SEA 105 - Transit Studies

Presentation to Indiana State Transportation Committee

August 2008

Central Indiana Commuter Rail Feasibility Study

- Preliminary Assessment of the Feasibility of Commuter Rail
- Identify Barriers to Implementation
- Provide Information on Benefits, Costs, Risks and Timing
- Compare to Peer Systems
- Potential for FTA Funding
- Which Alternatives could be Advanced for Further Study

Central Indiana Commuter Rail Feasibility Study

- What is Commuter Rail?
- Benefits
  - Reduction in Emissions
  - Conservation of Energy
  - Economic Development Potential
  - Minor Peak Hour Congestion Relief
  - Access to Jobs

Central Indiana Commuter Rail Feasibility Study

- Scope of the Study
  - Baseline Assessment
  - Definition of Alternatives (Including Bus Alternatives)
  - Evaluation
    - Ridership
    - Cost
    - Station Area Rating
    - Population/Households with Access
    - Ease of Implementation

DMU

Central Indiana Commuter Rail Feasibility Study

Indianapolis-to-Muncie Ranking Summary

ALT	Daily Riders (2030)	Cost (2008 $)	Rating	Cost (2013 $)	Cost (2018 $)
N-1	3000	$130 M	77.9	$155 M	$184 M
N-2	4800	$423 M	64.3	$503 M	$597 M
N-3	6600	$279 M	78.9	$332 M	$394 M
Bus	1600	22 M	-	$26 M	$31 M

- 2013/2018 Costs based on 3.5% Inflation Rate

Central Indiana Commuter Rail Feasibility Study

- Muncie to Indianapolis Recommendations
- N1 and N3 are feasible options that could be advanced for further analysis.
  - Coordination of N3 and NE Corridor
  - Right-of-Way Issues (Lapel to Noblesville)
  - N1 more direct for Muncie/Anderson
  - Active Freight Rail Line (N1)

Central Indiana Commuter Rail Feasibility Study

Indianapolis-to-Bloomington Ranking Summary

ALT	Daily Riders (2030)	Cost (2008 $)	Rating	Cost (2013 $)	Cost (2018 $)
S-1	2100	$447 M	72.5	$530 M	$630 M
S-2	1900	$387 M	75.8	$460 M	$546 M
S-3	2300	$448 M	63.9	$533 M	$633 M
S-4	4000	$352 M	88.1	$419 M	$497 M
S-5	3100	$389 M	81.8	$463 M	$550 M
Bus	1600	22 M	-	$26 M	$31 M

- 2013/2018 Costs based on 3.5% Inflation Rate

Central Indiana Commuter Rail Feasibility Study

- Bloomington to Indianapolis Recommendations
- S4 and S5 could be advanced for further analysis.
  - S4 has highest rating because it has the highest projected ridership
  - All alternatives are very expensive
  - S4/S5 no direct connection to airport
  - Bus options on SR 37
  - Ridership primarily generated near Indy

Central Indiana Commuter Rail Feasibility Study

Comparison to Peer Systems

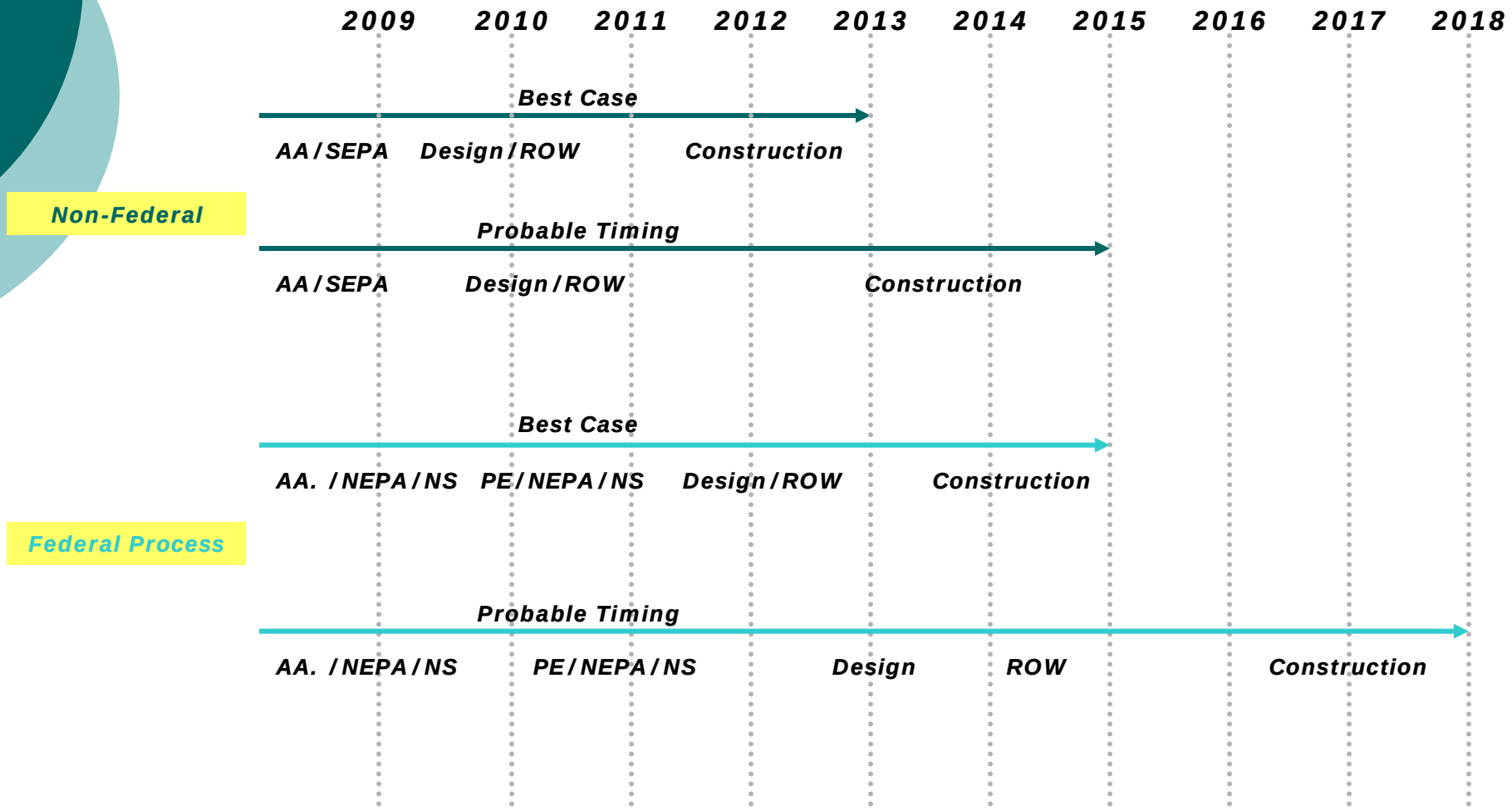
ALT	Annual Ops. Cost	Annualized Cap. Cost[1]	Annual Trips	Avg. Fare Trip	Est. Fare Rev.	Net Ops Cost/Trip	Annualized Cost/Trip[2]
N-1	$6.3 M	$5.2 M	0.77 M	$2.25	$1.7 M	$6.03	$13.34
N-3	$6.9 M	$11.1 M	1.68 M	$2.25	$3.8 M	$1.86	$8.98
S-4	$6.8 M	$14.0 M	0.99 M	$2.25	$2.2 M	$4.60	$19.79
Bus	$1.8 M	N/A	0.41 M	$2.25	$0.9 M	$2.13	$2.13
Miami	$33.5 M	$31.7 M	2.90 M	$2.21	$5.9 M	$10.34	$23.17
Nville	$5.5 M	$1.6 M	0.15 M	$4.00	$0.6 M	$31.95	$43.43
Albuq	$5.0 M	$5.4 M	0.41 M	$2.25	$0.9 M	$10.00	$24.18

1. Based on 2013 Capital Cost Estimate
2. Annualized Capital + Annual Operating Costs/Annual Ridership

Study Results

- ✓ Preliminary Assessment of the Feasibility of Commuter Rail
- ✓ Identify Barriers to Implementation
- ✓ Provide Information on Benefits, Costs, Risks and Timing
- ✓ Compare to Peer Systems
- ○ Potential for FTA Funding
- ✓ Which Alternatives could be Advanced for Further Study – N1, N3, S4, S5 and Bus Alternatives

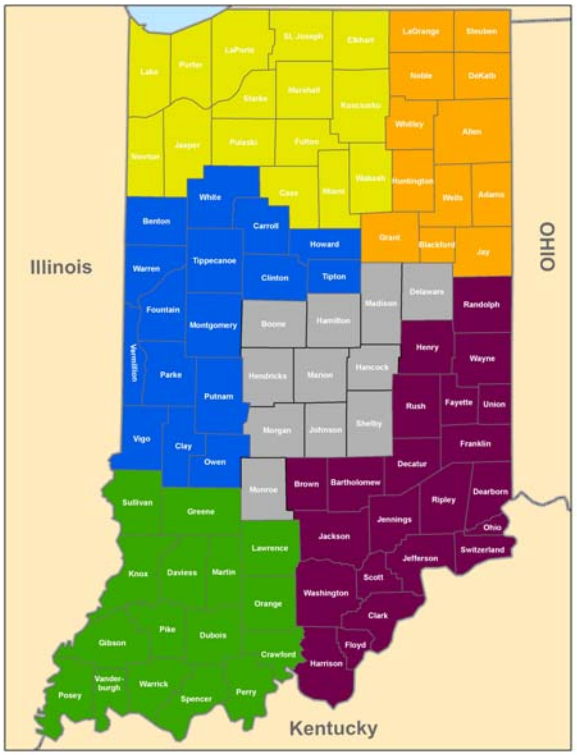
Central Indiana Commuter Rail Feasibility Study



AA = Alternatives Analysis
SEPA / NEPA = State / National Environmental Policy Act
NS = New Starts Application
PE = Preliminary Engineering
ROW = Right or Way Acquisition

Regional Mass Transit Studies

- Address 14 Questions Outlined in Legislation
- Key Considerations
  - Fact Finding Mission
  - Understanding the Different Needs and Priorities among the Regions Across the State
  - Demographic ⟷ Transit Impacts
  - Identifying Transit Funding Strategies Appropriate for the State and the Regions



Regional Mass Transit Studies

- Baseline Assessment
- Stakeholder Interviews
- Technology Glossary (Handout)

Regional Mass Transit Studies

- Match up Needs in Indiana to Peer Cities
- Assess Benefits Realized by Transit Investments in Peer Cities
- Develop Strategies for Comparable Indiana Communities

TRANSIT COMMUNITY TYPOLOGIES

Typology	Attributes	Case Studies	Relevant Indiana Cities/Regions
Major Metropolitan Area	Population threshold: >1M in MSA	Charlotte Dallas Denver - Boulder Minneapolis Salt Lake City	Indianapolis
Major Metropolitan Area – Suburban Portion	Counties / Cities bordering Major Metropolitan Areas centered across State line	Chicago MSA (Metra / NICTD) Philadelphia MSA (NJ Transit) St. Louis MSA (Metro)	Lake / Porter / Newton / Jasper / LaPorte Counties (Chicago MSA) Clark / Ford / Harrison / Washington Counties (Louisville MSA) Dearborn / Franklin Counties (Cincinnati MSA)
Medium City	Population threshold: 200k-1M in MSA	Quad Cities IL/IA Albuquerque NM Charleston SC Little Rock AR	Fort Wayne Evansville South Bend - Mishawaka - Elkhart
University/College Town	Population threshold: <300k in County / MSA and location of major college or university	Chapel Hill NC Ft. Collins CO Iowa City IA Champaign IL	Bloomington (Indiana University) Muncie (Ball State) Terre Haute (Indiana State) Lafayette / West Lafayette (Purdue)
Small City	Population threshold: <200k in County / MSA with small-sized City	Paducah KY Florence SC Traverse City MI	Kokomo Anderson Columbus Richmond Marion
Rural Areas	All Counties/Cities not included above	Central Texas (CARTS) SE Oklahoma (KI BOIS)	Remaining Indiana Cities/Counties

Regional Mass Transit Studies

- Public Opinion Poll
  - Travel Behavior
  - Impact of High Fuel Prices on Travel
  - Transportation Priorities
  - Role of Transit
  - Transit Funding

Regional Mass Transit Studies

- Next Steps
  - Assess Potential Benefits and Costs of Transit Investments
  - Identify Areas in each Region Where Transit Investments Make the Most Sense
  - Determine Funding Needs
  - Provide Potential Funding Strategies

Transit Technology

Glossary of Transit Technology

Prepared as part of the:
Indiana Statewide Mass Transit Studies
Prepared for:
Indiana Department of Transportation
Prepared by:
URS Corporation
August 20, 2008

URS

The purpose of this glossary is to describe the range of modal technologies in use throughout the United States and abroad. The glossary provides a brief description of each technology, it's guideway, basic performance statistics, and images of each modal option. An accompanying table is included to help summarize the key elements and identify the advantages and disadvantages of each transit technology.

For purposes of this report, thirteen technologies were identified, and information was gathered regarding their operating characteristics. Each of the technologies described focuses on characteristics including alignment, physical environment, vehicles, and typical operation. Variations of a specific technology are also described. The transit technologies analyzed include:

SUMMARY & OVERVIEW

- **Rubber Tired Technologies**
  - *Bus (pg. 3)*
  - *Electric Trolley Bus (pg. 5)*
  - *Bus Rapid Transit (pg. 7)*
  - *Paratransit (pg. 9)*
  - *Vanpool (pg. 11)*

- **Rail and Guideway Technologies**
  - *Heritage/Vintage Trolley (pg. 13)*
  - *Modern Streetcar (pg. 15)*
  - *Light Rail Transit (pg. 17)*
  - *Heavy Rail/Subway (pg. 19)*
  - *Commuter Rail (pg. 21)*
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  - *Monorail (pg. 25)*
  - *Automated Guideway Transit (pg. 27)*

Transit Technology

Transit Technology

Transit Mode Overview

Transit Mode	Capacity (Persons per Vehicle)	Vehicles per Set	Density Thresholds (Dwelling Units/ Residential acre)	Guideway	Speed (Miles per Hour)	Power Supply	Suspension	Station/Stop Spacing	Capital Cost	Operating Cost (per Vehicle Revenue Hour)
Bus	-Standard: **80** (40 seated, 40 standing) -Articulated: **120** (60 seated, 60 standing)	**1**	**4** (minimum service) - **5** (frequent service)	Mixed traffic or Exclusive right-of-way	**30** (Minimum) - **55** (Maximum)	Diesel or Alternative Fuels	Rubber tire on pavement	1-2 Blocks	Vehicle: $200K-$275K	$104.20
Electric Trolley Bus	**80** (40 seated, 40 standing)	**1**	**9** (5-minute peak headways)	Mixed traffic or Exclusive right-of-way	**30** (Minimum) - **55** (Maximum)	Electrically powered via overhead wires	Rubber tire on pavement	1-2 Blocks	Standard Vehicle: $560K-$600K Articulated Vehicle: up to $870K Electrification (2-way line): $900K-$1.5M	$124.40
Bus Rapid Transit	**80** (40 seated, 40 standing)	**1**	**9** (5-minute peak headways)	Mixed traffic butt Exclusive right-of-way recommended	**30** (Minimum) - **55** (Maximum)	Diesel or Alternative Fuels	Rubber tire on pavement	.5-1 Mile	Vehicle: $400K-$600K Construction: $7M-$12M per mile	$124.40
Paratransit	**15-30**	**1**	**1-2**	Mixed traffic	**45** (Minimum) - **55** (Maximum)	Diesel or Alternative Fuels	Rubber tire on pavement	Varies (usually exceeds several miles)	Vehicle: $50K-$175K	$54.90
Vanpool	**7-15**	**1**	**1-2**	Mixed traffic	**50** (Minimum) - **76** (Maximum)	Gasoline, Diesel or Alternative Fuels	Rubber tire on pavement	Varies (usually exceeds several miles)	Vehicle: $25K-$40K	$26.70
Heritage Trolley	**30** (single truck) - **70** (double truck)	**1**	**30**	Mixed traffic or Exclusive right-of-way	**15** (Minimum) - **35** (Maximum)	Electrically powered via overhead wires	Steel wheel on steel rail	.25 Mile	$15M-$25M per mile	$180.00
Modern Streetcar	**127** (35 seated, 92 standing)	**1-2**	**30**	Mixed traffic	**15** (Minimum) - **45** (Maximum)	Electrically powered via overhead wires	Steel wheel on steel rail	.25 Mile	$20M-$35M per mile	$180.00
Light Rail Transit	**160** (90 seated, 70 standing)	**1-4**	**9** (5-minute peak headways)	Mixed traffic or Exclusive right-of-way	**30** (Minimum) - **60** (Maximum)	Electrically powered via overhead wires	Steel wheel on steel rail	.5-1 Mile	Tunnel: $150M-$200M per mile Aerial: $80M-$120M per mile At-grade: $60M-$80M per mile	$216.00
Heavy Rail	**170-300**	**4-10**	**30** (5-minute peak headways)	Exclusive fixed guideway	**55** (Minimum) - **70-80** (Maximum)	Electrified third rail	Steel wheel on steel rail	.33-2 Miles	Tunnel: $150M-$225M per mile Aerial: $80M-$120M per mile At-grade: $60M-$80M per mile	$167.20
Commuter Rail	**120** (single level) - **240** (double level)	**4-10**	**1-2** using existing track (20 trains/day)	Exclusive fixed guideway	**50** (Minimum) - **79** (Maximum)	Diesel or Electric	Steel wheel on steel rail	4-7 Miles	Existing Rail ROW: $3M-$15M per mile New Facility: $15M-$30M per mile	$411.30
Diesel Multiple Unit	**120** (single level)	**1-2**	**9** (5-minute peak headways)	Exclusive fixed guideway	**40** (Minimum) - **80** (Maximum)	Diesel or Electric	Steel wheel on steel rail	4-7 Miles	$5M-$25M per mile	Not Available
Monorail	**45-55**	**4-6**	**Varies**	Exclusive fixed guideway	**25** (Minimum) - **40** (Maximum)	Electric powered, Rubber tired propulsion system	Rubber tire or elevated beam	.5-1 Mile	$80M-$120M per mile	$146.00
Automated Guideway Transit	**80-90**	**1-6**	**30**	Exclusive fixed guideway	**40** (Minimum) - **55** (Maximum)	Electrified third rail	Steel wheel on steel rail or Rubber tired	.25-.5 mile in activity centers & between .5-1 mile in other areas	$60M-$100M per mile	$492.80

* Data based on the FTA's 2006 National Transit Database

BUS

Buses are rubber-tired vehicles which operate on roadways in mixed traffic or in specially designated bus lanes. Buses represent the most common and one of the most flexible types of public transportation. Bus systems of some form exist in virtually every urbanized and suburbanized area of the country. Buses can operate on fixed routes according to published schedules, or may be dispatched individually to pick up passengers on a demand-responsive basis. Local bus route stops are typically as frequent as every one to two blocks, or every one-eighth mile. Express or limited service is characterized by fewer stops and higher average speeds.

Currently, the majority of buses in operation are diesel powered. However, vehicles powered by alternative fuels, such as compressed natural gas (CNG) and liquified natural gas (LNG), are available and have been put into service in some locations. These have proven to be a viable alternative to diesel operation. Battery-powered buses also have been implemented, primarily as short-haul, special use vehicles in activity centers because of their short operating range.

Although buses typically operate in mixed traffic, several cities have built exclusive busways that exclude other vehicles. On such facilities, buses can provide faster service by by-passing roadway congestion. Improved bus service would give priority treatment to buses on conventional urban roadways and would be expected to include some or all of the following features:

- Bus Lanes: A lane on an urban arterial or city street that is reserved for the exclusive or near exclusive use of buses.
- Bus Streets and Busways: A bus street or transit mall can be created in an urban center by dedicating all lanes of a city street to the exclusive use of buses.
- Bus Signal Pre-emption: Preferential treatment of buses at intersections can involve the extension of green time or actuation of the green phase at signalized intersections upon the detection of an approaching bus.

Bus transit encompasses a wide variety of vehicle types, ranging from converted vans to double-deck and articulated transit buses. Other technological innovations include low-floor buses, automatic vehicle location systems, automated demand responsive dispatching, transit operations software, electronic ticketing and automated fare payment.

Examples of bus service are present in most cities in the United States.

Transit Technology

Bus	
Characteristics	**Descriptions**
Person/Vehicle Capacity Standard Articulated	 80 total (40 seated and 40 standees) persons per vehicle 120 total (60 seated and 60 standees) persons per vehicle
Vehicles per Set	One
Density Thresholds	4 dwelling units/residential acre (minimum service level) to 5 dwelling units/residential acre (frequent service level)
Guideway	Mixed traffic or exclusive right-of-way
Speed (Maximum)	55 miles per hour
Speed (Average)	30 miles per hour
Power Supply	Diesel or alternative fuels (CNG, LNG, Hybrid electric)
Suspension	Rubber tire on pavement
Station/Stop Spacing	One to two blocks
Capital Cost	Bus Capital cost is primarily attributable to vehicles, generally ranging from $200,000 to $275,000
Operating Cost*	$104.20 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Can operate in mixed traffic or on its own guideway • Adaptable to a variety of fuels • Lower capital cost • Unequaled routing flexibility
Disadvantages	• Limited capacity • Higher operating cost per passenger • Travel times compromised in mixed traffic • Diesel engine has higher levels of pollution

* Data based on the FTA's 2006 National Transit Database

BUS

Transit Technology

ELECTRIC TROLLEY BUS

Electric trolley buses are a subtype of a standard bus. This technology was originally implemented as an alternative to the streetcar. The electric trolley bus should not be confused with actual or replicas of vintage streetcars, which are commonly referred to as "Trolleys."

Electric trolley buses receive power from an overhead wire. These buses are distinguished from other buses by electric propulsion only; otherwise they are identical in size to diesel buses and can operate in the same environments, provided that the overhead power source is available. Electric trolley buses are appropriate for hilly terrain since they can efficiently negotiate steep grades, and for very busy routes characterized by short headways. While once common in many cities, few systems or routes remain (e.g., Seattle, San Francisco, Boston).

Transit Technology

Electric Trolley Bus	
Characteristics	**Descriptions**
Person/Vehicle Capacity	80 total (40 seated and 40 standees) persons per vehicle
Vehicles per Set	One
Density Threshold	9 dwelling units/residential acre (5-minute peak headways)
Guideway	Mixed traffic or separate right-of-way
Speed (Maximum)	55 miles per hour
Speed (Average)	30 miles per hour
Power Supply	Electrically powered via overhead wires
Suspension	Rubber tire on pavement
Station/Stop Spacing	One to two blocks
Capital Cost Normal Vehicle Articulated Vehicle Electrification (2-way line)	 $560,000 to $600,000 Up to $870,000 $900,000 to $1.5 million per mile
Operating Cost*	$124.40 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Can operate in mixed traffic or on its own guideway • Lower capital cost than rail • Emits less noise and air pollution than traditional diesel buses • Can negotiate steep and hilly terrain
Disadvantages	• Limited capacity • Higher operating cost per passenger • Travel times compromised in mixed traffic • Routing not as flexible as standard buses

* Data based on the FTA's 2006 National Transit Database

ELECTRIC TROLLEY BUS

Transit Technology

BUS RAPID TRANSIT

The bus system of Curitiba, Brazil, is a model Bus Rapid Transit (BRT) system. BRT features include: vehicle movements unimpeded by traffic signals and congestion, fare collection prior to boarding, and quick passenger loading and unloading. The essence of BRT is that bus operating speed and reliability on arterial streets can be improved by reducing or eliminating the various types of delay.

Conventional bus rapid transit comprises buses operating on an exclusive roadway, or busway, that is access controlled. Busways which provide a very high level of service and allow high hourly passenger capacities are typically grade separated from cross streets (Orlando, Florida; Eugene, Oregon; Ottawa, Canada; Pittsburgh, Pennsylvania). Low volume busways often are characterized by at-grade intersections with cross streets (Seattle, University of Minnesota, downtown Orlando "Lymmo" Busway). Stops along express busways are made only at stations, which are typically spaced every one-half to one mile. Buses may operate non-stop along the busway or make selected stops based on passenger demand. Buses may also exit the specially designated busway and operate along streets to provide local area circulation and distribution. Additionally, bus rapid transit vehicles can be used on high-occupancy vehicle facilities.

Transit Technology

Bus Rapid Transit (BRT)	
Characteristics	**Descriptions**
Person/Vehicle Capacity	80 total (40 seated and 40 standees) persons per vehicle
Vehicles per Set	One
Density Threshold	9 dwelling units/residential acre (5-minute peak headways)
Guideway	Mixed traffic but separate right-of-way recommended
Speed (Maximum)	55 miles per hour
Speed (Average)	30 miles per hour
Power Supply	Diesel
Suspension	Rubber tire on pavement
Station/Stop Spacing	Half to one mile
Capital Cost Construction Vehicles	 $7 to $12 million per mile $400,000 to $600,000
Operating Cost*	$124.40 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Can operate in mixed traffic or on its own guideway • Moderate to high capacity system • Bus operating speed and reliability is improved by eliminating various types of delay • Unequaled routing flexibility
Disadvantages	• Higher operating cost per passenger • Travel times compromised in mixed traffic • Routing not as flexible as standard buses • Requires a wide guideway • Diesel engine has higher levels of pollution

* Data based on the FTA's 2006 National Transit Database

720 SANTA MONICA
Rapid

Colegio "24 de Mayo"

DRIVER TRAINING
MAX

PARATRANSIT

Paratransit is a subtype of the standard bus system. Pratransit is a demand responsive system that provides a very flexible and efficient alternative mode of transportation. Paratransit systems use rubber-tired vehicles that operate in mixed traffic, with vehicle size ranging from large passenger vans to mid-size buses. The carrying capacity of paratransit vehicles typically ranges from 15 to 35 persons. Most paratransit vehicles are powered by diesel fuel, though alternative fuels and battery-powered systems can be used.

The degree of flexibility a paratransit service can provide often varies depending on the system. At its most basic level, paratransit systems run along a generally defined route while picking up and dispensing passengers at their request. At its most demand-responsive level, paratransit systems can provide door-to-door service to any destination within a service area upon request.

Over the past few decades paratransit systems have been increasingly used as a transport service for people with disabilities, in large part due to their flexible, on-demand service. Many paratransit vehicles today are equipped with handicap accessible equipment such as wheelchair lifts, and are used exclusively for transporting passengers with disabling conditions.

Paratransit systems can be found in operation within many cities and towns across the United States. Due to their lower carrying capacity, flexibility and dispersed trip routes, paratransit systems are often well suited for serving mid-to-low density areas and disabled/elderly populations. Paratransit systems are also ideal to serve markets where conventional bus and rail modes are too expensive and inflexible.

Transit Technology

ParaTransit Characteristics	Descriptions
Person/Vehicle Capacity	15 to 35 persons per vehicle
Vehicles per Set	One
Density Threshold	1-2 dwelling units/residential acre
Guideway	Mixed traffic
Speed (Maximum)	55 miles per hour
Speed (Average)	45 miles per hour
Power Supply	Diesel or alternative fuels (CNG, LNG, Hybrid electric)
Suspension	Rubber tire on pavement
Station/Stop Spacing	Varies depending on application/use (travel distance usually exceeds several miles)
Capital Cost	Paratransit capital cost is primarily attributable to vehicles, generally ranging from $50,000 to $175,000
Operating Cost*	$54.90 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Flexible routing and scheduling • Can accomodate both short and long tavel distances • Adaptable to a variety of fuels • Lower capital cost • Not limited to a single guideway
Disadvantages	• Limited capacity • Not a commuter based system • Travel times compromised in mixed traffic • Diesel engine has higher levels of pollution

* Data based on the FTA's 2006 National Transit Database

GLEN CARBON SENIORS
288-2193

650
County Commuter
650
650

378
756-5550
TRANSIT
378
Operator:
N.E. Trans. Co

VANPOOL

Vanpools are a system of ride-sharing much like a carpool, but with a larger carrying capacity. Vanpool systems use rubber-tired vehicles that operate in mixed traffic, with van size ranging from a 7 to 15 person carrying capacity. Most vanpool vehicles are powered by gasoline, though alternative fuels and battery-powered systems can be used.

Vanpools serve passengers who have a common destination and choose to reduce traffic congestion and fuel costs by riding together. Vanpools usually depart from individual homes or a neutral meeting location and arrive at a common destination or office park. Vanpools are generally used for commuting purposes, and serve trips over several miles.

The specific route and schedule of vanpools are usually subject to passenger demand. Vanpool programs exist in many cities and suburbs across the United States. Vanpools are not limited to use by a public transit agency, and are often operated by private firms and businesses.

Transit Technology

VanPool	
Characteristics	**Descriptions**
Person/Vehicle Capacity	7 to 15 persons per vehicle
Vehicles per Set	One
Density Threshold	1-2 dwelling units/residential acre
Guideway	Mixed traffic
Speed (Maximum)	76 miles per hour
Speed (Average)	50 miles per hour
Power Supply	Gasoline, diesel or alternative fuels (CNG, LNG, Hybrid electric)
Suspension	Rubber tire on pavement
Station/Stop Spacing	Varies depending on application/use (travel distance usually exceeds several miles)
Capital Cost	$25 to $40 thousand dollars
Operating Cost*	$26.70 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Flexible routing and scheduling • Can accomodate both short and long travel distances • Adaptable to a variety of fuels • Lower capital cost • Not limited to a single guideway
Disadvantages	• Limited capacity • Travel times compromised in mixed traffic • Typically does not serve short distance trips

* Data based on the FTA's 2006 National Transit Database

VANPOOL

Transit Technology

HERITAGE TROLLEY

Heritage, or vintage trolley is the term used to describe modern use of trolleys of a design dating from roughly 1900 to 1950. Heritage trolleys operate much in the same was as electric trolley buses, yet the term "heritage trolley" can only be used to refer to either a replica car or an original preserved car restored to accurate standards.

A trolley is either a small single truck design or a larger double truck design. Single truck cars are typically less than 30 feet long and seat up to 30 people, where the double truck cars are typically 30-50 feet long with a seating capacity of 45-70 persons.

Trolleys operate on an at-grade fixed track and typically operate with other traffic along existing roadways. The trolley is electrically powered via a trolley pole from an overhead wire. The maximum operating speed of trolleys is 35 miles per hour.

Trolleys typically operate in urban centers and city streets. Station spacing is generally low (1/4 of a mile) due to their proximity to activity centers. Most operating heritage trolley systems in the U.S. are designed to attract tourists to historic city districts. North American cities where heritage trolleys are currently in operating use include New Orleans, San Francisco, Portland, Dallas, Memphis, Little Rock and Tampa.

Transit Technology

Heritage Trolley	
Characteristics	**Descriptions**
Person/Vehicle Capacity	30 (single truck) to 70 (double truck)
Vehicles per Set	One
Density Threshold	30 dwelling units/residential acre
Guideway	Mixed traffic or exclusive
Speed (Maximum)	35 miles per hour
Speed (Average)	15 miles per hour
Power Supply	Electrically powered via overhead wires
Suspension	Steel wheel on steel rail
Station/Stop Spacing	Quarter mile
Capital Cost	$15 to $25 million per mile
Operating Cost*	$180.00 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Does not require a locomotive to push and pull the coaches • Can serve constrained station site areas and streets • Can negotiate sharp turns and narrow areas • Short headways and close station spacing • Promotes tourism and economic development
Disadvantages	• No standardized vehicle designs • Overhead wire requires high vertical clearances • Routing not as flexible as standard buses • Overhead wires are visually intrusive • Travel times compromised in mixed traffic operation • Not a commuter based system • ADA concerns • Passenger loading not as efficient as other modes • Some vehicles are not bi-directional • Relatively slow speeds

* Data based on the FTA's 2006 National Transit Database

HERITAGE TROLLEY

Transit Technology

MODERN STREETCAR

Modern streetcars are essentially a hybrid combining features of heritage trolley lines and light rail transit. Modern streetcars operate much like a heritage trolley, on an at-grade fixed track with mixed traffic along existing roadways. However, the modern streetcar uses a low-floor vehicle design that is basically a smaller version of a light rail car.

Modern streetcar vehicles are typically 66 feet in length and can accommodate bi-directional operation. These vehicles are larger in length than heritage trolleys, and can carry more people, with a capacity of 127 persons. Power is generated electrically by current from an overhead wire. The maximum operating speed of modern street car systems is 45 miles per hour.

Modern streetcars typically operate in urban centers and city streets. Station spacing is generally low (1/4 of a mile) due to their proximity to activity centers. Modern streetcars are currently operating in the cites of Portland, Seattle and Tacoma.

Transit Technology

Modern Streetcar	
Characteristics	**Descriptions**
Person/Vehicle Capacity	127 (35 seated and 92 standing)
Vehicles per Set	One or two
Density Threshold	30 dwelling units/residential acre
Guideway	Mixed traffic
Speed (Maximum)	45 miles per hour
Speed (Average)	15 miles per hour
Power Supply	Electrically powered via overhead wires
Suspension	Steel wheel on steel rail
Station/Stop Spacing	Quarter mile
Capital Cost	$20 to $35 million per mile
Operating Cost*	$180.00 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Does not require a locomotive to push and pull the coaches • Can serve constrained station site areas and streets • Short headways and close station spacing • Promotes economic development • Best suited for inner-city circulation and short trips • Can negotiate sharp turns and narrow areas
Disadvantages	• Not designed for long trips • Overhead wire requires high vertical clearances • Routing not as flexible as standard buses • Overhead wires are visually intrusive • Travel times compromised in mixed traffic operation • Not a commuter based system • Less capacity than Light Rail Transit • Relatively slow speeds

* Data based on the FTA's 2006 National Transit Database

MODERN STREETCAR

Transit Technology

LIGHT RAIL TRANSIT

Light Rail Transit (LRT) is a primarily at-grade rail mode with electricity powered vehicles receiving current from an overhead wire (catenary). This is in contrast to heavy rail vehicles that usually are powered from a track-level third contact rail. The overhead power collection feature allows LRT systems to be integrated with other on-street transportation modes and pedestrians. The most recent LRT systems in the U.S. use vehicles that are 90 to 95 feel long and are comprised of two body halves connected by a swiveling articulation joint. Operator cabs at both ends of the vehicles allow bi-directional operation.

LRT operates primarily in an exclusive right-of-way; it can also operate with other traffic along existing roadways. A light rail alignment may also be grade separated, either in a tunnel or elevated. Station spacing can be as close as one-quarter mile in activity centers, but typically ranges between one-half to one mile in other areas.

The maximum operating speed of modern LRT systems is 55 to 65 miles per hour, making it suitable for medium distance trips in suburbs or between central business districts and other major activity centers. System operating speeds are a function of the exclusivity of the right-of-way and the number of stops. Operating in mixed traffic reduces system speed.

Light rail operates as a single vehicle or in trains of up to four cars. The LRT train length is a function of the minimum length of a city block so that stopped vehicles do not block cross streets. LRT is currently operating in many North American cities including: Denver, Portland, Baltimore, St. Louis, Buffalo, Dallas, San Diego, Los Angeles, San Jose, Calgary, Edmonton, Boston, Cleveland, Hudson-Bergen, Newark, Philadelphia, Pittsburgh, Sacramento, Salt Lake City, San Francisco, and Toronto.

Transit Technology

Light Rail Transit (LRT)

Characteristics	Descriptions
Person/Vehicle Capacity	160 Total (90 seated and 70 standees) persons per vehicle
Vehicles per Set	Typically, one to three however can have four car train sets
Density Thresholds	9 dwelling units/residential acre (5-minute peak headways)
Guideway	Exclusive right-of-way or mixed traffic
Speed (Maximum)	65 miles per hour
Speed (Average)	30 miles per hour
Power Supply	Electrically powered via overhead catenary wires
Suspension	Steel wheel on steel rail
Station/Stop Spacing	Half to one mile
Capital Cost	Tunnel ($120M - $200M), Aerial ($75M - $100M), and At-grade ($25M-$50M) per mile
Operating Cost*	$216.00 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Flexibility of technology • May operate in mixed traffic, with cross traffic, or on exclusive right-of-way • Can operate in a variety of transit envelopes (at-grade, elevated, or in a tunnel) • Moderate to high capacity system • Can access both low- and high-density land uses • Vehicles can be spaced at three minutes or greater based upon service demands
Disadvantages	• Can not operate jointly with freight trains or other railroad equipment • Overhead catenary system requires high vertical clearances • Moderately higher capital cost • Routing not as flexible as standard buses • Overhead wires are visually intrusive

* Data based on the FTA's 2006 National Transit Database

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MetroTransit

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METRO

HEAVY RAIL

Heavy rail systems, often referred to as subways, are at the upper end of the transit spectrum in terms of speed, capacity and reliability. Heavy rail is a fully grade separated rail mode with electrically powered vehicles receiving power from an electrified third rail. The alignment is required to be in an exclusive right-of-way and may be elevated, in a tunnel or at-grade. No crossings of the right-of-way are permitted in the same plane with heavy rail operations.

Station spacing can be as close as one-third mile in activity centers, but typically ranges between one to three miles in most areas. Train length can vary from two to ten cars. Due to infrastructure costs, heavy rail is implemented when very high passenger capacity is required. Cities where heavy rail is currently operating include: Chicago, New York City, Philadelphia, Atlanta, Washington D.C., Baltimore, Boston, Los Angeles and San Francisco.

Transit Technology

Heavy Rail Characteristics	Descriptions
Person/Vehicle Capacity	170-300 persons per vehicle
Vehicles per Set	Four to ten
Density Threshold	30 dwelling units/residential acre (5-minute peak headways)
Guideway	Exclusive fixed guideway
Speed (Maximum)	70 to 80 miles per hour
Speed (Average)	55 miles per hour
Power Supply	Electrified third rail
Suspension	Steel wheel on steel rail
Station/Stop Spacing	One-third mile to 2 miles
Capital Cost	Tunnel ($150M - $225M), Aerial ($80M - $120M), and At-grade ($60M-$80M) per mile
Operating Cost*	$167.20 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Very high capacity system • Good for both short and long distance travel • Higher Speeds
Disadvantages	• Very high capital costs • No crossing of right-of-way permitted where subway operates

* Data based on the FTA's 2006 National Transit Database

HEAVY RAIL

Transit Technology

COMMUTER RAIL

Commuter rail is implemented along existing railroad rights-of-way and typically serves longer distance (20 to 100 miles) work trips to central cities from outlying areas. For conventional commuter rail operations, single or bi-level passenger cars are pushed or pulled by diesel or electrically powered locomotives. Electrically propelled vehicles may receive power from an overhead wire or a third rail. Typical station spacing ranges between four to seven miles. Train consists vary from four to eight cars. Conventional commuter rail is compatible with (may share track with) active freight railroad operations.

Generally, commuter rail operates to provide peak period, peak direction service. Due to federal regulations that require an automatic train control system for speeds in excess of 79 miles per hour, commuter rail generally operates at this maximum speed. Due to the slower acceleration and braking distances compared to the other rail technologies, commuter rail is best suited to longer distance trips with widely spaced stations. Commuter rail vehicles can use high or low platform boardings. Cities and states where commuter rail is currently operating include: New Jersey, New York City, Long Island, Miami, Dallas, Washington D.C., Chicago, Los Angeles, Baltimore, Seattle and San Diego.

Transit Technology

Commuter Rail Characteristics	Descriptions
Person/Vehicle Capacity	120 persons per vehicle for single level coaches (double level coaches can carry twice the number of people)
Vehicles per Set	four to ten
Density Thresholds	1-2 dwelling units/residential acre existing track (20 trains/day)
Guideway	Exclusive fixed guideway
Speed (Maximum)	79 miles per hour
Speed (Average)	50 miles per hour
Power Supply	Diesel or electric
Suspension	Steel wheel on steel rail
Station/Stop Spacing	Four to Seven miles
Capital Cost With existing rail ROW New Facility	 $3 to $15 million per mile $15 to $30 million per mile
Operating Cost*	$411.30 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• High capacity system good for long distance travel • Lower capital and operating cost per passenger • Higher speeds • Numerous vehicle suppliers • Can access both low- and high-density land uses • Serves longer distance trips • Can operate in environment with freight and other long-haul services • Moderate capital cost
Disadvantages	• Does not serve short distance trips due to acceleration and deceleration requirements • For EMUs overhead catenary system requires high vertical clearances and are visually intrusive • Diesel emissions and noise • Short station spacing is not an option

* Data based on the FTA's 2006 National Transit Database

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TRI RAIL

Diesel Multiple Unit (DMU) operation is a subtype of commuter rail, consisting of one or two vehicles semi-permanently coupled. DMU service can operate on existing freight railroad tracks. DMU cars are self-propelled commuter rail cars that do not require a locomotive to push or pull them.

The cars are typically 85 feet in length and are capable of speeds up to 80 miles per hour. DMU service is often more appropriate for corridors with less freight railroad usage, lower passenger demand or constrained station sites. Trains are typically one or two cars.

DIESEL MULTIPLE UNIT

One example of a DMU currently operating within the U.S. is New Jersey's River Line. The River Line consists of 20 stations along a 34 mile track from Trenton to Camden. The River Line connects to many other modes and networks of transportation within New Jersey Transit, as well as PATCO and SEPTA which serves south east Pennsylvania. The River Line has exceeded its ridership predictions and transports over 2.3 million passengers a year.

Transit Technology

Diesel Multiple Unit	
Characteristics	**Descriptions**
Person/Vehicle Capacity	120 persons per vehicle for single level coaches
Vehicles per Set	One to two car train sets
Density Threshold	9 dwelling units/residential acre (5-minute peak headways)
Guideway	Exclusive fixed guideway
Speed (Maximum)	80 miles per hour
Speed (Average)	40 miles per hour
Power Supply	Self-propelled diesel or electric
Suspension	Steel wheel on steel rail
Station/Stop Spacing	Four to seven miles
Capital Cost	$5 to $25 million per mile
Operating Cost	Not Available
Current Revenue Operations	Yes
Advantages	• Does not require a locomotive to push and pull the coaches • Can serve constrained station site areas • High capacity system good for long distance travel • Lower capital and operating cost per passenger • Can access both low- and high-density land uses • Serves longer distance trips • Displays similar operating characteristics to LRT (i.e., shorter headways, closer station spacing, faster acceleration and deceleration)
Disadvantages	• Does not serve short distance trips • Few DMUs meet FRA requirements for operating on active freight tracks • Limited vehicle suppliers • Diesel emissions and noise

DIESEL MULTIPLE UNIT

Transit Technology

MONORAIL

Monorail is a fixed guideway transit mode in which a series of electrically propelled vehicles straddle atop or are suspended from a single guideway beam, rail, or tube. If fully automated, they are similar in operation to automated guideway transit systems but are classified separately due to their unique guideway configuration. The trains generally consist of permanently coupled cars where electric power is generally picked up by carbon collectors on the bottom of the vehicle in contact with a bar mounted on the side of the guideway beam.

Vehicles may travel in single units or may be linked together in train sets of one to six vehicles. A monorail must be grade separated from other traffic. The majority of monorail installations have been elevated; however, it could operate in tunnel or at-grade within its own right-of-way. Station spacing is comparable to light rail or subway, one-third to one-half mile in activity centers and one-half to one-mile or more in other areas. In the United States, monorail has predominantly been implemented in limited applications, such as recreational areas or amusement parks (Disneyland/Disneyworld) and short (approximately 1 mile) systems in downtown Seattle and Newark International Airport. An example of a larger monorail application exists in Las Vegas, Nevada.

Outside of the United States, straddle beam, large vehicle monorail systems are in operation in Sydney, Australia and Osaka, Kitakyushu, and Tokyo, Japan.

Transit Technology

Monorail	
Characteristics	**Descriptions**
Person/Vehicle Capacity	45-55 persons per vehicle
Vehicles per Set	Four to six
Density Threshold	Varies depending on application/use
Guideway	Exclusive fixed guideway
Speed (Maximum)	40 miles per hour
Speed (Average)	25 miles per hour
Power Supply	Electric powered, rubber-tired propulsion system
Suspension	Rubber tire or elevated beam
Station/Stop Spacing	One half to one mile
Capital Cost	$80-$120 million per mile
Operating Cost*	$146.00 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Narrow width of beam is less visually intrusive than other elevated systems • Automated train control system with supervision from central control center for small sized systems • Serves low to medium passenger volumes • Can access both low- and high-density land uses
Disadvantages	• Complex guidance/switching systems leads to reduced operating flexibility • Right-of-way must be grade separated. Emergency egress from vehicles on this elevated guideway has historically been a problem • Limited Vehicle suppliers • High capital cost per mile • Limited experience in urban applications. Mostly amusement parks and airports in the U.S. • Stations must be high level platform complexes

* Data based on the FTA's 2006 National Transit Database

MONORAIL

Transit Technology

Courtesy of Bombardier Transportation

AUTOMATED GUIDEWAY TRANSIT

Automated Guideway Transit (AGT) refers to a broad range of fixed guideway technology in which the most prominent feature is the automatic train operation. AGT can include steel-wheel, steel-rail or rubber tired vehicles which operate under automated control on an exclusive guideway, grade-seperated from regular traffic. AGT may utilize conventional, or alternative propulsion types such as magnetic levitation or linear induction. Other transit technologies such as monorail and Personal Rapid Transit may also be automated, operating without drivers as AGT.

Vehicles typically accommodate fewer passengers than other rail modes. The characteristic operating standard for this technology is service at very short intervals. This frequent service mitigates the smaller vehicle size so that AGT hourly passenger capacity can be comparable to that of light rail. Station spacing is comparable to light or heavy rail, one-quarter to one-third mile in activity centers and one-half to one-mile or more in other areas. Train sets vary between one and six vehicles.

AGT technology includes a wide range of service levels, from proven "people mover" such as downtown Miami MetroMover and numerous airport circulators. At the present time, the majority of AGT systems usually operate as a local distribution system in an environment where there are many trips concentrated over short distances. They are typically found at airports (Atlanta, Dallas/Fort Worth, Newark, Orlando and Miami), zoos and amusement parks.

The AGT service characteristics can vary considerably. Passenger capacities, generally speaking, are less than light rail or commuter rail systems. Depending on the context of the AGT setting, the speed of the AGT vehicle ranges from 25 to 55 miles per hour.

Transit Technology

Automated Guideway Transit

Characteristics	Descriptions
Person/Vehicle Capacity	80 to 90 persons per vehicle
Vehicles per Set	One to six
Density Threshold	30 dwelling units/residential acre
Guideway	Exclusive fixed guideway
Speed (Maximum)	55 miles per hour
Speed (Average)	40 miles per hour
Power Supply	Electric Third Rail
Suspension	Steel wheel on steel rail or rubber tired with linear induction motors
Station/Stop Spacing	Between one quarter to one third mile in activity centers and one half to one mile in other areas
Capital Cost	$60 to $100 million per mile
Operating Cost*	$492.80 per Vehicle Revenue Hour
Current Revenue Operations	Yes
Advantages	• Automated operations may reduce labor costs and shorten headways • Hourly passenger capacities are comparable to light rail • Higher capacity system good for short distance travel in urban applications
Disadvantages	• High capital cost per mile • Grade seperation required due to electrified third rail • All AGT systems are proprietary with limited pool of suppliers • Limited applications in US outside of airports

* Data based on the FTA's 2006 National Transit Database

AUTOMATED GUIDEWAY TRANSIT

Transit Technology