# Defining BRT for the City of Seattle, Developing Bus Rapid Transit to Operate in Existing Roadway Space

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## Abstract

Good transit service is a key part of any City's growth management strategy and maximizing person moving capacity of existing roadways. How a city manages the right-of-way has a major impact on the character and function of transit service. Bus rapid transit has the potential to attract new riders to transit and provide an alternative to single-occupancy vehicle trips. To capture more riders, the bus rapid transit service will need to provide travel time savings and reliability, increase the frequency and span of service, and have a distinct identity and image.

This paper examines the recent effort by The Seattle Department of Transportation (SDOT) to identify a framework of innovative transit treatments and concepts that can be used to establish bus rapid transit service in Seattle within existing roadway space. This paper will present the transit treatments that were selected for key locations along the Ballard-Crown Hill and West Seattle transit corridors. The transit treatments are described in detail in a toolkit developed for the City, and provides options for addressing traffic conditions that restrict transit's performance on roadways. Finally, this study focused on treatments that make use of existing right-of-way and can be implemented incrementally.

## Study Purpose and Objectives

The Seattle Department of Transportation (SDOT) and King County Metro (Metro) were looking for ways to improve transit service from Downtown to Ballard and West Seattle. SDOT reviewed existing transit studies and planning efforts and identified key considerations to guide this work:

- The Ballard-to-Downtown and West Seattle-to-Downtown transit markets should be evaluated and considered separately.
- Transit alternatives should connect neighborhoods and transit hubs in support of the Seattle Transit Plan.
- Improvements should be targeted to the next 3 to 5 years, in advance of the Alaskan Way Viaduct and Seawall Replacement Project and should coordinate with construction mitigation strategies.
- The implementation strategy would be adjusted as needed to reflect available resources to ensure it is feasible.

- The City should partner with transit agencies to leverage investments.

With these considerations, SDOT concluded that making transit speed and reliability investments for bus rapid transit was a good way to prepare for viaduct replacement with available resources and increase transit capacity in these corridors. Thus, the City began the process of identifying a framework of transit treatments and concepts that can be used to establish bus rapid transit service in Seattle.

## Seattle's Case for Transit

The City of Seattle's Comprehensive Plan focuses residential and employment growth in designated Urban Villages where increased density can be served with multi-modal and integrated transportation services and other infrastructure investments. A key goal of the Comprehensive Plan is "Making Transit a Real Choice." The Comprehensive Plan recognizes that convenient and accessible transit service can help reduce reliance on single-occupant vehicles, slow the increase in environmental degradation associated with their use, and increase mobility within our limited right-of-way. Transit provides an efficient way to move large numbers of people around the city as streets get more congested.

The Transportation Strategic Plan and Seattle Transit Plan provide the policy framework for implementing the transportation elements of the Comprehensive Plan, managing the City's rights-of-way, and promoting transit in Seattle. The Seattle Transit Plan identified the Urban Village Transit Network (UVTN), a network of key transit corridors to be served with fast, frequent and reliable service. The UVTN represents the backbone of Seattle's transit service and identifies objectives and performance monitoring measures for this service.

## Defining Bus Rapid Transit and Responsibilities for the Seattle

The first step was to define what bus rapid transit meant to the City: Bus rapid transit was defined as providing more buses and better bus facilities, and managing the streets and traffic signals to keep buses moving through traffic.

The second step was to examine and establish the need for partnerships: Implementing bus rapid transit will require SDOT and Metro to make complementary decisions and investments that improve the speed, reliability, comfort, and accessibility of the bus system.

| **City responsibilities:** | **Metro responsibilities:** |
|---|---|
| Managing streets and signals | Providing buses and bus facilities |

| | |
|---|---|
| Dedicated or managed bus lanes<br>Transit signal priority and queue jumps<br>Parking removal or peak-hour restrictions<br>General purpose traffic restrictions | Changes to existing routes, improved service<br>New bus stops with real-time bus information<br>Improved payment systems and transfers<br>Branded low-floor, low-emission buses |

## Characteristics of Bus Rapid Transit

The Seattle Department of Transportation (SDOT) recognized that it is the responsibility of local transit agencies to develop and deliver transit service. However, good transit service is a key part of the City's growth management strategy and maximizing person moving capacity of existing roadways. How SDOT manages the right-of-way has a major impact on the character and function of transit service. Bus rapid transit has the potential to attract new riders to transit and provide an alternative to single-occupancy vehicle trips. To capture more riders, the bus rapid transit service will need to:

- **Provide travel time savings and reliability.** This will include managing the streets and signals to keep transit moving and improving transit operations and routing to increase the speed of the service. For all of these treatments to truly maximize operations, bus rapid transit will need to move to a non-scheduled type service, meaning no time-points and the bus travels from one end of the route to the other as quickly as conditions will allow.
- **Increase the frequency and span of service.** More service over a longer period of time means that riders are less tied to scheduled bus trips and can rely on having transit available to them throughout the day. Currently, some express bus patrons have limited or no options for leaving downtown after about 6 p.m. on express bus routes and are forced to take a slower local bus in the evening. Consistent reliable transit service throughout the day will keep bus rapid transit an attractive choice beyond the peak hours.
- **Have a distinct identity and image.** Branded low-floor, low-emission vehicles and enhanced bus-stop amenities clearly identify the service as distinct from local and express buses and reduce passenger boarding time. Providing a welcoming environment and a good transit experience are key to attracting more riders.

The City has adopted standards for key transit corridors as part of the Urban Village Transit Network and monitors transit service progress towards meeting frequency, reliability, span of service, travel speed, and passenger loading goals.

## Right-of-Way and Transit Priority

There are different ways to manage the City's streets to meet the needs of transit and provide varying levels of transit priority. One method is the development of new right-of-way exclusively for transit use versus accommodating transit use within existing roadway space (on existing paved surfaces). New exclusive transit right-of-way was not evaluated for this study because of the high cost to acquire land and build new bus-only facilities, so the City considered treatments that provide transit priority and preference within existing roadway space.

The highest level of transit priority considered for these corridors was the creation of all day bus-only or combined business-access and transit (BAT) lanes. BAT lanes allow general purpose traffic to use the transit lane for turning movements only. This type of treatment is typically applied to the outside lane (usually the curb lane). This treatment could be limited to specific hours of the day depending on the level of transit service, level of congestion, and other lane needs.

The next level of transit priority considered was to allow buses to stop in-lane by constructing a curb extension. This treatment can also be used to preserve on-street parking and provide more space for bus stop amenities with a curb bulb in the parking lane, albeit eliminating the option of peak-hour parking restrictions for an additional lane. Allowing buses to stop in-lane prioritizes transit over general traffic and ensures that a bus is able to resume the ride immediately after transferring passengers without having to merge into traffic. Since bus rapid transit is anticipated to have fewer bus stops with faster boarding times, this treatment may be appropriate even for sections of road with only one travel lane, depending on the level of congestion and the character of the street. However, underlying local service should be structured such that it doesn't interfere with express and bus rapid transit operations as an increase in stop spacing would be negated if the bus rapid transit cannot pass a local service bus which stops more often.

The last level of transit priority considered was for buses to pull-out of traffic for stops. This is generally how most local bus service operates and may be appropriate in low-congestion, residential areas at the ends of the bus rapid transit route. If BAT lanes are used only for peak hours, buses would have to pull-out of traffic during off-peak hours.

Transit signal priority (TSP) was also considered at many key intersections and can be used in conjunction with any of these right-of-way treatments. Although TSP can be used to coordinate transit operations throughout a transit corridor using an 'always on' or 'running late' strategy, the spacing of existing signals and lack of interconnect communication may limit the ability to integrate signal timing in these corridors without significant

infrastructure improvements. TSP treatments can also be used more locally to facilitate a specific transit movement through an intersection, and this study identified intersections which warrant treatment and further evaluation. Although TSP can improve transit speed and reliability, the real benefit comes from restructuring routes to take full advantage of a compliment of treatments, such as eliminating time-stops. However, actively managing the street space for transit (such as providing bus only or BAT lanes) is expected to provide greater transit speed and reliability benefit even if TSP is not included.

## Achieving Success

The road network needs to move people and goods efficiently if we are to ensure the social and economic well being of our communities. Buses have a vital role to play in this as they can make excellent use of limited road space, carrying many more passengers than private cars for a given amount of road space. However, the potential benefit of the bus can be stifled by traffic congestion. Working together, the City of Seattle, and our regional transit agencies can make buses a more attractive alternative to the car by releasing them from the congestion delays experienced by other road users.

Where traffic is severely congested, bus lanes can provide the greatest benefit to bus passengers, but it is precisely in these places where it may be difficult to reduce the amount of space available for general traffic or on-street parking and thereby may be perceived to worsen general purpose lane congestion while the transit lane may appear under utilized.

It is important to recognize that there is a range of strategies available and that there is not an 'off the shelf' solution that will maximize the benefits to buses regardless of location. The most appropriate strategy in any one area will depend upon the prevailing local conditions. In general, the reliability and travel time benefits follow the maxim 'the whole is more than the sum of the parts'. A range of strategies can be adopted that impact the types of delays that transit can experience relating to the roadway, route structure, vehicle type, and many others. Often, these types of treatments fall under the operational and policy umbrellas of different organizations such as a City with its roadways and signals and the local transit provider with its buses and route structures. In this instance, success can oftentimes hinge on an equal partnership with one side providing a higher level of treatment prioritizing transit and the other side implementing a corresponding and complimentary effort. Unless contributions are equally supportive and complimentary, the complete benefits to bus operations could be compromised and incomplete.

## Transit Treatment Toolkit

The transit treatments described in the City of Seattle's Transit Treatment Toolkit represented a cross-section of some of the treatments currently used by transit agencies in the United States, Canada, Europe, and around the world at the time. These treatments continue to be successful and offer real benefits to transit riders. They provide examples and concepts of transit treatments that could be considered in Seattle.

New transit treatments will challenge the status-quo. Many design guidelines and manuals do not expressly deal with bus transit treatments that are commonly used by transit agencies. Instead, documents like the Manual of Uniform Traffic Control Devices (MUTCD), apply a sound engineering judgment standard to address areas not specifically covered in the guidelines. The MUTCD was not intended to block the implementation of new technologies and its policies continue to evolve and address new applications.

Public education is also an important aspect of any transit treatment toolkit. General purpose traffic and transit vehicles will operate on the same street system. Proper design is needed to ensure consistency and legibility in traffic markings and control. When encountered for the first time, signals, lane markings, and signage may confuse drivers if these treatments are not logical and intuitive. Implemented correctly, these transit treatments—bus lanes, transit queue jumps, branded bus vehicles and enhanced stops, etc.—firmly establish transit's presence in these corridors and will draw a driver's attention to bus rapid transit as a desirable alternative to driving alone. Some of the treatments included in this toolkit, organized by type of treatment, include the following:

### *Roadway Treatments*

- Transit Lanes
- Enforcement by Design
- Curb Extensions
- Parking Restrictions
- Median Transit Stop
- Far Side versus Near Side Bus Stops

### *Signal Treatments*

- Transit Signal Priority
- Special Transit Phases for Transit
- Turns Across Same Direction Transit
- Transit Specific Turning Phase
- Signalizing Intersection to Assist Transit
- Signal Display

- Transit Queue Jumps
- Bus Merge Assistance
- Traffic Management Measures

***Support Infrastructure Treatments***

- Bus Stops and Stations
- Next Bus Technology
- Fare Collection
- Intelligent Transportation Systems
- Environmental Quality
- Potential Coaches
- Safety and Security

## Criteria for Establishing Transit Treatment Priority

The intent of the criteria developed for the City of Seattle was to provide guidance as to a hierarchy for implementing treatments to improve transit operations. Coupled with sound planning and engineering is the need to foster strong partnerships and a decision-making process that includes key stakeholders and transit providers in order to achieve the greatest success for bus rapid transit in the city of Seattle. The following points provide general criteria, in descending order of importance for implementation.

- Provide treatments that are essential to accommodate bus rapid transit operations within the corridor.
- Provide treatments that support a key connection (stop location) to riders.
- Provide treatments that provide the highest reduction in delay to transit.
- Provide treatments that favor bus rapid transit operations over other modes within the corridor.

Treatments that fix physical impediments or provide the necessary infrastructure to accommodate bus rapid transit within the street right-of-way need to be implemented first. Complimentary improvements necessary for bus rapid transit to operate are those treatments that connect bus rapid transit to its riders. Thus, treatments that restructure underlying service to best suit bus rapid transit, propose new stations and to some extent accompanying amenities, informing the public, and other such treatments, are also strongly recommended to be implemented before opening day.

## Aggressive versus Moderate TSP Assumptions

Aggressive TSP places the highest level of priority on transit movements at signalized intersection. The justification for this is that the allocation of green time at any intersection should be managed to benefit the greatest

number of people and to reduce the traveling delay for the greatest number of travelers.

When a bus loaded with patrons arrives at an intersection, total person delay is minimized if the traffic signal controller can recognize the temporary increase in person demand and adjust the signal phasing and timing to serve that demand. The bus rapid transit bus represents a temporary spike in person demand and if the demand can be served quickly and efficiently, person delay is minimized. Once the bus is served and passes through the intersection, person demand on all approaches returns to normal levels. The idea of adjusting signal timing to respond to actual demand is not new to traffic engineering. Most signal controllers adjust the signal timing automatically to respond to the vehicular demand on each approach as it fluctuates over the peak hour and over the day. TSP adjusts the signal timing to respond to a temporary increase in person demand instead of the traditional vehicular demand used by the traffic signal controller. Aggressive TSP forces the signal controller to serve the transit vehicle as quickly as possible. Moderate TSP allows the controller to balance the need to serve other vehicles and phases with the need to quickly serve the bus.

The need to serve transit vehicles more quickly and to reduce the delay to transit is more urgent and compelling than the need to serve single occupancy or even carpool vehicles because any delay or impacts imposed on the transit vehicle are not confined to the vehicle or those physically riding the bus. In addition to those patrons on the bus, delay to transit impacts those waiting for the bus at the next stop and those transferring to or from the bus from other modes. This delay can severely impact the ability of the transit agency to configure service and allocate resources which impacts quality and frequency of service which impacts all riders of the transit system.

Level of service and delay calculations were completed at key study intersection assuming aggressive and moderate levels of TSP. For aggressive TSP the calculation assumed that vehicular phases will be skipped if needed to advance to the BRT phase. Under aggressive TSP operations, a BRT vehicle could arrive at the intersection when the traffic signal controller is already serving the concurrent BRT phase. When this happens, the traffic signal controller would extend the green phase if needed to allow the BRT vehicle to proceed through the intersection. If the BRT vehicle arrives during a non-BRT phase the traffic signal controller would serve a minimum green for the non-BRT phase, then terminate the non BRT phase and proceed directly to the BRT phase.

Under moderate TSP operations, the analysis assumed that all vehicular phases will be served (no skipping of phases). If the BRT vehicle arrives

during the BRT phase, the traffic signal controller would extend the green phase if needed to allow the BRT vehicle to proceed through the intersection. If the BRT arrives during the non BRT phases, the controller would terminate all non BRT phases and would serve a minimum green for each phase before advancing to the BRT phase.

The benefit to BRT travel time savings presented in calculations is the potential savings that could be established as a target goal for TSP at each intersection. The analysis assumed that with an aggressive TSP strategy, most if not all of the BRT signal delay could be eliminated. The analysis also assumed that the delay presented in Synchro is representative of the actual signal delay. In reality, Synchro does not report transit delay but an average vehicular delay for all travel lanes. The actual delay that is experienced by transit, which operates for the most part in the curb lane (which experiences higher delay), could be greater than that reported by Synchro.

## Policy Choices

In order to achieve the travel time savings defined by some of the proposed treatments, the City's existing policies would need to be strengthened or better defined. For example, the City recognized that its policy on signal timing did not address the skipping of phases as well as other supportive actions needed to favor transit vehicle movement over general purpose vehicle movement. Also, policy will need to be in place that supports those decisions that favor people movement and allows for management of the roadway system to favor transit in select corridors for bus rapid transit.

## Key Takeaway Messages

Bus Rapid Transit is a high speed bus system typically operating in corridors with additional priority and preference over other modes, including local transit routes. Bus rapid transit means simple route layout, increased frequency, faster transit times, limited stops, passenger information systems, traffic signal priority for transit, and speedier fare collection. Bus rapid transit does operate on the roadway, however unlike regular bus service it should have policy and design guidelines that prioritize it as mode for any specific corridor, perhaps not unlike the treatments in-road light rail operations receive.