Review of Existing Service Standards

This chapter presents a review of the MBTA's existing and previous service standards as well as the service standards used by peer agencies. As part of this review, the metric(s) used to evaluate each standard will be considered.

2.1 MBTA Service Delivery Policy

The purpose of the MBTA's Service Delivery Policy is to guide both the design and evaluation of transit services that will meet the needs of the riding public. To do so, the Service Delivery Policy establishes a set of policy objectives that are related to the service-planning process. The Service Delivery Policy also establishes service objectives that define the key performance characteristics of quality transit services. To measure progress toward meeting these objectives, the Service Delivery Policy identifies quantifiable service standards, the performance metrics that are used to measure them, and the thresholds that are used to determine compliance.

The Service Delivery Policy was first formulated in 1996 and last updated in 2010. In 1996, it was anticipated that the Service Delivery Policy would need to be updated over time, particularly as new technologies enhancing the ability to collect and analyze data become available. Updates to the Service Delivery Policy occurred in 2002, 2004, 2006, 2009, and 2010. A forerunner to the Service Delivery Policy was the Service Policy for Surface Public Transportation, which was finalized by the MBTA in 1977. This Service Policy defined a set of policy and service objectives generally consistent with those of later iterations of the Service Delivery Policy. It also discussed the legal policy framework that established the Service Policy and set forth service standards and guidelines that are similar to those in subsequent Service Delivery Policies, but were more expansive and less focused.

The following sections discuss the policy objectives, service objectives, and service standards and metrics found in the MBTA's current Service Delivery Policy.

2.1.1 Policy Objectives

While the service standards and objectives of the Service Delivery Policy have changed throughout the years, the policy objectives that these standards attempt to measure have remained relatively consistent. As described in the 2010 update, the policy objectives comprise:

- Establishing service objectives that define the key performance characteristics of quality transit services
- Identifying quantifiable service standards that are used to measure achievement of the MBTA's service objectives
- Evaluating whether MBTA services are provided in an equitable manner (as defined by Title VI)
- Outlining a service-planning process that applies the service standards in an objective, uniform, and accountable manner
- Involving the public in the service-planning process in a consistent, fair, and thorough manner

The policy objective of evaluating the equity of MBTA services was added in the 2004 Service Delivery Policy to internalize the requirements of Title VI of the Civil Rights Act of 1964 to ensure that minority populations are not discriminated against (either intentionally or unintentionally) in the provision of transit services. The 1977 Service Policy included several policy objectives not listed in later versions of the Service Delivery Policy. In addition to the goal of offering the best possible level and quality of service for existing public transportation users, the Service Policy also explicitly aimed to reduce auto usage, attract new customers, and address the transportation needs of those traveling locally within and between areas outside the regional core. The 1977 Service Policy also defined as policy goals the conservation of natural resources and the generation of benefits to the regional economy and environment.

This chapter will consider the first two policy objectives of the current Service Delivery Policy, since those are the only policies with explicit service objectives. Specifically, the following sections will focus on the MBTA's service standards and the respective service objectives and performance measures. This chapter will not explicitly consider, in this discussion of service standards, the equity implications of the service

standards. Nor will this chapter discuss the service-planning process itself. However, the results of the Core Efficiencies Study should eventually feed into such a process, which should itself consider the equity implications of adopting, eliminating, or changing any service standards.

The MBTA has several additional policies and guidelines that address issues not covered explicitly by the standards in the Service Delivery Policy. This chapter will reference these reports or programs when discussing the relevant standards. However, several of these standards concern issues that could easily be classified under the first policy objective of the Service Delivery Policy: to establish service objectives that define the key performance characteristics of quality transit services. Issues related to the structure, provision, and efficiency of service all potentially fall under this objective. The distribution of physical infrastructure can also affect the quality of service that riders receive. Indeed, while the Service Delivery Policy has traditionally been understood as a service-planning document, several of its standards reflect operational issues that directly affect service quality. Where standards not covered by the existing Service Delivery Policy, but tied to service quality, are discussed, this chapter generally recommends their inclusion in the Service Delivery Policy.

2.1.2 Service Objectives

Through several revisions to the 1996 Service Delivery Policy, the policy and service objectives have been restructured. In the 2004 revisions, the service objectives were refocused to include only those that are directly tied to the established service standards. Thus, the service standards are intended to measure whether or not the service objectives are met, and the service objectives, in turn, measure whether the MBTA's mission of providing excellent, accessible, and reliable service is met. The following are the service objectives found in the 2010 Service Delivery Policy:

- Accessibility: Services should be geographically available throughout the community and should operate at convenient times and frequencies.[1]
- Reliability: Services should be operated as scheduled.

[1] The MBTA addresses accessibility for persons with disabilities through other processes.

- Safety: Services should be provided in a safe manner.
- Comfort: Services should offer a pleasant and comfortable riding environment.
- Cost-Effectiveness: Services should be tailored to target markets in a financially sound and cost-effective manner.

As mentioned above, these service objectives, which were defined in 2004, are somewhat different than those found in the first Service Delivery Policy, in 1996. As with the current Service Delivery Policy, the 1996 policy included objectives related to accessibility, reliability, and cost-effectiveness. It did not, however, specifically include comfort as a service objective, and referred to safety as a policy objective, rather than a service objective. Furthermore, the 1996 Policy included service objectives to encourage market-oriented strategies to derive the highest return and to promote intermodal services and connections. The first of these service objectives could be considered part of the cost-effectiveness objective. The second service objective is not measured by the current service standards and is considered to be an implicit part of the service-planning process. Another 1996 service objective was to involve the public in the service-planning process in a consistent, fair, and thorough manner. This became a policy objective in the 2004 Service Delivery Policy, as it is not measured by the service standards but is an important part of the service-planning process that is outlined in the Service Delivery Policy.

The 1977 Service Policy included many of the same service objectives that are found in subsequent versions of the Service Delivery Policy, such as accessibility, safety, and comfort. However, it also included service objectives such as convenience and speed, and focused on minimizing travel time, wait time, and transfer time, competing with automobile travel times, and providing schedules that are easily remembered by customers when headways exceed 10 minutes. While not identifying cost-effectiveness as a service objective, the 1977 Service Policy did provide a list of “efficiency” goals, such as optimizing utilization, maximizing average operating speeds, and minimizing the ratio of recovery time to revenue-producing time.

2.1.3 Service Standards

As stated in the 2010 Service Delivery Policy, for “each of the service objectives, the MBTA has established quantifiable service standards, which allow the MBTA to evaluate the performance of MBTA services relative to each of the service objectives.” The following table lists the current service objectives with their respective service standards.

Table 1
MBTA Service Objectives and Service Standards

Service Objective	Service Standard/Guideline
Accessibility	Coverage Span of Service Frequency of Service
Reliability	Schedule Adherence
Safety and Comfort	Vehicle Load
Cost-Effectiveness	Net Cost per Passenger

The current service standards are the same ones that were defined in the 1996 Service Delivery Policy, and all except the net-cost-per-passenger standard were also included in the 1977 Service Policy. The 1977 policy measured cost-effectiveness through several other standards, including market potential (a combination of measures of average passengers per vehicle and revenue hours of service and average service-area density), labor productivity, and economic standards (revenue-to-direct-cost ratios, passengers per hour, and passengers per mile).

Unlike the 2010 Service Delivery Policy, the 1977 Service Policy measured the route layout and the directness of service, or the percentage of transfers made in the transit system, to meet the service objective of lowering travel times. The policy also determined standards for passenger stops, such as spacing, length, location, and delineation, and passenger shelters (the MBTA now has a policy for shelter placement that is separate from the Service Delivery Policy). In terms of the service objectives of maximizing convenience and speed, service standards for average operating speeds, average scheduled speeds, and recovery times were determined.

The following section is a discussion of each of the MBTA's service standards, including the metrics that are used to measure whether or not each service standard is achieved. The descriptions are taken from the 2010 Service Delivery Policy.

Coverage

An important aspect of providing the region with adequate access to transit services is the geographic coverage of the system. Coverage is expressed as a guideline rather than a standard, because uniform geographic coverage cannot always be achieved due to constraints such as topographical and street network restrictions. In addition,

coverage in some areas may not be possible due to the infeasibility of modifying existing routes without negatively affecting their performance.

The coverage service standards (shown in Table 2) are established specifically for the service area in which bus, light rail, and heavy rail operate, as riders most frequently begin their trips on these services by foot. Because commuter rail is usually accessed via the automobile, the coverage guidelines do not apply in areas where commuter rail is the only mode provided by the MBTA.

Table 2
Coverage Service Standards

Service Days	Minimum Coverage
Weekdays and Saturdays	Access to transit service will be provided within a quarter-mile walk to residents of areas served by bus, light rail, and/or heavy rail with a population density of greater than 5,000 persons per square mile.
Sunday	On Sunday, this range increases to a half-mile walk.

The coverage service standards have remained mostly consistent throughout the various iterations of the Service Delivery Policy. The 1977 Service Policy introduced a minimum coverage standard of one-half mile for at least 90 percent of all residences in areas with a population density in excess of 4,000 persons per square mile. The 1996 Service Delivery Policy introduced the concept of different standards for different days of the week, setting the minimum coverage standards to the existing levels, where they have since remained.

Span of Service

Span of service refers to the hours during which service is provided. The MBTA has established span-of-service standards that define the minimum period of time that any given service will operate. This provides customers with the confidence that particular types of services will be available throughout the day.

The span-of-service standards, stated in Table 3, vary by mode and by day of the week, reflecting the predominant travel flows in the region. The standards require that the first trip in the morning in the peak direction of travel (typically toward Boston) must arrive at the route terminal at or before the beginning span-of-service time (e.g., 7:00 AM for local bus). At the end of the service day, the last trip in the evening in the peak direction of travel (typically away from Boston) must depart from the route terminal at or after the ending span-of-service time (e.g.,

6:30 PM for local bus). The minimum span of service indicated in the table may be extended at either end of the day, based on customer demand and in accordance with the other service standards.

The span-of-service standards have remained mostly consistent throughout the various iterations of the Service Delivery Policy. In 2004, span-of-service standards were introduced for the newly identified Key Bus Routes, and in the 2009 update the end of service was lengthened to 6:30 PM for modes that previously ended service at 6:00 PM. The 1977 Service Policy specified span-of-service standards for bus, trackless trolley, and surface streetcar services on weekdays only.

Table 3
MBTA Span-of-Service Standards

Mode		Day	Minimum Span of Service
Bus	Local Routes	Weekday	7:00 AM – 6:30 PM
		Guideline for high-density areas:	
		Saturday	8:00 AM – 6:30 PM
		Sunday	10:00 AM – 6:30 PM
	Community Routes	Weekday	10:00 AM – 4:00 PM
	Express/ Commuter Routes	Weekday	7:00 AM – 6:30 PM (no service required 9:00 AM – 4:00 PM)
	Key Bus Routes	Weekday	6:00 AM – midnight
		Saturday	6:00 AM – midnight
		Sunday	7:00 AM – midnight
Heavy Rail		Weekday	6:00 AM – midnight
		Saturday	6:00 AM – midnight
		Sunday	7:00 AM – midnight
Light Rail		Weekday	6:00 AM – midnight
		Saturday	6:00 AM – midnight
		Sunday	7:00 AM – midnight
Commuter Rail		Weekday	7:00 AM – 10:00 PM
		Saturday	8:00 AM – 6:30 PM
Boat		Weekday	7:00 AM – 6:30 PM

Frequency of Service

To maintain access to the transportation network within a reasonable waiting period, the MBTA has established minimum frequency-of-service levels for each mode, by time of day (often expressed as

maximum headways). On less heavily traveled services, these minimum levels dictate the frequency of service, regardless of customer demand.

Table 4 shows the weekday time-period definitions used by the MBTA for all modes for the frequency-of-service standard as well as for the vehicle-load standard. Because travel patterns on the weekend are different than on weekdays, specific time periods are not defined for Saturdays and Sundays. Table 5 shows the minimum frequency-of-service levels for each mode by time period.

Table 4
MBTA Weekday Time-Period Definitions

Time Period	Definition
Early AM	6:00 AM – 6:59 AM
AM Peak	7:00 AM – 8:59 AM
Midday Base	9:00 AM – 1:29 PM
Midday School	1:30 PM – 3:59 PM
PM Peak	4:00 PM – 6:29 PM
Evening	6:30 PM – 9:59 PM
Late Evening	10:00 PM – 11:59 PM
Night/Sunrise	12:00 AM – 5:59 AM

On heavily used services, the minimum frequency-of-service levels may not be sufficient to meet customer demand. When load levels indicate that additional service is warranted, as defined in the vehicle-load standard, the frequency of service will be increased to provide a sufficient number of vehicles to accommodate passenger demand.

The frequency-of-service standards have remained mostly consistent throughout the various iterations of the Service Delivery Policy. The 2004 update introduced the concept of Key Bus Routes with frequency-of-service standards similar to those of rapid transit. Also in 2004, additional time periods were defined for use in the frequency, schedule-adherence, and vehicle-load standards. In the 2009 updates, the frequency of service for boats was reduced.

The 1977 Service Policy also set minimum service levels for local and community bus routes that match those used today. In addition, the 1977 Service Policy provides greater detail on the setting of frequencies that, while not part of the existing Service Delivery Policy, is no doubt considered when determining frequency levels. For instance, the 1977 Service Policy stipulates that service frequency “will be set to correspond with clock-face values to the maximum extent practicable when frequencies exceed 10 minutes.”

Table 5
Minimum Frequency-of-Service Standards

Mode		Weekday Time Periods (unless noted)	Minimum Frequency
Bus	Local/ Community Rtes.	AM & PM Peak	30-minute headway
		All Other Periods	60-minute headway (Midday policy objective of 30-minute headway in high-density areas)
		Saturday & Sunday – all day	60-minute headway
	Express/ Commuter Rtes.	AM & PM Peak	3 trips each in peak direction
		AM & PM Peak	10-minute headway
		Early AM & Midday Base/School	15-minute headway
		Evening & Late Evening	20-minute headway
		Saturday & Sunday – all day	20-minute headway
Light Rail/ Heavy Rail		AM & PM Peak	10-minute headway
		All Other Periods	15-minute headway
		Saturday & Sunday – all day	15-minute headway
CR		AM & PM Peak	3 trips each in peak direction
		All Other Periods	180-minutes in each direction
		Saturday & Sunday – all day	180-minutes in each direction
Boat		AM & PM Peak	3 trips each in peak direction
		Off-Peak	180-minute headway

Schedule Adherence

The on-time performance of service is affected by many variables, including traffic congestion, accidents/incidents, weather, road/track conditions, infrastructure maintenance work, vehicle failures, etc. The schedule-adherence standard provides ways of measuring how reliably services adhere to the published schedules. If a service does not pass the schedule-adherence standard, the MBTA will determine the reason why it does not perform reliably and will take action to correct the problems. In terms of service planning, this may mean adjusting running times, changing headways, etc.

The schedule-adherence standard varies by mode and provides the tools for evaluating the on-time performance of individual MBTA routes. The schedule-adherence standard also varies based on frequency of service. The Service Delivery Policy assumes that passengers using high-frequency services are generally more interested in regular, even headways than in strict adherence to published timetables, whereas

passengers on less frequent services expect arrivals and departures to occur as published.

The schedule-adherence standards (shown in Table 6) for buses are broken down into two tests. The bus-timepoint test measures the schedule adherence of each trip and the bus-route test demands that 75 percent of all timepoints over the entire service day pass the bus-timepoint test. The bus-timepoint test is applied differently depending on the scheduled headway. For trips with a headway greater than or equal to 10 minutes (scheduled-departure service), the trip must leave its origin timepoint between zero minutes before and three minutes after its scheduled departure time, leave its mid-route timepoint(s) between zero minutes before and seven minutes after its scheduled departure time, and arrive at its destination timepoint between three minutes before and five minutes after its scheduled arrival time. Essentially, these standards attempt to ensure that no trip will run ahead of schedule (since passengers on scheduled-departure service are more likely to time their arrival to a stop based on the bus schedule) and to minimize the extent to which trips run behind schedule. For trips with a headway of less than 10 minutes (walk-up service), the trip must leave its origin and mid-route timepoints within 1.5 times the scheduled headway and have an actual run time within 20 percent of the scheduled run time. These standards place a greater emphasis on consistent service spacing and trip run times (since passengers on walk-up service are more likely to arrive at a stop without looking at a schedule and expect only a brief wait).

Table 6
Summary of Bus Schedule-Adherence Standards

Timepoint Test	Origin Timepoint	Mid-Route Timepoint(s)	Destination
Scheduled-Departure Trips (Headways ≥10 minutes)	Start 0 minutes early to 3 minutes late	Depart 0 minutes early to 7 minutes late	Arrive 3 minutes early to 5 minutes late
Walk-Up Trips (Headways <10 minutes)	Start within 1.5 times scheduled headway	Leave within 1.5 times scheduled headway	Running time within 20% of scheduled running time
Route Test	75% of all timepoints must be on time according to the above definitions		

The Service Delivery Policy notes several exceptions to these standards:

- Express routes that serve only two points and do not have a midpoint are tested only on their origin and destination timepoints.
- Express route trips may arrive more than three minutes early at their final destinations.
- A schedule may note that certain trips will not leave until another vehicle arrives and allows passengers to transfer. When applying the standard, these trips are not included.
- The first trip of the day, which does not have a leading headway, is considered a scheduled-departure trip.
- If a route does not have published departure times, its trips shall be considered walk-up trips regardless of the scheduled headway.

Schedule adherence for light rail and heavy rail trips is evaluated according to the same standard as walk-up bus trips—that is, the percent of trips that operate within 1.5 scheduled headways and a comparison of actual to scheduled total trip time. Because headways in the core area for light rail are often less than two minutes, schedule adherence is measured by the percent of trips with headways less than five minutes. Table 7 provides a summary of the schedule-adherence standards for light rail and heavy rail services.

Table 7
Schedule-Adherence Standards for Light Rail and Heavy Rail

Mode	Headway Performance	Trip Time Performance
Light Rail – Surface	85% of all trips operated within 1.5 scheduled headways over the entire service day	95% of all trips operated within 5 minutes of scheduled total trip time over the entire service day
Light Rail – Subway	95% of all trips operated with headways less than 5 minutes over the entire service day	95% of all trips operated within 5 minutes of scheduled total trip time over the entire service day
Heavy Rail	95% of all trips operated within 1.5 scheduled headways over the entire service day	95% of all trips operated within 5 minutes of scheduled total trip time over the entire service day

The schedule-adherence standards for commuter rail and boat measure the percent of trips that depart/arrive within five minutes of scheduled departure/arrival times. These standards reflect the long distances and

wide station spacing of commuter rail, and the absence of intermediate stations on most boat services. Table 8 shows the schedule-adherence standards for commuter rail and boat services.

Table 8
Schedule-Adherence Standards for Commuter Rail and Commuter Boat

Mode	Standard
Commuter Rail	95% of all trips departing and arriving at terminals within 5 minutes of scheduled departure and arrival times
Commuter Boat	95% of all trips departing and arriving at ports within 5 minutes of scheduled departure and arrival times

Much attention has been given to the schedule-adherence standards over time. The first time the 1996 schedule-adherence standards were applied, every bus route failed. Since then, a number of changes have been made to the schedule-adherence standard in an attempt to relax it enough to make it useful for diagnosing the routes with the worst problems, while keeping it strong enough to be meaningful.

The 1996 standard required that 75 percent of bus trips operate on time during each time period. In 2002 the standard was changed to apply the 75-percent on-time requirement to the entire service day instead. However, most bus routes still failed the standard. Consideration was also given to allowing buses on routes with headways greater than 10 minutes to arrive early at the end of the route, as many routes failed the standard due to an early arrival at the last stop. Although it is important for buses not to arrive early at intermediate timepoints, most riders are not concerned about arriving early at the end of the route. This change was, however, not adopted in 2002.

The 2006 policy introduced three major changes. First, the schedule-adherence standards were applied to mid-route timepoints as well as those at the beginning and end of a route. Second, buses on routes with headways greater than 10 minutes were allowed to arrive early at the end of the route. The maximum number of minutes a bus could arrive late at a mid-route timepoint was also added. Third, the requirement that the trip time for 95 percent of all trips be no more than 5 minutes greater than the scheduled trip time by time period and direction was dropped.

The 2006 schedule-adherence standard anticipated the rollout of CAD/AVL (computer-aided dispatch/automatic vehicle location)

equipment, which allows the measurement of multiple mid-route timepoints and provides large amounts of data that can be averaged over many days. By 2009, it was deemed necessary to revise the schedule-adherence standard again to be able to take advantage of the CAD/AVL data. Most notably, the requirement that, for any given route, 75 percent of all trips must adhere to the arrival/departure standards was changed so that 75 percent of all timepoints must adhere to the arrival/departure standards.

The schedule-adherence standards in the 1977 Service Policy were defined only for bus, trackless trolley, and surface streetcar, and were similar to the bus standards in the 1996 policy.

Vehicle Load

The public's perception of comfort and the reality of public safety are influenced by the number of passengers on the vehicle and whether or not a seat is available to each rider for all or most of the trip. The vehicle-load standards, which vary by mode and time of day, establish the average maximum number of passengers allowed per vehicle to provide a safe and comfortable ride.

Because heavy and light rail in the core area are heavily used throughout the day, some standees can be expected during all time periods. For the purposes of this policy, the core area is defined in Table 9, as follows:

Table 9
MBTA Core Area Boundaries

Light Rail and Heavy Rail Core Area	
Blue Line	Bowdoin to Maverick
Orange Line	Back Bay to North Station
Red Line	Kendall to South Station
Green Line	All underground stations as well as Lechmere and Science Park

By mode and time period, the acceptable levels of crowding are shown in Table 10. The load standards in the table are expressed as a ratio of the number of passengers on the vehicle to the number of seats on the vehicle. To determine whether a service has an acceptable level of crowding, the vehicle loads are averaged over specified periods of time. Due to scheduling constraints and peaking characteristics, some individual trips may exceed the load levels expressed in the standards.

For most modes the load standards shown represent average maximum loads over any time period on weekdays and over the whole day on weekends. For bus (which, for purposes of the vehicle-load standard, encompasses all rubber-tired vehicles, including diesel, CNG, trackless trolley, dual-mode, etc.), on weekdays the loads cannot exceed the standard when averaged over any 30-minute segment of an Early AM, AM Peak, Midday School, or PM Peak period, or any 60-minute segment of a Midday Base, Evening, Late Evening or Night/Sunrise period. On weekend days, the loads cannot exceed the standard when averaged over any 60-minute segment of the whole service day.

Table 10
Vehicle-Load Standards by Mode

Mode	Time Period	Passengers/Seats
Bus	Early AM, AM Peak, Midday School & PM Peak	140%
	Midday Base, Evening, Night/Sunrise & Weekends	
	Surface Routes	100%
	Tunnel portions of BRT routes	140%
Green Line	Early AM, AM Peak, Midday School & PM Peak	225%
	Midday Base, Evening, Night/Sunrise & Weekends	
	Core Area	140%
	Surface	100%
Red Line #1 & #2 Cars	Early AM, AM Peak, Midday School & PM Peak	270%
	Midday Base, Evening, Night/Sunrise & Weekends	
	Core Area	140%
	Outside Core Area	100%
Red Line #3 Cars	Early AM, AM Peak, Midday School & PM Peak	334%
	Midday Base, Evening, Night/Sunrise & Weekends	
	Core Area	174%
	Outside Core Area	100%
Orange Line	Early AM, AM Peak, Midday School & PM Peak	225%
	Midday Base, Evening, Night/Sunrise & Weekends	
	Core Area	140%
	Outside Core Area	100%
Blue Line	Early AM, AM Peak, Midday School & PM Peak	225%
	Midday Base, Evening, Night/Sunrise & Weekends	
	Core Area	140%
	Outside Core Area	100%
Commuter Rail	Early AM, AM Peak, Midday School & PM Peak	110%
	Midday Base, Evening, Night/Sunrise & Weekends	100%

Boat	Inner Harbor – All time periods	100%
	Outer Harbor – All time periods	100%

Because there are a number of different types of vehicles in the MBTA's fleets at any given time, and because the fleets change over time, the actual seating capacity and maximum number of passengers allowed by the load standards will vary for each type of vehicle. For example, as seen in Table 10, the load standard is different depending on the type of Red Line car. The Service Delivery Policy includes an addendum of load standards for all vehicle types that is regularly updated as vehicle fleets change.

The load standards have remained relatively consistent throughout the various iterations of the Service Delivery Policy. The first time the 1996 service standards were applied, every bus route passed the load standard, indicating that the standard was not strict enough. This policy was changed in 2002. Rather than averaging total passengers over seated capacity for an entire time period, the 2002 update introduced the concept of measuring compliance based on any 30-minute segment of a peak period and any 60-minute segment of an off-peak period. Also in 2002, the 100-percent load standard for express buses was increased to match the load standards for local buses (140 percent in the peak, 100 percent in the off-peak). Likewise, the 100-percent load standard for commuter rail was increased to 110 percent. Most recently in the 2009 update, the load standard for Inner Harbor ferries was lowered from 125 percent to 100 percent.

The 1977 Service Policy only defined a load standard for bus, trackless trolley, and surface streetcar services. Like the subsequent versions of the Service Delivery Policy, two different load standards were used for peak and off-peak time periods. However, the 1977 peak load standard was higher for the peak 30 minutes than for the total peak period.

Net Cost per Passenger

The operation of MBTA service must be conducted within the resource levels budgeted for each mode. It is therefore important to have a measure that can compare the economic productivity of any given route in relation to other routes or to the system average for that mode. The net cost per passenger is calculated by subtracting the average revenue from the cost of operating a route and dividing by the number of passengers (see Table 11). This ratio reflects the benefits of a given service (measured in customers) against the public cost of operating the service.

During the regular service-planning process, all bus routes and their respective net cost per passenger are compared against the bus-system average. Routes that have a net cost per passenger more than three times the system average are considered deficient and are subject to review for modifications that could improve their performance. Exceptions to the net-cost-per-passenger standard can be made, on a case-by-case basis, due to extenuating circumstances such as geographic isolation.

Table 11
Net-Cost-per-Passenger Standard

Net Cost per Passenger:	$\frac{\text{Operating Costs – Service Revenue}}{\text{Boarding Customers}}$
Deficient Route:	≥ 3 times the system average

As a part of the 1996 Service Delivery Policy, the MBTA developed the net-cost-per-passenger standard to measure the cost-effectiveness of bus routes. This standard was developed only for the bus mode at that time, because bus services were considered most appropriate for this type of comparative analysis. Unlike rail services, bus-route alignments and services can be more easily adjusted to accommodate changes in ridership patterns and demands. Since 2004, the MBTA has considered developing similar service-productivity standards for other modes that would allow comparative evaluations within and across modes. However, the MBTA has yet to adopt such standards.

The 1977 Service Policy utilized a collection of performance indicators to measure bus cost-efficiency. The first standard was a minimum ratio of revenue to direct cost. For regular bus routes, this standard was set at 30 percent. The second standard was a minimum number of 30 passengers per revenue hour. The third standard was a minimum number of passengers per mile (2.5 in the peak periods, 1.5 in the off-peak periods). The 1977 Service Policy also provided for less-stringent standards under any of the following conditions:

- if, of the average daily ridership, 75 percent or more was transit-dependent or 15 percent or more was elderly and/or handicapped
- if the number of automobile vehicle-miles traveled that was avoided through operation of the service totaled 200 or more per revenue hour
- if 60 percent or more of the patrons of a service transferred to another service

2.2 Comparison of Peer Agencies by Service Standards

This section compares the existing service standards and related performance measures of peer public transportation agencies to those of the MBTA (see Table 12 for a list of the peer agencies for which service delivery policies were discovered). Discussed first are the service standards used by the MBTA, as compared to peer agencies. Subsequent peer comparisons consider additional service standards not used by the MBTA.

2.2.1 Service Standards Used by the MBTA

Coverage

As mentioned above, the MBTA uses coverage guidelines that require access to transit within a walking distance of one-quarter mile on weekdays and Saturdays and one-half mile on Sundays for residents in areas served by bus, light rail, and/or heavy rail with a population density of greater than 5,000 persons per square mile.

CTA has a coverage service standard requiring service within one-quarter mile during the peak time period on weekdays in high-density areas (where the distance between bus routes is less than one-half mile). The coverage standard rises to one-half mile at all other times and in low-density areas (where the distance between bus routes is between one-half and one mile) during the peak time period on weekdays, except for late-night Owl service, when the standard rises to one mile. CTA also associates standard distances between routes with typical walk distances in which the recommended distance between routes is two times the typical walk distance (e.g., a typical walk distance of one-quarter mile is associated with a one-half-mile distance between routes).

King County Metro Transit uses one-quarter mile as the typical walking distance at all times, though greater distances are recognized as feasible with more frequent service. King County Metro Transit also uses a standard for bus route spacing of approximately one-half mile in urban, higher-density areas, and one mile in lower-density areas, though it recognizes the need to adjust this standard when the nature of the terrain discourages pedestrian travel.

TransLink's service guidelines state that at least 90 percent of all residents and employees in urbanized development areas (defined as areas having more than 15 residents or 20 jobs per hectare, approximately 3,880 residents or 5,180 jobs per square mile) should

have a walking distance of less than 450 meters (approximately 0.28 miles) to the nearest bus stop.

Nashville MTA, in its Service Delivery Policy, notes the standard transit industry use of a quarter-mile walking distance, but cites CTA's varying standards, which depend on the density of the area served. Recognizing the comparatively low density of its service area, Nashville MTA uses a half-mile standard. Nashville MTA also cites an industry population-density standard of around 5,000 persons per square mile (around 3 dwelling units per acre) in order to consider justifying fixed-route transit.

YRT uses a maximum walking distance of 500 meters, or approximately 0.31 miles, during daytime service Monday through Saturday, and 1,000 meters for all other periods (weekday evenings, Saturday evenings, and all day Sunday and holidays). YRT endeavors to apply this standard to approximately 90 percent of the urban area.

SEPTA defines its coverage service level as "well-served" or "served," depending on the maximum walking distance, but it does not appear to require any standard per se. An area is "well-served" if a stop is no more than one-quarter mile from any passenger's origin point and "served" if a stop is no more than one-half mile from any passenger's origin point.

AC Transit defines its coverage standard as a maximum walking distance depending on the population density of the area served. High-density areas with population densities greater than 20,000 persons per square mile require a standard of one-quarter mile. Medium-density areas with population densities between 10,000 and 20,000 persons per square mile require a standard of one-half mile. Low-density areas with population densities between 5,000 and 10,000 require a standard of three-quarters mile. Very-low-density areas with population densities less than 5,000 persons per square mile are allowed a maximum walking distance of one mile or greater.

AC Transit also establishes a route-spacing standard that is dependent on the population density and the nature of the transit network. For densities greater than 20,000 persons per square mile with a grid transit network, the average recommended route spacing is one-quarter mile. For densities between 10,000 and 20,000 with a grid transit network, the average recommended route spacing is one-quarter to one-half mile. For densities between 5,000 and 10,000 with a transit network based around a focal point, the average recommended route spacing is

Table 12
Profiled Transit Agencies and Transit Modes Provided

Agency (Acronym)	Metropolitan Area	Transit Modes Provided				
		Bus	Light Rail	Heavy Rail	Commuter Rail	Ferry
Chicago Transit Authority (CTA)[2]	Chicago	X		X		
King County Metro Transit[3]	Seattle	X	X			
Greater Vancouver Transportation Authority (TransLink)[4]	Vancouver	X	X			X
Nashville Metropolitan Transit Authority (Nashville MTA)[5]	Nashville	X				
York Region Transit (YRT)[6]	Ontario	X				
Southeastern Pennsylvania Transportation Authority (SEPTA)[7]	Philadelphia	X	X	X	X	
San Francisco Municipal Transportation Agency (SFMTA)[8]	San Francisco	X	X			
Toronto Transit Commission (TTC)[9]	Toronto	X	X	X		
Alameda-Contra Costa Transit District (AC Transit)[10]	Oakland	X				
Denver Regional Transportation District[11]	Denver	X	X			
Miami-Dade Transit (MDT)[12]	X					

[2] Chicago Transit Authority, “Service Standards,” July 2001, www.transitchicago.com/assets/1/miscellaneous_documents/servicestandards129737.pdf

[3] King County Metro Transit, “Transit Service and Facility Guidelines,” June 2008, www.kingcounty.gov/transportation/kcdot/PlanningAndPolicy/TransitPlanning

[4] Greater Vancouver Transportation Authority, “Transit Service Guidelines,” June 2004

[5] Nashville Metropolitan Transit Authority, “Appendix C: MTA Service Delivery Policy,” August 2009, www.nashville.gov/mta/docs/StrategicTransitMasterPlan/14AppendixCMTAServicePolicy.pdf

[6] York Region Transit, “Transit Service Guidelines,” May 2006, www.yorkregiontransit.com/assets/pdfs/2006_Transit_Guidelines.pdf

[7] SEPTA, “Service Standards and Process,” March 2007, http://www.septa.org/reports/pdf/standards.pdf

[8] SFMTA, “Proposed FY10 Service Standards and Milestones,” www.sfmta.com/cms/rstd/documents/6-26-09Item15FY10ServiceStandardsChangesPROPOSED.pdf

[9] Toronto Transit Commission, “Service Improvements for 2003,” October 2002

[10] AC Transit, Board Policy, “Service Standards and Design Policy,” Policy No. 550, January 2008

[11] Regional Transportation District, “Service Standards,” December 2002, www.rtd-denver.com/PDF_Files/Service_Standards_12_02.pdf

[12] Miami-Dade Transit, “Service Standards,” November 2009

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one-half mile. For densities below 5,000 with a transit network based around a focal point, the average recommended route spacing is one mile.

MDT requires that 90 percent of the county population within the Urban Development Boundary (areas with a combined population and employment density of 10,000 persons per square mile) shall be provided with transit service having an average route spacing of one mile.

Table 13
Peer Agency Comparison of Coverage Standards

Agency	Maximum Walking Distance (miles)	Average Route Spacing (miles)	Day of Week/ Time Period*	and/ or	Density Threshold (persons/ square mile)
MBTA	0.25 0.50		WD & SA SU	and and	≥5,000 ≥5,000
CTA	0.25 0.50	0.50 1.00	WD peak WD non-peak & WE	and or	high density low density
King County Metro	0.25 0.25	0.50 1.00			high density low density
TransLink	0.28				≥3,800
Nashville MTA	0.50				≥5,000
YRT	0.31 0.62		WD daytime & SA WD non-daytime & SU		
AC Transit	0.25 0.25-0.50 0.75 1.00	0.25 0.25-0.50 0.50 1.00			≥20,000 10−20,000 5−10,000 <5,000
MDT		1.00			≥10,000

** Day of week codes: WD (weekday); WE (weekend); SA (Saturday); SU (Sunday)*

In summary, most of the profiled peer transit agencies use a quarter-mile standard as the maximum walking distance to fixed-route bus and heavy and light rail transit (see Table 13). Agencies differ with regard to when and where they require this standard and any less stringent applications. Some agencies distinguish their standards by the day of the week or the time period. Other agencies apply different standards

depending on the density of the surrounding service area. The MBTA employs a combination of these approaches, using a quarter-mile standard Monday through Saturday and a half-mile standard on Sunday in areas with a population density greater than 5,000 persons per square mile. YRT uses the same differentiation of standards depending on the day of the week (Monday through Saturday versus Sunday), while CTA makes a further distinction between peak and non-peak time periods on weekdays. Like the MBTA, Nashville MTA also uses a population density of 5,000 persons per square mile as a threshold for application of the coverage service standard. CTA, King County Metro Transit, TransLink, AC Transit, and MDT also use density to determine the necessary coverage standard, though the latter two agencies specify density levels higher than that used by the MBTA. Finally, several agencies also use an average route-spacing standard to evaluate coverage.

Span of Service

As mentioned above, the MBTA uses minimum span-of-service standards that vary by mode and day of the week. Heavy and light rail and Key Bus Routes operate between 6:00 AM and midnight on weekdays and Saturdays and between 7:00 AM and midnight on Sundays. The minimum span-of-service standard for local bus routes is 7:00 AM−6:30 PM on weekdays, 8:00 AM−6:30 PM on Saturdays, and 10:00 AM−6:30 PM on Sundays. The weekday span-of-service standards for community routes is 10:00 AM−4:00 PM, and for express/commuter routes is 7:00 AM−6:30 PM, with no service required between 9:00 AM and 4:00 PM. No weekend service is required for these two bus modes. The span-of-service standard requires commuter rail to operate between 7:00 AM and 10:00 PM on weekdays and 8:00 AM and 6:30 PM on Saturdays; no service is required on Sundays. Boat services are required between 7:00 AM and 6:30 PM on weekdays only.

CTA uses a span-of-service standard for its key routes only, and defines them based on the number of hours of required service rather than by fixed beginning and ending service times. For the 46 key routes, services are offered every day, generally for a minimum of 16 hours. The span-of-service hours for all other bus routes (defined as support routes) are determined by demand on an ongoing basis. CTA has also established a procedure for regularly considering span-of-service extensions when the hour immediately before the end or after the beginning of the current service shows productivity (based on passengers boarding per bus hour) greater than the average system productivity for that hour. Similarly, a key route may become a support

route, and lose its guaranteed span of service, if boardings per vehicle hour fall below an established minimum.

TransLink's minimum span-of-service standards stipulate that 95 percent of trips meet the following conditions: the latest arrival time of the first transit trip at the start of service is no later than 7:00 AM on weekdays, 8:00 AM on Saturdays, and 9:00 AM on Sundays and holidays; and the earliest departure time of the last transit trip at the end of service is no earlier than midnight on weekdays and Saturdays and 11:00 PM on Sundays and holidays.

Nashville MTA defines span-of-service standards according to various service classes and sets a goal for the number of hours of service provided. For example, in the "most frequent" service class, weekday span-of-service standards are defined as 6:00 AM−6:00 PM, but a goal of 18 hours of service for weekdays is also set. On Saturdays and Sundays, there are no span-of-service standards, but there is a goal of 18 hours and 12 hours, respectively, of service provided. For the "frequent" service class, the span-of-service goal drops to 17 hours on weekdays and Saturdays and 10 hours on Sundays. This method of determining when service must be provided allows more flexibility in setting the hours of operation, at the expense of providing customers with a guaranteed beginning and end of service times.

SEPTA only specifies a span-of-service standard for its suburban transit division and does not require certain routes in this division to operate on Saturdays and/or Sundays. For routes within this division that do operate during the weekends, the rail mode has the longest minimum span of service: 6:00 AM−10:00 PM. All bus routes are also required to start service at 6:00 AM. Routes connecting with the Market-Frankford rapid transit line are required to operate until 8:00 PM, while all other routes are required to operate until 6:00 PM. The minimum Saturday and Sunday span-of-service standards are 7:00 AM−9:00 PM and 8:00 AM−8:00 PM, respectively, on rail service, and 8:00 AM−6:00 PM and 10:00 AM−6:00 PM, respectively, on bus service. SEPTA also has span-of-service standards for its regional rail division: 7:00 AM−11:00 PM on weekdays, 8:00 AM−10:00 PM on Saturdays, and 9:00 AM−9:00 PM on Sundays. Finally, SEPTA's City Transit Division offers 24-hour "Owl" service on some bus routes, two of which replace rapid transit service, based on demonstrated demand.

AC Transit, which operates bus service only, defines its span-of-service according to various service classes based on the total number of hours, not specific beginning- and end-of-service times. A range of 19

to 24 daily hours of service constitutes Night or Owl service; 17 to 18 hours late-evening service; 14 to 16 hours early-evening service; 12 to 13 hours daytime service; 4 to 11 hours peak-hour-only service or limited-weekday service; and up to 3 hours very-limited service.

MDT applies the same span-of-service standard on every day of the week. MDT provides 24-hour service on select busway, Metrobus, and paratransit services. Metrorail and Metromover (a people mover) operate between 5:00 AM and midnight, and express service only operates during peak hours.

In summary, about half of the profiled peer agencies use a span-of-service standard like the MBTA (see Table 14). The MBTA generally has the same required hours of operation as its peer agencies. Only MDT requires 24-hour service, and only on select bus and paratransit services. Like the MBTA, most other agencies define different span-of-service standards depending on the day or time period and the service class. The longest span-of-service standards are generally for rapid transit service during the weekday. Instead of span of service, several agencies define a minimum number of hours, though the number of hours also generally varies depending on the day or time period and the service class.

Frequency of Service

As mentioned above, the MBTA uses a detailed matrix of frequency standards depending on the type of service and the time period. Generally, a 10-minute headway is required for the services and time periods most in demand. This includes AM and PM peak trips on light rail, heavy rail, and the Key Bus Routes. A 15-minute maximum headway is required at all other times for these services, with the exception of Key Bus Routes, which operate at a 20-minute maximum headway during the evening and on the weekend. Local bus routes are required to have at most a 30-minute headway during the peak periods and a 60-minute headway at all other times. Commuter-oriented services, such as express bus, commuter rail, and boat, are required to operate a minimum of three trips in the peak direction during each peak period; during all other periods, commuter rail and boat are required to operate at least one trip every 180 minutes.

CTA defines its frequency standard based on passenger flow, the type of service, and the time period. The required rail service peak headway ranges from 3 minutes to 15 minutes, and the off-peak headway ranges from 4 minutes to 60 minutes. Bus peak headways range from under 5

minutes for the highest passenger flows to as much as 30 minutes, while off-peak headways range from under 10 minutes to 30 minutes.

Table 14
Peer Agency Comparison of Span-of-Service Standards

Agency	Span of Service	Minimum Hours	Service Class	Day of Week*
MBTA	6:00 AM−12:00 AM 7:00 AM−12:00 AM		Heavy/light rail and key bus	WD & SA SU
	7:00 AM−6:30 PM 8:00 AM−6:30 PM 10:00 AM−6:30 PM		Local bus	WD SA SU
	7:00−9:00 AM and 4:00−6:30 PM		Express bus	WD
	7:00 AM−10:00 PM 8:00 AM−6:30 PM		Commuter rail	WD
	7:00 AM−6:30 PM		Ferry	WD
CTA		16	Key routes	
TransLink	7:00 AM−12:00 AM 8:00 AM−12:00 AM 9:00 AM−11:00 PM			WD SA SU & H
Nashville MTA		18 12	Most frequent	WD & SA SU
		17 10	Frequent	WD & SA SU
		6	Commuter	WD
		17 8	Circulator	WD SA & SU
		18 13	BRT	WD SA & SU
		14 10	Flexible routes	WD SA
SEPTA	6:00 AM−10:00 PM 7:00 AM−9:00 PM 8:00 AM−8:00 PM		Rail	WD SA SU
	6:00 AM−8:00 PM 6:00 AM−6:00 PM 8:00 AM−6:00 PM 10:00 AM−6:00 PM		Bus connecting to rail Other bus All bus All bus	WD WD SA SU
AC Transit		19-24 17-18 14-16 12-13 4-11 <3	Night or owl service Most-frequent service Early-evening service Daytime service Peak-hour service Very-limited service	
MDT	All day 5:00 AM−12:00 AM Peak hours		Select bus/paratransit Metrorail/Metromover Express service	

** Day of week codes: WD (weekday); WE (weekend); SA (Saturday); SU (Sunday); H (Holiday)*

TransLink identifies maximum headways by type of service and time of day. Rapid transit services should be provided at least every 5-6 minutes during weekday peak and midday periods and every 8-10 minutes during evenings (after 6:00 PM). Rapid bus services should be provided at least every 10 minutes during weekday peak and midday periods and every 15 minutes at other times. Local bus services should be provided at least every 30 minutes during weekday peak and midday periods.

Nashville MTA uses frequency to define two of its fixed-route service categories. “Most Frequent” routes have maximum headways of 30-60 minutes, with targeted headways of 15 minutes in the peak, 20 minutes in the midday, and 30 minutes in the evening and weekends. “Frequent” routes have maximum headways of 60 minutes, and targeted headways of 30 minutes in the peak, 45 minutes in the midday, and 30 minutes in the evening and weekends.

YRT defines a 15-minute maximum headway on its most heavily used bus routes at all times. The next level of bus service (“Base Grid”) has a required maximum headway of 20 minutes on weekdays during the peak periods, 30 minutes during the weekday off-peak and Saturday, and 60 minutes on Sunday. The third level of bus service (“Local Routes”) has a required maximum headway of 30 minutes on weekdays during the peak periods and 60 minutes at all other times. The final level of bus service (“Community Bus”) has a required maximum headway of 60 minutes on weekdays during the peak periods and 120 minutes at all other times.

SEPTA has established a matrix of frequency standards based on the type of service and time period, and whether the service is in the city or in the suburbs. For city service, the maximum headways for “high-speed” (rapid transit) service range from 5 minutes during the peak hours to 15 minutes off-peak. “Rail” (streetcar) lines operate at required maximum headways of 15 minutes in the peak to 30 minutes in the off-peak. Urban bus and trackless trolley services have maximum headways of 20 to 30 minutes in the peak and off-peak, respectively. Saturdays from 8:00 AM to 6:00 PM headways are 10 minutes on “high-speed” services, 20 minutes on “rail,” and 30 minutes on bus and trackless trolley. Sunday headways range from 15 minutes on “high-speed” services to 30 minutes on all other city transit services. Lower service frequencies are required for suburban transit services than for comparable city services. For bus and streetcar routes, TTC has set not only a maximum headway of 30 minutes, but also a minimum headway of 60 minutes.

Table 15
Peer Agency Comparison of Frequency-of-Service Standards

Agency	Maximum Headway (minutes)	Number of Trips	Service Class	Day/Time Period
MBTA	10		Light/heavy rail & Key Bus	WD peak
	15		Light/heavy rail	All other times
	20		Key Bus	All other times
	30		Local bus	WD Peak
	60		Local bus	All other times
		3	Commuter rail/boat & express bus	WD peak
		3	Express bus	WD peak
	180		Commuter rail/boat	All other times
CTA	3-15		Rail (rapid transit)	WD peak
	4-60		Rail (rapid transit)	All other times
	<5-30		Standard buses	WD peak
	<5-7.5		Articulated buses	WD peak
	<10-30		All buses	All other times
TransLink	5-6		Rail (rapid transit)	WD peak
	8-10		Rail (rapid transit)	All other times
	10		Rail (rapid transit)	WD peak
	15		Rail (rapid transit)	All other times
	30		Local bus	WD peak
Nashville MTA	30-60		Most frequent service	
	60		Frequent service	
YRT	15		VIVA (BRT)	
	20		Base Grid	WD peak
	30		Base Grid bus	WD off-peak & SA
	60		Base Grid bus	SU
	30		Local bus	WD peak
	60		Local bus	All other times
	60		Community bus	WD peak
	120		Community bus	All other times
SEPTA	5		High-speed (rapid transit)	WD peak
	15		High-speed (rapid transit)	WD off-peak
	15		Rail (streetcar)	WD peak
	30		Rail (streetcar)	WD off-peak
	20		Bus & trackless trolley	WD peak
	30		Bus & trackless trolley	WD off-peak
TTC	30-60		Bus and streetcar	
	5		Subway	
AC Transit	10-14		Rapid corridors (limited stop)	
	15-20		Major corridors	
	21-30		All other services	
RTD	30		Local bus	WD peak
	60		Local bus	WD evening & WE
	30-60		Local bus	Midday
		3	Express bus	WD peak
MDT	20		Metrobus express	Peak
	30		Metrobus limited	Peak/midday
	60		Metrobus local	All day
	7.5		Metrorail	Peak
	15		Metrorail	Midday/early night
	30		Metrorail	Late night & WE
	1.5		Metromover	Peak
	3		Metromover	All other times

** Day of week codes: WD (weekday); WE (weekend); SA (Saturday); SU (Sunday)*

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Within this range, headways can be varied based on demand. On subway lines, the minimum service level is 5 minutes.

AC Transit sets the frequency-of-service standard in most urban areas at 10-to-14-minute headways for rapid corridors and 15-to-20-minute headways for other trunk routes and major corridors. In other, less dense areas, the frequency-of-service standard is 21-to-30-minute headways.

RTD sets its maximum allowable local service headways on local bus routes at 30 minutes in the peak periods, 60 minutes for evenings and weekends, and 30 to 60 minutes in the midday, depending on ridership levels. Express and regional trips to the central business district are required to offer three trips in both peak periods on weekdays.

MDT sets maximum headways by service type and time period. Metrobus peak headways range from 20 minutes on express services to 60 minutes on local services. Metrorail headways are as low as 7.5 minutes in the peak period and as high as 30 minutes in the late evening and on weekends. Metromover headways are 1.5 minutes in the peak period and 3 minutes at all other times.

In summary, frequency is defined by the MBTA and all profiled peer agencies as a maximum headway that typically varies depending on the day or time period and the service class (see Table 15). Some agencies, such as CTA and AC Transit, allow for a range of headways that, in the case of CTA, are associated with different passenger volumes. The MBTA's 10-minute maximum-headway standard for rapid transit during the weekday peak periods is among the lowest for the profiled peer agencies, after CTA (3 minutes), SEPTA (5 minutes), TransLink (5-6 minutes), and MDT (7.5 minutes). Generally, most agencies set the maximum headway during peak periods for all rail and bus modes between 5 and 20 minutes. Like the MBTA, RTD sets a number of trips (three) as the frequency standard for commuter services during the peak periods.

Schedule Adherence

As mentioned above, the MBTA uses two types of metrics to determine bus route schedule adherence: a timepoint test, which varies based on service frequency, and a route test. The timepoint test for scheduled-departure trips (those with a headway of 10 minutes or more) states that trips must depart the origin timepoint 0-3 minutes late, depart the mid-route timepoints 0-7 minutes late, and arrive at the destination timepoint 3 minutes early to 5 minutes late. The timepoint test for walk-up trips (those with a headway of less than 10 minutes) states that trips

must depart the origin and mid-route timepoints within 1.5 times the scheduled headway and arrive at the destination timepoint with a trip running time within 20 percent of the scheduled running time. The determination of route schedule adherence is based on the route test, which states that at least 75 percent of all timepoints on a given route must meet the timepoint test.

For light rail operating on the surface, 85 percent of all trips must be operated within 1.5 times the scheduled headways; for light rail operating in the subway, 95 percent of all trips must have headways of less than 5 minutes; and for heavy rail, 95 percent of all trips must be operated within 1.5 times the scheduled headways. In addition, for both light and heavy rail, 95 percent of trip running times must fall within 5 minutes of the scheduled total trip times over the entire service day. For commuter rail and boat, 95 percent of all trips must depart and arrive within 5 minutes of the scheduled departure and arrival times.

TransLink bus service guidelines indicate that 90 percent of bus trips on each route should depart each terminus not more than two minutes late, no trips should depart early, and 90 percent should arrive at each terminus not more than three minutes late. In addition, 85 percent of bus trips on each route should depart each mid-route scheduled timing point not more than three minutes late and no trips should depart early. For TransLink's SkyTrain light rail service, schedule-adherence guidelines indicate that 98 percent of trips should be provided with no more than two minutes of delay compared to scheduled times.

SEPTA applies its schedule-adherence standard only to services operating in private rights-of-way and defines "on-time" as 0 to 6 minutes late. Within the city and suburban transit divisions of services, for those routes operating at a scheduled headway of less than 10 minutes, 75 percent of departures must meet the standard in the peak period, and 80 percent of departures must meet the standard at other times. For services with scheduled headways greater than 10 minutes, the required on-time departure percentages are 85 percent in the peak period and 95 percent at other times. For the regional (commuter) rail, 90 percent of train departures are required to meet the schedule adherence standard.

MDT Metrobus trips are considered on-time if the actual departure lies within 0 to 5 minutes after the scheduled departure. Metrorail trips are considered on-time if the actual departure lies between 1 minute before and 5 minutes after the scheduled departure. To meet the schedule-

adherence standard, 75 percent of Metrobus departures and 95 percent of Metrorail departures must be on time.

In summary, the MBTA generally has a more detailed set of on-time standards than the profiled peer agencies (see Table 16). All of the agencies with a schedule-adherence standard define on-time as the number of minutes late compared to the posted schedule. The acceptable number of late minutes ranges between 0 and 6 minutes for origins and 0 and 7 minutes for midpoints, and trips are considered on-time if they arrive at destinations between 3 minutes early and 5 minutes after the scheduled arrival. The MBTA is the only agency that uses a standard based on the scheduled headway or running time. In terms of the percentage of a route's timepoints required to meet the on-time standard (the route standard), the MBTA has a lower standard for bus route schedule adherence than only one of the profiled peer agencies, but the MBTA's standards for rail schedule adherence fall within the range of those for all peer agencies.

Vehicle Load

As mentioned above, the MBTA defines the vehicle-load standard as a maximum ratio of passengers to seats depending on the mode, vehicle type, time period, and service area. Generally, the highest ratio is applied to the time periods of greatest demand. The maximum ratio for bus is 140 percent; for the Green, Orange, and Blue Lines, it is 225 percent. All three types of Red Line cars have higher capacities than those on other lines; therefore, the maximum ratios are higher: 270 percent for the #1 and #2 cars and 334 percent for the #3 cars. At other time periods for these modes, the vehicle-load standard depends on the service area. For bus, the tunnel portion of the Silver Line has a ratio of 140 percent; otherwise, the maximum ratio is 100 percent for all surface routes. For the Green, Orange, and Blue Lines, and the #1 and #2 cars on the Red Line, service in the core area has a ratio of 140 percent; outside the core area, the maximum ratio is 100 percent. For the #3 Red Line cars, the core area vehicle-load standard is 174 percent and the non-core standard is 100 percent. Commuter rail has a vehicle-load standard of 110 percent during the time periods of greatest demand and 100 percent at other times. Commuter boat has a vehicle-load standard of 100 percent at all times.

CTA establishes its vehicle-load standards by mode based on assumptions about the maximum passenger flow. The resulting maximum ratios of passengers to seats are 150 percent for bus, 143 percent for articulated bus, and 225 percent for rail cars. However, CTA has defined an acceptable maximum range of passengers per bus for

the entire range of passenger-flow rates. If the vehicle-load standard for any passenger-flow rate were violated at any point, the resulting

Table 16
Peer Agency Comparison of Schedule-Adherence Standards

Agency	Timepoint or Trip	On-Time Standard	Route Standard	Headway	Location	Service Class	Time Period
MBTA	Timepoints	0-3 minutes late	75%	≥10 min.	Origin	Bus	
		0-7 minutes late	75%	≥10 min.	Midpoints	Bus	
		3 minutes early to 5 minutes late	75%	≥10 min.	Destination	Bus	
	Timepoints	Within 1.5 scheduled headway	75%	<10 min.	Orig. & Mid.	Bus	
		20% of scheduled running time	75%	<10 min.	Destination	Bus	
	Trips	Within 1.5 scheduled headway	85%			Surface light rail	
		Headways <5 minutes	95%			Subway light rail	
	Trips	Within 1.5 scheduled headway	95%			Heavy rail	
		Within 5 min. of scheduled run time	95%			Light/heavy rail	
	Timepoints	5 minutes early to 5 minutes late	95%		Orig. & Dest.	Commuter rail/boat	
TransLink	Timepoints	2 minutes late	90%		Origin	Bus	
		0 minutes early	100%		Orig. & Mid.	Bus	
		3 minutes late	85%		Midpoints	Bus	
		3 minutes late	90%		Destination	Bus	
SEPTA	Timepoints	0-6 minutes late	75%	≤10 min.	Origin	City and suburban	Peak
		0-6 minutes late	80%	≤10 min.	Origin	City and suburban	Other
		0-6 minutes late	85%	>10 min.	Origin	City and suburban	Peak
		0-6 minutes late	90%	>10 min.	Origin	Regional rail	
MDT	Timepoints	0-5 minutes late	75%		Origin	Metrobus	
		1 minute early to 5 minutes late	95%		Origin	Metrorail	

consequence would presumably be an increase in frequency in order to reduce the vehicle load. King County Metro Transit's guidelines provide everyone a seat during non-peak periods and tolerate standees for no longer than 20 minutes during weekday peak hours. The maximum peak-period vehicle-load ratio is 120 percent.

TransLink has different standards based both on type of vehicle and time of day. It allows some standees during the off-peak and calculates peak maximum loads over both the peak 30-minute and peak 15-minute intervals. During the peak 15 minutes of the peak periods, TransLink uses a maximum vehicle-load ratio of 145 to 158 percent and states that on 90 percent of peak bus trips and on 95 percent of off-peak trips, no passenger should stand for longer than 30 minutes.

Nashville MTA uses a maximum peak vehicle-load ratio of 133 percent on BRT routes, 125 percent on all other non-commuter routes, and 100 percent on commuter routes. A maximum non-peak ratio of 100 percent is used on all routes.

YRT's maximum vehicle-load standards for local bus routes vary between 120 percent and 138 percent depending on the type of bus. Other express bus, shuttle, and community bus routes use a 100 percent passengers-to-seats ratio.

SEPTA's maximum vehicle-load standards for bus routes vary between 152 percent and 169 percent depending on the type of bus. Other modes' ratios of passengers to seats are 167 percent for light rail, 164 percent for trackless trolley, and between 167 and 211 percent for rapid transit. The vehicle-load standard for regional rail permits no standees.

SFMTA uses a 125 percent peak-period vehicle-load standard with a goal that no more than four percent of runs exceed this standard.

TTC defines its maximum vehicle-load standards depending on the time period, frequency, and type of service. TTC has a fleet of 40-foot buses for which the peak standard varies between 145 percent and 179 percent. The non-peak standard depends on whether the frequency of service is greater than once every 10 minutes. For headways greater than 10 minutes, the maximum ratio is 100 percent. For headways less than 10 minutes, the maximum ratio is 125 percent. The various ratios are similar for TTC's fleet of standard and articulated streetcars. The maximum peak vehicle-load standard for subway trains is 281 percent and the maximum non-peak standard ranges between 125 and 130 percent.

AC Transit uses a vehicle-load standard of 125 percent for most routes and 100 percent for routes traveling in areas of very low density and all-night routes.

RTD uses a 125 percent vehicle-load standard for all local- and limited-stop routes during the peak period. For all other routes, and for these routes during the non-peak period, the standard is 100 percent.

MDT defines its maximum vehicle-load standards depending on the time period, headway, and type of service. For Metrobus headways less than or equal to 15 minutes, the standard ranges between 160 percent during the peak period and 110 percent at night. For Metrobus headways between 16 and 30 minutes, the standard ranges between 130 percent during the peak period and 110 percent during the midday period and on weekends. For Metrobus headways greater than 30 minutes, the peak standard is 110 percent; otherwise, it is 100 percent. For Metrorail headways less than or equal to 10 minutes, the standards are 145 percent in the peak, 125 percent in the midday and on weekends, and 100 percent at night. For Metrorail headways greater than 10 minutes, the standards are 130 percent in the peak, 110 percent in the midday and on weekends, and 100 percent at night. The Metromover vehicle-load standard is 75 percent at all times.

In summary, the MBTA, along with the profiled peer agencies, provides detailed vehicle-load standards that depend on the service class, time period, location, or other factors such as the length of time standing or the headway (see Table 17). Generally, some level of standing is acceptable during high-volume time periods on bus and rapid transit services. Bus peak vehicle-load ratios range between 120 percent and 180 percent. Rail peak vehicle-load ratios are much higher—as much as 334 percent on the #3 Red Line cars used by the MBTA. The MBTA is the only agency among the profiled peer agencies that varies its vehicle-load standard based on location, and MDT and TTC are the only agencies with vehicle-load standards based on the scheduled headway. King County Metro Transit and TransLink both use a standard for an acceptable limit to the amount of time customers must stand. In general, little-to-no standing is acceptable on long-distance, limited stop services, such as commuter rail or express bus.

The MBTA and the profiled peer agencies all use ratios of passengers to seated capacity when setting the load standard. Typically, different ratios are used as the standard for different service classes. Indeed, although the MBTA does not currently make a distinction between service classes, the available standing area on buses differs considerably between bus types. On low-floor buses, slimmer center

Table 17
Peer Agency Comparison of Vehicle-Load Standards

Agency	Vehicle-Load Ratio	Service Class	Time period	Location	Other
MBTA	140%	Bus	Early AM, peak, school	Outside core	
	100%	Bus	All other times	Surface	
	140%	Bus	All other times	Tunnel	
	225%	Green, Orange, Blue	Early AM, peak, school		
	270%	Red #1 & #2 cars	Early AM, peak, school		
	334%	Red #3 cars	Early AM, peak, school		
	140%	Green, Orange, Blue, Red #1 & #2 cars	All other times	Core	
	174%	Red #3 cars	All other times	Core	
	100%	Green, Orange, Blue, Red	All other times	Outside core	
CTA	150%	Bus			
	143%	Articulated bus			
	225%	Rail			
King County Metro Transit	100%		Non-peak		
	120%		Peak		Standees ≤ 20 min.
TransLink	145%-158%	Bus (high/low floor)	Peak 15 minutes		Standees ≤ 30 min.
	157%	Articulated bus	Peak 15 minutes		on 90% of trips
	132%-145%	Bus (high/low floor)	Peak 30 minutes		
	139%	Articulated bus	Peak 30 minutes		
	118%	Bus (high/low floor)	Off-peak		Standees ≤ 30 min.
	120%	Articulated bus	Off-peak		on 95% of trips
Nashville MTA	133%	BRT	Peak		
	125%	Non-commuter bus	Peak		
	100%	Commuter bus	Peak		
	100%	Commuter bus	Off-peak		
YRT	138%	Local buses			
	120%	VIVA buses (BRT)			
SEPTA	159%	40’ standard bus			
	169%	40’ low-floor bus			
	152%	60’ articulated bus			
	167%	Light rail			
	167%-211%	Rapid transit			
	164%	Trackless trolley			
	100%	Regional rail			
SFMTA	<4% of trips exceed 125%		Peak		
TTC	145%-179%	40’ buses	Peak		
	125%	40’ buses	Off-peak		Headway ≤ 10 min.
	100%	40’ buses	Off-peak		Headway > 10 min.
	161%	Standard streetcar	Peak		
	177%	Articulated streetcar	Peak		
	125%	Streetcar	Off-peak		Headway ≤ 10 min.
	100%	Streetcar	Off-peak		Headway > 10 min.
	220%-281%	Rapid transit	Peak		
	125%-130%	Rapid transit	Off-peak		
AC Transit	125%	Most bus routes			
	100%	Low-density and night routes			
RTD	125%	Local and limited routes	Peak		
	100%	Local and limited routes	Off-peak		
	100%	Express and regional routes			
MDT	160%	Metrobus	Peak		Headway ≤ 15 min.
	120%	Metrobus	Midday/weekend		Headway ≤ 15 min.
	110%	Metrobus	Night		Headway ≤ 15 min.
	130%	Metrobus	Peak		Headway 16−30 min.
	110%	Metrobus	Midday/weekend		Headway 16−30 min.
	100%	Metrobus	Night		Headway 16−30 min.
	110%	Metrobus	Peak		Headway > 30 min.
	100%	Metrobus	All other times		Headway > 30 min.
	145%	Metrorail	Peak		Headway ≤ 10 min.
	125%	Metrorail	Midday/weekend		Headway ≤ 10 min.
	100%	Metrorail	Night		Headway ≤ 10 min.
	130%	Metrorail	Peak		Headway > 10 min.
	110%	Metrorail	Midday/weekend		Headway > 10 min.
	100%	Metrorail	Night		Headway > 10 min.
	75%	Metromover			

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aisles mean that passengers have less room for standing. In this case, since crowding likely occurs at a ratio of passengers per seated capacity of less than 140 percent, this standard would fail to identify crowding where it occurs. Similarly, buses serving the Silver Line Waterfront have fewer seats because of their luggage racks, but more standing room. In this case, crowding likely occurs at a ratio of passengers per seated capacity of greater than 140 percent; therefore this standard would identify crowding where it does not occur. Another potential metric for measuring passenger crowding could be the ratio of passengers to floor area. Rather than setting a different load standard for passengers per seated capacity based on the vehicle type, a standard of passengers per floor area could be consistently applied across all types.

Net Cost per Passenger

As mentioned above, the MBTA calculates the net cost per passenger for each bus route. This calculation is the ratio of operating costs minus service revenue to the number of boarding customers. A route is classified as "deficient" if its net cost per passenger is greater than or equal to three times the systemwide average.

The only agency in the list of peer properties compiled for this analysis that uses a strict net-cost-per-passenger standard is MDT, which sets the maximum level of the net cost per passenger at $4.40.

2.2.2 Service Standards Not Used by the MBTA

These service standards are grouped into general categories in order to facilitate organization and discussion. Multiple categories may potentially cover one standard; however, each standard is grouped with the category considered most relevant.

Service Structure

The following service standards measure the way in which service is structured and how passengers use that service given its structure.

Stop Spacing

This standard sets a minimum distance between stops or general guidelines for the placement of stops (see Table 18).

CTA sets an average stop distance of approximately 0.125 miles (a standard Chicago block), depending on the population density of a neighborhood.

YRT sets an average stop distance of approximately 0.155 miles in developed areas and 0.311 miles in undeveloped areas, with the provision that specific major trip generators may require variances in the spacing between stops.

SEPTA sets minimum spacing standards that are dependent on the location. In urban areas, established routes have a minimum spacing of 500 feet (0.095 miles, a standard Philadelphia city block). New urban routes have a minimum spacing of 1,000 feet (0.189 miles, approximately two city blocks). In residential suburban areas, the minimum spacing is set at 1,000 feet (0.189 miles). SEPTA also sets minimum spacing standards for its rail division. The minimum average station spacing is 0.25 miles in urbanized areas (population densities between 1,000 and 10,000 persons per square foot) and 0.5 miles in less-dense areas. In all cases, exceptions can be made when considering specific geographic or demographic conditions.

Table 18
Peer Agency Comparison of Bus Stop-Spacing Standards

Agency	Stop Spacing (miles)	Type of Area or Service
CTA	0.125	
YRT	0.155	Developed areas
	0.311	Undeveloped areas
SEPTA	0.095	Urban areas
	0.189	New urban areas
	0.189	Residential suburban areas
MDT	0.200	High-density areas
	0.250	Medium-density areas
	0.333	Low-density areas
	0.500	Rural-density areas
	0.200	Local service
	0.500-1.000	Limited/busway service
	Closed-door service for at least 50% of route	Express service

MDT sets standards for bus-stop spacing according to the density level and the service type. The following density levels correspond to stop-spacing standards: high-density areas such as central business districts (CBDs) and shopping centers (0.20 miles); medium-density areas such as fully developed residential areas (0.25 miles); low residential density (0.33 miles); and rural (0.50 miles). The following service types also correspond to stop-spacing standards: local (0.20 miles);

limited/busway (0.50-1.00 miles, with stops at all major transfer points); and express (closed-door service for at least 50 percent of the total route length).

Route Duplication and Competition

This standard sets general guidelines for the placement of routes such that they do not duplicate or compete with existing transit services.

King County Metro Transit notes that operation of more than one route on the same street should be avoided when the routes serve common destinations, except for streets approaching a downtown or urban center, transit center, or park-and-ride facility.

SEPTA policy asserts that potential new services cannot compete with existing services, especially the High-Speed and Regional Rail Lines.

Route Travel Time

This standard sets the maximum transit travel time per one-way trip. Generally, transit routes should be designed to be as short as possible while still serving their markets.

King County Metro Transit sets the maximum transit travel time per one-way trip at 60 minutes.

Directness of Travel (Comparison to Auto Trip Times)

Unlike private travel, public transit cannot offer the same level of direct travel between origins and destinations. However, this standard compares transit in-vehicle travel times to private vehicle travel times and sets a maximum ratio of the transit time to the private vehicle time (see Table 19).

King County Metro Transit sets the guideline that transit travel times should be no more than 20–25 percent longer than comparable trips by automobile.

Nashville MTA has established six perception grades based on the difference between transit travel times and automobile travel times: A (0-minute difference: transit trips same as automobile); B (1-to-15-minute difference: transit and auto trips close to equal); C (16-to-30-minute difference: tolerable for “choice” riders); D (31-to-45-minute difference: difficult to compete for “choice” riders); E (46-to-60-minute difference: system cannot compete for “choice” riders); and F (60+ minute difference: unacceptable to most riders). Nashville MTA’s guideline is to make most trips achieve a grade of at least C and to minimize the number of trips with an E grade.

YRT distinguishes by mode the acceptable ratio of a route's actual trip time to the travel time of the most direct path between the start and end points of the route. Base Grid routes and BRT-like routes should have actual travel times between 0 and 10 percent greater than the direct-path time. The travel times of all local bus routes should be between 0 and 20 percent greater than the direct-path times. Travel times of express routes should not exceed the direct-path times within the express or limited-stop portion of the route.

MDT sets the guideline that transit travel times should be no more than 25 percent longer than comparable trips by automobile. In addition, MDT analyzes the additional travel time incurred by through-passengers of deviations from the most direct through-path. The ratio of the total additional through-passenger travel time in minutes to the number of passengers served by the deviation should not exceed five to one. Thus, according to this standard, the total additional travel time for all through-passengers shall not exceed five minutes for each rider boarding or alighting along the route deviation.

Table 19
Peer Agency Comparison of Directness-of-Travel Standards

Agency	Ratio of Route Time to Direct (Auto) Trip Time	Absolute Difference	Type of Trip
King County Metro Transit	1.20-1.25		
Nashville MTA		16-30 min. 46-60 min.	Perception Grade A-C Perception Grade D-F
YRT	1.00-1.10 1.00-1.20 1.00		Base Grid and BRT routes Local bus routes Limited-stop portion of express route

Ease of Use

Of the peer properties included in this analysis, only Nashville MTA includes guidelines for ease of use. Nashville MTA specifies better ease of use through the following measures: the extent of clock-face headways so that the service schedule is easy to remember; the use of new technology to provide online access to schedules and real-time information on the service schedule by location; the use of simple fare collection methods such as passes and payment by credit cards; the

extent to which routes run consistently throughout the day with minimum variations; and the extent of information or training provided to new users to help them learn how to use the transit system.

Number of Transfers and Transfer Waiting Time

While none of the peer agencies included in this analysis have established an explicit standard for transfers, King County Metro Transit, in its guidelines, notes how transfers between routes can add to a rider's total trip time, but can also provide an increased choice of destinations accessible by transit. The goal in these guidelines, as well as those specified by CTA, is to minimize the transfer waiting time.

Service Provision

The following service standards measure the quality of service provided.

Service Delivery

This standard measures the percentage of scheduled service hours that are actually delivered. SFMTA sets a goal of delivering a minimum of 98.5 percent of the scheduled service hours. This minimum increases to 99.0 percent in the AM and PM peak periods.

Service Failure

This standard sets the minimum acceptable miles of operation, averaged by mode, between vehicle failures. SFMTA sets a minimum mean distance between failures of 5,000 miles for its light rail vehicles and 3,400 miles for its motor coaches.

Vacancy Rate

This standard sets maximum employee vacancy rates for various service-critical positions. SFMTA sets a maximum quarterly vacancy rate of five percent for positions in transit operations, crafts, and maintenance.

Accident and Incident Rate

This standard sets a maximum rate of accidents and incidents. MDT sets a maximum accident and incident rate of six per 100,000 vehicle-miles.

Passenger Complaints

This standard sets a maximum rate of complaints by mode. MDT's maximum standards for complaints are 1.5 per 100,000 boardings on rail, 11 per 100,000 boardings on bus, and two percent of all paratransit trips.

Service Efficiency

The following service standards measure the efficiency of service, with regard to either cost or ridership.

Cost-Effectiveness

Cost-effectiveness is part of the calculation of the net cost per passenger. However, several agencies calculate it separately. It represents the ratio of service revenue to operating costs.

Nashville MTA evaluates the cost-effectiveness of each route. The 10 percent of routes with the highest cost-effectiveness ratios are targeted for frequency improvements, while the 10 percent with the lowest ratios are evaluated for potential ways to improve cost-effectiveness.

SEPTA has established a minimum cost-effectiveness ratio for a given route of 60 percent of the systemwide ratio. Exceptions to this required minimum occur when any route or portion of a route is subsidized by sources outside of the regular SEPTA operating budget or when a route provides the only service coverage for an area.

RTD has adopted a systemwide cost-effectiveness standard of 30 percent, though this ratio includes more categories than just operating revenue and costs.

MTD has a minimum cost-effectiveness standard of 20 percent for all local routes and 100 percent for all express bus routes.

Passenger Productivity

Passenger productivity is another part of the calculation of the net cost per passenger. However, several agencies calculate it separately. It represents the number of passengers per revenue-hour (see Table 20).

CTA has established a minimum bus productivity level of 30 boardings per revenue-hour when the headway is at least 30 minutes.

YRT bases its passenger-productivity standard on the mode and time period. Generally, the Base Grid and local services have a minimum standard of passengers per hour of 10 boardings in the peak period and 7 boardings at all other times. As routes become more specialized,

such as express routes or rail shuttles, the minimum passenger-productivity standards increase. YRT also has passenger-productivity standards for fixed-route and demand-responsive paratransit of 5 boardings per hour in the peak period.

SEPTA only has a passenger-productivity standard for its regional rail division. Each station must have a minimum of 75 daily boarding or alighting passengers.

RTD only applies a passenger-productivity standard to routes operating at the minimum service frequency. The number of passengers per hour is calculated for each route and the bottom 10 percent of local routes and 25 percent of limited routes are targeted for evaluation.

MTD applies a passenger-productivity standard to its Metrobus and Metrorail operations based on the day of the week. On weekdays, 30 passengers per hour is the minimum standard for Metrobus, and 60 passengers per hour is the minimum standard for Metrorail. On Saturday, the rates are 25 and 60, respectively. On Sunday, the rates are 25 and 50, respectively.

Table 20
Peer Agency Comparison of Bus Passenger-Productivity Standards

Agency	Passengers per Revenue Hour	Criteria for Standard
CTA	30	Headway at least 30 minutes
YRT	10 7	Local services in the peak Local services in the off-peak
MTD	30 25	Metrobus on weekdays Metrobus on weekends

Physical Infrastructure

The following standards measure how the provision of various physical infrastructure impacts service delivery and the quality of that service.

Distribution of Revenue Equipment

Of the peer properties included in this analysis, only CTA and SEPTA include guidelines for considering investment in rail stations. CTA guidelines specify several factors to consider when distributing revenue equipment. The top priority is to ensure that all routes are accessible. Other guidelines are the distribution of buses with air conditioning and the average age of buses (CTA states that all bus garages should have roughly the same proportion of air-conditioned buses and that the average age of buses at the garages should be roughly equal). Finally,

CTA guidelines recommend that the number of bus types at each garage be kept to a maximum of four, with an optimum of three types.

SEPTA also has a goal of maintaining an approximately equivalent fleet age in each bus district, with the exception that certain bus types (those with shorter lengths, articulated buses, and buses with hybrid or special fuels) need to be assigned to certain districts.

Distribution of Transit Amenities

As with distribution of revenue equipment, there are guidelines associated with the provision of amenities such as benches, shelters, and trash cans. CTA only notes that priority is given to providing amenities at bus stops that have large numbers of passengers who board at the location, lengthy wait times between buses, a high percentage of transfer passengers, and/or a high percentage of seniors or persons with disabilities.

The MDT standard for amenities states that all bus stops with a minimum of 100 daily boardings and/or major transfer points should be supplied with real-time information. All stops with a minimum of 100 daily boardings and sufficient right-of-way should receive a shelter. All stops with less than 100 daily boardings but sufficient right-of-way should receive a bench. Finally, all MDT bus stops with either shelters or benches should receive trash bins. For the Metrorail system, a system map and relevant route schedules, along with trash bins and an emergency phone, should be provided at every station.

2.3 Policy Implications of Service Standard Metrics

The previous section reviewed the various standards and performance metrics that are used to evaluate MBTA and other peer agency services. Organized by service standard and by general themes, this section will consider the metrics used to measure performance and the resulting policy implications of each metric. The relative magnitude of the performance metrics will also be discussed in terms of their policy implications and potential application at the MBTA. Suggestions will be made for potential changes and additions to the current Service Delivery Policy where the specific standard or guideline relates to the stated policy objective of defining key performance characteristics of quality transit services.

2.3.1 Service Structure

Coverage

Among the agencies profiled, the metric most commonly used to evaluate coverage is the walking distance to the nearest transit service. Some agencies also use the average distance between routes (route spacing). According to these metrics, attainment of the defined standard in every single instance is typically required to reach the coverage standard or guideline. A standard of 0.25 miles is used by several peer agencies as an acceptable walk distance. At an average walking speed of 3 miles per hour, a quarter-mile walk would take approximately five minutes. A half-mile walk (approximately 10 minutes) represents what transit literature typically presents as the maximum acceptable walk distance in an urban context. Distances greater than a half mile are generally considered to be above the threshold at which most potential riders would consider walking to transit. With a grid street pattern and ubiquitous coverage, the maximum route spacing should equal two times the average walking distance. However, smaller maximum route-spacing performance measures may be necessary when the street pattern does not follow a grid structure.

The choice of the coverage metric (maximum walking distance or route spacing) should reflect the way that passengers access transit. A maximum walking distance is more appropriate in areas where walking to transit is a feasible access mode, as it provides the most realistic way of measuring how many passengers have access to transit. It is less likely that riders will access transit by walking in areas with curvilinear street patterns, cul-de-sacs, and poor sidewalk conditions. Indeed, it would be unreasonable to apply a walking-distance standard to some of these areas, as the walkers would likely exceed the maximum walking distance well before they reached the transit stop. The route-spacing standard, because it does not consider walking distances to transit, may be a more appropriate standard in these areas. However, outside of areas where walking is feasible, it may not be practical to apply a coverage standard. It does not appear, therefore, that the route-spacing metric offers any additional level of coverage evaluation beyond that provided by the maximum walking distance.

Many of the profiled agencies, including the MBTA, use a density threshold above which to apply the coverage standard. Routes serving areas below this threshold are not required to meet the coverage standard. Some peer agencies apply a range of coverage standards that corresponds to a range of density levels. Density, in many cases, can serve as a proxy for describing the relative ease of walking

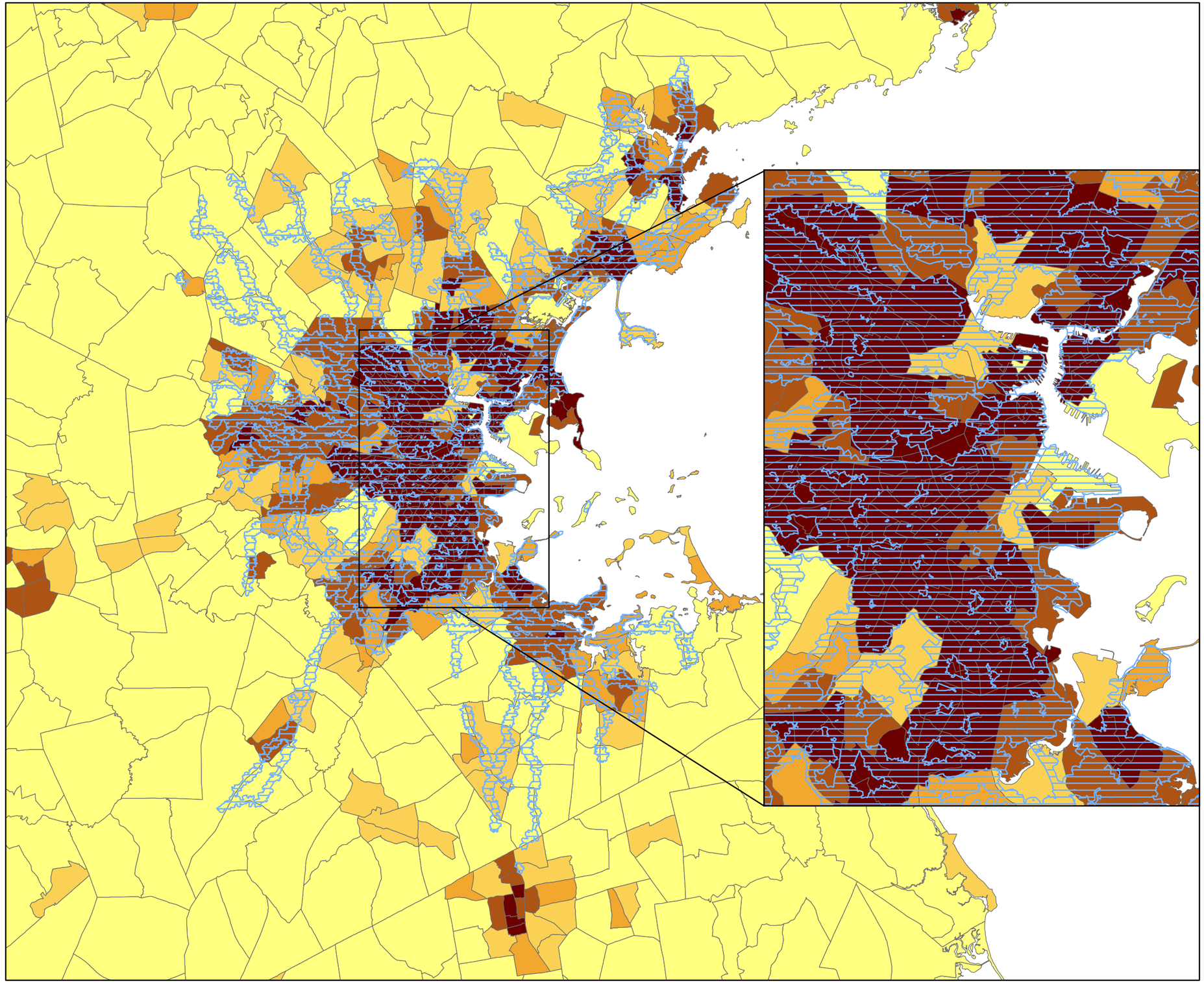
accessibility. Figure 1 presents MBTA bus and rapid transit coverage assuming a quarter-mile walking distance layered over population density by census tract using data from the 2000 U.S. Census.

As seen in the figure, it appears as though most areas with a population density greater than 5,000 persons per square mile lie within a quarter-mile walk to bus, light rail, or heavy rail service. According to the 2008 MBTA Title VI Report, 80 percent of street-miles that lie within census tracts with a population density of 5,000 or greater are within a quarter mile of transit service.[13] The coverage appears to be consistent for at least most of the areas with a population density between 4,000 and 5,000 persons per square mile, and even a majority of the areas with a population density between 2,500 and 4,000 persons per square mile.

The goal of a coverage standard is to provide the same access to service in the areas with relatively similar transit-demand characteristics. Population density is the most convenient proxy for estimating this demand and required coverage level. While the MBTA currently uses a population-density threshold of 5,000 persons per square mile for applying its coverage standard of a quarter mile as the maximum walking distance, it may make sense, given the existing coverage level already provided by the MBTA, to provide a range of thresholds and corresponding coverage standards. For instance, the population-density threshold could likely be decreased to 0.20 miles for areas with population densities greater than 10,000. Similarly, a threshold of 0.33 miles for population densities between 4,000 and 5,000 and 0.50 miles for population densities between 2,500 and 4,000 likely largely reflects the coverage of existing service. In practice, these multiple thresholds do not dramatically change the extent of the geographic area where coverage is required, increasing total coverage in the entire bus and rapid transit service area of 158 square miles by 29 square miles, an 18 percent increase. Figure 2 shows where the additional coverage would be required by adding multiple thresholds. Instituting a standard for lower population densities would, however, ensure that similarly dense areas receive similar coverage.

[13] Central Transportation Planning Staff, MBTA Title VI Report. Boston, MA, 2008.

FIGURE 1
Transit Coverage in Relation to Population Density by Census Tract



Legend

Area within 0.25-mile walk to transit

Persons per Square Mile

- Under 2,500
- 2,500 to 3,999
- 4,000 to 4,999
- 5,000 to 9,999
- 10,000 and over

N

0 3 6 12 Miles

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FIGURE 2
Additional Areas Requiring Transit Coverage Based on Population Density by Census Tract

Legend

- Area within 0.25-mile walk to transit
- Additional required coverage

Persons per Square Mile

- Under 2,500
- 2,500 to 3,999
- 4,000 to 4,999
- 5,000 to 9,999
- 10,000 and over

N

0 3 6 12 Miles

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Stop Spacing

Among the agencies profiled that use the stop-spacing standard, the metric used to evaluate stop spacing is generally an average or minimum distance between stops. Some agencies require the average stop spacing across all routes and/or stops on a route to meet a certain minimum standard while others establish a minimum distance between stops applied to each individual pair of stops. An average stop-spacing standard allows for more flexibility in route planning, but a minimum standard ensures that no two stops are too close together. The required stop-spacing values used by peer agencies in an urban context generally match the average size of a city block (from approximately 0.10 to 0.20 miles). Several profiled peer agencies also have stop-spacing standards for non-urban areas and for rail stations. None of the profiled peer agencies appear to have a maximum stop-spacing standard.

Certain modes obviously cannot be held to a stop-spacing standard. Existing heavy rail stations, for example, have their locations fixed. Express buses operate a significant portion of their routes without any stops. However, the understanding of average or minimum stop spacing, even for these modes, can be useful when considered in relation to those modes for which stop location is flexible for purposes of comparison of the respective service levels. For example, the average stop spacing of any bus route that intends to offer bus rapid transit service should be close to that of heavy rail rapid transit.

For local bus and surface light rail, even if a stop-spacing standard has not been explicitly set, many agencies operate with at least a tacit understanding of what the spacing should be. The MBTA could better justify its decisions with regard to stop location, elimination, and relocation by including a stop-spacing standard in its Service Delivery Policy. However, such a standard would need to recognize that the various municipalities served by the MBTA make the final decisions regarding stop location. As part of this standard, the MBTA could also state general policy guidelines for the location of stops near intersections (near-side vs. far-side).

Table 21 presents the number and percentage of MBTA stops with an average distance between stops at various levels.[14] As seen in the table, nearly one-half of the routes have an average stop distance between 0.10 and 0.20 miles. Less than five percent of all stops have a

[14] Data from the MBTA HASTUS database, spring 2010 quarter.

stop distance less than or equal to 0.05 miles. Slightly more than 30 percent have a stop distance less than or equal to 0.10 miles. The percentage of stops with a stop distance less than or equal to 0.15 miles is 63 percent. Slightly less than 20 percent of all stops have a stop distance between 0.15 miles and 0.20 miles, and 8 percent of stops have a stop distance between 0.20 miles and 0.25 miles. More than 10 percent of stops have a distance to the next stop greater than 0.25 miles.

Table 21
Number and Percentage of MBA Stops by Distance to Next Stop

Distance to Next Stop	Number	Percent
0.001-0.050 miles	1,905	4.7%
0.051-0.100 miles	10,613	26.2%
0.101-0.150 miles	12,827	31.7%
0.151-0.200 miles	7,178	17.7%
0.201-0.250 miles	3,235	8.0%
Greater than 0.250 miles	4,699	11.6%

Route Duplication and Competition

The route-duplication standard prohibits more than one route from serving the same corridor when the routes serve common destinations. The route-competition standard is more general, stating that transit services should not compete with other transit services for riders. Even the route-duplication standard involves some subjective judgment, however, as exceptions are made for routes that use the same road to serve a downtown or urban center, a transit center, or a park-and-ride facility.

A route-duplication standard would be most relevant to a hub-and-spoke transit system. In this type of system, multiple routes each serve distinct service areas (the spokes) except for coming together and allowing for transfer opportunities at a central location (the hub). In this way, no route duplicates or competes with another. Such a standard would not necessarily be appropriate for a system designed around trunk segments that are each served by multiple feeder routes. In this type of system, multiple feeder routes serve distinct service areas, but join together to provide a higher service level along a trunk segment.

To the extent that the existing MBTA bus network is not generally characterized by a hub-and-spoke system, the route-duplication

FIGURE 3
Extent of Duplication for MBTA Bus Routes

Legend

MBTA Bus Routes

Number of Routes Serving Road Segment

- 1 - 2
- 3 - 4
- 5 - 6
- 7 - 10
- 10 or more
- Town boundary

N

0 3 6 12 Miles

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standard would not appear to be relevant. However, should the MBTA employ greater use of such systems, particularly in the suburban context, this standard might be more useful. The relative inflexibility of such a standard, however, conflicts with the common need for flexibility in transit planning, particularly in the suburban context, where travel is often only possible on certain major arterials. While it may be advisable to have a general guideline stating that transit services should not compete with each other, it may not be necessary or advisable to restrict planning through a firm route-duplication standard.

Figure 3 presents the extent to which existing MBTA directly operated bus routes duplicate each other. As seen in the figure, the highest levels of duplication are on the express portion of express bus routes (such as the Massachusetts Turnpike and the Salem Turnpike). High levels of duplication are also seen in and around rapid transit stations, because multiple bus routes converge to serve those stations.

Route Travel Time

The route-travel-time standard generally sets a maximum travel time for any individual transit vehicle trip. It does not consider the passenger trip time (which may involve transfers and riding only a portion of certain routes), only the one-way travel time from a route's origin timepoint to its destination timepoint. King County Metro Transit, the only profiled peer agency that used this standard, set it at 60 minutes.

As with the route-duplication standard, the use of this standard is limited by the existing service structure. Certain modes, such as commuter services, will typically have longer trip times. Demand for service between two points separated by a large distance will also often result in long route travel times. At the MBTA, for example, the longest trip times (which are around 90 minutes) are express bus trips from Salem to downtown Boston. Table 22 presents the percentages of MBTA directly-operated bus routes with average, maximum, and minimum route running times at various levels.[15] More than 90 percent of all bus routes have an average route running time at or below 45 minutes, while only 10 percent have a maximum route running time greater than 60 minutes. Almost 10 percent of all routes have a minimum route running time greater than 30 minutes, and nearly three-quarters of all routes have at least one route variation with a route running time of less than 20 minutes.

[15] Data from the MBTA HASTUS database, spring 2010 quarter.

Table 22
Percentage of MBTA Routes by Time Range for Average, Maximum, and Minimum Running Time

Time Range	Average	Maximum	Minimum
Less than or equal to 20 minutes	32%	11%	74%
20.1 to 30 minutes	35%	25%	17%
30.1 to 45 minutes	26%	32%	6%
45.1 to 60 minutes	4%	22%	2%
Greater than 60 minutes	3%	10%	1%

A route-travel-time standard is perhaps most useful for designing and measuring the performance of service when it reflects passenger trip time. The average passenger-trip time could be estimated for each route using a calculation similar to that for the average passenger-trip length. This calculation equals the trip time at each stop weighted by each stop's passenger load. For example, Table 23 presents a ridechecked weekday trip from the fall 2009 quarter for Route 66 in the outbound direction. By weighting the elapsed time by the passenger load, the average passenger-trip time equals 27 minutes and 7 seconds. The CTPS ridecheck database could potentially be modified to calculate the average passenger-trip time in addition to its current calculation of average trip-length.

Directness of Travel (Comparison to Auto Trip Times)

Among the agencies profiled, the metric used to evaluate directness of travel is the comparison of in-vehicle (only the portion of a transit rider's trip spent in the vehicle) transit trip times to comparable auto trip times. Since transit, by virtue of intermediate stops and deviations from the most direct route, cannot offer the same point-to-point travel time as a direct auto trip, this standard sets a maximum ratio of the transit trip time to the direct/auto trip time. Nashville MTA set the maximum absolute difference in the number of minutes for a route at 30 minutes. The maximum standard set by most of the profiled peer agencies was generally between 120 and 125 percent of the direct/auto trip time, though one agency, YRT, set it at 100-to-110 percent for BRT services.

CTA uses a standard that no route deviation should result in additional travel time for all through passengers (the sum of the number of through passengers multiplied by the additional route travel time for the deviation) greater than five minutes per each rider boarding or alighting along the deviation. For example, a route deviation that added eight

Table 23
Route 66 Weekday Outbound Ridecheck Form

Stop #	Stop Description	Time at Stop	Boardings	Alightings	Elapsed Time	Passenger Load
64000	Dudley Station	9:52:23	19	0	0:00:00	0
1357	Tremont St. opp. Roxbury Crossing	9:54:39	7	0	0:02:16	19
1362	Tremont St. @ Huntington Ave.	9:59:29	0	6	0:07:06	26
1363	Huntington Ave @ Fenwood Rd.	10:00:54	1	2	0:08:31	20
1365	Huntington Ave opp. Parker Hill Ave.	10:01:50	4	1	0:09:27	19
1366	Huntington Ave. @ Riverway	10:03:03	4	0	0:10:40	22
1526	Washington St. @ Pearl St.	10:05:18	5	1	0:12:55	26
1367	Harvard St. @ Kent St.	10:07:05	2	2	0:14:42	30
1368	Harvard St. @ Linden St.	10:07:47	1	0	0:15:24	30
1370	Harvard St. opp. Auburn St.	10:09:23	2	1	0:17:00	31
1371	Harvard St. opp. Vernon St.	10:09:54	1	3	0:17:31	32
1372	Harvard St. @ Beacon St.	10:11:45	2	5	0:19:22	30
1375	Harvard St. @ Coolidge St.	10:14:36	1	4	0:22:13	27
1376	Harvard St. opp. Verndale St.	10:15:25	1	2	0:23:02	24
1378	Harvard Ave. @ Commonwealth Ave.	10:19:45	7	1	0:27:22	23
1379	Harvard Ave. @ Brighton Ave.	10:22:26	0	3	0:30:03	29
964	Brighton Ave. opp. Quint St.	10:24:22	5	0	0:31:59	26
965	Brighton Ave. @ Craftsman St.	10:24:43	2	4	0:32:20	31
1111	Cambridge St. @ Craftsman St.	10:25:44	4	0	0:33:21	29
1112	Cambridge St. @ Harvard Ave.	10:26:56	2	0	0:34:33	33
1113	Cambridge St. @ Linden St.	10:27:54	2	1	0:35:31	35
2558	North Harvard St. @ Empire St.	10:31:24	4	0	0:39:01	36
2559	North Harvard St. @ Oxford St.	10:32:17	1	3	0:39:54	40
2561	North Harvard St. @ Western Ave.	10:33:33	0	4	0:41:10	38
2562	Opp. 175 North Harvard St.	10:34:40	0	1	0:42:17	34
25641	JFK St. @ Eliot St.	10:38:44	0	12	0:46:21	33
2168	Massachusetts Ave. @ Johnston Gate	10:42:41	0	20	0:50:18	21
22549	Harvard Square @ Garden St.	10:43:37	0	1	0:51:14	1

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minutes to the route travel time, or an additional 80 minutes for the 10 through passengers, would need to have at least 16 passengers boarding or alighting along that deviation for it to meet a standard of five minutes.

A directness-of-travel standard using a comparison of transit to auto trip times for all routes would be a useful tool for identifying routes that are experiencing travel delays that are not caused by traffic conditions. Before implementing a directness-of-travel standard, the MBTA would need to catalog the auto travel times that compare to each MBTA route. Such a comparison could be created for a matrix of trip points including route origins, destinations, and major midpoints. The Boston Region MPO's travel demand model set contains this type of data and could be used to perform this comparison. As an example, MPO staff compared the in-vehicle travel time of a passenger riding the Silver Line Washington Street between Dudley Station and Temple Place. In the inbound direction (Dudley Station to Temple Place), a bus has an estimated travel time of 19.23 minutes, while a single-occupant vehicle (SOV) has an estimated travel time of 10.30 minutes. In the outbound direction (Temple Place to Dudley Station), the estimated travel times are 17.51 minutes for a bus and 11.17 minutes for a single-occupant vehicle. The calculated ratios of bus to SOV travel times are 187 percent in the inbound direction and 157 percent in the outbound direction. These ratios would fail the directness-of-travel standards of other agencies. The MBTA would want to calculate the travel time ratios for all routes before determining the level at which the MBTA directness-of-travel standard should be set.

A route-deviation standard could also be used to analyze potentially more efficient routings. Demand for through service and corresponding deviations would need to be identified, and the additional deviation time would need to be calculated and compared to the number of passengers served on that deviation to determine if elimination of that deviation might be considered. For instance, Route 59 (Needham Junction – Watertown Square) deviates from Eliot Street in Newton to serve two stops on Chestnut Street at Oak Street and Pennsylvania Avenue. This deviation from the most direct path takes approximately 3.7 minutes, adding approximately 2.6 minutes to the Route 59 travel time in each direction compared to the estimated travel time if Route 59 continued straight on Eliot Street and did not serve these two stops. According to the most recent CTPS ridecheck for Route 59, these two stops have 46 boardings and 8 alightings in the inbound direction and 6 boardings and 56 alightings in the outbound direction. There were also 206 passengers in the inbound direction and 191 passengers in the

outbound direction who traveled through this deviation. Therefore, the 397 through passengers incurred an additional 17.9 hours of travel time. According to the CTA route-deviation standard, at least 214 passengers boarding or alighting would need to board or alight along the route deviation (17.9 hours divided by 5 minutes). The 116 passenger-trips using the deviation would therefore not meet the CTA route-deviation standard.

Ease of Use

The ease-of-use standard generally includes measures of several service and physical characteristics. These include the extent of clock-face headways, which make the service schedule easy to remember, the extent to which routes run consistently throughout the day with minimum variations, the use of new technology to provide online access to schedules and real-time information on the service schedule by location, the use of simple fare collection methods such as passes and payment by credit cards, and the extent of the information or training provided to new users to help them learn how to use the transit system.

Table 24 shows the percentage of MBTA bus route headways at various clock-face times (those that can be divided evenly into or by one hour).[16] Routes with headways equal to or less than 10 minutes (assumed for walk-up service, where riders are less likely to consult a schedule given the small headway) make up the greatest percentage of all route headways in the AM and PM peak periods; these are not considered clock-face routes, even if their headway is divisible into 60 minutes. Routes with clock-face headways greater than 10 minutes range from 25 percent to 30 percent of all routes over various time periods. Routes without clock-face headways that are also greater than 10 minutes make up between 56 percent and 75 percent of all routes over various time periods.

In terms of minimizing variations, the ratio of route variations to general routes can provide some indication of the extent of consistent routing. For all MBTA directly-operated bus routes, this ratio is predictably the highest on weekdays, at 283 percent. The ratio falls to 170 percent on Saturday and 144 percent on Sunday.

[16] Data from MBTA Line Statistics, fall 2010 quarter.

Table 24
Percentage of MBTA Routes by Headway

Headway (minutes)	AM Peak	AM Base	PM Base	PM Peak	Late	Sat. Peak	Sun. Peak
15	4%	0%	3%	5%	1%	2%	2%
20	8%	3%	4%	11%	4%	3%	2%
30	15%	12%	9%	11%	6%	9%	3%
60	2%	14%	12%	3%	14%	15%	17%
120	0%	0%	0%	0%	0%	0%	1%
Total	29%	29%	29%	30%	25%	28%	25%
≤10	15%	2%	5%	12%	0%	3%	1%

Currently, schedules and real-time information are available for all directly-operated MBTA bus routes and heavy rail lines via the internet and several smartphone applications. Passengers can use the applications to view the locations of transit vehicles or obtain stop-based predictions for transit vehicles' arrival times based on real-time data. In terms of fare payment, the automated-fare-collection (AFC) system provides information about how passengers paid for and used their fares and passes. For instance, the extent to which riders are using passes is generally indicative of a simpler fare collection operation, as customers will not need to repeatedly visit fare-vending machines (FVMs) to add stored value or insert cash into an onboard farebox. Table 25 shows the percentages of state fiscal year (SFY) 2010 MBTA passenger-trips using pay-per-ride or passes for different modal categories.[17] Subway stations have the highest percentage of pass use, while surface light rail (surface Green Line routes and the Mattapan High-Speed Line) have the highest percentage of pay-per-ride use. Another potential measure of ease of use with regard to fare payment is the extent to which credit cards are used versus cash at FVMs, since FVM sales make up 45 percent of all unit sales and 71 percent of all AFC unit sales. As an example, in June 2010, credit card transactions at FVMs accounted for 40.8 percent of the FVM total.[18]

It would be difficult to measure the extent of information or training provided to new users in a quantitative manner. Furthermore, as seen

[17] Data from the MBTA's AFC database.

[18] Data from the MBTA Revenue Department.

Table 25
Percentage of Pay-per-Ride and Pass Trips by MBTA Mode

Mode	Pay-per-Ride	Pass
Bus	43%	57%
Surface Light Rail	49%	51%
Subway	39%	61%
Total	42%	58%

above, while quantitative measurements could be used to define other ease-of-use standards, this aspect of service is perhaps better considered a guideline, as it would be difficult to explicitly define a standard for the ratio of route variations to general route numbers, or the percentage of routes with clock-face headways, or the percentage of pass trip interactions. Each of the measures could be collected, summarized, and compared year to year, but as they are all generally objectives to which the MBTA could aspire to do better, using them as goals may be preferable.

Number of Transfers and Transfer Waiting Time

Standards for the number of transfers and the transfer waiting time may include several different metrics. While none of the profiled peer agencies included such standards, it is possible to conceive a standard for an average of the number of transfers that riders traveling systemwide or by route could be expected to take. The potential to measure the extent of transferring exists with the AFC system, and a transfer study could summarize the number and percentages of transfers to and from each bus route and rapid transit station. Additionally, a standard could be established for an average waiting time based on scheduled headways, assumptions (such as those used in the MBTA's schedule-adherence standard) as to how early passengers typically arrive at a transit stop, and data on actual travel times. Average transfer waiting times could also be calculated, using a matrix of transfer numbers from AFC transfer study data.

With regard to the transfer standard, routes for which passengers exceed the standard average number of transfers would potentially be candidates for new, more-direct routes. A general waiting-time standard would likely point out issues similar to those indicated by the schedule-adherence standard. However, a standard that is set for transfer waiting time could reveal opportunities for better transit connections. While it does not appear that a general waiting-time standard offers any additional value over that of the schedule-adherence standard, a

transfer-waiting-time standard may be useful, as may a transfer standard, in pointing out situations where a more direct service may reduce the need for transfers.

Summary of Recommendations for Route-Structure Standards

For standards and guidelines that relate to route structure, the following possible changes to the MBTA's Service Delivery Policy should be considered:

- Maintain the distance-to-nearest-transit metric used for the coverage standard but consider introducing a range of coverage standards both greater and less than the current MBTA standard that corresponds to a range of population-density levels.
- Consider adopting a minimum-distance-between-stops metric for a stop-spacing standard and guidelines for stop location.
- Consider adopting a general guideline stating that transit services will not compete with each other.
- Consider adopting a general guideline to minimize route travel times whenever possible.
- Consider adopting a maximum ratio of transit travel time to auto travel time as a directness-of-travel standard. Consider analyzing the increase in through-passenger travel time per passenger using a route deviation as part of a route-deviation standard.
- Consider adopting a set of general guidelines for improving ease of use.
- Consider adopting a maximum-average-number-of-transfers and a maximum-transfer-waiting-time metric for transfer standards.

2.3.2 Service Provision

Span of Service

The metric used to evaluate the span of service for the MBTA and the peer agencies included in this analysis is typically a range of hours (with the beginning and ending hours noted). Some of the profiled peer agencies only require a certain number of hours of operation, but do not specify the times at which service should begin and end. Agencies usually require different span-of-service standards depending on the day and the service class. Most standards require service between 7:00 AM and 8:00 PM or the equivalent number of hours, and many require service until midnight or later.

The choice of the metric used to evaluate the span of service depends on a balance of flexibility for the transit agency in terms of when to provide service and usefulness for customers in terms of scheduling their trip. A standard that sets the beginning and ending hours provides no flexibility. A route must provide service even if there is no potential demand, or service could end despite a demonstrated demand. A standard that sets the number of hours of operation permits flexibility with regard to when to provide the service. However, this metric does not provide customers with a clear sense of when service will and will not be offered. In practice, both of these metrics likely represent exactly the same span of service and can be used interchangeably. Stating the beginning and ending hours does provide customers with a better sense of when service is actually offered, however, and is probably more useful to customers. The MBTA's span-of-service standard does allow for service to be extended at either end of the day, based on demand. Therefore, it is recommended that the MBTA keep its existing minimum span-of-service standard.

According to the MBTA's 2008 Service Plan, 19 directly-operated weekday MBTA bus routes, composing 11 percent of all service, failed the span-of-service standard. On Saturdays and Sundays, only one bus route failed the span-of-service standard. Table 26 lists the routes that failed the standard. As seen in the table, most routes that failed the span-of-service standard are express/commuter routes that primarily serve work-based trips and have a span-of-service requirement of 7:00 AM to 9:00 AM and 4:00 PM to 6:30 PM. For several of these routes, the failure to meet the span-of-service standard is caused when the last AM peak trip departs before 9:00 AM or the first PM peak trip departs after 4:00 PM.

Frequency of Service

The metric commonly used to evaluate frequency of service for the MBTA and the peer agencies included in this analysis is a maximum headway. Headway represents the number of minutes between transit vehicles. Frequency represents the number of transit vehicles per some defined time period. Therefore, a headway of 10 minutes would equate to a frequency of six vehicles per hour. The maximum headway for most peer agencies is 10 minutes or less for peak-period rapid transit service. Higher headway standards are typically set for other time periods and service classes. Some commuter modes use a frequency metric of the number of trips during the peak periods.

Table 26
MBTA Bus Routes Failing the 2008 Span-of-Service Standard

Bus Route Number and Description	Weekday	Saturday	Sunday
4: North Station – World Trade Center	X		
5: City Point – McCormack Housing	X		
18: Ashmont Station – Andrew Station	X		
70A: North Waltham – University Park	X		
75: Belmont Center – Harvard Station	X		
121: Wood Island Station – Maverick Station	X		
170: Oak Park – Dudley Station	X		
171: Logan Airport – Dudley Station	X	X	X
210: Quincy Center Station – North Quincy Station or Fields Corner Station	X		
221: Quincy Center Station – Fort Point	X		
325: Elm Street – Haymarket Station	X		
355: Mishawum Station – State Station	X		
424: Eastern and Essex – Haymarket Station or Wonderland Station	X		
434: Peabody – Haymarket Station	X		
436: Danvers Square – Central Square, Lynn	X		
448: Marblehead – Downtown Crossing via Paradise Road	X		
449: Marblehead – Downtown Crossing via Humphrey Street	X		
468: Danvers Square – Salem Depot	X		

Some of the profiled peer agencies use a range of frequencies that correspond to a range of passenger flows. The corresponding standards can then be used to proactively identify routes with frequencies that may need to be adjusted to account for changes in demand. The MBTA does not currently differentiate its headway standards to the level that some other agencies do, preferring instead to set the headway levels for general service classes and offer a minimum level of service regardless of demand. However, while the existing frequency standards may be appropriate for MBTA rapid transit modes, comparing bus passenger flows to the scheduled frequencies may help the MBTA to proactively identify opportunities to increase or decrease bus headways. Resulting guidelines for frequency of service could be developed as a result of this comparison. For instance, Figures 4 and 5 demonstrate how passenger flow generally correlates with trip frequency throughout the day for Route 66.[19]

[19] Data from CTPS ridecheck, fall 2009 quarter.

Figure 4
Route 66: Inbound Hourly Passenger Flow and Trip Frequency

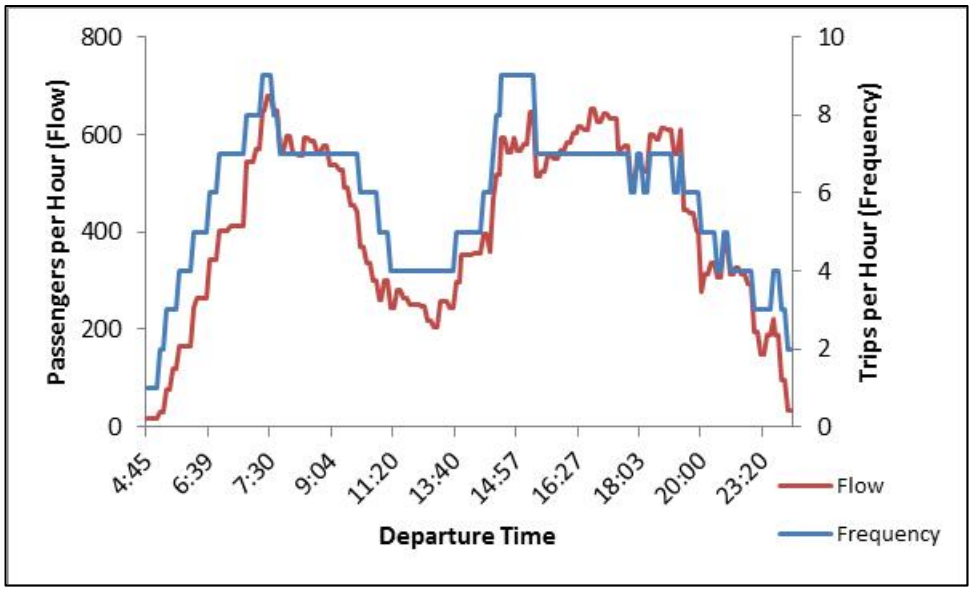
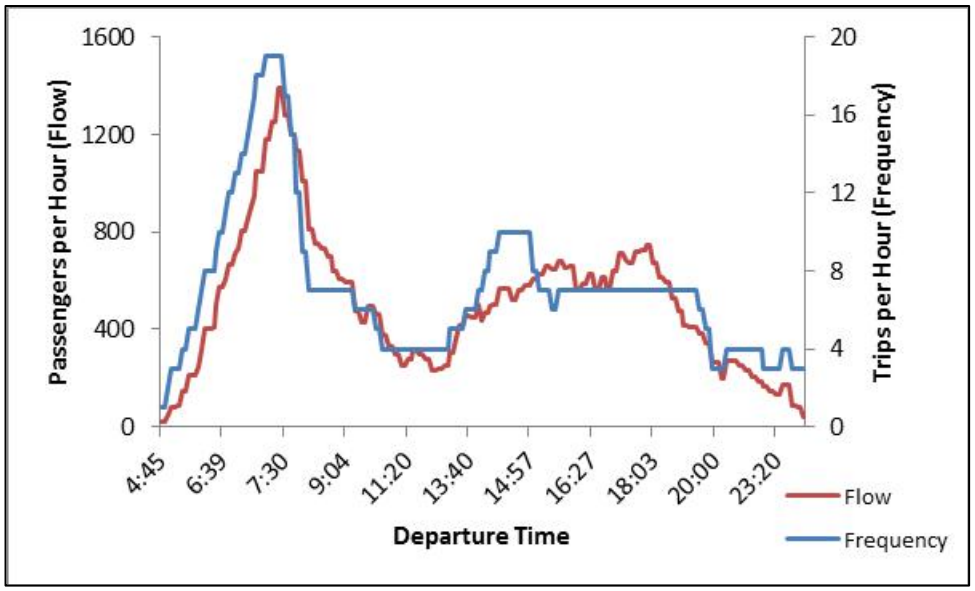


Figure 5
Route 66: Outbound Hourly Passenger Flow and Trip Frequency



According to the 2008 Service Plan, 48 directly operated weekday MBTA bus routes, composing 27 percent of all service, failed the frequency-of-service standard. On Saturday, the number of failing routes dropped to 18, or 13 percent, and on Sunday, the failing number was 25, or 24 percent. Table 27 lists these routes.

Table 27
MBTA Bus Routes Failing the 2008 Frequency Standard

Bus Route Number and Description	Weekday	Saturday	Sunday
1: Harvard Square – Dudley Station via Mass. Avenue			X
5: City Point – McCormack Housing	X	X	
14: Roslindale Square – Heath Street Loop	X		
15: Kane Square – Ruggles Station	X	X	
18: Ashmont Station – Andrew Station	X		
28: Mattapan Station – Ruggles Station			X
33: River and Milton Streets – Mattapan Station	X		
35: Dedham Mall – Forest Hills Station			X
38: Wren Street – Forest Hills Station	X		
52: Dedham Mall – Watertown Yard	X	X	
57: Watertown Yard – Kenmore Station			X
59: Needham Junction – Watertown Square		X	X
60: Chestnut Hill – Kenmore Station			X
62: Bedford V.A. Hospital – Alewife Station	X		
62/76: Bedford V.A. Hospital – Alewife Station via Hanscom		X	
66: Harvard Square – Dudley Station via Brookline	X	X	X
70: Cedarwood – Central Square Cambridge			X
70A: No. Waltham – University Pk., Cambridge	X	X	
74: Belmont Center – Harvard Station via Concord Avenue	X	X	
75: Belmont Center – Harvard Station via Fresh Pond Parkway	X		
76: Hanscom Air Force Base – Alewife Station	X		
78: Arlmont Village – Harvard Station		X	
85: Spring Hill – Kendal MIT Station	X		
86: Sullivan Station – Cleveland Circle			X
90: Davis Square Station – Wellington Station	X		
94: Medford Square – Davis Square Station	X		
99: Boston Reg. Med. Center Stoneham – Wellington Station	X		
100: Elm Street – Wellington Station	X		
101: Malden Station – Sullivan Station via Medford Square		X	X
104: Malden Station – Sullivan Station via Ferry Street			X
105: Malden Station – Sullivan Station via Main Street	X	X	
112: Wellington Station – Wood Island Station	X		X
119: Northgate Shopping Center – Beachmont Station	X		
132: Redstone Shopping Center – Malden Station	X	X	
134: No. Woburn – Wellington Station			X
136: Reading Depot – Malden Station via Lakeside	X		
137: Reading Depot – Malden Station via North Avenue	X		
170: Oak Park – Dudley Station	X		
171: Logan Airport – Dudley Station	X	X	X
211: Quincy Center Station – Squantum			X
212: Quincy Center Station – North Quincy Station		X	
215: Quincy Center Station – Ashmont Station	X		
221: Quincy Center Station – Fort Point	X		
230: Quincy Center Station – Montello Station	X		X
236: Quincy Center Station – South Shore Plaza	X	X	
238: Quincy Center Station – Holbrook/Randolph Comm. Rail Station			X
240: Avon Line – Ashmont Station	X		X
245: Quincy Center Station – Mattapan Station	X	X	X
350: North Burlington – Alewife Station	X		X
355: Mishawum Station – State Street	X		
411: Malden Station – Revere/Jack Satter House	X		
429: Northgate Shopping Center – Central Square Lynn	X		
430: Saugus, Appleton Street – Malden Station	X		
431: Neptune Towers – Central Square Lynn	X		X
434: Peabody – Haymarket Station	X		
435: Liberty Tree Mall – Central Square Lynn	X		X
436: Danvers Square – Central Square, Lynn	X		X
442: Marblehead – Haymarket Station or Wonderland Station			X
450: Salem Depot – Haymarket Station or Wonderland Station			X
451: North Beverly – Salem Depot	X		
456: Salem Depot – Central Square, Lynn	X		
465: Liberty Tree Mall – Salem Depot	X		
468: Danvers Square – Salem Depot	X		
553: Roberts – Federal and Franklin Streets	X	X	
554: Waverly Square – Federal and Franklin Streets	X	X	
555: Riverside Station – Federal and Franklin Streets via Newton	X		

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Schedule Adherence

The metric most commonly used to evaluate schedule adherence for the MBTA and the peer agencies included in this analysis is an absolute number of late minutes. For most profiled agencies, the acceptable number of late minutes ranges between 0 and 6 minutes for origins and 0 and 7 minutes for midpoints, and trips are considered on-time if they arrive at destinations between 3 minutes early and 5 minutes late. Some agencies only consider schedule adherence at the origin and not at midpoints or the destination. The MBTA is the only agency that uses a standard based on the scheduled headway (greater or less than 10 minutes) or running time. A typical part of any schedule-adherence evaluation is also a route standard that requires a certain percentage of timepoints or trips to meet the on-time standard. This percentage is generally lower for local bus and higher for rapid transit.

Schedule-adherence standards evaluate reliability. This is commonly the most important service characteristic identified by passengers when ranking service qualities. The measurement of on-time performance across the entire route—not only at the origin timepoint but also at mid-route timepoints and the destination timepoint—is therefore likely to be more useful to and relevant for customers. This is the reason that the MBTA includes all timepoints, not just the origin and destination, in its analysis of schedule adherence. However, for transit services that run more frequently, customers generally care more about buses maintaining a constant headway than remaining on schedule.

According to the 2008 Service Plan, the average weekday timepoint on-time percentage weighted across all directly-operated MBTA bus routes by each route's respective average weekday daily ridership was 59.1 percent. Only six bus routes, or 3 percent of all routes, met the route-level schedule-adherence standard that 75 percent of timepoints adhere to the on-time standards. On Saturdays, the timepoint on-time percentage increased to 61.5 percent, and eight bus routes, or 6 percent of all routes, met the route-level schedule-adherence standard. On Sundays, the timepoint on-time percentage further increased, to 63.5 percent, and 17 bus routes, or 16 percent of all routes, met the route-level schedule-adherence standard. Table 28 lists these routes. The Silver Line Washington Street is the only bus route that meets the schedule-adherence standard on all days of the week.

Table 28
MBTA Bus Routes Failing the 2008 Schedule-Adherence Standard

Bus Route Number and Description	Weekday	Saturday	Sunday
7: City Point – Otis and Summer Streets	X		
17: Fields Corner Station – Andrew Station			X
18: Ashmont Station – Andrew Station			X
24: Wakefield Avenue – Mattapan/Ashmont Station			X
37/38: Baker and Vermont – Forest Hills Station		X	
38: Wren Street – Forest Hills Station		X	
51: Cleveland Circle – Forest Hills Station		X	
57: Watertown Yard – Kenmore Station		X	
72/75: Belmont Ctr. – Harvard Station via Huron		X	X
75: Belmont Ctr. – Harvard Sta. via Fresh Pond Pkwy.		X	
85: Spring Hill – Kendal MIT Station	X		
88: Clarendon Hill – Lechmere Station via Highland			X
99: Boston Reg. Med. Ctr. – Wellington Station			X
105: Malden Station – Sullivan Station via Main St.			X
106: Franklin Sq./Lebanon St. Loop – Wellington Sta.			X
108: Linden Square – Wellington Station		X	
110: Wonderland Station – Wellington Station			X
136: Reading Depot – Malden Station via Lakeside			X
137: Reading Depot – Malden Station via North Ave.			X
210: Quincy Ctr. Sta. – No. Quincy/Fields Corner Sta.			X
211: Quincy Ctr. Station – Squantum			X
502: Watertown Yard – Copley Square	X		
741 Silver Line 1: Logan Airport – South Station	X		X
742 Silver Line 2: BMIP – South Station	X		X
749 Silver Line 5: Dudley Sta. – Downtown	X	X	X

Obviously, the MBTA's schedule-adherence standard, as currently formulated, is difficult to meet. While the inclusion of all timepoints in the analysis of on-time performance does ensure the consistent application of the schedule-adherence standard across the entire route (the origin, destination, and all mid-route timepoints), this consistency is itself difficult to achieve. In particular, the inclusion of multiple mid-route timepoints, which have a more stringent timepoint on-time standard than the origin or destination, make the achievement of the route-level schedule-adherence standard more difficult.[20] In essence, therefore, the

[20] Origin timepoints have a three-minute on-time window and may not be early; however, the on-time standard for origins is the easiest to meet, given the recovery time allocated to bus routes. Destination timepoints have an eight-minute on-time window and may be early,

large number of failures to meet the schedule-adherence standard is due to the large number of timepoints. The resulting percentages of failure more accurately reflect schedule adherence on a timepoint basis. Applying the schedule-adherence standard at only major timepoints would provide a more accurate representation of on-time performance on a route basis. In addition, the 2008 Service Plan reports the timepoint on-time percentage for all routes instead of whether the routes pass or fail the schedule-adherence standard. In this way, the relative performance of routes can be determined, and routes with greater on-time problems can be identified. The schedule-adherence standard could be made more useful for planning purposes if it included a range of percentages of meeting the route-level standard. For instance, while only 3 percent of routes met the existing route-level standard that 75 percent of timepoints adhere to the on-time standards, if the standard were changed to 65 percent, the routes meeting the standard would increase to 27 percent. On the other end, 17 percent of routes have less than 50 percent of timepoints that meet the on-time standard. A schedule-adherence standard using several different route-level standards could better identify the routes with the worst on-time performance.

Service Delivery

Only one of the profiled peer agencies, SFMTA, has a service delivery standard. The metric associated with this standard is a minimum percentage of scheduled service hours that are actually delivered. The agency's goal is to deliver a minimum of 99.0 percent of the scheduled service hours in the AM and PM peak periods and 98.5 percent at all other times. In effect, this standard measures the extent of dropped trips due to any reason. A similar standard would set a maximum percentage of dropped trips.

The MBTA regularly reports via its online ScoreCard the percentage of dropped trips, but does not have a dropped-trip standard. Establishing a standard for service delivery—either in terms of the percentage of service hours delivered or the percentage of dropped trips—would help the MBTA communicate to the public the expected level of dropped service as well as to proactively identify routes with problems.

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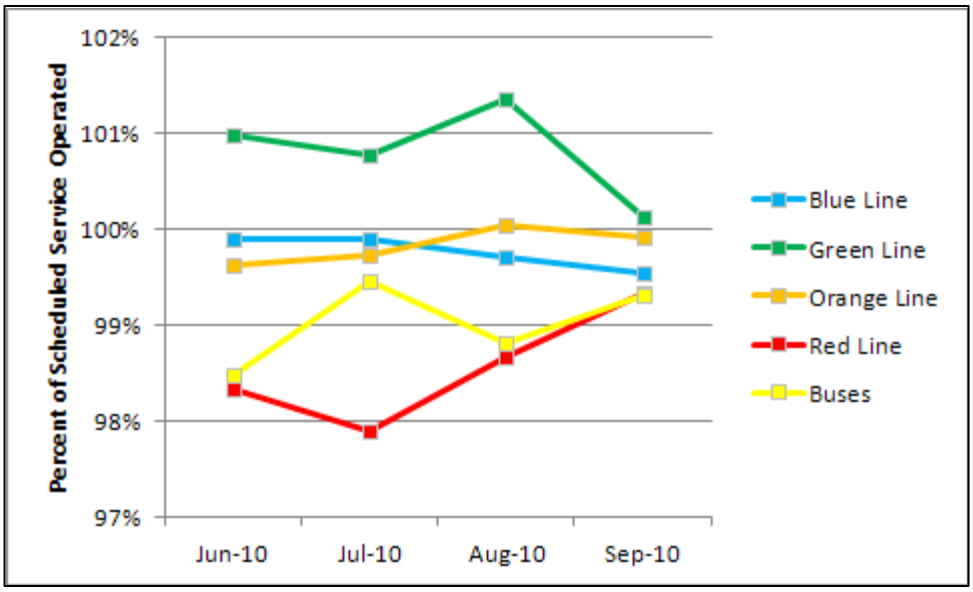
while mid-route timepoints have a seven-minute on-time window and may not be early. Therefore, of the three types of timepoints, the on-time standard for mid-route timepoints is the most difficult to meet.

Figure 6 shows the percentages of scheduled MBTA service operated for the four rapid transit lines and all buses over a four-month period. As seen in the figure, only the Green Line delivered at least 100 percent of scheduled service in each month of the time period.

Figure 6
Percent of Scheduled Service Operated by MBTA Mode, June 2010 through September 2010



Service Failure

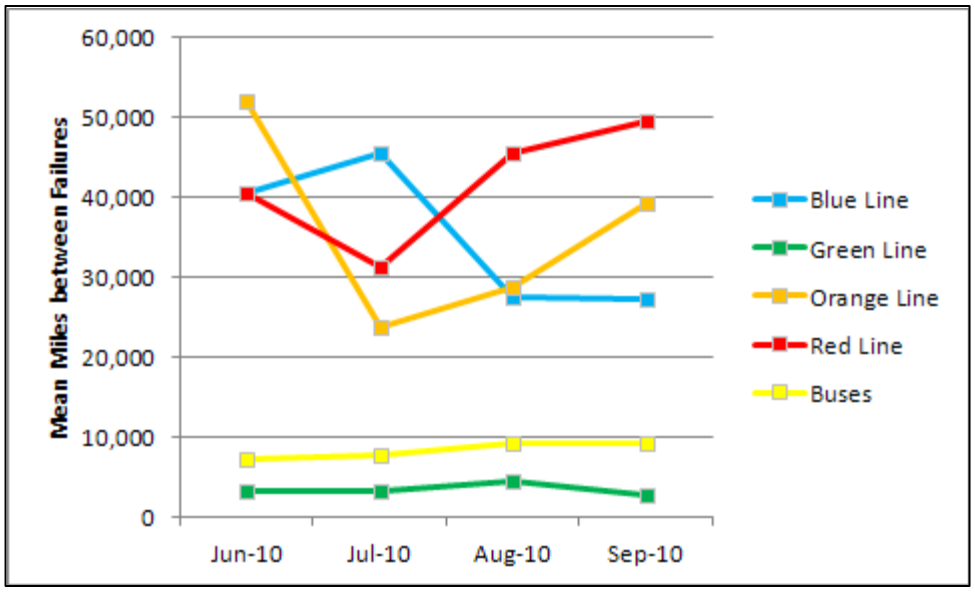
Only one of the profiled peer agencies, SFMTA, has a service failure standard. The metric associated with this standard is a minimum distance, averaged by mode, between vehicle failures. The agency's goal is to have an average minimum of 5,000 miles for light rail and 3,400 miles for motor coaches between failures. This standard measures one of the potential reasons for a dropped trip. It also includes a safety element.

The MBTA collects data on service failures and has various goals for bus, commuter rail, and each rapid transit line for the average number of miles between failures. As with the service-delivery standard, establishing a standard for service-failure would help the MBTA communicate to the public the maximum acceptable level of vehicle failures as well as to proactively identify problems.

Figure 7 shows the average number of miles between MBTA service failures for the four rapid transit lines and all buses over a four-month period. As seen in the figure, the averages for the three heavy rail lines vary significantly by month, while the averages for the Green Line and

buses are more consistent from month to month. More failures usually occur in the summer months, due to failures of air conditioners. This may indicate that different reasons for failures should be classified in different ways.

Figure 7
Mean Miles between Failures by MBTA Mode,
June 2010 through September 2010



Vacancy Rate and Vehicle Availability

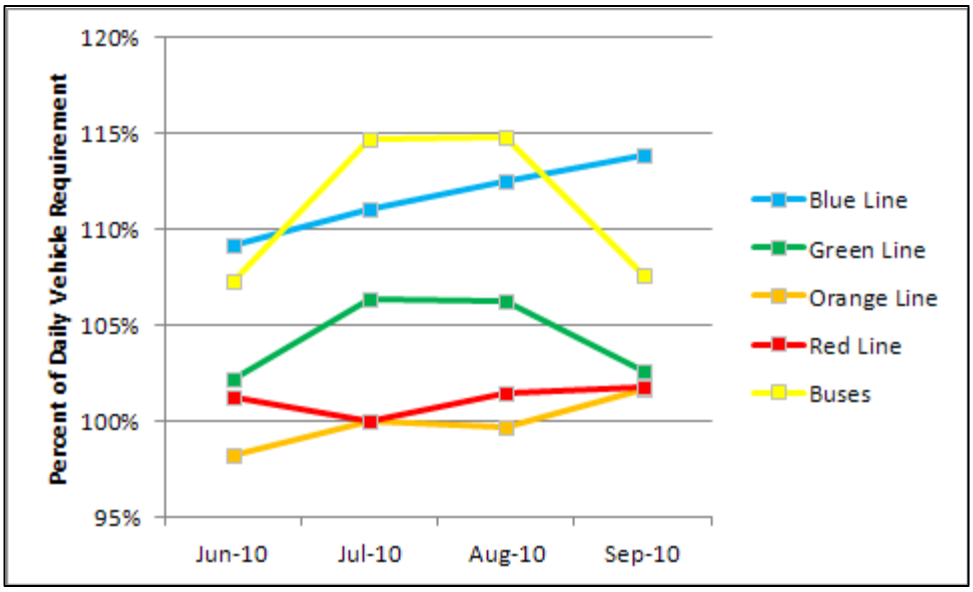
Only one of the profiled peer agencies, SFMTA, has an employee vacancy-rate standard. The metric associated with this standard is a maximum vacancy rate for various service-critical positions. The agency's goal is to have a maximum quarterly vacancy rate of five percent for positions in transit operations, crafts, and maintenance. A similar measure would be vehicle availability, or whether there are enough vehicles available to run the service that is scheduled each day. Both of these standards measure possible reasons for a dropped trip.

The MBTA collects data on vehicle availability and sets a requirement for the number of vehicles that should be available for use. As with the service-failure standard, establishing a standard for vehicle availability would help the MBTA communicate to the public the expected level of dropped trips due to lack of vehicles, as well as to proactively identify services with problems.

Figure 8 shows the ratio of available daily vehicles to the number of vehicles required for the four rapid transit lines and all buses over a four-month period. As seen in the figure, only the Orange Line failed to

meet a 100-percent vehicle-availability ratio in some months of the time period.

Figure 8
Percent of Daily Vehicle Requirement by MBTA Mode,
June 2010 through September 2010



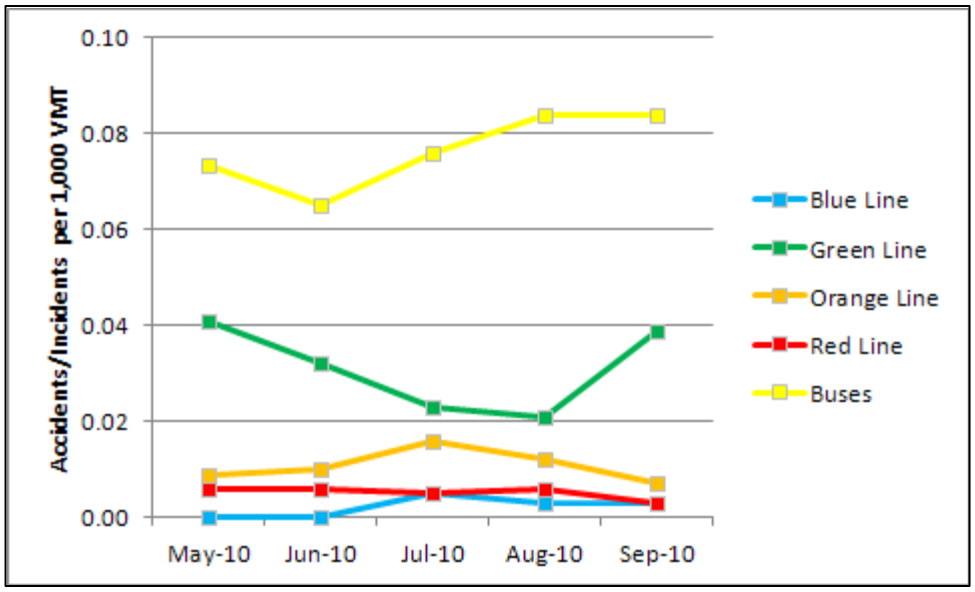
Accident and Incident Rate

Only one of the profiled peer agencies, MDT, has a standard for accident and incident rates. The metric associated with this standard is a maximum rate of accidents and incidents. The agency's goal is to have a maximum rate of six per 100,000 vehicle-miles. This standard measures another reason for a dropped trip. It also includes a safety element.

The MBTA collects data on accidents and incidents. As with the service-failure standard, establishing a standard for the accident-and-incident rate would help the MBTA communicate to the public the expected level of dropped trips due to this reason, as well as to proactively identify routes with problems. It would also reinforce the perception that the MBTA has a culture of being concerned with safety.

Figure 9 shows the average number of accidents or incidents per 1,000 vehicle-miles traveled (VMT) for the four rapid transit lines and all buses over a five-month period. As seen in the figure, the rates for the Green Line and buses are generally higher than those for the three heavy rail lines. The rates for the heavy rail lines are also more consistent from month to month.

Figure 9
Accidents/Incidents per 1,000 Vehicle-Miles Traveled (VMT) by MBTA Mode, May 2010 through September 2010



Passenger Complaints

Only one of the profiled peer agencies, MDT, has a passenger-complaints standard. The metric associated with this standard is a maximum rate of complaints. A separate standard is set for each mode. The agency's goal for complaints is to have a maximum rate of 1.5 per 100,000 rail boardings, 11 per 100,000 boardings on bus, and two percent of all paratransit trips.

The MBTA collects data on passenger complaints. Unfortunately, complaints are subjective in nature, and this makes their categorization and summary difficult. However, to the extent that the MBTA already makes this effort for internal analysis, it might be possible to associate service-related complaints with individual routes or modes. The MBTA could determine the existing rate of passenger complaints and then decide whether setting a standard would be appropriate. Establishing a standard for the passenger-complaints rate would help the MBTA communicate to the public its awareness and consideration of passenger input. Such a standard would also help the MBTA better identify routes or trips that have problems that may not be identified by other service standards, such as those related to operator attitudes, fare collection, or obstruction of the passenger aisle.

Figure 10 shows the number of complaints for all buses and rapid transit lines over a six-month period. As seen in the figure, the bus

mode has, on average, more than three times the number of complaints per month compared to the rapid transit mode.

Figure 10
Number of Complaints by MBTA Mode, March 2010 through August 2010

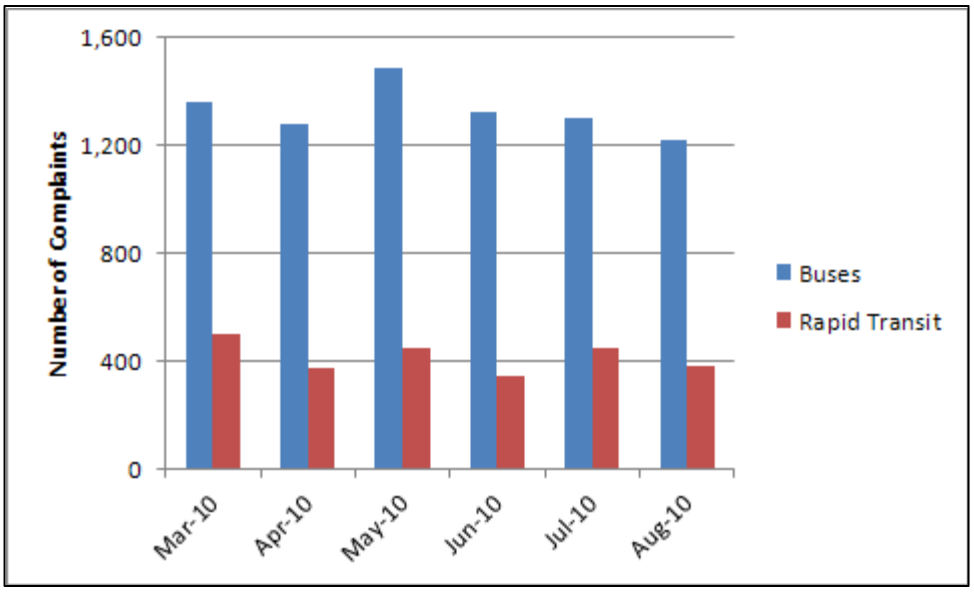
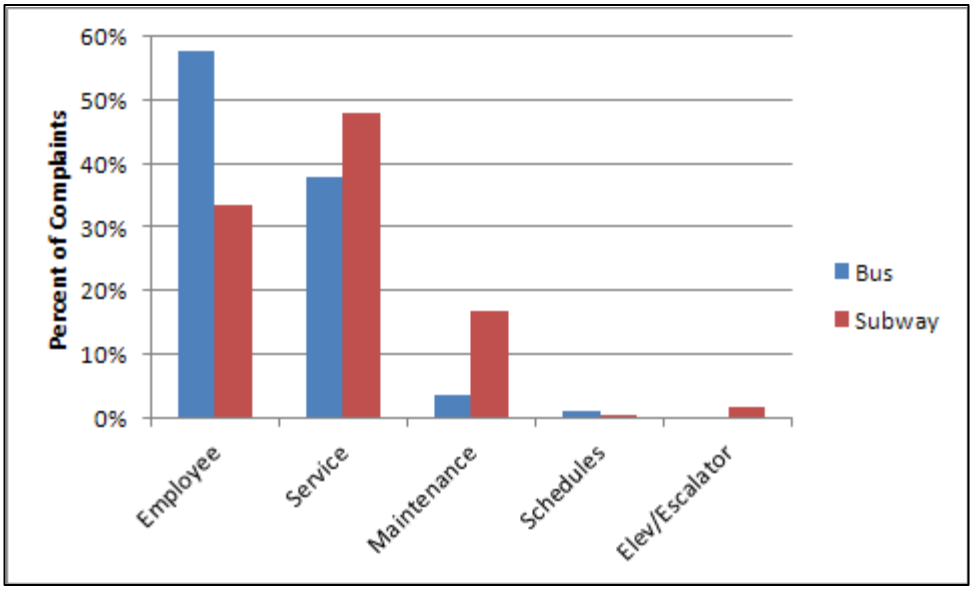


Figure 11 shows the breakdown of complaints into various categories for the month of August 2010. A majority of bus complaints concerned MBTA employees, while the largest percentage of subway complaints concerned service.

Figure 11
Breakdown of Complaints by MBTA Mode, August 2010



Summary of Recommendations for Service-Provision Standards

For standards and guidelines that relate to service provision, the following possible changes to the MBTA's Service Delivery Policy should be considered:

- No change is recommended for the MBTA's span-of-service standard.
- Consider adopting general guidelines that associate a range of bus passenger flows with a range of minimum service frequencies.
- Consider only including major timepoints in the application of the MBTA's schedule-adherence standard. Also consider using a range of route-level schedule-adherence standards.
- Consider adopting either a percentage-of-service-hours-delivered or percentage-of-dropped-trips metric for a service-delivery standard.
- Consider adopting a miles-per-failure metric for a service-failure standard.
- Consider adopting vacancy-rate metrics associated with service-critical positions for a vacancy-rate standard.
- Consider adopting a miles-per-accident/incident metric for an accident-and-incident standard.
- Consider adopting a complaints-per-boardings metric for a passenger-complaints standard.

2.3.3 Service Efficiency

Net Cost per Passenger, Cost-Effectiveness, and Passenger Productivity

The three service-efficiency standards used by the MBTA and the other peer agencies reviewed—net cost per passenger, cost-effectiveness, and passenger productivity—are all interrelated. Net cost per passenger is the ratio of operating costs, minus service revenue, to the number of passengers; cost-effectiveness is the ratio of service revenue to operating costs; passenger productivity is the ratio of the number of passengers to the amount of service (measured as the number of trips or revenue-hours). Deficient routes are determined by comparing the respective service-efficiency measure to an absolute standard or to a standard percentage of the average of other routes.

The three standards, despite using different metrics, do generally measure service efficiency in the same manner. For example, higher cost-effectiveness is generally associated with higher passenger productivity since greater service revenue is correlated with a greater number of passengers and greater operating costs are correlated with a greater amount of service. Net cost per passenger essentially combines cost-effectiveness and passenger productivity. A lower net cost per passenger is, therefore, associated with higher cost-effectiveness and higher passenger productivity.

Measuring service efficiency through any of these three measures is a useful tool for transit agencies when allocating resources. Services with high efficiency generally are candidates for providing more service or improving service quality. Services with low efficiency are often candidates for service restructuring or elimination. While service efficiency is undoubtedly an important evaluation tool in service planning, other service structure and provision standards may require the operation of certain services or levels of service that are not necessarily efficient.

The MBTA currently uses a net-cost-per-passenger standard to analyze all bus routes. As this standard essentially combines the cost-effectiveness and passenger-productivity measures, it does not appear that the MBTA needs to add any additional cost-efficiency standards for buses. However, there is no reason that similar cost calculations could not be performed for other modes.

According to the 2008 Service Plan, the average weekday net cost per passenger, weighted across all directly operated MBTA bus routes by each route's respective average weekday daily ridership, was $1.59. Twenty bus routes, or 11 percent of all routes, failed the cost-effectiveness standard because their net cost per passenger exceeds three times this average. On Saturdays, the average net cost per passenger increased to $1.64, and 25 bus routes, or 19 percent of all routes, failed the cost-effectiveness standard. On Sundays, the average net cost per passenger further increased, to $1.82, and 11 bus routes, or 10 percent of all routes, failed the cost-effectiveness standard. Table 29 lists the routes that fail to meet the 2008 net-cost-per-passenger standard. Routes 78, 245, and 436 are the three bus routes that fail the cost-effectiveness standard on all days of the week.

Table 29
MBTA Bus Routes Failing the 2008 Net-Cost-per-Passenger Standard

Bus Route Number and Description	Weekday	Saturday	Sunday
5: City Point – McCormack Housing		X	
6: South Station – Haymarket Station	X		
8: Harbor Point/UMass – Kenmore Station			X
48: Centre and Eliot Streets – Jamaica Plain Loop	X	X	
52: Dedham Mall – Watertown Yard	X	X	
60: Chestnut Hill – Kenmore Station			X
62/76: Bedford V.A. Hosp. – Alewife Sta. via Hanscom		X	
74: Belmont Ctr. – Harvard Station via Concord Ave.		X	
76: Hanscom Air Force Base – Alewife Station	X		
78: Arlmont Village – Harvard Station	X	X	X
99: Boston Reg. Med. Ctr. – Wellington Station		X	X
100: Elm St. – Wellington Station		X	
132: Redstone Shopping Ctr. – Malden Station		X	
136: Reading Depot – Malden Station via Lakeside		X	
137: Reading Depot – Malden Station via North Ave.		X	
170: Oak Park – Dudley Station	X		
201/202: Fields Corner Station – Fields Corner Station		X	X
211: Quincy Ctr. Station – Squantum		X	X
212: Quincy Ctr. Station – No. Quincy Station		X	
216: Quincy Ctr. Station – Houghs Neck		X	
217: Wollaston Station – Ashmont Station	X		
222: Quincy Ctr. Station – East Weymouth		X	
230: Quincy Ctr. Station – Montello Sta.		X	X
245: Quincy Ctr. Station – Mattapan Sta.	X	X	X
275: Downtown Boston – Long Island Health Campus	X		
325: Elm St. – Haymarket Station	X		
350: North Burlington – Alewife Station			X
351: Oak Park – Alewife Station	X		
355: Mishawum Station – State Street	X		
431: Neptune Towers – Central Square, Lynn		X	X
435: Liberty Tree Mall – Central Square, Lynn	X		
436: Danvers Sq. – Central Square, Lynn	X	X	X
439: Bass Point Nahant – Central Square, Lynn	X		
448: Marblehead – Downtown Crossing	X		
451: North Beverly – Salem Depot		X	
465: Liberty Tree Mall – Salem Depot	X	X	
468: Danvers Sq. – Salem Depot	X		
500: Riverside Station – Federal and Franklin Streets	X		
553: Roberts – Federal and Franklin Streets		X	
554: Waverly St. – Federal and Franklin Streets		X	
558: Auburndale – Federal and Franklin Streets	X		

Vehicle Load

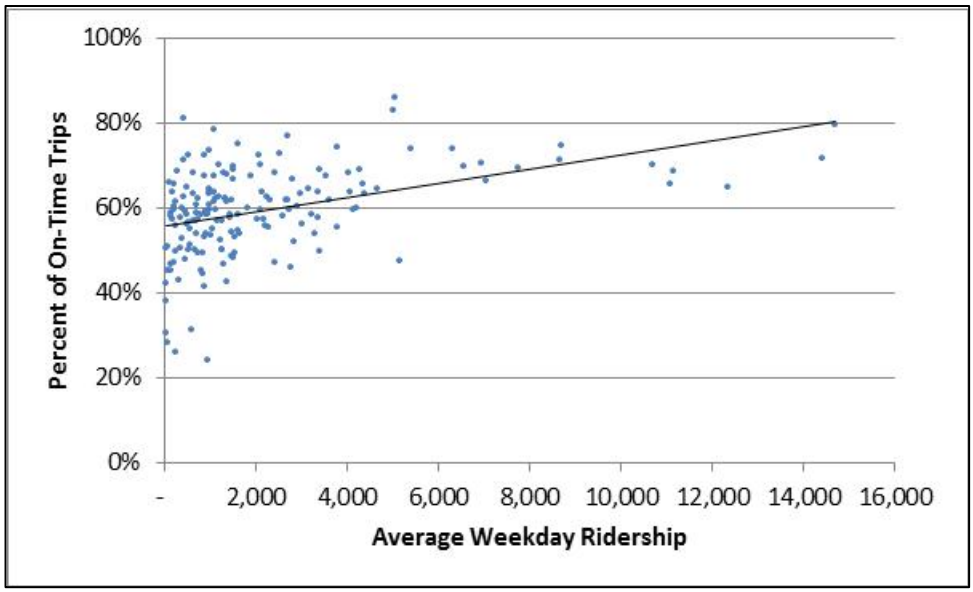
The metric used to evaluate vehicle load for the MBTA and the peer agencies included in this analysis is the ratio of passengers to seating capacity. Every one of the profiled peer agencies had a set of vehicle-load standards. Typically, these standards differed depending on the service class, day or time period, or location. Two agencies also included in their standards the maximum amount of time that passengers should be required to stand. Two agencies also used the scheduled headway to set the vehicle-load standard. The minimum standard for most peer agencies was 100 percent (no standing passengers) on certain commuter trips and during non-peak time periods. Bus peak-period vehicle-load ratios ranged from 120 percent to 180 percent. Rail peak-period vehicle-load ratios were much higher—as much as 334 percent on the #3 Red Line cars used by the MBTA.

The vehicle-load standard is partly a measure of passenger comfort. Less stringent standards permit a greater number of standing passengers and general passenger crowding. This typically decreases passenger comfort as personal space is limited and passengers sometimes must force themselves through a crowd to board or alight vehicles. Vehicle load is also tied to the amount of service provided. More stringent standards reduce the number of passengers per vehicle and require reduced headways and more vehicles. Therefore, while not an explicit measure of service efficiency, vehicle load does govern a key component—namely, the cost and resulting hours of operating a certain number of vehicles. Less stringent vehicle-load standards improve both the cost-effectiveness and productivity of transit. However, this comes at a cost of reduced passenger comfort and service quality. Service provision standards for minimum headways may also require correspondingly more stringent vehicle-load standards.

The MBTA already provides a detailed list of vehicle-load standards that depend on service class, time period, and location. However, the MBTA only uses one vehicle-load standard for all bus vehicle types despite differences in the available standing area. Crowding on low-floor and Silver Line Waterfront buses is not well identified by the existing vehicle-load standard of passengers per seated capacity due to lesser and greater amounts of standing area caused by narrow aisles and luggage racks, respectively. The MBTA could introduce separate vehicle-load standards for these two bus types, as it does for different rapid transit vehicle types. Alternatively, the MBTA could use a ratio of passengers to floor area as the standard and consistently apply it across all bus vehicle types.

Another potential change to the vehicle-load standard would be to link it with the schedule-adherence standard. Linking the two would prioritize providing on-time service to routes with a greater number of riders. However, as shown by Figure 12, routes with a greater average weekday ridership actually tend to have better schedule adherence than routes that average lower ridership. According to figures from the 2008 Service Plan, for every additional 1,000 average daily weekday riders, the percentage of trips adhering to the schedule increased by 1.7 percent. In addition, routes that failed the vehicle-load standard performed better, on average, with regard to schedule adherence, with 62.7 percent of trips running on time compared to 58.5 percent of trips on routes that met the vehicle-load standard. Finally, while prioritizing schedule adherence on routes that fail the vehicle-load standard would generally improve routes with greater ridership, this would only benefit 24 percent of riders, as 76 percent of riders use routes that meet the vehicle-load standard.

Figure 12
Average Weekday Ridership by Percent of On-Time Trips
by MBTA Bus Route



According to the 2008 Service Plan, 23 directly operated weekday MBTA bus routes, composing 13 percent of all service, failed the vehicle-load standard. On Saturdays, the number of failing routes dropped to 14, or 10 percent, and on Sundays, the failing number was 9, or 8 percent. Table 30 lists the failing routes.

Table 30
MBTA Bus Routes Failing the 2008 Vehicle-Load Standard

Bus Route Number and Description	Weekday	Saturday	Sunday
1: Harvard Square – Dudley Station via Mass. Avenue		X	X
16: Forest Hills Station – UMass		X	
19: Fields Corner Station – Ruggles/Kenmore Station	X		
21: Ashmont Station – Forest Hill Station	X		
23: Ashmont Station – Ruggles Station	X		
28: Mattapan Station – Ruggles Station	X	X	
34: Dedham Line – Forest Hills Station	X		
34E: Walpole – Forest Hills Station	X	X	X
40: Georgetowne – Forest Hills Station	X		
55: Queensberry Street – Park and Tremont Streets	X		
57: Watertown Yard – Kenmore Station	X		
66: Harvard Square – Dudley Station via Brookline		X	X
70: Cedarwood – Central Square, Cambridge	X	X	
73: Waverly Square – Harvard Station	X		X
87: Clarendon Hill – Lechmere Station	X		
89: Clarendon Hill/David Square – Sullivan Station			X
93: Sullivan Station – Downtown via Bunker Hill			X
104: Malden Station – Sullivan Station via Ferry Street		X	
109: Linden Square – Sullivan Station		X	
116: Wonderland Station – Maverick Sta. via Revere	X	X	X
117: Wonderland Station – Maverick Sta. via Beach	X	X	X
137: Reading Depot – Malden Station via North Ave.	X		
225: Quincy Ctr. Station – Weymouth Landing	X		
236: Quincy Ctr. Station – South Shore Plaza		X	
238: Quincy Ctr. Station – Holbrook/Randolph Station		X	
240: Avon Line – Ashmont Station	X		
441: Marblehead – Haymarket/Wonderland Station			
442: Marblehead – Haymarket/Wonderland Station	X		
450: Salem Depot – Haymarket/Wonderland Station	X		
701 CT1: Central Sq. – South End Med. Area	X		
741 Silver Line 1: Logan Airport – South Station	X	X	
742 Silver Line 2:BMIP – South Station	X		
743 Silver Line 3: City Point – South Station	X		
746 SL Waterfront: Silver Line Way – South Station			X

Summary of Recommendations for Service-Efficiency Standards

For standards and guidelines that relate to service efficiency, the following possible change to the MBTA's Service Delivery Policy should be considered:

- No change is recommended for the MBTA's net-cost-per-passenger standard.
- Consider adopting different vehicle-load standards for different bus vehicle types or replace the standard for the ratio of passengers to seated capacity with a ratio of passengers to floor area that is consistent across all bus vehicle types.

2.3.4 Physical Infrastructure

Distribution of Revenue Equipment

One of the profiled peer agencies has guidelines for the distribution of revenue equipment. The top priority is to ensure that all routes are accessible. Other guidelines concern the distribution of buses with air conditioning, the average age of buses, and the number of bus types at each garage.

Although the MBTA does not codify a requirement for air-conditioning in the Service Delivery Policy, it does require that all transit vehicles have air conditioning, and it has established a maximum allowable average age for the bus fleet. In addition, the MBTA has policies that govern how vehicles are assigned throughout the system. These policies vary by mode and are governed by various operational characteristics and constraints. Due to the nature of these policies, they do not have any quantifiable standards associated with them, and may change as fleets turn over.

MBTA vehicle assignment policies are described in the triennial Title VI report, through which the MBTA monitors compliance with Title VI of the Civil Rights Act of 1964. For Title VI monitoring, the MBTA evaluates bus vehicle assignment based on vehicle age and air conditioning operability, and evaluates rail vehicle assignment based only on age. Because the vehicle assignment policies and monitoring are documented in the MBTA's Title VI report, it does not appear necessary to incorporate them into the Service Delivery Policy.

Distribution of Transit Amenities

As with distribution of revenue equipment, one of the profiled peer agencies has guidelines for the distribution of amenities such as benches, shelters, and trash cans. Priority is given to providing amenities at bus stops that have large numbers of passengers who board at the location, lengthy wait times between buses, a high percentage of transfer passengers, and a high percentage of seniors or people with disabilities.

The MBTA has an official policy that governs the placement of bus shelters throughout the system; however, it does not have placement policies for all transit amenities. As with vehicle assignment, the MBTA evaluates and documents the distribution of many amenities through Title VI monitoring and reporting. Therefore, it does not appear necessary for the MBTA to include these in its service standards.

Summary of Recommendations for Physical-Infrastructure Standards

The MBTA already has guidelines and policies outside of its Service Delivery Policy that govern the distribution of equipment and amenities. These are documented and monitored as part of the MBTA's Title VI reporting; therefore, no changes to the Service Delivery Policy's standards are recommended.

2.4 Summary of Review of Service Standards

Service standards are both a reflection of and a driving force behind service conditions and structure. While service standards are generally set at levels representing the minimum level of acceptable service, and therefore guide the design and provision of that service, they can also be used to measure performance and how well the service is functioning in relation to the standard. In turn, the analysis of service standards not only identifies poorly performing services, but also opportunities for improving services when the demand exists.

The MBTA's existing service standards, as described in its Service Delivery Policy, are: coverage, span of service, frequency of service, schedule adherence, vehicle load, and net cost per passenger. All of these standards are tailored to particular service characteristics that describe the MBTA as well as transit more generally. Characteristics such as service class and the day or time period are commonly used to differentiate the level of each standard. Other differentiating factors, such as the population density, passenger flow, and location, are also used for specific standards.

Other profiled peer agencies do use some additional service standards. These include standards concerning service structure for stop spacing, route travel time, directness of travel, etc. There are also standards concerning service provision for service delivery, miles between service failures, and passenger complaints. Similar to the service standard for net cost per passenger, some profiled peer agencies use measures similar to the MBTA's, such as cost-effectiveness or passenger productivity. Finally, a few profiled peer agencies also have general

guidelines for the distribution of physical infrastructure, such as bus types, air conditioning, benches, shelters, etc.

While the MBTA's existing service standards do provide a comprehensive evaluation of service structure, provision, and efficiency, there may be some slight modifications to the existing standards, as well as the adoption of some potentially new standards, that may be useful. With regard to existing standards, the coverage standard uses a population-density threshold over which a minimum-distance-to-transit standard is applied. Creating a range of density categories, with a corresponding range in the minimum-distance-to-transit standard, might provide a more consistent level of service across areas with similar population densities. Similarly, adopting general guidelines that associate a range of bus passenger flows with a range of service frequencies could provide a more consistent level of service for bus routes with similar levels of demand. No other changes are recommended for the existing service standards.

As for potentially new standards, one of the policy objectives stated by the Service Delivery Policy is the establishment of service objectives that define the key performance characteristics of quality transit services. However, there are only a few used by the profiled peer agencies that appear to be potentially useful to the MBTA. A stop-spacing standard that establishes a minimum distance between stops would provide a standard to which the MBTA could point when restructuring the stop locations of various routes. A directness-of-travel standard would compare the in-vehicle transit travel time to that of a private automobile and establish a minimum ratio. This could help the MBTA target routes or route segments for which significant delays are caused by non-traffic factors. An adjustment to this metric could also be used to evaluate the effectiveness of route deviations. A transfer standard that establishes a maximum average number of transfers for each bus route or rapid transit station could identify particular groups of passengers who may be candidates for receiving direct service with no required transfers. Finally, various standards relating to service delivery, such as the percentage of service hours delivered, the percentage of dropped trips, miles per service failure, miles per accident or incident, and the vacancy rate, would likely only formalize policies that the MBTA already has. Several other guidelines and/or standards used by the profiled peer agencies for employee vacancy rates, passenger complaints, ease of use, and the distribution of revenue equipment and transit amenities could be used as guidelines by the MBTA. These guidelines would state general policies but would not establish strict standards.

As changes are considered to the structure and amount of MBTA core service, the resulting service concepts will consider the standards described in this chapter. Indeed, the rationale behind several of the concepts will draw from particular emphasis on one or several of these service standards. A long-range vision for MBTA core service may emphasize certain standards over others, but since each of these standards represents an important element of transit service, they will all be considered.