

# MASS TRANSIT

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## Leading the way

TriMet's Powell Garage in Portland, Ore., which was completed in 2022 after four years of construction, is four times the size of the old garage and accommodates charging infrastructure for future zero-emission buses.

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The garage, which was completed in 2022 after four years of construction, is four times the size of the old garage and accommodates charging infrastructure for future zero-emission buses.

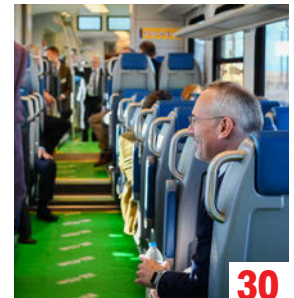
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# MASS TRANSIT

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# Urban mobility's hands-free future is near

Account-based ticketing, MaaS utilization and expanding partnerships all drive a move toward a hassle-free travel experience.

By Nick Mackie

▶ We're on the road to a frictionless, door-to-door urban mobility experience as new technology paves the way to advance the rider experience.

**WHAT IF** you could travel through a city anywhere in the world without the need to fumble for your wallet or even your phone? This vision of “hands-free” transit is part of the future—and it's closer than we may realize.

Digital payments on transit, like open-loop contactless ‘tap-to-ride’ technology, is an early step toward this new era of urban mobility. It's no longer a question of whether transit systems will adopt these types of payments—it's now a question of when they'll do it and how they'll implement. So, what's the next step? Here's where urban mobility is heading in the short and long term.



sit riders noting they use four or more payment methods per month. Globally, fewer than one in five riders use a single payment method.

The solution to this problem could be solved with Mobility as a Service (MaaS). As cities focus on reducing friction on their transit systems, boosting resilience and catering to the preferences of the traveling

public, MaaS can help bring the experience (payments included) into one centralized app. Also underpinned by ABT architecture, MaaS connects riders to a wider array of choices to plan, book and pay for multimodal travel.

## Where the future meets hands free

The increasingly global adoption of contactless payments signals a widespread shift towards the hassle-free travel experience. Already, open-loop technology, which is a form of account-based ticketing (ABT), enables a faster, easier and more secure way to pay for fares and it's available in more than 750 transit systems worldwide.

With ABT infrastructure, cities are laying the groundwork for more intuitive experiences. ABT differs from traditional card-based ticketing (CBT) in that its system is linked to an account in a central host system rather than the smart cards themselves, as you'd see with CBT.

Whether through biometrics, Bluetooth, geofences or ultrasonic data, a range of technologies will further transform the way we access urban travel, building on the potential of ABT. Transit agencies are already exploring Be In / Be Out (BIBO) systems that are not just hassle-free, but also hands free.

## Partnership and the road ahead

Open-loop systems can help public transit agencies as they strive to broaden accessibility for all, regardless of income or access to formal financial services and it's underpinned by the same ABT architecture that will enable the bright futures of MaaS and other technologies that can facilitate a hands-free travel experience.

With contactless, open-loop systems, transit agencies can allocate banking and clearinghouse tasks to financial service firms – creating more opportunities for collaboration between both industries. These partnerships can help agencies simplify fare payment processes, reduce cash management and fare collection overheads and mitigate financial risks such as fraud and fare evasion. That will be important as transit agencies work to free up resources to optimize route plans, enhance operational efficiency and invest in more sustainable transportation.

We're on the road to a frictionless, door-to-door urban mobility experience as new technology paves the way to advance the rider experience. So, grab your 'virtual' ticket and come ride with us towards a hands-free travel future. **L**



### About the author

**Nick Mackie** is global head of urban mobility for Visa.

### Transportation's MaaSive potential

Public transit can still be a fragmented experience in many cities, with the majority of public tran-

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# People & Places



On March 26, L.A. Metro, LADOT and the city of Los Angeles celebrated the opening of 5.6 miles of new bus priority lanes on Sepulveda Boulevard.

Photo: L.A. Metro

## New bus priority lanes open on Sepulveda Boulevard in Los Angeles

On March 26, the Los Angeles County Metropolitan Transportation Authority, Los Angeles Department of Transportation and the city of Los Angeles celebrated the opening of 5.6 miles of new bus priority lanes on Sepulveda Boulevard. The new lanes will move 50,000 weekly bus riders through the congested corridor while improving bus speeds by 15 percent or more and increasing service frequency. With the new bus priority lanes serving riders in the San Fernando Valley, Los Angeles will have approximately 51 miles of bus priority lanes across the city, with another 46 miles of bus lanes to be implemented during the next year.

[MassTransitmag.com/55000110](https://MassTransitmag.com/55000110)



A file photo of a CAF-manufactured Purple Line train.

Photo: Maryland Transit Administration

## MDOT MTA delays Purple Line opening until winter 2027

► The Maryland Department of Transportation Maryland Transit Administration received approval

from the Board of Public Works to modify the Purple Line Public-Private Partnership Agreement that extends the contractual deadline for achieving Revenue Service Availability to winter 2027. The Purple Line, which was previously targeted to open in spring 2027, is a critical infrastructure project that will expand transit opportunities between Prince George's and Montgomery counties, two of the most populated counties in the state. The 16.2-mile, 21-station light-rail line will offer convenient east-west transit access for jobs, school, shopping and recreation.

[MassTransitmag.com/53098080](https://MassTransitmag.com/53098080)



Caltrain advances electric train testing between Redwood City and San Jose, Calif

Photo: Caltrain

## Caltrain advances electric train testing between Redwood City and San Jose

► Caltrain has successfully tested electric trains and overhead wires between Redwood City and Mountain View, Calif., for the first time, which will allow the agency to ramp up the testing of the new fleet before the launch of its electrified service in fall 2024. Each of the 23 electric trainsets must complete 1,000 miles of testing before it can carry passengers. Initial tests were conducted between Santa Clara and College Park Stations on the Santa Clara Drill Track but Caltrain has steadily been expanding the available testing area from San Jose to Mountain View.

[MassTransitmag.com/53098924](https://MassTransitmag.com/53098924)

## RTA of Southeast Michigan cuts ribbon on Detroit Air Xpress service pilot

► On March 21, the Regional Transit Authority (RTA) of Southeast Michigan hosted a ribbon-cutting ceremony for its new Detroit Air Xpress (DAX) service that will travel nonstop between downtown Detroit, Mich., and Detroit Metro Airport. The pilot period, which begins service on March 25 and is expected to last between 12 and 18 months, will allow the RTA of Southeast Michigan to initiate service, monitor progress, assess ridership demands and understand long-term service needs for the service. DAX will be available 365 days per year (including holidays and high travel days), making 16 round trips per day between 3:30 a.m. and 11 p.m. The trip is expected to take 30 to 50 minutes each way depending on traffic.

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## PEOPLE IN THE NEWS

### Southeast Missouri Transportation Service (SMTS)



Effective July 2024, **Tracy Jones** will assume her new position with SMTS as executive director of the agency. Until then, she will remain in her current position with the agency as director of finance.

SMTS Accounting Manager Debbie Elders will fill the soon-to-be vacant position of director of finance for the agency.

[MassTransitmag.com/53098477](https://www.masstransitmag.com/53098477)

### Southeastern Pennsylvania Transportation Authority (SEPTA)



SEPTA has named **Elisa Cunningham** as chief technology officer. In this newly created position, Cunningham will lead SEPTA's information technology department and develop and implement a long-term technology strategy that ensures system resiliency and security.

[MassTransitmag.com/53098730](https://www.masstransitmag.com/53098730)

### Santa Cruz Metropolitan Transit District (Santa Cruz Metro)



**Corey Aldridge** will become Santa Cruz Metro's CEO, effective April 29, 2024. Aldridge will be tasked with helping Santa Cruz Metro increase ridership, implement the agency's zero-emission

master plan and incorporate affordable housing into Santa Cruz Metro-owned transit centers. Aldridge comes to Santa Cruz Metro from Mountain Line Transit in Missoula, Mont., where he held the position of CEO.

[MassTransitmag.com/53098726](https://www.masstransitmag.com/53098726)

### Sound Transit



**Terri Mestas** has been named Sound Transit's new deputy CEO for megaproject delivery, a new position that was created to lead the development of the agency's concurrent projects quickly and effectively and bring forth ways to accelerate project timelines and reduce capital expenditures. Mestas has more than 30 years of experience leading large infrastructure programs for space exploration, military installations, national and international antiterrorism physical security.

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## People & Places

### FTA issues NPRM to protect transit rail worker safety

► Under a Notice of Proposed Rulemaking published on March 22, the Federal Transit Administration is proposing mandatory minimum standards to protect those who perform track work for all rail transit agencies nationwide. The mandatory minimum

standards would require transit agencies nationwide to create a protection program geared at personnel who work on or around the tracks, implement comprehensive training for workers and ensure that unsafe acts and conditions are reported. The proposed rule would apply to rail agencies and state safety oversight

agencies (SSOAs) that are tasked with overseeing safety. The proposed rule would also require SSOAs to review and approve worker protection program elements, monitor implementation and conduct annual audits to ensure compliance.

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### OCTA, Metrolink to study long-term solutions to protect San Clemente rail line

► Regular passenger rail service through San Clemente, Calif., resumed March 25, restoring a critical link in southern California's transportation system with the completion of a 200-foot-long catchment wall at Mariposa Point that will protect the track from soil and debris from a privately owned slope that slid into the rail right of way in late January. The Orange County Transportation Authority is working with Metrolink to address other potential problem areas along the coastal rail line and to further study longer-term solutions for protecting the track that connects passengers and freight from San Diego to Orange County and farther north. The suspension of service on the rail line in late January was the fifth service interruption in the past three years.

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### MORE NEWS AT A GLANCE

► Metra has contracted Stadler for a \$154 million base order for eight two-car, battery-powered trainsets, including engineering, training and spare parts.

[MassTransitmag.com/53097272](https://www.masstransitmag.com/53097272)

► The Gateway Development Commission Board of Commissioners has awarded a Delivery Partner contract to the joint venture MPA Delivery Partners for the Hudson Tunnel Project.

[MassTransitmag.com/53097879](https://www.masstransitmag.com/53097879)

► Herzog Contracting Corporation has been awarded a construction contract by Amtrak to design and construct a new Heavy Maintenance Facility at Amtrak's Penn Coach Yard in Philadelphia, Pa.

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For more information, visit [www.masstransitmag.com/21207835](https://www.masstransitmag.com/21207835)

# The Impacts of Successful System Adoption and How it Leads to a Better ROI



308887926 | Montree Lapakdee | Dreamstime

**With the increasing importance of** data-driven decision-making, transit agencies are investing in software to manage, analyze and derive insights from vast amounts of data. This helps in strategic planning, identifying trends, understanding rider behavior and optimizing operations. Software not only streamlines processes and boosts productivity, but it cuts costs by minimizing manual labor and errors.

The return on investment can only be substantiated if transit agencies are being good stewards of system adoption and the technology providers they partner with are actively engaged in helping them reach their goals. Often, it is one of these two areas that fall short and as a result, the agency is left with an expensive product that never fully lives up to the vision of its original procurement.

## **What key considerations should an agency keep in mind, whether they're venturing into technology adoption for the first time or upgrading from legacy software?**

The key to this process is ensuring that all staff understand why the technology was purchased and the value it brings to the transit agency. Engaging key stakeholders from different departments and

levels of the organization early in the process will aid with buy-in and create a sense of ownership amongst staff. Creating ownership and accountability in the early stages of the project implementation process is vital for successful system adoption.

Effectively managing change within the agency is another crucial component to overcoming internal resistance and facilitating successful system adoption. Identifying within the agency those staff members who will help influence and promote system adoption while also proactively addressing concerns by other team members is essential. Without strong cross departmental system champions, it will be more difficult to overcome the challenges that come along with implementing a system that is driving more efficient ways of doing business.

## **What can ITS vendors do to assist with system adoption for new projects?**

Several considerations come to mind, with none more crucial than integrating role-based standard operating procedures (SOPs). SOPs help all transit personnel understand the things that need to be done in the system, as it pertains to their role, to be successful adopters of the product. This is important not only

for first time adopters, but also plays a key role as the transit organization evolves in the future.

During the past several years, we've seen staff retire, transition to new roles or leave agencies altogether for different opportunities. Change is going to naturally occur; we want to ensure we are setting the agency up for success by implementing the SOPs that will help mitigate the effort needed to onboard unfamiliar staff in the future.

## **Does the approach differ for transit agencies not currently engaged in new projects or under warranty and support?**

The people helping to assist with the effort may change but the process should remain the same. The goal being that post project, transit agencies continue to build off the adoption foundations that were administered during original project implementation. Vendor staff will continue to utilize the Key Performance Indicators established during the project as a baseline for the agency's adoption level. This serves as a springboard toward a continuous improvement process cycle focused on maximizing a transit agency's system adoption.

Monitoring system usage is another great way to stay on top of user adoption. Product engagement metrics serve as a powerful tool that highlights areas of product that are being heavily utilized. Most importantly, it identifies underutilized areas, which prompts discussions to improve adoption.

System adoption is an ongoing improvement process where we, as the technology provider, collaborate with the transit agency to meet their goals. Working together from project implementation to post-warranty support is critical for maximizing the agency's initial investment return.

## **About the author**



**Todd Beaumont** is director of customer experience at Avail Technologies, Inc.

# Special Report: Bus Fleet Snapshot

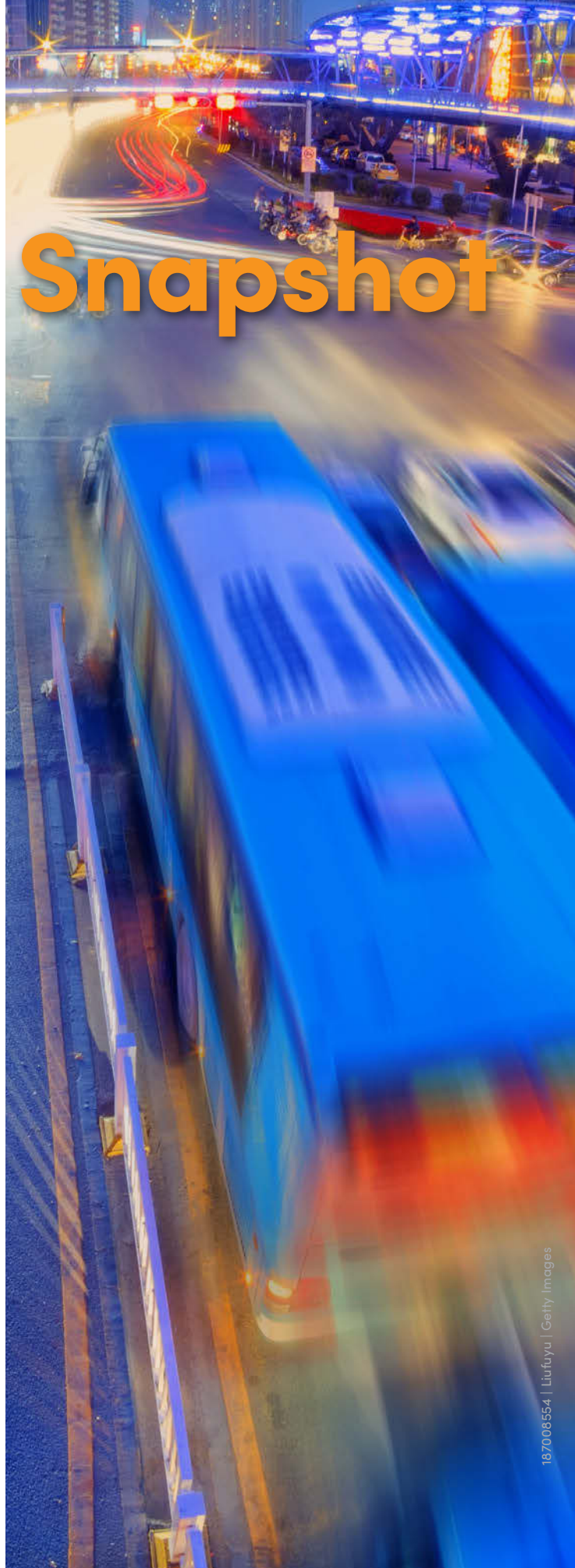
**Ridership continues to increase on North American bus networks and the market continues its move toward a future with lower or zero-emission fleets.**

**COMPILED BY MISCHA WANEK-LIBMAN,  
EDITOR IN CHIEF**

**T**he bus continues to be the workhorse of the transit industry. New bus projects to enter revenue service during the past year include C-TRAN's Mill Plain Bus Rapid Transit (BRT), Capital District Transportation Authority's BusPlus Purple Line BRT, EMBARK's inaugural RAPID line and Community Transit's Swift Orange Line. The mode is experiencing general ridership return at a faster rate than other modes and it's driving the industry's movement toward lower and zero emissions. This report is designed to provide a snapshot of what is occurring in the bus market through recent news and data analysis.

A policy brief released in December 2023 from the American Public Transportation Association (APTA) offers a national view of ridership trends in the U.S. Overall, transit ridership has reached more than 77 percent of pre-pandemic levels, which is a significant gain when compared against the lowest levels that represented 20 percent of pre-pandemic ridership. While the job market and return to office polices have helped transit ridership recovery, office occupancy rates have slowed while ridership continues to increase, indicating the attraction of transit for non-commute trips.

The APTA brief explains bus ridership has consistently led other modes in ridership recovery "due to bus rider population groups," which include



## Active Vehicles in the United States

Active vehicles declined slightly across most rubber-tired modes except for double decker buses, which saw nearly a 13% increase in active vehicles between 2021 and 2022.

Source: NTD 2022 Vehicles Type by Agency

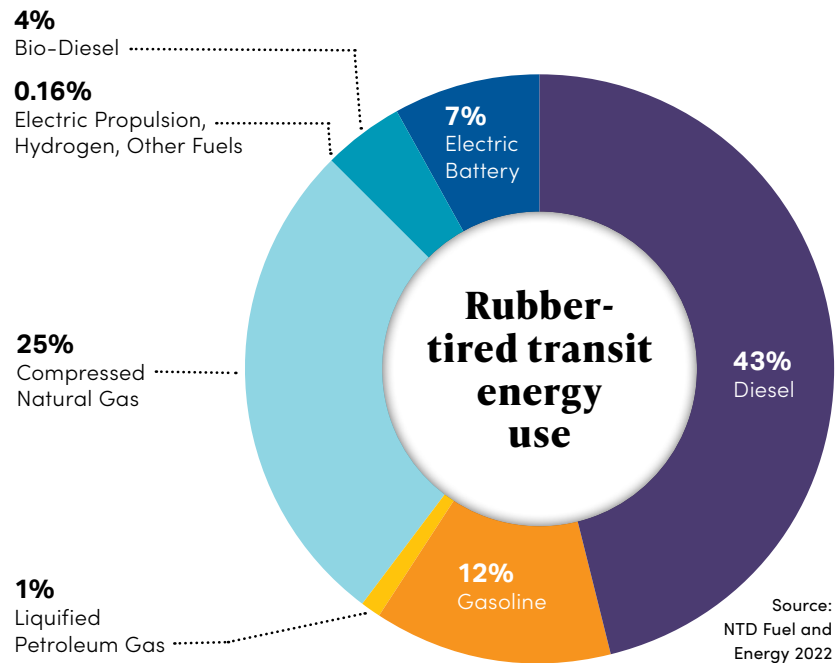
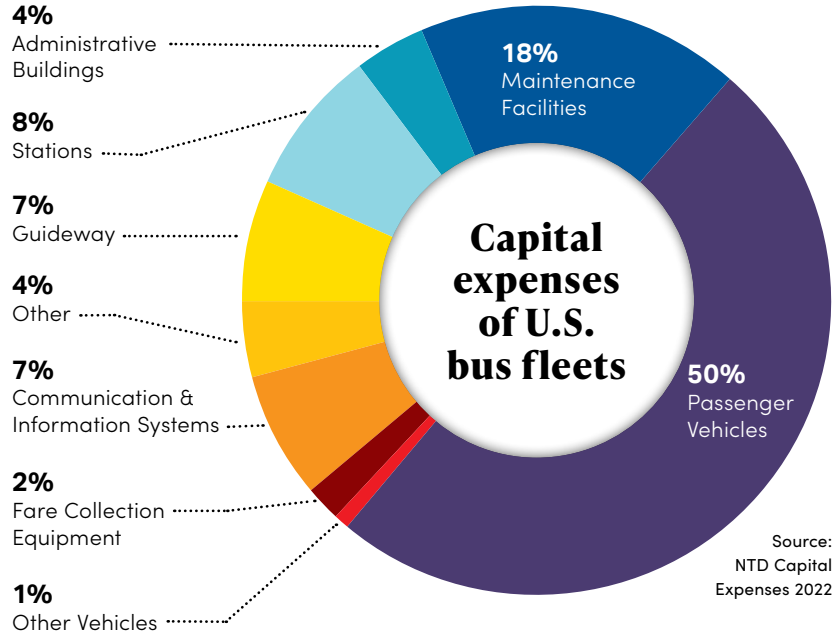
riders under 25 and those who work in non-office jobs.

The brief concludes that agencies focused on serving historically marginalized communities could see ridership growth. This includes support for hourly, late night and early morning workers by reinvesting in equitable transit. Additionally, the brief explains real estate investment in central-city areas could potentially further an increase in ridership.

Another recent development impacting transit vehicles, in particular rubber-tired vehicles, is the publication at the end of March of the Environmental Protection Agency's (EPA) final rule on Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles-Phase 3. The rule phases in standards for heavy-duty vehicles, including transit and shuttle buses, over Model Years (MY) 2027 through 2032. EPA says standards are technology-neutral and performance-based, allowing each manufacturer to choose what set of emissions control technologies is best suited for them and the needs of their customers. The agency also explained the standards can be met through a variety of vehicle models, including advanced internal combustion engine vehicles, hybrid vehicles, plug-in hybrid electric vehicles, battery electric vehicles and hydrogen fuel cell vehicles.

For heavy-duty transit vehicles, the Phase 3 standards in the final rule are 13 percent stronger than Phase 2 starting in MY 2029 and increase to 30 percent stronger in MY 2032.

EPA says the standards will avoid 1 billion tons of greenhouse gas emissions and provide \$13 billion in annualized net social benefits related to public health, the climate and savings for fleet owners and operators.



## Terminology NTD Mode Types

- RB** – Bus Rapid Transit
- CB** – Commuter Bus
- DR** – Demand Response
- TB** – Trolleybus
- VP** – Vanpool
- MB** – Bus

Numbers reflected in this report used information within the National Transit Database for the modes listed.

Rubber-tired mode capital expenses in 2022 shows 85% of all capital expenses went toward the improvement of existing service, while close to 11% went toward the expansion of service.

Source: NTD 2022 Capital Expenses (by Capital Use)

The U.S. zero-emission rubber-tired fleet traveled 35.7 million active miles in 2022, which is a 36% year-over-year increase.

Source: NTD 2022 Revenue Vehicle Inventory

The final rule includes analysis of costs under the new standards, including costs per mile, as well as maintenance and repair costs. The EPA final rule estimates fuel cost per mile for MY 2032 vehicles from calendar years 2023 to 2055 will range from 20.2 cents/mile to 38.2 cents/mile for diesel urban buses, 8.5 cents/mile to 16 cents/mile for electric buses and 23.2 cents/mile to 43.9 cents/mile for compressed natural gas (CNG) buses.

EPA estimates the maintenance and repair cost per mile for the same model years as above

will range from 13.6 cents/mile to 29.9 cents/mile for diesel and CNG buses and 9.7 cents/mile to 21.2 cents/mile for electric buses.

### Continuing move to zero emissions

While EPA stressed flexibility among a variety of vehicle models as a key component to its new standards, the transit industry has been strengthening its commitment to transition toward lower-emission and zero-emission buses (ZEBs).

In *Mass Transit's* recent "2024 Mobility Outlook" survey, 49 percent of respondents answered their agency planned to award a battery electric bus contract in 2024, 10 percent reported that a fuel cell electric bus (FCEB) contract would be awarded this year and 16 percent reported a contract for diesel vehicles would

be awarded.

CALSTART, which produces an annual report tracking the adoption of zero-emission vehicles, said transit agencies in the U.S. and Canada "made steady, measurable strides in transitioning their fleets to zero-emission buses" during the past year.

CALSTART's "2024 Zeroing in on ZEBs" report determined the total count of full-size battery-electric and fuel-cell electric transit buses in the U.S. has grown to 6,147 as of September 2023, which is a 12 percent increase compared to 2022. The total count of small ZEBs deployed in the U.S. number 1,010, which is a 15 percent increase compared to 2022.

Canada has also experienced year-to-year growth in full-size and small ZEB adoptions. As of September 2023, the number of ZEBs across the country has

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grown to 976, with ZEBs found in eight of the country's 10 provinces. Data analysis from the Canadian Urban Transit Research and Innovation Consortium (CUTRIC) found the country has 2,144 ZEBs in the funding, procurement, commissioning or in-service stages of fleet transition. CUTRIC's analysis also determined Canada would achieve its goal of introducing 5,000 ZEBs by 2026.

CALSTART notes the North American ZEB fleet consists primarily of battery-electric vehicles, with a total of 419 fuel cell electric buses – 381 vehicles in the U.S. and 38 in Canada – deployed as of September 2023.

In the U.S., leaders at SunLine Transit Agency have been open about the challenges faced with its hydrogen fueling station, which has been unable to

supply SunLine with the hydrogen needed to operate its fleet of FCEBs. The agency is leasing CNG vehicles as a short-term solution and began construction on a new liquid hydrogen station to build resilience into its hydrogen program. In Canada, CUTRIC explains FCEBs carry challenges, including a higher procurement cost and costs associated with their operations and maintenance, the lack of Canadian best practices for hydrogen-powered transit buses and a lack of smaller to medium vehicle options for FCEBs.

Respondents to *Mass Transit's* "2024 Mobility Outlook" survey said the availability of federal funds was a top influencing factor in their pursuit of low- or no-emission fleets. The CALSTART and CUTRIC reports also note the important

role funding availability plays in the transition of fleets. CUTRIC called Canada's 2021 Zero Emissions Transit Fund a "paradigm shift" for agencies working to transition their fleets. The fund, along with Canada Infrastructure Bank's Zero Emission Bus Initiative, is supporting 6,500 ZEB acquisitions.

In the U.S., the Federal Transit Administration's (FTA) Low or No Emission Bus Program and Buses and Bus Facilities Competitive Program awarded a combined \$1.7 billion in grants to support 690 ZEBs. Additionally, the two programs awarded a combined \$342 million to projects involving infrastructure to support zero-emission projects. In February, FTA made \$1.5 billion available through the two programs for the Fiscal Year 2024 funding round. [L](#)

### Percentage of active vehicles that meet or exceed useful life

- 17.9% of buses
- 8.1% of articulated buses
- 24% of cutaways

Source: 2022 NTD – Vehicles Type Count by Agency

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# TriMet's Powell Garage leads way modern trans facilitie

The garage, which was completed in 2022 after four years of construction, is four times the size of the old garage and accommodates charging infrastructure for future zero-emission buses.

BY BRANDON LEWIS,  
ASSOCIATE EDITOR



# T

TriMet's Powell Garage was built in 1976 on Southeast Powell Boulevard in Portland, Ore., as a temporary facility while the Center Garage in southeast Portland was under construction. The temporary facility ended up lasting TriMet more than four decades.

In 2016, the agency began the process of building a new Powell Garage that would deliver a facility that was four times the size of the original. The decision to build a new garage was made by TriMet to accommodate charging infrastructure for future zero-emission buses, as well as provide a comfortable space for its bus operators and employees to work and operate.

Before beginning the construction process, TriMet went through a full Request for Proposals (RFP) process with designers and contractors for the project. TriMet originally chose a firm known as RNL Design for the design of the project. The firm was acquired by Stantec in 2017 and Stantec took over as lead designer.

For the construction contract, the agency selected JE Dunn Construction. Both companies would work hand-in-hand with TriMet throughout the duration of construction for the project, which began in 2018. The garage opened in late 2022.

"The construction of the garage was like that nine-piece puzzle where you're kind of moving the empty box around to make the picture," described Katie MacKinnon-Kiser, TriMet's project manager on the new Powell Garage.

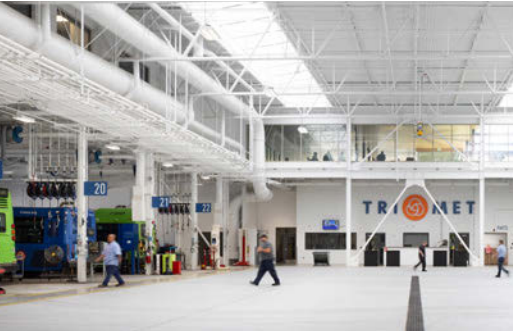
The project would be completed in phases so TriMet could continue operation of the old Powell Garage while the new garage was being built. Phase 1 included a 24,000-square-foot fuel and wash building while Phase 2 more than doubled the original bus maintenance area.

When determining how big the new garage had to be, TriMet considered how many buses the agency could acquire with their staff levels and the size



**Above, the new Powell Garage at night from the parking lot. Left, an outdoor area offers views of both employee and work spaces.**

Photos: TriMet



People moving around the shop floor of the new Powell Garage.

of the buses. The garage can hold anywhere from 300 to 346 zero-emission buses. Another consideration was building height with TriMet and its partners ensuring the garage was tall enough to accept lighter than air fuels.

MacKinnon-Kiser said both Stantec and JE Dunn Construction were easy to

work with on the project.

“Stantec had worked on a lot of these facility-type projects in the past, so it was nice to have that veteran presence there,” MacKinnon-Kiser said. “They knew what we could and couldn’t do when it came to design. With JE Dunn, they had never worked for TriMet before, but we learned a lot from them because TriMet doesn’t build a lot of buildings, so we leaned on their experience, as well, that we will implement in other projects down the line.”


Barb Berastegui, a design principal with Stantec who worked with TriMet on the project, noted when the firm entered the garage project, it felt it could

be exactly what the Portland-based agency was looking for when it came to a lead design partner.


“We really valued TriMet’s commitment to sustainability, to their community and our values at Stantec very closely aligned with theirs,” Berastegui noted. “We design a lot of facilities for buses, but we design them for the people who work in them because they’re very important civic buildings. They bring a lot of value to the communities they serve and it’s very important to create designs and iconic buildings that represent the sustainability and the people focused values that TriMet upholds.”

Jeff Byrne, JE Dunn Construction’s lead superintendent on the Powell Garage, noted some of the challenges during construction included dealing with the relocation of the 911 Fiber Line that is part of Portland’s 911 Call Center, explaining that the main fiberoptic utility feeding to the central hub ran directly through the TriMet site, passed up and over the existing building and out the east side of the property.

“The potential risk was disruption of emergency services for the entire Portland Metro area,” Byrne said. “Great care had to be taken to avoid disturbing this critical piece of infrastructure. The




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project team successfully relocated the fiber into an underground vault system and then continued to work around the fiber to perform work on mass excavation, foundations and underground utilities. Service was never interrupted and the integrity of the critical lifeline was maintained throughout the four-year life of the project.”

Along with Stantec and JE Dunn Construction providing services for the project, the Powell Garage project received a lot of support from Disadvantaged Business Enterprise firms.

“There’s not a lot of building vertical buildings,” MacKinnon-Kiser said. “When we were meeting with contractors about the project, we got a lot of questions, asking if the project was another light-rail extension and it’s like, ‘No, it’s a building’ so then the contractors told us they knew people, so we got a lot of exposure to a lot of different contractors and design consultants, which is good because we’re going to do more and we can’t just keep investing in the same companies and firms.”

The project had a Certification Office for Business Inclusion and Diversity firm participation rate of more than 26 percent. MacKinnon-Kiser notes the percentage shows the commitment TriMet puts into supporting the local Portland community.

Our local contractors are doing good business. They’re able to make money in a way that sustains not only some of their businesses, but also some people are able to grow from that,” MacKinnon-Kiser said.

Now that the project is completed, MacKinnon-Kiser said it has been rewarding to see TriMet employees use the facility and have a positive attitude while on the job.

“We have generations upon generations of drivers so I really feel like we were able to take some of their stories and give them a space that they could still identify with that being Powell Garage and their hub,” MacKinnon-Kiser noted. “The garage has a training room where there is a lot of hands-on learning for our mechanics and they have mock-up vignettes of the buses.” L



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# Park City investment in driver subsidized housing is a win-win

Utah's Park City Transit teamed up with the city to address seasonal housing challenges, which led to improved service efficiency and stronger recruitment.

BY EMAN ABU-KHALED, ASSOCIATE EDITOR



Photos: Park City Transit

In the bustling ski resort town of Park City, Utah, the busy winter season requires the local transit agency, Park City Transit (PCT), retain extra help to ensure efficient transportation for the community and visitors. PCT's free, year-round bus service utilizes seasonal bus operators who come into town to assist with this influx in ridership.

Many of these operators, staying only a couple of months in the city, find themselves facing high living expenses and housing costs in the agency's service area. Park City home prices were up 47.5 percent in February 2024 compared to last year, selling for a median price of \$2.5 million according to Redfin. Many of the rentals in the area average around or above \$1,600 a month based on Zillow listings.

PCT faced a problem that many public transit agencies have faced: How to hire and retain reliable, skilled workers who cannot afford to live where they work.

The agency wanted to help alleviate the housing stress experienced by its bus operators by ensuring they would have a roof over their head and keep more of their hard-earned dollars in their pocket.

In 2013, the agency invested federal funding secured by Kent Cashel, PCT's transit manager at the time, in a 13-unit property to provide subsidized housing units closer to the bus lines. PCT built another 23 units in 2018 with one being an ADA-accessible unit.

The units resemble hotel rooms in their simplicity, providing renters with all the necessities. PCT ensures that bus operators are comfortable in the city, with many food places and convenient stores located in the vicinity.

The units are first come, first served, with many applying for the housing before the winter season.

### A more efficient system

Being able to live closer to their work has increased efficiency for PCT and has provided stability and peace of mind to bus operators.

Prior to PCT's worker housing initiative, high housing costs forced many to live far from work and it became an inconvenience for operators working early shifts and coming home late. It also drove skilled workers away from working with the agency at one point or another.

Kim Fjeldsted, transit manager for PCT, said the commute to work for bus operators was a potential setback to starting service on time for the day.

"Commuting is tough on a bus operator because you're looking at a 45-minute commute up a canyon, trying to make it to work on their own time and be reliable is really hard for the people that are getting the buses out on the street first thing in the morning," said Fjeldsted.

In addition to proximity to work, the affordable units are fully furnished, which Fjeldsted indicates is a point of convenience for seasonal operators.

"They can just come with their backpack," said Fjeldsted. "They don't have to move their furniture or anything and have a place to live comfortably right next door to their work."



Commuters can ride their bikes, walk or scooter their way into work in less than 10 minutes.

PCT's housing program currently has 36 employees in affordable housing located in the Park City area, paying a rate of \$600 per month.

Since PCT hires nearly 100 people each winter, including 75 full-time drivers, it is exceeding the 20 percent housing goal that the city set for new developments.

The success PCT experienced with the program was honored by the American Public Transportation Association with its Innovation Award, which recognized the program's results in supporting PCT's bus operators and riders.

### Nothing but highs

PCT's housing units have established an overall better climate in the system and in the city itself. The agency has not only expanded its driver retention rate, but also diversified its workforce by supporting lower-income employees and offering affordable living opportunities within the city.

Fjeldsted commented on the need for this type of program in Park City.

"I don't believe Park City could have fulfilled the growing transit needs without the housing," said Fjeldsted.

The housing program was launched as PCT was rapidly growing its system to serve an increasing population while also undergoing organizational change. PCT provided service in Summit County between 2006 and 2021 under an inter-local agreement. U.S. Census data shows the population of the city increased more than 14 percent - from 7,000 to 8,000 - between 2010 and 2020. Organizational

**PCT's subsidized housing units are very near to the resort town's tourism locations, giving PCT employees a chance to "live like the locals" and experience everything Park City has to offer.**



**The PCT housing program was the brainchild of Kent Cashel (above), transit manager at the time of the program's creation in 2013.**



**The subsidized housing units resemble hotels with most of them fit for single occupancy.**

periences the same issue and they are pursuing housing for their operators, as well.”

The agency is also working to support operators wanting to stay on after the winter season and establish a life in Park City.

“The cost of living has just gotten worse in Park City,” said Fjeldsted. “We were struggling to recruit and retain full time employees so we started to set aside some of our seasonal housing for them to live there year-round in the hopes that they will be able to put some money aside to be able to get their own place or get on one of the city’s affordable housing programs.”

Fjeldsted notes the program has retained some bus operators for up to four years in Park City.

changes came in 2021 when the county formed a regional transit system, High Valley Transit (HVT), which allows PCT to focus on the city service.

“While our staffing needs were reduced by approximately 40 percent, we still find ourselves in need of more employee housing,” said Fjeldsted. “HVT expe-

Overall, the quality of life for PCT employees has improved. They can experience the city and all it has to offer with tasty foods and access to the ski resorts in the area, they get to “live like the locals.”

**Expanding accessibility**

To increase access to flexible transportation, Park City will re-launch its microtransit service in partnership with HVT in July 2024, which will grant the Park City community access to transportation in its more dense areas.

Riders will be able to put in their destination on the High Valley app and their entire trip will be planned for them, including bus routes.

The Park City Council has indicated it may establish a permanent microtransit service in the future but wants to evaluate ridership data from the pilot before making any decisions.

PCT is working to expand its housing units to continue to provide better living for its employees. **L**



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# Vehicle Design:

## Managing Wheel/Rail-Generated Noise and Vibration from the Ground Up

In the first of a two-part series, the relationship between vehicle and track design is examined to understand how the affiliation can mitigate vibration and noise on rail transit systems.

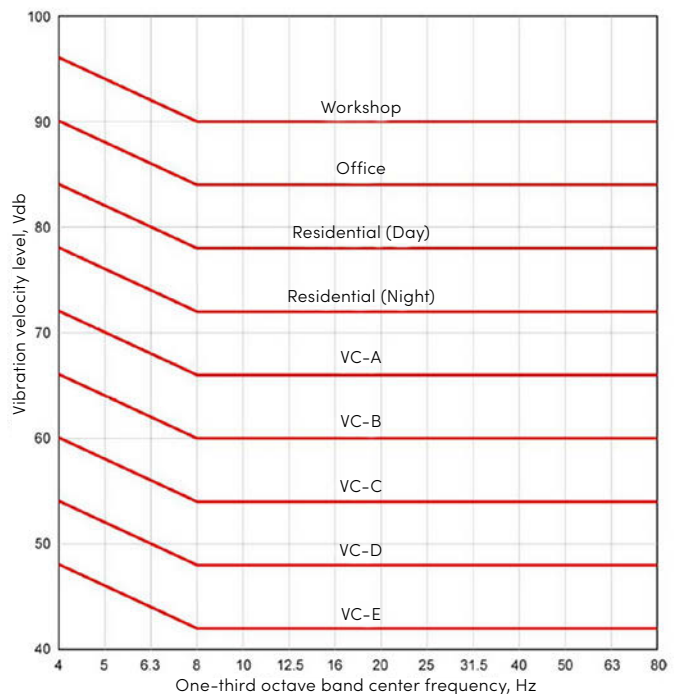
BY JEFF TUZIK, CONTRIBUTOR

Vibration and noise are an intrinsic part of rail transit operations. Vibration and the noise generated as a result can generate complaints, disrupt sensitive scientific equipment in nearby buildings and damage or accelerate wear in components of the vehicle and track itself. There are many tools transit systems use to mitigate vibration and noise, including sound barriers, lubrication and rail grinding, but much of this mitigation occurs before the wheel even meets the track. It is done during the track and vehicle design process. Wheel/Rail Seminars convened a group of experts, including a transit operator, vehicle manufacturers and a noise and vibration consultant, to examine how to mitigate wheel/rail-generated noise at the source from the vehicle perspective at the WRI '23 Rail Transit conference, of which *Mass Transit* is the Presenting Sponsor.

Rail transit vehicles are highly specialized. Every fleet is built to exacting specifications and designed for its unique operating environment. A key characteristic that drives new vehicle/car design is vibration. Vibrations generated at the vehicle/track and wheel/rail interfaces cause noise, wear and damage. The car builder has an important role to play in minimizing noise and vibration at the source.

Vibration (and noise produced because of vibration) is one of the Federal

FIGURE 1. One-third octave band center frequency FTA guidelines.



Transit Administration's (FTA) criteria that transit systems in the U.S. are beholden to. Some transit systems maintain their own, more stringent thresholds and although there are many vibration and noise mitigation techniques that transit systems employ — including track design elements, wheel rail interface management and path control, such as vibration isolation and noise barriers — much of the mitigation is done on the front end at the design level. Vehicle design is a key factor in reducing and eliminating noise and vibration issues.

Designing and optimizing a vehicle is no small feat. There are many criteria that car builders must meet before considering the noise and vibration implications of the design including speed, performance, steering, stability, service-proven design standards and ease of maintenance. Shankar Rajaram, executive project director at Sound Transit, told attendees at the WRI '23 WRI Rail Transit Conference that "all these boxes have to be checked while you're trying to optimize your vehicles and trucks."



He explained there are several vehicle design factors that influence vibration and noise: Primary suspension stiffness, unsprung mass, resilient wheels (wheels with elastomeric tyres to help damp vibration), carbody connections, axle spacing, solid axles versus independently rotating wheels and the wheel/rail profile match. Rajaram explained that once a vehicle goes into operation, factors such as wheel flats and out-of-roundness and wheel/rail surface roughness can also contribute to high vibration events.

Of these variables, unsprung mass and wheel flats tend to contribute most to the magnitude of generated vibrations, added Briony Croft, an acoustic engineer and director at Sahaya Consulting (Canada) and Acoustic Studio (Australia).

“Unsprung mass, a known contributor to noise and vibration, is a variable that can only be adjusted in the design phase,” Croft said.

Even then, Croft noted findings by the European Union Rail Induced Vibration Abatement Solutions (RIVAS) project found a 25 percent reduction in unsprung mass results in an average broadband vibration reduction of only 1 to 2 dB. Achieving a 6 dB vibration reduction could require as much as a 50 percent reduction in unsprung mass, which may not be practical in many cases. So, while minimizing unsprung mass is the first step to controlling noise and vibration from a design standpoint, it is only one of many variables.

Regarding primary suspension, conventional wisdom is that it should be relatively soft. Rajaram explained the FTA Transit Noise and Vibration Impact Assessment Manual states that if a vehicle’s primary suspension resonant frequency is 15 Hz or higher, the base operational noise level predictions should be increased by 8 dB. A soft suspension is desirable but a too soft suspension can cause stability issues and negatively affect ride quality.

“In my experience, 10 Hz to 13 Hz eigenmode (a normal mode in an oscillating system in which all parts of the system are oscillating with the same

**FIGURE 2. Description of the VdB levels shown in figure 1.**

Criterion curve	Max Lv,* VdB	Description of use
Workshop (ISO)	90	Vibration that is distinctly felt. Appropriate for workshops and similar areas not as sensitive to vibration.
Office (ISO)	87	Vibration that can be felt. Appropriate for offices and similar areas not as sensitive to vibration.
Residential Day (ISO)	78	Vibration that is barely felt. Adequate for computer equipment and low-power optical microscopes (up to 20x).
Residential Night, operating rooms (ISO)	72	Vibration is not felt, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100x) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400x), microbalances, optical balances, and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1,000x) and inspection and lithography equipment to 3-micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1-micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capabilities.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment

**FIGURE 3. Effect of stiff primary suspension on predicted resonant frequency. (From the FTA Noise and Vibration Assessment Manual).**

Vehicle parameters (not additive, apply greatest value only)		
Vehicle with stiff primary suspension	+8 dB	Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. Include this adjustment when the primary suspension has a vertical resonance frequency greater than 15 Hz.
Resilient wheels	0dB	Resilient wheels do not generally affect ground-borne vibration except at frequencies greater than about 80 Hz.
Worn wheels or wheels with flats	+10 dB	Wheel flats or wheels that are unevenly worn can cause high vibration levels.

frequency) seems to be the optimal range in terms of stability, noise and vibration,” Rajaram said.

Rajaram also noted the FTA figures are predictive guidelines and that previous studies have shown that differences in suspension stiffness are more likely to cause a shift in the frequency of vibrations, rather than a change in magnitude.

In addition to these factors, there are adjacent elements like track condition and wheel/rail profile design that affect the car builder’s analyses and calculations during the design phase and continue to play an important role in vehicle performance long after the customer has taken delivery.

Vehicle procurement is a complex process. On top of these conditions, the specifications that transit systems set for vehicle

Measured vibration data | Wheel condition

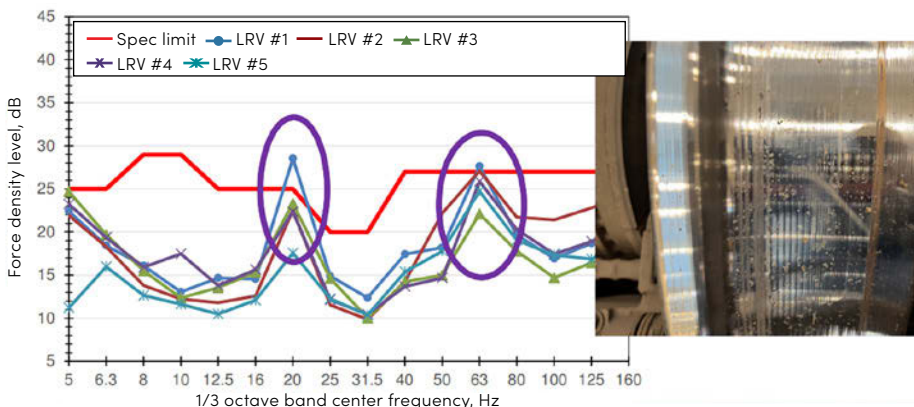


FIGURE 4. Sound Transit has developed its own vibration criteria for vehicle procurement.

(Rajaram Shankar Presentation).

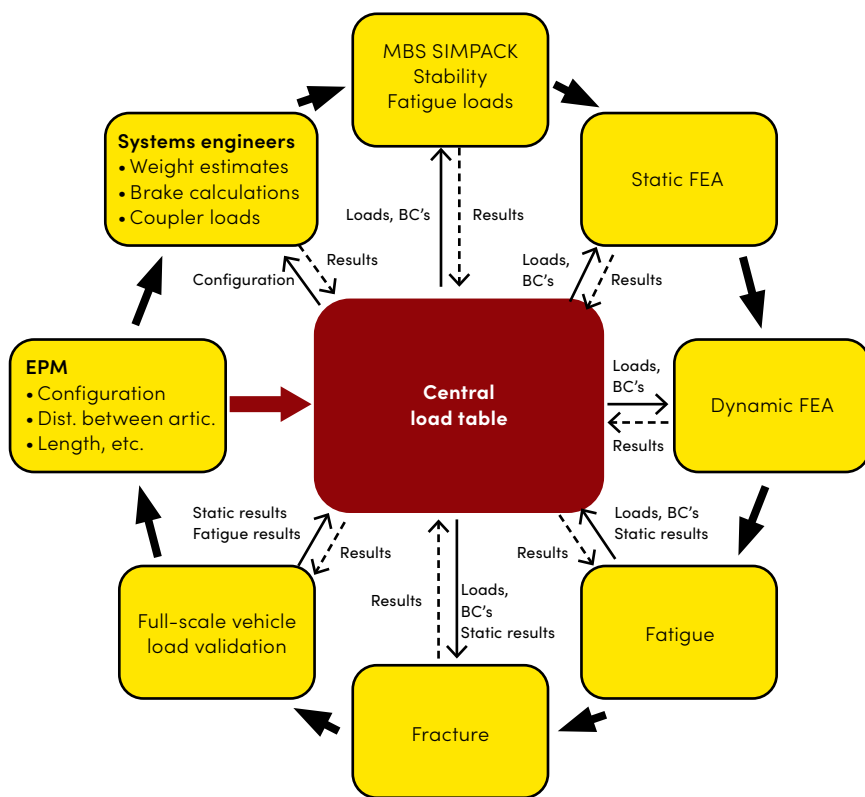


FIGURE 5. A typical project lifecycle for vehicle development.

(Kevin McClain presentation).

procurement continue to grow more stringent, particularly regarding noise and vibration. These improvements are made possible by vehicle designers and builders leveraging new technologies and materials to push the performance envelope as far as possible and by the refinement of noise and vibration measurement and prediction techniques.

Sound Transit, for example, has developed its own vibration criteria for vehicle procurement. According to Rajaram, the

Y-axis shows on-third octave band frequency in hertz and the X-axis shows force density level in decibels, a metric used by the FTA to determine vibration generated at the source, independent of external factors. Per Sound Transit’s contract, every new vehicle delivered to the agency is tested and must meet this specification. The measured vibration data also shows two peaks – one at 20 Hz and one at 63 Hz. Subsequent analysis indicated the 20-Hz

peak was related to wheel out-of-roundness while the 63-Hz peak was related to wheel surface roughness.

Rajaram notes at one point in their monitoring, multiple trains abruptly began to exceed their vibration threshold in the 63-Hz range. It was later determined this was due to a mis-calibrated wheel truing machine that was introducing significant surface roughness. Once this was corrected, vibrations returned to acceptable levels.

### A strong foundation

Light-rail vehicle truck designs can be subject to many different requirements depending on the customer. Sergio Perez, manager of Carbody and Truck Engineering and Development at Stadler Rail Valencia, explained the requirements can take the form of comparative analysis, such as equivalence or improvement over current vibration measurements, absolute requirements like a specified value for noise or vibration and requirements defining the product parameters like unsprung mass or use of resilient wheels. Comparative analysis can be particularly challenging to assess without extensive analysis. Perez said that without knowing the transmission path or characteristics of ground-borne vibrations, it’s difficult to design a solution.

Absolute requirements, such as those that Sound Transit uses in its procurement specification for ground vibrations, are often based on FTA Transit Noise and Vibration Impact figures (in the U.S.). According to Perez, ISO 2631

is also used as a ground vibration reference, though typically oriented toward on-board ride quality.

Requirements defining vehicle parameters can be beneficial in scenarios where a customer has previously implemented a vehicle-based solution to resolve an issue and wants to replicate that success.

“These types of requirements have major implications for the design phase and may even be in conflict with one another and it’s important to consider the effect of each component on the vehicle as a system; a component or parameter optimized for one specific vehicle may be sub-optimal in another,” said Kevin McClain, director of mechanical systems engineering at Siemens Mobility Inc.

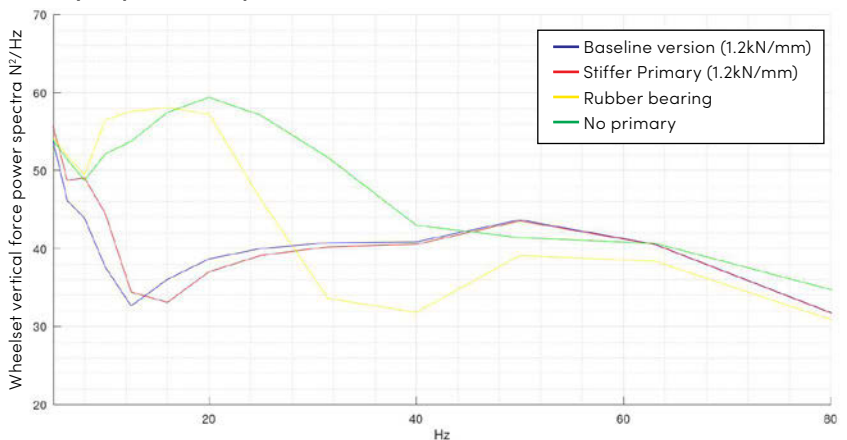
McClain went on to note that once a car builder begins a project, it tends to follow a prescribed lifecycle and while the details and specifications of each project vary, the process does not. Within the project lifecycle, car builders work with a tremendous amount of data. Every point of data, whether taken from the specification, theoretical calculations or simulations, finite element analyses or full-scale testing, helps to improve the end-result: The vehicle. Whether they are collecting it or not is provided by the customer, car builders depend on accurate and readily available data to deliver an optimized vehicle on spec and on time.

Due to the several components that make up a vehicle and because so many variables affect vehicle performance, car builders such as Stadler and Siemens make heavy use of multibody simulations. These simulations allow them to model the effects of design choices on vehicle parameters and characteristics like ground vibrations.

Figure 6 shows an example analysis of primary suspension solutions of varying stiffness and their effect on truck vibration. In this model, the softer primary suspensions (1.2kN/mm and 1.8kN/mm) significantly outperform the stiff rubber bearing (8kN/mm) and no-suspension solutions.

“Of course, it’s always better to have some suspension than none but there is

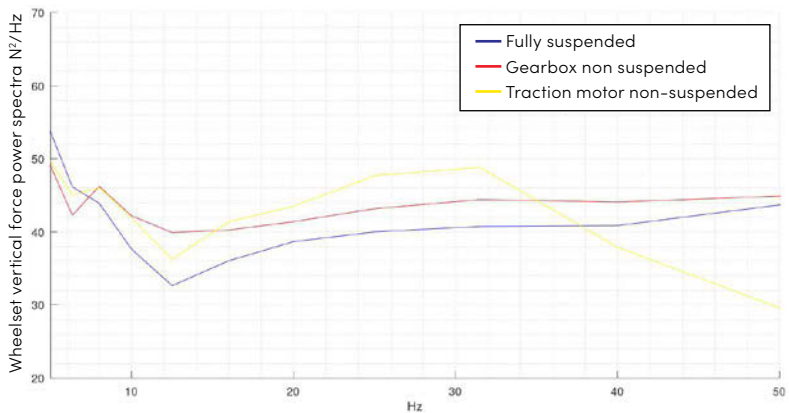
**Primary suspension comparison**



**FIGURE 6. Analysis of primary suspension stiffness.**

(Sergio Perez presentation)

**Unsprung mass comparison—1/3 octave—30 mph**



**FIGURE 7. Comparison of unsprung mass values in a vehicle drive unit.**

(Sergio Perez presentation)

an improvement by a factor of four in terms of force power spectra when moving to a soft suspension,” Perez said.

The same simulation can be used to isolate and model unsprung mass values. In this case, three values are modeled:

- A baseline fully suspended drive
- A partially-suspended/gearbox-unsuspended drive
- An unsuspended drive and motor

Perez notes that in this model, the results for the three variations are similar but there are caveats, the first being, that all variants in the model have resilient wheels, potentially damping the effects of unsuspended components.

“And this model doesn’t give us much information past 40 Hz, likely underestimating the impact of the fully unsuspended drive,” Perez noted.

Models including higher frequencies and tests Stadler has performed indicate that a fully unsuspended drive imparts about 30 percent more vertical dynamic force to the system than baseline for a vehicle moving at 30 mph.

According to Perez, resilient wheels modeled in the same simulation show results in line with those found in FTA documentation. In conjunction with a soft suspension, changing only the resilient wheel variable (solid wheel versus resilient

wheel versus ultra-resilient wheel) has very little effect on average vibration for a vehicle already equipped with a soft primary suspension.

“But even in this case, the resilient wheel is still very important for noise control, despite the lesser impact on ground vibrations, as it provides more benefit at higher frequencies,” Perez said.

Car builders also use multibody simulations to model carbody connection types, truck steering configurations and solid axles versus independently rotating wheels. This performance is typically expressed in vibration and noise, truck lateral force values and wheel squeal propensity, respectively.

According to Perez, both models and field tests have shown that independently rotating wheels meet the excitation threshold associated with wheel squeal more frequently than solid-axles under a wide variety of operating conditions.

“Although independently rotating

wheels don’t have a profound effect on the lower frequency range affecting ground vibrations, they have a very clear impact on higher frequencies affecting noise generation,” Perez said.

These simulations and data from field testing have helped Stadler develop general internal guidelines for optimized truck designs:

- A soft primary suspension is the main vehicle parameter influencing ground vibrations, followed by a low unsprung mass.
- Ultra-resilient wheels are only justified when combined with stiff primary suspension.
- Friction-free carbody connections produce lower vibration and noise than alternatives.
- Optimized primary suspension steering systems and solid axles provide the best performance in terms of truck lateral forces and noise generation.

Guidelines like these are valuable, especially when backed by simulation and field data. On top of these design considerations, car builders must consider vehicle/track interactions unique to the customer and their operating environment. By incorporating track data into their modeling and simulations, car builders can tailor their design to the true track condition rather than the design spec and ensure that even in the worst-case scenario, the vehicle will meet performance and safety specifications. **L**

**Part 2** of this article will continue to follow the discussion on vehicle design, held at the 2023 Wheel/Rail Transit Conference and will take a closer look at some of the ways in which car builders collect and integrate track data and the importance of taking a holistic approach to vehicle/track interaction.

**About the author**

**Jeff Tuzik** is managing editor of *Interface Journal*.

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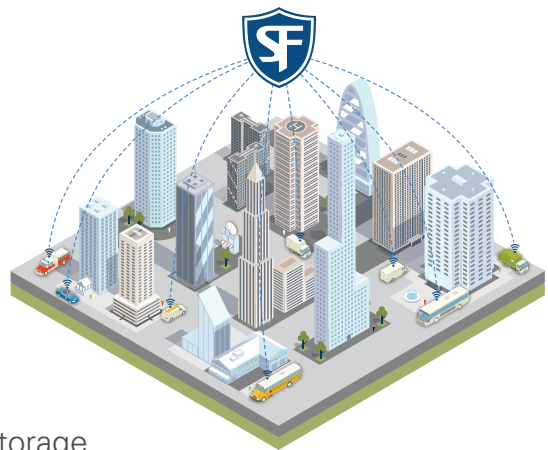
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# The Transportation Technology Center:

## A Hub for Advanced Passenger Train Testing

TTC evaluates operational readiness of Stadler's FLIRT DMU, as well as the innovative ZEMU, which will support the future of sustainable passenger rail transportation.

BY MATTHEW DICK, CONTRIBUTOR

In the dynamic world of passenger rail transportation, the Transportation Technology Center (TTC) in Pueblo, Colo., emerges as a critical resource for cutting-edge testing and validation of the latest passenger train technologies. Operated by ENSCO since October 2022, the facility offers an unparalleled environment for the rigorous assessment of new passenger rolling stock prior to their deployment in various transit systems, commuter railways and intercity services. This article explores recent operational testing achievements at the TTC, focusing on significant milestones with the Stadler FLIRT Diesel-Multiple Unit (DMU) trainsets for Dallas Area Rapid Transit (DART) and the pioneering hydrogen-powered Zero Emission Multiple Unit (ZEMU) train destined for the San Bernardino County Transportation Authority (SBCTA).

### Operational excellence in testing: Stadler FLIRT DMU for DART

The TTC has long been revered as the ideal setting for exhaustive qualification testing of new passenger trains, offering a controlled, isolated environment that ensures thorough attention to safety and reliability without disrupting existing transit operations. This attribute was vividly illustrated with the arrival of Stadler's DART DMU trainsets to the TTC in fall 2022. The testing of the DMU at the TTC not only marked the



first passenger trainset to be evaluated at the newly revitalized center under ENSCO's stewardship, but also symbolized the commencement of a new chapter for TTC in serving the future needs of the passenger rail industry.

The DART FLIRT DMUs, featuring a diesel-electric configuration with a focus on high passenger comfort and efficient operation, underwent extensive testing phases. This included static and dynamic evaluations covering brake and traction performance, noise levels, electromagnetic compatibility and onboard train control systems testing. The TTC's vast 52-square-mile facility, boasting 50 miles of test tracks, provided an optimal environment for these comprehensive assessments. Among these tracks is the Rail Transit Track (RTT), a 13.5-mile high-speed loop with a maximum speed of 165 mph and equipped with AC catenary. Additionally, the Transit Test Track, another 9.1-mile loop with a maximum speed of 90 mph and equipped with third rail and DC catenary, further facilitated continuous testing of the trainsets with dedicated track access and simultaneous testing for other customers.

Throughout the testing program at the TTC, the Stadler DMU and its team were accommodated in the Passenger Rail Services Building (PSB), a three-bay, 46,000-square-foot depot specifically designed for supporting passenger car testing at the TTC. The trainset and team also received support from TTC staff and equipment for vehicle maintenance activities during testing, including the loading and unloading of sandbag ballast into the DMU to simulate passengers. In addition to the PSB, there are three other depot buildings utilized for passenger trainset testing:

- The 19,400-square-foot Urban Rail Building
- The 7,700-square-foot Transit Maintenance Building
- The 38,800-square-foot Center Services Building used for conducting heavy vehicle maintenance and equipped with two 30-ton cranes and machine shop.

Testing at the TTC included brake and traction performance, noise testing, Electromagnetic Compatibility (EMC)

testing and train control testing for onboard equipment. Brake and traction performance tests were conducted on the TTC's high-speed test tracks to ensure the DMU met essential operational performance and safety requirements. This is key to perform at the TTC as opposed to on a transit's revenue tracks so that revenue service is not impacted and Stadler had free control to make the test runs needed and allow time for adjustments to the vehicle. Similarly, noise testing is performed on the high-speed test tracks to confirm that the noise inside and outside of the vehicle meet expectations to ensure comfortable experiences from passengers and the public.

EMC testing ensured the DMU does not emit at-risk electromagnetic signals that could interfere with electronic infrastructure equipment and ensuring the DMU itself is not susceptible to anticipated outside electromagnetic interference. This is particularly important for the DMU's train control system to ensure it operates in anticipated electromagnetic conditions without issue. Additionally, the Stadler DMU was featured in the TTC 50th Anniversary Event on Oct. 25, 2022. During this event, attendees enjoyed a historic ride on the Stadler DMU around the TTC's largest test loop, the RTT, symbolizing the beginning of a new era for the TTC.

**Stadler DMU  
FLIRT Trainset  
at the TTC.**

Photos: ENSCO





Passengers ride on the Stadler DART DMU during the TTC 50th Anniversary Event on Oct. 25, 2022.

### Pioneering the future: Hydrogen-powered MU train testing

In parallel, the TTC has played a pivotal role in advancing the green transportation agenda through the testing of the United States' first off-wire zero-emission passenger train—Stadler's Hydrogen-Electric Multiple Unit the FLIRT H2 for SBCTA. Amidst a growing environmental focus and the urgent need for sustainable transportation solutions,

the FLIRT H2 project represents a significant leap towards reducing greenhouse gas emissions in the rail sector. Utilizing hydrogen fuel cells for propulsion, the FLIRT H2 showcases the potential of hydrogen as a clean, efficient alternative fuel, aligning with the nation's decarbonization goals.

The FLIRT H2 combines hydrogen fuel cells and batteries to propel the vehicle. Electrical power is generated by combining hydrogen with oxygen in on-board fuel cells. During operation, the FLIRT H2 emits only water vapor, resulting in zero carbon emissions. When hydrogen is produced using green methods, the entire system can achieve zero carbon emissions.

The hydrogen train, comprising two cars with a power module in-between housing the hydrogen tanks and fuel cells, accommodates 108 passengers with generous standing room and can achieve a maximum speed of up to 79 mph. It is expected to start operation as part of Metrolink's Arrow service between San Bernardino and Redlands, Calif., in 2024.

Arriving at the TTC in 2023, the SBCTA Zero-Emission Multiple Unit (ZEMU) underwent testing encompassing both static and dynamic phases, evaluating its acceleration, deceleration, maximum speed, brake performance and, crucially, its operational service with zero-emission capabilities. The specialized tracks at the TTC facilitated thorough examinations of the FLIRT H2 performance in various operational scenarios.

Both Stadler and ENSCO prioritized proper fueling operation and storage at the TTC during the testing program. The team successfully sourced and fueled the hydrogen trainset, with ENSCO establishing a roadmap, in collaboration with partners, for short-term solutions and a longer-term plan to establish a permanent hydrogen fueling station and conduct ongoing hydrogen transportation research and testing at TTC.

The North American railway industry needs alternative green energy sources such as hydrogen trains to meet increasing sustainability requirements. The TTC is proud to support the first U.S. hydrogen passenger train testing and is ready to support all future research and testing needs to enable a safe and sustainable transportation future.

### Supporting safety, sustainability and security

The role of the TTC, as evident by the testing of both the Stadler FLIRT DMUs and the FLIRT H2, extends beyond the validation of trainsets' technical specifications. It represents a commitment to fostering innovation in passenger rail transportation, ensuring that new technologies are safe, reliable and aligned with future sustainability targets. ENSCO's operation of the TTC has injected fresh momentum into this endeavor, broadening the scope of transportation modalities that can be tested and thereby supporting the industry's evolving needs.

Moreover, the TTC's support for the hydrogen fuel initiative, through the establishment of a roadmap for fueling operations and future research, underscores its role as a catalyst for the adoption of green energy solutions in rail transportation. This aligns with the broader industry and governmental

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**Stadler Hydrogen ZEMU FLIRT Trainset at the TTC.**

objectives to decrease dependency on petroleum fuels and mitigate environmental impacts.

In addition to safety and sustainability, the TTC has launched the Center for Critical Infrastructure Protection (CCIP). Leveraging ENSCO's cybersecurity expertise, CCIP supports passenger transit cybersecurity needs, including penetration testing (pen-testing) of rolling stock. A unique capability of CCIP at the TTC is its ability to perform pen-testing in a safe operating environment without affecting revenue operations of a passenger transit or railway. As cybersecurity concerns continue to rise, testing the on-track service worthiness and cybersecurity resilience

of new rolling stock becomes increasingly essential.

### Conclusion

The TTC stands at the forefront of technological advancement and sustainability in the rail industry. Through its comprehensive testing capabilities, the TTC is not only validating the operational readiness of innovative trainsets like the Stadler FLIRT DMU and the ZEMU, but is also playing a pivotal role in shaping the future of safe, secure and sustainable passenger rail transportation. As the TTC continues to support and facilitate these advancements, it reaffirms its essential position within the industry, ensuring the safe, efficient and sustainable movement of passengers across North America's rail networks. Additionally, in the new era of the TTC, it now has the directive to expand its mission beyond rail and include all modes of surface transportation. [L](#)



### About the author

**Matthew Dick** is chief of strategy and development at ENSCO, Inc.



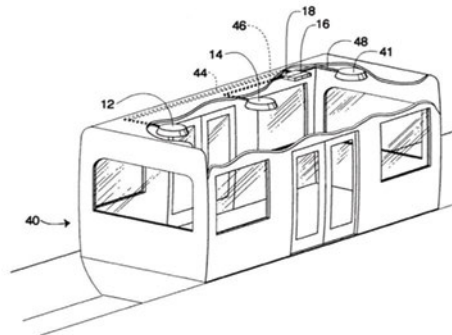
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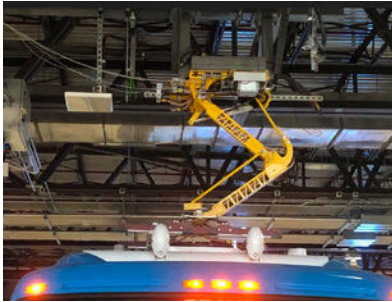
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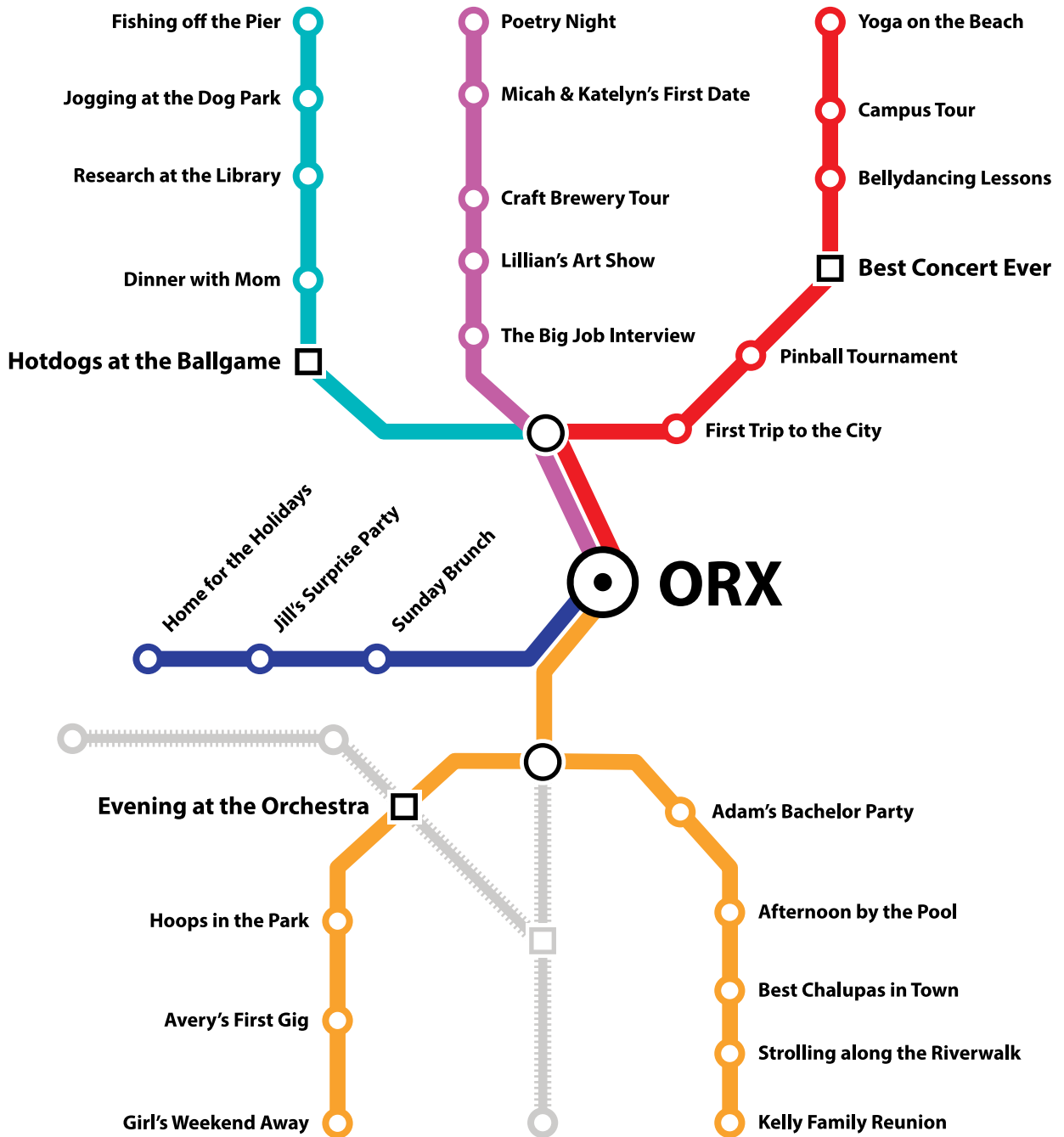
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