LoopWorks Business Plan

Version 7
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(http://sunnyhillsneighborhood.org/business-plan.pdf)

Milpitas Dual-Loop Personal Rapid Transit (PRT) Project

Executive Summary

Loopworks hopes the Milpitas advanced transit project will be a see, touch and ride inspiration to change the way transportation is viewed in cities across the world. That starts with a Vision to "Provide climate-friendly and easy-to-use Personal Rapid Transit (PRT) for movement around Milpitas that bypasses traffic with quick, point-to-point and fare-free rides." The vision, however, extends worldwide: *The LoopWorks PRT project inspires rapid adoption of advanced transit that dramatically reduces transportation sector emissions.*

PRT delivers:

- clean, quiet and responsive public transportation
- automated service available 24 hours a day, rain or shine
- personal comfort and safety at stations and in transit
- construction and operating costs lower than comparable transit options

Project Description

The Transit Area around the Milpitas BART transit hub is badly congested, densely populated, and rife with barriers that challenge walkers and cyclists. A Dual-Loop PRT System is proposed to mitigate both the congestion and the accessibility issues. Using small electric vehicles on elevated guideways unobstructed by ground-level conditions, residents from 7 separate housing areas could easily access the BART station, new elementary school, Great Mall shopping center, and three city parks.

PRT has been technically and financially viable for the past 40 years, but institutional inertia and fear of political consequences has impeded progress. To reduce fear and avoid institutional resistance, LoopWorks will use 3 innovative strategies:

1) Utilize a vehicle design that minimizes guideway size and substantially reduces PRT costs.
2) Adopt a California Benefit Corporation legal structure to provide flexibility and transparency unavailable through governmental, for-profit, and non-profit corporate structures.
3) Seek foundation funding rather than money from government agencies or investors for designing and building the system to minimize delay and ensure financial viability.

Business Model

LoopWorks will secure grant funding for engineering and construction from foundations with goals of reduced greenhouse gas emissions, increased transit ridership, or social equity. To provide free rides to users, alternative revenue streams will be secured to fund the low cost of operations and maintenance. All revenue can be applied to running the system and serving people because grant money eliminates the need to pay for both capital costs and interest on debt.

The LoopWorks PRT system will achieve two major goals: 1) provide extraordinary public transportation service in the Milpitas Transit Area, and 2) provide a new model for future transportation projects. The data and the knowledge gained from building this first PRT system will be useful in sparking, refining and strengthening future projects.

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Company Description

Our Climate Crisis demands bold, out-of-the-box solutions, especially in the transportation sector. LoopWorks is committed to one such solution – Personal Rapid Transit (PRT) - that represents a paradigm shift in public transit, and provides climate-smart opportunities to improve the lives of people.

LoopWorks will build and operate a PRT system in Milpitas comprised of two loops. The first loop of the dual-loop system will be the Mini-Loop, which will be followed by the BART Circulator as shown here. Unlike traditional public transit, PRT offers electric-powered, quiet, responsive transit with automated non-stop service available 24 hours a day. In addition to these service benefits, PRT costs far less to build and operate than other transit options – and is safer than walking and cycling on nearby busy streets.

The technological foundation for the system will be the hardware designs, software specifications, and engineering data from Intelligent Transportation Network System (ITNS). Also, much of the material in this business plan is drawn from the ITNS Business Plan.

The ITNS plan uses a traditional economic model focused on attracting for-profit investments from outside of a community. The unfortunate result of such a model is that wealth leaves the community, rather than remaining available for the community's benefit. LoopWorks chooses another path in which the owner-operator is of, by, and for the community.

LoopWorks will be legally structured as a California Benefit Corporation under the Corporate Flexibility Act of 2011 which "authorizes and regulates the formation and operation of flexible

purpose corporations." Such corporations are empowered to pursue both for-profit and non-profit objectives. As Directors of a Benefit Corporation, the LoopWorks Board will pursue the triple bottom line of profit, people and planet when making business decisions. In exchange for this flexibility, the State requires the corporation to 1) pursue a general public benefit, and 2) create built-in mechanisms to enforce transparency and accountability.

As a Benefit Corporation, LoopWorks enjoys these benefits:

- improved prospects for securing grants from foundations interested in building community more than profiting companies;
- community wealth benefits more people because it remains in the local economy;
- legal flexibility to quickly adjust to economic and other changes in its environment.

LoopWorks will lead the effort to build a Mini-Loop to serve the Milpitas BART/VTA Transit Center, Great Mall, proposed grocery store, park/school, and 2 housing areas. Success there will be followed by a second loop - the BART Circulator - that includes 7 more stations serving 3 additional housing areas, another park, and the City's industrial core.

Until the system goes operational, the Board of Directors will likely contract work out as much as possible to businesses located within Santa Clara County and paying prevailing wages.

The LoopWorks Board of Directors will be annually elected by verified members. This will ensure that the Board considers the impact of its decisions on people employed to create the system along with customers, suppliers, community, and the environment.

Stakeholders

LoopWorks recognizes that this project will affect many people and businesses in Milpitas. Stakeholders to consider while moving forward include:

- nearby residents who could use the PRT system
- nearby businesses whose customers and employees could use the PRT system
- all Milpitas residents and businesses who could benefit from a PRT "tourist attraction"
- various right-of-way (r-o-w) property owners
- City of Milpitas gains prestige and economic development opportunities
- other cities and agencies with an interest in PRT development (Mt. View, Sunnyvale, San José)
- foundations interested in reducing CO_2 emissions or increasing transit use and/or social equity
- government agencies interested in reducing CO_2 emissions or increasing transit use
- Transit Area developers that want to reduce parking ratio requirements
- other developers with an interest in PRT service such as the proposed mega-project just outside Milpitas (north of Montague along Coyote Creek).

High levels of transparency are essential to the accountability and functioning of organizations with highly participatory decision-making processes like LoopWorks. Thus, financial, strategic and operational information will be readily available to stakeholders.

Key partnerships

Our strategic partners will include Intelligent Transportation Network System (ITNS - the system designer), the City of Milpitas and a major construction company. Additionally, long-time Milpitas resident Rob Means has been promoting efficient clean-energy transportation for 24 years. After a career in computer communications helping lay the foundation for the Internet, Mr. Means began promoting electric scooters and bikes long before they were popular. As that market matured, Mr. Means has turned his full focus to champion a PRT system for the Transit Area of Milpitas. His vision for systems that reduce energy needs, enhance life, and help society has drawn him to PRT technology and this Dual-Loop PRT System.

System Design - ITNS

LoopWorks Advisory Board member Dr. J. Edward Anderson is arguably the most knowledgeable and renown PRT expert in the world. Both his long career and impressive

accomplishments speak to his integrity and that of his work results. (Find both his resumé and values in the ITNS Business Plan, pages 2 and 92-94.) The difference between Dr. Anderson's approach to PRT and the work of other PRT investigators is the rigorous process of SYSTEMS ENGINEERING he has applied – and that was possible because of the many disciplinary engineering skills he acquired over the years.

In his most publicly acclaimed work, Dr. Anderson designed and supervised the construction of the fully automatic vehicle for a budget of only $600,000 and 6 months from the initial order-to-proceed until operation. The vehicle operated on a 60-ft section of covered-steel-truss guideway at the 2003 Minnesota State Fair 12 hours per day for 12 days with no failures. The system (shown below) operated exactly as designed.

In 1992, Dr. Anderson's PRT system was selected unanimously by a 17-person committee over various bus and rail systems proposed for deployment at the Seattle-Tacoma International Airport. In 1996, he chaired an international conference on PRT and related

technologies in Minneapolis. In 1998, his work led to acceptance of his PRT system out of over 60 elevated systems as the preferred technology promoted for the Greater Cincinnati Area by a committee of Forward Quest, a Northern Kentucky business organization.

Dr. Anderson is a principal in Intelligent Transportation Network System (ITNS), which owns the 1500-page, 3-volume product of his decades of experience designing PRT systems. Entitled Contributions to the Development of Personal Rapid Transit that multi-volume work provides the details underlying the broad concepts offered in this business plan. Volume 1 is on-line. Volumes 2 & 3 will be provided to LoopWorks when 2nd stage funding is secured for Design and Management Costs. Additionally, Dr. Anderson has offered to advise the team of designers and engineers that will plan, supervise and execute the construction of this project.

The intellectual knowledge and expertise presented in the 1500 pages of detailed plans and specifications of ITNS are both remarkable and unique. Thus, a financial evaluation of it is not possible. Its value results not only from the direct activity that has gone into it, but in the associated work by many companies and governments without which ITNS could never have been developed. Building upon that intellectual foundation, LoopWorks will implement the physical reality of their PRT vision.

Construction Company

The LoopWorks PRT system has two distinct phases: design/construction and operation/maintenance (O&M). LoopWorks will contract out the design/construction work and then become the company that performs on-going O&M. At this point in time, LoopWorks is considering Devcon Construction as the primary contractor for both design work and construction. (Devcon Construction, 690 Gibraltar Drive, Milpitas, CA 95035, 408-942-8200, http://devcon-const.com/)

In their website's Who we are section, they declare:

> An innovative and creative product of its Silicon Valley roots, Devcon Construction, Inc., a veteran-owned company, matches its general contracting and design/build experience and capabilities to meet the needs of each unique project. Ranked as the largest general contractor in Silicon Valley for the majority of the past two decades, Devcon maintains a significant regional presence with offices throughout the West, handling both large and small projects for a wide range of owners, developers and end users.

Their Culture statement emphasizes partnering with customers to "do large, challenging, interesting projects". Their values and abilities appear well-aligned with the objectives of LoopWorks and this PRT project. Another aspect of the company that makes them ideal for this project is their proximity. Devcon's headquarters are located within the Milpitas Transit Area that will be served by this project. In fact, one of the 12 PRT stations currently planned

is across the street from Devcon Headquarters at the (South) intersection of Gibraltar Dr. and Milpitas Blvd.

If early meetings with Devcon surface any serious issues, we can also utilize the engineering and construction management services of Rudolph and Sletten. With over five decades of building experience, Rudolph and Sletten has literally built the foundation of California's industries – including Monterey Bay Aquarium and Stanford's Keck Science Building. They have 6 regional offices in California, and proclaim: *Let's Build technically challenging projects, with uncompromising quality, faster with innovation.* (Rudolph and Sletten , 2 Circle Star Way 4th Floor, San Carlos, CA 94070 https://www.rsconstruction.com/)

City of Milpitas

The City of Milpitas is a key stakeholder and will benefit substantially from the LoopWorks PRT project in these ways:

- The City and its residents will enjoy the prestige of hosting the 1st true PRT system built in the USA.
- Numerous economic development opportunities open up when more transit infrastructure is introduced to the community including better marketability of area businesses and properties.
- A significant increase in property tax revenues is forecast from in and around the Transit Area.
- Reductions in CO_2 emissions by PRT users who would otherwise drive will help the City meet challenging targets required by State law.

Loopworks believes these excellent advantages, and more, will be a great incentive for City leaders and residents to support the PRT project.

Key Innovations

Intelligent Transportation Network System (ITNS) represents a long overdue *paradigm shift* in providing public transit. The many inventors and engineers who have worked to introduce this new and markedly superior form of public transportation have encountered fierce opposition from established institutions. LoopWorks may confront similar resistance. Financing and engineering a PRT system are relatively easy compared with overcoming institutional inertia. If successful, this may be LoopWorks' primary contribution to advancing the PRT industry.

PRT has been technically and financially viable for the past 40 years, but institutional inertia and fear of political consequences has impeded progress. Even when municipalities such as

Palo Alto and Milpitas are offered no-cost, no-risk PRT systems, they decline. To reduce fear and avoid institutional resistance, LoopWorks will use 3 innovative strategies:

- Utilize a captured-bogie PRT design - rather than a car-like design - to substantially reduce costs.
- Adopt a Benefit Corporation legal structure rather than for-profit, non-profit or governmental corporation to provide more flexibility than the other three types with fewer restrictions.
- Seek foundation funding rather than government or investor money to design and build the system to minimize special-interest influences and ensure financial viability.

As public awareness grows of the severity and urgency of our Climate Crisis, and traffic congestion continues to encroach upon discretionary time, public pressure will compel institutions to adapt. As that evolution in both awareness and adaptation proceeds, introducing a new paradigm will become easier.

Key resources

PRT Industry Research

Many decades of research has gone into PRT development. Here are prominent examples.

Mineta Transportation Institute (MTI) – Founded in 1991, the Mineta Transportation Institute (MTI), an organized research and training unit in partnership with the Lucas College and Graduate School of Business at San José State University (SJSU). Their mission is to increase mobility for all by improving the safety, efficiency, accessibility, and convenience of our nation's transportation system. Through research, education, workforce development, and technology transfer, MTI helps create a connected world. MTI has been working on PRT issues for nearly a decade. The Institute's 2014 peer-reviewed report supports PRT as a viable and desirable transit solution: AUTOMATED TRANSIT NETWORKS (ATN): A REVIEW OF THE STATE OF THE INDUSTRY AND PROSPECTS FOR THE FUTURE. Here is the Abstract:

> This study explains ATN technology, setting it in the larger context of Automated Guideway Transit (AGT); looks at the current status of ATN suppliers, the status of the ATN industry, and the prospects of a U.S.-based ATN industry; summarizes and organizes proceedings from the seven Podcar City conferences that have been held since 2006; documents the U.S./Sweden Memorandum of Cooperation on Sustainable Transport; discusses how ATN could expand the coverage of existing transit systems; explains the opportunities and challenges in planning and funding ATN systems and approaches for procuring ATN systems; and concludes with a summary of the existing challenges and opportunities for ATN technology. The study is intended to be an informative tool for planners, urban designers, and those involved in public policy,

especially for urban transit, to provide a reference for history and background on ATN, and to use for policy development and research.

California Public Utilities Commission - The California Public Utilities Commission (CPUC) ensures that all rail transit system extensions and new construction projects undergo a safety certification review and approval. CPUC's long experience with amusement park rides provides them with the expertise to act as an independent 3rd-party to ensure quality control on the project. After construction, CPUC will provide Certification.

88 questions about PRT – All the FAQs that people ask are already answered in Chapter 11 (pages 232 - 257) of *Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume I*. These will be useful as supporting material when marketing PRT to funders, property owners, and other stakeholders.

On-Line PRT Resources - While few PRT systems have been implemented, research and development has been extensive. The most comprehensive web site devoted to Innovative Transportation Technologies is managed by Emeritus University of Washington Regional Planning Professor Jerry Schneider. Also, there is a growing number of other web pages devoted to new transit technology, the most prominent of which are supported by the Advanced Transit Association and Get on Board! PRT. From these web pages, many web pages devoted to specific technologies and systems can be found.

Advanced Transit Association (ATRA)

The Advanced Transit Association (ATRA), a 501(c)(3) nonprofit formed in 1976, is an international association of professionals and others that promote the consideration of advanced transit options. ATRA may help consultants undertake large feasibility studies to obtain solid data about 1) the public's propensity to pay for riding a large PRT deployment, 2) the cost of building, maintaining and operating it, and 3) other direct and indirect costs and benefits.

Many large philanthropies are anxious to fight climate change and willing to fund applied research in order to do so. Most of these philanthropies will not fund government agencies or for-profit companies. As a 501 (c)(3) nonprofit, ATRA is eligible for this type of funding. LoopWorks anticipates partnering with ATRA to obtain funding and CPUC certification.

ITNS Design Work

The relationship between LoopWorks and Intelligent Transportation Network System (ITNS) is critcal. The ITNS design is the leading embodiment of the paradigm-shifting class of transit systems called Personal Rapid Transit (PRT). Before ITNS hardware was built for exhibition at

the 2003 Minnesota State Fair, the basic design won competitions in Chicago, SeaTac, and Cincinnati. Furthermore, a Swedish report concluded that if it were tested full-scale, it would be the preferred PRT system for Swedish cities. The State Fair demonstration showed that when Dr. Anderson supervised the project tha implemented his hardware design, it worked exactly as specified. (Dr. Anderson is pictured inside the vehicle.)

The engineering science needed to design PRT systems can be found in the public domain either through books, reports, published papers, expired patents, web pages, and courses given; but this information is scattered, as a result of which many new people entering the field spend unnecessary time reinventing what is already known somewhere. A bibliography of such papers is included in Section 25 (starting on page 228) of *Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume I*.

Patents

Dr. Anderson's PRT design obtained the following patents for the University of Minnesota which were licensed exclusively to ITNS (then called Automated Transportation Systems).

U. S. Patent Number	Title	Issue Date
4,522,128	Switch Mechanism	June 11, 1985
4,671,185	Switch Mechanism	June 9, 1987
4,665,829	Guideway Construction and Method of Installation	May 19, 1987
4,665,830	Guideway Construction and Method of Installation	May 19, 1987
4,726,299	Method & Apparatus for Controlling a Vehicle	Feb. 23, 1988

These basic patents which were granted to the University of Minnesota on the system invented by Dr. Anderson have expired. ITNS has exhaustively searched for patents upon which this project may infringe and have found only one – U. S. Patent 7,617,977 "Ticketing system for personal rapid transit," a method that has been common knowledge for decades. This patent can easily be circumvented and the company that owns it is out of business.

Although LoopWorks believes all required basic patents are now available, other patentable ideas will be sought and secured as part of the development process. Doing so will prevent

for-profit companies from claiming them, and then controlling or preventing their use in other projects. LoopWorks will own the detailed plans and specifications needed to build the Dual-Loop PRT System, and will make them easily available on-line to the public as an encouragement to others to build their own systems.

Market Analysis

In 2019 a press conference was held to promote the Valley Transportation Authority's (VTA) Get On Board campaign. To increase awareness of, and support for, public transportation, Matt Mahood, President & CEO of The Silicon Valley Organization (SVO), joined various elected officials and company executives and noted a few transportation statistics for the Valley:

- Over the past decade, commuter times have increased by 20% which equates to 50 minutes weekly or 43 hours annually extra time spent in traffic.
- In 2017, 6.5% of local employees, about 95,000 people, spent more than three hours commuting to and from work on a daily basis.
- Traffic delays equate to an annual loss of $2.7 billion in productivity.

What the press release did not mention was the number of jobs in Silicon Valley rising 30% during the previous decade while housing supply rose only 4%. Unless that jobs/housing imbalance is addressed, or some new transit option becomes available, severe traffic congestion in Milpitas will likely continue to worsen. In fact, the typical American city dweller can only reach 30% of jobs within 90 minutes using public transport.

Traditional Transit Options

The attractiveness of public transit rises with the frequency of service, personal security, and the destinations that can be quickly accessed. Unfortunately, VTA's service level at best is 20 minutes and typically much more between buses. To reduce that headway to 10 minutes – a frequency at which public transit starts to become attractive – would imply a doubling of buses, staff and operating losses. The cost of doing so is not practical for VTA because only 11% of their 2019 operations was covered by rider fares leaving the remaining 89% subsidized by taxes.

Within VTA's domain, 3 factors undercut demand: personal security, timeliness, and proximity to origins and destinations. Personal security of all riders – and female riders in particular – has become a problem, especially during non-commute times. Public transportation is safest when it is monitored and has the full support of local police departments. VTA's difficulties in providing on-time performance stem from fleet reliability, and cause riders to become late or stranded, and thus less likely to choose

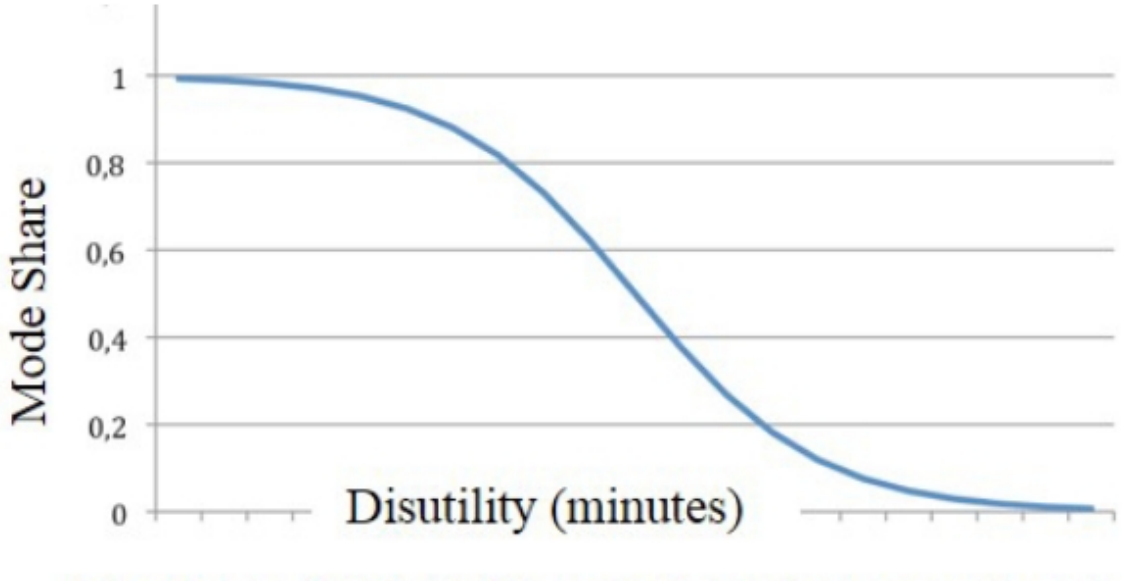
their service. Furthermore, VTA has been unable to provide bus stops close to enough origins and destinations, further reducing demand.

The transportation industry is ripe for disruption, with "Rail and road" – the domain of public transit - being particularly identified. Continued congestion, widespread Uber/Lyft service, dockless electric scooters and bikes, and driverless cars will continue to increase pressure for innovation.

Non-Linear Demand

Nerd Alert! In a technical way, the following points out that the transportation mode(s) people use depends upon at least 6 factors. As those factors add up (increasing disutility), people are less likely to use that particular mode. For example, Milpitas residents will generally find the disutility of Caltrain (hourly service on the other side of the Valley) is very high, and therefore unlikely to be used. The high disutility of bus and LRT service in Santa Clara County will continue to produce low ridership. The disutility of PRT is low, so even this small system will attract more ridership than high-disutility buses currently serving the area.

> Transit **mode share** depends on the utility of transit trips in comparison with those of alternative modes (car, walk etc.). **Disutility** is defined as a weighted sum of transit trip time components, transfers and the transit fare. Out-of-vehicle time and Driver-access time are typically perceived as twice as onerous as in-vehicle time. Each transfer is penalized by 5 minutes in addition to the time spent in transfer (waiting and walking). Trip disutility X = in-vehicle minutes + (2 * out-of-vehicle minutes) + (2 * drive-access minutes) + 5 minutes for each transfer + mode-penalty + (fare / value-of-time). As shown in this table (from page 4 of this transit comparison study), as disutility increases, ridership decreases in a non-linear way.



Capital Costs to Build Transit

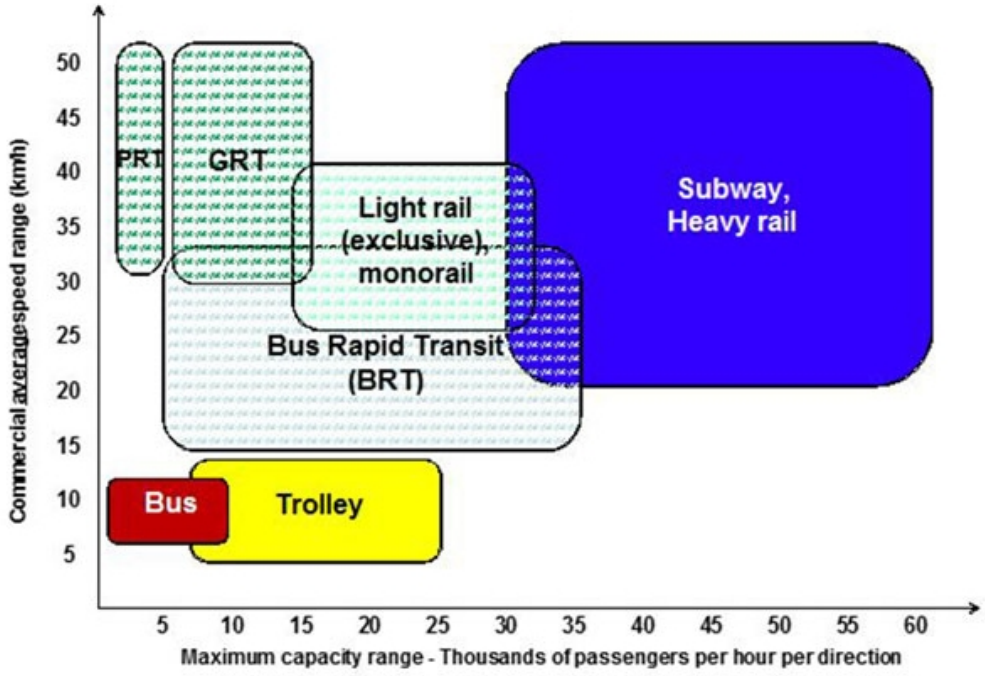
Transportation Options Through a PRT Lens offers an introduction to various transit factors. Page 9 of that document presents the following cost estimates for various transportation technologies. All are compared using a corridor model with travel going both ways (bi-directional). While the specific costs and estimates will vary, each mode generally maintains its cost-position relative to the others.

Transportation Technology	Bi-Directional Cost Range
Bus Rapid Transit (BRT) - when re-purposing existing roadway	$4-9M/mile
Freeway/Expressway Lanes - at ground level (no land acquisition)	$10-20M/mile
Personal Rapid Transit (PRT) - elevated	$20-60M/mile
Automated People Mover (APM) - at ground level	$30-50M/mile
Light Rail Transit (LRT) - at ground level	$60M/mile
Bay Area Rapid Transit (BART) - at ground level	$130-230M/mile
Pedestrian Over Crossing (POC) - elevated	$150M/mile

PRT costs already compare favorably with APM, LRT and BART, and will likely be less expensive after adding in land-acquisition costs to BRT and Freeway Lanes, PRT will likely be less expensive than those options also. Elevated versions of APM, LRT and BART would cost twice as much as ground-level corridors.

Throughput Capacity

Throughput capacity of a transit system is how many people can be moved per hour or day. Throughput capacity depends upon the number of people per vehicle and time between vehicles (headway). Capacity of a transportation corridor can be increased with larger vehicles, shorter headways, or both. As you can see in the following diagram, PRT (Personal Rapid Transit), GRT (Group Rapid Transit), Light Rail, and Heavy Rail all travel at roughly the same speed (20 – 40 mph), but potentially transport widely differing numbers ranging from a few thousand to more than 50,000 passengers/hour.



The figure above shows that PRT and GRT systems fill a "white spot" on a transit planner's map: medium capacity and high average speed (for any origin-destination pair). Characteristics of other systems may differ from those shown in the figure; the intention is to show the relative placement of PRT and GRT systems rather than to show precisely the characteristics of all systems in absolute values.

In Silicon Valley, the capacity of both bus and LRT is substantially underutilized. In the case of LRT, it could be argued that another, lower-capacity technology would have been a better choice.

Corridor vs. Grid

Fixed rail systems like BART and Caltrain are fundamentally corridor transportation systems that serve a series of stations along the corridor. Old time rail systems that served towns and cities along the line served them well for long-distance travel, as do modern equivalents that serve to transport people between cities. *Corridor systems with on-line stations have fewer stations spaced farther apart which allows for higher speeds between stations.*

Network systems like roadways generally run at lower speeds and serve to connect many origins with many destinations in a defined area. For example, sidewalks and bike lanes/paths interconnect to create pedestrian and cyclist networks.

Because South Bay cities have been designed around the car and a network of roads, they sprawl rather than concentrate around corridors. Bus networks (as pictured) are composed of many bus routes, each of which is usually a corridor with buses running from one end point to the other, then back again along the same route. Bus routes intersect and allow for transfers from one bus to another. That intersect-and-connection-transfer to another vehicle is also how a riders utilized the various corridor and network systems in their area.

Not only does a grid system provide for more origin and destinations, grids also serve more people by covering more area. For a graphic presentation of area coverage of corridor/linear vs. grid systems, see this short explanation. The benefits of a grid system over a linear one is described in *Transportation Options for Greenville* (page 51).

The biggest benefit of PRT systems over corridor systems is the value created as each expands. As corridor systems extend, value increases linearly with each additional station. Under Metcalfe's Law, the value of a network rises with the square of the number of connected nodes (n^2). For example, the proposed Mini-Loop with 5 stations provides 25 units of value (5 x 5). By adding 7 more stations with the BART Circulator (12 stations total), the system value jumps to 144 units of value (12 x 12). If a Civic Center Loop were added that included 3 more stations (City Hall, Library, Main Street/Midtown), the value would increase from 144 to 225 (15 x 15). That 3-station expansion will generate an 81-unit increase in value (225 – 144 = 81) will be greater value than the original 5-station Mini-Loop.

What We Know About Transportation Systems

By looking at transportation options in the South Bay through various lenses, we can deduce some general rules to guide our technology choices in the future.

Rule 1: Designing a system that works well for people goes a long way toward a system that works well to transport stuff.

Rule 2: Corridor systems with on-line stations have fewer stations that are farther apart to allow for higher speeds.

Rule 3: Network systems like roadways generally run at lower speeds and serve to connect many origins with many destinations in a defined area.

Rule 4: Networked systems come in two types, those that require a transfer to another vehicle and those that don't.

Rule 5: Maximum capacity on a corridor is rarely achieved, and the average loading is less than half of theoretical maximum capacity.

Rule 6: Adding parallel lines to a low-volume transit network adds capacity that can eventually exceed high-volume corridor capacity.

Rule 7: Low-capacity transit like PRT can use multiple stations with multiple berths – all operating in parallel – to achieve high surge capacity when needed.

Rule 8: Nearly all trips are multi-modal, requiring more than one transportation mode.

Rule 9: Moving between transit modes or vehicles can be quick and easy unless the transfer requires a wait – largely because waiting time seems longer to people than it really is.

Rule 10: The more physical materials required to build a transportation option, the more it tends to cost.

Rule 11: A transportation option that costs X dollars at ground level, will cost 2X dollars when elevated, and 3X dollars when under-grounded.

Rule 12: Capital costs for a specific technology vary widely depending upon constraints and requirements of the place where it will be built.

Rule 13: Land costs are high in Silicon Valley.

Rule 14: People are willing to endure a longer commute if they can do something else during the trip.

These rules, when applied to the South Bay Area, lead to these guidelines:

- Prioritize networked systems over corridor systems. Due to the car-facilitated sprawl of the South Bay Area, networked systems work better in our area for most transportation needs, while higher-speed corridor systems serve for longer links.
- Balance capacity to demand. Due to low-density sprawl, higher-capacity transit options are rarely needed.
- More no-wait connections are generally better than fewer connections that require waiting.
- Reducing door-to-door time is more important than increasing the speed of any particular link between those doors.
- When gauging the value of any particular transportation option, consider the value it contributes to the entire network of existing transit systems.

Having reviewed various factors in our transportation analysis, we come to the critical question: What combination of options makes sense for this defined area?

If, over the course of twenty years, untold millions of dollars are spent on a public transit system, and the growth in ridership has not kept pace with the growth of the population base being served, that is a system in decline. Before continuing along the same declining path, transportation agencies and experts owe an honest solution to this equation:

value = *f* (performance, price, benefits, impacts) vs. alternatives

In plain English, the value of a transportation option is a function of various factors, and must be compared with the alternatives.

Driverless Vehicles

"We are on the cusp of one of the fastest, deepest, most consequential disruptions of transportation in history. By 2030, ... 95% of U.S. passenger miles traveled will be served by on-demand autonomous electric vehicles owned by fleets, not individuals, in a new business model we call 'transport-as-a-service' (TaaS)." That bold statement comes from Rethinking Transportation 2020-2030 - Disruption, Implications and Choices, a RethinkX Report by James Arbib & Tony Seba (page 6).

The start of this disruption will be the date that driverless vehicles are approved for widespread use on public roads. This start date, of course, depends upon both technological readiness and regulatory approval. Very limited driverless testing has already begun.

Recent studies indicate, however, that driverless vehicles without multiple riders are expected to increase congestion in congested areas (but not in uncongested areas). Introducing driverless cars will have little or no impact on infrastructure other than potentially reducing parking needs if ridesharing catches on. Find more discussion about this in *Transportation Options for Greenville* (pages 54 – 65).

Furthermore, driverless cars rely upon roadway infrastructure. Under current tax structures, funding is often insufficient to adequately maintain our roads. Additionally, funding shortfalls over recent decades have created the need to reconstruct a significant percentage of the pavement in many areas. The substantial investment needed to re-build and maintain our roads remains elusive.

Failure to relieve congestion implies that driverless car passengers will still get stuck in traffic as they do today. In fact, congestion may worsen if workers who currently avoid the rush hour opt to join it because, as driverless passengers, they can now use commute time to work, relax or entertain themselves while in traffic. While the technology merits support for various reasons, driverless cars in congested areas may be most useful by supporting PRT with rides to and from PRT stations – just as PRT will support the transportation options at the Milpitas Transit Hub by bringing people to and from there.

Competitive Advantage

PRT systems can reduce dependence on oil, reduce greenhouse gas emissions, and reduce congestion. These three benefits are the primary societal advantages over most public transit. Additionally, other advantages that benefit people and their community include:

- **Increased Energy Efficiency:** Light-weight vehicles traveling non-stop use about 90% less energy than cars.
- **Green Careers:** While construction jobs to build PRT are temporary, careers in PRT O&M are long lasting.
- **Low Construction and Operating Costs:** In addition to using smaller-scale technology, stations can be sized to demand, thus further decreasing capital costs to build a PRT system. Operations & Maintenance (O&M) Costs are far lower which makes it easier to provide high-level service.
- **Economic Benefits:** Fewer transportation dollars leave the community, and more property tax dollars flow to public agencies. A pleasant ride is provided for commuting employees, thus permitting them to arrive at work rested and relaxed. A PRT system also opens future possibilities for moving freight, recyclable materials, and garbage.
- **Better Service:** PRT offers safe, quiet, responsive public transit with automated non-stop service available 24 hours a day. Because every trip bypasses intermediate stations, stations can be spaced closer together without slowing the average speed, thus providing both increased access to the community and competitive trip times. Seniors and other non-drivers will have much needed mobility and independence. All users will enjoy easier access to stores, clinics, offices, schools and recreational opportunities.
- **Reduced Congestion:** PRT's attractiveness to many auto users will help reduce congestion while also boosting the effectiveness of alternaitve modes of transportation.
- **Reduced Pollution:** Because PRT can use any type of electrified renewable energy it will reduce CO_2 emissions, all other carbon-fuel pollutants, and most noise common to cars and other forms of transit.
- **Land Savings:** Land required for PRT is about 0.02% vs. 30-70% for the auto system, and less than 10% of total right of way needed for surface-level rail. This minimal need for land enables PRT to reduce congestion where no space exists for traditional alternatives. Furthermore, more livable high-density communities become possible.
- **Increased Safety and Security:** PRT safety has been demonstrated at Morgantown University where over 200 million injury-free passenger miles shows it is 50X safer than cars. Security is enhanced by spreading the service among many lines and stations, thus eliminating high-value targets for terrorists.

- **Time Savings:** Riders won't usually spend time waiting for a vehicle and won't be stopping frequently along the way, so they will arrive sooner at their destinations.
- **Network Value:** PRT systems can easily expand, and the value of a network rises with the square of the number of stations in the system (n^2); see Metcalfe's Law.

- **Synergy with Other Transit:** Combined with other existing public transit modes, PRT Synergy will dramatically increase transit ridership while reducing transit subsidies.

While many PRT designs provide the above benefits, the ITNS-designed PRT technology chosen by LoopWorks achieves a higher level of value by meeting specific design goals:

- Operating costs low enough to be recovered from fares and/or other revenue streams.
- Highly efficient operation using network topology and renewable energy.
- Time competitive with urban auto trips within the service area.
- Low use of construction and fabrication materials.
- Low air and noise pollution.
- Visually acceptable.
- Adequate capacity.
- Low energy use.
- Minimal land use.
- Safe.
- Secure.
- Reliable.
- Comfortable.
- Attractive for riders.
- Available 24 hours a day.
- Expandable without limit in an ever-widening network.
- Low-value target for terrorist attacks.
- Compliant with Americans with Disabilities Act (ADA).
- Operational in all kinds of weather, except for extremely high winds.

The ITNS-designed PRT technology chosen by LoopWorks achieves the above goals, and thereby provides the riding public with these benefits:

- The system is easy for everyone to use. No driver's license needed.
- Vehicles wait for people, rather than people waiting for vehicles.
- Less than a minute wait during rush periods, and no waiting during off-peak times.
- There are no time-consuming vehicle-to-vehicle transfers within the system.
- Vehicles are heated, ventilated, and air conditioned.
- The system is available at any hour on any day.
- User trips are short, predictable, and nonstop.
- Everyone gets a seat; no standing.
- Travel is cost competitive.
- There is no crowding.
- The chance of injury is extremely remote.
- Personal security is high.
- The ride is comfortable, private and quiet.
- There is space for luggage, a wheelchair, a baby carriage, or a bicycle.

- Riders can make phone calls, text, read, relax, meditate, etc.

In short, by delivering automated non-stop service 24 hours a day, PRT can provide a level of service far superior to conventional public transit options. PRT may be the simplest and least expensive means to add capacity in congested environments, and the most acceptable to communities.

Furthermore, compared on a per-passenger-mile basis with the average surface-level urban rail transit system, PRT costs far less for construction, operation and energy use. Construction costs, or example, are expected to be one-tenth the cost of typical transit for which Federal regulations allow expenditures of roughly $30,000 per daily rider. As shown in *Figure 4. Capital Cost per Daily Ride* of the ITNS Business Plan (page 23), PRT costs less than $3,000 per daily rider.

Ridership

LoopWorks intends to offer free transit service which will increase equity and, more importantly, increase ridership – as outlined in this article: Here's What Happens When Public Transit Is Free). The traditional mass transit option - buses - capture a modal split in most U. S. cities that hovers around 3% of all trips. Estimated ridership on a PRT system ranges from 25% to greater than 50% of the daily trips, a huge increase! (See page 214 of *Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume I*). Even higher ridership potential is shown in the table on page 11 of a study comparing LRT, GRT and PRT.

The potential of PRT to reduce single-occupancy vehicle (SOV) driving is amazing! The abstract from a 188-page peer-reviewed study indicates that the SOV rate at a high-tech job center in Palo Alto could be cut in half.

More specifically, PRT ridership was estimated for an example system comprised of 30 miles of guideway with 60 stations (2 stations/mile) served by 321 vehicles (10/mile). Ridership of the Milpitas PRT system can be estimated using those numbers which are repeated here. (See page 36 of the ITNS Business Plan.)

- Peak Days/year = 340
- People/sq mile = 9,000
- Trips/person/day = 3
- Mode split to ITNS = 20% [a conservative percentage compared to estimates above]
- **PRT Passenger-Trips/Day/sq mile = 5,400** (9000 X 3 X .20)
- Total Passenger Trips/yr/sq mile = 1,836,000 (340 X 5400)
- Peak-hrs/Day = 10
- Passenger-Trips/peak hr/sq mile = 540
- Average Trip Length = 1.60 mile
- Fraction of Vehicles moving while empty = 25%
- **Transit Service Area (within 1/3-mile of a PRT station) = 1.4 sq mile**
- People/occupied vehicle = 1.35
- Vehicle-miles/year = 2,380,000 [(1,836,000 X 1.4 X 1.25) / 1.35]

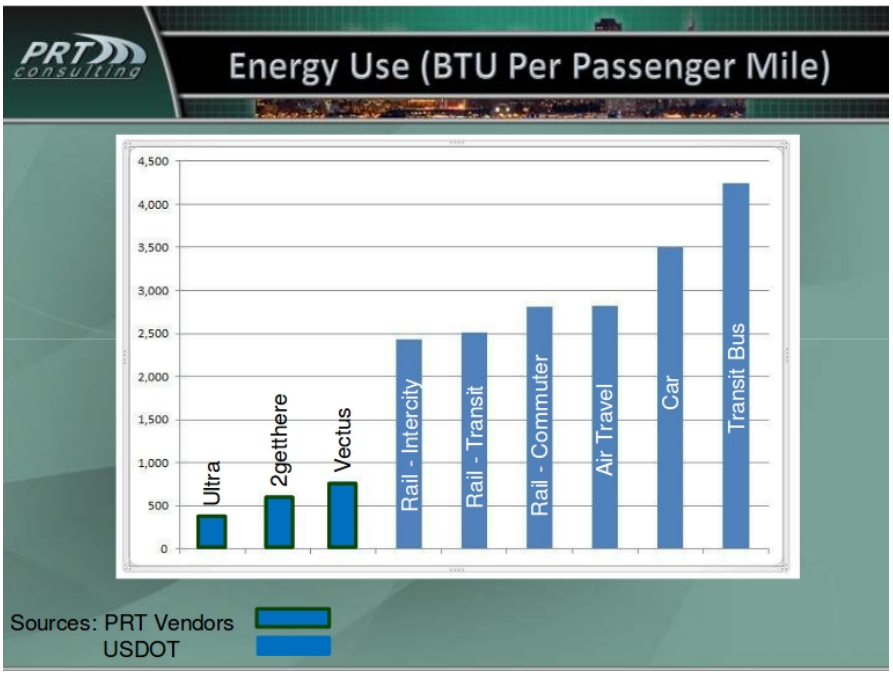
If PRT passenger-trips/day/square mile holds at 5400 for the Transit Area, then the 1.4 sq. mile served by the **Milpitas Dual-Loop PRT System will provide 7560 trips per day**. Validating (or not) this estimate will be the real world numbers reported by LoopWorks via Performance Reports – The Big Payoff.

Energy Consumption

PRT uses less than one-third the energy per passenger mile of automobiles and public transit. This is because:

- PRT vehicles are light-weight and roll on smooth surfaces; moving them is easy.
- PRT travel is relatively slow; little energy is expended overcoming wind resistance.
- PRT vehicles stop only once; little energy is expended decelerating and accelerating.
- PRT systems have no schedule that requires continually moving empty vehicles.

Comparison of gallons of carbon-based fuel per passenger-mile



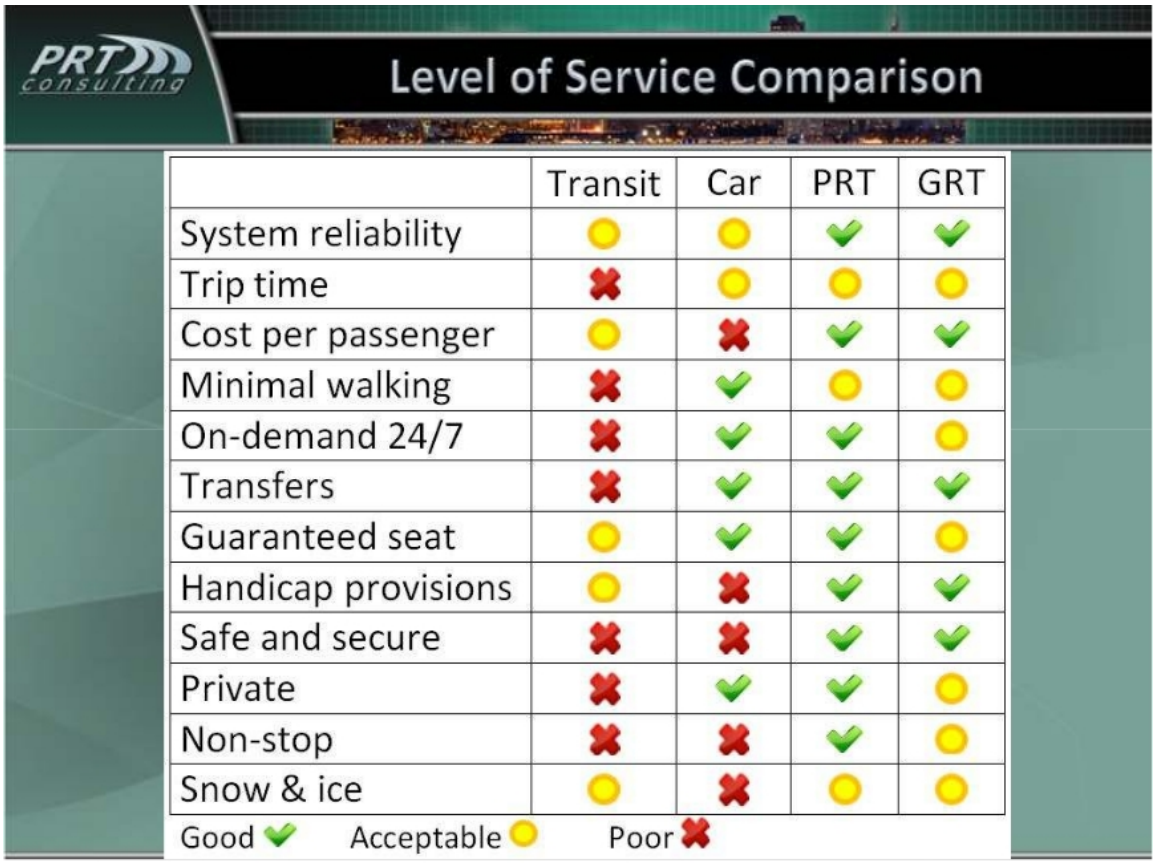
Computing and comparing CO_2 emissions numbers can be tricky.* Regardless, the 3 types of PRT shown in the accompanying chart (Ultra, 2geththere, Vectus) clearly use far less energy per passenger mile than other transportation modes. PRT systems also have fewer emissions because they use electricity to power the system – electricity that may come from clean, renewable sources such as solar or wind.

* For example, nationwide bus occupancy averages only 9, which is only 0.18 (18%) for a 50-passenger bus. An occupancy rate of 0.20 (20%) for private vehicles (assuming 5 seats available) is achieved with just the driver.

Level of Service

Various factors contribute to the service level of any particular transportation option. (See Non-Linear Demand.) PRT Consulting compared urban transportation solutions that are currently in use or under consideration including personal rapid transit (PRT), bus rapid transit (BRT), light rail transit (LRT), and other options. Find the results in the 10-page article SOME 21ST CENTURY TRANSPORTATION SOLUTIONS: A COMPARATIVE ANALYSIS by Peter J. Muller, P.E., President, Advanced Transit Association. On page 10, the Summary of Results shows that PRT outscores the other 5 options by 50% or more.

Likewise, the comparison chart below from PRT Consulting provides an overview and comparison of 4 transportation options. This chart and others show that PRT consistently and clearly offers significant service advantages over traditional transportation options.



Resilience

System reliability is just part of PRT's contribution to community resilience. PRT transit offers redundancy and resilience to a community in these ways:

1. Mobility is electrified and transformed to reduce emissions, reduce congestion and save user time.

2. EV use by low-income customers and those living in multi-unit dwellings becomes easier without concerns about capital costs and charging of privately-owned cars.

3. PRT provides safe and reliable transit that complements and supports other forms of transportation.

4. In addition to transporting people, PRT can move packages, cargo, recyclable materials and garbage.

5. As an elevated system, PRT can continue operating in the event that the flood plain on which it is build actually floods.

6. Conduit space within the guideway structure provides alternative electric and broadband utility paths through the Transit Area of Milpitas.

7. If a community plans to distribute energy-storing batteries in an area, siting them at PRT stations is a possibility.

Competing PRT Technologies

While few PRT systems have been implemented, research and development has been extensive. The most comprehensive web site devoted to Innovative Transportation Technologies is managed by Emeritus University of Washington Regional Planning Professor Jerry Schneider. Also, there is a growing number of other web pages devoted to new transit technology, the most prominent of which are supported by the Advanced Transit Association and Get on Board! PRT. From these web pages, links to additional information to specific systems can be found.

While many have tried to develop and implement a PRT system, few have succeeded due to 1) Semmelweis reflex and 2) inadequate knowledge. A nineteenth-century Hungarian doctor, Ignaz Semmelweis

> "…noticed obvious and important empirical truths that should have been investigated by other scientists but were reflexively rejected by these scientists because the suggested explanations were not in line with the conventional thinking of the time. Today this is known as a Semmelweis reflex. Individuals still hang on to old theories in the face of seemingly overwhelming evidence; it happens all the time in science and in life in general. The human tendency to gather and interpret new information in a biased way to confirm preexisting beliefs is called confirmation bias".

This partly explains why transit agencies have ignored PRT for so long despite the poor results of traditional mass transit systems.

Another factor in failed attempts to field a PRT system is the requirement for adequate knowledge. A successful PRT system requires a thorough understanding of the design goals before detailed design should be initiated. That in-depth understanding includes skilled practice of every relevant engineering science, a strong command of engineering mathematics, and experience in laying out and mapping PRT systems in specific applications. Good systems engineering requires strict objectivity in selecting components which, in turn, depends upon a great deal of research. It is unlikely that any engineering group working in a time frame acceptable to for-profit investors will have enough time to develop the comprehensive collection of requirements and technology that a successful PRT design requires.

Due to Semmelweis reflex and inadequate knowledge, few PRT systems have been fully tested. Thus, most of the systems shown on Professor Schneider's web page are not serious competitors. However, there are two that may be.

ULTra PRT, which was development at Bristol University in the United Kingdom, is now moving people and their luggage from parking lots into the terminals of Heathrow International Airport. This system uses a wide guideway, which has a large visual impact and is a snow-catcher in winter months. This system possesses the following characteristics, which will limit its use to fair weather, low-speed, low capacity system that are small:

- Rotary motor propulsion and wheel braking limit minimum headways to about 6 seconds.
- Synchronous control software limits the practical system size.
- On-board battery power limits both speed and range while adding weight.

Posco's Vectus PRT built a demonstration project in Uppsala, Sweden which, like ULTra, uses a wide guideway. The vehicles are propelled by linear induction motors (LIMs) mounted in the guideway. These motors must be placed quite close together to be able to simulate continuous thrust resulting in a need for about ten times as many LIMs as if they were mounted in the vehicles. This makes the guideway heavier and costlier than

a system, such as ITNS, in which the LIMs are mounted in the vehicle – even after including the weight and cost of ITNS power rails.

Since the weight - and therefore cost - of the guideway is proportional to the weight of the vehicle, weight minimization is important. That factor sets ITNS hardware apart from other PRT options. Specifically, ITNS vehicles are expected to weigh only 1100 pounds – with the empty cabin weighing 500 lbs., and the assembled chassis weighing no more than 600 lbs.

ITNS represents a culmination of research and development directed at achieving an economical and reliable solution to urban transportation that will

- minimize use of land
- minimize use of materials and energy
- minimize pollution of all kinds
- provide an unparalleled level of service.

The work that led to ITNS was conducted by Dr. Anderson and colleagues at two major research universities, in cooperation with three government agencies and five major private companies. Remarkably, this combination of benefits also minimizes capital and operating costs for the LoopWorks PRT system in Milpitas.

The Summary of the Site Assessment Report for Kungens Kurva, Sweden (page 11) validates this point. The report compares the Benefit / Cost ratio of 3 types of PRT, and shows that the ITNS design of Taxi 2000 is substantially better than the other two options.

Risks

The ITNS Business Plan (page 33) lists the following business risks which have been slightly modified to better reflect the business model of LoopWorks PRT in Milpitas.

1. **Management.** We are a small start-up company that will consist of managers and engineers who thus far have little experience in working together. The investor must be satisfied that such a group, which must enlarge substantially, will work together cooperatively and successfully, and that new members will be provided opportunities to become thoroughly proficient in their assigned areas of the technology. The burden is on the company to be as certain as reasonably possible that new hires and contractors have the knowledge and commitment needed for success. By working in cooperation with established engineering companies that subcontract to us, we will accomplish more in a shorter time frame than by building a manufacturing company.

2. **Technology.** ITNS is a new configuration of technologies, albeit all existing technologies. These technologies must function economically, day after day, with less than one hour of delay for every 10,000 hours of operation for decades and with acceptable ride comfort and an outstanding safety record. Because computations practical only on digital computers are

needed in planning, designing, manufacturing, operating, and managing PRT systems, the practicality of these systems has depended on advances in computer hardware, software, and fault tolerance. The investor must be satisfied that any necessary technical advancements will be used, and that the systems engineering team to be assembled will be sufficiently versed in such technologies. Under development for over 30 years, the proposed technology has been subject to extensive design reviews that have shown it to be well within the state of the art.

3. **Competition.** Several companies are planning, designing, and building PRT systems. The investor must be satisfied that the ITNS design will be strongly competitive to other approaches to PRT in both technology and people involved. However, no other PRT company has the ITNS design or the depth and breadth of experience possessed by Dr. Anderson, the world's leading expert on PRT systems. The process that has been the foundation of that expertise is described in Chapter 6. Rules of Engineering Design, pages 87 – 89 of *Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume I*.

4. **Code Requirements.** Introducing a new system into the present complex fabric of industrial society requires compliance with a wide range of codes and standards. Mainly because of the Chicago PRT project (1990-1994), all the codes and standards required for PRT systems have been identified, the most important of which are the ASCE Automated People Mover Standards, the National Fire Safety Board standards for automated people movers, International Standards Organization ride-comfort standards, and the Americans with Disabilities Act. As our project begins, all the legally required standards will be assembled and reviewed.

5. **Costs and Schedules.** While our program plan has benefited over many years from a great deal of analysis, design, discussions with manufacturers, and operating experience, LoopWorks' plan to meet the projected costs and schedule depends upon securing the services of many skilled personnel and companies. Inability to obtain the services when needed could delay the effort and increase its costs.

6. **Marketing.** As an O&M firm focused only on PRT within the City of Milpitas, LoopWorks has no need for marketing outside the city for riders. However, marketing will be done to cultivate Alternative Revenue Streams.

7. **Risk of Obsolescence.** While every effort has been made to insure an optimum, adaptable design – one very difficult to improve or circumvent – other technological breakthroughs may shorten the life expectancy of our approach to PRT. An important strategy in the design of ITNS has been to use off-the-shelf components wherever possible and to seek out new ideas that will improve performance and/or lower cost. No one can ever assume that no new technology can render any system obsolete, but the basic ideas that led to the PRT concept and how to optimize it have been thoroughly researched and are amenable to change when

new technologies become practical.

8. **Additional Funding Needs.** While LoopWorks believes that the projected funding requirements are adequate to cover costs necessary to design, build, and prove its system, there can be no assurance that additional funds will not be needed. The cost projections and schedules we have developed have benefited from review of similar costs and schedules planned and achieved on similar projects going back to the early 1970s. The data, in addition to mature judgment, have led us to conclude that **our estimates are conservative**. Moreover, Dr. Anderson managed in six months the design and construction of a full-scale, automated, linear-induction-motor (LIM) propelled vehicle that ran flawlessly for thousands of rides on a 60-foot section of guideway. The cost and schedule experience from this project have been incorporated into our current cost estimates and schedules.

9. **Community Resistance.** The most common objection to PRT is about visual intrusion, a highly subjective matter but important nonetheless. While most people agree that overhead powerlines are not desirable, how would they respond to aesthetically-designed overhead guideways on which futuristic podcars silently glide along? And how does that compare to the appearance and noise of most city streets? What people think about Podcars as public transportation was explored with a user survey by Spartan Superway investigators at SJSU. The survey concluded that although nearly 80% of respondents had never of this type of system, 73% would feel comfortable "using an automated public transport system", while 67% would "be willing to support the building of it with an increase in taxes."

Value proposition

The urgency of our Climate Crisis demands bold, out-of-the-box solutions that can be scaled to meet the challenges we face. LoopWorks is working to implement one such solution – a solution that represents a paradigm shift in public transit that promises high-leverage possibilities for improving the lives of people.

LoopWorks' paradigm shift will produce extraordinary service for residents and visitors around the Milpitas Transit Area. The leveraging follows from the real-world data this project will provide transit experts and decision-makers. That data and the knowledge we gain from building this first PRT system is the biggest payoff for investing in this project. The

LoopWorks PRT system will provide data on safety, reliability, comfort, and both capital and operating costs. (See Performance Reports – The Big Payoff.)

Those taking the time to understand the full extent of the mobility problem facing today's cities will discover that the solutions presently being proposed do not go far enough. While they may alleviate some problems, other serious issues are ignored. *Transportation Options for Greenville* (page 43) outlines the situation by examining the impact of 5 factors: congestion, accessibility, safety, land use and infrastructure. Conclusion of the report: the automobile infrastructure is the real problem. The PRT paradigm addresses that problem.

In addition to the brief economic considerations presented here, ITNS presents a more thorough Economics analysis as part of Task #1 of Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume II (pages 559-607).

LoopWorks, as a Benefit Corporation, enjoys advantages unavailable to government agencies. Both can build a PRT system, and share information publicly to encourage replication. However, given the long history of resistance by governmental institutions to PRT, there is little reason to believe any one of them will precede our efforts to build the first-in-the-nation PRT system. The latest example comes from Mountain View where efforts to investigate advanced transit have been pushed back another year. Thus, LoopWorks may be the first to enjoy the following benefits.

Land Savings

As shown in the following 4 images, a single PRT guideway can carry as many vehicles as 3 lanes of roadway. Such high transit capacity without significant land requirements can benefit two types of developments: 1) In already-developed areas like Milpitas, transit capacity can be added without much disruption. 2) In new developments, far lower land requirements enables lower overall costs or more natural area preserved.

Figure 17.1. A Freeway Running at Capacity.

Figure 17.2. The People Riding.

Figure 17.3 shows all of the people moved to the center and Figure 17.4 shows the vehicles in which they could be riding. This pair of guideways can also carry 6000 vehicles per hour – the throughput of the entire three-lane freeway. We would normally put these guideways along the fence lines so that the stations would be near people's destinations, but the figure illustrates the land savings. A typical freeway width from fence line to fence line is about 300 feet.

Unique Value

PRT service is more like that of individual cars rather than mass-transit trains and buses. Trips on PRT vehicles are characterized by:

- Little or no waiting
- No transfers
- Nonstop, seated travel
- Choice of traveling alone or with friends/family
- Very short walking distances due to numerous stations

Driverless cars promise improved mobility for people unable or unwilling to drive themselves. The same could be said of PRT. Additionally, PRT provides great service while virtually eliminating noise and air pollution. Driverless cars can complement PRT, which in turn

complements other transit options. Several studies have shown that PRT will attract at least five and possibly 10 times as many trips as conventional transit serving the same area.

PRT's greatest value is where the roads are congested and there is no room for a bus or train. PRT is attractive in congested areas for these reasons:

- Only very small, widely-separated land plots are needed instead of wide, continuous strips of land.
- PRT's low per-passenger-mile cost results from low capital and operating costs combined with high ridership.
- Along with energy efficiency, PRT provides higher average speeds and shorter trip times (without energy-consuming high-speed cruising between stations) by eliminating intermediate stops.
- Using electric-motive force allows use of carbon-free energy sources, which has become critical as the need to reduce fossil fuel emissions has increased.
- Other automobile-generated pollutants (toxic fumes, noise, brake lining dust, tire particles, etc.) are dramatically reduced.

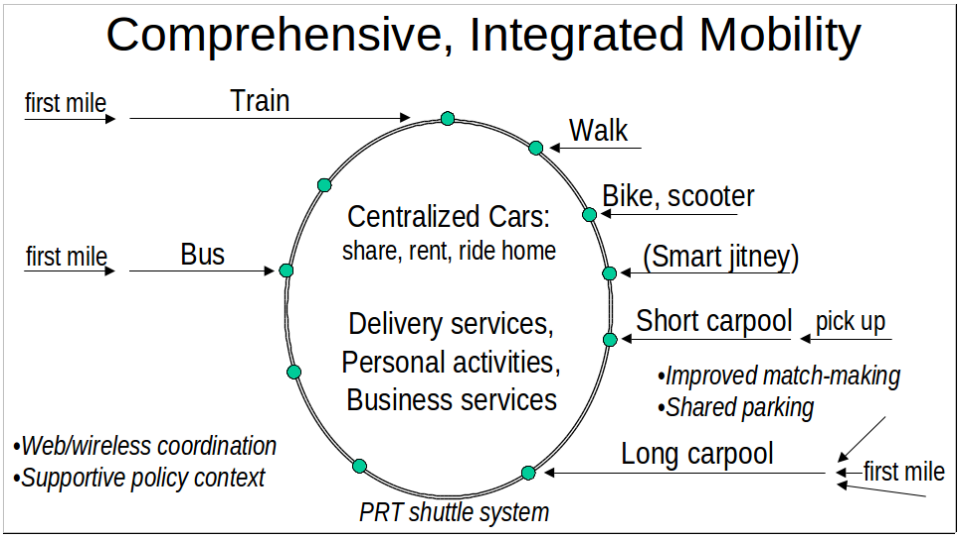
PRT Synergy

PRT provides convenient connections between existing transportation options. That feature produces the benefit of dramatically higher use of those options. Too much single-occupancy vehicle (SOV) driving causes congestion. Yet, the many attempts made to reduce it have been ineffective. This abstract from a 188-page peer-reviewed study, however, indicates that the SOV rate at a high-tech job center could be cut in half:

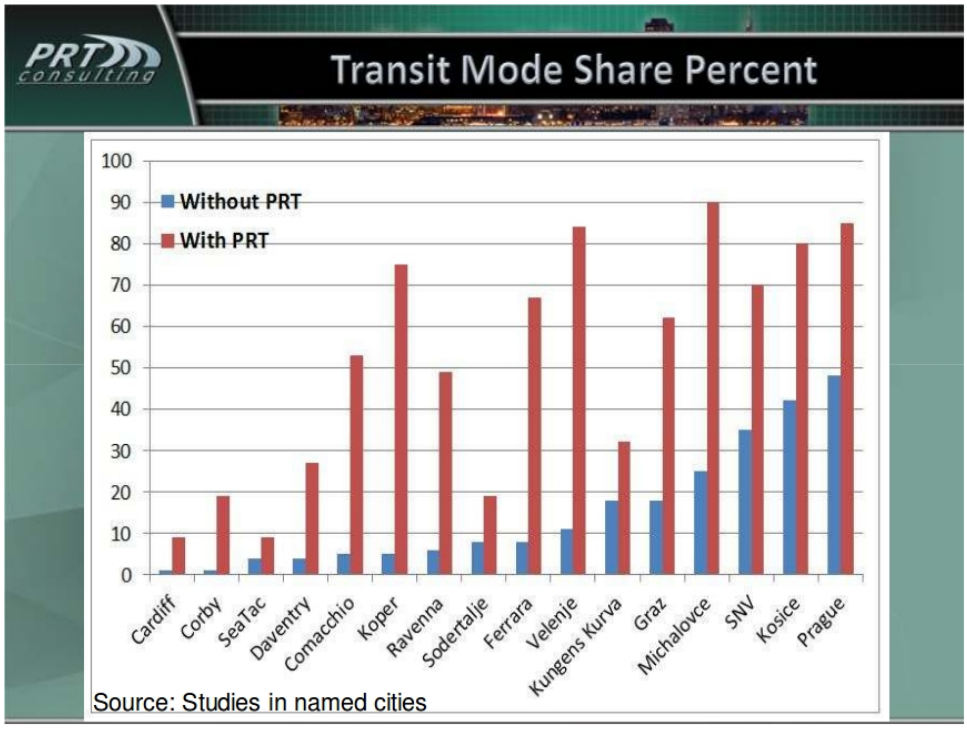
> ABSTRACT: A five-mile, $50M Personal Rapid Transit (PRT) "shuttle" system is proposed for Palo Alto's Stanford Research Park (SRP), complementing and significantly increasing the attractiveness of commuter rail, carpool, vanpool, bicycle, and bus commutes for the center's 20,000 employees. ...
>
> A complex travel demand analysis was conducted on a sample of suburban employees, of which 89% drive alone. When presented with a hypothetical Year 2008 commute alternative scenario, where PRT solved the "last mile" problem and new mobility services solved specific objections, drive alone commutes dropped to only 45%. Extrapolating to the entire office park, 6,600 cars per day are removed, freeing 50 acres of parking for reclamation, conservatively worth $150M. It appears possible to eliminate traffic congestion and air pollution without lifestyle sacrifice ... The model for Palo Alto plausibly translates to other job-rich major employment centers.

The reason that the SOV rate could be cut in half is shown below by the oval which represents a PRT system that quickly and conveniently connects all the other forms of transportation together. No matter how a commuter gets to the PRT system, it will quickly

deliver them to the next leg of their trip. To a large degree, this 2003 study of SRP anticipated Transportation as a Service (TaaS). Implementation today could be easier and more effective than 17 years ago. For example, now Uber/Lyft fill the role of "Smart jitney".



These two impacts – dramatically cutting SOV driving and major increases in transit ridership – have been predicted in many studies as shown in the chart below.



As envisioned, the LoopWorks PRT system will increase unionized transit employment by increasing ridership on public transit. Although bus service in the Transit Area will likely be reduced, the dramatic increase in transit use predicted above will more than compensate.

Safety and Security

The safety of LoopWorks' PRT system is expected to be better than the technology used in the Morgantown PRT system – which is itself much safer than conventional surface transportation. With over 200 million injury-free passenger miles, the PRT system at the University of West Virginia has demonstrated it is **50X safer than cars**. Regular transit would have injured over a hundred passengers in that many miles. In fact, the vehicles and guideways of the PRT system will be much safer than the platforms, stairs and elevators common in conventional transit systems.

In 2006, ANALYSIS OF SAFETY AND SECURITY CONCERNS For Automated Small Vehicle Transportation (ASVT) On A University Campus was published. Funded by Kansas Department of Transportation, it made these findings about ASVT (their term for PRT):

> "Safety issues result from accidental causes, and security issues result from deliberate causes, but the effects are similar and both were analyzed in terms of threats (or hazards) and vulnerabilities. … The study concludes that there is no aspect of ASVT that poses any significant security or safety issues that have not been successfully mitigated in other forms of public transit. Furthermore, the inherent nature of ASVT in which passengers are aggregated in small groups rather than large groups provides significant threat deterrence when compared to traditional transit."

PRT's security-enhancing separation of people into small groups works even during times of high demand. PRT service is distributed first through many small stations and then through parallel paths rather than bulked up along a single major transit line. This design feature avoids high-volume stations, interchanges and concentrated corridors that could be points of vulnerability to terrorist attack or robbery. By eliminating crowds at stations and in vehicles, security is improved and riders feel safer and more comfortable.

Concerns about security and vandalism at the stations will be addressed through a combination of standard practices including installing motion-sensing and tracking video recorder systems. The video stream could easily be linked to the police substation a short distance away at the Great Mall. The LoopWorks Human Interface (Ergonomics) of both stations and vehicles will enhance both security and safety.

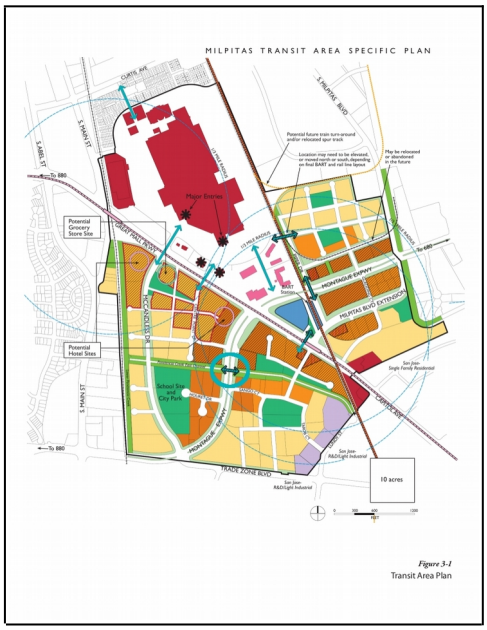
Benefits for Milpitas

The effects of traffic congestion on quality-of-life is a big issue in Milpitas, especially in the Transit Area. A 16-page traffic analysis of the area's congestion states that congestion is bad

and will likely get worse. And, as noted above, Driverless Vehicles traversing our roadways will not reduce congestion. LoopWorks PRT will provide residents, workers and visitors an alternative that mitigates congestion.

Milpitas Transit Area Congestion

Traffic data shows Milpitas experiencing approximately 3% annual growth in traffic volume on our roadways. Accumulated over the past 10 years, that 30% increase in traffic correlates well with the 30% increase in Valley jobs (compared to only 4% growth in housing). That unbalanced growth rate between jobs and housing is not something Milpitas can rectify alone, although thousands of housing units are being built in the Transit Area.



Furthermore, traffic patterns around the Milpitas BART station will change once its passenger service begins. BART's estimated 12,000 daily transit passengers (projected to rise to 20,000 in 2030) represents a potential 20% increase above recent estimates of 60,000 vehicles per day passing the station on Montague Expressway. Only 1650 parking spots will be available for the estimated 4000 daily passengers arriving by private motor vehicles (7200 are expected to arrive/depart by bus). Most of the transit ridership passing through that transit hub will be able to use the LoopWorks PRT.

These are the big-picture trends: 1) more jobs = more traffic and congestion, and 2) opening BART transit hub = more traffic and congestion. Refer to the Transit Area Traffic Analysis for details on level of service (LOS) measures, housing growth and impacts, and capital improvement projects (CIP) planned in the Transit Area.

Unfortunately, both walking and cycling in the Transit Area are discouraged by the many physical barriers: 2 sets of railroad tracks, 2 major limited-access roadways, and a creek. The ubiquity of PRT service in the area will make walking and cycling far more attractive, thus producing the dramatic increase in Ridership noted above.

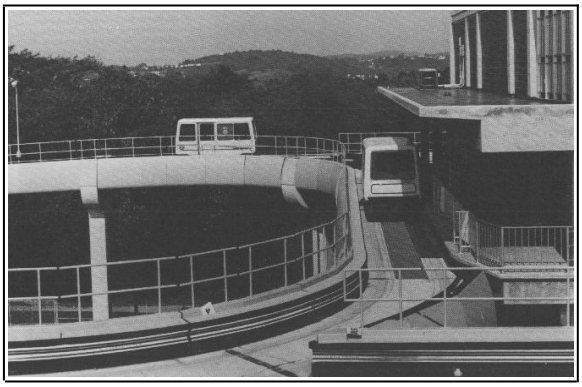
Direct Benefits to Milpitas of PRT System

The LoopWorks PRT system will provide these benefits to the community:

- less traffic
- less greenhouse gas
- more vibrant city
- more auto-free mobility

- improved public transit
- increased ability to attract employees
- increased commercial, industrial and residential land values
- increased retail sales
- no taxpayer cost
- potential for expansion within the City

Leveraged Benefits



Test sites, demonstrations and one-off systems show the promise of PRT. However, what is really needed are initial deployments that can grow, be replicated, and scale. The Morgantown PRT System has been enormously successful for 45 years (an essentially perfect safety record, an excellent availability record and customer valued mobility). Unfortunately, the system was never expanded or duplicated anywhere. It is a one-off.

Although demos and one-offs are "great", replication and scaling is required to deliver PRT's potential value. And it is possible. Consider, for example, the rapid spread of the electric trolley. In 1888, Frank Sprague successfully deployed a small electric street railway system in Richmond, VA, which became the reference for many other cites. "... By 1889 110 electric railways incorporating Sprague's equipment had been begun or planned on several continents..." Although eventually supplanted by the automobile, for more than 30 years trolleys delivered substantial improvements to the quality-of-life for many, many people.

Replication and scaling, so necessary to revers Global Warming, is what the LoopWorks project promises. **It can grow locally, be replicated virally, and scale to serve large metropolitan areas.** This local system can grow until it serves most of the 14 square miles that comprise Milpitas. The technology can be replicated most anywhere experiencing congestion problems. And PRT can scale from a simple crossing of a creek through small-area coverage (as envisioned for Milpitas) all the way up to serve a large metropolitan area like San José.

Assisting the viral spread of PRT technology will be popular media. As has occurred previously with other PRT advances, magazines, newspapers, on-line news sources, television stations, cable channels, etc. will be anxious to describe the PRT system to their audiences. A great deal of additional advertising will be provided by other groups and individuals that have already been watching progress on this project.

Critical to that rapid replication is the data provided by the LoopWorks PRT system on safety, reliability, comfort, capital costs, and operating and maintenance costs. (See Performance

Reports – The Big Payoff.) This data will be leveraged by communities across the country as they build their own systems.

Prof. Anderson's demonstration system during the 2003 Minnesota State Fair prompted a reporter to ask: "What was the most surprising thing about it?" Dr. Anderson responded "the thrill people got out of riding only 40 feet." That feel-good embrace of this technology has been repeated with each new PRT installation. People responding positively to PRT will be invaluable as it spreads to other communities.

Network Value

PRT systems are easy-to-expand networks. Under Metcalfe's Law, the value of a network rises with the square of the number of connected (n^2). In the case of a PRT network, each station is a node. For example, the proposed Mini-Loop with 5 stations provides 25 units of value (5 x 5). By adding 7 more stations with the BART Circulator (12 stations total), the system value jumps to 144 units of value (12 x 12). (See Corridor vs. Grid.) Non-linear growth of value as a network expands will provide the impetus to grow the initial PRT system – perhaps until it serves most of the 14 square miles that comprise Milpitas.

Potential Markets

Early deployments of PRT, mainly for passenger movement, are expected to be found in highly congested business districts, airports, theme parks, college campuses, office parks, hospital complexes, shopping centers, and retirement communities. However, as noted above, pedestrian overcrossings (POCs) may be the easiest path for initial introduction into other communities.

Today, demand for ITNS lies in every corner of the world, and the return to the investor could exceed almost any other investment. A lead investigator estimated the worldwide market to be over $1 trillion. The internal paper "Economics of ITNS Networks" and its Excel companion piece provide a methodology for estimating the return on investment as an ITNS-based system expands over a metropolitan area. Network Value is at the core of PRT's potential.

In an effort to provide transparency and encourage others to pursue their own PRT projects, LoopWorks will build and maintain a website with information relevant to such endeavors. A successful PRT system in Milpitas will likely lead to presentations at many transportation and planning conferences. LoopWorks will develop brochures, displays and presentation slides to support those appearances. These materials will also be available on the website.

Supportive Trends and Forces

Our worsening Climate Crisis is compelling people and institutions to consider new solutions. Primary among the efforts is the Green New Deal that proposes to create 20 million jobs by transitioning to 100% clean renewable energy by investing in public transit and other sustainable infrastructure. Research funds will be redirected from fossil fuels into renewable

energy and conservation. PRT projects are likely to benefit from trends to reduce greenhouse gas emissions and increase government-sponsored employment.

At the same time, Baby Boomers approaching the end of their lives are more often thinking about giving back to their communities and creating some sort of legacy. Wouldn't a PRT project satisfy either desire? Other seniors in their seventies, eighties, and nineties become concerned about travel to their many activities. Trends predict longer life expectancies, a core desire for active lifestyles, and a growing senior population. These trends will support the demand for, and the spread of, PRT systems more seniors look for alternatives to driving.

Disruption in Rail Transit?

Due to the use of LIMs (linear induction motors) for acceleration/deceleration, spacing between vehicles can be 1 second or less. Thus, a capacity of 3600 vehicles/hour (over 10,000 passenger seats) combined with 40-mph non-stop speeds makes high-capacity PRT (HC-PRT) a challenger to commuter rail and other traditional ways of moving lots of people.

Pedestrian Over-Crossings (POCs) Obsolete?

As mentioned above in Capital Costs to Build Transit, Pedestrian Over-Crossings (POC) cost about $150M/mile to cross creeks, roadways, railroads and other barriers. Using standard steel-and-concrete bridges has become increasingly costly in terms of money and time. For example, the Don Burnett Bicycle-Pedestrian Bridge (shown below) is a 503-foot-long cable-stayed bridge over Interstate 280 that connects Cupertino with Sunnyvale. It was completed in 2008 at a cost of $14.8 million, or $155M/mile. At $30M/mile (bi-directional), PRT could provide comparable service for one-fifth the cost.

Another example comes from the Transit Area in Milpitas. The City of Milpitas just spent $4.5M of its own money to partner with VTA in building the 200-foot, $14M POC over Montague Expressway (from the VTA parking structure to The Edge Apartments). Another crossing of Montague is called for in the City's Transit Area Specific Plan. Using PRT technology to ferry people across Montague Expy. appears to cost less than $4M.

If moving people across barriers with PRT technology proves cost-effective, PRT can substitute for POCs across the county and the country. PRT technology would make currently-too-costly crossings more affordable, and therefore more likely to be built and used sooner. Given the extensive need for barrier crossings just in Santa Clara County, the potential number of PRT shuttles in the U. S. could exceed 1000.

Project Description

ITNS-designed PRT is a fundamentally new form of public transportation. It is designed to provide users with a high level of service, safely and reliably, over an urban area without the need for driving. Furthermore, PRT maximizes ridership while minimizing cost, energy use, material use, land use, and noise. Being electrically operated, it does not emit greenhouse gases nor any fossil-fuel pollutants.

This remarkable set of attributes is achieved by operating small, light-weight, automatically controlled vehicles on a network of minimum-weight, minimum-sized exclusive guideways. Non-stop travel between origin and destination stations is achieved by placing all stations off the main line, i.e. off-line. To achieve reliable all-weather operation, the system uses non-contact linear induction motors (LIMs).

Location, Location, Location

For most areas in the South Bay, congestion is not a big problem – but it is in the Milpitas Transit Area. By the end of 2020, a major transit hub in that area at the southern edge of Milpitas will offer access to BART, LRT, bus and Uber/Lyft along with provisions for cyclists and pedestrians. Unfortunately, 1) various barriers discourage access to that cornucopia of transportation options, and 2) already-bad traffic congestion in the Milpitas Transit Area will worsen as the expected 7000 new homes are occupied and the BART transit hub starts operating (12,000 daily BART riders plus a similar number for all the other transit hub options combined). Driverless Vehicles without multiple riders will further increase congestion due to latent demand (by people unable to drive) and dead-heading (driving around empty to fetch the next rider).

Two barriers in particular (Great Mall Parkway and Montague Expressway) separate nearly all housing in the Milpitas Transit Area from the BART transit hub. Although both are walkable/bikeable, most parents would not want their children using those high-volume, limited-access roadways unless absolutely necessary. Even for experienced cyclists, these roads are not convivial – and, thus, another impediment to getting people to use alternative (non-car) transportation options.

Other barriers to travel in the Transit Area include the BART tracks, a separate set of railroad tracks, and a creek. Access by motor vehicle will likely remain the dominant way to get to the transit hub, especially for residents living in the northern half of Milpitas. Unfortunately, access by motor vehicle can be problematic during commute hours due to the heavy congestion between I-680 and I-880 – congestion that will likely worsen as driverless vehicles become common, thousands of new residents arrive, and the BART transit hub starts operating.

In such a congested, high-density area, common sense suggests moving into the 3rd dimension by considering technologies that use elevated guideways such as Personal Rapid Transit (PRT), Group Rapid Transit (GRT), and Automated People Movers (APM). PRT capacity is adequate to serve the expected demand, so higher capacity GRT or APM options are an unnecessary expense.

Dual-Loop PRT System

An advanced transit PRT system comprised of two loop (one within the other) is proposed to mitigate both the congestion and the accessibility issues described above. (Find an 8-slide overview of the project at http://sunnyhillsneighborhood.org/presentation-people.pdf) Using small electric vehicles on an elevated guideway, residents from 7 separate housing areas could easily access

- the BART station
- new elementary school
- an industrial/business park
- The Great Mall
- a grocery store (Trader Joe's)
- and three city parks

Residents and visitors can get there and back without using a car, and without walking/cycling out-of-the-way routes on high-volume, high-speed roadways.

As shown above, an initial dual-loop PRT system is proposed to include 4 miles of guideway connecting 12 stations for a cost of $60M (4 miles x $15M/mile), about the cost of Milpitas City Hall in inflation-adjusted dollars. Operations & Maintenance (O&M) Costs would run between $0.6M and $1.8M per year ($60M x 1-3%).

Upon successful completion of this system, extensions are expected that may ultimately cover most of Milpitas. Regardless, this small PRT project will draw international attention to the city, and help validate estimated costs and benefits.

Outstanding ROI Potential

With successful operation of the Milpitas PRT system, the transportation picture for many United States metropolitan areas could change – rapidly! The PRT adoption rate could match that of the electric trolley when first successfully deployed over a hundred years ago. Investment in this project could generate Leveraged Benefits sparked by a wave of systems across the country within ten years that would generate benefits totaling tens of billions of dollars.

Adoption rates elsewhere are expected to be high partly because siting PRT is far easier than other conventional rail-based transit projects where routes are often the determining factor with station locations secondary. PRT technology encourages placing stations where they make sense because guideway routing between stations is easy. PRT can handle tight turning radii and steep gradients (10% or more) while gliding over most ground-level obstructions. Thus, destinations (station locations) can be chosen first, and then routes planned to connect them.

Most people familiar with the Milpitas Transit Area would agree that stations are needed to serve the BART station/transit hub, the Great Mall, and the elementary school. Other popular destinations were selected, and routing between them identified. In all the outreach efforts conducted on behalf of this project, no substantial objections have surfaced – neither to station locations nor guideway routing. Thus, only minor adjustments of guideway paths and station locations are expected.

A Dual-Loop PRT System combined with the current transportation options would enhance the usefulness of them all (see PRT Synergy). In particular, it would provide convenient access to/from the transit hub for residents, their visitors, and Transit Area business employees and customers. Commuters will benefit from a safer, easier rides to their home or transit connection when opting to leave their cars at home. LoopWorks PRT will enable pedestrians and cyclists to travel safely between destinations where no safe options currently exist. Bus routes and TaaS vehicles (Lyft/Uber) could be scaled back as PRT serves more people, more conveniently in the area. Ridership of both this advanced transit system and the existing transportation options is likely to be high due to improved access and expanded service.

Capital cost to build PRT is competitive with other options (as outlined above in Capital Costs to Build Transit). Likewise, O&M costs are far lower than conventional transit as outlined in Operations & Maintenance (O&M) Costs. Also, a bridge planned for the area won't be needed. City documents show a planned $14M east-west pedestrian over-crossing of Montague (along the Penitencia Creek channel). Instead, PRT would provide the needed service, thus saving the City and VTA the expense.

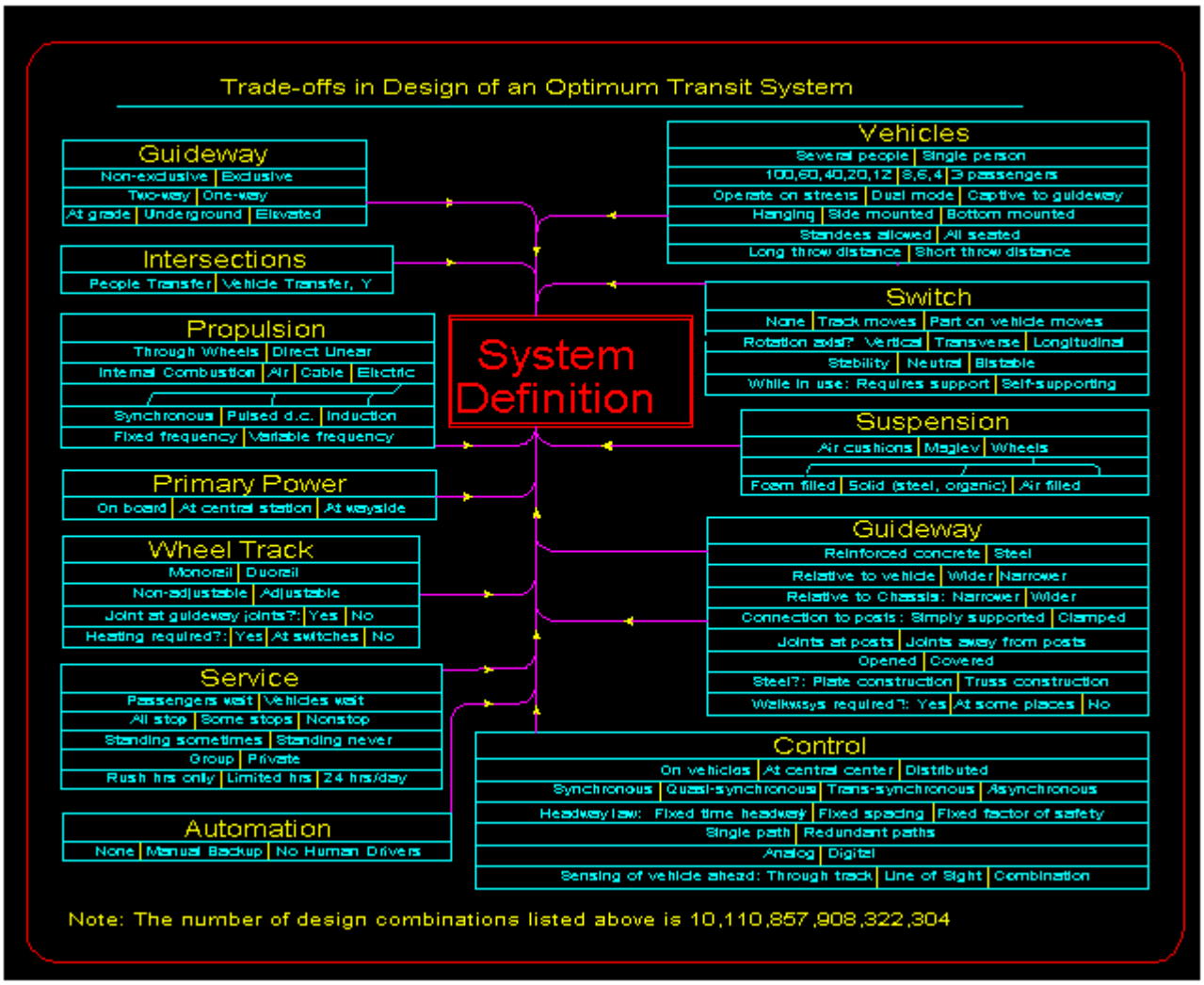
The PRT system promises **individual benefits** of convenience, commute time reduction, and free time. In addition to on-demand, no-wait vehicle availability at 12 conveniently-located stations, non-stop/non-transfer rides to any of those stations reduces door-to-door time to less than that of driving. And PRT riders may use the few minutes of travel time for purposes other than attending to driving.

Societal benefits include increasing transportation equity and reducing fossil fuel emissions. As mentioned in PRT Synergy, dramatically cutting SOV driving combined with major increases in transit ridership has been predicted in many studies. The traditional mass transit option – buses - capture a modal split in most U. S. cities that hovers around 3%. Estimation of ridership on a PRT system range from 25% to greater than 50% of the daily trips. See Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume I (page 214). Even higher ridership potential in some places is shown in the table on page 11 of a study comparing LRT, GRT and PRT.

In addition to providing extraordinary service to residents and visitors around the Milpitas Transit Area, this project will provide transit experts and decision-makers with real-world data about capital costs, O&M costs, public acceptance, ridership, and transit synergy. The primary value to be gained from building this first PRT system will be the Performance Reports – The Big Payoff.

Hardware

The LoopWorks PRT System is markedly superior to any other PRT design because resources were invested sorting through all the ways a PRT system could be built. As shown below, there are many factors to consider when designing a PRT system. For example, selection of a guideway requires 3 choices from 7 options (upper left corner). Such a large number of variables with complex relationships between them presents a daunting challenge to PRT designers.



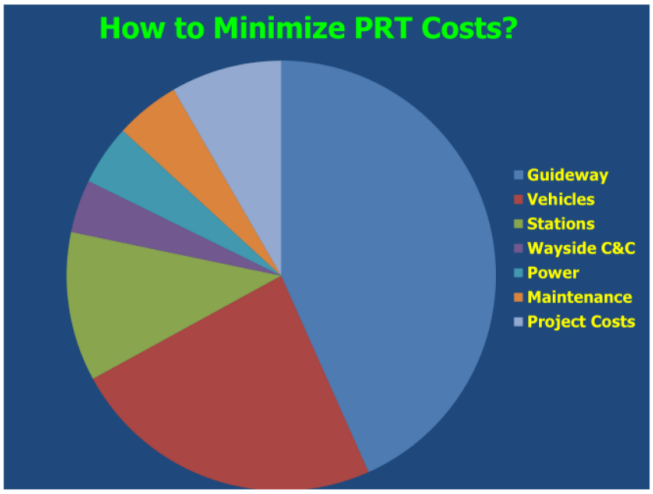
Major Design Trade-offs

Despite the complexity of 10 quadrillion combinations, ITNS sorted through the design factors. Here are the major design trade-offs examined in the ITNS Business Plan (page 9), and the options chosen for implementation for the Milpitas PRT system:

1. Exclusive Guideway vs. Mixed Traffic
2. In Vehicle vs. In Track Switching
3. Small Vehicles vs. Large Vehicles
4. Off-line vs. On-line Stations
5. Captive Vehicles vs. Dual Mode
6. Supported Vehicles vs. Hanging Vehicle
7. Suspension on Wheels vs. Magnetic Suspension (Maglev)

8. Propulsion by Linear Motors vs. Rotary Motors
9. Linear Induction Motors vs. Linear Synchronous Motors
10. Motors in Vehicles vs. Motors in the Guideway
11. Power Source at Wayside vs. On Board
12. Guideway Narrow vs. Wide
13. Control Asynchronous, Synchronous, Quasi-Synchronous, or Trans-Synchronous
14. Control Point Follower vs. Car Follower

Dr. Anderson's document "How to Reduce Congestion and Save Energy" (pages 13 - 22) outlines the rationale behind each design decision in the context of resolving design problems. As an example, the decision to choose a narrow guideway follows from this chart:

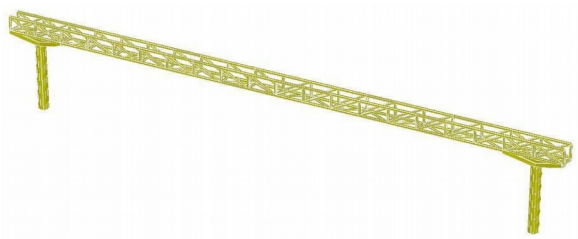


Here is the cost distribution of our system, showing with no surprise that the guideway, being the most expensive component, deserves primary attention.[15] Years before, I found in a surprising number of PRT development programs that the guideway design was taken as an afterthought, perhaps because control received the bulk of attention.

The ITNS Business Plan delves more deeply into the rational behind each major trade-off. Beyond hardware trade-offs are other considerations, perhaps the most critical being the impact of line speed upon design choices:

> "All of the important parameters involved with network design depend on line speed. Kinetic energy, air drag, curve radius, and stopping distance all depend on the square of speed. The power to overcome air drag increases as the cube of speed; and, with given guideway roughness, however small it may be, the suspension required is more demanding as speed increases. The system will therefore become more expensive as line speed increases, and this must be balanced against the expected increase in ridership as the average trip speed increases. The bottom line is that the planner needs to know how line speed affects cost per passenger-mile." (page 89)

Hardware Attributes



Details of the ITNS design are explained in the 69-page Technical Specifications for ITNS Technology. Here are the attributes of the ITNS hardware design used by LoopWorks in the Dual-Loop PRT System:

- Off-line stations.
- Fully automatic control.
- Minimum-sized, minimum weight vehicles.
- Small, light-weight, generally elevated steel-truss guideways. (pictured)
- Vehicles ride above guideway to minimize cost and maximize both rider comfort and speed range.
- Hierarchical, modular, asynchronous control to permit indefinite system expansion.
- Dual duplex computers for high dependability and safety.
- Accurate, dual position and speed sensors.
- Dual linear-induction-motor propulsion and braking for all-weather operation.
- Smooth running surfaces for a comfortable ride.
- High-pressure, pneumatic tires to minimize guideway cross section and weight, and to minimize rolling resistance and noise.
- Guideway support-posts separated by at least 90 ft (27 m) to meet planning requirements.
- Propulsive power from two electric lines within the guideway (dual wayside bars shown upper right in photo) for high system reliability.
- Adaptable to all renewable energy sources.
- Switching with no moving track parts to permit reliable, no-transfer travel in networks.
- Well lit, CCTV-surveyed stations to insure passenger security and reduce vandalism.
- Nonstop trips with known companions or alone.
- Adequate speed, variable with application and location in a network.
- Vehicle movement only when trips are requested.
- Automatic empty-vehicle rerouting to fill stations.
- Planned & unplanned maintenance *within the system*.
- Full compliance with the Americans with Disabilities Act.

As materials science evolves and the price of electricity-storing batteries falls, LoopWorks will consider their use. By powering from wayside batteries charged at night, the PRT system need not add to the peak utility load, and may reduce operating (fuel) costs. PRT stations may be desirable sites for storage batteries, whether owned by LoopWorks or a 3rd party.

Human Interface (Ergonomics)

While engineers appreciate specific hardware features, the interface of that hardware with people is arguably what matters most in a successful system. These are the rules designed into the ITNS system that directly impact people.

Station Facilities

- People must be able to select the destination in the simplest possible way – by viewing a map of all possible destinations.
- If, upon seeing the vehicle door open, the rider notices that the vehicle has been vandalized or needs cleaning, there must be a means of rejecting the vehicle and notifying system personnel.
- For reasons of security, each station must be equipped with video cameras connected to screens at a control room, there must be a means of alerting control room personnel that they must pay attention to a specific station, and there must be a two-way voice communications system between the control room and either all stations or one specific station.
- It must not be possible for a patron to walk out onto the guideway.
- The station must be well lit and have fire-extinguishing equipment.

Passenger and Environmental Controls

There shall be three buttons conveniently located in the vehicle that can be actuated by the passengers: a "Go" button, a "Stop" button, and an "Emergency" button.

- The "Go" button causes the door to close and signals to the station computer that the vehicle is ready to leave the station.
- The "Stop" button causes the vehicle to stop at the next station and then the door to open after it is stopped.
- The "Emergency" button alerts a human operator located in a control station to inquire through a communications system as to the problem. If the rider feels the temperature in the vehicle is too high or too low, the operator can adjust it. When the system grows to include stations at the police department building and the County Health Clinic, then operator options increase to include: 1) if the rider indicates sickness, the operator can change the vehicle's destination to that of the clinic, and 2) if the rider is in danger, the operator can change the vehicle's destination to that of the police station.

Voice Communications

There shall be a two-way voice communication system in each vehicle to connect an individual vehicle or a group of vehicles to the system's control room. (Vehicle-to-vehicle communications is available through privately-owned cell phones.) This voice system is separate from the data communication system that controls the speed and position of the vehicles. There will be a television screen in the front center of the vehicle near the floor. It must be possible for the passengers to turn the set ON or OFF, and if ON to switch to site-specific advertising, travel information about the passing surroundings, news, entertainment, or information about system operation and features.

Lighting

The cabin will be equipped with reading lights that can be switch ON or OFF by the passengers. Exterior lighting is optional but low lumen lights are recommended, both front-facing "parking lights" and red tail lights.

HVAC

A heating, ventilating, and air conditioning (HVAC) system shall be designed into the cabin, with the large components, such as the compressor and the drive motor, placed in the compartment behind the seat.

Accommodations

The cabin is to be designed to accommodate any portion of the following maximum weight/bulk rider combinations:

- a person in a standard-sized wheelchair entering from the side (then turning to face forward) and a companion
- 3 adults and 2 children
- a person with a bicycle
- 2 people with large suitcases
- 2 people with a baby carriage.

Visual Intrusion

In those cases where it is undesirable to have passengers looking down into sensitive or private areas, the vehicles could be designed with windows that automatically fog over for that segment of the journey.

Codes

The system shall be in conformance with the following codes and standards:

- American National Standards Institute (ANSI)
- Electronic Industries Association (EIA)
- Insulated Cable Engineers Association (ICEA)
- Institute of Electrical and Electronic Engineers (IEEE)
- National Electrical Code (NEC/NFPA 70)
- National Electrical Safety Code (NESC)
- National Electrical Manufacturers Association (NEMA)
- National Fire Protection Association (NFPA)
- Underwriters Laboratory (UL)

The BART station is built in a flood plain. Thus, so will be the Mini-Loop and BART Circulator. When siting electrical power in the area, elevating it will be required under Section XI-15 of the Milpitas Municipal code regarding construction in a flood plain. Although this requirement is already in place courtesy of NEC/NESC, this note is included out of an abundance of caution.

Certification (CPUC)

Certification of a PRT system relies upon getting the permission from various government agencies that regulate the safety of things with which people interact. For example, the cabin must be designed to comply with the requirements of ISO 9000 (quality management) and NFPA 130 (guideway standards). In addition to all the applicable Codes identified above, the California Public Utilities Commission (CPUC) must certify the LoopWorks PRT system before starting public operations.

> The CPUC has safety and security regulatory authority over all rail transit and other public transit fixed guideway systems under Public Utilities Code Section 99152 and other statutes. … The CPUC ensures that all rail transit system extensions and new construction projects undergo a safety certification review and approval.

LoopWorks will involve the CPUC early, and keep them involved throughout design, construction, and O&M (during which LoopWorks is required to report incidents that meet specific thresholds). The CPUC will focus on the project (not the technology) and the project owner (not the contractors). Thus, this CPUC-interface function is one that LoopWorks will retain as it contracts out the final design, fabrication, construction and testing. Meetings

between LoopWorks and the Milpitas Fire Department will also be held to ensure this infrastructure project supports their goals.

The goal is attaining a CPUC General Order 164-E certification to permit LoopWorks to commence PRT operations for the public. The framework for LoopWorks' relationship with the CPUC will be *Rules and Regulations Governing State Safety Oversight of Rail Fixed Guideway Systems*. For the purpose of ensuring a high level of safety, ITNS has augmented these rules with its own Test Program in Task #11 of Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume II (pages 1495-1509).

Although General Order 164-E does not mention ASTM standards, LoopWorks will ensure that the PRT system meets the standards set by the ASTM International F-24 Committee on Amusement Rides and Devices. By doing so, the ITNS design will meet standards across the globe, thereby addressing requirements involved in deploying systems outside of California.

ASTM International is one of the largest standards-writing bodies in the world. The F-24 committee establishes standards on amusement ride design and manufacturing, testing, operation, maintenance, inspection, and quality assurances. The ASTM standards are used in 44 of 50 States and many nations. The ASTM standards:

- Are widely used and well established.
- Are tailored to pedestrians, especially children.
- Have an existing enforcement industry.
- Have an existing insurance industry.
- Have an existing common law. This is very important because privately funded transportation networks will not have the sovereign immunity that protects DOT from poor safety performance.
- Produce dramatically better injury-rates than roadways:
    - ASTM injury rates are 0.2 per million.
    - Self-regulated DOTs have a death-rate of 118 per million in the US.

Software

During the past decade, ITNS has developed the software programs needed to operate an ITNS-based network of any complexity. The Control System is described in detail as Task #7 in Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume III (pages 1230-1454). When a company is selected to implement the software, ITNS will provide additional information on the details of PRT network control on an as-needed basis.

Transit Control Solutions, Inc. is one company under consideration to supply the control software. Eugene Nishinaga, President and CEO, wrote a letter of support for the project:

> I have been a technologist in the field of public transportation now for almost 45 years. Of this time, I spent 25 years at SF BART. During my early years, I was involved in

developing cutting edge transportation control technology for the BART system. Then later, I was tasked with managing BART's R&D Division that studied and reported on developing and promising transportation technologies for BART's consideration.

In this latter role, one of the subjects of investigation was the viability and potential of personal rapid transit and group rapid transit modes of passenger and goods transport. What I surprisingly discovered was that, if properly developed and deployed, these systems can achieve a cost-benefit that is approximately four times better than what can be achieved by more conventional means.

Although I retired from BART to pursue other opportunities before the results of my report were given serious consideration by the management at BART, the conclusions I reached stand, and I continue to believe that PRT and GRT systems can become a mode of transport that is superior to other more conventional forms of transport.

Regardless of the source of control software, security is paramount. In early 2020, as part of investing in its cybersecurity, Tesla challenged hackers to crack its cars with ~$1 million on the line and a few Model 3 vehicles. These types of hacking competitions with white-hat hackers enable Tesla to test and improve its security systems, which are becoming increasingly important in cars as they are becoming more like computers on wheels. While CPUC Certification is adequate to begin operating the PRT system, LoopWorks may employ a variation on this concept to ensure the no black-hat hackers can adversely impact the system and its service.

Peopleware

People with specific knowledge and skills will be needed to design, build, test, operate and maintain the proposed Dual-Loop PRT System. The following table shows the Areas of Responsibility that have been identified and the Tasks associated with each. While LoopWorks employees will fulfill some roles, most tasks will be performed by contractors.

Areas of Responsibility	Tasks
Systems Engineering	Responsibility for coordination of all aspects of the design.
Standards	Review all applicable standards and report specific system and component requirements to the project managers.
Safety & Reliability	Responsibility for all aspects of system safety, dependability, hazard analysis, fault-tree analysis, and failure modes and effects analysis. Documentation of all procedures used to insure safety in keeping with accepted standards for operation of automated transit systems. Based on existing information and methodology, develop and maintain a model for calculating system dependability.

Areas of Responsibility	Tasks
Weight & Cost Control	Develop computer models for weight control of the vehicle and cost control of the system. Maintain contact with all subsystems designers to keep models up to date. Report to project director and operations officer any deviations from target weight and cost. Develop a model for calculating operation and maintenance costs.
Vehicle Dynamics	Based on an available program, perform dynamic analysis of vehicle moving through merge and diverge sections of the guideway with the worst combination of side loading (wind + centrifugal) + maximum unbalanced load to verify the requirements regarding maximum tire loads, tire stiffness, switch placement, flared switch rails, and ride comfort.
Finite-Element Analysis	Perform FEA to finalize the specifications of the post-guideway bracket, the switch arm, and the chassis-cabin attachments.
Test Program	Review available descriptions of all necessary tests, define the test program, supervise all testing, and document the results.
Control System	The software for the system and vehicle control has been defined and the required types of hardware have been identified. Based on this information, complete the design of the operational software and hardware, supervise procurement and installation of the components in the test system, update the test plan, and supervise testing.
Propulsion & Power System	Specify LIM-VFD (linear induction motor - variable frequency drive) system with power-supply and distribution system, both on-board and at wayside. Identify suppliers and work with them to finalize the designs. Supervise installation in test system.
Guideway, Posts & Foundations	Perform computer verification of the guideway & post design. Develop post-foundation design. Coordinate space requirements inside guideway with the chassis designer. Develop the final design and drawings. Specify and supervise design of computerized jigs, fixtures, and robotic-welding equipment for guideway fabrication. Help select the fabricator & supervise fabrication.
Vehicle Chassis 	The chassis includes wheel-axle-bearing assemblies, LIM & VFD, shock absorbers, switch assembly, parking and emergency brake, mounting of power-pick-up shoes and transverse, equipment compartment for control and a/c components, frame, wiring, and interface with cabin. Develop final design drawings, find necessary suppliers, and supervise fabrication.
Vehicle Cabin	Review the design requirements. Finalize bid documents and find

Areas of Responsibility	Tasks
	cabin designer and fabricator. Work with fabricator to develop and build the final design. Supervise fabrication. Consider styling, structural design, thermal design, material selection, human factors, HVAC, aerodynamics, seat, automatic door operation and its fatigue testing, lighting, push-button controls, and interface with chassis.
Director	Overall direction, supervision, and education of systems engineering team.
Operations Officer	Responsible for daily coordination, facilitation and expediting.
Contracts & Purchasing	Responsible for negotiating contracts and for purchasing of components and subsystems.
Support	Develop ways for, and provide support of, maintaining financial and accounting records and project controls. The human-resource functions also fall under this responsibility.

Detailed Task descriptions can be found in Appendix A (pages 38 – 91) of the ITNS Business Plan. System Safety and Reliability is a major part of any engineering program related to automated guideway transit in order to ensure that the system is safe. An agreed definition of safety will be developed (see Certification). The existing Automated People Mover Standards require that any APM program have on its staff at least one full-time person devoted to safety issues and who operates separately from the design teams. This person must be familiar with the analysis of safety problems in complex systems that include real-time, safety-critical software.

Additionally, safety issues include fire safety, natural disasters, station security, robustness and redundancy in the software, design loads and stresses, and all other issues involving safety. This person will work collaboratively with the Rail Transit Safety Branch (RTSB) of the California Public Utilities Commission (CPUC). RTSB's engineers and analysts conduct continuous review and safety oversight of design and construction of capital projects, operations, emergency response, accident reporting, and incident investigation. The RTSB inspectors conduct on-site visits to inspect infrastructure and vehicles, monitor operations, evaluate maintenance practices, and other activities to identify noncompliance, safety concerns, and unsafe conditions. The CPUC ensures that all rail transit system extensions and new construction projects undergo a safety certification review and approval.

Policies and Procedures

In addition to taking guidance from the book Reinventing Organizations, more details can be found at the volunteer-created Wiki that covers structures, processes and practices used by self-managing groups and companies. Alternatively, an entire package of self-management tools is available from Holacracy and Sociocracy.

LoopWorks can also avail itself of work done in this area by Silicon Valley Clean Energy. Posted on their website are policies regarding:

- Finance Policies
- General & Administrative Policies
- Human Resources Policies
- Information Technology Policies
- Additional Policies

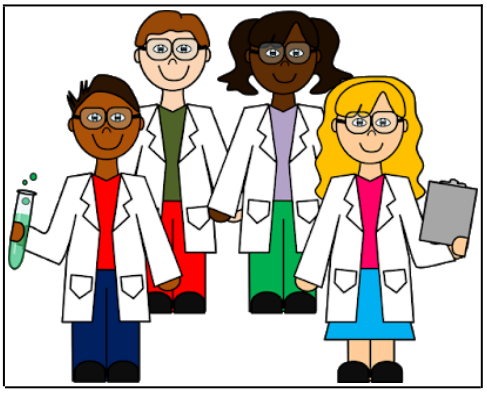
Performance Reports – The Big Payoff

In addition to providing extraordinary service to residents and visitors around the Milpitas Transit Area, this project will provide transit experts and decision-makers with real-world data. That data and the knowledge we gain from building this initial PRT system is the biggest payoff for investing in this project. Thus, LoopWorks will establish monitoring metrics for both performance monitoring and reporting purposes.

Valuable assets derived from this first PRT system:

- Verify construction and O&M costs.
- Demonstrate safety and reliability.
- Confirm ride comfort.
- Create a business model for potential widespread replication.
- Provide an operating system and documentation for training engineers, planners, technicians, and consulting firms asked to evaluate PRT technology.
- Enable an insurance company to establish a liability rate.
- Establish ITNS PRT as "proven technology" for comparison with other transit technologies in major investment studies.

Data to Collect and Share



As the first ITNS-based PRT system built in the world, nearly every fact about the system will be useful to others considering PRT for their own applications. Therefore, keeping detailed records will be invaluable. In addition to standard accounting figures and design specifications that will be a part of building the system, details about operations and maintenance will be recorded. Involving an independent third party to verify and record such information will help ensure the integrity of the data.

Silicon Valley Clean Energy (SVCE) has selected experienced partners to support programs that help local communities reduce carbon pollution. In particular, all programs and pilot projects are audited by ADM Associates, Inc., a third party contracted for Evaluation,

Measurement and Verification services with headquarters in Sacramento and a branch office in Fremont (One Fremont Place, 39650 Liberty Street Suite 425, Fremont, CA 94538, business@admenergy.com, 916-363-8383, https://www.admenergy.com/). ADM presents itself as a likely candidate company to conduct various performance assessments:

> "Our team of engineers, social science researchers, and analysts has developed innovative energy research and program evaluation strategies, which have been presented at the International Energy Program Evaluation Conference (IEPEC) and other professional forums. Our multi-disciplinary staff facilitates efficient, comprehensive energy efficiency program evaluation."

Reliability & Safety

Establish and maintain a daily failure log and computerized data files, and perform the following analyses:

- Compare actual reliability with system-engineering allocations and predictions.
- Determine component modifications for future systems.
- Determine causes and effects of failures and prescribe corrective actions.

As part of ITNS Task #3, Safety & Reliability, LoopWorks will develop and maintain a model for calculating system dependability.

As part of ITNS Task #7, Test Program, LoopWorks will supervise all testing and document the results.

Environmental

Establish and maintain a daily weather log and computerized data files. Analyze the effects of water, heat and wind on the operation of the system. Extensive noise studies should be conducted along with subjective perceptions of the visual impact of PRT.

Maintenance, Maintainability, & Supportability

Establish and maintain an equipment maintenance log and computerized data files. Perform the following analyses:

- Compare actual maintainability with system-engineering allocations and predictions.
- Establish design criteria for all maintenance-support equipment.
- Refine estimates of operating and maintenance costs.
- Develop preventative maintenance procedures.

As part of ITNS Task #4, Weight & Cost Control, LoopWorks will develop a model for calculating operation and maintenance (O&M) costs.

Ride Comfort

After CPUC Certification, but before opening the system to the public, LoopWorks will determine the acceptability of the ride comfort. Opinions of passengers of various ages and

conditions will be obtained after they have ridden in a vehicle at various speeds up to the design maximum. In this way, the values of comfort acceleration, jerk, roll rate, and bank angle to which the guideway was designed will be evaluated and reviewed.

Vehicle Performance and Efficiency

- **Speed-profile control.** Determine that vehicle acceleration, deceleration, and jerk rates when moving from rest to constant speed, from constant speed to rest, and from one speed to another are as specified.
- **Control accuracy.** Measure the ability of the controller to maintain constant speed in the presence of simulated wind gusts produced by means of a drag brake, and with minimum, average, and maximum vehicle gross weight. Measure stopping accuracy at a predetermined point.
- **Drive performance.** By accelerating and braking the vehicle on a pre-programmed schedule, determine that the LIM (linear induction motor) thrust vs. speed, thrust vs. current, transport delay, and power factor are as expected.
- **Acceleration efficiency.** Determine the energy efficiency in accelerating from rest to cruising speed in terms of the ratio of the electrical energy input to the energy required to overcome inertia, air drag, and road resistance. Perform these tests with minimum, average, and maximum vehicle gross weight.
- **Cruise efficiency.** Determine the motor and drive efficiencies at various constant speeds up to 16 meters/second (36 mph). The power output is the force required to overcome air drag and road resistance multiplied by vehicle speed. The power input is the electrical power input to the vehicle from the wayside source.
- **Overall efficiency.** Determine the electrical power input to one vehicle required to start a vehicle from rest, circle the Mini-Loop guideway once, and stop again in calm air. Compare with the value calculated using data from the previous tests.

3rd Party Data

While the above specified data will be gathered and documented by LoopWorks, other interested parties are likely to gather their own data for studies they may conduct. For example, students and teachers in the Mineta Transportation Institute at San Jose State University may find this project fruitful in following their mission to increase mobility for all by improving "safety, efficiency, accessibility, and convenience". One aspect that may prove valuable to explore is vandalism. Since PRT is a fun and humanizing technology that people embrace, less vandalism is expected. If so, that fact would be valuable to transit agencies.

LoopWorks will assist such others while giving priority to educational and research institutes. Although LoopWorks requests that data and findings secured by a 3rd parties be publicly shared, that decision is up to them.

Data on property values, collected by the Santa Clara County Assessor, will be publicly available. This data will indicate what happens to property values and tax revenue when a PRT infrastructure is introduced – information important to any city investigating their own PRT system.

Because LoopWorks is implementing principles from Reinventing Organizations, posting information regarding the company's progress on Enlivening Edge may spark the interest of researchers more interested in the business structure than the PRT technology.

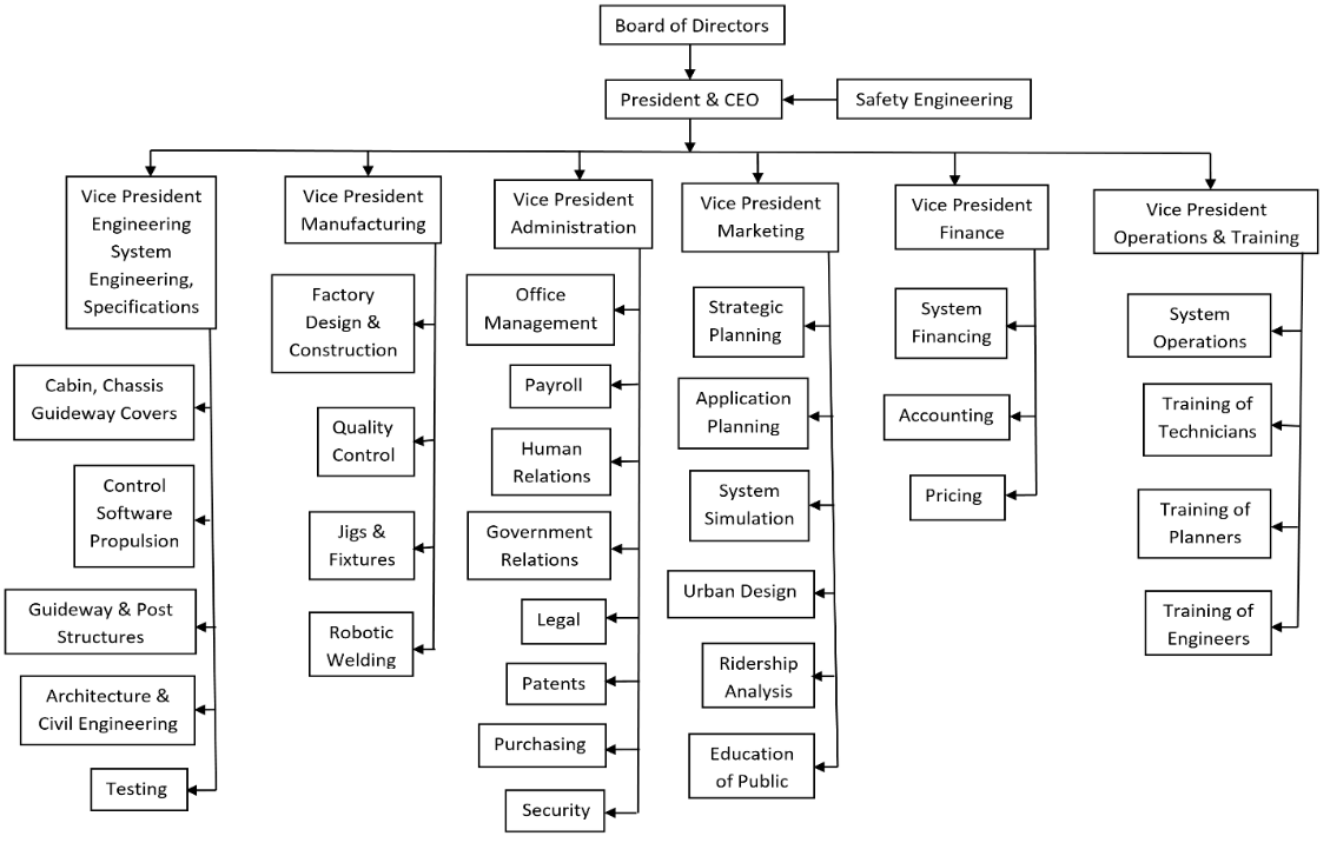
Another 3rd party research project could investigate whether moving people across barriers with PRT technology is cost-effective. Given the extensive need for barrier crossings just in Santa Clara County, the subject warrants investigation.

Organization and Management

The LoopWorks Advisory Board, whose members come from various roles in high-tech companies, includes an entrepreneur, 2 financial experts, the top PRT hardware expert in the world, and members with deep connections into the Milpitas community. This business plan will guide development of the Milpitas PRT project with operations expected to commence in 5 to 7 years (2025 - 2027).

The business model employed by LoopWorks anticipates a limited-growth company the provides long-term service. Thus, some functions needed in a traditional business model that plans for extensive growth are unnecessary. For example, page 16 of the ITNS Business Plan presents the following paragraph and organization chart to describe their structure:

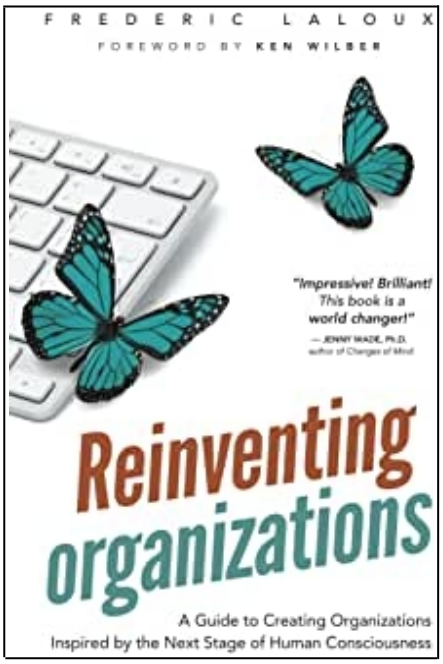
> The proposed organizational structure is as shown in following chart. Over the first six months, we expect the organization to grow to about 20 engineers plus about six to ten members of the support staff. In a year, we expect the staff to grow to a total of about 50 people.



ITNS planned for a PRT-manufacturing business as the payoff for early-stage investors looking for a profit. LoopWorks offers a different business plan to investors that calls for building one system, and then maintaining it into the long-term future. By contracting out most of the work to build the Milpitas system, LoopWorks can focus on managing the project and preparing to operate and maintain it. Thus, the VPs of *Engineering* and *Manufacturing* – along with their entire staff - are not needed. By making all documentation created by LoopWorks easily available on-line, planners and engineers working on other systems can self-train – which eliminates the need for these two Operations & Training functions: *Training of Planners*, *Training of Engineers*.

LoopWorks will need knowledgeable and experienced project managers to oversee the engineering and manufacturing done by contractors. Specification Development and Supervision are the two primary functions needed to insure safety, ride comfort, reliability, service level and cost containment.

The *Pricing* function in *Finance* may also be unnecessary because LoopWorks will not be selling PRT systems. Likewise, the *System Simulation* and *Urban Design* functions under *Marketing* are unnecessary. However, all other Marketing functions will be necessary to develop the Alternative Revenue Streams required to keep the system operating. The remaining roles and functions in the ITNS organization chart shown above will be needed by LoopWorks. After construction, an O&M staff of 5 (*System Operations*) will provide 24/7/365 coverage to ensure uninterrupted service for the community.



Any particular role or function noted above may require only part-time effort, or the full-time efforts of many. Regardless, to accomplish the necessary functions, LoopWorks will implement structures, practices and processes using guidelines listed in Reinventing Organizations. Author Frederic Laloux's research in the field of emerging organizational models has been described as groundbreaking, brilliant, spectacular, impressive, and world-changing by some of the most respected scholars in the field of human development. The book describes the structures, practices and processes of highly successful businesses comprised of mission-driven teams of 6 to 12 people. Using the guidelines of Reinventing Organizations, the LoopWorks organizational chart may differ substantially from the traditional type pictured above – while still fulfilling the functions. An engaging introduction to exploring this new way of (self-) managing is the workbook entitled Reinventing Organizations: An Illustrated Invitation to Join the Conversation on Next-Stage Organizations.

Non-Disclosure Agreements (NDA)

Use of non-disclosure agreements is the rule with companies pursuing new technologies. Most for-profit companies that use NDAs do so out of a mindset of fear and scarcity – fear that some other company will beat them to market or steal their very valuable intellectual property, and a zero-sum/Malthusian/scarcity worldview that there is not enough to go around.

LoopWorks holds a different worldview that follows the model of nature where cooperation and synergy are the primary operating principles, not competition. Since transparency is a key LoopWorks value, information about the company's operations will be publicly available. By making documentation freely available, the company's vision is accomplished easier and quicker: *The LoopWorks PRT project inspires rapid adoption of advanced transit that dramatically reduces transportation sector emissions.* Thus, LoopWorks and the entities with which it works will avoid NDAs where possible.

Stakeholder Perspective

As a Benefit Corporation, LoopWorks has a responsibility not only to investors, but also to management, employees, customers, suppliers, the local community, and the environment. Maintaining this "stakeholder perspective" might come with higher costs in the short term, but it will deliver better returns in the long run for all parties. The role of LoopWorks is to make the right trade-offs so that all stakeholders can thrive. The following stakeholders will benefit most directly from the PRT system:

- nearby residents and their visitors who could use PRT
- nearby businesses whose customers and employees could use PRT
- all Milpitas residents and businesses who could benefit from a PRT "tourist attraction"
- various r-o-w property owners
- City of Milpitas (prestige and economic development opportunities)
- other cities and agencies with an interest in PRT development (Mt. View, Sunnyvale, San José)
- foundations interested in reducing CO_2 emissions or increasing transit use and social equity
- government agencies interested in reducing CO_2 emissions or increasing transit use
- Transit Area developers that want to reduce parking ratio requirements
- other developers with an interest in PRT service such as the proposed mega-project just outside Milpitas (north of Montague along Coyote Creek).

The following table provides some insight into how stakeholders can participate with LoopWorks in forwarding the Milpitas PRT project.

Function/Purpose	Role	Potential LoopWorks Allies
Program Management	Oversees project to ensure scope, schedule, and budget goals are met	Public agency staffs, planning and engineering consultants, private transport staff
Funding Partners	Provide funding for project planning, implementation, and ongoing O&M	Foundations, public agencies grants, private funding, corporate sponsors, local businesses, etc.
Project Planning	Conduct financial, technological, and service planning activities to ensure successful project implementation	Public agency staffs, planning and engineering consultants, community representatives
Deployment	Provide site assessment and vehicle set-up services	Public agency staffs, planning and engineering consultants, r-o-w owners, developers, funding partners
Operations & Maintenance	Provide staffing for day-to-day operations and maintenance	Public agency staff inc. police, private transport staff, private company security, nearby businesses, PRT riders
Miscellaneous	Have vested interest in some aspect of the project	All parties in Stakeholder List above, groups desiring to build other PRT systems

High levels of transparency are essential to the accountability and functioning of organizations with highly participatory decision-making processes like LoopWorks. Thus, financial, strategic and operational information will be readily available to stakeholders.

Democratic Governance

Integral to the LoopWorks business model is community self-determination. LoopWorks will be owned and controlled by stakeholders through their elected representatives while providing transparency, accountability and social responsibility. Democratic decision-making processes ensure bottom-up, community-led solutions that emphasize community benefit over private gain. LoopWorks believes that people and places thrive when democratic communities determine their own social, cultural, and economic needs and solutions.

Bylaws will be developed that provide for democratic involvement of stakeholders and equitable operation of the business. As specified in the Bylaws, people and organizations residing in Milpitas that donate $100 or more to LoopWorks become members with voting privileges; people and organizations residing outside Milpitas that donate $1000 or more can become voting members upon approval of the Board. A Milpitas resident may also acquire voting membership by donating 5 hours of work that help forward the project. (Qualifying residents will report when they worked, what they worked on, and their results – all of which will be included in the data available to the public.)

Once public operations commence, the Board will employ an O&M staff. Whether direct employees or contracted personnel, at least two O&M employees must then become members of the Board.

Due to obstacles presented by state and federal securities laws regarding issuance of stock, no solicitation or acceptance of donations or grants shall imply that any or all of the funds donated will be returned. However, a record will be kept of donations, and the Board will have the authority to benefit donors in appropriate ways that conform with the Bylaws.

A key process in any self-directed organization is the "advice process": in principle, any person in the organization can make any decision. But before doing so, that person *must* seek advice from all affected parties and people with expertise on the matter. Big decisions that affect the organization must, of course, seek the Board's advice.

Outline of Incorporation

After Start-up Costs and Activities are handled, efforts will focus on preliminary engineering. Remaining questions will be answered, a more detailed design will be developed, and project costs calculated. If the results of this preliminary-engineering process are satisfactory, then funding ($6M) will be secured to complete engineering and to manage implementation of the project. Final funding ($60M) will then be secured to construct, test and operate the system for the first year. Alternative revenue streams will be secured to continue paying for on-going Operations & Maintenance (O&M) Costs.

Funding for capital costs to design, construct and test is expected from foundations interested in reducing fossil fuel emissions, increasing transit ridership, or promoting social equity. To promote all 3 objectives, free transit service will be provided to Milpitas residents and visitors – thus benefiting many of the stakeholders.

Steps Before Incorporation

1. Choose a business name (which includes an abbreviation that indicates incorporation, such as "Incorporated" or "Inc."), and check for availability of that name with the

California Secretary of State. (Mail a completed Name Availability Inquiry Letter (PDF) to the California Secretary of State's office in Sacramento.)
2. Identify initial members and/or Board of Directors.
3. Decide whether and how to issue membership shares.
4. Prepare Bylaws for operating the business. (See Appendix for Bylaws.)
5. Develop a membership agreement and receipt procedure for individuals and legal entities accepted as members.
6. Determine which (if any) licenses, permits, and insurance must be procured – and at what stage in the process.
7. Prepare and file the Articles of Incorporation with the Secretary of State. The filing fee is $30.
8. File a Statement of Information with the Secretary of State within 90 days of filing the initial Articles of Incorporation. The filing fee is $20.

Steps After Incorporation

1. Hold the first Board of Directors meeting – adopt bylaws, appoint officers, and discuss other business plans.
2. Obtain employment identification number (EIN) with IRS and employer account number with the state.
3. Open a bank account for LoopWorks.
4. Obtain licenses, permits, and insurance needed to operate.
5. Hire or retain an accountant or bookkeeper to manage finances.
6. Maintain up-to-date membership records (names & addresses).
7. Implement the structures, practices and processes using guidelines listed in Reinventing Organizations.

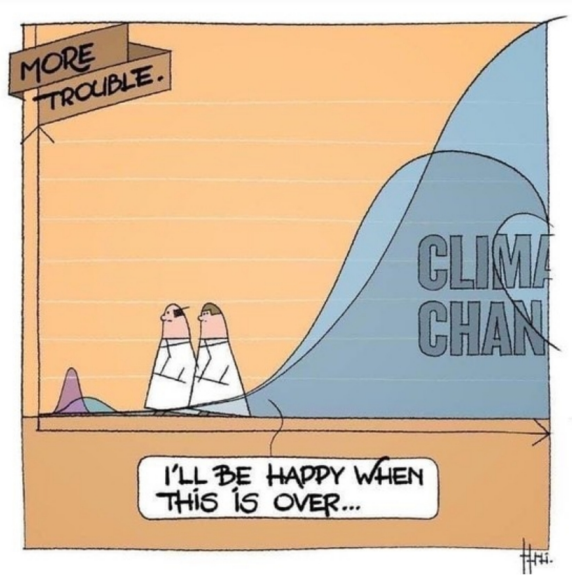
Marketing and Sales

LoopWorks has chosen to be a localized entity that owns, operates and maintains a PRT system within Milpitas. As such, the normal functions of marketing and sales that would be appropriate to a manufacturing or product-driven company are mostly unnecessary. Although the LoopWorks PRT system may grow to cover most of Milpitas, any PRT built outside the City limits will be done by some other company.

ITNS has estimated in Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume I (page 322) that the total worldwide market value is at least $1.5T:

> To get a feeling for the magnitudes, suppose that at full deployment ITNS would attract only as many trips as conventional transit carries now [1%]. It is reasonable to assume, on the basis of many studies, that the average application will require about 40 vehicles per mile of guideway. Thus to carry as many passenger-miles as conventional transit carries now (418,000/40) = 10,450 miles of guideway would be required. At an estimated overall system price of $15 million/mi, this is a market of $156 billion. As shown in Appendix D, the market for PRT is likely at least ten times as large, or in the United States alone at least $1.5 trillion. The world market can be expected to be several times as large.

Opportunities exist for other PRT-related companies to create or extend their own business models. Manufacturing or assembly of any PRT components is an obvious example. Those subcontractors who supply parts for the Milpitas system will be well-situated to do so for other systems. Construction companies and their subcontractors already exist, so that part of the PRT production system is in place. At this time, the most-needed service/product is PRT-knowledgeable consulting firms that guide municipalities and transportation agencies to develop successfully operating PRT systems.



As the urgency of our Climate Crisis heats up, foundation and government agency money may become available to finance system construction for entities looking to create their own version of the Milpitas PRT system.

For-Profit Opportunities

LoopWorks will act much like a government agency by seeking grant funding and operating in the public interest rather than investor interest. However, another for-profit business model could secure funding, build and operate a PRT system in a more traditional way. That may prove likely because investor-financed systems appear to be viable given the low cost and high value of PRT systems – especially as they grow to cover more area.

For example, ITNS shows what is possible in the Economics section (pages 35 – 37) of the ITNS Business Plan. By charging a mere $1.10 fare, the company can break even on a PRT system with 30 miles of guideway and 60 stations serving 9 square miles. For comparison, Milpitas covers 14 sq. miles. Imagine living in Milpitas and only paying a $1 fare to get from a station near you to a station near anywhere you want to go in town.

Any for-profit company looking to enter the PRT field is advised to read sections 13 - 19 of the Plan for Commercialization (Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume I, pages 322 - 325):

- The Potential Market for ITNS
- The Gross Profit from Building and Operating PRT Systems
- The Size of the Market
- Strategy for Market Entry
- The Business
- How the Enterprise will make Money

In addition to selling, designing and building PRT systems, other businesses may provide maintenance services or technical training. There may also be opportunities arising from the amount of valuable land freed up that would otherwise serve cars (roads and parking lots).

After the Milpitas PRT system is operational, ridership numbers will be available to any organization considering construction of their own system. Using actual ridership data, developers can determine if the cost of their proposed PRT system is justified. They may also investigate the ITNS internal paper "Economics of ITNS Networks" and its Excel companion which provide a methodology for estimating the return on investment of a PRT system as it expands over a metropolitan area.

The early markets for PRT will primarily transport people. Target markets are expected to be found in highly congested business districts, airports, theme parks, office parks, hospital complexes, shopping centers, and retirement communities. For-profit companies may find that endowment funds which provide Foundation Grants are eager to invest in PRT systems. For example, five years after 17 foundations pledged to stop investing in fossil-fuel companies and increase their stake in climate-friendlier investments like renewable fuels, almost 200 foundations and family offices have joined the movement.

LoopWorks Project

LoopWorks will facilitate marketing and sales to enroll the various stakeholders:

- nearby residents who could use the PRT system
- nearby businesses whose customers and employees could use the PRT system
- all Milpitas residents and businesses who could benefit from a PRT "tourist attraction"
- various right-of-way (r-o-w) property owners
- City of Milpitas (prestige and economic development opportunities)
- other cities interested in PRT development (Mt. View, Sunnyvale, San José)
- foundations interested in reducing greenhouse gas emissions or increasing transit use and social equity
- government agencies interested in reducing CO_2 emissions or increasing transit use
- Transit Area developers that want to reduce parking ratio requirements
- other developers with an interest in PRT service such as the proposed mega-project just outside Milpitas (north of Montague along Coyote Creek).

Since this project should not proceed without an enthusiastic statement of support from the City of Milpitas, LoopWorks has endeavored to enroll the City Council. A "no risk" Memorandum of Understanding (MOU) that the City could adopt forward a private-sector proposal for the Dual-Loop PRT System. The goal of the MOU is to focus the public sector on removing barriers while assuming little or no financial risk itself.

In addition to the City of Milpitas, various all other right-of-way property owners must be enrolled:

1. Santa Clara County Roads and Airports Department
2. Santa Clara Valley Water District
3. Valley Transportation Authority
4. Great Mall owner Simon Property Group
5. Courtyard by Marriott Milpitas Silicon Valley
6. TownePlace Suites by Marriott Milpitas Silicon Valley
7. Flextronics
8. Parc Metro HOA

Right-of-way agreements will permit construction of poles, guideways and stations. Additionally, egress agreements may be necessary for the purpose of access in the event of a maintenance emergency occurring on or above the property. In the case of Flextronics (and likely others), agreements must be reached with the real property owners rather than the lease holders currently occupying the property.

The transportation model LoopWorks seeks to replicate is the spread of the electric trolley that began in 1888. It was created by cities granting franchise agreements whereby private-sector firms built trolley systems for speculative real estate gains. Although an initial MOU has

been proposed to the City of Milpitas, LoopWorks expects changes in line with a Cities 21 model offered in "Statement of Willingness to Enter into PRT4SRP Franchise Agreement".

Franchise Agreements

PRT technology and systems have been demonstrated to work. There is clearly money available for transit projects (e.g. the $6B BART Burrow). The fact that no PRT system has been built the U.S. in the past 40 years suggests a political problem. Municipalities hesitate even when offered a no-cost system. Fear of political consequences may be the basis for refusals by both Palo Alto and Milpitas to accept such "no risk" agreements.

Background Information

Franchise agreements, detailed contracts between the public sector and a third party, grant such third parties the right to provide a particular service. For example, the City of Milpitas maintains a franchise with Comcast to provide cable television to residents. The City of Las Vegas granted a franchise to build and operate a large monorail transit system.

In the late 1880's, cities granted franchise agreements to real-estate speculators who built electric trolley systems. "The first electronic trolley line opened in Richmond in 1888, was adopted by two dozen other major cities within a year, and by the early 1890's was the dominant mode of intra-urban transit. The rapidity of the diffusion of this innovation was enhanced by the immediate recognition of its ability to mitigate the urban transportation problems of the day." (Peter Muller)

Specifics

Only right-of-way agreements to permit construction, and egress agreements for emergency access, will be needed from most property owners. Each publicly-owned property may also require a franchise agreement.

In recognition of the many benefits to the City of Milpitas, the City will charge LoopWorks an annual franchise fee of one dollar ($1). Similar no-cost franchise agreements seem likely for 1) Santa Clara County Roads and Airports Department (Montague expressway) and 2) Valley Transportation Authority (BART transit hub). Although benefits for the Santa Clara Valley Water District (Penitencia Creek) are not so apparent or generous, it does receive property-tax funding. So, when the PRT system c causes increased property values, property tax revenues will go up and SCCVWD will benefit.

Customer relationships

Details of the limited interaction between customers and LoopWorks personnel are described in Human Interface (Ergonomics). Briefly, only in unusual circumstances will the customer/rider initiate voice communications with operating personnel.

By eliminating intermediate stops, PRT dramatically increases energy efficiency and decreases trip time. That reduction in trip time will provide value directly to the rider, thereby leading to a mutually-supportive relationship. LoopWorks anticipates that this relationship – along with CCTV surveillance – will reduce vandalism and other security issues. Furthermore, PRT technology virtually eliminates noise and air pollution further enhancing its contribution to the relationship.

By involving Stakeholders early and often, LoopWorks plans to build the trust needed to proceed rapidly to an operating system.

Customer segments

Traditional advice regarding customer segments is "Be specific when you name your target market. Your business won't be for everybody, so it's important to have a clear sense of who your business will serve." PRT is not a traditional technology. By choosing to serve the most vulnerable members of our society – whether special needs, aged or children – LoopWorks is able to provide outstanding service to all segments of our population.

Details of how people use the PRT system is outlined in Human Interface (Ergonomics). Those details make clear that most anyone, regardless of abilities, will be able to use the ITNS-designed vehicles and user interface to travel between any of the PRT system stations.

The issue of how seniors in their seventies, eighties, and nineties travel to their many activities will continue to grow. Trends predict longer life expectancies, a core desire for active lifestyles, and a growing senior population. All 3 trends will increase demand for PRT service.

In the case of young children, they can be dispatched by a parent from one station to a destination station. Arrangements could be made to have another adult greet the child at the destination. Either way, PRT could save the time now used to chauffeur elementary school students each day. As they become older, PRT will support their growing independence within their community.

Customer Communication Channels

The customer base that LoopWorks expects to attract will become aware of the PRT system as it is built in their neighborhood. Additional outreach will be important to allay concerns and inform other Milpitas residents of project progress and objectives. LoopWorks plans to use these communications channels:

- email list of Milpitas residents who are active in the community

- email and phone list of people who have supported this PRT project
- local Nextdoor groups (one of which reaches over 10,000 homes)
- email list of PRT Petition signers
- Milpitas Beat (local on-line newspaper)
- Milpitas Post (although without local reporters, PRT will catch their attention)
- On-line petition (if appropriate)

Alternative Revenue Streams to Pay for O&M

In order to provide free rides to users, alternative revenue streams will be secured to fund Operations & Maintenance (O&M) Costs of the PRT system proposed for the Transit Area. O&M are estimated to be 1% to 3% of capital costs, or $600,000 to $1.8M per year.

LoopWorks' 3-tier approach includes an endowment fund (Plan A), add-on services (Plan B) and farebox recovery (Fallback Plan). While planning to pursue Plan A first, LoopWorks expects to also develop Plan B add-on services. Only if those two income streams prove inadequate to cover all O&M costs will user fares be considered.

Plan A: After foundations provide the $60M required to build the system, they may also be willing to fund all or part of a $12M endowment that pays for O&M. A $12M endowment earning a 5% annual return would cover $600,000 per year of O&M costs. Endowments for on-going expenses are common and will be the first choice pursued by LoopWorks simply because it represents the easiest way to cover O&M. At commencement of public operations, any unused capital funds will be put into an O&M endowment fund.

Plan B: In parallel with Plan A, LoopWorks will investigate and evaluate each of the following potential revenue streams for likely return on investment (ROI). At least 3 factors will be considered: potential amount of annual funding generated, monetary cost to generate that revenue, and likelihood of securing the revenue stream. That research will determine which of these multiple add-on revenue streams to pursue. The 23 currently identified possibilities are clustered under these headings:

- Advertising
- Donations
- Community Support
- Data Sales
- Add-On Services

1. Advertising (The 2019 ITNS Business Plan (page 36) estimates advertising revenue at $0.40 per vehicle-trip.)
    - vehicle advertising wraps
    - guideway advertising wraps
    - other guideway-mounted signs, both static and dynamic
    - ad messaging within the cabins via screen and speaker

- station sponsorship (e.g. Levi's Stadium)

2. Donations
   - In lieu of free fares, LoopWorks may provide donation boxes at stations that acknowledge/reward deposits with receipts, flashing lights, message displays, and engaging sounds.
   - On-line donations are encouraged from people around the world who are interested in GHG reductions and promoting alternative transit options.

3. Community Support
   - Contributions will be encouraged from local businesses, organizations, and government agencies that benefit from the PRT system.
   - Benefit sharing will be encouraged from property owners whose property values or customer count goes up as a result of extra transit infrastructure.
   - Benefit sharing will be sought from property-taxing agencies when property values and tax receipts go up 30% or more as a result of new transit infrastructure.
   - Benefit sharing will be sought from VTA which would be relieved of the 89% subsidy for bus service currently provided in the PRT service area.
   - Benefit sharing will be sought from VTA and BART which would receive a substantial increase in ridership. (See Ridership and PRT Synergy.)

4. Data Sales (unlikely due to LoopWorks' intention to freely share information)
   - Sell data that is collected about ridership, construction costs, and O&M costs.
   - Franchising or licensing of LoopWorks intellectual property (detailed plans and specifications).

5. Add-On Services
   - Sell electricity from solar panels mounted on station roofs and attached to guideways and guideway posts.
   - Lease station area space to small-footprint businesses or devices (e.g. coffee kiosks and ATMs).

   - Users may suppress in-cabin advertising messages for a small fee (e.g. 10 cents to suppress audio, 25 cents to suppress both video and audio).
   - Sell Wi-Fi service within cabins to users.
   - Merchandising of PRT products either through direct sales or 3rd-party agreements.
   - Solicit a fraction of the revenue from systems operated by franchisees or concessions using the LoopWorks/ITNS design.

- Lease utility conduits within guideways (broadband fiber-optic cable, electricity lines, telephone lines). (The ISP Sonic may be interested in partnering as "a community of internet revolutionaries re-thinking, re-wiring, and re-imagining the future of the internet.")
- Explore partnership arrangements for offering broadband service. (Publicly owned broadband networks in the US have been widely credited with attracting business investment, creating and retaining jobs, lowering costs for consumers, improving access for marginalized groups, improving quality of life, and supporting advances in health and education.)
- Charge fees for moving freight, recyclable materials, and waste. (The number of off-peak light-freight trips is estimated at 50% of daily passenger trips on page 36 of the ITNS Business Plan.)

To get an idea of what the market would bear in terms of Advertising charges, LoopWorks checked VTA advertising price sheets. Based on VTA charges, LoopWorks estimates that these prices are fair:

- station advertising: $8000/month
- guideway wrap over major streets (30"h x 144"w): $12,000/month
- vehicle wrap (21"h x 72"w): $6000/month

With 12 stations, 24 vehicles and several major street crossings, monthly advertising revenue from a PRT system could far exceed the estimated annual O&M costs of $600,000 to $1.8M.

Clear Channel Outdoor handles advertising at VTA shelters where ad space is sold on 4 week periods at about $450 per unit per 4 weeks with a minimum of 20 units. Pricing varies slightly depending on how specific, total quantity, length of commitment…etc.

An example of Donations income, the Ubuntu/Communitarian spirit of users who see PRT as part of the greater good may prompt them to contribute donations. The Mini-Loop will be a sight-seeing attraction for at least 5 years – during which time donations from users could be encouraged (e.g. with explanatory signs and contribution boxes that make sounds and flash lights when fed).

As an example of a Community Support revenue stream that might be shared, consider tax revenue to the City of Milpitas. Asking for an annual share of the increased tax revenue flowing to the city would be based upon an estimated increase in property tax revenue of $1M annually. So, a presentation to the City may go like this:

> Like a golden goose, PRT will regularly generate a boost to the City's property tax revenue. Here are the numbers. The proposed Dual-Loop PRT System will provide easy transit access (as defined as within a 1/3-mile radius) for 1.4 sq. miles of the City's

total of 14 sq. miles, or 10%. Using a 2018/2019 Milpitas property tax revenue number of $31M for all of Milpitas, 10% is $3M (see page 102 of the 2018/2019 City of Milpitas Budget). The estimated increase in property values due to convenient and reliable transit with good regional connections is 30% - 40% according to the Federal Transit Administration (https://www.transit.dot.gov/valuecapture). Applying a 33% increase to the current $3M property tax revenue yields an annual golden egg of $1M. In order to keep that golden goose healthy, the City may want to contribute a portion of that extra property tax revenue to help operate and maintain the system.

Another example of a Community Support revenue stream is revenue sharing by the Great Mall. As a sight-seeing attraction, the Mini-Loop would add value to nearby businesses, especially the Great Mall where more entertainment attractions are being added rather than retail stores and eateries (e.g. Legoland Discovery Center). LoopWorks PRT complements those attractions with a Disney-like ride that creates synergy with those businesses.

Funding Request

This business plan will be the primary document used to represent both LoopWorks and the PRT project when writing formal Grant Requests.

As a California Benefit Corporation with ties to all stakeholders, LoopWorks improves its prospects for securing foundation grants, even those that normally fund only non-profits. Also, the flexibility afforded a Benefit Corporation enables LoopWorks to quickly adjust to economic and other changes in its environment – and makes it easier to show foundations how LoopWorks can help them achieve their goals.

As shown in Financial Projections, LoopWorks will seek 3 rounds of funding in the sums of $0.6M for initial business development, $6M for design work and project management, and $60M for construction, testing and 1 year of O&M. At the end of that first year of operations, most data will be available to fairly estimate costs of a PRT system (using the ITNS design) proposed anywhere. That data – and the knowledge we gain from building this first PRT system – is the biggest payoff for investing in this Dual-Loop PRT System. For specifics, see Performance Reports – The Big Payoff.

While LoopWorks anticipates support from foundations, many other methods of financing are available – any combination of which may provide the required capital. Following are the types of funding that could apply to PRT systems - listed in order of preference.

"Free" Money

Although "free" money need not be paid back, there will certainly be "strings attached". The funding entity will expect - and receive - a say in how the project is run, regular reports on how funds are spent, and what results have been accomplished. In conformance with LoopWorks' goal of transparency, reports and results will also be made publicly available.

Because grant money eliminates the need to pay for capital costs and servicing debt, all revenue can be applied to maintaining a high level of service. Because "free" money unburdens LoopWorks from both repayment of capital costs and servicing debt, LoopWorks will be much better positioned financially to cover Operations & Maintenance (O&M) Costs without charging fares. Free fares for all - the "transportation equity" aspect of this system - will further endear LoopWorks to foundations and others poised to contribute to improving the lives of people.

Note: in the following descriptions of various organizations, their publicly-stated values and goals that align with what LoopWorks is planning and doing are *emphasized with italics*.

Foundation Grants

LoopWorks expects to secure grant funding for start-up, engineering and construction from foundations interested in reducing carbon fuel emissions, increasing transit ridership, or promoting social equity.

Foundation funding is preferred because 1) foundations have more flexibility than government agencies in selecting which projects and programs to fund, and 2) turnaround time between request and grant funding disbursement is likely quicker than all other options.

Although excellent foundations with an interest in addressing our Climate Crisis are located across the country, LoopWorks will offer foundations and organizations within the Bay Area the opportunity to invest early before offering the opportunity outside our watershed. Here is a short list of Bay Area candidates to approach:

- Silicon Valley Clean Energy (SVCE): although not a foundation, SVCE funds energy-efficiency programs – and they understand our environment: *"We were formed to be innovative, because the traditional institutions and ways of thinking were insufficient to address the climate crisis we are facing."* Their Decarbonization Strategy and Programs Roadmap was developed and approved to ... cut emissions from power supply and transportation, all while enhancing energy efficiency and the grid's ability to use more renewable energy. The Innovation Onramp program offers two stages of grant funding, of which LoopWorks would choose "Stage 1: $10,000 – $75,000 for proofs of concept". In recognition of their pioneering contributions to clean energy and its efficient use, right of first refusal will be extended to SVCE.

- The California Wellness Foundation partners with community organizations to ... put in place more *equitable processes and systems* that improve individual and community wellness.

- Silicon Valley Community Foundation advances innovative philanthropic solutions to challenging problems, engaging donors to *make our region and world a better place* for all.

- The Schmidt Family Foundation (TSFF) works to advance the *wiser use of energy* and natural resources and to support efforts worldwide that empower communities to build resilient systems for food, water, and human resources.

- Energy Foundation accelerates the *transition to a clean energy economy* by supporting policy solutions that create robust, competitive markets and the benefits they bring.

- Tides Foundation accelerates the pace of social change, working with innovative partners to *solve society's toughest problems*.

- Chan Zuckerberg Initiative (CZI), through grantmaking and a venture portfolio, invests in *bold ideas* that have the potential to accelerate social change. Since 2015, CZI has awarded approximately $1.6 billion in grants and made more than $100 million in venture investments. "Our mission is to find new ways to *leverage technology, community-driven solutions*, and collaboration to accelerate progress in Science, Education, and within our Justice & Opportunity work."

- Buckminster Fuller Institute's Regenerosity Program is a network and fund dedicated to accelerating the development and deployment of on-the-ground solutions which radically *advance human well-being* and the health of our planet's ecosystems.

Further research is needed to extend the above preliminary list of Bay Area candidates. If timing or level of local funding seem inadequate for timely progress, out-of-area foundations will be solicited. Potential interest from out-of-state foundations is clear from results generated at the **Divest Invest Philanthropy**.

Divest Invest Philanthropy represents over $10 billion in total assets with commitments to shift at least 5% - and in many cases over 10% - of their respective endowments to investments in new energy solutions. Five years after 17 foundations pledged to stop investing in fossil-fuel companies and increase their stake in climate-friendlier investments like renewable fuels, almost 200 foundations and family offices have signed on. Specific commitment examples include:

- **The John Merck Fund** (JMF) is planning to allocate up to 100% of its more than $65 million endowment for investments focused on *climate solutions*, clean energy generation, and environmental health.
- **The Sierra Club Foundation** is making commitments to climate solutions and clean energy investments that are consistent with both its fiduciary responsibilities and its mission to educate and empower people to protect and improve the natural and human environment. The foundation's $60 million operating and endowment funds include $6 million of investments in renewable energy, efficiency, and *clean energy technologies* as well as green bonds. A recent new commitment of $4 million specifically targets *innovative technologies* and clean energy investments that offer potential solutions to accelerate the transition to a clean energy economy by 2050.

- **The Wallace Global Fund** is aligning 100% of its endowment with its mission, including approximately 35% of the portfolio dedicated to investments in climate solutions, and $20 million deployed into new *clean-energy technologies*.
- **The Flora Family Foundation** is committing to invest over $5 million with a focus on market innovations related to climate solutions, renewable energy generation, *energy efficiency, and environmental sustainability*.
- **Mercy Investment Services**, the socially responsible investment program of The Sisters of Mercy, a community of Roman Catholic women, is directing half of its private equity investments to companies focused on renewable energy, *energy and water efficiency*, materials recycling, green building practices, and sustainable agriculture.
- **Treehouse Investments**, which is committing substantially all of its assets to investments in *transformational business models* that mitigate the adverse impacts of climate change, including renewable energy technology and production, *energy efficiency*, natural resources conservation, and *market innovation* supporting climate resilience in emerging markets.
- **Unitarian Universalist Association,** which has long incorporated the principles of socially responsible investing into its endowment, and is now placing a priority on moving capital towards *climate solutions*.

Foundations shifting their endowment funds into clean and efficient energy systems demonstrates their awareness of our Climate Crisis; that mindset will also influence where they invest their grant money. LoopWorks and the Milpitas PRT system are ideal candidates for such grants. If foundation grants must go to a 501(c)(3) nonprofit, the Sunnyhills Neighborhood Association may be helpful as a fiduciary agent.

The number of funding opportunities is growing rapidly. Helping LoopWorks sort through them is the Funding Wizard – which combs the internet weekly for funding opportunities (grants, rebates, and other financial incentives). Filters include funding type, category, eligible applicants or using keywords. The California Air Resources Board (CARB) manages the website with a stated purpose of providing a public clearinghouse "to assist cities and counties with searching for grants, rebates, and other financial incentives for sustainable projects."

Crowd-Funding

While crowd-funding a $60M project is unrealistic, funding the first $600,000 for initial business development is quite possible – both in terms of the cash amount and the legalities.

Legally, the crowdfunding opportunity is created under Title III of the Jumpstart Our Business Startups (JOBS) Act. Specifically, Section 4(a)(6) of the Securities Act exempts eligible crowdfunding offerings from registration. Crowdfunding commonly refers to raising funds for an enterprise over the Internet from a potentially large number of people; this is

also known as investment crowdfunding. If a company wants to use this exemption, the offering must comply with the following restrictions and requirements:

- A company can raise up to a maximum of $1,070,000 over a 12-month period.
- Investors whose annual income or net worth is below $107,000, can invest the greater of $2,200 or 5% of the lesser of the investor's annual income or net worth.
- Investors whose annual income and net worth are equal to or greater than $107,000, can invest 10% of the lesser of the investor's annual income or net worth.
- Businesses raising money must have their financial statements reviewed by an independent accountant if raising more than $107,000, or audited by an independent accountant if raising more than $535,000.
- Companies must use a regulated web platform.

Additionally, issuers must disclose investment related information such as business activities, how investment proceeds will be used, financial statements, price of the security, target capital goal, and related deadlines. This exemption has some filing and reporting requirements. Multiple platforms exist to assist in crowd-funding.

Government Agencies

Many government agencies are interested in reducing CO_2 emissions or increasing transit use. The following are just a few examples.

The Strategic Incentives Division (SID) of the Bay Area Air Quality Management District offers financial incentives for projects that *improve air quality, reduce air quality health impacts, and protect the global climate*. SID oversees approximately 1,000 projects funded by state, federal, and local resources every year. Since 1992, SID has awarded over $400 million in grant funding to public agencies, private companies, and Bay Area residents for *cost effective emission reduction projects*. SID also operates an Advanced Technology Demonstration program with the goal of advancing clean and sustainable *technologies for transportation*.

The Clean Transportation Program (also known as Alternative and Renewable Fuel and Vehicle Technology Program) invests up to $100 million annually in a broad portfolio of transportation and fuel transportation projects throughout the state. The Energy Commission leverages public and private investments to support adoption of *cleaner transportation* powered by alternative and renewable fuels. The program plays an important role in achieving California's ambitious goals on climate change, petroleum reduction, and *adoption of zero-emission vehicles*, as well as efforts to reach air quality standards.

The U.S. Department of Transportation (DOT) allocated $1 billion in Fiscal Year (FY) 2020 for discretionary grant funding through the Better Utilizing Investments to Leverage Development (BUILD) Transportation Discretionary Grants program. FY 2020 BUILD Transportation *grants are for planning and capital investments* in surface transportation infrastructure and are awarded on a competitive basis for projects that will have a significant local or regional impact. BUILD funding can support roads, bridges, *transit*, rail, ports or *intermodal transportation*. Projects for BUILD will be *evaluated based on merit criteria* that include safety, economic competitiveness, quality of life, environmental sustainability, state of good repair, innovation, and partnership.

The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy often turns to the private sector for assistance in accomplishing its mission and program objectives. Organizations and individuals are encouraged to submit proposals that are relevant to DOE's research and development mission either in response to formal DOE solicitations or through *self-generated unsolicited proposals*. Funding of Unsolicited Proposals is considered a noncompetitive action. For further information relating to the process for submitting unsolicited proposals, please visit NETL's Unsolicited Proposals page.

Complete Trip - ITS4US Deployment Program aims to solve mobility challenges of all travelers, regardless of location, income, or disability, in accessing jobs, education, healthcare, and other activities. The Complete Trip portfolio will identify ways to provide more efficient, affordable, and accessible transportation services for people. This program will make up to $40 million available to enable communities to showcase *innovative business partnerships, technologies, and practices that promote independent mobility for all*.

As with foundation grants, a service exists to sort through the nearly 3000 federal and non-federal grant programs: https://www.grants.gov/web/grants/search-grants.html

Corporate Sponsorship

Although the pool of corporations that are wealthy enough and motivated enough to sponsor a project like the Milpitas PRT system is relatively small, at least 3 exist in Santa Clara County that may find the project attractive.

Google has purchased land in Mountain View on the East side of Hwy. 101. Access is challenging, but the City is looking into an advanced transit system to serve that area.

Apple has over $200 billion in off-shore accounts and serious traffic congestion around its massive new headquarters complex in Cupertino (nicknamed the "spaceship").

Cisco City has expanded eastward from San José into Milpitas, roughly 1 mile from the Milpitas PRT system.

"Expensive" Money

"Expensive" money must be paid back along with interest. Like foundations, for-profit investors will expect - and receive - a say in how the project is run, regular reports on how funds are spent, and what results have been accomplished. In conformance with LoopWorks' goal of transparency, reports and results will also be made publicly available unless the investor conditions the loan upon some level of secrecy.

The need to repay capital costs and service debt until paid off will impose a heavy financial burden on LoopWorks. It is unlikely that Alternative Revenue Streams expected to pay for O&M will also cover those additional costs. Which means that revenue from fares will almost certainly will required. The goal of free fares for all - the "transportation equity" aspect of this system - will thus disappear, and along with it various benefits.

Secured Loans

While many options may be available in this space, one example did appear that is worth mention.
Climate Tech Finance Program – Small businesses can apply for **loan guarantees** on loans of up to $20 million, with a maximum guarantee of $2.5 million. Projects may be eligible for up to 90 percent guarantees through this program.

Investor Funded

These funds can be very expensive in terms of expected payback to, and control by, the investors. This can be especially true of venture capitalists who look for quick, high ROI returns on their investments. However, there are other investors with longer time horizons such as Breakthrough Energy which has a mission to lead the world to net-zero by supporting cutting-edge research and development; investing in companies that turn game-changing technologies into scalable and transformative solutions; and advocating for policies that speed innovation from lab to market.

Financial Projections

Looking only at the costs of addressing congestion, Climate Chaos and air pollution without noting the costs of doing nothing is misleading. Unfortunately, this asymmetry is widespread. When approaching foundations, LoopWorks will emphasize this point before outlining the financial costs of building a Dual-Loop PRT System in Milpitas.

Those who have studied the ITNS PRT design and estimated its cost have generally agreed that it can be built for $15M/mile – all costs included. For background on these studies, visit http://sunnyhillsneighborhood.org/cost.html

Going further, ITNS has detailed specifics in the Economics section (pages 35 – 37) of the ITNS Business Plan. Starting with a PRT system consisting of 30 miles of guideway, 60 stations and 321 vehicles, estimates of each major component of the system are listed below. (The rightmost column has been added to the original, and contains the total cost of each component for the entire system.) As shown, the system cost per mile is only $12M, not the $15M/mile LoopWorks is claiming publicly. And ITNS's $12M/mile includes a 40% buffer to cover Overhead, Fees and Taxes. Furthermore, when the cost of the Demonstration Project ($30,000,000) is included in the cost of an Operating System for a total of $390,435,996 for the 30-mile operating system, the cost per mile is still only $13M/mile.

System Cost

Cost of Demonstration	$30,000,000	
Operating Guideway Cost/mi	$5,530,000	$165,900,000
Cost of one station including bypass guideway	$718,511	$43,110,660
Cost of one vehicle including storage guideway	$88,326	$28,352,646
Cost of Control & Communication/mi	$300,000	$9,000,000
Cost of Maintenance Facility/mi	$54,853	$1,645,590
Construction Management Cost/mi	$314,841	$9,445,230
Overhead, Fees and Taxes	40%	1.4 X $257,454,126
System Cost/mi	$12,014,533	$360,435,996
Cost of Operating System + Demonstration	$390,435,996	
Interest on Bonded Debt	4.50%	
Time Horizon	30	
Annual Payment on Bonded Debt/mi	$798,982	
O&M Cost/vehicle-mile	$0.33	
First year annual O&M cost (reduced with learning)	$13,087,008	
Annual O&M as fraction of capital cost	3.35%	
First-Year Total Annual Cost/guideway-mile	$1,235,216	
First-Year Total Annual Cost/vehicle-mile	$0.93	

When seeking funding, LoopWorks also intends to solicit an extra 10% buffer over the publicly stated price of $60M for 4 miles of guideway. LoopWorks will seek 3 rounds of funding in the sums of $0.6M for initial business development, $6M for design work and project management, and $60M for construction and testing. At commencement of public operations, any remaining funds will be put into an O&M endowment fund to help cover costs going forward.

Successfully securing foundation funding for the PRT project means that only O&M costs will be needed to sustainably run the system without charging fares. By covering capital costs for the project, foundations will liberate LoopWorks from the burden of repaying both the capital costs and the interest that would otherwise be required.

Start-up Costs and Activities

CEO Tasks

The first round of funding for $600,000 will fund a CEO (at a total cost up to $300,000 including benefits) for one year along with start-up costs. The CEO will be tasked with accomplishing these goals:

1. Secure a Memorandum of Understanding (MOU) fom the City of Milpitas.
2. Identify the prime contractors for design and construction, and secure an MOU agreement with them.
3. Secure MOUs from all property owners required for the LoopWorks Project starting with those required for the Mini-Loop.
4. Determine whether each publicly-owned property requires a franchise agreement.
5. In conjunction with Sustainable Economies Law Center (SELC) develop Bylaws.
6. Secure legal counsel to review incorporation documents and other matters.
7. Incorporate with the Secretary of State as LoopWorks.
8. Establish a website.
9. Determine the amount of Insurance required for the construction phase, which will likely include bond money and tear-down insurance.
10. Identify an independent accounting firm that will provide reviews and audits of LoopWorks financial statements.
11. Confirm that the control system offered by Transit Control Solutions, Inc. (TCS) meets the requirements specified on page 58 of ITNS Business Plan (The Design and Assembly of the ITNS Control System).
12. Contact ADM Associates about Evaluation, Measurement and Verification services (see Data to Collect and Share).
13. Further develop and refine the Foundation Grants list of foundations and organizations within the San Francisco Bay watershed that will be offered the opportunity to invest early in PRT.
14. Select a company logo.

15. Inform the California Public Utilities Commission (CPUC) of the project and explore how to work together smoothly.
16. Work with a Construction Company to conduct preliminary engineering, in which remaining questions are answered, a more detailed design of the system is developed, and its costs are calculated.
17. Contact Trader Joe's regarding their proposed store which will be located at/near a PRT station on McCandless.
18. Contact other developers with an interest in PRT service such as the proposed mega-project just outside Milpitas (north of Montague along Coyote Creek).
19. Secure $6M in funding for design work and project management.

MOUs with property owners shall note that – in addition to right-of-way agreements to permit construction of poles, guideways and stations – agreements may be necessary for the purpose of egress in the event of a maintenance emergency occurring on or above the property.

Optional Tasks

Other tasks appropriate for the start-up phase:

Contact CALSTART, the nonprofit organization working nationally and internationally with businesses and governments to develop clean, efficient transportation solutions. From technology firms to transit operators and from vehicle manufacturers to research institutions, CALSTART connects every element of the clean energy sector, offering customized services, information and programming. Their Technology Development and Demonstration activities include

- Develop and organize competitive project teams around *strategically important technologies* to help fund and speed their commercialization.
- Work with member companies, agencies and fleets to manage prototype demonstrations or pilot stage *field trials of advanced technology vehicles*, components, renewable fuels, infrastructure and systems.
- Provide comprehensive value-add project support, from complex program and funds administration and management, to business case analysis, market assessment, *infrastructure development*, commercialization planning and *performance evaluation*.

Contact cities with an interest in PRT to solicit their support for this Dual-Loop PRT System. Results in Milpitas will inform and influence advanced transit possibilities in Cupertino, San José, Santa Clara, Sunnyvale, Mountain View and Santa Cruz.

Contact cities that have passed a Climate Emergency Declaration to assess their interest in supporting this experimental PRT system. A map of all cities in California can be found at https://www.theclimatemobilization.org/cal-map

Contact Fremont City Council member Vinnie Bacon (650-863-6549) to assess his interest in supporting this experimental PRT system. In his run for Alameda County Supervisor (1st District), he received the most votes. His opponent in the November 2020 election is described as "a pro-development Republican, who has drawn controversy by associating with far-right groups." That makes it likely that Mr. Bacon will win in November. Contacting him was suggested by Fred Morrison at 2019 Spring CDP Convention. Vinnie Bacon has a Masters Degree in City Planning and Transportation Engineering from UC Berkeley.

Contact ProspectSV, a nonprofit cleantech innovation hub that focuses on advanced mobility and energy solutions for urban communities. By collaborating with key public and private partners and providing resources for entrepreneurs in the field, ProspectSV is working to improve urban sustainability. The Advanced Mobility and Transportation segment of ProspectSV, working with private sector partners and local communities, leads an innovative public-private partnership to usher in the next generation of transportation technology, and offer truly unique platforms for innovation at the lab, field, and community scale.

Contact the Mineta Transportation Institute to invite their participation in gathering and reporting Data to Collect and Share. "At the Mineta Transportation Institute (MTI) at San José State University, our mission is to increase mobility for all by improving the safety, efficiency, accessibility, and convenience of our nation's transportation system. Through research, education, workforce development and technology transfer, we help create a connected world."

Contact California Stewardship Network to invite their participation in "developing innovative regional solutions to the state's most pressing economic, environmental, and community challenges" by using solutions based on breakthrough innovation and driven by a new generation of civic entrepreneurs. In 2019, the California Stewardship Network merged with California Forward, a non-profit organization founded in 2008 that advocates for shared prosperity across all of the state's regions and for improved government performance and accountability.

Estimate ridership on the PRT project using the Podaris multi-modal transport planning tool. "Create multi-modal transport networks and analyze their costs and benefits. Share these models with internal or external collaborators, ensuring that they are vetted and validated from every possible angle." The free version may be adequate to model the Mini-Loop and BART Circulator. "Our easy-to-use parametric design tools ensure that right-of-way, travel-time, and capacity calculations are extremely accurate from day one, based on validated engineering properties from transport technology vendors. This engineering accuracy is useful for planning any kind of transport infrastructure, but is particularly *crucial for helping planners to understand new and unfamiliar technologies*, such as hyperloops or driverless

pods." Podaris may be interested in contributing to, and benefiting from Data to Collect and Share.

Invite community members to create representations of PRT in the local built environment with a particular focus on stations. Such images and simulations will be helpful in presentations to stakeholders. Possibilities include high school students doing art projects or short videos, simulations using 3D base maps, and PRT game software. In this video, long-time PRT advocate Christer Lindstrom uses a free PRT game, 4Dialog, to present a model of how a podcar network would interact with humans in the built environment.

Compensation for Contributors

Development of the Bylaws will include some sort of compensation plan to provide equity for people and entities that support the project. While employee compensation will likely be handled internally using a process from Reinventing Organizations, other compensations including voting privileges will be determined.

For example, ITNS Managing Director and Principle Developer Ed Anderson has provided inestimable value to this project. He is willing to act as an advisor and provide "all the engineering in volumes 2 and 3." The first volume of 500 pages is already available. After a discussion with his wife, he would like 1) $200,000 after taxes for access to all of his technology, and 2) $30,000 per month for one year for advice to the engineering team and Board of Directors.

> "My intention is that once you receive the funds needed to build your first loop, I will send you the second and third volumes and more. I will also work as an advisor to the team of engineers you must hire to do the necessary work to the extent they will want my advice. From experience, the **engineers must sign up to follow the information mainly found in summary form in my Business Plan, and in detail in my 3-volume work**. If they want to deviate, as Raytheon did with disastrous results, they can do so only with my concurrence." – Ed Anderson

Design and Management Costs

The 2nd of 3 rounds of funding - for $6M - will be used for design work and project management. This sum of 10% of capital costs is expected to be adequate given the ratios common with other civil engineering projects. For example, consider the Montague Expressway Pedestrian Overcrossing (POC). Milpitas staff reported to the City Council Transportation Subcommittee on 2/12/2020 that "Project Management & Construction Management" would cost $2.8M out of the total cost of $19.7M. This 14% figure of work done before ground breaking is in the ballpark of the **rule of thumb that says 10% of costs go into design; 90% into everything else.**

The Major Milestones to be completed in this phase are:

- Establish an organized, working team that includes qualified engineering and architectural consultants.
- Complete the design of the basic components.
- Complete the final specification of the control system to match the performance goals.
- Retain a cabin design firm to prepare the final design of the cabin.
- Secure manufacturing partners for guideways, propulsion, chassis, and cabin.
- Develop the specifications and construction documents for the chassis, guideway, propulsion system, wayside power, stations and maintenance facility.
- Secure construction partners for site construction, guideways, off-line stations, and cabin.
- Update the detailed Project Schedule and detailed Project Cost Estimates.
- Secure permits and approvals necessary for construction.
- Prepare a Capital Funding Plan.
- Prepare Operations Plan.
- Prepare Education/Outreach and Public-Information Plans.
- Secure Capital Funding.
- Evaluate alternative revenue streams.
- Prepare a marketing plan for alternative revenue streams.

To successfully build the Dual-Loop PRT System, it is necessary to recruit and educate a group of engineers who will develop procurement specifications for components, direct their procurement or manufacturing, and direct the assembly and test of the operational system. The project is divided into 12 parallel tasks so that each engineer involved only needs to become familiar in detail with a small portion of the entire project, thus making it practical to move forward quickly.

Specifically, these tasks that need to be completed during the Construction phase must be started during this Design phase:

Task #1: Management and Systems Engineering.

Task #2: Safety and Reliability assurance.

Task#3: Cabin. This task will be subcontracted.

Task #4: Chassis. The design and manufacturing will be subcontracted. Components will be obtained from known sources.

Task #5: Guideway and posts. These components will be subcontracted. The posts are a specialty item that may be subcontracted to a firm such as Millerbernd in Winstead, MN.

Task#6: Guideway covers. This is a specialty item that will be subcontracted.

Task #7: Control system. This is a specialty item that may be subcontracted to Transit Control Solutions, Inc.

Task#8: Propulsion and braking. LIMs will likely be purchased from Force Engineering, Ltd.

Task#9: Wayside power. Power rails will likely come from Insul-8.

Task #10: Civil works –station, maintenance facility, foundations.

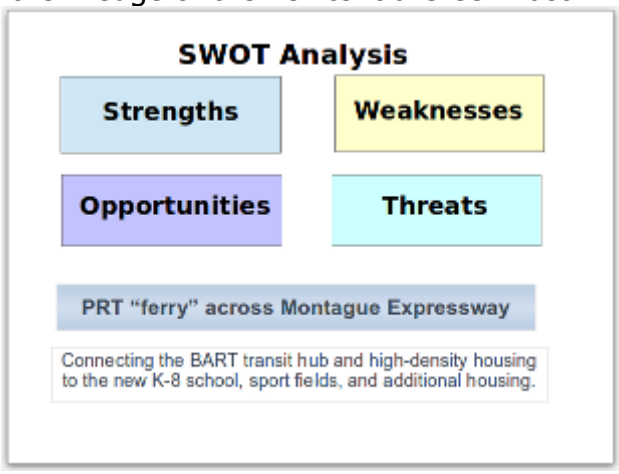
Task #11: Test program.

Task #12: Planning and marketing for the alternative revenue streams.

These 12 tasks are detailed in Appendix A of the ITNS Business Plan (pages 38 – 91). Dr. Anderson has an additional 1500 pages of analysis and specifications that support the program. For example, cost Analyses for PRT are addressed in detail as part of Task #1 in of Contributions to the Development of Personal Rapid Transit by J. Edward Anderson, Volume II (pages 608-623).

During examination of a portion of the Mini-Loop routing – the PRT guideway crossing of Montague Expressway parallel to the Penitencia Creek East Channel – these facts and requirements arose:

- The property owner, Santa Clara Valley Water District (SCVWD), must grant an easement for PRT guideway. SCVWD has worked with the City of Milpitas to provide channel access in the past (often with the City picking up certain maintenance costs). By erecting the dual guideways on the northern edge of the Penitencia Creek East Channel, the 30-foot wide northern embankment/levee is mostly available for SCVWD equipment to maintain the channel. SCVWD does not have defined criteria for encroachments, but rather decides on a case-by-case basis. Because PRT guideways are small and easily routed, we expect to reach a mutually beneficial joint-use agreement with SCVWD for use of their 70' wide right-of-way. A permit will also likely be required from the California Department of Fish & Wildlife.



- The parallel-running PG&E right-of-way is 50' wide and lies south of, and adjacent to, the SCVWD channel on both sides of Montague.
- Because PG&E most likely will not grant PRT station access on their right-of-way (other than for a 16-foot high crossing), both stations along the Channel will be sited north of the r-o-w. For example, the station East of Montague might be located in the "new park" area just south of the Lyons Communities development, adjacent to the SCVWD channel.
- ITNS-designed guideways and vehicles can negotiate turns with a mere 25' radius (50' diameter).
- PG&E high-voltage lines running north-south on the east side of Montague Expressway are high enough for PRT to operate below them safely. A minimum line elevation for the power lines would be 25 feet to accommodate PRT passing beneath: guideway is 16 feet above grade + guideway height (3') + vehicle height (5') + 1 foot gap = 25 feet.
- PRT vehicles will go counter-clockwise to provide quicker delivery of more residents to the transit center than if vehicles circulated clockwise.
- After the east-west crossing of Montague by the PRT guideway, it will proceed north toward the BART station along the eastern border of the "new park" and the Lyons Communities development above the planned 26'-wide access road/fire lane (for details, see page 17 of this City document), across Capitol Avenue and under the 25' elevated LRT into the VTA transit hub.
- Foot bridges across the creek channel and PG&E easement will be needed near each station to provide access across those barriers. (Both are being planned for construction, with the western crossing already completed.)

Ground-level impact on the property owners is expected to be minimal with 2' x 2' footings (spaced 60' to 90' apart) and 2' diameter poles supporting the guideway above. With the exception of the short construction time and time spent coordinating the project with the contractor, no other costs to property owners are expected. Concerns about security and vandalism at the stations can be addressed by installing a motion-sensing and tracking video recorder system.

"Third-rail" versions of PRT like that proposed for Milpitas will connect many electric motors to the existing electrical system. PG&E (or its successor) will be invited into a short exploratory dialog with PRT developers to better define required electrical system modifications to ensure continued high quality electric utility service to the surrounding area.

Whereas the ITNS Business Plan focuses marketing efforts on selling PRT systems, the LoopWorks marketing team will focus on marketing and selling Alternative Revenue Streams. During the investigation and evaluation of each for likely return on investment (ROI), at least 3 factors will be considered: potential amount of annual funding generated, monetary cost to generate that revenue, and likelihood of securing the revenue stream.

Insurance

ASTM International is one of the largest independent standards-writing bodies in the world. The ASTM International F-24 Committee on Amusement Rides and Devices establishes standards on amusement ride design and manufacturing, testing, operation, maintenance, inspection, and quality assurances. The ASTM standards are used in 44 of 50 States and many nations. The ASTM standards have an existing enforcement industry and an existing insurance industry to guide LoopWorks regarding:

- Bonding – LoopWorks must dedicate bond money for the construction phase, which will likely include some amount for tear-down insurance.

- Tear-Down Insurance – LoopWorks must dedicate funds before starting construction that is sufficient to be used to remove the system upon failure to meet various performance measures.

- Project Insurance – LoopWorks will purchase sufficient insurance to insure against losses due to natural disasters, man-made disasters, and system failures.

The BART Transit Hub is built within a Federal Emergency Management Agency (FEMA) 100-year floodplain (Zone AH). Much of the surrounding area is designated Flood Zone AO.

Construction Costs

The 3rd round of funding will secure $60M for construction, testing and 1 year of O&M.

Transportation Options for Greenville, (page 39) provides a cost range for PRT systems: "ATN systems cost far less than other fixed-guideway modes like light rail. One mile of one-way guideway complete with vehicles and stations ranges in cost from about $10 million to $30 million. Lower cost applications are at grade and have lower capacity while elevated, high capacity applications cost more." LoopWorks estimates a cost of $15 million per mile.

Compared to other elevated, mass-transit systems, PRT is dramatically lower cost. The key observation that led to PRT is stated here:

> By studying the dynamics of vehicles or trains moving over elevated guideways [7] it became clear that if the people-carrying capacity of the vehicles can be distributed over the guideway in many small units in which adult passengers are all seated instead of a few large conventional vehicles of the same capacity, **the weight per unit of length**

of the guideway can be reduced by a factor of at least 20. (See page 211 of Contributions to the Development of Personal Rapid Transit by J. Edward Anderson.)

The LoopWorks class of PRT is smaller than most offerings in both vehicle size and guideway size. The generally accepted "smaller costs less" rule, combined with a captured-bogie design (thus reducing vehicle parts and weight) is why various reports consistently estimate cost at less than $15M/ mile. Of particular interest is the 2019 ITNS Business Plan (page 36) that estimates $12M/ mile for entire system cost for the ITNS hardware design that LoopWorks will use. Those estimates will be refined during phase 2, Design and Management Costs. When this PRT system is actually built, we will get (and share) valuable data on actual costs.

ITNS provides additional information in the Economics section of the ITNS Business Plan (pages 35 – 37). Starting with a system consisting of 30 miles of guideway, 60 stations and 321 vehicles, they estimate each major component of the system. The rightmost column (added to the original) contains the total cost of each component for the entire system.)

System Cost

Cost of Demonstration	$30,000,000	
Operating Guideway Cost/mi	$5,530,000	$165,900,000
Cost of one station including bypass guideway	$718,511	$43,110,660
Cost of one vehicle including storage guideway	$88,326	$28,352,646
Cost of Control & Communication/mi	$300,000	$9,000,000
Cost of Maintenance Facility/mi	$54,853	$1,645,590
Construction Management Cost/mi	$314,841	$9,445,230
Overhead, Fees and Taxes	40%	1.4 X $257,454,126
System Cost/mi	$12,014,533	$360,435,996
Cost of Operating System + Demonstration	$390,435,996	
Interest on Bonded Debt	4.50%	
Time Horizon	30	
Annual Payment on Bonded Debt/mi	$798,982	
O&M Cost/vehicle-mile	$0.33	
First year annual O&M cost (reduced with learning)	$13,087,008	
Annual O&M as fraction of capital cost	3.35%	
First-Year Total Annual Cost/guideway-mile	$1,235,216	
First-Year Total Annual Cost/vehicle-mile	$0.93	

Although 3 vehicles are sufficient to test the Mini-Loop, at least five will be in the preliminary order to ensure testing can proceed quickly – possibly with different tests running in parallel. The full complement of 10 vehicles (2 for each of the 5 Mini-Loop stations) may be deemed useful enough to include in the initial order. An additional 15 will be ordered for the BART Circulator loop (2 for each of the 7 new stations, plus 1 spare).

At the conclusion of the Mini-Loop construction phase,

- all components required for system testing will be installed;
- system testing will have resulted in CPUC Certification so that public operations may commence;
- construction of the BART Circulator will have begun.

As mentioned earlier, when seeking funding, LoopWorks intends to include an extra 10% buffer above the public claim of 4 miles of guideway for $60M. At commencement of public operations, any excess construction funds will be put toward 1) paying for O&M costs during the first year of operation, and 2) establishing an O&M endowment fund to help cover costs going forward.

As appropriate, the marketing team will develop brochures, virtual-reality videos, a website and all other materials needed to promote the Alternative Revenue Streams. Marketing will also provide materials that explain the system in enough detail required by consulting engineers and planners working on their own PRT systems.

Operations & Maintenance (O&M) Costs

While transit industry O&M costs run between 3% and 5% of total capital costs, the ITNS Business Plan estimates O&M costs at 3%. However, a case can be made that O&M costs could be as low as 1%.

Author Tony Seba, a Stanford professor and guru of "disruption", points out that an internal combustion engine drive-train contains about 2,000 parts, while an electric vehicle drive-train contains about 20. All other things being equal, a system with fewer moving parts will be more reliable than a system with more moving parts. And that rule of thumb appears to hold for cars. In 2006, the National Highway Transportation Safety Administration estimated that the average vehicle, built solely on internal combustion engines, lasts 150,000 miles. Current estimates for the lifetime of today's electric vehicles are over 500,000 miles. As Seth Miller points out, "The total cost of owning an electric vehicle is, over its entire life, roughly 1/4 to 1/3 the cost of a gasoline-powered vehicle."

Furthermore, because the ITNS design uses captive vehicles that cannot leave the guideway rather than dual mode vehicles that can also drive on city streets, fewer parts are needed (e.g. steering, safety features, and battery pack) and simpler programming is required. For

example, the stainless steel chassis is designed for a lifetime of 20 years, during which time it can be expected to travel 1,600,000 miles.

Designing a system that meets required performance with minimum life-cycle cost, as ITNS has done, also leads to a more sustainable mode of transportation. With appropriate preventative maintenance, both repair costs and service interruptions go down. Thus, both financial and service goals dictate that preventative maintenance be high priority.

Electricity (Fuel) Usage

The 4-mile long Dual-Loop PRT System proposed for Milpitas is approximately the same length as the 5-mile PRT system proposed for Palo Alto's Stanford Research Park (PRT4SRP) which was expected to have a peak electrical "load" of 1.8MW or less during morning rush hour.

Accommodating peak capacity is an important part of electric utility strategy because increases in maximum peak usage may require the construction of expensive, new power generation plants. It is anticipated that PRT peak usage patterns will be complimentary with summer weekday early afternoon peak-power consumption patterns. Thus, no additional power plants will be required. Regardless, PG&E (or its successor) will be invited into a short exploratory dialog with PRT developers to better define required electrical system modifications to ensure continued high quality electric utility service to the surrounding area.

Using PRT4SRP's numbers, annual electricity usage will be 5,159 MWh or less. At roughly $0.12 per kWh (from Tariff E7 for large industrial users), annual cost will be $619,000. Due to the need to provide "high availability" power to the PRT system when the utility's power supply is low, an additional charge may occasionally be necessary. However, by including wayside batteries that can be charged at night, ITNS need not add to the peak utility load while also reducing electricity costs (because nighttime electricity costs less than daytime electricity).

Financing O&M

Operations and Maintenance (O&M) is expected to be 1% - 3% of capital costs, or $0.6M - $1.8M annually. To re-coup O&M costs from the farebox would 1) be something that no transit system in the Bay Area accomplishes, and 2) require 2000 - 6000 trips per day, each being charged $1/trip. (Ridership estimates for the PRT system satisfy this requirement.) While nearly all publicly-owned transit systems charge fares and lose money, LoopWorks seeks to provide free rides to users and pay for unusually low O&M expenses from Alternative Revenue Streams.

The equity impact of free rides is obvious: the most marginalized people are the least likely to own cars and thus rely most heavily on transit. And for those who count on it, transit is at

least as vital as other services that cities are expected to fund entirely through tax revenue, from parks and libraries to schools and police forces.

If the proposed Dual-Loop PRT System expands to other parts of Milpitas, the decision to provide free rides will be re-visited. One path forward would be to continue free rides between any of the initial 12 stations, and charge a fare for travel to or from any other station. If charged, fares will be set based upon each vehicle, not each rider.

Farebox Recovery – Not!

LoopWorks recognizes that making something non-free (i.e. charging a fare) alters the relationship between riders and the transit system. Also, charging a fare could provide a revenue stream for growing the initial Dual-Loop PRT System to serve more of Milpitas. However, LoopWorks is disinclined to charge fares at this time for these reasons:

1. The wide divide between rich and poor is toxic to the public welfare. Providing free transit for a trip, or portion of a multi-modal trip, helps reduce that divide for those with severe financial constraints -- and does so without the overhead of programs/prices designed for students, seniors and other disadvantaged people. Free rides also reduces the cost and complexity of the system by eliminating a ticketing system. However, designing fare collection into the system, and preparing for it by installing wiring as appropriate, makes sense and should be done.
2. The free fares can become non-free whenever LoopWorks chooses to do so. Such a change would provide new, useful data on ridership patterns and vandalism.
3. In looking at the potential Alternative Revenue Streams, it appears some combination of them will cover PRT's low O&M costs, thus making fares unnecessary.
4. If free fares can be shown to work financially, it will push transit agencies to defend and re-think their 80% - 90% subsidies of bus service. Frankly, just the audacity of LoopWorks' goal of free rides may be enough to start conversations about what else could be subsidized at that level if public transit was not.
5. A $60M transportation infrastructure project will increase the property values in the area which will increase property-tax revenue to the City of Milpitas and many other local government agencies – income unaffected by whether fares are charged or not. Likewise for most other benefits that will be enjoyed by the community.
6. Given our Climate Emergency, we want people using electric-drive vehicles like PRT. Free fares will entice more riders. When they tell others about their experience, the good word will spread and other systems will be built – and more people will use electric vehicles.

Alternative Revenue Streams

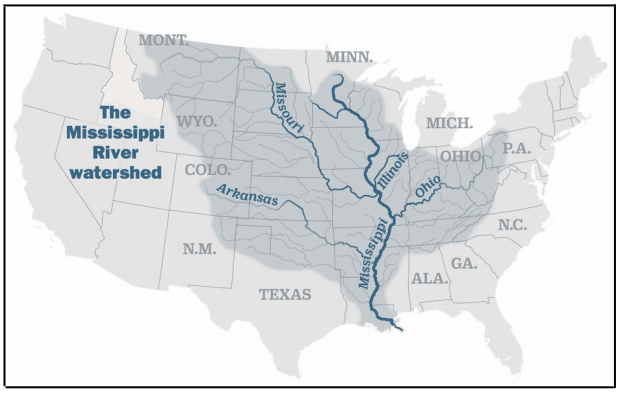
Since free rides will be offered, paying for Operations & Maintenance (O&M) Costs of the PRT system proposed for the Transit Area could be challenging. Depending upon whether O&M costs 1% or 3% of capital costs means that LoopWorks will need an estimated $600,000 to

$1.8M per year to cover costs. LoopWorks expects that a 3-tier approach will be successful that includes endowment (Plan A), add-on services (Plan B) and farebox recovery (Fallback Plan). While we plan to pursue Plan A first, we expect to also develop Plan B add-on services. Plan B, like tributaries to a river, will have several small income streams that add up. If those two income streams prove inadequate to cover all O&M costs, user fares will be considered.

Plan A: After foundations provide the $60M required to build the system, they may also be willing to fund a $12M endowment that pays to keep it going. A $12M endowment earning a 5% annual return would cover an estimated $600,000 per year of O&M costs. Endowments for on-going expenses are common and will be the first choice pursued by LoopWorks simply because it represents the easiest way to cover O&M. If successful, it represents a new model for financing pubic transit.

Plan B: Develop multiple "add-on" revenue streams to pay for O&M. The 20+ currently identified Alternative Revenue Streams (including examples) are clustered under these headings:

- Advertising
- Donations
- Community Support
- Data Sales
- Add-On Services



In looking at the potential Alternative Revenue Streams, it appears some combination of them will cover PRT's low O&M costs, thus making fares unnecessary.

Fallback Plan: Charge fares for rides. While LoopWorks anticipates covering all O&M costs with Plans A and B, any shortfall could be covered by implementing user fares. The free fares can become non-free whenever LoopWorks chooses. If the proposed Dual-Loop PRT System expands to other parts of Milpitas, the decision to provide free rides will be re-visited. One path forward would be to continue free rides between any of the initial 12 stations, and charge a fare for travel to or from any other station. If charged, fares will be set based upon each vehicle, not each rider – thus encouraging ride-sharing. If fares are implemented, plugging into the existing Clipper card system would be a likely aspect.

Appendix

Bibliography

The following references provide more detailed information on various subjects.

1. The Mineta Transportation Institute at San José State University released an academic report that supports PRT: "AUTOMATED TRANSIT NETWORKS (ATN): A REVIEW OF THE STATE OF THE INDUSTRY AND PROSPECTS FOR THE FUTURE") .

2. PRT Videos: http://www.sunnyhillsneighborhood.org/crossing.html#videos

3. Cost of PRT: various reports consistently estimate cost at less than $15M/mile.

4. Passenger Capacity of PRT guideways: http://sunnyhillsneighborhood.org/capacity.html

5. Contributions to the Development of Personal Rapid Transit by J. Edward Anderson

6. ITNS Business Plan

7. Assessor Maps of Properties Traversed by PRT Project. Here are the Assessor parcel maps for each quadrant of the east-west crossing of Montague Expressway:
   - northeast (includes SCVWD r-o-w)
   - southeast
   - northwest (includes SCVWD r-o-w)
   - southwest
   - The parallel-running PG&E right-of-way is 50' wide and lies south of, and adjacent to, the SCVWD channel on both sides of Montague.

8. Survey and Comparison of Transit Modes: Transportation Options Through a PRT Lens offers an introduction to various transit factors.

9. Transit Area Traffic Analysis looks at 2019 congestion conditions and trends in the area around the Milpitas BART transit hub.

10. Hardware Pictures: http://sunnyhillsneighborhood.org/hardware.html

11. Letters of Support for the Project: http://sunnyhillsneighborhood.org/mou-support.html
12. Grant Application to Silicon Valley Clean Energy: http://sunnyhillsneighborhood.org/SVCE-grant.pdf

Resumes:

Rob Means

After a 20-year career in computer programming (communications), Mr. Means left corporate America in 1992 to work on community-oriented projects. His continuous involvement since then with the Sunnyhills Neighborhood Association (SNA) has supported community building, local activism, and on-the-ground improvements. As an SNA event champion, Mr. Means spearheaded three annual Bike and Roller Fests. The most prominent SNA achievement is the two-mile long Hetch-Hetchy linear park/trail that stretches from Town Center to the northern city limits.

During his ten-year tenure on the Bicycle Transportation Advisory Commission (now BPAC) he got the ball rolling for the planning and construction of creekside trails in Milpitas. During that time, he was instrumental in putting the Yosemite/Curtis crossing of the railroad tracks (near the Great Mall) on the Bicycle Master Plan, Trails Master Plan, and Mid-Town Plan.

As the small business owner of Electro Ride Bikes and Scooters since 1996, he knows our transportation challenges - and solutions. The future lies in providing attractive alternatives to the automobile, not expanding the footprint of a system that requires foreign energy, vast amounts of land, and pollutes our air and water. Light electric vehicles offer a path forward that dramatically reduces the costs that come with the current transportation paradigm.

After running for City Council in 1994, Mr. Means has remained active in local politics by writing incisive letters to the Milpitas Post, participating in local campaigns (for candidates and propositions), and working for a sustainable Milpitas. Rob has lived in Milpitas since 1977, and shares his home with a wonderful wife and once-homeless cat.

Timeline

[Insert Gantt chart, and add link from Organization and Management.]
Gantt Chart

Major Milestones

1. Hire CEO
2. Incorporate LoopWorks and set up website.

3. MOU approval from Milpitas City Council
4. MOU approval from other r-o-w property owners (City of Milpitas, Santa Clara County Roads and Airports Department, Santa Clara Valley Water District, Valley Transportation Authority, and Great Mall owner Simon Property Group, Courtyard by Marriott Milpitas Silicon Valley, TownePlace Suites by Marriott Milpitas Silicon Valley, Flextronics, Parc Metro HOA)
5. Secure $6M in foundation/agency funding (10% of total cost goes to design work)
6. Preliminary design work (10%) completed (both Mini-Loop and BART Circulator)
7. Secure r-o-w agreements (easements) from Mini-Loop property owners.
8. Secure $30M in foundation/agency funding for Mini-Loop
9. Complete design work on Mini-Loop
10. Break ground on Mini-Loop
11. Start CPUC testing on Mini-Loop
12. CPUC Certification
13. start of public operations on Mini-Loop
14. gather data on ridership, O&M Costs, and contacts from interested parties (media, developers, public agencies, investors, etc.).
15. Cultivate endowments and revenue streams to pay for (O&M)
16. Secure r-o-w agreements (easements) from remaining/Circulator property owners.
17. Secure $30M in foundation/agency funding for BART Circulator
18. Complete design work on BART Circulator
19. Break ground on Circulator
20. Start CPUC testing on Circulator
21. CPUC Certification
22. start of public operations on Circulator
23. gather data on ridership, O&M Costs, and contacts from interested parties (media, developers, public agencies, investors, etc.).

Publicity Channels

Climate One at The Commonwealth Club is a thriving leadership dialogue on energy, the economy and the environment. We bring together top thinkers and doers from business, government, academia and advocacy groups to advance the discussion about a clean energy future.