

U.S. Bus Rapid Transit (BRT) System Profiles

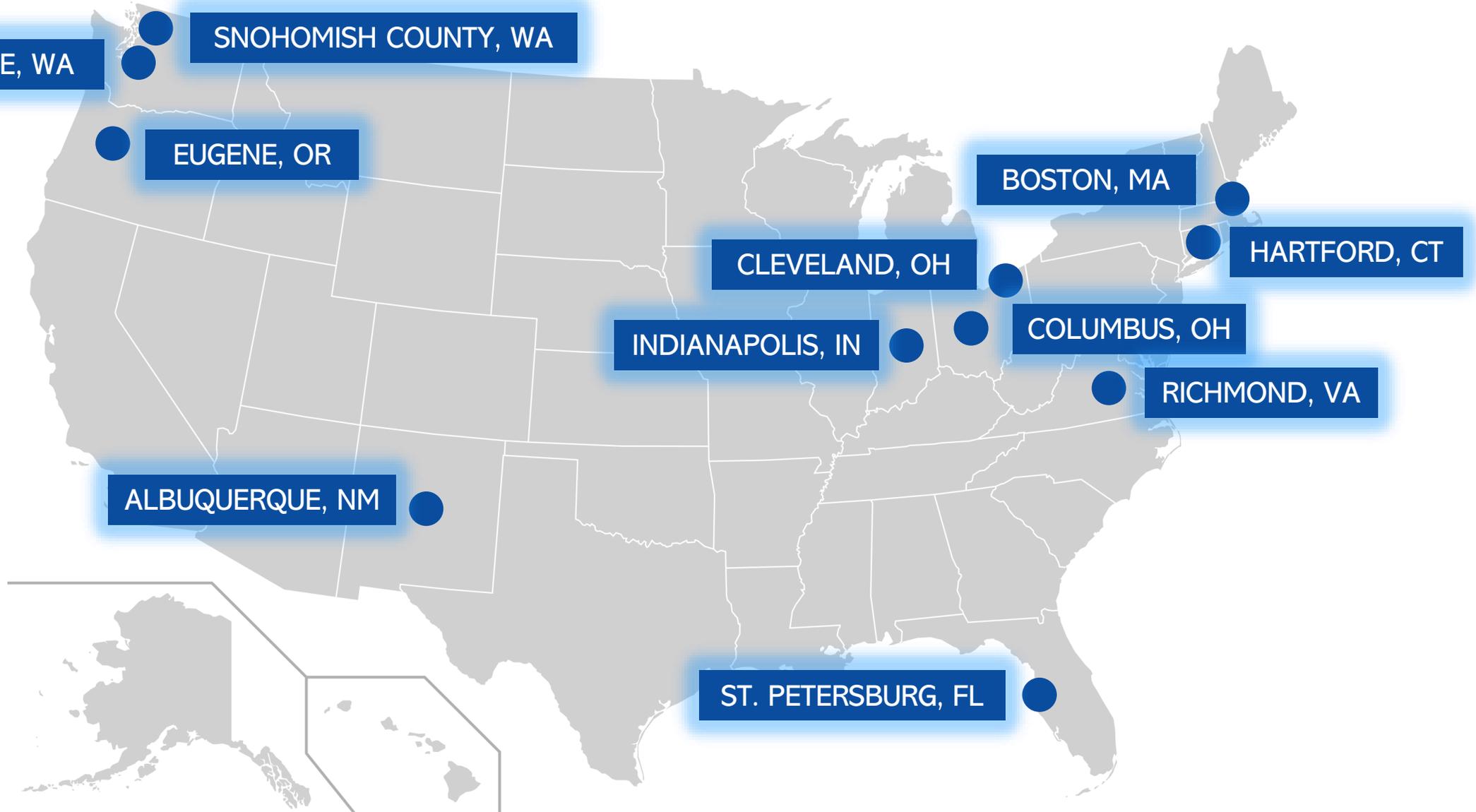


As Cincinnati and Hamilton County embark on the development of one of the major recommendations of Reinventing Metro - a network of Bus Rapid Transit (BRT) lines - it is important to look at the experience of other cities and transit agencies where BRT systems have been implemented.

Of the over 30 BRT systems in the U.S., 11 systems have been identified to provide best practices, relevant experience, and lessons learned. The 11 systems were selected based on their wide range of BRT features, service, and amenities, such as priority treatments for buses in traffic, frequency of service, station design, and passenger amenities. Costs and ridership are also identified for each.

Three tri-state cities are included in this group - Cleveland, Columbus, and Indianapolis - along with eight other BRT systems from across the U.S.

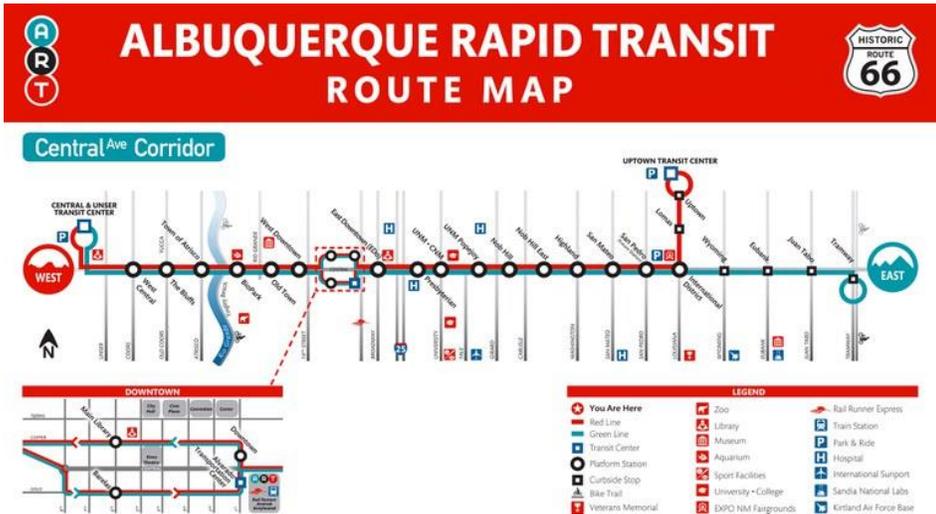




Opened:	2020
Length:	13 mi.
Stations:	28
Station spacing:	approx. 0.5 mi.
Capital cost:	\$134m
FTA share:	\$75m (Small Starts)
Other federal:	\$32m
Local:	\$27m
Operating:	\$1.6m/year (2020)
Peak buses:	15
Bus type:	60' articulated
Hours:	5:30 am – 10:00 pm
Wait time:	8 min
Ridership:	4,040/wkdy (2020)



The Central Avenue BRT in Albuquerque, branded Albuquerque Rapid Transit (ART), is the first BRT in New Mexico. It is operated by the City of Albuquerque's transit agency, ABQ Ride. ART runs in median transit lanes for about 3.5 miles west of downtown and 4.5 miles east of downtown, with a combination of dual lane (one-lane in each direction) operation with select areas of single, bi-directional lane operation (both directions served by a single lane with signal-controlled entry) through areas of restricted right of way.



Central Avenue, also known as historic Route 66, connects Downtown Albuquerque with key destinations to the east that include the University of New Mexico, ABQ Ride's intermodal transit hub, and moderately dense residential districts. To the west, the line serves expanding residential and commercial areas. ART consists of two lines (red and blue, as shown on the map, left) that merge into mixed traffic at Louisiana Boulevard and split, with the red line extending northward on Louisiana Boulevard for two miles, and the blue line continuing east on Central Avenue for another four miles. Limited improvements have been made in these mixed traffic sections beyond enhanced station areas.

To integrate the median bus lanes into the corridor, two strategies were implemented. In the first configuration, on-street parking was removed, and lanes were shifted outward to retain two general traffic lanes in each direction, matching the previously existing configuration. In the second configuration, one through lane each direction was removed and converted it to transit use while retaining on street parking for business fronting the corridor.

Except at signalized intersections, cross-streets were converted to right in/right out movements only. U-turns are accommodated at signalized intersection locations.

Pedestrian access was improved by replacing a considerable portion of the existing sidewalk to current standards and implementing landscape buffers, where feasible, to enhance pedestrian comfort.

The design theme of ART is based on the iconic signage found along historic Route 66. Downtown Albuquerque is located approximately mid-way along the line. It provides east-west service and a direct connection for a large part of the city to the University of New Mexico.



<https://www.norta.com/RTA/media/Capital-Projects-materials/BRT-Feasibility-Study/>



<https://www.dpsdesign.org/>



<https://nextcity.org/urbanist/news/albuquerque-bus-rapid-transit-line-opens>



<https://streets.mn/2021/05/26/>

Stations (center photos) were designed to be architecturally relevant to the Albuquerque area and provide for level boarding to the transit vehicle, off-board fare collection, and real time passenger information signage. Protection from the sun was a high design priority.

Fixed route local service was retained on the corridor, supplementing the BRT service with frequent local stops.

ART was the first BRT system in the U.S. to earn Institute for Transportation and Development Policy's (ITDP) Gold rating. ART's initial use of battery electric buses was highly problematic as the manufacturer was unable to meet specifications. ABQ Ride replaced the buses with "clean diesel" models for the time being.

Accidents (below right) were also an issue during the first months of operations. Some motorists entered the bus-only lanes illegally or turned against red lights with an oncoming bus to the left. Safety upgrades include additional red pavement markings and no left turn signs.

ART uses a variety of bus-only lane treatments (upper and lower left) including dual lanes and single, bi-directional lanes. Station design visibility for safety and protection from the sun. These were among the factors, along with service frequency and passenger amenities, that led ITDP to award ART the Gold rating.



<https://www.koat.com/article//30124642/>

Opened: 2004
Length: 2.3 mi.
Washington Street segment only
Stations: 20
Station spacing: 0.3 mi. – 0.5 mi.
Capital cost: \$625m (2007, entire
Silver Line system, including 2 tunnel segments
FTA share: \$331.7 (New Starts)
Other federal: \$150m
Local: \$144m
Operating cost: approx. \$5.8m/year
(2017, entire system)
Peak buses: 32 (entire system)
Bus type: 60' articulated
Hours: 24/7
Wait time: 5 min. peak
Ridership: 39,000/wkdy (2019,
entire Silver Line system)





<https://twitter.com/mbta/status/1167542571918344192>



<https://nelsonnygaard.com/projects/boston-washington-street-silver-line-brt/s>

The Silver Line is a network of BRT lines in Boston and Chelsea, Massachusetts, operated by Massachusetts Bay Transportation Authority (MBTA). The portion of the Silver Line along Washington Street was designed, in part, to provide high capacity, rapid transit service which was lost in the 1970s, when the elevated Orange Line (rail) was removed and relocated. The Silver Line is operated as part of the MBTA bus system but branded as BRT as part of the MBTA “T” rapid transit system, which is primarily rail. Six routes are operated as part of two non-connecting corridors. Silver Line service began operating as Routes SL2 and SL3 in 2004; full SL1 service began in 2005.

Two routes operate on Washington Street between Nubian station (at Nubian Square, formerly Dudley Square, in the Roxbury neighborhood) and Downtown Boston. Bus- and bike-only red lanes are used along most of Washington Street. They are either curbside, in both directions, or in the second lane from the curb to allow for on-street, curbside parking. Articulated diesel hybrid buses are operated on Washington Street. Articulated, or “bendy,” buses are 60 feet long with an accordion-like hinges between two sections, enabling turns.

The four Silver Line Waterfront routes operate out of an underground terminal at South Station and run through the South Boston Piers Transitway – a dedicated bus tunnel through the Seaport District with stations at Courthouse and World Trade Center. The Waterfront routes use articulated dual-mode buses that operate as electric trolleybuses in the Transitway and conventional diesel buses on the surface. The original fleet consisted of 32 60-foot articulated dual-mode electric-diesel buses with three doors. The fleet was overhauled in 2014-2018. MBTA is now transitioning to zero emission buses and has placed five battery electric buses (BEBs) into service in 2019 with additional BEBs starting in 2022.



<https://creativecommons.org/licenses/by-sa/3.0>



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<https://commons.wikimedia.org/w/index.php?curid=83073361>



© 2005 David Sailors



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<https://commons.wikimedia.org/w/index.php?curid=51682014>

A planned connecting tunnel (Phase III) was cancelled in 2010 due to rising costs; a surface route (SL4) was introduced the previous year. Much of the system lacks various standard BRT features such as dedicated lane enforcement, off-vehicle fare collection, and transit signal priority. As a result, the Washington Street segment of the Silver Line has been criticized for not being “true” BRT. It has some elements of BRT, however, such as frequent service, enhanced station treatments, and off board fare collection at stations, but not at all stops.

The Silver Line’s red lanes concept has been generally well-received and is being expanded to other non-BRT transit corridors in the Boston region. Recent efforts include the Rapid Response Bus Lanes Program which includes the implementation of up to 14 miles of bus lanes throughout Boston and adjacent suburbs of Chelsea, Somerville, and Everett.

The portion of the Silver Line that operates underground and serves the Seaport district is served by a mix of electric trolleybuses (upper left) and compressed natural gas (CNG)-powered buses (lower left). Sidewalk stations include a canopies that provide a level of weather protection while featuring an open design (upper right). Bus-only red lanes on Washington Street allow for on-street parking (lower right).

Opened:	2008
Length:	9.4 mi.
	7.1 median lanes
	2.3 curbside lanes
Stations:	36
Station spacing:	approx. 0.3 mi.
Capital cost:	\$200m (2008)
FTA share:	\$82.2m (New Starts)
Other federal:	\$0.6m
State:	\$75m
Local & MPO:	\$21.8m
Cleveland Clinic:	\$2.9m
Operating cost:	\$6.3m/year (2019)
Peak buses:	24
Bus type:	63' articulated CNG
Hours:	24/7
Wait time:	15 min. peak
Ridership:	13,200/wkdy (2018)



<https://transitcenter.org/transit-moneyball-targeted-fare-policies-can-build-ridership/>

The Health Line (originally called the Euclid Corridor Transportation Project) is operated by the Greater Cleveland Regional Transit Authority (GCRTA). The line runs along Euclid Avenue from Public Square in downtown Cleveland to the Louis Stokes Station in East Cleveland. It opened in October 2008. The "Health Line" brand name was the result of a long-term naming rights deal with the Cleveland Clinic and University Hospitals.



<https://www.sasaki.com/projects/euclid-avenue-healthline-bus-rapid-transit/>

The street network between Downtown and University Circle includes parallel arterial streets that handle traffic diverted from Euclid Avenue, which was narrowed to one traffic lane in each direction for most of its length.

Economic development is the Health Line's biggest success story. Just five years from its opening year, it was estimated that the Health Line helped stimulate \$9.5 billion in new investment, as shown left. After ten years of operation, its impact nearly doubled, with the Health Line helping to deliver over \$9.5 billion in economic development along the Euclid corridor - which equals \$190 gained for every dollar spent on creating and launching the new service. Significant segments of Euclid Avenue had sharply declined since the 1950s, resulting in numerous vacant and abandoned properties. Redevelopment, however, has resulted in minimal displacement. New development around Cleveland State University, as one example, has transformed both its campus and surrounding area. (below right).



<https://neo-trans.blogspot.com/2017/08/transit-station-area-development.html>

Opened:	2018
Length:	15.6 mi. 3.2 mi. exclusive
Stations:	30
Station spacing:	approx. 0.5 mi.
Capital cost:	\$48.6m (2018)
FTA share:	\$38.1m (Small Starts)
Local/State:	\$10.5m
Operating cost:	n/a (COTA does not report CMAX operating costs separately from the rest of the system)
Peak buses:	15
Bus type:	40' CNG
Hours:	4:30 am- 10:00 pm
Wait time:	10 min. peak 15 min. off-peak
Ridership:	approx. 4,300/ wkdy (2019)



<https://thenewamericansmag.com/2018/01/02/cmax-bus-rapid-transit-launches-with-free-fares-jan-1-7>

CMAX, the first BRT line in Columbus, is operated by the Central Ohio Transit Authority (COTA). It begins in the southern part of Downtown Columbus, traveling north and northeast to the southern edge of the suburb of Westerville. CMAX opened in 2018.

The CMAX line runs primarily along High Street (in downtown) and Cleveland Avenue. End-to-end travel time is about 56 minutes depending on the time of day.



CMAX
FREQUENT

TAKING you THERE
SERVING LOCAL DESTINATIONS

- Downtown
- Ohio Statehouse
- Columbus State Community College
- Linden Transit Center
- Northern Lights Park & Ride
- Northland Transit Center
- Mount Carmel St. Ann's
- Ohio Health Westerville

EFFECTIVE AS OF JANUARY 3, 2022

APTA #1 AWARD WINNER 2018 | 2020
COTA

GBAC STAR FACILITY 2021
LOCAL PUBLIC ADVISORY COUNCIL

In downtown Columbus, CMAX stops at two major transit centers, providing connections to many other COTA routes. CMAX buses are branded specifically for the service and were among the first in the COTA system to feature USB charging ports and onboard Wi-Fi. The fleet is powered by Compressed Natural Gas (CNG). COTA has a CNG fueling facility at its main garage, which also services other buses in its fleet.

Prior to implementation of CMAX, the local route serving Cleveland Avenue was COTA's second busiest. With dedicated bus lanes on its High Street segment during rush hours, transit signal priority at key intersections, and half-mile-spaced stations, CMAX service is about 20% faster than conventional local service. COTA opted to retain an all-stops local service, Route 6, on Cleveland Avenue, which runs every 30 minutes. The peak period bus only lanes on High Street are also used by other COTA routes.

Frequent service extends as far north as the Northland Transit Center. North of this point, every other bus continues north to Westerville with a 30-minute frequency.

CMAX uses 40-ft. CNG-powered buses (right) that are sized to carry riders during peak hours.





<https://itsenclosures.com/case-studies/central-ohio-transit-authority-cota-2/>



COTA



<https://www.ohm-advisors.com/projects/cota-cmax-bus-rapid-transit>

Most stations employ a consistent and distinctive design. They include covered shelters and prominent information displays showing real-time bus arrival times. Some stations feature local art. Along High Street, CMAX took advantage of shelters that had been installed a few years previously as part of a revamp of downtown's major north-south thoroughfare.

CMAX was intended, in part, to help reduce traffic congestion on Cleveland Avenue, stimulate economic activity, and increase job and health care access to low-income and minority neighborhoods on Cleveland Avenue. In the 1990s, COTA worked with the City of Columbus and neighborhood development entities to construct the Linden Transit Center, which includes medical offices and a daycare center. The transit center helped catalyze new public and private sector development in an economically distressed part of town. CMAX stations serve the transit center, where transfer connections can be made to crosstown routes.

COTA and the City of Columbus are now developing two additional BRT lines. Unlike Cleveland Avenue CMAX, the new lines will feature bus only lanes to improve speed and convenience.

CMAX stations (above) feature large, glass-enclosed shelters and prominent pylons that promote the CMAX brand and identity. The pylons also include next bus arrival displays. At the Northland Transit Center Station (left), riders can transfer to several other COTA bus routes.

Opened: 2007-2017
1st segment: 2007
2nd segment: 2010
3rd segment: 2017

Length: 19.0 mi.
45% exclusive bus-only lanes

Stations: 44

Station spacing: approx. 0.3 mi.

Capital cost: \$1.6m (2007-2017)
FTA share (3rd segment): \$75m (Small Starts)
Other federal (3rd segment): \$2m
Local (3rd segment): \$21m

Operating cost: \$3.0m/year (2017)

Peak buses: 8

Bus type: 60' articulated

Hours: 5:30 am - 11:30 pm

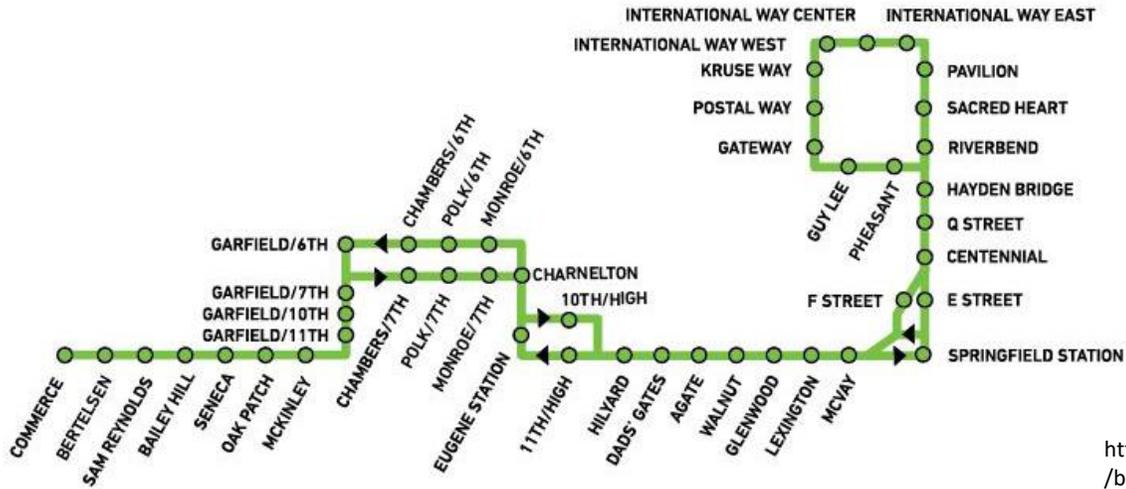
Wait time: 10 min. peak

Ridership: 13,000/wkdy (2018)



<https://www.eugencascadescoast.org/listing/lane-transit-district-%28ltd%29/550/>

Eugene, Oregon's Emerald Express (EmX, pronounced "EM-ex") BRT system consists of three separate project corridors combined to create a single BRT line over roughly 15 years from initial start of design in 2002 to completion of construction of the West Eugene Extension in 2017. EmX connects the adjacent cities of Eugene and Springfield and provide coverage within each city. Major employment and activity centers served in the University of Oregon and Sacred Heart Medical Center.



http://washtenawtod.blogspot.com/2013/12/bus-rapid-transit-through-light-rail_14.html



<https://pivotarchitecture.com/projects/emx/>

The route follows several one-way street pairs, primarily in the downtowns of the cities of Eugene and Springfield. Stations feature custom shelters, ticket vending machines, next bus real-time signage, and level boarding (using a “bridgeplate” to cover the narrow gap between bus and platform). The project also introduced low friction plastic “rub rails” (above, center photo) to the transit industry now used on many BRT projects implemented since. The rub rails enable buses to “precision dock” at stations, resulting in only a very narrow gap between bus floor and platform.

EmX replaced existing fixed route service, if it existed, on the route with stations spaced at approximately 1/3 mile. Portions of the EmX project required widening of street rights-of-way. Where this occurred, extensive pedestrian improvements were made, often exceeding minimum standards, to incorporate buffers from traffic, innovative approaches to integrating sustainable tree wells, and universal accessibility.

EmX was awarded a Bronze rating for BRT by the Institute for Transportation Development and Policy (ITDP) based on its level of bus priority, frequent service, stations, and passenger amenities.



https://t4america.org/2016/01/06/buses-mean-business/emx_ltd_charlie/



https://t4america.org/2016/01/06/buses-mean-business/emx_ltd_charlie/



<https://www.flickr.com/photos/8594149@N06/1152802867>



<https://pivotarchitecture.com/projects/emx/>

EmX operates along a combination of lane configurations that include:

- Two-way median transit lanes (upper left)
- Bi-directional median transit lanes (lower left and right)
- Curbside BAT lanes on both the left and right side of the roadway
- Median BAT lanes
- Mixed traffic

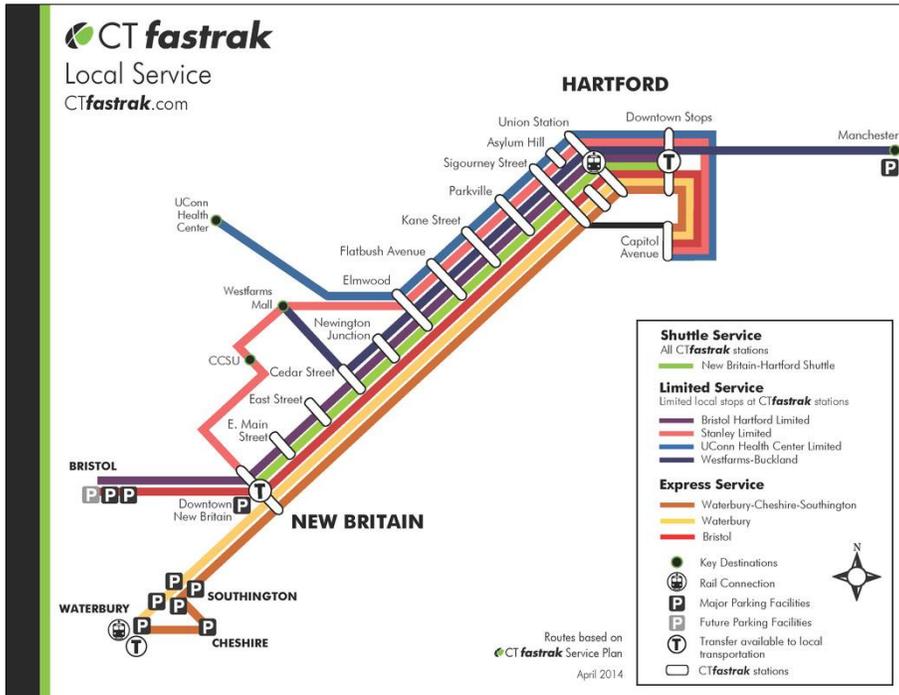
BAT lanes are “Business Access Transit” lanes, also called “Bus and Turn” lanes, that provide priority for bus operations. They are designed to discourage through traffic while allowing motorists to turn right into and out of residences, business, and other destinations.

Outside of the downtowns, the EmX route typically has followed major arterials and larger state highway routes that were originally as five lanes wide or more. In constrained areas, to minimize property or environmental impacts, bi-directional lanes have been implemented which at the time were the first of their kind for BRT in the U.S.

Opened:	2015
Length:	10.7 mi.
Stations:	10
Station spacing:	2 mi.
Capital cost:	\$567m (2015)
FTA share:	\$340.4 (CIG and other)
Other federal:	\$114.2m (CMAQ)
Local:	\$112.4m
Operating cost:	\$9.0m/year (2019)
Peak buses:	12
Bus type:	60' articulated
Hours:	5:30 am-10:00 pm
Wait time:	8-14 min. (service recently reduced due to driver shortage)
Ridership:	8,600/wkdy (2022)



<https://americatransportationawards.org/2016/06/01/connecticut-department-of-transportation-ctfastrak/#jp-carousel-2879>



CTfastrak is Connecticut's first BRT system. Several BRT route iterations and commuter express routes utilize a bus-only roadway (busway) for all or a portion of the trip. The busway connects the cities of Hartford and New Britain. It is located along a former rail line that was previously purchased by the State of Connecticut; freight service had been discontinued prior to that. CTfastrak routes are integrated with the statewide Connecticut Transit (CTtransit) bus and rail system.

CTfastrak works like a rail line with its own right of way, separated from all other traffic. There are a few at-grade intersections. The basic BRT service pattern operates between downtown Hartford and downtown New Britain, stopping at all intermediate stations on a frequent schedule. It is more flexible than rail, as the buses can exit at various points or at the end of the line and continue directly to other destinations away from the line. The busway consists of two lanes, one in each direction, with shoulders and bus pullouts at its eight stations to enable drop-offs and pickups, while also allowing through buses, such as express, to pass without being delayed.

In downtown Hartford, buses exit the busway and operate as a loop on downtown streets. BRT runs in mixed traffic in this area with no signal priority. Standard bus stops are used instead of the large station structures found along the busway. In the New Britain, the busway ends at a major new transit center; the BRT line does not loop through the downtown as it does in Hartford.

CTfastrak provides direct service to and from several suburban and outlying communities with routes that take advantage of the busway. It provides a one-seat, no-transfer ride to many major regional employment, shopping and health care destinations.

The system map (upper left) illustrates the multiple service patterns along the busway, which includes all-stops service between Hartford and New Britain as well as express service between the two downtown. Passing lanes (lower left) allow express buses to pass all-stops BRT buses.



https://commons.wikimedia.org/wiki/File:CTtransit_route_101_bus_at_Cedar_Street_CTfastrak_station,_December_2015.JPG



© 2005 David Sailors

Project construction began in 2012; CTfastrak opened for service in March 2015. CTtransit has pursued a transit-oriented development (TOD) program conducting with a market assessment of each station area. The agency worked with host neighborhoods and municipalities to analyze land use plans and potential for zoning changes and application of development incentives. The first results are starting to emerge with selective renovation of existing structures and new construction at stations west of downtown Hartford, including downtown New Britain (below right). Based on its range of priority treatments, and service, CTfastrak achieved a Silver rating for BRT by the Institute for Transportation Development and Policy (ITDP).



Google Earth Streetview

CTfastrak stations along the busway (above) share a common design featuring a curved roof, polished wood ceiling and seating, ticket vending machines, and real time arrival displays. Platforms are raised to the same height as the floor of the bus to allow for barrier-free level boarding. Conditions are less optimal in Downtown Hartford (left), where standard sidewalk bus stops are used.



<https://www.high-profile.com/columbus-commons-phase-1-completed/>

Opened: 2018
 Length: 13.0 mi.
 60% bus lanes. exclusive
 Stations: 27
 Station spacing: 0.3 mi. – 0.5 mi.
 Capital cost: \$96m (2018)
 FTA share: \$75m (Small Starts)
 Other federal: \$2m
 Local: \$19m
 Operating cost: \$8m/year (2019)
 Peak buses: 10
 Bus type: 60' articulated
 Hours: 5:00 am – 1:00 am
 Wait time: 15 min.
 Ridership: 4,000/wkdy (2020)



https://en.wikipedia.org/wiki/Red_Line_%28IndyGo%29

The IndyGO Red Line BRT is the first BRT in Indianapolis. It connects Downtown Indianapolis with the popular Broad Ripple area to the north and the University of Indianapolis campus to the south. The corridor includes 7.7 miles of dedicated bus lanes, traffic signal priority (TSP) at intersections, and stations with weather protection, level boarding platforms, real-time bus arrival information, and off board fare payment vending machines.



<https://www.shrewsusa.com/projects/indygo-red-line/>



<https://www.insideindianabusiness.com/articles/indygo-to-implement-red-line-improvements>

The Red Line provides fast and reliable service in a key north-south corridor serving a large portion of the city. An estimated 150,000 jobs and 50,000 residents are within one quarter mile of the line. The corridor includes the densest area of the city and serves four major universities, several hospitals, government agency offices, community services and the Julia M. Carson Transit Center in Downtown providing transfer opportunities to several connecting bus routes. The service improved bus service speed and schedule reliability through the urban core via dedicated BRT lanes and TSP.

One of the first all-electric battery BRTs in the country. Red Line has a total of 13 60-foot, articulated, fully electric buses with doors opening on either side of the bus operate in the corridor. The electric buses help IndyGO achieve its goal of running BRT with a zero-emission fleet. Issues with the bus manufacturer have led to a number of significant issues that InfyGo has been working to overcome. The original fleet were not meeting charging expectations - 275 miles vs 120-130 miles per charge during extreme weather, primarily hot and cold temperatures. The manufacturer has been paying for in-line charging facilities

Instead of front-of-bus bike racks, Red Line buses have on-board bicycle storage. New platform-level boarding allows riders to roll bicycles on and off with ease.

Infrastructure improvements associated with the Red Line included 208 upgraded traffic signals, 30,000 linear feet of sidewalks replacement, new crosswalks, 596 ADA curb ramps, 34 transit platforms, and landscaping, bike racks and bike lanes.

As shown left, Red Line stations employ a consistent design from end to end, using steel and wood, along with an open look, to create a welcoming environment. Wind screens, drip-proof overhangs, lighting, security cameras, and blue light emergency call boxes enhance comfort and safety.



<https://www.wrtv.com/news/local-news/indianapolis/indygos-red-line-is-about-to-go-live-heres-how-to-use-it>



<https://www.indystar.com/story/news/local/transportation/2019/08/29/red-line-indygo-how-use-bus-rapid-transit-indianapolis/2060619001/>



IndyGo



IndyGo

Red Line buses operate in three different types of bus-only lanes:

- Bus only lanes, painted a solid red where general traffic is not allowed at any time (upper left and middle).
- Combination lanes with red horizontal stripes where motorists can make left turns or U-turns at specific points (upper left)
- Single lane, bi-directional lanes, delineated with a red stripe and a mountable, center median (upper right). These lanes are used along College Avenue, which is narrower than most other Red Line streets. At stations, the single wide widens to two.

IndyGo experienced some opposition to bus-only lanes during the design process. Issues were resolved through extensive community dialogue and design modifications.

Opened:	2018
Length:	7.6 mi. 3.2 mi. exclusive
Stations:	14
Station spacing:	approx. 0.5 mi.
Capital cost:	\$65m (2018)
Federal:	\$25m (TIGER)
State:	\$32m
City/County:	\$8m
O&M cost:	\$4.9m/year (2019)
Peak buses:	8
Bus type:	40'
Hours:	5:30 am- 1:30 pm
Wait time:	10 min. peak 15 min. off-peak
Ridership:	4,600/wkdy (2021)



<https://plancharlotte.org/story/charlotte-transit-atlas-transportation>



Pulse BRT service was launched on June 24, 2018. It is described by the Greater Richmond Transit Company (GRTC), Richmond’s transit agency, as a modern, high quality, high-capacity rapid transit system that serves a 7.6-mile route along Broad Street and Main Street, from the developing Rocketts Landing neighborhood in the City of Richmond to Willow Lawn in Henrico County. Pulse is jointly sponsored by Bon Secours Richmond Health System and VCU Health System. Pulse links several destinations including Downtown Richmond, Virginia Commonwealth University, Union University, suburban shopping areas, businesses, major medical centers, services, and restaurants.

A 3.6-mile section of the line converted existing right of way from three general purpose lanes in each direction to two, creating center-running BRT bus only lanes. The project also reduced general purpose lanes from 10.5–11-ft. lanes to 9.5–10-ft. lanes for autos and wider lanes for buses in the lanes in which they operate.

Pulse travels through a variety of land uses, including suburban, retail/office, university and museum, dense downtown retail, government, and recreational. This variety of land use presented a wide range of needs for the project corridor’s design. The design of the project changes along the corridor based on different needs and available options (buses operating in mixed traffic, center-running and curb-running in various segments of the route) and reflects that there is no single or best solution for integrating a BRT system into an existing right of way, particularly within dense corridors.



<https://richmondbizsense.com/2018/08/27/pulse-line-business-assistance-funds-divvied-among-neighborhood-groups/>



<https://ggwash.org/view/69056/xx-photos-of-richmonds-new-brt>



<https://ggwash.org/view/69056/xx-photos-of-richmonds-new-brt>



<https://www.nbc12.com/2022/06/21/richmond-dept-public-works-start-painting-red-pulse-bus-lanes>

Project partners included the U.S. Department of Transportation, the Commonwealth of Virginia (Virginia Department of Rail and Public Transportation - DRPT - and Virginia Department of Transportation - VDOT), the City of Richmond, Henrico County, and GRTC. The Commonwealth of Virginia made this project a high priority, providing significant funding, early leadership, and technical support. While the Pulse BRT project benefitted from strong state leadership, the City of Richmond was also heavily engaged and committed to the project.

Pulse increase bus speeds in the corridor by approximately 65%, compared with the previous local service, and reduced travel time for riders by about 33%

Pulse recently achieved a Bronze rating for BRT by the Institute for Transportation Development and Policy (ITDP) based on the extent of its exclusive bus lanes, service frequency, stations, and passenger amenities.

GRTC used a variety of pavement markings and signage to clearly identify the bus-only lanes along the Pulse route. Concrete bus pads are used at stations while white and yellow lines separate the bus lanes from general traffic lanes. Red lane color has also been added.

Opening:	October 2022
Length:	10.3 mi.
	70% Bus and Turn (BAT) lanes
Stations:	16
Station spacing:	approx. 0.75 mi.
Capital cost:	\$44m (2022)
FTA share:	\$22m (Small Starts)
State:	\$11m
Local:	\$21m
Operating cost:	\$3.8m/year (estimated)
Peak buses:	7
Bus type:	40' hybrid
Hours:	6:00 am–12:30 am
Wait time:	15 min.
Ridership:	5,550/weekday (projected; 2,800 currently on current local service)



<https://stpetecatalyst.com/pinellas-transit-authority-completes-first-sunrunner-station/>



The newest BRT system in the U.S., SunRunner, is scheduled to open in October 2022 in St. Petersburg. The Pinellas Suncoast Transit Authority (PSTA) is developing its first BRT line, connecting downtown St Petersburg westward to the resort community of St Pete Beach on the Gulf of Mexico. Planning for the line began in 2009. In addition to this recreational destination, SunRunner route will connect the Tampa Bay Rays stadium, regional hospitals, and the Central Avenue commercial district.

Along over approximately 70% of the corridor, dedicated BAT lanes are being installed to support BRT speed and reliability. BAT lanes, called “Business Access Transit” or “Bus and Turn” lanes, provide a measure for transit priority while allowing motorists to access and exit destinations on the curb side of the street. End-to-end travel time will be 35 minutes- about 30% faster than current local service. Bus only lanes are being marked red. On Pasadena Avenue, the lanes were created by converting the right curbside lanes to BAT lanes. On 1st Avenue South and North, along a pair of streets bordering Central Avenue one block south and north respectively, the BAT lanes are for the most part along the left curb. Space for the lane was created by removing on-street parking.

PSTA elected not to purchase buses with left side doors and, even if they had, such vehicles are not currently available in a 40-ft length. As a result, stations on the 1st Avenue North and South were designed as “island” stations that can accommodate right-side boarding. With transit lanes on the left side, pedestrians heading to the Central Avenue business district do not have to cross the street while buses avoid conflicts with bicycles lanes.

Vehicles for the service are 40-foot diesel electric hybrids offering bicycle racks onboard and Wi-Fi internet access. SunRunner’s branding features a “Mr. Sun,” an icon (shown left) developed by a local artist.





**BUS-AND-TURN
LANE ENFORCEMENT
BEGINNING SOON!**



**DO NOT RISK
A FINE**



As red pavement appears, don't drive, park, load or unload vehicles in the lane.



Vehicles are only allowed in lanes to make a turn.



Only PSTA buses and emergency vehicles are allowed to drive in the red lanes.

Stations (right) are relatively simple with shelters geared towards providing shade from the Florida sun. Platforms are designed for level boarding. Fares can only be paid through cashless fare media. Prominent pylons identify station names and display real-time bus arrival information signage. Some stations will feature artwork, created by a local artist, integrated into the design of the shelters.

PSTA has begun an extensive public information campaign to alert motorists about the new SunRunner BRT BAT lanes, some of which can be used by cyclists.

RIGHT LANE BICYCLE BUSES ONLY	RIGHT LANE BUSES ONLY	LEFT LANE BUSES ONLY
RIGHT TURNS ALLOWED	RIGHT TURNS ALLOWED	LEFT TURNS ALLOWED



<https://www.tampabay.com/news/transportation/2022/07/13/sunrunner-first-bus-rapid-transit-line-in-tampa-bay-is-opening-in-october/>



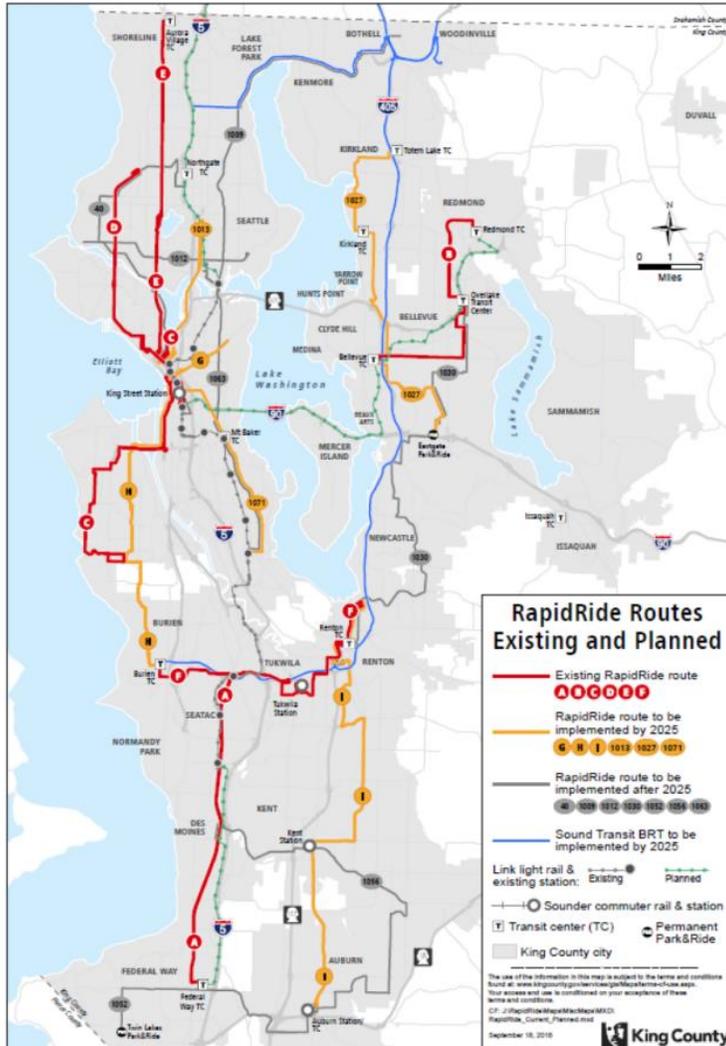
<https://www.masstransitmag.com/technology/facilities/shelters-stations-fixtures-parking-lighting/press-release/21249104/pinellas-suncoast-transit-authority-psta-psta-unveils-first-completed-sunrunner-station>

Opened:	2014
Length:	12.5 mi. 50% peak hour exclusive lanes
Stations:	14
Station spacing:	approx. 0.4 mi.
Capital cost:	\$48m (2014)
FTA share:	\$22m (Small Starts)
Other federal:	\$1m
Local/State:	\$25m
Operating cost:	\$4.9m/year (2019)
Peak buses:	12
Bus type:	60' articulated
Hours:	24/7
Wait time:	7 min. weekday 10 min. weekend
Ridership:	15,800/wkdy (2021)



<https://www.seattletimes.com/seattle-news/transportation/metro-cant-add-all-the-bus-service-seattle-wants-to-buy-to-improve-service>

The RapidRide E Line connects Downtown Seattle with neighborhoods to the north. At its northern terminus, the E Line connects to the neighboring Swift Blue Line, which serves suburban Snohomish County.



King County (Seattle) currently operates six RapidRide BRT lines with another six in various stages of development. Most of the corridors involved limited use of exclusive, bus only lanes; they instead operate mainly in mixed traffic with spot improvements (such as “queue jumps” that allow buses to pass through major intersections before other traffic) and implementation of transit signal priority to improve speed and reliability. The forthcoming G and H Lines, both currently in construction, will make more extensive use of dedicated transit lane infrastructure.

The RapidRide E Line, therefore, stands out from those lines in operation by providing “Bus and Turn” (BAT) lanes on much of the corridor length. The BAT lanes are in effect only during the peak hours of the day, restricting general traffic or parking use between 6am and 9am and between 3pm and 7pm. During all other times, the lanes revert to general traffic or curbside parking use. As such, streets were typically not widened to accommodate RapidRide. Articulated diesel-electric hybrid vehicles were purchased specifically for RapidRide and comprise a considerable portion of the system capital costs. The buses follow Metro’s typical bus livery dominated by a gold paint scheme (below). The roofline is painted red to distinguish the buses as dedicated to RapidRide service, which are painted green.



Left: King County Metro; right: Zack Heistand via Flickr)

Of King County Metro’s six RapidRide routes, the E Line is the least reliable failing to meet headways 20% of the time. The part time transit lane priority lanes are considered a factor in this performance. However, despite these issues, ridership grew 20% in the first year of operations compared with the previous local, all-stops route.



<https://ggwash.org/view/32756/notes-from-seattle-bus-rapid-transit-lite>



<https://kingcountymetro.blog/2021/07/06/alignment-for-rapidride-j-line-receives-county-council-approval/>



<https://kingcountymetro.blog/2020/10/02/celebrating-10-years-of-rapidride/>

RapidRide is considered an example of “BRT Lite,” with a relatively small portion of their routes in priority lanes (shown left.) Red lane markings are not yet commonly used.

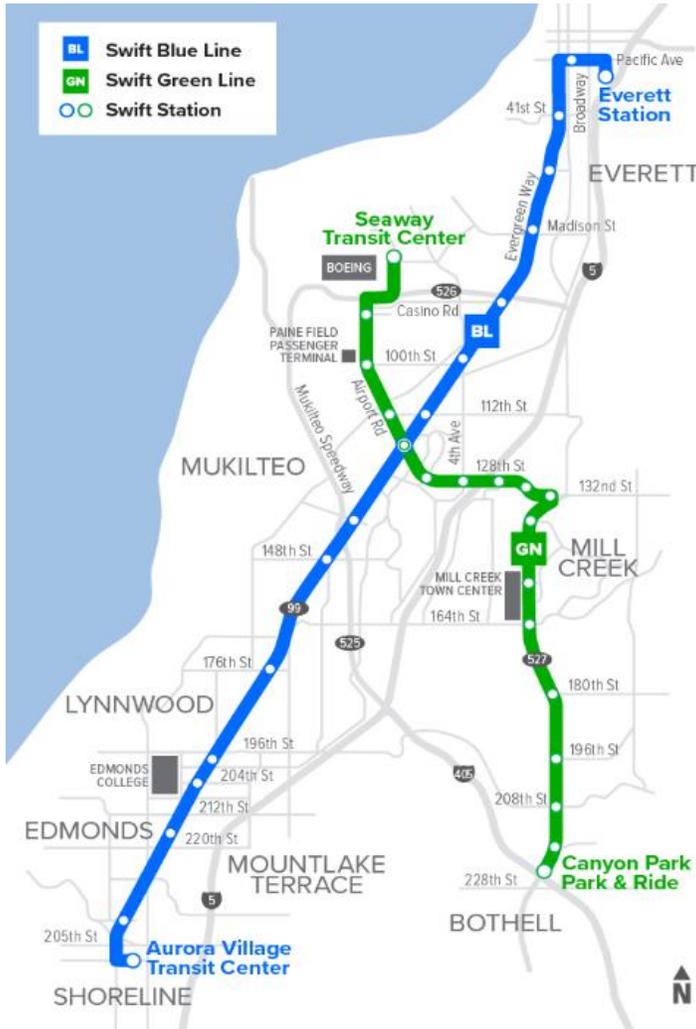
Stations (shown center and right) use a custom shelter “kit of parts” that are delivered to King County Metro unassembled. King County maintenance crews assemble and install the kits. This approach saves a considerable cost of labor. RapidRide stations are not custom built as is common with many BRT systems, with an implementation approach similar to fixed route transit stops just with a larger shelter footprint.

Stations also include a “tech pylon” designed as an all-in-one solution for major information technology and electrical components, negating the need for a separate electrical and communications enclosure. The pylon includes real-time next bus signage, a map case (behind which is the electrical panel), and an “Orca” (regional fare card) e-fare reader.

Opened:	Blue Line: 2009 Green Line: 2019
Length:	29 mi. (combined) 29% exclusive BAT lane
Stations:	14
Station spacing:	0.75-1.0 mi.
Capital cost:	\$102m (combined)
FTA share:	\$72m (Small Starts)
Other federal:	\$3m
Local/State:	\$27m
Operating cost:	\$11.2m/year (2021)
Peak buses:	21 (combined)
Bus type:	60' articulated
Hours:	4:15 am-11:00 pm
Wait time:	10-12 min. peak 15-20 min. off-peak
Ridership:	7,700/wkdy (2021)



By SounderBruce - Own workFlickr: CT 29709 at Wetmore Avenue Swift station, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?curid=41355695>



Community Transit

Serving suburban Snohomish County, located just north of Seattle, Community Transit’s Swift BRT system currently consists of two routes, the Blue and Green lines, with two more lines in development. The Blue Line was the first of the routes implemented. It operates along State Route 99 which links the city of Everett and surrounding communities to Seattle (King County) where commuters can transfer to King County Metro’s RapidRide E Line. The Swift Green Line provides an east-west link through Snohomish County and serves the Boeing aircraft factory, one of the region’s biggest employers, and other businesses that support aircraft production. Combined, the Blue and Green lines provide 29 miles of BRT service, each with just over four miles of exclusive lanes.

On the Blue Line, exclusive lanes were implemented by converting one of three lanes in each direction into a “Bus and Turn” (BAT) lane. On the Green Line, an existing HOV lane was leveraged for provide transit speed improvements. Both projects were implemented with limited investment in roadway infrastructure, keeping costs per mile low. Only the Green Line used an FTA Small Starts grant as part of the funding package.

Both lines maintained local service with Swift BRT becoming an “overlay” focused on longer trips. Each station includes a nearby local bus stop to facilitate transferring between the two services. This approach allowed Community Transit to open capacity on the local service while offering customers making longer trips a quicker ride via Swift service.

	4:15 a.m.	6 a.m.	7 p.m.	11 p.m.
Weekdays Bus runs every	15 min	10 minutes	20 min	
	15 min	12 minutes	20 min	30 min
Saturday Bus runs every		6 a.m.	7 p.m.	10 p.m.
		15 minutes	20 minutes	
		20 minutes		
Sunday and Major Holidays Bus runs every		7 a.m.	9 p.m.	
		20 minutes		
		20 minutes		



Herald.net



The Swift Blue Line was among the first BRT lines in the U.S. to have buses outfitted with rear facing, self-secured wheelchair berths. Community Transit also developed an on-board bike rack system that became the template for BRT systems nationwide, which are now available from bus manufacturers as an option.

Stations include custom shelters, a tall branding pylon, ticket vending machines, and Orca card (regional, multi agency fare card) readers. A “kit of parts” design was developed to manage costs as the system expands, relying on a standard design that can be adapted to different locations and conditions. Community Transit contracts directly with the shelter manufacturer to manage station “kit” costs and maintain access to spare parts.

Community Transit points out the efficiency of its system with station dwell times (the amount of time a bus is stopped at a station) averaging only 10 seconds, helping to speed up overall travel time.



<https://diologix.com>



<https://www.heraldnet.com/news/community-transit-starts-construction-on-green-line-stations/>

City	System	Opened/ Opening	Length	Average Station Spacing	Bus Type	Peak Buses	Hours	Wait Time	Average Weekday Ridership
Albuquerque NM	ART	2020	13.0 mi.	0.5 mi.	60'	15	5:30a-10:00p	8 min.	4,040
Boston MA	Silver Line	2004	2.3 mi Washington St. only	0.3-0.5 mi.	60'	8 Washington St. only	24/7	5 min.	39,000 entire Silver Line
Cleveland OH	Health Line	2008	9.4 mi.	0.3 mi.	60'	24	24/7	15 min.	13,200
Columbus OH	CMAX	2018	15.6 mi.	0.5 mi.	40'	15	4:30a-10:00p	10-15 min.	4,300
Eugene OR	EmX	2007-2017	19.0 mi.	0.3 mi.	60'	8	5:30a-11:30p	10 min.	13,000
Hartford CT	CTFastrak	2015	10.7 mi.	2.0 mi on busway	60'	15	5:30a-10:00p	8-14 min.	8,600
Indianapolis IN	Red Line	2018	13.0 mi.	0.3-0.5 mi.	60'	10	5:00a-1:30a	15 min.	4,000
Richmond VA	Pulse	2018	7.6 mi.	0.5 mi.	40'	8	5:30a-1:30a	10-15 min.	4,600
St. Petersburg FL	SunRunner	2022	10.3 mi.	0.75 mi.	40'	7	6:00a-12:30a	15 min.	5,500 est.
Seattle WA	RapidRide E Line	2014	12.5 mi.	0.4 mi.	60'	12	24/7	7-10 min.	15,800
Snohomish Co. WA	Swift	2009-2019	29.0 mi.	0.75-1.0 mi.	60'	21	4:15a-11:00p	10-20 min.	7,700