1. Introduction

Transit is returning to its central place in the life of cities. With more people using buses, streetcars, and light rail than ever before, our street design paradigm is shifting to give transit the space it deserves. People are choosing to live, work, and play in walkable neighborhoods, and cities are prioritizing highly productive modes like transit as the key to efficient, sustainable mobility for growing urban populations. Transit agencies and street departments are working together to create streets that not only keep buses and streetcars moving, but are great places to be. Cities are extending light rail systems, investing in streetcar lines, and creating new rapid bus lines at a stunning pace, with ridership growing even faster in city centers. Transit agencies are rethinking their networks to serve neighborhoods at a high level all day, not just at commute times, while bike share and active transportation networks make it even easier to not only reduce driving, but to avoid the expense of owning a car.

At the heart of these changes is the need for cities to grow without slowing down. Transit is a key that unlocks street space, bringing new opportunities to create streets that can move tremendous numbers of people and be enjoyed as public spaces at the same time.

Cities around the country and around the world are finding new ways to create these places. To codify and advance best practices in transit design, the National Association of City Transportation Officials has brought together practitioners and leaders from the transit and street sectors to develop the *Transit Street Design Guide*. This new framework for designing transit corridors as public spaces will help cities and their residents work together to create the streets that are the foundation of a vibrant urban future.

Key Principles

BETTER STREETS, BETTER SERVICE

Making transit work in cities means raising the level of design across the entire street network. Cities can take the lead on transit, creating dedicated lanes and transitways, designing comfortable stops and stations, and coordinating action with transit agencies on intersections and signals.

Transit-first street design also means treating walking as the foundation of the transportation system. Ultimately, the efficiency of transit creates room for public space, biking and walking networks, and green infrastructure—allowing cities to remake their streets as safer, more sustainable public spaces.

TRANSIT CREATES URBAN PLACES

Cities and transit are deeply linked. In vibrant, bustling cities, people are on the move, and transit plays an indispensable role in keeping them moving. Walkable urban places have a critical mass of people and activities that support and rely on transit to connect them to other places. Cities can strengthen this synergy by creating transit streets: places that move people.

With the majority of US residents preferring walkable, bikeable urban environments,[1] the value of better transit accrues not only to existing transit passengers and newly attracted ones, but to people who will decide where to live and start businesses—in which neighborhood, city, or region—based on the availability of transit-served walkable neighborhoods. These location decisions affect the competitiveness of the entire metropolitan area and justify transit-first policies in street design and investment.

A MOBILITY SERVICE FOR THE WHOLE CITY

Making it possible to quickly and reliably go anywhere by transit is a way for cities to significantly improve quality of life. A transit system designed as a mobility service focuses on its value to the rider, providing prompt, seamless, and safe connections to where people want and need to go. A public transit-based mobility system, open to people of all ages and abilities, is fundamentally more equitable than one based primarily on private vehicles.

A crucial complement to the transit network is a suite of flexible, convenient, and affordable mobility choices—walking, bicycling, shared mobility, and on-demand rides—that, together with fixed-route transit, allow residents to avoid the costs of car ownership and make proactive decisions about each trip they take.

GROWTH WITHOUT CONGESTION

Transit streets allow growth in economic activity and developmental density without growth in traffic congestion by serving more people in less space. Transit is most productive for a city and most effective for riders when a large number of people want to travel along one street, but these types of streets are inherently prone to automobile congestion, with unreliable travel times when the most people need to travel.

Streets designed for rapid transit reverse this equation, making transit trips fastest on streets with high travel demand, where frequency is greatest. A public transit-based mobility system benefits everyone in a city, whether or not they choose to ride transit, as people using transit and private vehicles alike can access more destinations in the same amount of time after transit has been improved and density increased.

SAFE MOVEMENT AT A LARGE SCALE

With transit's order-of-magnitude safety advantage over private automobiles, promoting transit is integral to policies that seek sustained improvements in pedestrian, bicyclist, and vehicle occupant safety. Transit mode share and transit-supportive infrastructure are directly correlated to lower traffic fatality rates.[2]

Improving transit does not mean creating speedways, since higher top speeds have little benefit for transit on city streets. Transit streets designed with people in mind are safe places to walk and bike, and transit improvements go hand in hand with better pedestrian access, safer crossings, and more enjoyable public space.

PERMANENT ECONOMIC BENEFITS

Transit streets save both time and money, making frequent service into a financially sustainable proposition and setting off a virtuous cycle of more riders, more service, and more street space for people. Beyond the well-documented local economic benefits of transit-friendly street design, savings are accrued by transit agencies, which can provide mobility to more people at a lower cost, as well as to passengers who can access more destinations faster. And since transit supports higher-value, more compact development, it is a more fiscally sustainable investment than highway infrastructure. These savings are good for businesses and residents along a transit corridor and far beyond.

Powell Street, **SAN FRANCISCO, CA**

Why Transit Streets Matter

High-quality transit allows a city to grow without slowing down. When prioritized, transit has the potential to stem the growth of vehicle congestion, provide environmentally efficient and responsible transportation, and reduce both personal mobility expenses and overall public infrastructure expenses. And transit that can be relied on makes it possible to build walkable urban places—the kinds of places that city residents increasingly demand.

Accomplishing all of this requires that cities set priorities and make investments, both in transit service itself and in the streets on which transit operates. Much of the transit street design challenge lies in aligning the priorities and demands of city departments with those of transit operators, and in demonstrating the value of investments and dedicated street space to city residents and leaders. Balancing multiple modes in a limited right-of-way calls for a considered approach, with short-term successes building to long-term gains.

Designing to Move People

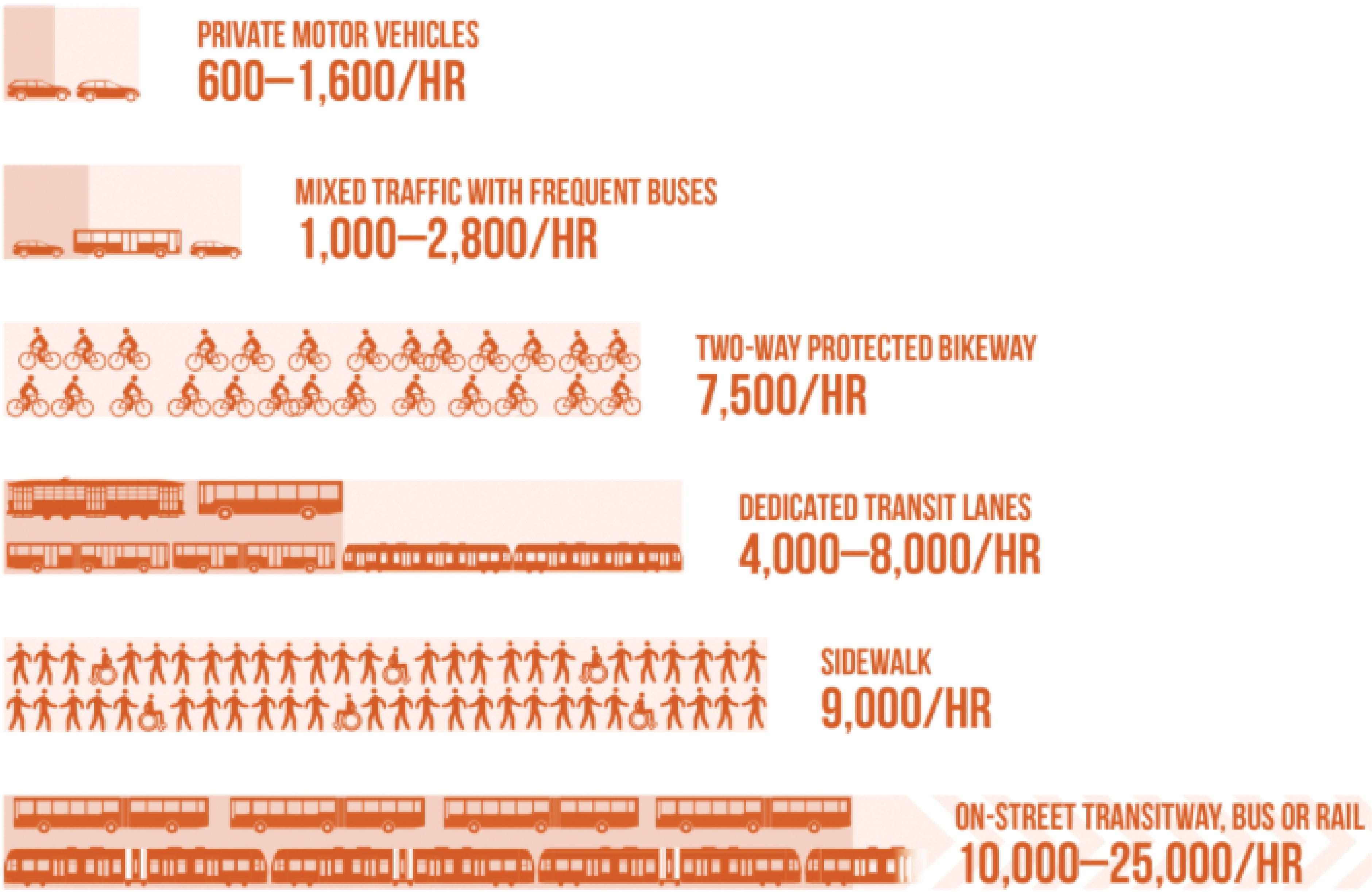
Transit streets are designed to move people, and should be evaluated in part by their ability to do so. Whether in dense urban cores, on conventional arterials, or along neighborhood spines, transit is the most spatially efficient mode.

Traditional volume measures fail to account for the entirety of functions taking place on urban streets, as well as the social, cultural, and economic activities served by transit, walking, and bicycling. Shifting trips to more efficient travel modes is essential to upgrading the performance of limited street space.

Using person throughput as a primary measure relates the design of a transit street to broader mode shift goals.

While street performance is conventionally measured based on vehicle traffic throughput and speed, measuring the number of people moved on a street—its person throughput and capacity—presents a more complete picture of how a city's residents and visitors get around. Whether making daily commutes or discretionary trips, city residents will choose the mode that is reliable, convenient, and comfortable.

Transit has the highest capacity for moving people in a constrained space. Where a single travel lane of private vehicle traffic on an urban street might move 600 to 1,600 people per hour (assuming one to two passengers per vehicle and 600 to 800 vehicles per hour),[3] a dedicated bus lane can carry up to 8,000 passengers per hour. A transitway lane can serve up to 25,000 people per hour per travel direction.[4]



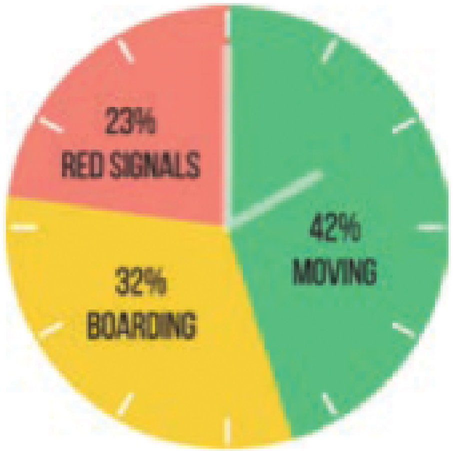
The capacity of a single 10-foot lane (or equivalent width) by mode at peak conditions with normal operations.[5]

Reliability Matters

Unlocking the enormous potential of transit requires active measures to make trips take less time. To achieve this, the *Transit Street Design Guide* details street design strategies to improve transit reliability and reduce overall travel times.

Transit service that is reliable and efficient brings value to people and cities, but slow and inconsistent service will discourage passengers and jeopardize local benefits. If a trip takes significantly longer by transit than by other modes, or if actual trip time ranges so widely as to be unpredictable, people may choose not to take transit and cities will miss out on opportunities to reduce congestion and spur development.

For urban transit, getting to a destination faster means removing sources of delay rather than raising top travel speeds. The most significant sources of transit delay are related to both street design and transit operations, calling for coordinated action by transit and street authorities.



MINNEAPOLIS, MN: In the Twin Cities, the transit agency estimates that the majority of transit runtimes on a major corridor are when transit vehicles are not moving. (Source: Metro Transit).

NEW YORK, NY: After implementing a series of street and service improvements including all-door boarding and dedicated lanes on First and Second Avenues, New York's Metropolitan Transportation Authority and Department of Transportation observed substantial travel time improvements on the M15 Select Bus Service compared with the previous M15 Limited service. (Source: NYC DOT).

TRAFFIC & INTERSECTION DELAY

In mixed traffic, transit is limited by prevailing traffic conditions, and will be delayed by all the factors that delay the cars it shares space with. Time spent waiting for signals or slowing for stop signs, known as intersection delay or traffic control delay, increases as traffic volume nears the capacity of the street, and as cross streets are more frequent or reach their own capacity. Providing transit lanes (see page 110) and using signal strategies (see page 149) can help cut travel times by half, with the greatest benefits made available by using transitways (see page 126). While these levels of priority stop short of grade-separated facilities, they can be the foundation of every city's transit design toolbox, and are inherently adaptable to a variety of street conditions.

While signal delay is relatively easy to address through active TSP if traffic queues are short, signals with long or variable queues can add up to very long delays for buses and streetcars in mixed-traffic conditions. Time spent slowly approaching red signals or stop signs in heavy traffic can also contribute to overall delay.

Unreliable travel times are a major issue for transit operations because short delays can quickly snowball as more passengers try to board a late-arriving vehicle. Missing one green signal can cause a bus or streetcar to fall behind enough to delay the transit vehicle behind it.[6]

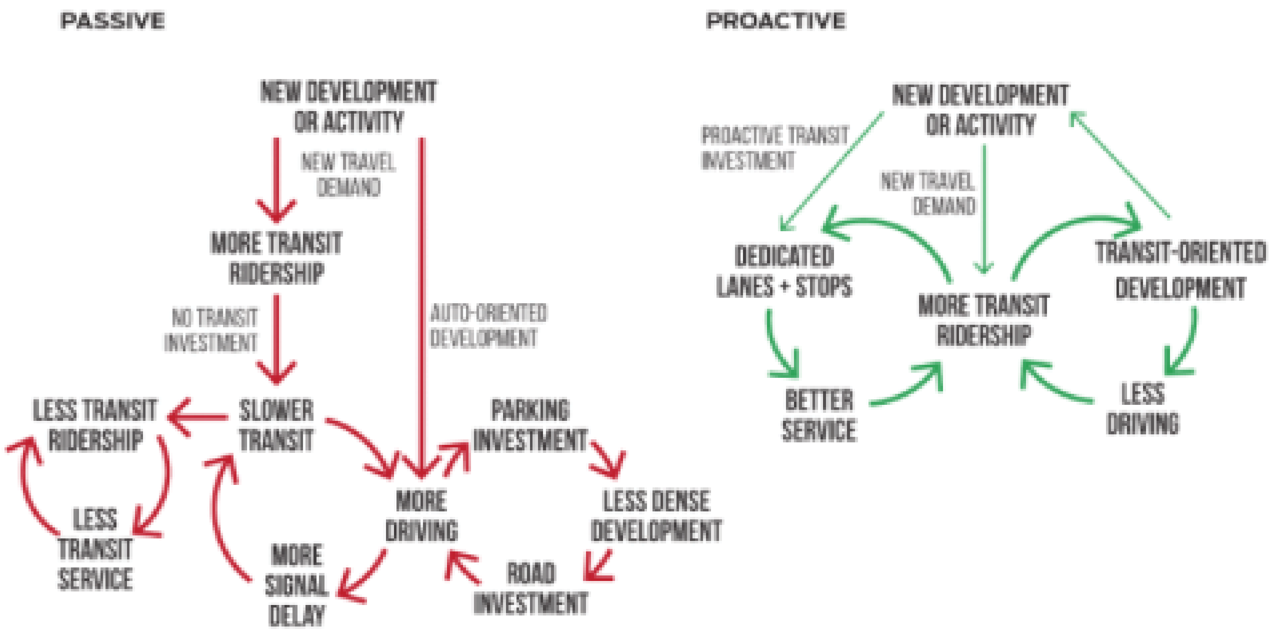
DWELL TIME

Dwell time related to passenger boarding and payment is a large component of total travel time on productive routes, especially in downtowns and destination areas. Level or near-level boarding (see page 64), multi-door boarding and advanced payment options (see page 182), and better passenger information can cut dwell time in half or more. Stop consolidation also reduces the amount of time spent dwelling at stops.[7]

Savings from Transit Improvements

Example of operational savings from transit improvements.

Responding to development



Examples of the compounding benefits from responding proactively to development through transit investment (right), and the compounding issues from auto-oriented development without transit investment (left).[8]

TIME IN MOTION: ACCELERATION, MERGING, AND ROUTE DIVERGENCE

Acceleration, deceleration, and door operation time approaching or leaving a stop can add 15–30 or more seconds per stop. Consolidating from stops to stations (see page 181) and introducing rapid services (see page 10) can dramatically reduce this time expenditure.

For buses in particular, merging into or re-entering the flow of general traffic after a conventional curbside pull-out stop is a perennial source of delay. Reduce this delay by providing in-lane stops and stop-related signal treatments (see *Signals & Operations* on page 149, and *Stop Placement & Intersection Configuration* on page 60), or by enforcing a yield-to-bus law.

Circuitous routes and turns can be time consuming for transit operators and confusing for passengers, often adding significantly to travel time. Keeping transit lines simple and direct serves to minimize this delay, improving transit travel times. While this may increase the time spent walking to a stop, it can benefit overall trip times. Evaluate any changes based on a walking network model and transit travel times.

PASSENGER ACCESS AND WAIT TIME

In addition to on-board transit time, a passenger's trip time also includes time spent walking to a stop, waiting for transit to arrive, making any transfers, and accessing a destination. Since passengers place 2.5 times more value on a shorter wait than on a shorter amount of time spent in motion or a shorter walk to transit, a small improvement in wait time can provide a larger benefit to passengers and a greater boost to ridership than a similar improvement in speed.[9]

Reliability affects how passengers perceive wait times. If wait time and travel time vary significantly, or are routinely much longer than the scheduled time, passengers build this time into their trips, and transit becomes less useful for them.

Transit and street design can make wait time valuable to passengers by providing comfortable waiting areas at stops (see *Stations & Stops*, page 57), by providing real-time information to reduce start-of-trip wait times, and by reducing the time needed for transfers through network design (see *Transit System Strategies*, page 175). Quality urban street design can make walking to a transit stop a positive feature of transit trips.

UNLOCKING OPERATIONAL EFFICIENCIES

Addressing the main sources of transit delay has two related benefits. It shortens door-to-door time for a passenger trip, improving the competitiveness of transit. It also reduces the time and cost of each transit vehicle's run, enabling a transit agency to provide more frequent service to each stop with the same number of vehicles and drivers. In this context a small travel time savings is a large cost savings.

Buses in mixed traffic are susceptible to a downward service spiral, in which increased congestion—exacerbated over the long term by designing streets primarily to accommodate private motor vehicles—results in lower ridership and revenue, resulting in service cuts and lower ridership and revenue.

This cycle can be reversed by improving on-street transit travel times. Shorter travel time allows transit operators to run more frequent service, with more runs per hour using the same number of vehicles and drivers. Greater frequency and shorter trip time yields higher ridership, raising revenue and permitting still greater service frequency.

For detailed information and analysis of transit delay, see the Transit Capacity and Quality of Service Manual, 3rd Edition.

16th Street, **DENVER, CO**

Service Context

Different transit services call for different facilities. While street design practice has historically focused on motor vehicle movement and has treated transit capacity as primarily influenced by stop design, street design processes are increasingly recognizing that key transit lines—those with higher ridership, higher frequency, and more potential for growth—both need and justify greater accommodation than lower-ridership routes.

Designing for the type and frequency of transit service on a street means providing transit with priority treatments and the space necessary to perform at a high level. Whether a route uses bus, light rail, or streetcar, service decisions in an urban transit network are made based on a complex combination of capacity, reliability, comfort, and the need to accommodate passengers in a network. Some projects involve a simultaneous change in transit service on a street along with transit prioritization or streetscape investments, but all street design projects have a service context.

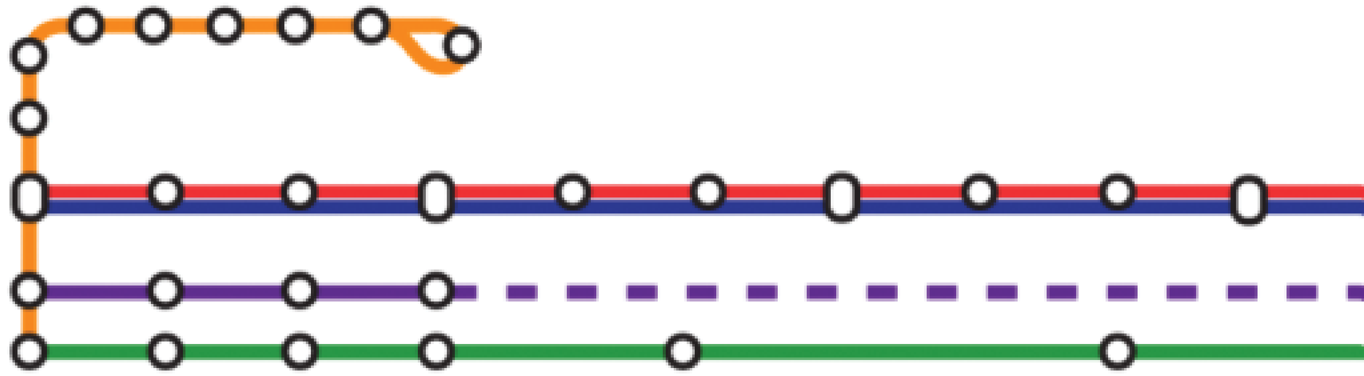
This section provides designers and planners with a basis of discussion of the needs of transit, by linking specific design elements and comprehensive street designs, found later in the *Guide*, with concepts of transit service frequency and the type of transit route supported by a street.

Transit Route Types

Different streets, neighborhoods, and cities have different transportation needs, and a wide range of service types are available to meet them. Likewise, service can be complemented by a range of design elements depending on service needs and street context.

When prioritizing street investments, differentiate between "structural" and "non-structural" transit routes. Structural routes form the bones of the transit network, and yield the greatest results from upgrades. Non-structural routes serve to fill gaps in the transit network.

Robust evidence-based service planning using realistic data can identify new service and growth opportunities, especially opportunities to add rapid routes. These can be supported by street design to create broader transit benefits.



DOWNTOWN LOCAL

Downtown local routes, often frequent, serve an area with a very high demand for short trips and are sometimes operated by a city transportation department or civic group. Unlike conventional loop circulators, downtown locals provide a core transit function for short distances, sometimes parallel to longer local or rapid routes. If planned to complement rather than compete with other structural routes, they can become a permanent feature of the city.

APPLICATION

Downtown locals can be used to connect a high-capacity node (such as a commuter rail terminal) with a broader destination area.

Downtown locals provide extra capacity where dense residential areas are close to major employment or education centers.

Complementary designs:*

- In-lane stops
- Transit lanes

*Complementary Designs are detailed in Chapters 4 *(Lane Elements)*, 5 (*Stop Typologies*), 6 (*Stop Elements*), and 7 *(Intersection Strategies)*.

SERVICE DETAILS

- Stop Frequency: 4 or more per mile.
- Service Area: Compact, dense.

LOCAL

Local routes, whether served by bus or rail, are the basic building blocks of urban transit. Local service must balance access—usually considered in terms of stop frequency—with speed. For passengers and operators alike, reliability is often more important than running time. To be effective, local service must be as direct as possible. Deviating from a direct route to serve areas of relatively low ridership will degrade the quality of service.

APPLICATION

Appropriate for all urban contexts, local service serves trips within and between neighborhoods, downtowns, and other hubs.

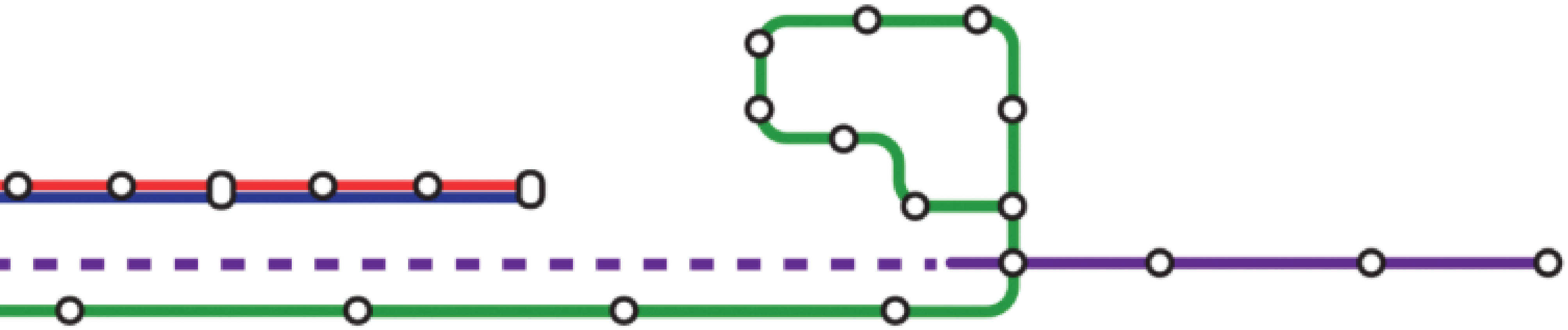
Provide stop and intersection investments, potentially tied to modest increases in stop distance, to reduce delay on local routes.

Complementary designs:

- Enhanced shared lanes
- Dedicated transit lanes
- Conversion from stops to stations
- Multi-door boarding
- Transit signal progressions and short cycle lengths

SERVICE DETAILS

- Stop Frequency: 3–5 per mile.
- Service Frequency: Moderate to high, depending on context.
- Service Area: While route length is variable, riders typically use for short- to medium-length trips (less than 3 miles).



RAPID

With less frequent stops and higher capacity vehicles, rapid (or "limited") service can provide a trunkline transit service for longer trips and busy lines, or can run along the same route as a local service. Most bus rapid transit, light rail transit, rapid streetcars, and limited-stop bus lines run on this service pattern.

APPLICATION

On long, direct, or high-demand transit routes, especially on priority corridors such as those connecting downtowns to dense neighborhoods.

Rapid service can make transfers worthwhile to more passengers on routes that intersect many other transit routes.

Complementary designs:

- Separated transitways
- Dedicated transit lanes
- Stations or high-amenity stops
- Transit signal priority
- All-door boarding

SERVICE DETAILS

- Stop Frequency: 1 to 3 per mile.
- Service Frequency: Moderate to high.

COVERAGE

In low-density areas, or where street networks are poorly connected, basic transit accommodation often results in indirect or infrequent service. In these areas, routes have to be circuitous to serve small pockets of ridership. This is best done by using a coverage route rather that adding a deviation to a local route. Keeping coverage routes as direct as is reasonable can be a prelude to a more productive service as density and demand increases.

APPLICATION

In less densely populated urban edges, coverage service provides a functional connector to regional hubs and destinations, and to the full transit network.

If coverage service is provided to a planned development corridor, include transit-supportive design in initial capital projects.

Complementary designs:

- Enhanced stops
- Complementary mobility services, such as taxi, for-hire vehicles, and car sharing can reduce the need for coverage service in some areas.

SERVICE DETAILS

- Stop Frequency: 2 to 8 per mile.
- Service Frequency: Low.
- Service Area: Low density, feeder to intermodal hubs.

EXPRESS

Provide direct point-to-point service with few stops using limited-access highways, sometimes in dedicated or HOV lanes, to reach destinations quickly. Express bus operation is usually more expensive per passenger than limited service, since it often uses one central boarding/alighting point. Many express services run coach buses.

APPLICATION

Connecting neighborhoods with peak-period ridership directly to downtown or other destinations such as airports.

Where freeways or other limited access routes are available.

Primarily serving long-distance commuter routes.

Complementary designs:

- Access to on-street terminals and other high-capacity stops
- Passenger queue management
- Dedicated transit lanes, especially in access routes to freeways or in downtowns

SERVICE DETAILS

- Stop Frequency: Non-stop "express segments" between service areas that have more frequent stops.
- Service Frequency: Scheduled, often infrequent and concentrated at peak periods. Schedule adherence is critical.

Transit Frequency & Volume

The volume of transit vehicles and passengers moving through and stopping on a street are key factors in both the selection of street elements and their detailed design. Street design has an interactive effect on transit frequency, both supporting transit at different volumes, and attracting passengers to different degrees. For decisions about street space and time allocation, the combined frequency of all routes is more significant than the frequency of any given route.

Frequency is discussed here in the context of standard buses during peak periods. For larger vehicles, consider both ridership and vehicle frequency in determining spatial needs.

Santa Fe Depot, **SAN DIEGO, CA**

LOW VOLUME

- Over 15 minute headways
- 4 or fewer buses per hour
- Typically fewer than 100 passengers per hour

Street design must accommodate transit vehicle geometry, but passenger and pedestrian safety and access are often larger issues on lower-use routes. Many express and coverage routes have low frequencies, with schedule adherence and general reliability the primary concern for passengers and operators alike.

Active transit signal priority (TSP) has relatively strong benefits for transit and minimal impacts on other modes.

Enhancing stops improves comfort and customer confidence.

Passenger information both at stops and online is critical to basic usability of the service.

Elements & Strategies:

- Enhanced stops
- Intermodal stations
- Active transit signal priority
- Passenger information
- Access to dedicated lanes
- Combined queue jump/turn lanes

MODERATE VOLUME

- 10–15 minute or shorter headways, generally 5–10 at peak
- 4–10 buses per hour
- 100–750 passengers per hour

Providing a qualitatively different service than low frequency routes, transit lines that are part of a frequent network should be kept prompt and reliable for easy transfers, overall usability, and a good passenger experience. These transit streets have room for growth, and services must be as competitive as possible.

Traffic delay, rather than dwell time, is usually the main source of delay. Intersection priority focused on reliability, and dedicated lanes at slow points, can put these services on the path to growing ridership.

Street design should prioritize transit stop convenience and provide transit vehicles with a preferred position in traffic, including in-lane stops and other priority treatments.

Moderately frequent service can be integrated into spaces shared with active modes, including shared streets.

Elements & Strategies:

- Active transit signal priority (all service)
- Transit approach lanes and queue jumps
- In-lane stops
- Boarding islands/bulbs; near-level boarding
- Multi-door boarding
- Dedicated transit lanes
- Dedicated peak-only lanes
- Shared bus-bike lanes

San Francisco's transit map clearly distinguishes route headways, helping riders consider wait times when making trips (MUNI map by David Wiggins & Jay Primus).

HIGH VOLUME

- 2–6 minute combined headways
- 10–30 buses per hour
- 500–2,000 passengers per hour

With transit arriving every few minutes, schedule adherence is less important to passengers than wait time, and maintaining headways matters for reliability as well as speed.

At these high service frequencies, buses and rail vehicles have a major influence on general traffic operations, and might account for a majority of travel on the street. Providing dedicated lanes or improving existing dedicated lanes can expand total street capacity, attracting more passengers. Transit can easily become the fastest mode on a street if given space.

If multiple routes operate or long dwell times occur, refer to very high volume guidance.

Elements & Strategies:

- Dedicated transit lanes or peak transit lanes
- In-lane stops
- Boarding islands/bulbs
- Low-speed signal progression
- Active transit signal priority (late vehicles only)
- Robust stops or stations
- All-door boarding

VERY HIGH VOLUME

- Combined headways under 2–3 minutes
- More than 20–30 buses per hour
- Over 1,000 passengers per hour on multiple routes, or over 2,500 per hour on one route with multi-unit vehicles

The performance of transit on streets where multiple routes converge at key points in the network often determines the fate of the entire transit network. On these highly productive transit streets, transit will dominate the streetscape whether or not the design prioritizes it effectively. Exclusive transit lanes are crucial for maintaining speed and reliability.

At headways of 3 minutes and shorter, buses and rail vehicles carry thousands of passengers per hour, and must be insulated from general traffic delay. Dedicated lanes or transitways are indispensable for the efficient movement of people. Stop capacity is a critical operational factor.

Signal and intersection operations should favor transit, with transit-friendly signal progressions or dedicated transit phases providing stronger benefits than active transit signal priority.

Elements & Strategies:

- Transitways or dedicated transit lanes with turn management
- Dual transit lanes or dedicated lanes with pull-out stops
- On-street terminals
- Boarding islands/bulbs
- Transit signal progression

Case Study: Houston Metro System Reconfiguration

On August 16, 2015, Houston's Metro transit system implemented one of the largest bus network changes in US history. All local routes, including routes that had not been rethought since the 1920s, were redesigned and integrated with recently opened light rail lines.

Just a few months after implementation of the New Bus Network, local bus ridership had increased 4.3%, and total local network ridership increased 11% from November 2014 to November 2015. Weekends in particular received much more frequent service, resulting in a Sunday ridership jump of 30%. The fast success of this effort demonstrates the value that cities can generate by matching the transit network to the street network.

The New Bus Network replaced a mostly peak-oriented low-frequency radial network with a high-frequency all-times grid. The first major aspect of this change is turning a radial system focused on Downtown Houston into a grid that reaches Houston's polycentric employment clusters. The second aspect is a focus on frequency, doubling the number of routes that have service every 15 minutes or better. This change provides dramatic improvements in midday, evening, and weekend service, transforming the network into a full-time system. Routes now operate as frequently on a Sunday morning as they do at midday on a Monday.

The grid network allows simpler, more direct, and faster routes by creating logical transfer locations. Riders are no longer forced to go through Downtown, and routes are both easier to use and more efficient. About 95% of the city's population now lives within one quarter of a mile of a frequent service, and less than half a percent of existing riders moved beyond a quarter mile of service.

The network was created through a planning process that took a "blank sheet" look at the network, convened a policy discussion on whether to focus resources on ridership or coverage goals, and involved extensive public discussion and consultation. The result was a decision to intentionally shift service hours towards ridership goals, and to rethink all routes—even successful ones. Rail and bus are complementary rather than competitive in the new network; the new light rail lines are used as high-capacity network spines for access to Downtown, carrying riders who previously used buses. By making each route more productive, the network change was implemented with almost no increase in bus operating costs. Ridership growth building on these service changes is expected to continue, as people make decisions on where to live and work based on it and as the system becomes easier to use through better passenger information, real-time arrival information by text messaging, three-hour tickets, and longer-term investments in stops and pedestrian improvements.