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Viability of Personal Rapid Transit In New Jersey

Executive Summary

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and

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INTRODUCTION

The following report was prepared for the New Jersey Legislature to document the current state of Personal Rapid Transit (PRT) development and implementation and to explore the potential viability of implementing PRT in New Jersey. The report summarizes the history of PRT development efforts worldwide, documents lessons learned from past research and development activities, explores the opinions of several PRT industry experts regarding the current state of PRT development, presents the theoretical benefits of PRT when compared to other modes of public transportation, identifies the challenges and risks associated with PRT implementation and presents a series of options for advancing PRT development in New Jersey should decision makers decide to do so.

PRT has been the subject of research and development efforts for approximately 40 years. However, there has yet to be a full scale deployment of this technology. A fully operational PRT system is needed to demonstrate the theoretical benefits of PRT and establish commercial readiness and significant research and development activities must still be undertaken. Such a research and demonstration program has been conceptually estimated to require $50-100 million over a three year period. It is important to note that PRT is an emerging public transportation technology and has not yet advanced to the stage of commercial deployment or achieved wide-spread public operation. As such, much of the information presented in the report, especially information related to the potential benefits of PRT, is based on conceptual engineering and theoretical research from PRT developers, government researchers, or independent consultants. Wherever appropriate the potential or theoretical nature of particular data and information is made clear and the source of information is noted.

BACKGROUND AND RESEARCH OVERVIEW

In October 2004, the New Jersey Legislature passed P.L. 2004, Chapter 160 directing the Commissioner of Transportation, in consultation with the Executive Director of NJ TRANSIT, to prepare a report evaluating the viability of Personal Rapid Transit (PRT) in New Jersey. The bill recognized that New Jersey's transportation needs are broad and diverse and noted that it is in the State's interest to actively improve and diversify a transportation system that has proven fundamental to its long-term economic success.

In July 2005, the New Jersey Department of Transportation (NJDOT) contracted with the Alan M. Voorhees Transportation Center at Rutgers University (VTC) and Booz Allen Hamilton (BAH) to conduct a study of PRT designed to:

1. Provide a complete and thorough description of the key elements of PRT technology and identify PRT components that have been demonstrated successfully and those that are conceptual in nature;

2. Identify potential PRT system developers and assess the current status of PRT relative to implementation readiness;

3. Compare and evaluate the potential benefits and costs of PRT to other modes of transportation in terms of: capital costs, operations and maintenance (O&M) costs, energy use, ability to reduce congestion, and potential environmental/community impacts; and

4. Evaluate the viability of integrating PRT as a supplement to NJ TRANSIT's current and future transportation networks and services.

FUNDAMENTAL ELEMENTS OF PRT TECHNOLOGY

As previously stated, PRT is an emerging public transportation technology designed to address the needs of urban transportation in a variety of settings. Since it was first conceived in the 1960's as a new, yet complementary mode of transport, it has undergone a variety of design and technology innovations. The literature provides a variety of descriptions and definitions of PRT that have evolved over its history. Today, there is general consensus among transit experts and PRT developers that the key characteristics of PRT include:

- On-demand, origin-to-destination service – At the originating station, a traveler using a PRT system would input his or her desired destination station. A waiting PRT vehicle or one dispatched to the station would then transport the traveler to the desired destination with no intermediate stops. There are no pre-determined schedules;

- Small, fully-automated vehicles – PRT vehicles are intended to operate under computer control and require no operator or driver. Prototype vehicles are designed for two to four passengers and can be ADA accessible;

- Exclusive-use guideways – Tracks or "guideways" for PRT vehicles must be designed to prohibit at-grade crossings with pedestrians or other types of vehicles. The guideways are usually designed as elevated systems with beams and support structures sized appropriately for lightweight two-four passenger vehicles ;

- Off-line stations – Off-line stations are designed with a "siding" track or guideway so that vehicles not stopping at a particular station can bypass that station and are not delayed by other vehicles boarding and alighting passengers; and

- A network or system of fully-connected guideways – Unlike conventional public transportation systems that are generally constructed as a single line or a line with branches, PRT systems are usually conceived as an interconnected system or “grid” of guideways, with junctions at the intersecting points of the grid. These junctions allow PRT vehicles to select from a variety of paths through the network, similar to autos operating on a street grid. The density and extent of the PRT grid system will determine the maximum walk distances to stations and the number of origin and destination points to be served by the system.

These characteristics are fundamentally distinctive from conventional guideway transit systems that typically involve larger vehicles operating on a schedule using larger guideways in a line-haul configuration with on-line stations. As a new technology, PRT combines the elements of current automotive, computer networking and transit technologies using state-of-the-art technologies including: advanced propulsion systems, on-board switching and guidance, and high speed controls and communication. As such, PRT systems represent a new paradigm for urban public transportation.

CURRENT STATE OF PRT DEVELOPMENT

According to the Advanced Transit Association (ATRA), there are more than 90 new transportation technology systems under development including many PRT systems. In 2003, ATRA studied various PRT systems under development evaluating and comparing their technology, features and development status. The study reaffirmed that PRT is technically feasible and concluded that the most persisting barriers to implementation are financial and political (ATRA, 2003).

Based on a review of the literature and research team experience, four prototype PRT systems were selected for more detailed review and analysis. These four systems provide the fundamental PRT characteristics, have a current or past development program, and have potential to support a near-term PRT implementation. They include:

System	Developer
SkyWeb Express	Taxi 2000 Corporation
ULTra	Advanced Transport Systems
Vectus	Vectus PRT
Cabintaxi	Cabintaxi Corporation USA

Other systems considered for analysis included those from Austrans, Coaster, Ecotaxi, Skytran, Megarail, RUF, York PRT and 2getThere. These systems are less well advanced but are recognized as having development programs that may result in commercial system capabilities.

To understand better the current state of the PRT industry and to learn from the history of PRT development, the research team conducted a survey of leading PRT system developers and industry “experts” to gather insight into the future of the technology and the challenges inherent to PRT implementation. The following is a summary assessment of the current state of the industry based on the survey of PRT developers and expert interviews:

- **PRT systems are approaching but not yet ready for public deployment.** Significant PRT research, engineering, development and application study programs have been conducted over the past 40 years. These programs have been supported by a variety of academic, governmental and private industry organizations around the world. Several system development programs are nearing completion of an initial pilot or demonstration system. Although these past efforts provide a foundation of engineering and test information that can be used for initial application and alternatives analysis, additional development work is needed to validate the capital and operating costs associated with deployment of this technology for a specific application and minimize any risk for a public deployment.

- **Many of the technical components needed to support PRT systems are commercially available and are used in other industries.** These components include:

    - Advanced control and communication systems to deliver the required levels of safety, reliability and performance;

    - Network management systems and on-board switching or guidance needed to achieve short headways in order to optimize system capacity; and

    - Advanced propulsion and braking systems to provide the required vehicle performance in all weather conditions.

  While each of these components has been tested in small-scale PRT development programs and/or may be commonly used in related automated transit or industrial automation applications, the task remains to assemble, integrate and test such components under rigid safety requirements and the demanding day-to-day reliability requirements of a transit environment.

- **Global PRT interest and development programs are expanding.** Cities and regions continue to display interest in PRT around the world. The most advanced PRT development efforts include:

    - An active test track in Cardiff Wales and a joint development program between ***ULTra*** and the British Airport Authority for an installation at Heathrow Airport;

    - A comprehensive development program including test tracks in Sweden and Korea for the ***Vectus*** system;

    - A prototype vehicle and section of guideway in Minnesota as well as a small-scale network model for the ***SkyWeb Express*** system in the United States; and

    - An extensive test track (not currently operating) that verified system technology and operation of the ***Cabintaxi*** system.

- **A fully operational PRT system is needed to demonstrate the theoretical benefits of PRT and establish commercial readiness.** The Morgantown system serving the University of West Virginia is the only active operating automated guideway system with off-line stations and on-demand service similar to the PRT concept of operations. This system is no longer commercially available and uses large vehicles. A fully operational PRT system of reasonable scale with multiple small vehicles operating on-demand with off-line stations is needed to verify commercial viability and gain public support. Even further, to fully understand the benefits of competing technology configurations, several demonstration systems may require completion to help select a preferred configuration.

- **A comprehensive technology research and demonstration program is needed to develop a PRT system.** As noted above, PRT technology has not yet advanced to a state of commercial readiness and several competing designs are under development. The development of PRT technology requires a comprehensive system engineering program that includes alternatives analysis, initial design, prototyping, component testing, system design, testing and certification. The programs reviewed for this report are meeting these goals with various degrees of rigor, funding, public support and eventual success. New Jersey has the option to monitor these development programs or pursue a new program that builds upon these efforts. According to the industry experts interviewed for this study, a comprehensive program to develop and test a commercially-viable PRT system including a small test track is estimated to require $50-100 million over a three-year program that will require consistent support to maintain program objectives.

POTENTIAL APPLICATIONS OF PRT IN NEW JERSEY

Many factors affect the viability of a public transportation system for a specific location. Key factors include population, employment and household density, as well as other factors such as household income, automobile ownership rates, land use mix, site design, and even the quality of the pedestrian environment in a particular area. Not all places in the State are appropriate for public transportation service.

The viability of PRT to effectively serve transportation demands in New Jersey is conditioned upon matching the technology with the local need. Using the lessons learned from previous PRT research and development activities, the following examples are local needs that could potentially be served by a PRT system:

- **Areas with high demand for local circulation:** PRT systems have the potential to be viable in areas that exhibit significant demand for local circulation such as regional activity centers and campuses. PRT networks could effectively support areas that have many origins and many destinations derived from a mix of land uses such as residential, retail, employment and entertainment. PRT has the potential to be quite effective where the origins and destinations have travel demand throughout the day in addition to a peak commuter travel demand.

- **Areas with the potential to extend the reach of nearby conventional public transportation:** PRT systems have the potential to be viable where the system provides an intermodal connection to conventional fixed-guideway or fixed-route transit services such as an existing express commuter bus terminal and high ridership rail stops or stations. PRT systems could be used to extend the reach of the conventional public transportation system by connecting nearby areas and neighborhoods to the station or terminal. Within that context, PRT could also be used to manage parking demand at the station or terminal by providing an alternative to auto access and the ability to connect to remote/satellite parking facilities.

- **Areas with constrained access and/or congested local circulation:** Individual mode choice decisions are often made based on travel time considerations comparing public transportation alternatives to the private automobile. Consequently, areas with congested travel conditions on roadways that provide access to and circulation within a location may be an attractive location for a PRT system as an alternative to private auto travel. The viability of a PRT system in such locations would be even further enhanced where access is constrained and limited land availability limits the ability to expand capacity on congested circulation routes and local street networks. In these constrained and congested locations, PRT could provide an opportunity to connect the core area with remote and satellite parking facilities reducing the need to travel within the core area.

- **Areas with constrained and/or expensive parking:** Although regional and local congestion helps to shape individual mode choice decisions, an even more significant factor is the availability and cost of parking. As in the case with conventional public transportation modes, areas with limited and/or expensive parking would be expected to generate higher demand for PRT service. PRT could provide an opportunity to connect to/from remote parking facilities helping to manage parking demand at these places.

- **Areas requiring connectivity between high activity centers:** Initial PRT system implementations could potentially be viable in the areas previously described such as regional centers, campuses, congested locations and as extensions to conventional public transportation system station. PRT could also be expected to be viable as a connector of these initial systems, providing an integrated public transportation network across a region, eliminating the need to transfer between modes or within the mode. As a scaleable network system, PRT could initially be deployed to support the locations with the highest need and then expand to connect these initial deployments as demand and economic conditions allow.

It could be anticipated that initial PRT systems will be deployed in non-residential areas along commercial roadways with limited potential community impact and disruption. Initial PRT systems will require thorough testing and must achieve public acceptance before they would be considered for larger scale expansion. The scalability and reliability of the system would need considerable validation. If this is achieved, PRT systems could also be envisioned to expand along secondary roadways and potentially serve residential areas as community interests would require.

CHALLENGES TO IMPLEMENTATION

Currently the PRT development industry receives only limited support from the public and private sector. There are only a few small firms advancing the development of PRT technology. There are limited industry standards guiding PRT development and there is limited expertise and understanding of PRT concepts in conventional transportation consulting, engineering, planning and policy-making sectors. As an emerging technology, the market processes of product evaluation, acceptance, and standardization are to be anticipated before full technology maturation is achieved. Since there are only a few PRT systems in development and only one hybrid system in operation, any State or agency choosing to implement an initial PRT system will assume higher risks of system implementation and operation and may incur greater expense and other difficulties in addressing problems that may arise from public operation.

The following challenges will need to be addressed as PRT development continues:

- **Engineering and planning expertise:** There is limited depth of experience or understanding in the transit industry regarding the advanced technology concepts central to PRT design and operations. This experience does exist, however, in other industries that support advanced technology development such as aerospace, automotive, defense, computing and networking. It will be important to draw upon the technology expertise from these industries and combine it with the operating expertise from the transit industry to develop an advanced, robust and “public ready” PRT system.

- **Open technology development**: PRT technology is currently under development by independent suppliers that are seeking to develop products that have a competitive advantage to other suppliers. This is a normal and advisable business practice in the early stages of product development. As the industry matures, it will be in the interest of potential customers of PRT suppliers to encourage the use of open technology that avoids proprietary designs and vendor exclusivity. It will also be in the interest of potential customers to encourage the use of commercially available components to avoid specialized product development, unique support and maintenance requirements, higher costs, and less flexible and responsive operating environments.

- **Development and application of standards**: As a new technology, PRT could benefit from the development and application of appropriate performance and operating standards as the technology advances. Standards will be needed in various areas including safety, security and interoperability. It will be important to ensure that technology standards do not unnecessarily limit innovation and competition which could improve the performance of PRT systems overall. Conversely, it will also be important to guide the development of the technology with standards that protect the public’s health, safety and welfare.

  In terms of standardization, lessons can be learned from the past experience of the American Society of Civil Engineers which developed standards for Automated People Mover industry and the National Fire Protection Association (NFPA), which developed NFPA Standard 130 covering fire protection and fire life safety issues applicable to fixed guideway transit and passenger rail system including Automated Guideway Transit. Additional analysis will be needed to determine the efficacy of applying current industry standards versus the development of new standards.

- **Intellectual capital management**: To provide for competition in the PRT marketplace, it will be important to seek multiple vendors with the capability to provide interoperable components and sub-systems. If patents are owned solely by the initial system provider, that provider may monopolize the market and set high prices for system extensions, upgrades and replacement parts. In addition to open architectures and interface standards, it will be important to foster sharing of key patented technology through licensing or other arrangements between vendors, suppliers and customers.

- **Institutional framework support:** Currently, there is minimal institutional infrastructure and expertise (i.e., experienced and knowledgeable design, operations and maintenance professionals within the conventional transit industry) to support the specialized analysis, design, construction and operations needed to implement PRT and ensure safety and security. This expertise can be acquired by retraining personnel, hiring additional staff or contracting with private firms, as appropriate, depending on the implementation agency's needs.

- **Consistent political, economic and technology support:** The development and implementation of an initial PRT system and the subsequent implementation of PRT in other locations will require a long-term commitment of financial resources. It will also require vision, innovation and consistent political support. The history of PRT has many examples of development programs that started with good intentions but were halted due to changing political agendas, incomplete funding, inadequate engineering and economic analysis, inappropriate design standards and many other factors. Specific attention should be given to the lessons learned from the Chicago Regional Transportation Authority (RTA) effort to develop a PRT system in partnership with the Raytheon Corporation. Changes in requirements, technology, political leadership caused this program to fail. The lessons learned from these previous development programs can be used to simplify and streamline any future PRT development efforts but may not eliminate all potential pitfalls.

COMPARING PRT TO OTHER MODES

Although largely untested under "real-world" operating conditions and despite the many challenges to implementation, PRT developers, researchers and advocates believe that PRT has the potential to provide a unique level of cost and service for certain specific urban applications some time in the future. This section compares PRT to other modes of transportation. In reviewing this section, the reader should note that some of the comparative information has been extrapolated from limited PRT experience. As such, the comparisons made as part of this study should be reviewed and validated over time as additional "real-world" application data becomes available.

- **Average travel speed and overall trip times for comparable trips:** When comparing observed national data for conventional public transportation modes to model data from conceptual PRT simulations, it appears that, PRT could conceptually achieve between 14 and 65 percent faster average travel speeds and between 14 and 125 percent faster overall trip times than bus, light rail and heavy rail transit. This is primarily due to the non-stop, on-demand nature of PRT operations. Estimates are for station to station travel and do not include walking or other mode travel times to access transit stations/stops which will vary by mode and the unique characteristics of each transit system.

- **System capacity:** Conceptual PRT simulation data also indicate that PRT systems could have theoretical capacities up to 10,000 people per hour per direction (pphpd) with operating capacities of 3,000 to 7,000 pphpd. This capacity is similar to the observed operating capacity of most current light rail and bus rapid transit applications.

- **Capital costs:** Engineering cost estimates provided by various PRT developers and empirical data from comparable conventional elevated guideway systems built in the United States were used as part of this study to derive engineering capital cost estimates for potential PRT applications. These estimates indicate that capital costs for constructing a two-way PRT system could be expected to average $30-50 million per mile. The estimates assume that initial pilot PRT systems have been developed, successfully operated in a test environment and that manufacturing efficiencies have been achieved. It can be anticipated that early PRT systems may have higher costs due to development issues and initial manufacturing startup inefficiencies.

  Although these estimates compare favorably to other larger guideway, larger-vehicle modes, actual costs will depend on the specifics of guideway design, local land use and geological conditions and the extent of the guideway network. Furthermore, it should be noted that the actual capital cost of transportation infrastructure investments constructed in New Jersey have frequently exceeded original cost estimates. Costs in certain categories have risen sharply over the years. Increases in many of these categories, including those associated with land acquisition, environmental mitigation, utility relocation, financing, engineering, insurance, administration and construction management, are likely to apply to PRT as well as conventional transit systems. Finally, it is also worth noting that the Morgantown, WV system, the only PRT-like system constructed in the United States, exceeded estimated construction cost by four times. Until more commercially-viable PRT systems are built in the United States or elsewhere, capital cost estimates will remain somewhat speculative.

- **Operating and maintenance (O&M) costs:** As conceived, PRT systems would be highly automated with low staffing levels, energy use and maintenance requirements. A comparison of observed national average O&M cost data for conventional public transportation modes and O&M cost estimates developed for this study using data provided by PRT developers and observed O&M cost estimates for APM systems, indicate that PRT O&M costs per passenger mile might range from $0.30 to $0.80. This compares favorably to other modes. However, since PRT vendors have very limited O&M experience, until more commercially-viable PRT systems are built, O&M cost estimates will remain somewhat speculative. Also, when comparing vendor O&M estimates with observed transit operating costs, it should be noted that transit agencies incur a number of cost categories that may not be reflected in vendor estimates, such as policing and security, fare vending and collection, station cleaning and maintenance, claims and insurance.

- **Ridership and congestion relief:** Depending on the system scale, design, and fare policy, PRT systems could theoretically attract a high level of ridership in certain transit markets due to potentially improved service characteristics such as shorter travel times, lower cost, and greater comfort, access and availability when compared to other conventional public transportation modes. These service characteristics could theoretically be competitive with automobile travel under some circumstances. To the extent they are, PRT possesses the potential to attract auto users and thereby reduce congestion.

- **Energy use and environmental impact:** As conceived, PRT systems will operate non-stop, on-demand service using lightweight vehicles on exclusive-use guideways. As such PRT developers estimate that PRT systems will consume 50 to over 300 percent less energy than conventional public transportation systems and could achieve an automotive equivalent energy use of 70-90 miles per gallon. In addition, because of their conceptual design using rubber tires and electric propulsion, PRT systems could be expected to have lower noise and local pollution impacts than other conventional public transportation modes. Given the fact that PRT system will most likely be built utilizing elevated guideways, they could have potentially more visual impact than comparable at-grade systems. It should also be noted that elevated guideway systems by their very nature are likely to engender citizen concern as part of any public project development process.

The comparative conceptual benefits of PRT described above are predicated on the assumption that PRT technology development achieves the goals described in Section V of this report. As discussed in Section V, PRT technology development is progressing with limited funding and without the coordinated support or endorsement of a major public entity. The conceptual benefits of PRT are fully realizable using current technology. However, in order to fulfill the promise of PRT, system developers will need to apply rigorous, methodical and careful engineering to final system design in order to achieve the proper balance of performance, cost, service, safety and security. Many past PRT technology development programs have attempted to demonstrate these benefits but have not been successful in one or more areas.

OPTIONS FOR NEW JERSEY

The following options are presented for consideration by decision-makers to advance the state of PRT and become viable options to address transportation needs within the State of New Jersey:

Option 1 – Monitoring and support

Under Option 1, State officials would play no active role in advancing the development of PRT. The State would monitor PRT development activities conducted by private developers and other governmental organizations around the world and reconsider the State's role in the future, as appropriate. This option requires no commitment of State funds and eliminates the risk of State agencies selecting sub-optimum technology configurations for early implementation. At the same time, this option limits the State's ability to influence the pace and direction of PRT development. In addition, PRT development activities may favor technology solutions not appropriate for implementation in New Jersey. For example, technology solutions that operate in fair weather climates may advance while those appropriate for cold weather operation do not. Finally, this option may prevent the State from capitalizing on an opportunity to develop a new PRT industry centered in New Jersey.

Option 2 – Research and analysis

Under Option 2, the State would sponsor New Jersey-based research in areas that will advance PRT development, including the use of tools, analysis techniques and data that support the understanding, development, implementation and operation of PRT systems. This option could provide a foundation for effective demonstration and implementation of PRT systems in the State and elsewhere. It could also raise New Jersey's profile as a leader in helping to guide and shape the new technology and industry. This option could help to ensure that advancements in PRT technology are appropriate for New Jersey applications (i.e., systems capable of operating in cold climates). Finally, this option could help to cultivate a base of knowledgeable and experienced engineers, designers and planners to support the growth of a PRT industry in the State.

Option 2 requires a level of risk and investment of State resources in research that may not have tangible results in the short or long term. Further, research alone, with no commitment to a comprehensive research and development program and/or implementation, could be of limited effectiveness. Finally, even with additional research, PRT developers may fail to secure the investment funds needed to advance PRT to operational deployment.

Option 3 – Detailed application studies

Under Option 3, State officials would identify and select a limited number of potential PRT application sites and conduct feasibility assessments of one or more applications including cost, performance, ridership, layout and impact analysis. This option could also include public outreach activities to explore public perceptions of PRT as a viable mode of transport.

This option lays the foundation for potential PRT implementation if PRT technology development and demonstration systems prove successful. It enhances PRT developers' ability to secure private investment by identifying potential applications and creates an opportunity to educate the public regarding the technology and its potential benefits. At the same time, this option requires the commitment of limited State resources without any guarantee of tangible benefits. It may also raise expectation among the public and policy makers before the technology is ready for implementation.

Option 4 – "Proof-of-concept" public/private program to develop and operate a pilot test track

Under Option 4, State officials would help build, partially fund and support a public/private partnership to conduct a comprehensive program to develop and operate one or more test tracks to demonstrate PRT performance. The comprehensive program would include product design and engineering, prototype and component testing, construction of at least one full-scale test track, system testing for reliability and safety, and efforts to achieve commercial readiness. From previous PRT and similar development programs, it is expected that the program may require between $50 and $100 million depending on the selection of technology from previous and current programs and the degree of test track construction and testing.

This approach would establish a shared risk funding and ownership program with other state and federal transportation agencies and various private partners. Under this option, the State could limit its share of the program to some acceptable level of investment. To help to ensure success, the State could take a leadership role in developing system performance requirements, testing the technology, and working with the partnership to construct initial system demonstrations.

This option could provide New Jersey with the opportunity to demonstrate international leadership in shaping the future of the technology; structure a program around New Jersey applications; and create a network of engineers, planners, technology developers, manufacturers, and support organizations in New Jersey to foster the creation of a new PRT industry in the State. It may also shorten the implementation time frame and provide a higher probability of success with an opportunity for the State to receive return on its investment from revenue sharing and economic development benefits.

At the same time, this option requires the State to commit public funding to support the development partnership. Given the nature of public/private partnerships, this option comes with risk. There is some potential to develop sub-optimal technology solutions as experienced in the Chicago RTA program and public/private partnerships are vulnerable to leadership change over time. This could negatively impact success, especially if political support weakens, or technology development is delayed.

It should be noted that this development program would result in a full technology readiness and the ability for the State to begin implementations of the technology for public operation. It is expected that the test track from the development effort would remain an ongoing test and development facility for the partnership or a research university that may be part of the partnership.

CONCLUSION

PRT is an emerging and innovative transportation concept designed to offer the comfort and convenience of the private automobile with the efficiency of public transportation. PRT offers the theoretical potential to increase travel speed, quality of public transportation service and mobility while potentially reducing the costs and environmental impacts associated with travel. PRT has the potential to be a mode of urban transportation that offers a flexible and scalable capacity with higher levels of service and less expense than many current public transportation alternatives. Conceptually, PRT could serve as a stand-alone public transportation system or be part of the larger multi-modal network of urban transportation services.

If system development continues as expected, PRT could theoretically become an effective tool to improve urban congestion, sustainability and livability. PRT offers a mode of service that could be more competitive with the private automobile than conventional public transportation systems and potentially attract more drivers from their cars. Further, PRT offers the potential to reduce the energy use, land use, and environmental impact of transportation allowing the implementation of more sustainable transportation solutions in today's congested infrastructure.

While PRT may offer future potential, it requires additional development and demonstration. PRT has undergone significant research and development but has not fully advanced to a state of commercial readiness. Current PRT development activities are proceeding with limited resources and limited public support or guidance. Although initial PRT systems may potentially be available for commercial implementation in several years, the full development and implementation of PRT must be a long-term strategic initiative. Additional support and resources will be needed to help PRT to reach maturation and to realize its theoretical benefits.

As an emerging technology, PRT requires a market that is receptive to the new paradigms of smaller scale infrastructure, automated small vehicles, off-line stations and on-demand service. The development and support must continue throughout the emergence PRT must complete before it can become a full member of the transportation community. Each of the options presented above would be legitimate responses to the current state of PRT development. Ultimately, State decision-makers will need to determine how proactive they wish to be. Option 1 requires no investment of public funds or political capital. Options 2 and 3 carry some risk but also limit potential gains. Option 4 represents the greatest risk to the State in terms of financial investment and exposure in a time of significant fiscal constraint and commitment to a specific policy direction; however, it also may result in firmly establishing the real costs and benefits of employing PRT and therefore the greatest return.

PRT has the potential to help the State address certain transportation needs in a cost-effective, environmentally-responsible, traveler-responsive manner. The ability of the State to take advantage of this technology will depend upon the State's ability to sustain an adequate level of investment and commitment to support the full maturation of the technology.

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