



Potential Viability of Automated Rapid Transit at the Minneapolis-St. Paul Airport

Minnesota
Department of
Transportation

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Final Report

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Executive Summary

Automated rapid transit (ART), also referred to as personal rapid transit (PRT), personal automated transport (PAT) and Podcar transit, is a public transportation mode featuring small automated vehicles operating on specially-built guideways. ART is a type of automated guideway transit (AGT) that also includes systems with large vehicles, such as small subway systems, and group rapid transit (GRT) with medium-sized vehicles.

This report examines the potential viability of ART by organizing inquiry and analysis around three distinct objectives: to investigate the status of ART applications in airport environments, to understand their characteristics and attributes, and to explore the viability of an ART system at the Minneapolis-St. Paul (MSP) International Airport.

The report includes an overview and general description of the ART concept, and also provides summaries of two nascent airport ART systems. One of these is being tested at Heathrow Airport in London, and an ART feasibility study is currently being conducted for the Mineta Airport in San Jose, California. Two GRT systems currently operating at the MSP airport are also examined. The report provides some background and defining criteria for automated transit systems, as well as offers a description of each system analyzed, including its infrastructure, service, and demand characteristics. The importance of right-of-way considerations to ART implementation is also addressed.

According to the Advanced Transit Association (ATRA) and current systems being tested, ART schemes typically entail the following general attributes: fully automated, driverless vehicles; availability of a guideway – either at grade, elevated or underground – dedicated for exclusive ART use; small vehicles (often one to four seated passengers plus luggage); direct origin to destination service (no transfers or stops); service on demand 24/7 (not scheduled); very low passenger wait time (one to two minutes); high average operating speeds (20-25 mph); and fully integrated systems where all guideways and stations are available to vehicle use on a network basis. Additional characteristics that differentiate ART from other transit services include high level of passenger service in terms of fast travel times, low energy use and greenhouse gas emissions, and moderate capital and operating costs. These characteristics also make ART competitive with automobile use in many applications.

In addition, there are three basic ART designs: open guideways, captive bogey, and suspended pods. These design approaches can be situated at grade, underground, or along an elevated track or suspension apparatus. Guideway schemes typically include use of rail, concrete, steel, cable, or any combination of these materials.

It is anticipated that in 2011 the Heathrow's PRT system will begin offering passenger revenue service at the airport. Commissioned by BAA (formerly the British Airport Authority), the Heathrow system comprises some four kilometers of guideway and will link one station in Terminal 5 to two remote stations in the business car park. Although airport ART systems have been identified as a means of offering efficient, cost-effective service for certain business travelers, many details of the system remain unknown at this time. For instance, project managers have been hesitant to discuss, at this time, a number of aspects of the project until the system is fully open to passenger revenue service. As a result, questions remain, such as

implementation principles and technology selection regarding decisions affecting guideway, traction, and power technology choice, as well as various risks and risk mitigation approaches – including availability of back-up systems and the impact of security measures on system design.

By 2015, San Jose plans to have an extensive PRT system that will connect major hubs within two miles of the airport, including connections to Valley Transit Authority (VTA) bus rapid transit, to Caltrain rail (that connects to cities within Silicon Valley and terminates in downtown San Francisco), Santa Clara University, major hotels, major employers, and a nearby “Kiss ‘N Ride” lot. By the end of the decade it will also connect to BART and the anticipated 800-mile California high-speed rail system.

ART has been identified as a means of offering eco-friendly, efficient, and cost-effective service for travelers seeking transportation between Mineta San Jose Airport and nearby parking, transit stations, and possibly area lodging and retail. The project is at a preliminary feasibility phase, and thus lacks specific design and concept parameters. Nonetheless, early indications are that a potential PRT system serving Mineta San Jose would exceed the London Heathrow system both in scope and overall level of services.

At this time it is difficult to conclusively determine the potential viability of ART at the MSP airport – primarily because no specific, formal proposal is available for detailed review, and also because the status of other airport ART systems remains “in progress.” However, the anticipated opening of Heathrow’s ART system to the general public and the completion of a Phase I feasibility study in San Jose, California, should offer additional insight into the future viability of ART.

The report concludes with a recommendation that an airport ART feasibility study be undertaken in order to address a range of issues and questions raised in the report. In Appendix A, the report identifies a number of questions such a study should examine, with attention given to the following areas of inquiry: definition of study purpose and need; alternatives analysis related to preferred site and mode; impacts, both positive and adverse; technology; business plan development; outreach and education; and permitting and approvals. The combination of additional insight from projects elsewhere and detailed review of ART feasibility for the MSP airport should provide additional information necessary for evaluating the appropriateness and viability of ART as a rapid transit option for the MSP airport.

Chapter 1. Introduction

This document is comprised of an introductory section that provides an overview and general description of the automated rapid transit (ART) concept, and a second section that provides summaries of two airport ART systems¹. One of these is being tested at Heathrow Airport in London, and an ART feasibility study is currently being conducted for the Mineta Airport in San Jose, California. Two “Group Rapid Transit” systems currently operating at the Minneapolis-Saint Paul International Airport are also examined. The first section provides some background and defining criteria for automated transit systems, while the second section offers a description of each system analyzed, including its infrastructure, service and demand characteristics.

This content herein is the result of an initial literature review and search conducted with the assistance of two professional research librarians. Although a fair amount of information on automated rapid transit, personal rapid transit, group rapid transit, and automated guideway transit is available online, many details related to specific projects, project performance and costs are either lacking in specificity, difficult to find, or simply unavailable. The second part of the review process, which consisted of face-to-face and telephone interviews with staff from the systems described, has revealed additional detail and context.

¹ The automated rapid transit (ART) designation is used in lieu of personal rapid transit (PRT) because, in its current conception, the system may not be personal, but retains its automation, speed advantage, and intrinsic transit service quality.

Chapter 2. Objectives

The objectives of this research were to investigate the status of ART applications in airport environments, to understand their characteristics and attributes, and to explore the viability of a ART system at the MSP airport.

Chapter 3. Overview

Automated rapid transit (ART) also referred to as personal rapid transit (PRT), personal automated transport (PAT) and Podcar transit, is a public transportation mode featuring small automated vehicles operating on specially-built guideways. ART is a type of automated guideway transit (AGT) that also includes systems with large vehicles such as small subway systems, and group rapid transit (GRT) with medium-sized vehicles.

In ART designs, vehicles are sized for individual or small group travel, typically carrying five or fewer seated passengers and/or luggage. Guideways may be arranged linearly, in interconnected loops, or in a network topology, with all stations located off-line on sidings, and with regularly-spaced merge/diverge points. This approach allows for nonstop, point-to-point travel, bypassing all intermediate stations. The point-to-point service has been compared to that offered by taxis and/or horizontal elevators. However, unlike taxis, ART vehicles operate on grade-separated guideways and do not conflict with vehicular traffic, traffic signals or pedestrians.

Chapter 4. ART Description and Characteristics

According to the Advanced Transit Association (ATRA) and current systems being tested, ART schemes typically entail the following general attributes: fully automated, driverless vehicles; availability of a guideway – either at grade, elevated or underground – dedicated for exclusive ART use; small vehicles (often one to four seated passengers plus luggage); direct origin to destination service (no transfers or stops); service on demand 24/7 (not scheduled); very low passenger wait time (one to two minutes); high average operating speeds (20-25 mph); and fully-integrated systems where all guideways and stations are available to vehicle use on a network basis. Additional characteristics that differentiate ART from other transit services include high level of passenger service in terms of fast travel times, low energy use and greenhouse gas emissions, and moderate capital and operating costs. These characteristics also make ART competitive with automobile use in many applications.

There are three basic designs: open guideways, captive bogey and suspended pods. These design approaches can be situated at grade, underground, or along an elevated track or suspension apparatus. Guideway schemes typically include use of rail, concrete, steel, cable, or any combination of these materials.

Current ART studies are targeted at serving niche applications in areas not well served by traditional transit modes. As such, these ART applications are designed to address the types of congestion and transit challenges faced by busy airports and activity centers. Typically, these proposals are aimed at investigating the feasibility of ART for surface transportation between parking facilities and terminals; securing inter-concourse travel; and connecting to existing or planned nearby transit stations and to hotel and nearby activities.

Chapter 5. ART Origins and ART Today

ART was a major area of study in the 1960s and 1970s. In 1975, the Morgantown people mover – at the time an experimental automated system that exhibited some (but not all) features of ART – opened to the public after significant construction cost overruns. The Morgantown people mover remains in use today, has had a sterling safety record, and there are short-term plans for expanding it.

In November 2010, the City of Masdar in Abu Dhabi opened its PRT system to the public. This system called 2getthere and developed by the Dutch, is part of an underground network and is currently operating with 13 vehicles, including three freight vehicles, and 5 stations. The Masdar system represents a significant step in ART implementation.

Several test tracks have been operational and undergoing active testing for some time. The system at London's Heathrow Airport, constructed using the ULTra PRT design, is undergoing passenger trials using airport employees. In addition, test tracks have been built in Sweden by VECTUS, and feasibility analyses have been completed for 20 competing cities. Selection of a finalist city is expected to be announced in the near future. Other cities have expressed interest in ART, and two systems are currently being studied: one in the Coastal Wetlands Park of Suncheon City, South Korea (VECTUS), and one in Amristar, India (ULTra PRT).

ART is currently gaining serious attention in several U.S. cities and urban areas, notably San Jose, New Jersey, Ithaca, NY and, to some extent, Minneapolis-Saint Paul. We will be looking at systems currently being tested (Heathrow PRT), one that is being formally studied (Mineta Airport PRT), and two operational systems at the Minneapolis-Saint Paul (MSP) International Airport, and although they are automated people movers, they are instructive for future consideration of ART at the airport.

Chapter 6. London's Heathrow Airport PRT

It is anticipated that in 2011 the Heathrow's ULTra PRT system will begin offering passenger revenue service at the airport. This will be the second commercial ART system anywhere in the world (after the Masdar system (2getthere) in Abu Dhabi. Commissioned by BAA (formerly the British Airport Authority), the Heathrow system comprises some 4 kilometers of guideway and will link one station in Terminal 5 to two remote stations in the business car park.

Although airport ART systems have been identified as a means of offering efficient, cost-effective service for certain business travelers, many details of the system remain unknown at this time. For instance, ULTra has been hesitant to discuss, at this time, a number of aspects of the project until the system is fully open to passenger revenue service. As a result, questions remain such as implementation principles and technology selection regarding decisions affecting guideway, traction and power technology choice, as well as various risks and risk mitigation approaches – including availability of back-up systems and the impact of security measures on system design. While the choice of electric vehicle-power technology will produce no local emissions, it is unknown at this time what specific technologies were considered and what considerations guided the system design process.

Similarly, the absence of passenger revenue service makes it difficult to ascertain a number of system performance characteristics at this time. For instance, questions pertaining to system reliability, impact of adverse weather conditions, fulfillment of project objectives, and plans for system expansion are still unknown.

Following is a description of the Heathrow Airport ART system, using available information.

Heathrow System Characteristics

1. Overview
 - Year planning began: **2005 (selection of ULTra PRT as vendor)**
 - Year testing/trial started: **2010 (for passenger, non-revenue service)**
 - Year opened to general or revenue-service: **2010/2011 (expected)**
 - Facility Description (and Map) **Connecting Terminal 5 and business parking lot**



Figure 1. ULTra Layout for PRT System at London Heathrow Airport

2. Infrastructure characteristics

- | | |
|--|---------------------------------------|
| • Length of guideway: | 2.4 miles (3.8 km) |
| • Direction of guideway: | two-way |
| • Guideway type: | steel and concrete |
| • Traction type: | rubber tires |
| • Alignment Location: | at grade and elevated |
| • Number of stations: | 3 (initially) |
| • Number of active cars: | 18 |
| • Number of spare cars: | 3 |
| • Cars per train (peak/off-peak): | N/A |
| • Vehicle passenger capacity (seated/maximum): | 5/5 (not including luggage) |
| • Maintenance facility size and capacity: | TBD |
| • ADA compliance: | yes |
| • Vehicle power technology: | electric (battery on vehicles) |
- 3. Service characteristics (peak and off peak; if actual service or revenue-service)**
- | | |
|----------------------------|--|
| • Hours of operation: | TBD |
| • Frequency of service: | TBD |
| • Headways per month: | TBD |
| • Duration of total trip: | 5-6 minutes |
| • Dwell times at stations: | 12 seconds average; 95% within 60 seconds |

- Design speed: **25 mph (40 kph)**
 - Right-of-way: **exclusive**
 - Owner of right-of-way: **BAA Heathrow**
4. Demand characteristics:
- Maximum hourly passenger demand: **Tested at 576 per hour***
 - Average weekday/weekend passengers: **TBD**
 - Annual passengers: **TBD**
5. Cost and revenues:
- System capital cost: **£25 million (2008); \$40.1 m. (2010 exch. rate)**
 - Total capital cost: **TBD**
 - Annual O&M cost (year): **TBD**
 - Fares: **Included in parking fee**
 - Annual revenues, if fares charged: **TBD**
 - Annual subsidy: **TBD**
 - Source of funding: **TBD**

* To demonstrate the ability to accommodate peak passenger demand, ULTra demonstrated 48 passengers departing from the four-berth London Heathrow (LHR) Terminal-5 station in 5 minutes, for an equivalent hourly PRT outbound station capacity of 576 passengers per hour (March 2010).

Chapter 7. Future San Jose’s Mineta Airport PRT System

By 2015, San Jose plans to have an extensive PRT system that will connect major hubs within two miles of the airport, including connections to Valley Transit Authority (VTA) bus rapid transit, to Caltrain rail (that connects to cities within Silicon Valley and terminates in downtown San Francisco), to Santa Clara University, major hotels, major employers, and a nearby “Kiss N Ride” lot. By the end of the decade it will also connect to BART and the anticipated 800-mile California High-Speed Rail system.

ART has been identified as a means of offering eco-friendly, efficient and cost-effective service for travelers seeking transportation between Mineta San Jose Airport and nearby parking, transit stations, and possibly area lodging and retail. The project is at a preliminary feasibility phase, and thus lacks specific design and concept parameters. Nonetheless, early indications are that a potential PRT system serving Mineta San Jose would exceed the London Heathrow system both in scope and overall level of services. For instance, a Mineta airport model likely would serve commuters and area residents not destined for the airport itself. Early rough estimates of system cost are in the \$190 million range. A brief description of the planned Mineta Airport PRT follows, using the limited information available at this time.

Mineta Airport PRT Characteristics

- | | |
|--|--|
| 1. Overview | |
| • Year planning began: | 2008 (city issued RFI) |
| • Year testing/trial started: | 1-year feasibility study underway |
| • Year opened to general or revenue-service: | By 2015 (estimate) |
| • Facility Description (and Map): | TBD (goal to connect terminal to parking and nearby retail and lodging) |

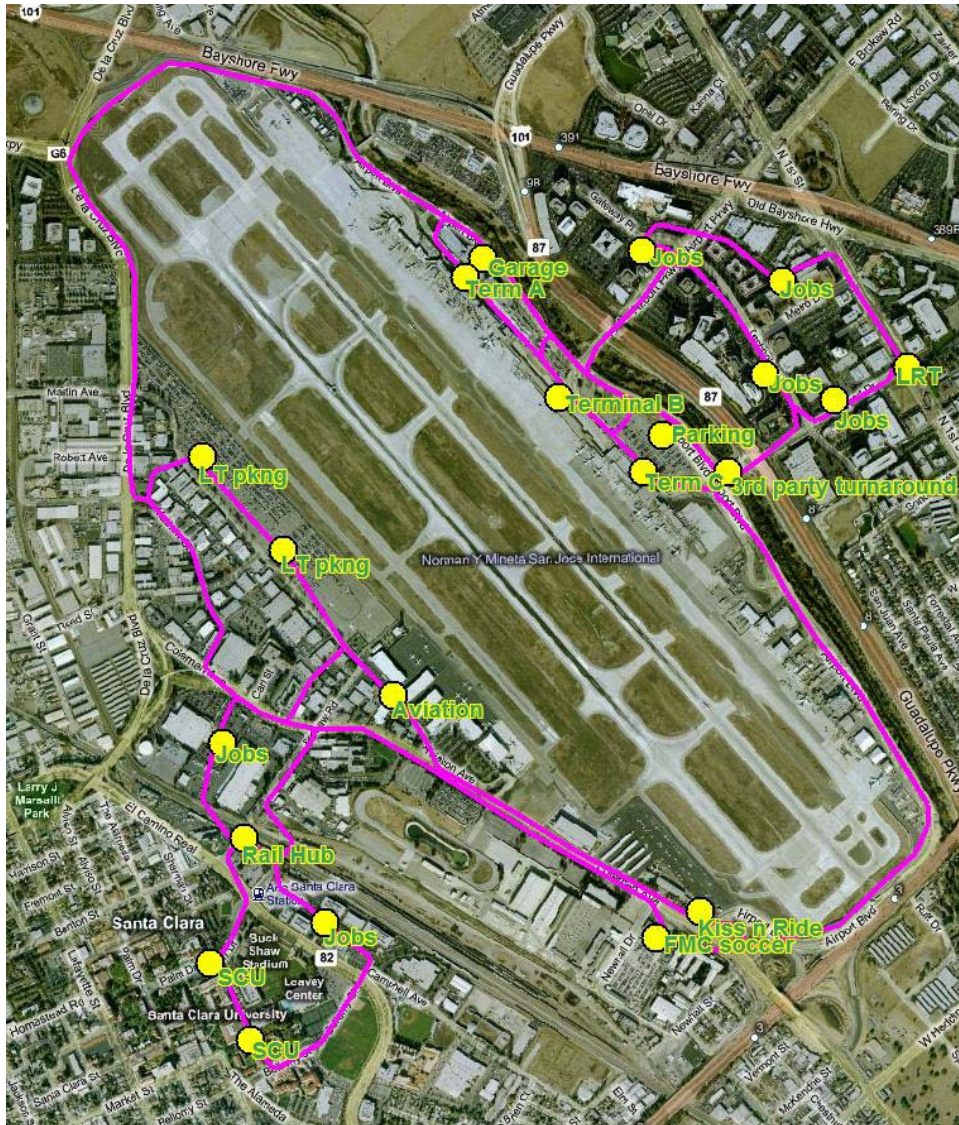


Figure 2. Layout for Potential PRT System at Mineta San Jose Airport

2. Infrastructure characteristics

• Length of guideway:	12.6 miles
• Direction of guideway:	two-way
• Guideway type:	track
• Traction type:	TBD
• Alignment Location:	elevated
• Number of stations:	3 (initially)
• Number of active cars:	21
• Number of spare cars:	TBD
• Cars per train (peak/off-peak):	TBD
• Vehicle passenger capacity (seated/maximum):	6/6

- Maintenance facility size and capacity: **TBD**
- ADA compliance: **TBD**
- Vehicle power technology: **electric**

Chapter 8. MSP C-Concourse Tram and Hub Tram

The C-Concourse Tram, a Group Rapid Transit (GRT) people mover system, originally opened in 2004 and was the second of two automated people mover systems to begin operation at the airport. Covering a distance of 2,700 feet, the tram was designed to quickly transport passengers between the concourses of the Lindbergh Terminal. The tram was originally scheduled to open in 2002, but computer software problems and a collision (during testing) with the end-of-the-line safety buffer (caused by human error) resulted in postponing its opening to 2004. The Hub Tram, of similar but not identical design and covering a span of 1,100 feet, has provided transportation between the Lindbergh Terminal and nearby parking garages and ground transportation since 2001. The Metropolitan Airports Commission is contemplating expansion of Concourse G within the next decade, and is considering a connection to the main terminal via an automated people mover or, perhaps, a ART system.

The C-Concourse Tram and Hub Tram systems were implemented to improve customer service, convenience, and satisfaction for air travelers, since the previous bus shuttle service was very poor. These systems replaced the bus shuttle service entirely, and were considered a more convenient alternative to using moving walkways. System technology was not predetermined, and a cable-driven approach was selected because of the short distances between stations. Although emissions, environmental impacts, energy consumption, and visual impact issues were not a driving force in system design, such factors will be considered in future system expansion (emissions concerns were not an issue when moving from shuttle buses to trams in the 1990s). In terms of risk considerations, the C-Concourse Tram presented unique challenges because it was required to be a secure environment, even though it is directly exposed to an unsecure external airport environment. Specific approaches related to emergency exiting and access limitations were addressed during the design process. Emergency requirements for both systems adhere to National Fire Protection Association (NFPA) regulations, and walking and moving walkways are available as back-up systems. The need for security – specifically, a secure airport perimeter – imposes certain limitations on potential ART system design. This concern currently applies to the C-Concourse Tram, and is an issue to be considered for any future ART system.

Although human error resulted in a crash during testing of the C-Concourse Tram, current reliability (availability to operate) is 99% and exceeds the stated goal of 98%. This standard is applicable except in adverse weather conditions (i.e., below -20° F or above 95° F, lightning, high winds, or over four inches of snow). Such weather-related weather conditions are rare.

The MSP system has met its stated objectives and validated the rationale for its implementation. Due to this success, plans are in place for future expansion of the airport automated system approach.

Considerations include:

- Plans to build another automated system for Concourse G (by 2015-2020).
- Possibility for looping the potential G-Concourse system with the C-Concourse Tram, but perimeter security issue must be resolved.

- The expected growth from 32.5 million passengers per year to 56 million passengers by 2030 will require significant improvements in MSP's airport internal and external transportation system.
- ART could be one of the options considered, provided issues of security, capital cost, and passenger loading, among others, are resolved.

Following is a description of the MSP GRT systems.

MSP System Characteristics	C-Concourse Tram	Hub Tram
1. Overview		
• Year planning began:	1997	1996
• Year testing/trial started:	2002	2001
• Year opened to general or revenue-service:	2004	2001
• Facility Description (and Map)	Terminal 1, along "C" Concourse, to Gate C27 & "A" Concourse	Terminal 1 to Parking & Ground Transportation

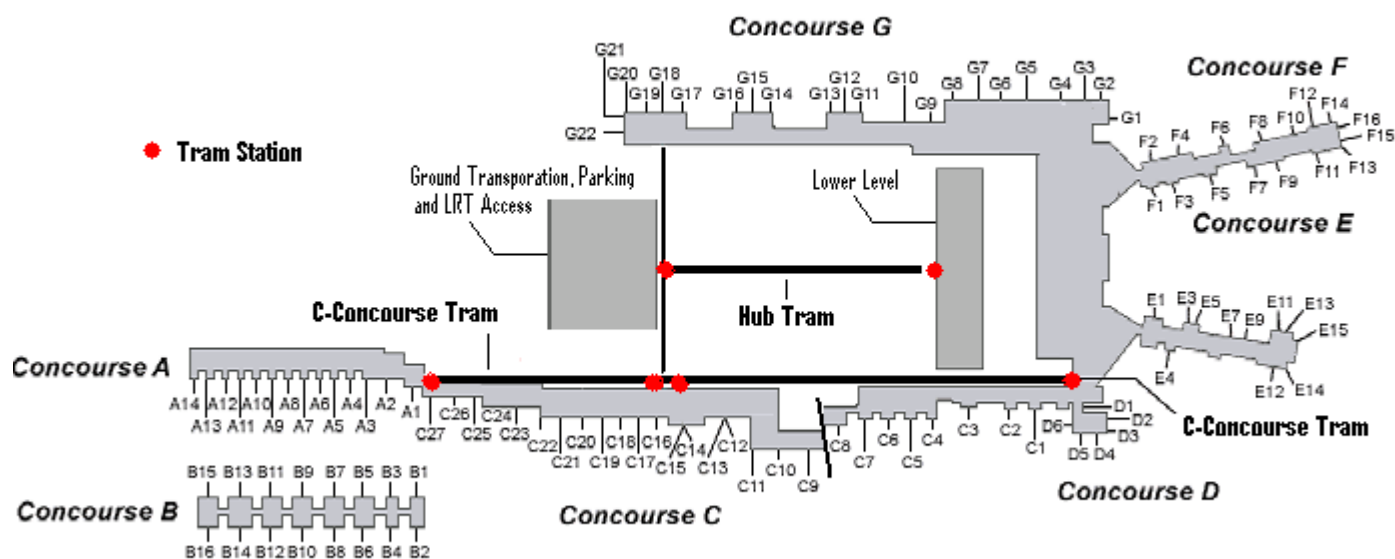


Figure 3. MSP C-Concourse and Hub Trams

2. Infrastructure characteristics		
• Length of guideway:	2,700 feet	1,100 feet
• Direction of guideway:	two-way	two-way
• Guideway type:	cable-propelled	cable-propelled
• Traction type:	steel wheels on steel track	"hovair" technology
• Alignment Location:	elevated	underground
• Number of stations:	4 (3 stops each direction)	2

- Number of active cars: **4** **4**
- Number of spare cars: **0** **0**
- Cars per train (peak/off-peak): **2/2** **2/2**
- Vehicle passenger capacity / car: **45 per car** **45 per car**
- Maintenance facility: **3,085 square feet;**
one train at a time **6,438 square feet;**
one train at a time
- ADA compliance: **yes** **yes**
- Vehicle power technology: **electric** **electric**

3. Service characteristics (peak and off peak;

- Hours of operation (Train 1/ Train 2): **6 AM – 11 PM** **24/7/365**
6 AM – 10 PM **6:30 AM – 10 PM**
- Frequency of service: **6-7 min per train** **1-2 min per train**
- Headways per month: **7,800** **9,600**
- Duration of total trip: **3.5 minutes** **1 minute**
- Dwell times at stations: **< 3.5 minutes** **< 1 minute**
- Design speed: **26 mph** **26 mph**
- Right-of-way: **exclusive** **exclusive**
- Owner of right-of-way: **MAC** **MAC**

4. Demand characteristics:

- Maximum hourly passenger demand: **N/A** **N/A**
- Average weekday/weekend pass. **N/A** **N/A**
- Annual passengers: **N/A** **N/A**

Chapter 9. Lessons Learned from Airport Systems

Of the airport systems examined, only the MSP rapid transit has been in full public service for about a decade. However, the Heathrow and Mineta experiences—added to the news that the Masdar PRT system is now in public service in Abu Dhabi—throw light on a number of issues, and provide several lessons for a potential future implementation of ART at MSP.

- The capital costs of the MSP GRT systems were on the order of \$36 M for the 2700-foot C-Concourse system (which included the cost of the elevated infrastructure), and \$25 M for the 1100- foot Hub Tram (which included the cost of a tunnel). The capital cost of the newer Heathrow starter-test system was under \$18 M per mile, and will likely be lower once the system is expanded and fixed system costs are spread over a larger system.
- Building a small system to test ART operations under realistic conditions makes a lot of sense. It has taken more than a year to work out system kinks at Heathrow, and it was during the system test period that the MSP system experienced an accident due to human error. Expectations for the Mineta ART system is that, if proven feasible, a period of testing will be undertaken.
- A set of standards does not currently exist for issuing ART system specifications. As ART technology continues to advance, multiple systems will become available, which will make it difficult to determine which technology will be the most appropriate. In the case of MSP, the most important step will be to develop system requirements that ensure that ART developers conform to these specifications, including interfacing with the airport's legacy systems.
- Airports pose significant challenges because of the tight security required. It appears that Heathrow has addressed these issues. Maintaining airport security is a key concern for any future system at MSP.
- The most recent four-week trial period with limited public service at Heathrow resulted in a service availability of 99.6%, which is very high for transit services. It may not be premature to conclude that ART can work well in configurations such as airports.

Chapter 10. Other ART Interest in the Twin Cities

Potential ART applications have also been discussed in a number of communities in the Twin Cities. Maple Grove has examined an application in the Arbor Lakes area, and the Cities of Bloomington and Edina have identified ART as a possible transportation alternative. Potential ART applications in Bloomington and Edina are of interest because, ultimately, they may have a connection to the MSP airport.

In Bloomington, the Mall of America initially incorporated ART as part of its Phase II development plan for land immediately north of the original Phase I development. The Mall identified a potential provider and engaged in talks with the city to include a ART demonstration in Phase II development. However, city staff report no further progress since Phase II development was delayed indefinitely due to funding constraints.

In Edina, the city's Housing Task Force identified ART as a potential example of innovative public transportation in its comprehensive report, "Housing Succession Plan for Edina's Future." Specifically, the document states: "Use Southdale area as a case study for 'healthy community design,' including features such as life cycle housing, sustainable design in all new buildings (e.g., green roofs), pedestrian-friendly environment, and innovative public transportation (perhaps a personal rapid transit experiment)." Edina was identified by ULTra PRT as one of several potential locations in a slate of "PRT Niche Systems Options for Minnesota." In Edina, a small-sized ART system would complement existing transit to serve Edina's Southdale Center, The Galleria, Fairview Hospital and the Centennial Lakes development (see map). Specifically, ULTra PRT lays out a system that would include 15 stations and six miles of one-way guideway at an estimated capital cost of \$42M to \$90M. Among the benefits identified are the following:

- Makes Edina retail more competitive with Mall of America
- Spurs economic development
- Transforms what has been characterized as an "edge city" into a huge transit village
- Complements existing bus transit
- Grows in the future to service other areas such as "South of 494" and Bloomington.

Private vendors also have identified a separate layout for a potential ART system linking Bloomington with Edina along the I-494 corridor, France Avenue and toward Southdale Mall. Similar to other vendor concepts, this idea lacks financing and has not been seriously considered by either community.

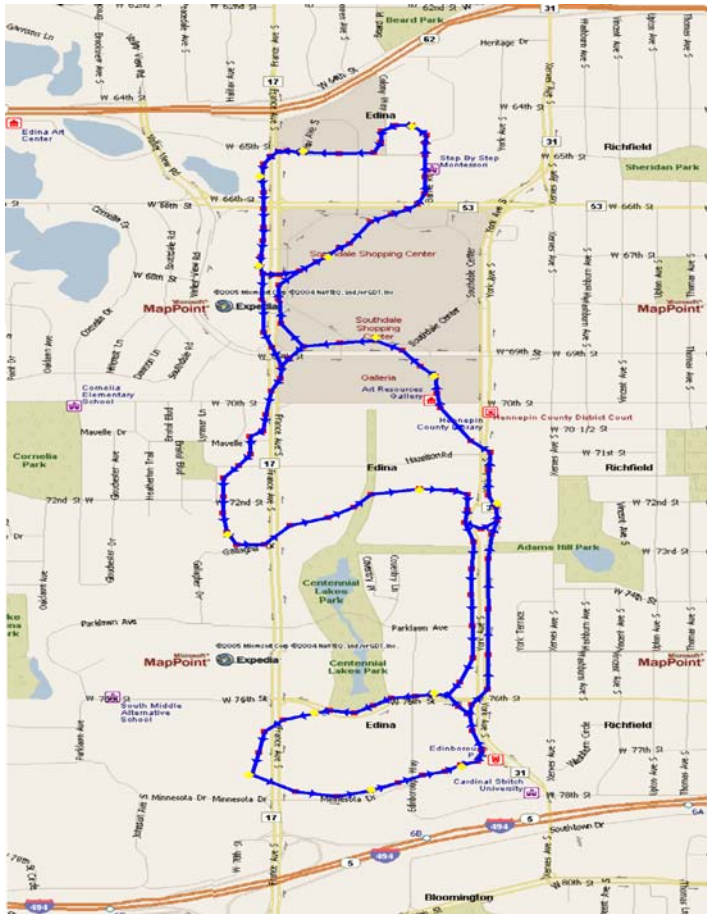


Figure 4. ULTra PRT Layout of Potential PRT System in Edina

Chapter 11. Potential ART Impact on Mn/DOT's ROW

Most of the ART system concepts described above for the Twin Cities are likely to encroach on parts of Mn/DOT's right of way (ROW), either by running within or crossing a state or interstate highway. It is not known at this time what alignment a future airport ART might follow. If ART were to remain within airport property, encroachment on Mn/DOT ROW is not likely to occur. However, if the alignment were to go beyond airport property to serve, say, nearby parking facilities and hotels, it is virtually certain that some encroachment on Mn/DOT's ROW will occur. Similarly, ART systems in Edina, Bloomington or Maple Grove will very likely affect Mn/DOT's ROW.

At some point during the early development of any future ART system, Mn/DOT and FHWA authorization for use of its ROW will be sought. In anticipation of this eventuality, it is incumbent on Mn/DOT to begin to consider what its response will be, whether to a private or public sector entity seeking permission to use its ROW. Some of the issues that need to be considered include disruption to traffic flow and operations, safety, disruption to utilities within the ROW, potential relocation costs, and work-zone safety during construction. Also, as explained below, there are a variety of federal regulations that govern the use of federal ROWs.

The Code of Federal Regulations (CFR) Title 23, Subchapter 810.200, "permits the Federal Highway Administrator to authorize a State to make available to a publicly-owned mass transit authority existing highway rights-of-way for rail or other non-highway public mass transit facilities." Furthermore, it states that the "Administrator may authorize the State to make available to the publicly-owned mass-transit authority the land needed for the proposed facility, if it is determined that: (a) The evidence submitted by the State highway agency...is satisfactory; (b) The public interest will be served thereby; and (c) The proposed action in urbanized areas is based on a continuing, comprehensive transportation planning process carried on in accordance with..." the appropriate regulations. And, finally, the use of the ROW is to be without charge.

CFR 23, Section 710.405, addresses "...airspace management on the Interstate for non-highway purposes..." Paragraph (d) of this section states that: "An individual, company, organization, or public agency desiring to use airspace shall submit a written request to the STD. If the STD recommends approval, it must forward an application together with its recommendation and any necessary supplemental information including the proposed airspace use to the FHWA. The submission shall affirmatively provide for adherence to all policy requirements...and conform to the provisions in the FHWA's Airspace Guidelines..." The question of monetary charges will need to be investigated since a determination of fair market value must be made (Sec. 710.709).

It is not known at this time whether a private-sector entity or a publicly-owned transit authority or a public-private group will take on the responsibility for a future ART implementation effort. It does appear, however, that FHWA's regulation governing the use of their ROW and airspace is open to a variety of applicants, provided the appropriate regulations are adhered to and the applicable permits are obtained.

Chapter 12. Conclusions

This examination of the potential viability of ART at the MSP airport is somewhat inconclusive at this time, primarily because no specific, formal proposal is available for detailed review, and because the status of other airport ART systems is “in progress.” It is hoped that the picture will become clearer in the near future, as Heathrow opens its ART system to the general public, as expected, and San. Jose completes its Phase I feasibility study.

In addition to following-up on the progress of the above airport ART systems, several important issues need to be investigated further, as they relate to the MSP airport:

- With the anticipated growth in activity at the airport, and the planned expansion of Concourse C, it will be necessary to examine potential alternative people-moving systems, including ART, for serving MSP over the next 20 or more years. Once this step is taken, impacts on Mn/DOT ROW will have to be determined for any alignment that goes beyond airport property, since it is very likely that Mn/DOT ROW will be affected.
- Regardless of what future system is considered, the ability to guarantee system security will be paramount. This includes any system that must go outside the current security perimeter in order to serve on- or off-site activities (e.g., remote parking, hotels).
- Airport operations must function smoothly during system construction. Therefore, any system considered must require minimal use of space and minimal disruption to everyday airport and passenger activities.
- Performance criteria for evaluating future technology options, including ART, should be developed in advance. Key among these are potential interface solution between the new system and the current cable-traction tram systems; environmental factors that should be considered (energy use, emissions, noise, etc.); definition of system reliability and availability requirements; and definition of key operating characteristics (frequency, wait time and dwell time, operating speed, passenger-handling capacity, ADA compliance, etc.)
- Another important question, if ART is considered, is how NFPA emergency requirements for transit systems will be addressed. What back-up systems will be in place if passengers have to be evacuated promptly and safely?
- One question that needs to be addressed is: What are the capital and operating costs of an ART system compared to the costs of alternative systems? And, given the limited funds available, how will the system be funded and financed?
- Given the expected high growth in passenger demand at MSP, the question of whether ART will be able to handle the demand needs to be answered.

Chapter 13. Recommendation

It is recommended that an airport ART feasibility study be undertaken in order to address, at a minimum, the issues and questions posed above. A preliminary outline of factors that would need to be considered in a feasibility study is included as an attachment to this report. It should be noted, however, that a funding source for conducting a feasibility analysis has not been identified, although it has been suggested that a public-private sector partnership could serve as the model for advancing such a feasibility analysis.

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Appendix A: Automated Rapid Transit (ART) Feasibility Study Outline

If there is interest in pursuing ART, a Feasibility Study will be needed to assess potential benefits and costs, to identify impediments and how to overcome them, and to determine whether ART is the preferred solution and could move forward to implementation. The following or similar elements should be included in the feasibility analysis:

1. Define study purpose and need
 - Provide more transportation choices?
 - Complement current transit services?
 - Serve an area, market segment or trips not currently well served?
 - Reduce auto traffic in the service area?
 - Reduce energy use and emissions?

2. Conduct alternatives analyses to select a preferred site and mode
 - a. Alternative sites to be evaluated
 - b. Alternative modes to be evaluated
 - c. System design and connections
 - Connectivity to trip generators
 - Access to employment
 - Connectivity to transit services
 - Connectivity to parking facilities
 - Connectivity to remote special generators
 - Service characteristics (frequency, wait time, dwell time, operating speeds, etc.)
 - Fare structure and transfer arrangement
 - System design characteristics (alignment/route layout, number of stations and locations, system length, one-way/two-way operations, at-grade, below or elevated system, etc.)
 - d. Passenger demand and socioeconomic profile
 - e. ADA compliance (station access, vehicle access and accommodation, etc.)

3. Impacts: positive and adverse
 - Conflicts with pedestrians and traffic
 - Travel time reliability
 - Passenger and public safety
 - Change in mode share
 - Reduction in vehicle-miles of travel
 - Air quality and greenhouse gas emissions
 - Energy consumption
 - Visual intrusion/aesthetics
 - Noise
 - Right-of-way needs and property impacts
 - System footprint and use of land
 - Land use and transit-oriented development
 - Disruption to transportation and land uses during construction
 - Utility relocation

4. Technology

- System and component reliability
- Passenger safety
- System security
- Emergency evacuation systems
- Operations under adverse weather conditions (e.g., snow/ice removal)
- System expandability
- Compatibility with legacy systems

5. Business Plan

- Civil capital costs (tunnels, elevated structures, etc.)
- Right-of-way (ROW) costs
- Total system capital cost
- Annual operation and maintenance costs
- Revenue-generation options and total revenue
- Operating subsidies
- Economic development and job creation potential
- Funding options, including public and private sources
- Analysis of procurement options
- Risk assessment

6. Outreach and education

- Stakeholder identification and engagement
- Identification of policy and political champions
- Outreach and education plan

7. Permits and approvals

- Safety (fire, emergency evacuation, etc.)
- Environmental clearance (NEPA)
- ROW use regulations (FHWA, Mn/DOT)
- Utility relocation