related to parking and traffic congestion in suburban and urbanized areas, including those in Centre County. In theory, AVs could park themselves after dropping off a passenger, and likewise be summoned when picking one up. Through this separation of vehicle and driver, there would be no associated need for nearby parking, or even for parking at all. AVs could park remotely from a downtown or other heavily congested area, return to a home location, or continue driving until summoned by the initial passenger (or by another passenger). Where additional driving to a home location or circling around is involved, traffic congestion may be predicted to increase. This has the potential to change the current balance between nearby parking and roadway lane-miles.

Expansion of Pennsylvania Testing – PennDOT, the Pennsylvania Turnpike Commission, and Penn State University are partnering to advance the Pennsylvania Safety, Training, and Research Track (PennSTART), a state-of-the-art training and testing facility to address the needs of Pennsylvania and the Mid-Atlantic Region in terms of emergency responders, transportation organizations, and research institutions. PennSTART will provide for safety training and research needs in six key areas: traffic incident management (TIM), tolling and intelligent transportation systems (ITS) technology, work zones, commercial vehicles, transit vehicles, and CAVs. Renderings of the proposed new facility – which will replace the existing testing facility – have been prepared, and site selection and planning activities are underway.

At the present time, eight entities are authorized to conduct AV testing in Pennsylvania, within the counties of Adams, Allegheny, Armstrong, Beaver, Bedford, Bucks, Butler, Centre, Chester, Crawford, Cumberland, Dauphin, Delaware, Erie, Fayette, Franklin, Fulton, Greene, Lancaster, Lawrence, Mercer, Montgomery, Philadelphia, Somerset, Venango, Washington, Westmoreland, and York. As CAV technology continues to advance, and more companies and academic institutions enter the market, the number of authorized testers may increase, and the geographic reach of testing in Pennsylvania may spread. Specific to Centre County, downtown State College and the Penn State University campus may provide an attractive testing environment for automated transit shuttle service.

Advancement of Technology – While advancement of CAV technology has the potential to further influence transportation planning and policy decisions—such as those related to pedestrian and bicycle interactions, parking and congestion, and testing—it also has the potential to change how we live and interact on a broader level. Specific to Centre County, there may be impacts to the local economy and academic programs. The county is already home to a major research institution, as well as a number of technology-based companies with varying degrees of association with Penn State University. Particularly as (and if) Central Pennsylvania continues to grow in importance as a testing and development center for CAV technology, it is feasible that Penn State may see shifts in academic offerings and program sizes, and the local economy may see corresponding shifts in business and industry. These latter changes would have planning and policy implications also.

Potential TNC Partnerships –CATA's "Assessment of Alternative Service Models for Areas of Low Population Density," completed in 2018, suggested a potential partnership between public transportation and TNCs. Continued advancement of CAV technology could also give rise to a potential TNC partnership. Such a relationship could possibly take advantage of the size, economies, and standardization of fleet-based testing and deployment, and/or could allow TNC companies—currently grappling with economic sustainability—to lower their operational costs through the use of driverless vehicles.

Bus Rapid Transit

Generally making use of dedicated right-of-way and increased service frequency along high-density corridors—as well as advanced technologies that facilitate traffic signal priority and quicker passenger boarding, alighting, and fare collection—bus rapid transit (BRT) is designed to improve the capacity, reliability, and speed of bus-based public transportation, while retaining cost, flexibility, and simplicity advantages over rail-based transit modes.

State of the Practice

Regardless of location, most modern, successful BRT facilities have many of the following features in common:

- Dedicated right-of-way to avoid mixed traffic congestion;
- Expedited fare collection at stations and/or through contactless systems, or universal access;
- Traffic signal priority or pre-emption;
- Traffic patterns that minimize or eliminate crossings of the BRT right-of-way;
- Raised boarding platforms and/or low-floor buses to expedite passenger boarding and alighting;
- High-capacity vehicles—such as articulated buses—and high-capacity stops and stations to accommodate them;
- Fewer stops, and greater distance between stops to improve route running time, such as would be typical for passenger rail service;
- Dedicated branding that distinguishes BRT service from other local transit services to create a unique identity; and
- High-frequency service on the main BRT line, as well as adequate feeder service to deliver passengers from other locations.

Pittsburgh has one of the most well-developed examples of BRT in the U.S., operated by the Port Authority of Allegheny County. The 4.3-mile South Busway opened in 1977—the first formalized

BRT facility in the US. It includes a two-lane dedicated transit right-of-way and tunnel, allowing transit vehicle to bypass a heavily congested section of PA Route 51. However, the South Busway does not include some of the other features traditionally associated with BRT.

Port Authority added the 6.8-mile Martin Luther King, Jr. East Busway in 1983 (later extended to a total of 9.1 miles in 2003), and the 5.1-mile West Busway in 2000. These facilities are more advanced than the South Busway in terms of BRT-related features and technologies, including raised (accessible) platforms at designated stops, traffic signal priority, dedicated branding of routes, and very frequent headways. Port Authority is considering a fourth BRT corridor between downtown Pittsburgh and Oakland, which is a secondary employment, retail, health care, and education node several miles from the Pittsburgh city center.

In Philadelphia, the Southeastern Pennsylvania Transportation Authority (SEPTA) and the City of Philadelphia Office of Transportation and Infrastructure Systems (oTIS) have partnered to implement elements of BRT—delivering greater transit efficiency, convenience, and speed—without using a dedicated right-of-way. SEPTA launched its "DIRECT BUS" in 2017 along Philadelphia's heavily traveled Roosevelt Boulevard corridor. The service makes use of dedicated branding, high-capacity vehicles, limited stops, intelligent transportation systems (ITS) technology, frequent service, and amenities at passenger stops. DIRECT BUS has cut transit travel times in mixed traffic by almost a third; trip times are very competitive with those taken in a private automobile.

Elsewhere in the United States, a total of 60 other BRT facilities are in operation—mainly in major metropolitan areas including Boston, Honolulu, Kansas City, Las Vegas, Los Angeles, New York City, Portland, and Seattle. An additional 33 facilities are in the formal planning stages in such urban areas as Chicago, El Paso, Jacksonville, San Jose, and Salt Lake City.

Internationally, the world's first BRT implementation was the Rede Integrada de Transporte (Integrated Transportation Network) in Curitiba, Brazil, which was placed into service in 1974. As of March 2018, a total of 166 cities on six continents have implemented BRT systems, accounting for about 3,050 miles of infrastructure. Continuing forward from the Rede Integrada de Transporte, Latin America continues to be a leader in BRT operations, with Brazil, Colombia, and Mexico all distinguished by daily BRT ridership measured in the millions of people. China and Iran are also characterized by similar levels of daily BRT ridership. Currently, the world's most extensive BRT system operates in Jakarta, Indonesia, with about 156 miles of infrastructure connecting parts of the city.

First Applications in Centre County

North Atherton Corridor – Though there are no true BRT facilities in Centre County, CATA has implemented several service elements commonly associated with BRT throughout its system in general, and along the North Atherton Street corridor specifically. These elements contribute to enhanced mobility, improved operations, and a significant mode share through the most heavily traveled corridor in its service area.

Particularly during Penn State University fall and spring semesters, CATA operates very high service frequency along the North Atherton Street corridor through a combination of its A, G, N, V, and W routes. For a rider traveling North Atherton Street to and from the Penn State campus, without regard for the specific route taken, service can be as frequent as every 5-10 minutes during peak morning and evening periods.

Along the North Atherton Street corridor, and throughout its service area, CATA's fixed-route fleet is comprised predominantly of 35- and 40-foot low-floor transit buses manufactured by New Flyer and

Gillig. These low-floor vehicles—with kneeling capability—speed the boarding and alighting process for all riders, but especially for those who have mobility limitations and/or use mobility devices.

In early 2011, transit signal priority (TSP) was implemented as part of a larger traffic signal improvement and coordination project at 18 North Atherton Street intersections spanning Patton and Ferguson townships and State College Borough. The system is activated by emitters placed on board every CATA fixed-route vehicle. It does not preempt a red signal, but holds a green signal for a limited amount of time to allow a transit vehicle to clear the intersection, thereby decreasing delays and increasing on-time performance. A project after-study noted increases in transit on-time performance between 1.7 percent and 11.8 percent, depending on route. These improvements, however, were primarily attributed to signal coordination rather than implementation of TSP.

A more advanced BRT system linking downtown State College and the Penn State University campus with housing, retail, and commercial trip generators to the north has been listed in previous long-range transportation plan documents as a "project for future consideration," but has not advanced past the conceptual stages.

Downtown State College / Penn State University Campus – At the present time, just under half of CATA's fixed-route ridership comes from its four integrated campus routes. The Blue and White loops provide circulator service around the Penn State Campus and Downtown State College. The Red Link operates east–west across campus, between Innovation Park and West Campus via Curtin Road and Park Avenue. The Green Link provides additional service along the more heavily traveled portion of Curtin Road between Beaver Stadium and North Atherton Street.

All four campus routes provide fare-free service to riders, the result of a partnership between CATA and Penn State University through which hours of service are purchased in quantity at a rate negotiated between the two entities. Because campus route riders need not pay a cash fare or furnish a magnetic stripe pass, the boarding process is expedited, and bus dwell time is reduced. Low-floor vehicles and a high level of service frequency—similar to the North Atherton Street corridor—combine with fare-free service to allow CATA to move large numbers of riders quickly and efficiently.

Actions and Planning Implications for Centre County

Need and Purpose – Given the scarcity of transportation funding within the region, establishing a robust statement of need and purpose for the implementation of BRT or deployment of related features will be critical to funding competitiveness and operational success. CATA assumes a very high mode share within the North Atherton Street corridor, so implementing a modified version of BRT—or BRT-related features—is one potentially viable path to further improving transit operations, speed, and convenience within the corridor while containing project costs to the greatest possible extent. As incremental implementation of individual features associated with BRT—for both the North Atherton Street corridor and within other portions of the service area—seems a viable outcome, it may be useful to examine other systems as well as CATA's current operations to determine a reasonable cost-benefit ratio for each of these elements.

Right-of-Way – The acquisition and improvement of dedicated right-of-way for BRT within Centre County seems unlikely under current conditions. However, there may be ways to use existing right-of-way more efficiently in order to implement elements of BRT to improve bus dwell time, running time, efficiency, and capacity. A reversible bus lane, oriented to the prevailing direction of traffic during peak commute hours and special events, is one such potential improvement. Both CATA and the CCMPO should be encouraged to examine methods by which CATA's important role in mobility within the North Atherton Street corridor and other corridors can be further supported, and possibly expanded, given existing right-of-way constraints. Moreover, there is a desire on the part

of local elected officials to see BRT implemented without undue disturbance to the recent drainage and paving improvements to North Atherton Street.

Funding – A phase-out of the CCMPO's eligibility for funding under the Congestion Mitigation and Air Quality (CMAQ) program, based upon air-quality conformity status, places an additional pressure on identifying potential funding sources for the implementation of BRT or related features. Going forward, such projects will face a higher level of competition and scrutiny when measured against other road, bridge, and transit fleet replacement and expansion projects as part of the LRTP and TIP processes. Adopting BRT-related features incrementally within existing right-of-way could provide the benefit of improved operations and service, while keeping project costs more manageable.

Ownership and Maintenance – Incremental implementation and refinement of some of the features most commonly associated with BRT—such as larger vehicles, fare collection systems, signal priority, enhanced stops, and advanced technologies—would be fully consistent with CATA's current ownership and maintenance practices. Utilizing current right-of-way more effectively would likely require that a new set of core competencies and regional partnerships be developed. This specific issue may warrant further study by CATA with potential support from the CCMPO.

Performance Metrics – As both federal and state governments continue to move toward performance-based planning and programming, both predicted (pre-implementation) and actual (post-implementation) measures of BRT or BRT feature utilization, such as on-time performance, operating speed, stop dwell time, cost-benefit ratio, and the like will be useful in assessing the potential and tangible return on investment, as well as the competitiveness of BRT projects when compared to other types of transportation projects.

Potential Future Developments

Articulated Buses – In 2017, CATA's "Assessment of Articulated Bus Utilization" was completed. The purpose of this assessment was to analyze the implications of, and provide recommendations for, articulated bus service on corridors within CATA's service area. The assessment determined that articulated bus service is both warranted and recommended within the service area. Accordingly, CATA is engaged in the procurement of several 60-foot, natural-gas-powered articulated vehicles. As these vehicles are placed into service, they should both relieve overcrowding on heavily traveled corridors and speed the alighting process at key stops.

Fare Collection Technology – CATA's "Analysis of Fare and Contract Structures and Policies" – to be completed by the end of 2020 – encompasses, among other elements, "recommended next steps in terms of procurement, installation, and use of fare hardware and equipment," and "new and emerging alternatives for fare media, relative to CATA current fare hardware and equipment, as well as any future recommendations." It is possible that such recommendations from the project, should CATA decide to move forward with implementation, may result in fare media and collection technology that will expedite the boarding process throughout the system.

Pennsylvania Department of Transportation (PennDOT) Regional Operations Plan (ROP) – At its June 2019 meeting, the Centre County Metropolitan Planning Organization (CCMPO) Coordinating Committee adopted the 2018 Central Region ROP. As part of this plan, Long-Term Project #5 specifies the upgrade of signal controllers at 29 intersections (including along North and South Atherton Street) for the purposes of integrated corridor management. These improvements are expected to improve corridor operations and reduce delay. The ROP notes that the North Atherton Street corridor features transit signal priority that must be maintained. As part of this project, however, it may be possible to further optimize the functionality of signal priority within the corridor to yield greater benefit to public transportation and the community. This could be accomplished by

linking signal priority to other available information, such as passenger load and schedule adherence.

PennDOT Fixed Route Intelligent Transportation System (FRITS) – In partnership with Avail Technologies, Inc., of State College, PennDOT is sponsoring a public transportation technology upgrade for 32 Pennsylvania transit systems, including CATA. Though CATA has already deployed a high level of technology through its own Advanced Public Transportation Systems (APTS) initiative, it is possible that further upgrades may facilitate quicker fare collection or other operational processes; these may reduce dwell times and running times along all corridors within the CATA service area.

Other Corridors and Locations – Although North Atherton Street is the most active transit corridor in the region (also the most heavily traveled highway corridor), other corridors and locations may warrant BRT-associated elements in future years. For example, ridership east of downtown State College has been growing with the establishment of both student and workforce housing, and with associated retail and commercial growth. Moreover, transit signal priority for the College and Beaver Avenue corridors has been proposed during previous LRTP cycles, as has a queue-jump feature for transit vehicles near the College Avenue and Allen Street stop.

BRT or Modified BRT Corridor – As described above, the North Atherton Street corridor already features, or will shortly feature, many of the individual attributes that make up a BRT corridor. Moreover, other corridors within the CATA service area may benefit from the same or similar attributes. CATA—with potential assistance from the CCMPO—desires to further examine how these features may be pulled together to yield a cohesive and lasting benefit to transit operations, speed, convenience, and overall congestion mitigation.

First-Mile/Last-Mile Mobility

"First-mile" and "last-mile" connections describe the very beginning and/or end of an individual trip made primarily by public transportation. In most cases, people walk to and from transit if feasible. On either end of a public transit trip, however, the initial origin or final destination may be difficult or even impossible to access by a short walk. In these situations, other modes of transportation, or other improvements, may come into play.

For example, a traveler may easily access their local train or bus station from home on foot, but after de-boarding, may encounter very real challenges in reaching the final destination. The destination may be too far to walk to from the station, or pedestrian facilities may be lacking. Some readily accessible form of connection is needed to the final destination. First-mile/last-mile issues apply to any mode of transit.

Though the generally accepted standard for transit access by walking is ¼-mile, transit planners must be cautious about assessing a potential rider base by simply drawing a radius around transit stops. Geographic or infrastructure barriers may prevent walking to transit; sidewalks, for example, may be inadequate or non-existent, or fences may block the shortest path. Mitigating or eliminating these barriers can greatly improve and facilitate transit access.

State of the Practice

Some of the most innovative communities are currently addressing first-mile/last-mile considerations in the following ways:

Pedestrian Improvements – Transit systems regarded as most successful in addressing first-mile/last-mile considerations have stops that are connected to dense residential areas and other major trip generators by well-developed pedestrian networks, which are compliant with the Americans with Disabilities Act (ADA) of 1990 to provide mobility for persons with disabilities. The Maryland Transit Administration (MTA), for example, works closely with local jurisdictions to improve sidewalks and crosswalks, particularly in the vicinity of key transfer facilities. These are essential to facilitate passenger experiences that are safer and more comfortable.

Cycling and Scooters – Bicycling can greatly extend the range of mobility and improve access, if it is safe (or even possible) to ride between a point of origin and the boarding stop, and between the de-boarding stop and the final destination. The provision of high-quality bike parking at key stops and stations often also helps to increase transit utilization. Additionally, transit agencies may provide bicycle racks on the front of buses, and may even allow bikes within a bus or rail car to promote multimodal trips. Foldable bicycles are growing in popularity with commuters in some areas, and may be allowable where standard bikes are not. Moreover, bike-sharing programs can play an important role in helping users access transit stops and final destinations. More recent growth in scooter-sharing programs has the potential to convey similar benefits in terms of using wheeled devices to extend access and mobility.

Wayfinding – Information is not a physical connection, but is critical for transit users to successfully navigate a system. Wayfinding can consist of a city-wide visual style for signs directing individuals to common destinations, or can be as simple as a straightforward, easily readable bus schedule pamphlet. It can also include mobile applications or “apps,” the best of which tend to integrate transit information with other transportation options, such as walking, biking, transportation network companies (TNCs), microtransit, taxis, and/or car sharing. Information is often best presented as if the reader is unfamiliar with the area to accommodate visitors and newcomers, in very simple form.

Local and Connector Transit – In many areas successful at addressing first-mile/last-mile considerations, local transit connections to regional transit include shuttle buses or local fixed-route service with strategic stop placement and spacing. For example, Emeryville, CA, provides a free bus shuttle system connecting to the nearest Bay Area Rapid Transit (BART) station. Connecting local and regional service can be challenging. If local and connecting service is infrequent, long waits for transfers can make the service unattractive to potential passengers. Timing local service to connect, or even wait for, regional service is an option, but may decrease reliability elsewhere within the route network.

Taxis and Transportation Network Companies (TNCs) – Taxis can possibly be utilized as an alternative for first-mile/last-mile connections. While taxis proliferate around airports, hotels, and nightclubs, their role in conjunction with public transit is somewhat less clear. In some areas, transit agencies have entered into partnerships with taxi services to enhance and supplement transit access. In other areas, especially in tourist centers and warmer climates, "pedi-cabs" (bicycle taxis) can also provide these connections over a comparatively smaller area. Similar in nature to taxis are TNCs such as Uber and Lyft. These entities match vetted drivers with potential riders in an individualized transportation system. Although the ability to directly integrate this newer alternative with the transit network remains in somewhat in question, mapping and other applications have already successfully illustrated linkages between the two. Transit planners continue to examine and test methods by which to further increase and utilize these linkages.

Car Sharing – Car sharing companies such as ZipCar, Enterprise CarShare, and others can provide an additional level of connection and flexibility in communities seeking to address first-mile/last-mile considerations, though they tend to be more prevalent in larger urban areas. Availability of shared cars around major transit stations can allow transit riders to reach their final

destination more conveniently. Car-sharing, however, is probably most practical in addressing first-mile/last-mile considerations for occasional transit users and for passengers of long-distance modes such as intercity rail. Further research is needed to ascertain the existing as well as the most effective linkages between public transportation and car-sharing.

Microtransit – These services are enabled by mobile app technology, in a similar manner to the technology underpinning TNCs. The mode of operation is also somewhat similar to TNCs. In microtransit, a van or smaller bus owned or operated by a public transit agency offers more flexible routing and on-demand scheduling within a set service area. Within this service area, a potential passenger will often use a mobile app to schedule a mutually agreeable pick-up time and location, as well as a drop-off location; the service itself functions as a hybrid between fixed-route and demand-responsive modes. In the U.S., public transportation agencies are experimenting with these more on-demand, shared, and dynamic models to augment traditional fixed-route bus and train services. For example, CATA rolled out its **CATA**GO! microtransit service in early 2020.

Zoning and Density – Although outside the direct control of most transit agencies, zoning and density impact the manner in which transit agencies deliver service, and the effectiveness of those services. In certain areas, a light rail or major bus line may be better able to serve the full potential customer base because higher density of development and an appropriate mix of land uses place more individuals within walking range of transportation services. Moreover, planning and operating park-and-ride capacity at major stations can encourage some users to make a comparatively short drive and then use transit for the majority of their trip. Columbus, OH, and numerous other jurisdictions have demonstrated that cooperation among transit agencies and local governments to encourage density and a suitable land use mix around transit stops can be highly effective in encouraging transit ridership.

First Applications in Centre County

In Centre County, first-mile/last-mile considerations are currently addressed using the following local techniques:

Pedestrians – All Centre Region municipalities—as well as some local municipalities outside of the Centre Region—have some form of sidewalk ordinance requiring pedestrian facilities along public streets. Moreover, CATA participates on an advisory basis in the local land development approval process with the Centre Region municipalities as well as many outlying municipalities. This provides both CATA and local governments with a mechanism to remove barriers to and from transit stops through pedestrian improvements that are mutually agreeable to the transit agency and the local community. These improvements provide safety, comfort, and accessibility to all pedestrians, not just those who are also transit passengers.

Cyclists – Where is convenient and safe to do so, bicycling helps to extend the capture area of transit beyond the area of walkability. Not only is the Centre Region designated as a bronze-level "Bicycle-Friendly Community" by the League of American Bicyclists, but outlying Centre County contains a number of high-level bike facilities as well, with several of these facilities instrumental in connecting Centre County to other portions of Pennsylvania. These accommodations facilitate access to transit stops throughout our region. Moreover, CATA provides bicycle racks on the front of all fixed-route and microtransit vehicles. Bicycle parking at key transit stops within Centre County can be somewhat lacking, although such parking does exist in close proximity to a number of transit stops on the Penn State University campus. Further, a bike-sharing program was implemented on the Penn State University campus and in downtown State College, although the program provider (Zagster) suspended all U.S. operations in June 2020.

Wayfinding – Centre County is especially well-positioned in terms of displaying and distributing digital and physical information with respect to transit availability, with CATA providing a range of wayfinding options for both new and regular customers. The agency makes current information available via Google Transit, which not only illustrates transit options, but also details first-mile/last-mile pedestrian, bicycling, driving, intercity bus, and airline options. CATA's Ride Guide contains detailed schedule information, route maps, and passenger tips to assist riders in navigating the system. Moreover, all bus stops are clearly marked using recognizable CATA logos, colors, and emblems. CATA employs the TransLoc app to assist riders in using microtransit service. Perhaps most importantly in the current operating environment, CATA offers its own proprietary app in conjunction with Avail Technologies; this app shows bus locations in real time and offers trip planning features.

Local and Connector Transit – CATA covers most of its key stops and transfer points by connecting local community service with high-frequency service to the campus of Penn State University and downtown State College. This high-frequency service often operates on such a short headway that physical schedules and long wait times are not required. However, because CATA's fixed-route network primarily operates on a "hub-and-spoke" system, traveling between two outlying points may require a transfer and not be as direct or efficient as a private trip. The agency provides convenient connections to intercity bus services such as Greyhound and Megabus, but does not currently provide a fixed-route connection to the University Park Airport. No formal park-and-ride locations exist within Centre County, but several smaller informal clusters are served by fixed-route, vanpooling, and ridesharing services.

Taxis and Transportation Network Companies (TNCs) – Although the launch of TNCs in the State College area has correlated with the decline of taxi service, both modes continue to provide possibilities for partnership with public transportation. CATA's recent "Evaluation of Alternative Service Models for Areas of Low Population Density" study suggested a potential taxi or TNC voucher program for residents living outside of CATA's core service area. Such a program has not been implemented but may warrant consideration, given the potential to bring taxis, TNCs, and transit services from an environment of strict competition to one of more mutually beneficial cooperation. In order for this to happen, however, a number of specific regulatory, contractual, data-sharing, and funding considerations would need to be investigated and addressed. The State College area also has a pedi-cab service (Vamos! Lion Chariot) that can connect bus stops with other locations in the downtown State College area.

Car-Sharing – Car-sharing is currently still somewhat limited in the State College area, so impacts on first-mile/last-mile considerations are difficult to quantify. Moreover, these services typically work best as a first-mile/last-mile solution to long-distance services, which are not offered by CATA. Still, car-sharing continues to operate within the region; it may be useful to examine available data to determine precisely how these services interface with more traditional public transportation services.

Microtransit – As mentioned previously within this section, CATA launched its own microtransit service—**CATA**GO!—in early 2020 to serve the Bellefonte area, and to connect the Bellefonte area with several key locations closer to State College. This service combines a fixed-route transit model with elements of demand-responsive transit, as well as with elements of local and connector transit and TNC service as described above. Because the service is still in its early stages, a long record of reliable ridership data does not yet exist. Limited early ridership data, however, seems to suggest that this more flexible service is gaining market share, and playing a noteworthy role in improving mobility both within the Bellefonte area and between the Bellefonte and State College areas.

Zoning and Density – CATA enjoys strong working relationships with local municipal and Centre County governments in terms of voluntary participation in the land development plan review process. As part of this relationship over the last 25+ years, CATA has been successful in negotiating improved transit access, as well as complementary pedestrian and bicycle facilities, as part of both new land developments and property redevelopments. The agency has also been effective in establishing improved transit stops with bus pull-off areas, stop pads, shelters, real-time signage, and other amenities. Such improvements very often correspond to locations where appropriate density of development and mix of land uses help to enhance transit ridership and overall mobility. This advisory relationship has resulted in the elimination or mitigation of a number of potential barriers to transit usage within the region.

It is important to note, however, that this long-standing relationship is largely advisory and voluntary, backed up in only limited and rare instances by local ordinance. This means that not all worthwhile improvements are pursued as part of a new development or redevelopment. Moreover, sometimes improvements are necessary to an existing development, even if the property is not being redeveloped. In such cases, it is critically important that CATA be able to maintain an appropriate budget to implement and maintain improvements that cannot be addressed through cooperative work with local governments and developers. Examples might include expansion of a bus stop pad area or sidewalk connections, or placement of a shelter, at or near a location that is experiencing growth in ridership and utilization.

Actions and Planning Implications for Centre County

Multimodal Focus – Public transportation is a documented, contributing factor in improving mobility and reducing congestion within Centre County, particularly within the Centre Region and the immediate surrounding area. State College is one of the most transit-intensive urban areas of any size within Pennsylvania and the United States, in terms of transit trips taken per capita. Nevertheless, traditional transit services are not available in all portions of Centre County, or even the Centre Region. Real first-mile/last-mile challenges and barriers to accessibility continue to exist. Additional modes and service offerings continue to grow in their ability to meet these challenges and barriers. To the extent that traditional transit can be successfully and appropriately integrated with these additional modes and offerings, transit utilization will continue to grow, overall regional access will continue to improve, and mobility options will increase.

Funding – There are specific ways in which transit funding affects the ability to more effectively respond to first-mile/last-mile challenges. First, the mix of available funding at the federal, state, and local levels favors maintenance of existing services, and new funding streams for additional needs in expansion areas is difficult to generate. The current legislative environment in Pennsylvania, for example, does not support locally generated fees and assessments for such additional services. Second, the region is growing in population; new high-density development has taken place outside of the core CATA service area, or within corridors where service is already well over reasonable capacity. Both scenarios require funding for expansion, either in the form of significant additional service hours, or in the form of additional rolling stock—along with the space, workforce, and materials necessary to maintain that rolling stock. At a very basic level, regional providers need a mechanism to generate and utilize additional funding to both maintain existing services and assets and expand these services and assets as appropriate to better cover first-mile/last-mile needs.

Encouraging Appropriate Zoning and Density – As also previously noted within this section, transit services tend to perform better in terms of mode share—and are more accessible to individual riders—when operated in close proximity to sufficient population and development density, as well as an appropriate mix of land uses. Other factors being equal, these elements work in favor of

transit within the CATA service area. The Centre Region growth boundary and sewer service area tend to steer new development closer to locations where current development and services (such as transit) already exist. Moreover, varying types of land uses are all provided for and thoughtfully distributed within the CATA service area. Given limited budgets for public transportation and other public services, it makes sense to locate future residential, commercial, and office development—particularly those anticipated to generate a large number of daily trips—as close to existing infrastructure as is practical.

Cost/Benefit Analysis – Because upgrades to bus stop areas, bicycle parking, and/or pedestrian infrastructure are periodically required beyond what can be provided for through the development plan review process, it is critically important for CATA and local governments to appropriately weigh the cost of such improvements against the number of users (or potential users) who may benefit, as well as against the significance of the first-mile/last-mile challenge being addressed, or the mobility barrier being removed.

Integration of Technology – CATA has expressed interest in pursuing a "Mobility as a Service" concept that better links traditional fixed-route transit services with other CATA services, and with other modes and service offerings such as intercity bus, bicycling, car sharing, taxis, and TNCs. This concept may be centered on one or more "mobility hubs" within the region. The degree to which such a concept can be successfully deployed rests heavily not only on better connections between the actual modes of transportation themselves, but also on the extent to which the mobile apps associated with each of these types of transportation can be coordinated to better provide scheduling and use information. The Google Transit feature (in which CATA participates) provides one good example of such integration. A more localized app might include Google Transit features combined with elements of CATA's fixed-route and microtransit apps, bike sharing and car sharing apps, intercity bus and TNC apps, and the like.

Potential Future Developments

Electric Scooters – Scooter programs have been established in other locations worldwide, including the U.S., with varying degrees of success. They might be expected to provide a range of travel similar to personal bicycles and bike-sharing programs, with ranges greater than that of pedestrians, and shorter than that of TNC patrons and car-sharing program participants. As of the writing of this document, electric scooters are not yet legal in Pennsylvania, and thus have not yet become established in Centre County, though Penn State University and several local jurisdictions are watching development closely. What such a program might look like once established remains somewhat unclear. If scooter abandonment, passenger safety, and other similar concerns are to be successfully mitigated, however, it seems clear that state and local regulation will play a significant role, as will the specific firm ultimately chosen to administer the program. It is especially important that individual regional jurisdictions attempt to come together on a single provider and set of rules should scooters become available within the area.

Expanded Car-Sharing – With Penn State University hosting Enterprise CarShare, and ZipCar having limited availability in the rest of the State College area, car-sharing holds a relatively low market share relative to overall regional mobility. Should one or both of these programs begin to grow and expand, however, additional data may become available in terms of the interface with public transit, as well as with other modes of transportation. Moreover, car-sharing may exhibit growth in the region as preferences shift to owning fewer family automobiles for daily use. Should this turn out to be the case, there will almost certainly be corresponding impacts to public transportation ridership and utilization.

Expanded Bike-Sharing – As with car-sharing, bike-sharing also holds a relatively small market share relative to overall regional mobility, although limited availability does exist on the Penn State University campus, and with small individual corporate fleets. Further, should availability begin to expand, it will almost certainly yield additional data by which the interface with public transit and other modes of transportation could be examined. Increased bike-sharing within the region could lead to eventual increased ownership of personal bicycles within the region, as potential users are able to test the utility of bicycling to their regular trip and begin to build a comfort level. If observed, this trend may change specific first-mile/last-mile considerations, or real or perceived barriers to be addressed. It may also change the linkage between bicycle use and public transit ridership and utilization. As with scooters, consistency in providers and regulations will be critical.

Cooperation with TNCs – As mentioned previously in this section, CATA's recent "Evaluation of Alternative Service Models for Areas of Low Population Density" study recommended a taxi or TNC voucher program for residents living outside of CATA's core service area. Whether or not such a program is implemented, it seems reasonable to more closely coordinate public transportation with increasing TNC availability and utilization. Doing so may help to stabilize the relative mode share between transit and TNCs, as well as to address some of the barriers to transit accessibility within the region. It may also help to gain access to the wealth of origin, destination, and travel-time data possessed by TNC entities, for the benefit of better transportation planning within Centre County.

Expansion of Microtransit – As mentioned previously within this section, CATA recently implemented microtransit service to serve the Bellefonte area, and connect it with the State College area. The more flexible, responsive, and personalized nature of this type of service seems to indicate that, if successful in its current application, the model may be suitable to meet first-mile/last-mile challenges in other portions of the CATA service area as well. Should this prove to be the case, changes would necessarily occur in CATA's financial, infrastructure, and operations strategies.