



7. Other Implementation Issues

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7. Other Implementation Issues

Introduction

This chapter summarizes many of the design and implementation issues related to Urban Rail, including:

- A summary of recent Urban Rail-like streetcar systems around the country;
- An overview of Urban Rail vehicle options;
- A summary of design issues related to Urban Rail passenger stops;
- A review of how Urban Rail can be integrated into the transportation and street network of Austin; and
- A summary of Urban Rail systems elements.

Recent Urban Rail-Like Streetcar Systems in the U.S.

This section summarizes the experiences and characteristics of streetcar systems throughout the U.S. that have implementation characteristics similar to those of Urban Rail. While there are at least fifteen or twenty cities with some form of streetcar service in this country, the majority of those systems are either heritage systems with long histories of service (including San Francisco, New Orleans, and Philadelphia) or tourist-oriented systems that do not serve a traditional daily mobility or commute trip market (such as the Little Rock River Rail or the Tampa Trolley, both of which use vintage replica vehicles). There are only three cities with recent experiences in Urban Rail construction and operations that are comparable models for potential systems in Austin:

- Portland, Oregon
- Seattle, Washington
- Tacoma, Washington

The next few pages are fact sheets on each of those systems, followed by a comprehensive table that summarizes many implementation and operating characteristics of those systems.

Portland Streetcar

The Portland streetcar opened its initial segment in July 2001 as a single-track counterclockwise loop from the Legacy Good Samaritan Hospital in Northwest Portland to Portland State University. This 4.8-track-mile system was constructed for approximately \$55 million (or \$11.9 million per track mile). The streetcar was seen as an option to help redevelop downtown Portland and its surrounding neighborhoods, and as a way to connect the north and south sides of town, which were previously bisected by a freeway off ramp. The area known as the Pearl District was rezoned from 15 units per acres to 125 units an acre and was to include parks, affordable housing, and the demolition of an elevated freeway off-ramp. Additional extensions to the south waterfront redevelopment area added four more track miles to the system. Total construction cost for the system stands at \$103 million, or \$12.9 million per mile. Total daily ridership is approximately 11,000. Its current annual operating cost is approximately \$5.5 million.



System Description

Portland uses a modern streetcar for its system. The system is four route miles long with eight miles of track that loop through downtown Portland connecting the South Waterfront District to the Pearl District and Northwest Portland (refer to Figure 7-2 for a system map). There are 46 stops; with connections to the MAX light rail system, Portland Aerial Tram, and Tri-Met buses. The streetcar runs with 12 to 15 minute headways from 5:30 a.m. to 11:45 p.m. Monday through Thursday, 5:30 a.m. to 12:00 a.m. Friday, 7:15 a.m. to 11:45 p.m. Saturday and Sunday from 7:15 a.m. to 10:30 p.m.

Table 7-1. Portland Streetcar System Summary

Portland Streetcar Summary	
System length (track miles)	4 route miles; 8 track miles
System Cost	\$103 million
Cost per mile	\$12.9 million
Annual O&M cost	\$5.5 million
Vehicle	Skoda (Modern)
Size	66' long x 8' wide
Vehicle capacity	140 (30 seats)
Ridership	~11,000 per day
Right-of-way	Mixed-flow
Operating rationale	Local/limited stop
Station/stop spacing	3-4 blocks
Fare collection	On-board (free in Fareless Square)
Owner/Operator	Portland Streetcar Inc./Tri-Met

Table 7-2. Portland Streetcar Funding Sources

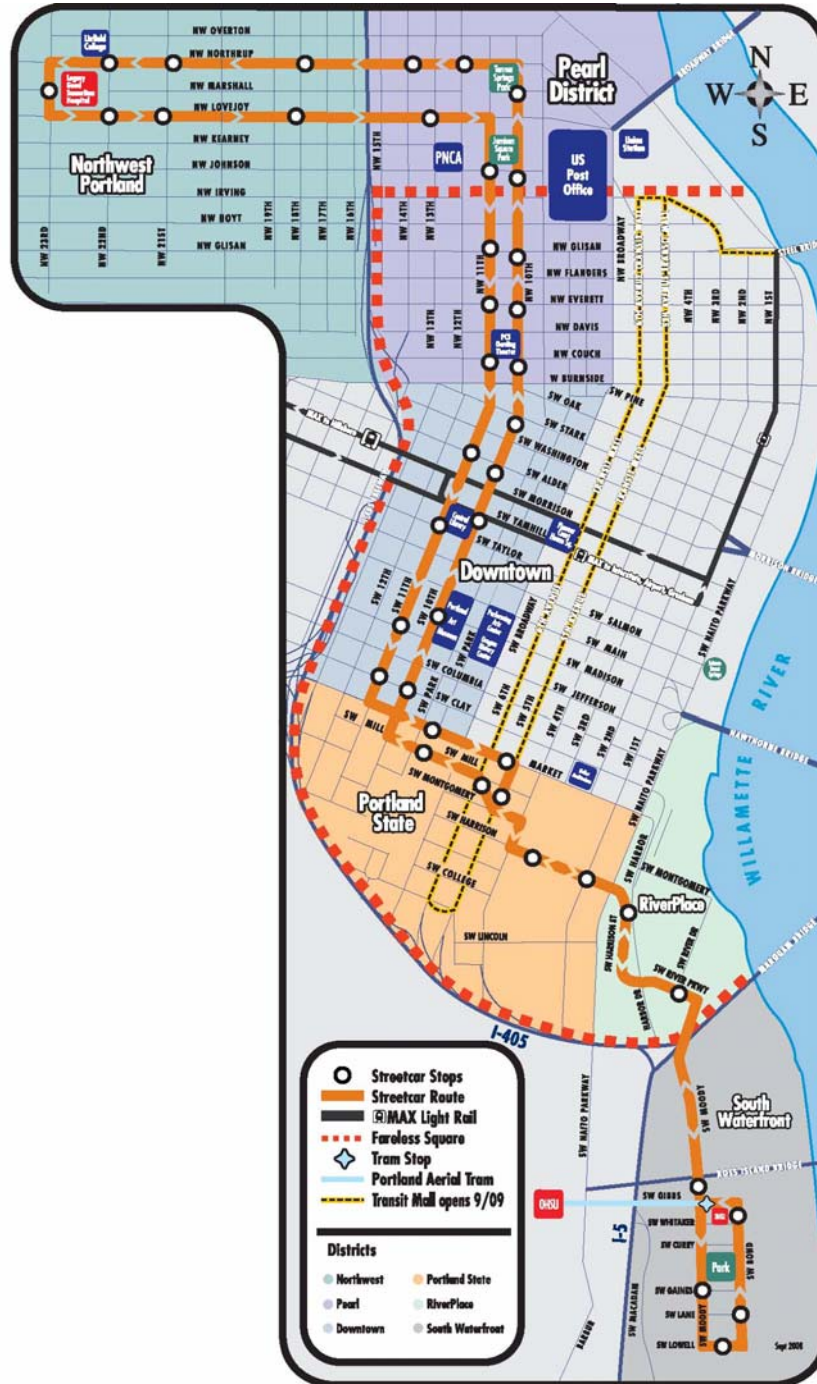
Portland Streetcar Funding Sources (millions)	
Capital	
City General Fund	\$1.8
City Parking Bonds	\$28.6
City Parking Fund	\$2.0
City Transportation Fund	\$1.7
Connect Oregon Funds	\$2.1
FTA Funds	\$5.0
Local Improvement District	\$19.4
Regional transportation funds	\$10.0
Tax Increment Financing	\$21.5
US HUD Grant	\$1.95
Other	\$8.9
TOTAL	\$103
Operating	
Tri-Met	\$3.3
Portland DOT (gas tax, vehicle registration, parking fee revenues)	\$1.8
Fares/sponsors/promotions	\$0.4
TOTAL	\$5.5

Future Expansion

The Portland Streetcar Loop project will add another 3.3 miles to the system (6.7 track miles) at a cost of \$147 million (or \$21.9 million per track mile); this extension will cross the Willamette River and serve the Lloyd District to the east of downtown.

The proposed Lake Oswego to Portland six-mile southern extension is currently undergoing a Draft Environmental Impact Statement. The extension is proposed for an existing railroad right-of-way corridor purchased by a consortium of local governments in 1988. While the intent has been to operate rail transit on this line, the Willamette Shore Trolley heritage streetcar has been running a generally seasonal, excursion-type service. The proposed streetcar service would likely operate at higher speeds – as a 'Rapid Streetcar' – in the dedicated right-of-way. Service may begin as early as 2016.

Figure 7-1. Portland Streetcar System Map



Source: www.portlandstreetcar.org

Seattle Streetcar

The Seattle South Lake Union streetcar is a 1.3-route-mile system that was proposed as a transportation investment for the South Lake Union District by local developers after seeing the success of initial development in the area around the Portland streetcar line. Property owners in the neighborhood south of Lake Union wanted a way to increase the redevelopment of the industrial nature of the area into a biosciences hub. Planning for the streetcar system began in 2003, with financing approved in 2005 and construction initiated in 2006. The streetcar system began operation in December 2007. The streetcar line connects downtown Seattle with the South Lake Union District and the Denny Triangle area. The initial 1.3-mile system (2.6 track miles) cost \$52.1 million, or \$20.1 million per track mile. The system currently serves approximately 1,000 riders per day. Its current annual operating cost is approximately \$2.5 million.



System Description

Seattle uses a modern streetcar for its system. The system is 1.3 route miles long running from Westlake and 7th north to Fairview and Campus Drive (refer to Figure 7-2 for a system map). There are 11 stops on the 2.6 track-mile route, and at the southern end, the streetcar connects with the monorail to Seattle Center and Link Light Rail. The streetcar runs with 15 minute headways from 6 a.m. to 9 p.m. Monday through Thursday, 6 a.m. to 11 p.m. Friday and Saturday, and Sunday from 10 a.m. to 7 p.m.

Table 7-3. Seattle Streetcar System Summary

Seattle South Lake Union Streetcar	
System length (track miles)	1.3 route miles; 2.6 track miles
System Cost	\$52.1 million
Cost per mile	\$20.1million
Annual O&M cost	\$2.5 million
Vehicle	Skoda (Modern)
Size	66' long x 8' wide
Vehicle capacity	140 (27 seats)
Ridership	~1,000 per day
Right-of-way	Mixed-flow
Operating rationale	Local/limited stop
Station/stop spacing	2-3 blocks
Fare collection	Off-board
Owner/Operator	City of Seattle/King County Metro

Table 7-4. Seattle Streetcar Funding Sources

Seattle South Lake Union Streetcar Funding Sources (millions)	
Capital	
Local Improvement District	\$25.7
Federal Funds	\$14.9
State grants	\$3.0
Surplus property sale proceeds	\$8.5
TOTAL	\$52.1
Operating	
King County Metro	\$2.0
Sponsorships	\$0.5
TOTAL	\$2.5

Future Expansion

In November 2008, voters in the Seattle area approved a second streetcar line (to the First Hill and Capitol Hill neighborhoods) as part of a regional transportation measure; in December 2008, the Seattle city council voted to create a multi-line streetcar network with three additional extensions, though no specific funding was identified for those additional lines.



Figure 7-2. Seattle South Lake Union Streetcar Map



Source: www.seattlestreetcar.org

Tacoma Link

The Tacoma Link system is a fare-free 1.6-route-mile system (2.4 track miles) that is called “light rail” by its owner/operator (Sound Transit) but is actually a modern streetcar system. The system was designed as a downtown circulator to connect major activity and transit centers in downtown Tacoma starting at the Tacoma Dome (including the Sounder commuter rail system) and ending at the Theatre District to the north. In addition to being a connector, the system was designed to facilitate economic development in the downtown and surrounding area as well as reduce street and parking congestion. The Tacoma system began operation in August 2003. It was constructed at a cost of \$78.2 million, or \$32.6 million per track mile (primarily because the trackwork and related construction were built to light rail standards), and currently carries approximately 3,000 riders per day. Its annual operations cost is approximately \$3 million.



System Description

Tacoma uses a modern streetcar for its system. The system is 1.6 route miles long (2.4 track miles) running from the Tacoma Dome Station to the Theatre District/South 9th Street (refer to Figure 7-3 for a system map). There are five stations on the route; the southern end connects with Sounder Commuter Rail at the Tacoma Dome Station, as well as with local and regional buses. The streetcar runs with 10 minute headways from 5:20 a.m. to 10:10 p.m. Monday through Friday, 8 a.m. to 10:10 p.m. Saturday, and Sunday from 10:10 a.m. to 6 p.m.



Table 7-5. Tacoma Link System Summary

Tacoma Link	
System length (track miles)	1.6 route miles; 2.4 track miles
System Cost	\$78.2 million
Cost per mile	\$32.6 million
Annual O&M cost	\$3 million
Vehicle	Skoda (Modern)
Size	66' long x 8' wide
Vehicle capacity	140 (30 seats)
Ridership	~3,000 per day
Right-of-way	Mixed-flow and dedicated
Operating rationale	Local/limited stop
Station/stop spacing	1/4 mile
Fare collection	Free
Owner/Operator	Sound Transit

Table 7-6. Tacoma Link Funding Sources

Tacoma Link Funding Sources (millions)	
Capital	
Sound Moves Regional Transit System Plan (sales tax and motor vehicle excise tax)	\$78.2
Operating	
Sound Transit	\$3.0

Future Expansion

Sound Transit is considering a number of extensions of the system, including to SeaTac Airport, as a result of the passage of a regional funding referendum in 2008.



Figure 7-3. Tacoma Link Streetcar Map



Source: www.soundtransit.org

Summary of Recent Urban Rail-Like Streetcar Systems in the U.S.

Table 7-1 summarizes the major cost and operating data of these three peer city Urban Rail-like systems.

Table 7-7. Summary of Urban Rail-Like Systems

	Portland	Seattle	Tacoma
Year Open/Ext Open	2001 / 2005	2007	2003
Length (route miles/track miles)	4 / 8	1.3 / 2.6	1.6 / 2.4
Capital Cost (original year of expenditure)	\$103 million	\$52.1 million	\$78.2 million
Cost per mile (YoE)	\$12.8 million	\$20.1 million	\$32.6 million
Annual O&M cost	\$5.5 million	\$2.5 million	\$3 million
Annual fare revenue	\$200,000	\$275,185	\$0
Recovery ratio	3.6%	11.2%	0%
Annual passenger miles	NA	378,200	871,778
Annual unlinked trips (total boardings)	4,000,000	413,300	860,349
Passenger trips/mile	NA	1.1	1.0
O&M cost/rider	\$1.38	\$5.95	\$3.46
Annual veh rev mile	200,000	56,600	97,115
Trips/veh rev mile	20.0	7.3	8.9
O&M cost/veh rev mi	\$27.50	\$43.46	\$30.68
Annual veh rev hrs	36,000	11,500	10,060
Trips/veh rev hours	111.1	35.9	85.5
O&M cost/veh rev hr	\$152.78	\$213.78	\$296.21
Ridership	~11,000/day	~1,000/day	~3,000/day

Source: Street Smart, 2009 (Reconnecting America), Portland Streetcar, Inc., 2007 & 2008 NTDB data.

Overview of Urban Rail Vehicle Issues and Options

The choice of an Urban Rail vehicle for use in Austin represents one of the more important decisions the community can make. The vehicles used in the system are a critically important element in the overall image of the project, as they are the most visible element of the system. The vehicles used in this system will serve not only as a mode of transportation for residents and visitors of the area, but also as a community amenity and asset with the power to attract and focus development/redevelopment and even serve as an attraction or destination in its own right. Therefore, the performance and look of the chosen vehicle is vital to the overall success of the project.

Vehicle Criteria

There are several important considerations that will impact the selection of an Urban Rail vehicle for the Austin system. Vehicle selection criteria fall into multiple categories: operational, performance, and aesthetic/contextual:

- Vehicles must be able to adapt to the nature of the service desired by the community. In other words, the local community should decide if it wants to focus on commuter transportation, special events and weekend transit, connections to activity centers, peak hour vs. off-peak service, and other sometimes competing operational characteristics, or if it wants to serve a number of (or all) of those potential types of trips and operational scenarios.
- Vehicles must have capacity and accommodations for all potential passengers and must include Americans with Disabilities Act (ADA) requirements.
- Vehicles must be able to operate in the local environment of Austin, including weather, topography, and roadway geometry.
- Vehicles should promote the image desired by the local community for the project. If the community wants to promote a more modern image (and higher capacity service) consistent with many recent Urban Rail/streetcar systems, it would focus on a modern vehicle (as opposed to a vintage replica vehicle like that used in Little Rock or Tampa or vintage restored vehicles such as those used in San Francisco).
- Vehicles must meet performance criteria for frequency of service, acceleration and deceleration rates, operating speeds, and track geometry, while operating within a given level of safety, comfort, and service reliability.

Specific issues to consider in the selection of an Urban Rail vehicle include:

- **The use of single-end vs. double-end equipment.** Single-end vehicles can only be operated in one direction. Double-end vehicles can move in both directions but could result in lower passenger capacity due to the requirement to construct an operator's area on both ends. Modern Urban Rail vehicles are double-end vehicles.
- **The use of single-side vs. double-side vehicles.** Single-side vehicles (similar to most buses, which open on the right side for curbside pickup) provide slightly higher passenger capacity but are more limited in operational flexibility than double-side vehicles, which can load and unload passengers from either side or center platforms.

- **The use of consists.** Some manufacturers build vehicles with couplers that can be joined together to operate in sets (or "consists") of two or more. Coupling trains doubles or triples, etc. passenger capacity for a relatively modest increase in operating costs since the same operator can run a two-car consist as a single-car train. Manufacturers may offer the ability to couple as an option; however, streetcar/urban rail train lengths are often limited by city block lengths. With it's typically 300 feet long downtown blocks, Austin should be able to accommodate two-car sets of most modern urban rail-type trains.
- **Turning radius and other geometric considerations.** Modern streetcar/urban rail vehicles have a slightly larger turning radius than vintage replica vehicles (usually 60 to 66 feet), which generally requires curb cuts or other special designs to negotiate tight turns. Light rail vehicles require a minimum turning radius of 85 feet. Commuter rail vehicles, like the Red Line need even greater radii. The use of multiple-unit, or articulated, equipment allows for much greater capacity while maintaining the maneuverability of smaller, single-unit vehicles.
- **ADA compliance.** A distinct difference in many transit systems around the country is in the platform and vehicle boarding height. There are two types of vehicles available for use in Urban Rail transit systems, low floor and high floor.
 - Low floor vehicles are typically 70 percent low floor, while there are 100 percent low floor vehicles becoming more available. A 70 percent low floor vehicle has level boarding for all doors and may use bridge plates for ADA boarding. This allows platform heights to remain low and easily accessible.
 - High floor vehicles require high platforms, low platforms with a mini-high block section, powered lifts, or other means for ADA access. These appurtenances take up a portion of the platform. However, as seen in Salt Lake City, mini-high blocks on low platforms easily allow level boarding on high floor vehicles. In urban settings where right-of-way is limited, high platforms can be more obtrusive, generally incompatible, and result in less than desirable pedestrian access.
- **Fare collection systems.** Fare collection can be accomplished on- or off-board. On-board equipment is similar to typical fixed-route buses and is often found on restored or replica vehicles. On-board equipment can be a maintenance problem, be more costly to maintain, limit passenger capacity, and increase station dwell time. Off-board (point-of-purchase or "honor") systems can improve passenger flow, reduce dwell times, and increase capacity on vehicles but is a more expensive fare collection system. An efficient off-board fare collection option is through the use of coordinated parking pay stations, which can be programmed to distribute rail tickets, in addition to parking passes. The City of Austin has recently converted a large number of conventional single-space meters to pay stations downtown.
- **Propulsion.** Most streetcar/urban rail and light rail systems are powered by overhead electric lines, typically at 600 to 750 volts direct current (DC). However, at least three systems in the country are powered by non-electric propulsion systems. Tourist streetcar operations in Galveston, TX, and Denver, CO, use vehicles that are powered by diesel engines. A recently restored tourist system in Savannah, GA, uses biodiesel fuel. Diesel-powered vehicles obviously do not require the construction of an overhead wire system, resulting in some capital cost savings. However, there is additional pollution from a diesel propulsion system (though biodiesel can help mitigate pollutants, and diesel fuel and engines have strict pollution standards), they are noisier than electric-powered vehicles, and they have relatively poor acceleration when compared to electric-powered vehicles.

In addition, some companies worldwide are experimenting with battery power; Kawasaki has recently been advertising a new light rail vehicle that combines on-board regenerative battery propulsion that can reportedly travel six miles without connection to overhead catenaries. An early version of this system is being tested in Paris, though the cars do not include power-hungry air conditioning (like they would need in Austin). Bordeaux, France, is running a prototype in-ground power system manufactured by Alstom; however, it has experienced substantial maintenance issues and is very costly. Bombardier is reportedly testing a magnetic induction propulsion system in Europe, as well, which only powers the segment of track actually occupied by the vehicle. These new technologies, while unproven and currently more expensive, should be considered for their potential to provide operational flexibility and capital cost savings.

- **Buy America.** When vehicles are procured with Federal Transit Administration (FTA) funds, Buy America provisions apply. This means that the cost of the components and subcomponents produced in the United States must be at least 60 percent of the cost of the components of the rolling stock, and the vehicles must undergo final assembly in the U.S. Under certain circumstances, an agency can request a waiver from the Buy America requirements. An example would be if the technology is not sufficiently produced and available in the U.S. A non-availability waiver can be requested if no responsive and responsible bid is received offering an item produced in the United States.
- **Costs.** Independent of the manufacturer, several factors can influence the cost of a vehicle including order size, customization, and cab equipment, among others.
 - There are often opportunities for cities considering streetcar/urban rail vehicle purchases to work with other cities to standardize vehicles reduce the cost per unit.
 - Additional savings can be realized by minimizing vehicle customization. Hampton Roads Transit in Norfolk recently accomplished this by purchasing the exact same vehicle as Charlotte. By purchasing a fully proven vehicle with no customization, it reduces production cost for items such as, extensive qualification testing, documentation, training, manuals, etc. Ordering an exact vehicle designed for another property with proven equipment can measurably reduce the vehicle cost.
 - Cab equipment in each vehicle can also add significant cost. In order for some cab equipment to function, it requires additional wayside system equipment that does not add cost to the vehicle but adds to system costs. Often the wayside systems costs may be significantly more than the actual cost of the cab equipment. An economical approach for a starter system may be to purchase a vehicle capable of advanced features (TWC cab equipment) and defer installing the wayside communications infrastructure needed for it to function. The wayside communication system could be upgraded in the future as ridership grows and it becomes necessary for more advanced operations. However, this issue is related to light rail operations, rather than Urban Rail and streetcars.
- **Vehicle Procurement.** Regardless of the vehicle type, it is important to incorporate vehicle procurement in the project schedule. Before any work on vehicles begins the agency must undergo a request for proposal (RFP) and procurement process to select a vehicle manufacturer. This process can take up to a year from RFP issue to selecting a vehicle and issuing a Notice to Proceed (NTP) to the manufacturer. From NTP to the first vehicle off the assembly line, typical manufacturing times vary from 18 months to three years depending on the number of vehicles ordered, the customization of the vehicle, etc. The remaining vehicles could be delivered at a rate of two-to-four per month thereafter. These ranges are approximate for planning purposes

and will vary depending on the manufacturer and vehicle requirements. The agency should carefully evaluate the procurement process used in selecting a vehicle and manufacturer. It is advisable to consider requiring technical qualifications from vehicle manufacturers where reliability, quality assurance plans, vehicle history, and other issues can be evaluated properly. It is especially important to qualify manufacturers for low-bid proposals to ensure quality control.

- **Quality Assurance.** When vehicles are customized for an agency’s particular needs, it is important to evaluate the manufacturer’s quality assurance program and reliability history as some agencies have had a poor experience with unreliable vehicles. It is strongly advised to have significant agency oversight in the procurement process and manufacturing of the vehicles. Careful monitoring and inspection of the vehicles and testing is needed to ensure agency expectations are being satisfied.
- **Other Considerations.** An agency or municipality can be as creative as it wants when acquiring vehicles for its system. As the industry is trending towards low-floor vehicles, some agencies such as UTA in Salt Lake City are purchasing used high floor vehicles to refurbish and use on its system. It is also possible, as was accomplished successfully in Dallas (DART), to retrofit high floor vehicles to low floor vehicles. These are just a few examples of cost saving approaches that other agencies have taken to lower their capital costs.

Urban Rail Vehicle Options

Recent Urban Rail systems in Portland, Seattle, and Tacoma have used modern vehicles that are larger and longer than vintage restored or replica vehicles but are smaller than light rail vehicles, though their appearance more closely resembles light rail vehicles. Generally, they are approximately 66 feet long and are double-articulated to allow urban street operations. Portland, Tacoma, and Seattle are using cars manufactured in the Czech Republic by companies Inekon and Skoda, and this design is now being manufactured in the US by Oregon Iron Works.

A recent addition to the modern Urban Rail fleet is a still-larger modern vehicle being manufactured by Siemens, the S70 Ultra Short vehicle. It is approximately 79 feet long and is double-articulated to accommodate urban street running, and can handle a maximum passenger load of approximately 165 (AW2). This vehicle is slated for use in San Diego and Salt Lake City.



Inekon/Skoda Streetcar in Tacoma



Siemens S70 Ultra Short Vehicle Proposed for Salt Lake City

Table 7-2 summarizes the major characteristics of the two modern Urban Rail-type vehicles in use or being procured today.

Table 7-8. Modern Urban Rail Vehicle Characteristics

Typical Characteristics	Inekon/Skoda	Siemens S70 Ultra Short
Configuration	Double-ended/Double-sided	Double-ended/Double-sided
Boarding characteristics	Low-floor center section for wheelchairs, carriages, bikes and standees	Low-floor center section for wheelchairs, carriages, bikes and standees
Size	66' long x 8'1" wide	79' long x 8'1" wide
Passenger capacity	140 (30 seats)	165 (60 seats)
Cost per vehicle	~\$3.75 Million	~\$4-4.5 Million
Geometry/curve minimum radius	60' minimum turning radius	66' minimum turning radius
Speed	Max 43 mph	Max 66 mph
Air-conditioned	Yes	Yes
ADA Accessible	Yes (level boarding with bridge plate, center doors)	Yes (level boarding, center doors)

Other Key Issues

Urban Rail Stations/Stops

An Urban Rail system's stations or passenger loading areas are the second most-visible components of the system after the vehicles. These facilities are the entrance or gateway to the system for the rider, and have the potential to become an essential part of the urban fabric and street environment. Therefore, they should be designed to fit into the character, scale, and style of the surrounding neighborhood. Several issues are important when considering Urban Rail stop locations and designs.

- In a developed urban area, Urban Rail stops generally are provided every two to four blocks, but can be slightly farther apart in less developed areas, much like traditional bus stops.
- Where possible, stations should be located near or adjacent to major cross-streets or near major activity centers and, if possible, a signalized intersection to facilitate Urban Rail movements through those intersections after passenger loading or unloading.
- The passenger loading areas should always be on tangent or straight tracks to facilitate ADA accessibility and passenger safety when loading. Therefore, stops work best when they are along traditional curb lines to avoid



the need for the guideway to curve or divert to line up with a loading area. This means that passenger loading traditionally takes place in an active travel lane, and would be located on curb extensions where parking currently exists on the street, resulting in the loss of two to three parking spaces depending on the length of the platform.

- The selection of the vehicle obviously influences the design of the station, both in architectural style and in size. At approximately 65 feet in length, a modern vehicle would have a smaller passenger platform than an S70 Ultra Short vehicle that is approximately 79 feet or longer.
- Passenger loading areas should be designed to work well with surrounding pedestrian traffic as well; stations should not interfere with normal pedestrian activity on the adjacent sidewalk.

The design of the station can be as simple or complex as budgetary resources and local preferences allow. Passenger amenities can vary as well and can include items such as:

- Design should be emblematic of the system brand, yet reflect the character of its surroundings;
- Shelter or canopies for passenger protection from the elements;
- Seating may be desired but is not always required; more than likely, if local bus stops provide seating, Urban Rail stops would as well;
- Customer information, either printed schedule or system information or electronic schedule information, along with information on the local neighborhood;
- Other amenities such as trash cans, lighting and bike racks are usually provided at stops if space allows;
- Optional amenities include advertising panels, concessions and newspaper racks, pay telephones, public art, and other amenities are often provided.

As noted earlier, stations generally would be located near major cross-street intersections, preferably a signalized intersection to facilitate Urban Rail movement through the intersection. The figures below show three examples of typical station design.

- Figure 7-4 shows a stop example located at the far side of an intersection, and Figure 7-5 shows a stop example located at a near side of an intersection (near side refers to a stop location in advance of a signal or intersection; far side refers to a stop just past a signal or intersection. Typical transit operational schemes show a preference for far side stops so that transit vehicles can pass through an intersection before stopping for passenger boarding, minimizing travel time delays). Both of these examples show a ‘bulb-out’ in a parking lane to accommodate the



passenger loading area. The passenger loading area dimension will vary depending on the exact size of the vehicle. Another design preference would be to locate the ends of the passenger loading area 30 to 50 feet away from an intersection to minimize traffic interference.

- Figure 7-6 shows a mid-block passenger stop. This type of station would most likely be designed to serve a major mid-block activity center or to minimize conflicts at a nearby intersection. This example shows a continuous curb line; obviously, this type of design could be integrated with parking as well.

Figure 7-4. Stop Example/Far Side of Intersection Platform

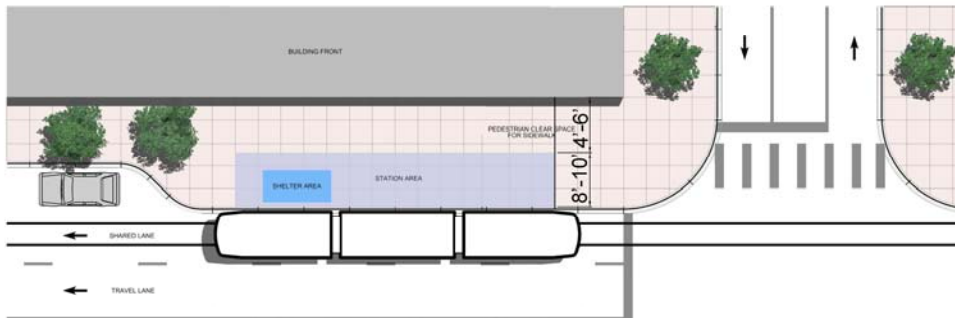


Figure 7-5. Stop Example/Near Side of an Intersection Platform

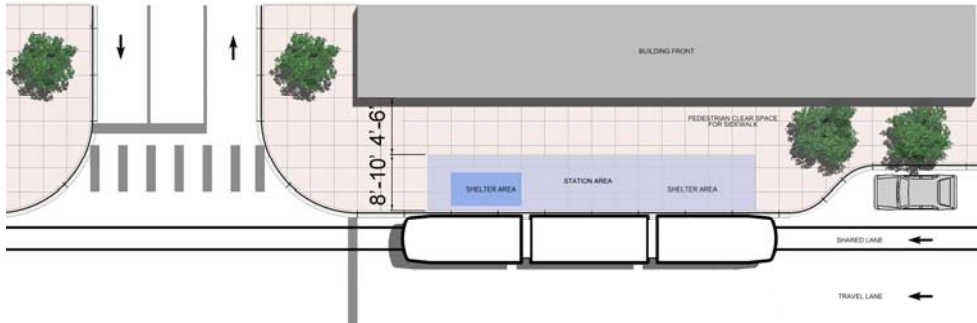
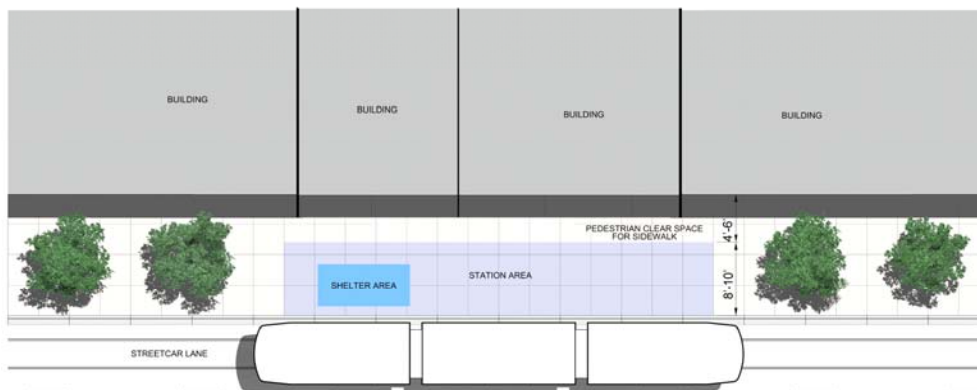


Figure 7-6. Stop Example/Mid-block Platform



Center platforms – which would be used only if an Urban Rail guideway were in the center of a street - are used in some instances, though this type of configuration does present other issues that should be taken into consideration. Center platforms can require either (a) the removal of a center turn lane or other significant changes to existing traffic configurations, or (b) additional right-of-way to accommodate existing traffic lanes, which could result in narrowing of lanes, sidewalks, curb lanes, or other redesign of the street where the Urban Rail vehicle is operating. Center platforms work best in lower-traffic areas; the

example shown is from the Portland South Waterfront area.



Integration with the Transportation Network

An Urban Rail system falls within a broad range of transportation options for a community to consider. Figure 7-7 is a matrix that shows how Urban Rail fits into a variety of transportation scenarios, ranging from the low end of local service at slow speeds up to regional service at higher speeds.

Figure 7-7. Urban Rail Integration into Transportation Network

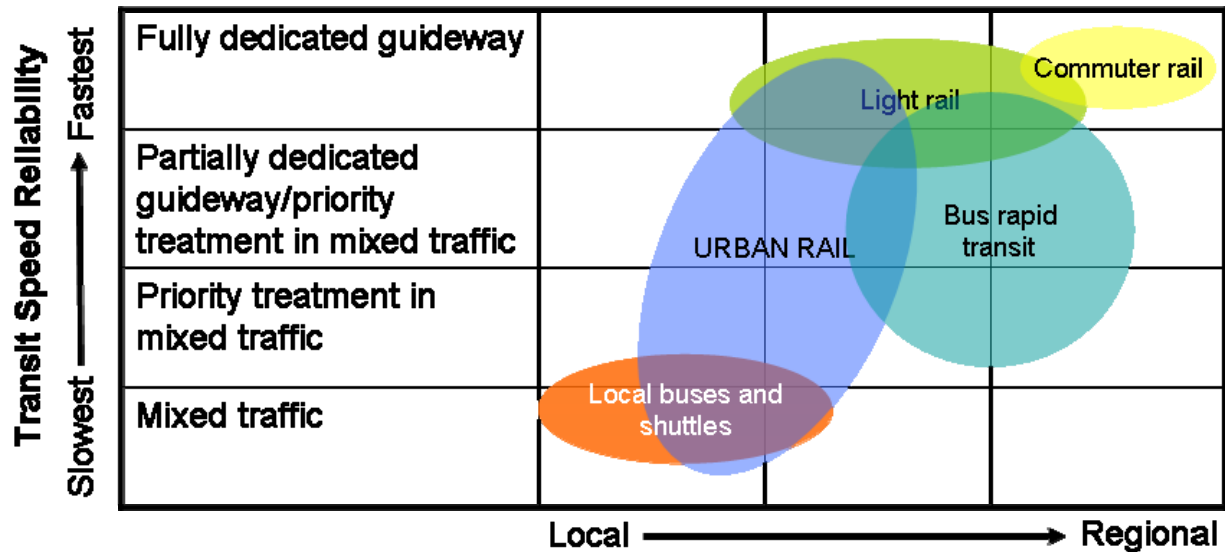


Figure 7-7 shows that local buses and shuttles provide relatively slow operating speeds, and focus almost entirely on local service, with some ability to receive priority treatment in mixed traffic. Bus Rapid Transit typically operates as a mixture of intra-city and longer-distance regional service, usually with priority treatment transitioning into semi-exclusive or exclusive guideways as speeds increase. Light rail can operate at relatively slow speeds in a localized urban environment in a semi-exclusive guideway, though its speeds and regional service ability increase as it moves into a fully dedicated guideway. Commuter rail and heavy rail are on the highest end of the spectrum, typically focused on regional service in a fully dedicated guideway, usually a railroad corridor.

Urban Rail is able to span several service scenarios. It can provide relatively localized service at slow speeds in mixed traffic, but it also can receive priority treatment for slightly higher speeds and can operate in semi-exclusive or exclusive guideways to provide even higher speeds, depending on station spacing. This flexibility is a cornerstone of the hybrid service that Urban Rail can provide in the proposed corridors.

One aspect of the flexibility of Urban Rail is its ability to function within existing travel lanes so that the vehicles share the right-of-way with autos, buses, and other vehicles. This minimizes costs (since a separate guideway is usually not required) while allowing maximum access to the system for the local community through frequent stops. The accompanying photos illustrate how Urban Rail can operate in a mixed-flow environment in several cities. Figures 7-8 through 7-9 are conceptual typical sections that illustrate Urban Rail guideways (and stops) in a couple of different street configurations.



Figure 7-8. Example of Urban Rail in-street, continuous center turn lane, no parking

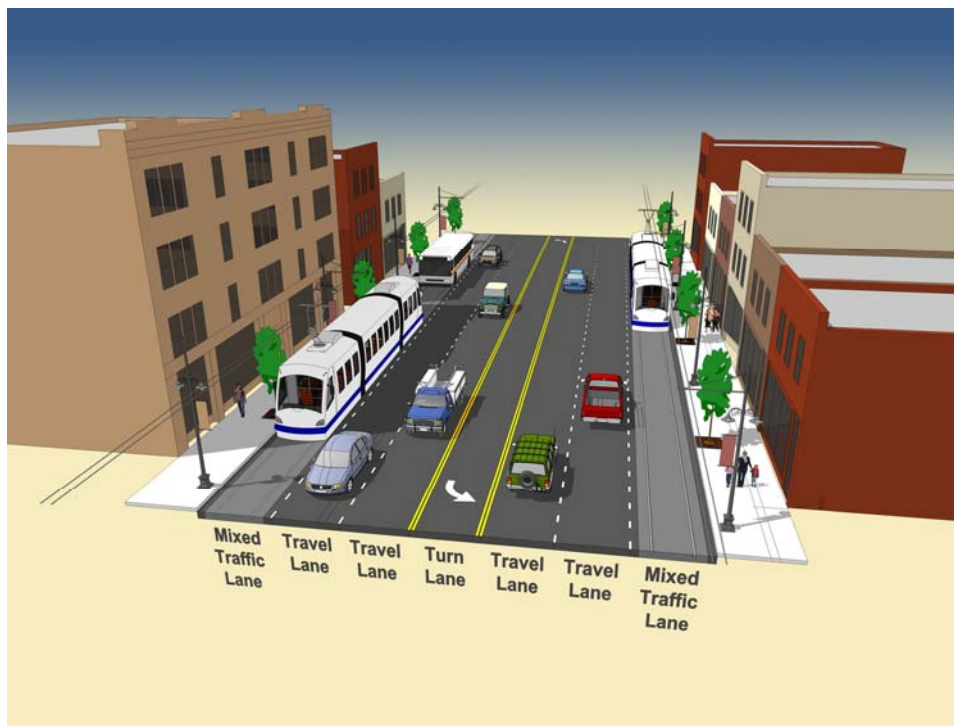
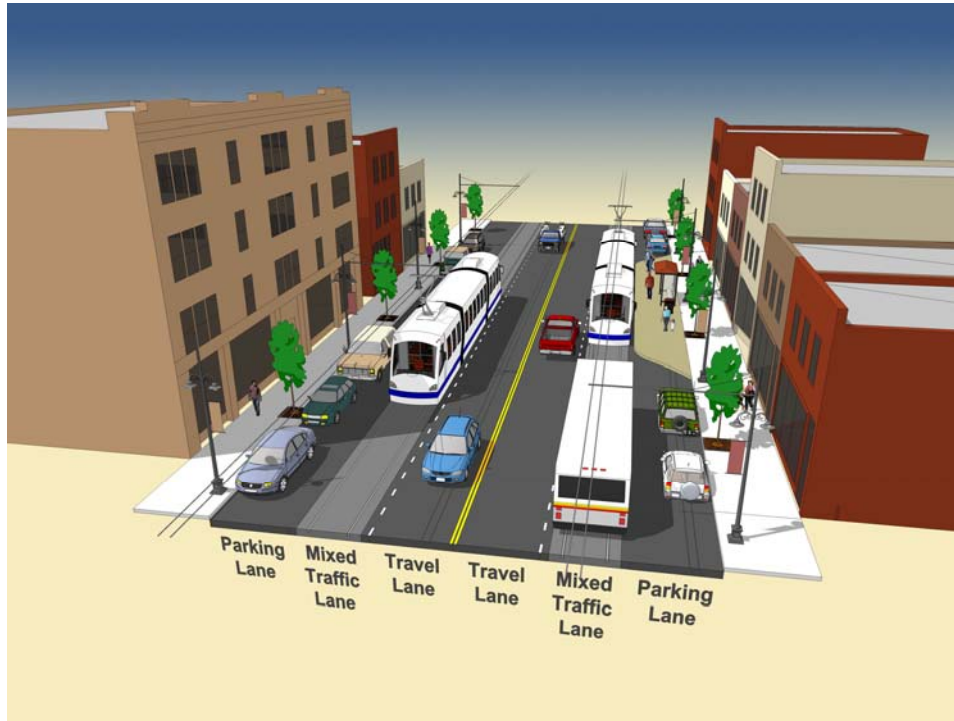


Figure 7-9. Example of Urban Rail in-street, parking on both sides



Bicycle Considerations

While Urban Rail and bicycle facilities are, in general, mutually supportive, there are compatibility issues that need to be addressed during planning and design of Urban Rail-type systems. Portland, OR has a vibrant and growing cycling community, as well as a model streetcar system, and offers a wealth of lessons. In fact, the Lloyd District Transportation Management Association (LDTMA) commissioned a study to define the issues, best practices, and design solutions related to this modal interaction. This 2008 study, *BICYCLE INTERACTIONS AND STRETCARS: Lessons Learned and Recommendations*, by Alta Planning + Design, is available online at http://www.altaplanning.com/App_Content/files/pres_stud_docs/Bicycle_Streetcar_Memo.pdf.

The LDTMA report made the following recommendations:

- *Streetcar tracks and platforms should be center-running or left-running wherever possible.*
- *Bicycle facilities should be separated from streetcar tracks as much as possible by:*
 - a. *Developing a parallel, excellent bicycle facility.*
 - b. *Creating high-quality cycle tracks or bicycle lanes adjacent to streetcar tracks.*
 - c. *Offering 90 degree track crossings whenever possible, by positioning the bike lane or cycle track*



Source: LDTMA, 2008.

to cross at 90 degrees (see photo on page 9); signing and/or marking the best angle for tuning (see photo, above) and creating “Melbourne left turn” opportunities (see page 15).

- *Develop a policy framework for future bicycle and streetcar integration, including:*
 - a. *Developing policies related to bicycle integration in streetcar planning processes.*
 - b. *Developing innovative design guidelines for integrated streetcar and bicycle facilities.*
 - c. *Developing performance measures to evaluate safety.*
- *Create supporting programs for education and wayfinding.*

The LDTMA study has provided the *Central Austin Transit Study* project team with valuable insight, which is currently being incorporated into the program. The recommended Urban Rail system plan, as designed to 10 to 15% in the *Urban Rail Conceptual Engineering Documents*, primarily utilizes right-running alignments with side platforms. As the conceptual design is advanced, there will be significant opportunities to incorporate potential conflict avoidance and mitigation strategies, including changes to the track assignment within the street, development of parallel but separate facilities, and consultation with Austin's own vibrant and growing bicycle community.

Urban Rail Systems Considerations

As noted earlier, most Urban Rail-type systems are powered by overhead electric wires; while new battery technology may provide alternatives in the future, electric power will likely be the propulsion system available for cities in the near to mid-term. Overhead electric power has a number of key factors and issues associated with it that should be taken into consideration in the planning and design of an Urban Rail system.

- Electric power for Urban Rail is generally 600 to 750 volts DC provided through overhead wires.
- Vehicles draw power from the overhead contact wire with either a spring-loaded trolley pole that straddles the wire, or a pantograph with a wide contact surface that slides along the wire. Modern vehicles traditionally use pantographs.
- Overhead wires are either single trolley wires hung from closely spaced poles or a catenary that is a double wire that allows longer spans and more efficient electrical power distribution.
- Small substations for electrical power distribution will be needed at intervals along the route, usually at half-mile or mile intervals.



- Electrical grounding is required to complete the DC circuit and allow a return current back to a substation. This is usually done by isolating the track from the ground with a rubber “boot” or other means.

Other systems elements and issues include:

- Signaling and communications to coordinate vehicle movements, which can include train-to-wayside communications (radios, in-street detection loops, or other means) that are integrated with local traffic signalization systems and Intelligent Transportation Systems, and vehicle location systems including GPS that allow tracking of vehicle movements and potentially a rider information system.
- Fare collection, which can be on-board, typical for vintage cars, requires fareboxes near the front doors. This can limit passenger capacity and increase boarding time, or off-board, requiring proof-of-payment with wayside ticketing and validation similar to most light rail systems. Under off-board fare collection, also known 'honor system', riders can enter through any door, reducing boarding times. Typically, roving fare inspectors check passengers for tickets. Interestingly, new City of Austin parking pay stations can be programmed to vend transit tickets as well, saving costs and reducing clutter in the right-of-way.



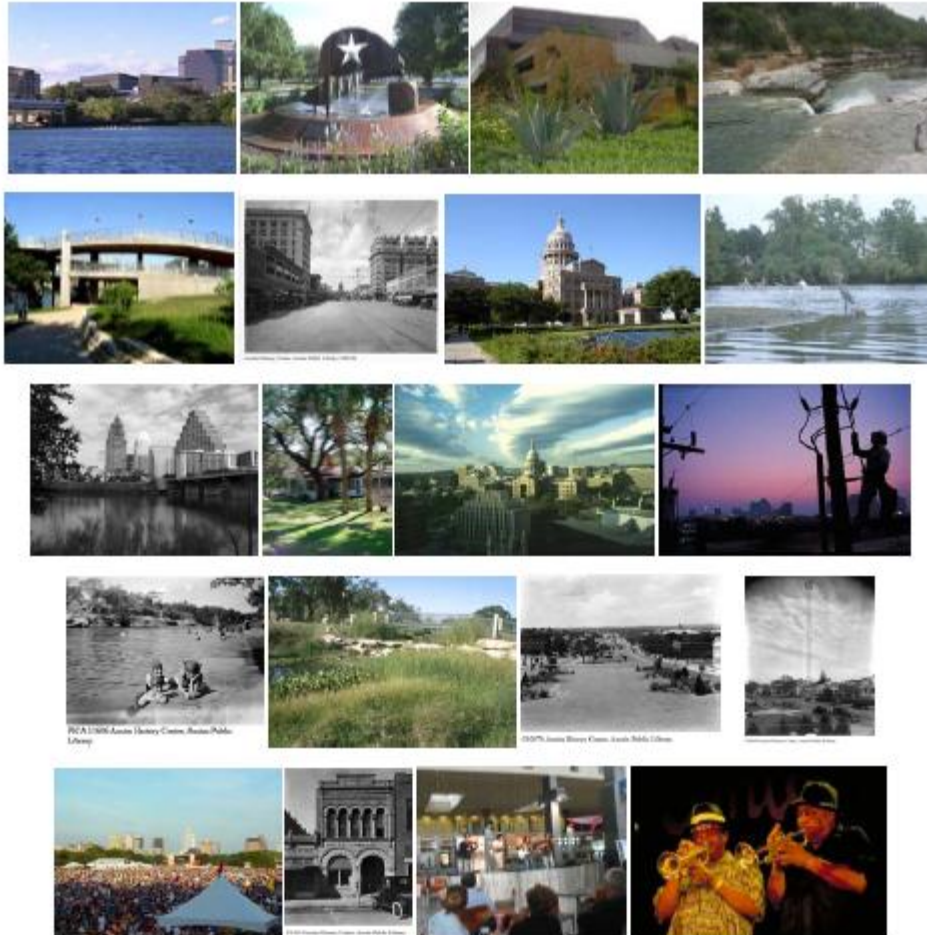


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