TRANSIT STRATEGIES

LIGHT RAIL TRANSIT (LRT)

Light rail transit (LRT) is electric urban rail service that typically operates in exclusive rights-of-way. Most often, it uses one to three car trains and is designed to serve high volume corridors at higher speeds than a local bus or streetcar service. Design and operational elements of LRT include level boarding, off-board fare payment, and traffic signal priority. Stations are typically spaced farther apart than those of local transit services and are usually situated where there are higher population and employment densities. While longer stop spacing can increase walking distances for some riders, people are typically willing to walk farther to reach transit if service is fast and frequent.

MAX LIGHT RAIL (PORTLAND, OR)

THE T LIGHT RAIL (PITTSBURGH, PA)

DEVELOPMENT OF LRT SERVICE

What is now known as light rail evolved from the streetcar services of the late 1800s as those services began to be provided with exclusive rights-of-way to avoid severe congestion in mixed traffic on surface streets. In 1897, Boston's Tremont Street Subway, which is now part of the MBTA's Green Line, was the first streetcar line to be placed in a tunnel, and, in effect, became the nation's first light rail line.

While light rail has a long history in older cities, it became increasingly popular beginning in the 1980s as a way for newer cities to obtain many of the benefits of rapid transit/subway systems at a lower cost through mostly surface operation. According to the Transportation Research Board, today's systems can be categorized into two types:

1. "First Generation systems that evolved from earlier trolley and tramway lines that remained in operation throughout their transformation [as in Boston].
2. Second Generation systems that were designed afresh (occasionally utilizing portions of abandoned trolley or railroad lines, or both)."[1]

[1] "This is Light Rail Transit," November 2000, Transportation Research Board, http://www.apta.com/resources/reportsandpublications/Documents/light_rail_bro.pdf

CHARACTERISTICS OF LRT SERVICE

LRT is popular with passengers for a number of reasons, the most important of which are that service is fast, frequent, direct, and operates from early morning to late night. These attributes make service more convenient—much more convenient than regular bus service—and more competitive with travel by automobile. Characteristics of LRT service include:

- ➔ Frequent service, typically every 10 minutes or better
- ➔ Long spans of service, often 18 hours a day or more
- ➔ Direct service along major corridors
- ➔ Fast service

Keys reasons that service is fast are the use of exclusive rights-of-way—exclusive lanes in the medians of roadways, in former rail rights-of-way, and in subways—and that stations are spaced further apart than with bus service, typically every half mile (although stations are often spaced more closely within downtown areas).

New U.S. Light Rail Systems and Line Extensions Since 2000

- Link Light Rail (Seattle and Tacoma, WA)
- River Line (Camden, NJ)
- Metro Rail (Houston, TX)
- Hudson-Bergen Light Rail (Jersey City, NJ)
- METRO Blue and Green Lines (Minneapolis, MN)
- Lynx Blue Line (Charlotte, NC)
- Sprinter (Oceanside, CA)
- Valley Metro Light Rail (Phoenix, AZ)
- The Tide (Norfolk, VA)
- Santa Clara VTA Light Rail (San Jose, CA)
- Baltimore Light Rail (Baltimore, MD)
- MetroLink (St. Louis, MO)
- Pittsburgh North Shore Connector (Pittsburgh, PA)
- Sacramento RT Light Rail (Sacramento, CA)
- Metro Rail (Los Angeles, CA)
- RTD Light Rail (Denver, CO)
- TRAX (Salt Lake City, UT)
- DART (Dallas, TX)
- MAX Light Rail (Portland, OR)

DIFFERENCES BETWEEN LRT AND STREETCAR

Light rail and streetcar service are often confused, largely because they share many similarities. The major similarities include the basic rail infrastructure, and for modern streetcar services, the vehicles. Major differences include:

- Light rail typically operates in exclusive lanes or an exclusive right-of-way while streetcar service operates in mixed-traffic.
- Light rail lines are longer (typically up to 15 miles, but sometimes longer) while streetcar lines are shorter (typically 2 to 3 miles).
- Light rail stations are spaced farther apart than streetcar stations.
- Light rail lines are designed to serve higher volumes of passengers and typically operate with two to three car trains while streetcar service operates with single car trains.
- Because light rail lines serve higher volumes of passengers, stations are larger and usually more elaborate.

TYPICAL DIFFERENCES BETWEEN STREETCAR AND LIGHT RAIL

Service Element	Streetcar	Light Rail
Vehicles	Modern or historic streetcar	Modern light rail vehicle
Train Length	One car	Two to three cars
Line Length	Shorter (2-3 miles)	Longer (12-15 miles)
Running Way	Mixed-traffic	Dedicated right-of-way
Fare Collection	On station platform or on vehicle	On station platform
Stations	Short platforms; modest facilities	Long platforms; significant facilities
Station Spacing	2 to 3 blocks	½ to 1 mile
Speed	Slower (up to 45 mph)	Faster (up to 65 mph)
Development Benefits	Along line	Around stations
Construction Impacts	Minor to moderate	Major

However, as described above, modern light rail evolved from streetcar service, and many modern light rail systems still retain many streetcar characteristics in some areas. For example, in Boston, Pittsburgh, and San Francisco, light rail operates in tunnels in downtown but in mixed-traffic in some outer areas.

LRT BENEFITS

LRT has become increasingly popular in the United States due to the benefits it provides:

- **Service Quality:** LRT is typically faster, more convenient, more comfortable, and more attractive than bus service.
- **Higher Ridership:** LRT can significantly increase ridership because it is more attractive. A recent American Public Transportation Association (APTA) study found that transit systems operating light rail services showed twice as much ridership growth in 2014 as transit systems offering no light rail service. The increase in ridership that results from LRT implementation was particularly evident in Minneapolis, where the opening of the METRO Green Line led to a 57% increase in annual ridership.[2]
- **Lower Per Capita Operating Costs:** Although it is more expensive to implement a light rail system than a Bus Rapid Transit (BRT) system, when ridership demand is high enough, the per capita operating costs are lower because each LRT vehicle can accommodate more passengers.
- **Development:** LRT has a demonstrated effect on generating transit-oriented retail and housing development. Portland's Westside LRT alignment was built with future development in mind. In 1994, there were approximately 1,500 acres of developable land near Westside stations. When Westside LRT opened in 1998, there had been more than $500 million in new development.[3]

CHALLENGES OF LRT

Light rail transit also has challenges:

- **Implementation Cost:** Because LRT requires a dedicated track and new infrastructure, developing a light rail system is much more expensive than increasing service in a typical bus network. Building a LRT system can cost upwards of $100 million per mile.
- **Required Density:** LRT only becomes a cost-effective option when ridership numbers are high. This is because the savings in per capita operating costs offset the initial financial cost of building the system. Most cities that have successfully implemented light rail have a density of at least 30 residents per acre or at least 15 jobs per acre. If the city does not have the density to support light rail, the light rail alignment must be very carefully designed to have stations in the densest areas of the city.

  Right-of-Way Availability: The development of LRT requires an exclusive right-of-way or exclusive light rail lanes on arterial streets, which often requires converting lanes from automobile to transit use. The availability of suitable right-of-way is often one of the major challenges in developing LRT.

LRT ELEMENTS

LRT offers high-quality service that provides some of the flexibility of bus systems with many of the attractive features of rail systems. The level of quality is dependent on physical elements including:

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[2] *Record 10.8 Billion Trips Taken On U.S. Public Transportation In 2014. (2015, March 9).* Retrieved August 10, 2015, from http://www.apta.com/mediacenter/pressreleases/2015/Pages/150309_Ridership.aspx

[3] "Light Rail and the American City: State-of-the-Practice for Transit-Oriented Development," G.B. Arrington in *Light Rail Transit and Transit-Oriented Development,* https://drcog.org/documents/LRT%20and%20TOD.pdf

- **Special Vehicles** that provide greater comfort, run on electricity (with overhead catenary wires and poles), have a greater carrying capacity, and can reach higher speeds (65 mph) than regular buses.
- **Exclusive Running Ways** that can be either dedicated right-of-way on existing roads or a grade-separated, off-street right-of-way. Depending on the topographic conditions of the corridor, a light rail system can be engineered to run through tunnels, above ground, and at street level to best optimize route performance.
- **Transit Signal Priority** for on-street light rail systems reduces the likelihood of automobile/LRT collisions and supports on-time performance by reducing average signal wait time.
- **LRT Stations** that provide similar features, amenities, and levels of passenger comfort as heavy rail stations.
- **Level Boarding** through the use of high-platform stations to reduce dwell times and facilitate boardings and alightings by people with disabilities.
- **Pre-Paid Fare Collection** via either pre-paid passes or the sale of tickets from ticket vending machines at stations and stops eliminates delays associated with on-board fare collection.
- **Real Time Passenger Information** to inform passengers when the light rail vehicle will actually arrive or depart from stations, which reduces much of the uncertainty that is associated with transit service.
- **Effective Connections** with other transit and surrounding areas.

These measures work together to make service fast and reliable, to make it convenient and comfortable, and to establish a strong customer demand for service.

LRT VEHICLES

LRT vehicles are electric vehicles that operate on metal rails that either were previously used as a railroad line or were installed specifically for the light rail. They are somewhat larger than streetcars (80 to 90 feet long, carrying 150 to 220 people per car), and are often coupled together to form trains that carry more passengers than a single car. Light rail vehicles can be faster over long distances than streetcar vehicles (with top speeds around 65 miles per hour, compared to about 45 miles per hour), although streetcars can accelerate more quickly. The greater speed and capacity of LRT vehicles make them an attractive choice for longer routes or regional intercity services.

GREEN LINE (MINNEAPOLIS, MN)

PHOENIX VALLEY METRO LIGHT RAIL (PHOENIX, AZ)

LIGHT RAIL RUNNING WAYS

LRT typically operates in exclusive rights-of-way, which include:

- **Grade Separated Rights-of-Way** in which LRT service operates in a completely exclusive right-of-way, often in a former rail right-of-way. Examples include the Central Link section of Link Light Rail in south Seattle and Tukwila, WA, which uses parts of an old rail line to travel quickly between cities, and the Green Line of the MAX Light Rail system in Portland, which uses grade separation to avoid a major freeway interchange. Many other light rail lines, such as Boston's Green Line, Pittsburgh's The T, and San Francisco's Muni Metro operate in tunnels in the urban core.

LINK LIGHT RAIL (SEATTLE, WA)

MBTA GREEN LINE (BOSTON, MA)

- **Exclusive Lanes on Arterial Streets,** which can be in either the center of streets or in curb lanes. Where exclusive light rail lanes are provided, center lanes are the most common approach. Exclusive lanes can be separated from general traffic by physical elements, such as curbs, or by striping. Physical separation helps to decrease the potential for light rail/automobile collisions.

CENTER LIGHT RAIL LANE (SACRAMENTO, CA)

CURB LIGHT RAIL LANE (PORTLAND, OR)

TRANSIT SIGNAL PRIORITY

Signal priority modifies normal traffic signal operation to facilitate the movement of transit vehicles by changing the signal to green early or by extending the green signal until the light rail passes through. This significantly reduces signal delays and can reduce travel times by 5% to more than 20%. Signal priority is typically implemented in conjunction with on-street light rail lanes.

LRT STATIONS

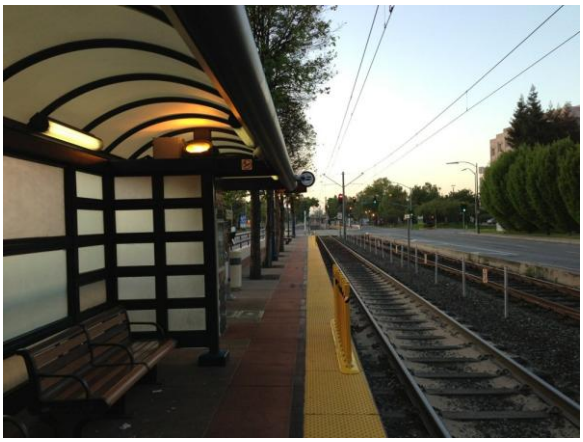
LRT systems usually have substantial stations. They typically have partial shelters, ticket-vending machines, schedule information, and platforms that are level with vehicle height to ensure accessibility.

LEVEL BOARDING

Most modern LRT systems are designed to support level boardings. This is typically accomplished by using high-platform stations. Level boarding allows passengers to board and alight faster, which greatly reduces dwell times. Level boarding also makes it much easier for people with disabilities to board and alight and eliminates the need to use lifts.

PHOENIX LIGHT RAIL STATION

SAN JOSE LIGHT RAIL STATION



LEVEL BOARDING (DALLAS AREA RAPID TRANSIT, DALLAS, TX)

LEVEL BOARDING (SAN FRANCISCO, CA)

FARE COLLECTION

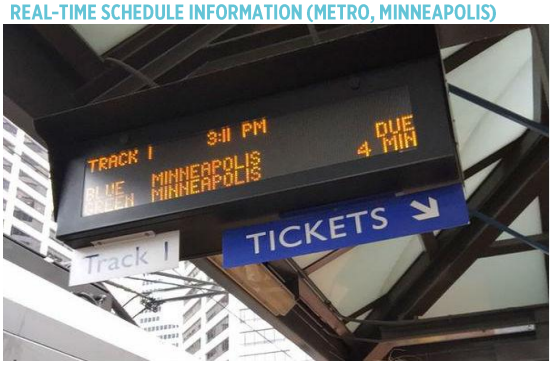
Off-board fare collection can significantly reduce dwell times at stations by eliminating the time involved for passengers to pay fares as they board vehicles. Ticket vending machines at stations allow passengers to purchase a ticket before boarding the light rail. Because a light rail train usually has multiple cars, this is an essential piece of the system because it removes the need to have fare collectors stationed in each car.

REAL-TIME PASSENGER INFORMATION

Real-time passenger information at stations lets riders know when the light rail will actually arrive or depart from stations, which reduces some of the uncertainty that is often associated with transit service.

TICKET VENDING MACHINES (METROLINK, LOS ANGELES)

REAL-TIME SCHEDULE INFORMATION (METRO, MINNEAPOLIS)



EFFECTIVE CONNECTIONS

Effective LRT services should be well connected to other transit services and the surrounding environment. Major LRT lines become a transit system's backbone with connections to other routes. In most cases, with the implementation of light rail, existing local bus routes are either discontinued or converted to feeder routes.

Like all transit services, most passengers access LRT lines by walking; therefore, effective pedestrian connections between LRT lines and the areas they serve are critical. It is important to provide signalized intersections near light rail stops to discourage jaywalking across arterials and light-rail tracks.

Bicycles can be an effective piece of a multimodal commute, and it is important that light rail vehicles accommodate bicycles. This is typically done by providing bike hooks for vertical bike storage in each light rail car. Light rail stations are also good locations for bike lockers and bike share programs.

BIKES ON LRT (SANTA CLARA VALLEY, CA)

BIKE SHARE AT LRT STATION (PHOENIX, AZ)

LRT IN THE UNITED STATES

The United States has more than 30 light rail systems, primarily in mid-sized to large cities. In the oldest systems, light rail is a carry-over from the first-generation streetcar systems of the 19th and early 20th centuries. A number of second-generation light rail systems opened in the 1980s (starting with San Diego in 1981), with several more in the 1990s, and many more since the early 2000s (see sidebar on page 2). According to the American Public Transportation Association, the light rail systems in six U.S. cities—Boston, Los Angeles, Philadelphia, Portland, San Diego, and San Francisco—carry more than 30 million passenger trips per year. Light rail has become increasingly popular in cities that are current or aspirational peers for Nashville and the Middle Tennessee region, and several of these are highlighted below.

SALT LAKE CITY, UT

Transit Express or TRAX, operated by the Utah Transit Authority (UTA), is the three-line light rail system that serves Salt Lake City and many of its suburbs. The full TRAX system serves 16,000 weekday boardings. TRAX operates between 5:30 AM and 11:30 PM Sunday through Thursday, with service extended until 1:00 AM on Friday and Saturday nights. TRAX operates seven days a week.

The Blue Line opened in 1999 and has been extended twice, in 2008 and 2013, to 19 miles and 24 stations. The Blue Line connects downtown Salt Lake City and Draper Town Center. The Green Line opened in 2001 and has also been extended twice, in 2003 and 2011, to 24 miles and 25 stations. The Green Line connects the University of Utah Medical Center with Daybreak (South Jordan). The Red Line opened in 2011 and was extended in 2013 to 15 miles and 18 stations. The Red Line connects Salt Lake City International Airport with West Valley City.

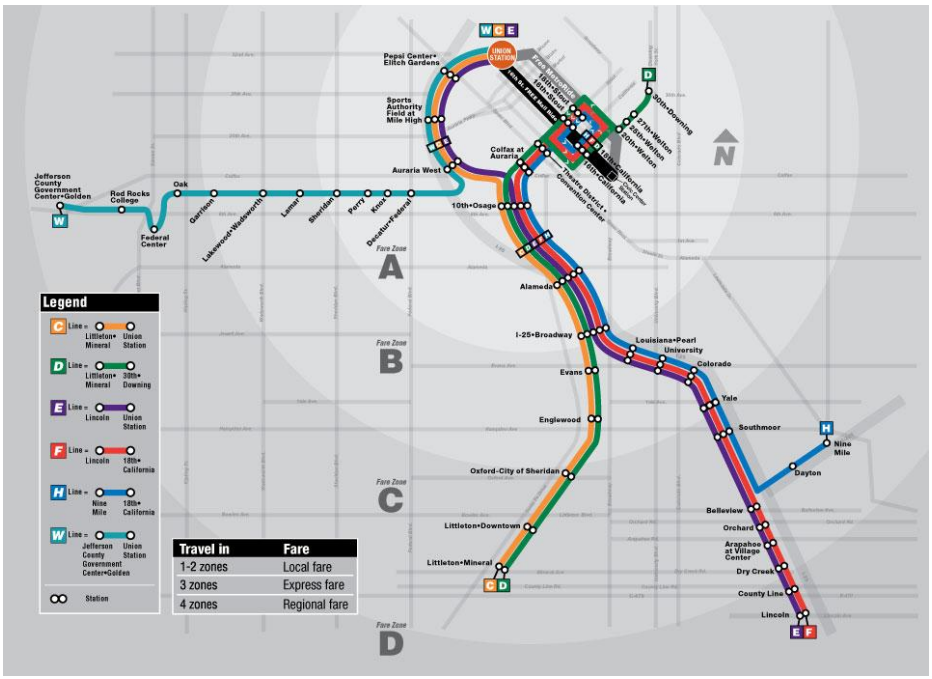
TRAX BLUE LINE

CENTER UTA STATION

DENVER, CO

The Regional Transportation District (RTD) operates six light rail lines with 46 stations and 47 miles of track. RTD's first light rail line, the D Line, opened in October 1994 and has been followed by the C, E, F, H, and W Lines. Daily ridership on the RTD light rail system is approximately 87,000 passengers per weekday.

RTD LIGHT RAIL SYSTEM



D LINE 20TH AND WELTON STATION

RTD LIGHT RAIL VEHICLE

Although the schedule varies by line, RTD light rail service generally begins at 4:00 AM and runs until 1:00 AM Monday through Thursday, until 2:00 AM on Friday and Saturday, and from 5:00 AM to 1:00 AM on Sunday.

In 2004, voters in eight counties approved a 0.4% sales tax increase for a multi-billion dollar public transportation expansion plan for commuter rail, light rail, and express bus services in the Denver area. Planned projects include southwest rail extensions of the C and D Lines and southeast extensions of the E and F Lines. The E and F Line extension is planned for completion in 2019 and, if successful, would use a $92 million Small Starts grant award from the FTA. The C and D Line extension has not yet secured funding.

CHARLOTTE, NC

Charlotte's LYNX is a 9.6-mile light rail system that serves 15 stations (seven of which include park-and-ride facilities). The line carries approximately 15,800 passengers per weekday. Service runs from 5:30 AM to 1:30 AM Monday through Saturday, and from 6:15 AM to midnight Sunday. Frequencies range from 10 to 20 minutes on weekdays and from 15 to 30 minutes on weekends.

CHARLOTTE LYNX LIGHT RAIL

Since its opening in 2007, Lynx has spurred over 8 million square feet in residential and commercial development, nearly 100,000 new jobs, and over $1 billion in private investment. While much of this development has been driven by the private sector, the City of Charlotte has also taken measures to ensure an effective mix of uses around stations and along the corridor. These include an Affordable Housing Trust Fund that provides public funding to private developers in exchange for affordable units through a competitive bid process; the city's 2020 Vision Plan that encourages high-density development along major transportation corridors; and the revision of zoning laws to align with transit investment and reduce the burden that developers face with time-intensive rezoning processes.

MINNEAPOLIS, MN

Metro Transit operates the Minneapolis/St. Paul area light rail system, which currently consists of two lines with more planned. The Blue Line is 12 miles long, with 19 stations extending from downtown Minneapolis to Target Field, Mall of America, and Minneapolis-St. Paul International Airport. The Blue Line opened in June 2004 and currently averages 28,000 weekday passengers. The Blue Line's total capital cost was $715 million, with $334 coming from federal sources.

The Green Line is an 11 mile long, 23 station line that connects downtown Minneapolis, University of Minnesota, and downtown St. Paul. With the opening of the Green Line in June 2014, rail now connects the Twin Cities for the first time since 1954. The Green Line carries over 35,000 passengers per weekday. The Green Line's total cost was $840 million, with $450 million coming from federal sources.

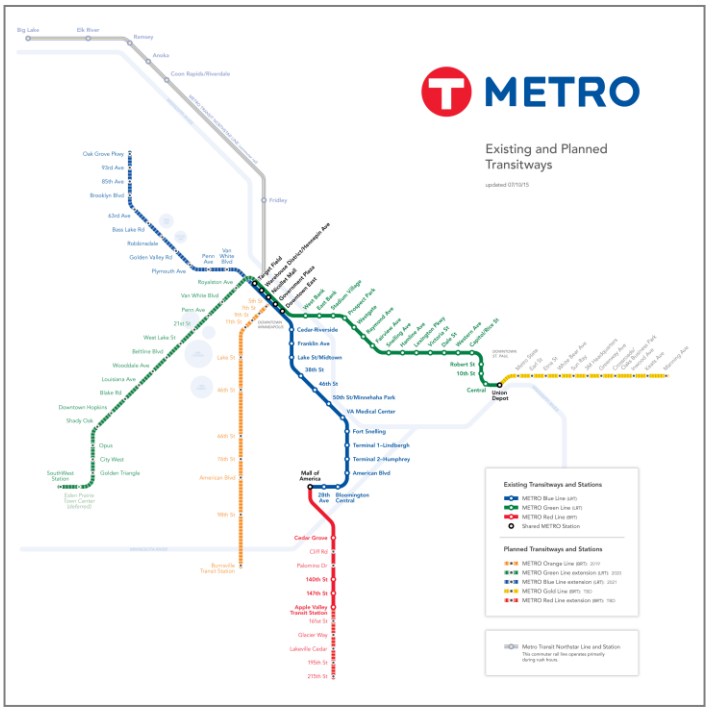
METRO BLUE LINE

METRO GREEN LINE NEAR UNIVERSITY OF MINNESOTA

Service on both lines begins daily at 4:00 AM and operates until 2:00 AM Sunday through Thursday, with service extending to 3:30 AM on Friday and Saturday nights. Fares for adults to ride the Metro light rail lines are $1.75 during off-peak times and $2.25 for peak times.

A planned expansion of the Green Line (formerly called the Central Corridor) is slated to be completed in 2020 and will run southwest from downtown Minneapolis to three large suburbs of the Twin Cities: St. Louis Park, Hopkins, and Eden Prairie. An extension of the Blue Line (formerly called the Hiawatha Line) is planned for completion in 2021, which will run northwest of downtown Minneapolis through Golden Valley, Robbinsdale, New Hope, Crystal, Brooklyn Park, and Osseo.

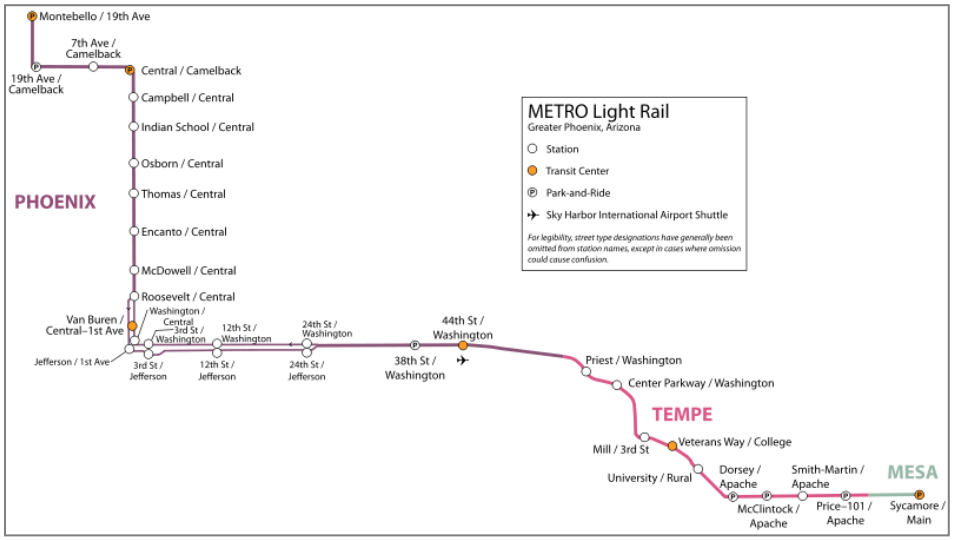
MINNEAPOLIS/ST. PAUL METRO LIGHT RAIL SYSTEM: CURRENT AND PLANNED



VALLEY METRO LIGHT RAIL (PHOENIX, AZ)

METRO is a 20-mile light rail line with 28 stations that is part of the Phoenix area's Valley Metro system. It serves Phoenix, Tempe, and Mesa and carries 44,000 passengers per weekday, making it the 13th busiest light rail system in the United States. Service starts at approximately 4:00 AM on weekdays and 4:30 AM on weekends. It ends at approximately 1:00 AM on Sundays through Thursdays and at nearly 4:00 AM on Fridays and Saturdays. Service frequencies range from 12 to 20 minutes on weekdays and 15 to 20 minutes on weekends.

METRO LIGHT RAIL SYSTEM



METRO operates a fleet of 50 light rail vehicles, each of which seats 66 people with total capacity of 200 people per car. The vehicles include bicycle racks and can accommodate up to four wheelchairs per car. They can operate at a maximum speed of 58 miles per hour.

METRO LIGHT RAIL OPERATES NEXT TO TRAFFIC

BOARDING VALLEY METRO LIGHT RAIL

Early on, population and employment densities and travel volumes in the Phoenix area indicated that there would be only limited areas with sufficient demand to support light rail. However, the line was cleverly routed in an L-shaped alignment through areas of denser development, leading to its immediate success. Businesses along the route have benefitted, especially in locations near the stations, and transit-oriented development investments in the three urban cores have exceeded $3 billion.

The first extension to the line is already underway and the additional 3.2 miles of light rail are expected to open in early 2016. Several more extensions are planned, both as part of Phase I and a future Phase II.

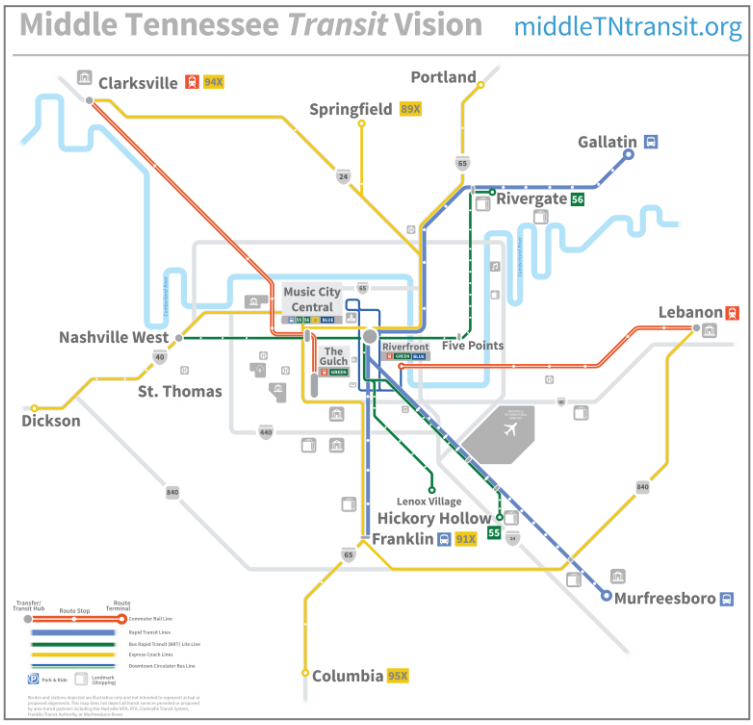
POTENTIAL MIDDLE TENNESSEE LRT SERVICES

The Nashville Area Metropolitan Planning Organization's (MPO) 2035 Regional Transportation Plan presents the northeast, southeast, and south corridors as regional rapid transit corridors that could be potential light rail corridors (shown in blue on the map below). These areas are the most densely populated and fastest growing within the region and have well-established patterns of cross-county travel.

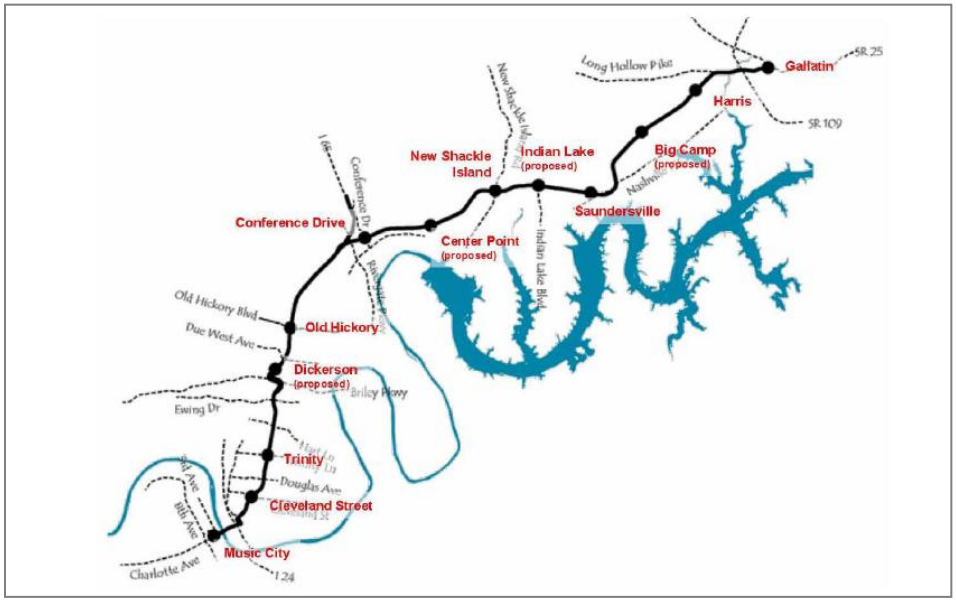
Each of these would be long light rail lines that would serve Middle Tennessee counties as well as trips within Davidson County. There would also be the potential for shorter lines within Davidson County, including along Gallatin, Nolensville, Charlotte, and Murfreesboro Pikes.

The 2011 Northeast Corridor Mobility Study, led by the Nashville Area MPO, identified light rail in a freeway alignment as the long-term locally preferred alternative for the 30-mile corridor between downtown Nashville and Gallatin. The intention was to initially implement BRT that could be subsequently upgraded to light rail. The inspiration for this vision was Denver RTD's T-Rex line, which operates in a freeway alignment similar to the potential configuration in the Northeast Corridor.

MIDDLE TENNESSEE TRANSIT VISION



NORTHEAST CORRIDOR MOBILITY PLAN'S LRT PROPOSED STATION AREAS



As MTA and RTA consider premium transit services such as light rail, implementation should be focused in corridors where significant changes are desired or planned. For example, the Gallatin corridor has a great deal of older, suburban development that may be ripe for redevelopment as Nashville and the Middle Tennessee region grow.

SUBURBAN DEVELOPMENT ALONG GALLATIN PIKE

Charlotte Pike includes a mix of old and new development, but has constraints in the right-of-way beyond Whitebridge Road. South of I-40, Nolensville Pike is generally wide, which could present opportunities for the dedicated right-of-way preferred for light rail lines. Additionally, with the expansion of the South of Broadway (SoBro) neighborhood, new mixed-use development is possible along this corridor.

There has also been discussion about the potential for a light rail line to Nashville International Airport, although a potential corridor has yet to be identified. Moving forward, Nashville MTA and RTA will need to engage with Metro Planning and the Nashville Area MPO to focus light rail planning efforts in areas identified for growth in NashvilleNext and other local and regional planning efforts.