CORE EFFICIENCIES STUDY

of the Massachusetts Bay Transportation Authority System

Boston Region Metropolitan Planning Organization

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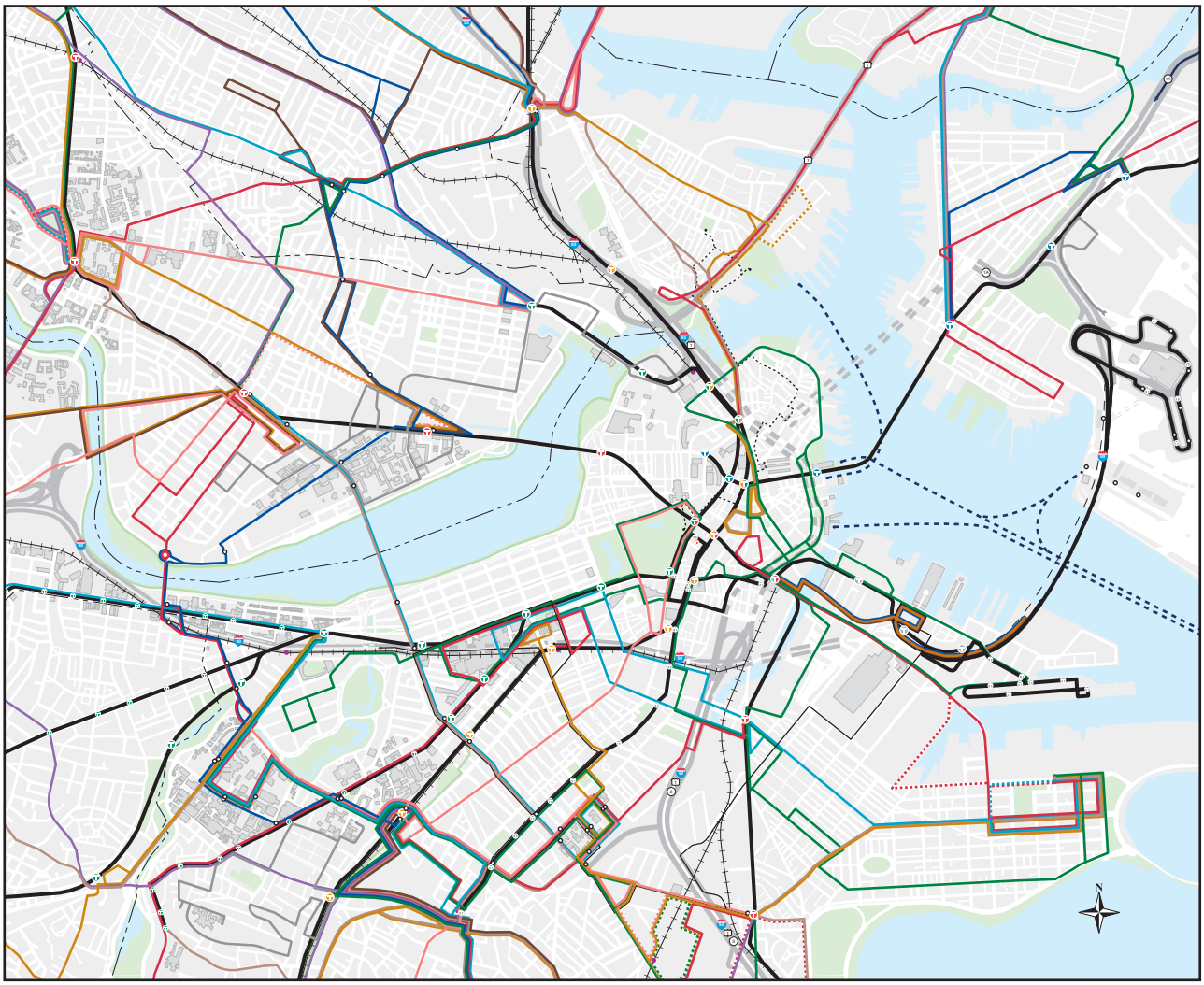

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Abstract

The Core Efficiencies Study analyzes the service standards and other measures that are used to evaluate transit services, and applies these standards and measures to the existing MBTA core bus and rapid transit system as well as to several potential concepts for MBTA service delivery. The service standards include those currently used by the MBTA—coverage, span of service, frequency, schedule adherence, vehicle load, and cost-effectiveness—as well as standards not currently used by the MBTA that would apply to stop spacing, route competition, and service delivery, among many possible service measures. Additional measures are used to evaluate the MBTA system for the Boston Region MPO's regional travel demand model set. These additional measures are used to analyze the number of trip origins and destinations and the various costs of transit trips between neighborhoods. Finally, the finances of the MBTA and the potential financial implications of the proposed concepts are also considered.

The Study proposes four different concepts for MBTA service delivery. The rail extension concept essentially maintains the existing service structure with extensions of the radial rail network (heavy and light rail), while primarily using buses as feeder routes or to serve circumferential trips. The bus rapid transit (BRT) corridor concept replaces local bus service in the urban core with a reduced number of high-frequency, BRT-level services, while local bus service outside the core would remain the same. The limited-stop corridor concept replaces local bus service with a combination of local- and limited-stop service during the peak travel periods along Key Bus Routes and other major routes that travel a long distance. The neighborhood services concept presents an entirely revised bus network, with new BRT routes along major radial and circumferential corridors, and other bus routes linking local neighborhoods to these corridors and the rail lines.

Each concept, and also the existing MBTA system, offers varying levels of service depending on which service standards are considered. In several cases, a higher level of service using one standard results in a lower level of service in another. Each concept therefore has positive and negative aspects, and the choice of which concept to more fully study depends on which measures are prioritized.

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Keywords

Service standards
Service delivery
MBTA
Transit demand model
Transit finances

Executive Summary

As one of the nation's oldest public transportation systems, the Massachusetts Bay Transportation Authority (MBTA) has undergone many changes since its origin in 1897, when services were provided only by streetcar lines. Over this time, the MBTA has regularly performed analyses of the quality of service delivery and of changing demographic and travel patterns in order to better provide services and to attract riders who have a choice between public and private transportation. Given the prospect of increasing deficits caused by annual expenses exceeding annual revenues, and the infeasibility of addressing these deficits through fare increases and service reductions alone, the MBTA will need to continue to find operational efficiencies and increase ridership. Taken together, these conditions argue for a reevaluation of where and how the MBTA currently provides transit service, as well as a review of the Service Delivery Policy to determine whether existing service standards need to be revised to guide the efficient provision of future services.

S.1 Review of Existing Service Standards

S.1.1 MBTA Service Standards

The purpose of the MBTA's Service Delivery Policy is to guide both the design and evaluation of transit services so that they meet the needs of the riding public. To do this, 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 following bullets summarize the service objectives and the service standard(s) or guideline(s) associated with each:

- Accessibility: coverage; span of service; frequency of service
- Reliability: schedule adherence

- Safety and comfort: vehicle load
- Cost effectiveness: net cost per passenger

S.1.2 Comparison of Peer Agencies by Service Standards

This study performed a review of the service standards used by peer agencies and found that several agencies use the same standards as the MBTA, as well as some additional standards. For the MBTA service standards that are also used by peer agencies, this study found that there is a range in the performance metric and threshold used by the various agencies; however, the MBTA's standards are generally consistent with those of the peer agencies.

Some service standards used by the peer agencies are not used by the MBTA. These include the following categories of standards:

- Service structure: stop spacing, route competition, and ease of use
- Service provision: the percentage of scheduled service hours that are delivered and the minimum number of miles of operation between service failures
- Service efficiency: the ratio of service revenue to operating costs and the number of passengers per revenue-hour
- The distribution of physical infrastructure

S.1.3 Policy Implications of Service Standard Metrics

MBTA service performance was analyzed according to each of the service standards identified in the review of peer agencies. The following recommendations were made for potential changes and additions to the MBTA's Service Delivery Policy:

Service Structure

- Maintain the distance-to-nearest-transit metric used for the coverage standard
- Consider introducing a greater range of coverage standards that corresponds to a range of population-density levels
- Consider adopting the following additional standards:
  - A minimum-distance-between-stops metric for a stop-spacing standard

    - A maximum ratio of transit travel time to auto travel time as a directness-of-travel standard
    - A maximum-average-number-of-transfers and a maximum-transfer-waiting-time metric for a transfer standard
- Consider adopting additional guidelines to:
    - Determine stop location
    - Eliminate competition between transit routes
    - Minimize route travel times
    - Improve the ease of use of the transit system

Service Provision

- Implement no changes in the MBTA's span-of-service standard
- Consider including only major timepoints in the application of the MBTA's schedule-adherence standard (the current standard uses all timepoints) and using a range of route-level schedule-adherence standards
- Consider adopting the following additional standards:
    - Either a percentage-of-service-hours-delivered or percentage-of-dropped-trips metric for a service-delivery standard
    - A miles-per-failure metric for a service-failure standard
    - Vacancy-rate metrics associated with service-critical positions for a vacancy-rate standard
    - A miles-per-accident/incident metric for an accident-and-incident standard
    - A complaints-per-boarding metric for a passenger-complaints standard

Service Efficiency

- Implement no changes in the MBTA's net-cost-per-passenger standard
- Consider adopting different vehicle-load standards for different bus vehicle types using the current vehicle-load standard, which is based on the ratio of passengers to seated capacity or consider adopting a new vehicle-load standard based on the ratio of passengers to floor area, which would be consistent across all bus vehicle types

Physical Infrastructure

The MBTA already has guidelines and policies outside of its Service Delivery Policy that govern the distribution of equipment and amenities; therefore, no changes are recommended.

S.2 Identify Transit Markets

S.2.1 MBTA Ridership Trends

MBTA ridership has increased on all modes over the past 10 years and, according to the Boston Region MPO's regional travel demand model, ridership on every mode is projected to increase by an even greater percentage and absolute amount by 2030. From pre-2000 ridership counts to pre-2010 counts conducted after 2000, the greatest percentage increase occurred on the Red Line and the greatest absolute increase occurred on the bus system. The greatest percentage increase from the pre-2010 ridership counts to the 2030 projections was forecast for the surface Green Line, and the greatest absolute increase was forecast for the bus system.

S.2.2 Transit-Use Indicators

The study area used to analyze trip patterns was limited to the towns that are either served by MBTA bus or rapid transit routes or lie within approximately one mile of these routes and could be considered to be within the service areas of the routes. Several indicators of transit usage, such as population density, employment density, the number of zero-vehicle households, and the locations of trip generators that lie within a half mile of any bus or rapid transit stop, were analyzed for the study area.

The neighborhoods with the greatest existing and projected population and employment densities and number of zero-vehicle households are largely located in or near downtown Boston. These include Chinatown, Downtown, and Longwood. East Cambridge, East Somerville, and Waterfront are among the neighborhoods with the greatest projected absolute and percentage changes in population, employment, and zero-vehicle households.

S.2.3 Modeled Trips

The regional model set can be used to estimate the volume of daily trips originating from and destined to each transportation analysis zone (TAZ) in the study area as well as the number of origin-destination

pairings between any two TAZs. The regional model set provides existing figures for daily trips as well as projections based on assumed changes to the model inputs for factors such as prices, trip times, and land use.

For existing trips, the regional model set showed:

- The greatest percentages of trips originating from and destined to each neighborhood come from that same neighborhood, followed by neighborhoods nearby or at least within the same town. This reflects the local nature of most trip making.
- The neighborhoods with the greatest numbers of origins and destinations are primarily those located in the urban core. This reflects the greater population and employment densities of these neighborhoods that lead to a greater number of trips.
- Specific neighborhoods with the greatest numbers of existing trip origins and destinations individually as well as origin-destination trip pairs include Back Bay, Chinatown, Downtown, and Harvard Square.

The projected changes in trips do not appear to shift the overall travel patterns of existing trips. For the projected change in trips, the regional model set showed:

- The greatest percentages of trips originating from and destined to each neighborhood come from that same neighborhood.
- The next greatest percentages of trips for each neighborhood typically come from neighborhoods nearby or at least within the same town.
- The neighborhoods with the greatest numbers of origins and destinations and also, in most cases, the greatest percentage increases in origins and destinations are those located in and near downtown Boston.
- The growth in trips to and from certain individual neighborhoods, especially Waterfront, East Cambridge, East Somerville, and East Lynn, stands out as being significantly higher than for other neighborhoods.

S.2.4 Level-of-Service Characteristics

Several transit level-of-service characteristics are also analyzed. The first characteristic considered was the frequency of vehicles serving each neighborhood and transit stop or station. As would be expected,

neighborhoods, stops, and stations with greater frequencies of service are typically located in areas that are served by multiple transit routes or lines, such as the Downtown neighborhood, which is served by all four rapid transit lines, or Dudley Station, which is served by numerous bus routes.

Other transit trip characteristics that are considered are the transit fare, the walk time to transit from the origin and from transit to the destination, the in-vehicle transit travel time, the initial waiting time, the transfer waiting time, and the number of transfers. All of these characteristics are taken from inputs to the regional model set and are combined to create a relative weighted cost index.

For existing trips, the model set showed:

- Smaller distances between origin and destination neighborhoods are generally associated with smaller transit costs. This is due to the trip likely taking the lower-priced bus mode, having a shorter in-vehicle travel time, and requiring fewer transfers.
- Lower transit costs are associated with neighborhoods located in and around downtown Boston because of greater transit service frequencies, fewer transfers, a shorter initial waiting time, and shorter access, egress, and transfer times.
- Certain neighborhoods, such as Chelsea, East Somerville, North Allston, and Waterfront, have transit costs that are greater than those of their surrounding neighborhoods.

S.2.5 Analysis of Trips and Costs by Transit Route

This section combines the following three analyses described in the previous sections:

- The existing and projected trips by transit route
- The modeled number of all trips between neighborhoods
- The existing costs of transit trips between neighborhoods

The combined analysis makes it possible to summarize all trips between neighborhoods that are served by each transit route and the cost of transit trips between those neighborhoods. The following conclusions can be drawn from this summary:

- Routes with the greatest ridership totals are typically those that serve downtown Boston or other neighborhoods that attract a large number of trips.

- Population and employment densities are typically greater in these neighborhoods, as are the number of zero-vehicle households.
- Transit costs are also generally lower for existing trips to and from these neighborhoods.
- The greatest number of existing trips occurs within neighborhoods or between neighborhoods that are nearby or within the same town. These neighborhoods include Chinatown, Downtown, Fenway, and Harvard Square.

For the projected change in trips, the model set showed:

- Several neighborhoods served by transit routes have greater projected increases in trips to and from their service areas, greater numbers of projected origins and destinations, and greater costs for transit trips.
- The Waterfront (in South Boston) and East Somerville neighborhoods have significantly higher-than-average projected trip increases. Neighborhoods such as Chinatown, Downtown, East Boston, East Cambridge, Fenway, Longwood, and North Roxbury also have higher-than-average projected trip increases.
- The existing transit system appears to adequately serve existing travel patterns, but increases in the number of trips to neighborhoods that currently have higher transit costs indicate that potential service changes may be advisable.

S.3 Develop Transit Concept and Plans

S.3.1 Potential Service Concepts

The final chapter of this study presents the following potential concepts for modifying and/or redesigning MBTA service delivery:

- A rail extension concept, which essentially maintains the existing service structure of heavy and light rail but would extend the radial rail network, while primarily using buses as feeder routes or to serve circumferential trips.
- A bus rapid transit (BRT) corridor concept, which replaces local bus service in the urban core with a reduced number of high-frequency, BRT-level services, while local bus service outside the core would remain the same.

- A limited-stop corridor concept, which replaces local bus service with a combination of local- and limited-stop service during the peak travel periods along Key Bus Routes and other major routes that travel a long distance.
- A neighborhood services concept, which presents an entirely revised bus network, with new BRT routes along major radial and circumferential corridors, and other bus routes linking local neighborhoods to these corridors and the rail lines.

S.3.2 Application of Service Standards

Each concept was analyzed according to the service-delivery standards presented in the second chapter. Each concept analyzed has positive and negative aspects, and the choice of which concept to more fully study depends on which measures are given the highest priority.

The rail extension concept focuses on strengthening the existing radial structure of the heavy and light rail network by extending several rail lines outward. Most extensions would serve areas outside the urban core; however, two extensions are located entirely within Boston and an area of Somerville that is currently served only by buses. This concept would not dramatically change the MBTA's performance according to most service standards.

The BRT corridor concept reduces service in the urban core to high-frequency BRT routes, eliminating all local bus routes in this area. Coverage would therefore decrease and passengers would have greater walking distances to access transit. However, transit would offer faster and more efficient trips with reduced headways in the BRT service area. Local bus routes outside the BRT service area would remain.

The limited-stop corridor concept would add a limited-stop variation to several of the routes that have the greatest ridership or longest distances. The vehicles used for this limited-stop variation would be taken away from local-stop service, requiring headways on local-stop service to increase. However, trips with an origin and a destination that are both served by the limited-stop service would have a dramatic decrease in their trip times.

Finally, the neighborhood services concept would also use BRT routes throughout the system. The service area of remaining local routes would largely be limited to specific neighborhoods, and these routes would shuttle riders to the nearest radial or circumferential rapid transit corridor. Therefore, while coverage would remain relatively high, the

number of transfers would likely increase and the directness of travel would decrease.

S.3.3 Modeled Trips for Each Service Concept

Each proposed service concept was also analyzed to evaluate how well each transit route would serve existing and projected trips that have an origin and/or a destination in that route's service area. The following conclusions were drawn from the model set:

- None of the proposed concepts would dramatically improve or worsen the percentages of origins or destinations served by the routes.
- The rail extension concept would slightly decrease these percentages for existing trips but would increase them for the projected change in trips.
- The BRT corridor concept would marginally improve the existing percentages of trips with both an origin and destination served by a route and would not affect service to neighborhoods that have greater projected increases in trips.
- The limited-stop corridor concept would not alter the service area of any route in the existing system.
- The neighborhood services concept would marginally decrease both the existing and projected percentages of trips that have both an origin and destination served by a route.

S.3.4 Financial-Constraint Analysis

An additional analysis of each proposed concept focused on the financial situation facing the MBTA and its impact on any potential service changes. If the MBTA continues to face a shortfall between its annual expenses and revenues that is the same as or worse than the projected deficit, it is likely that some of that total deficit would need to be addressed through fare increases and/or service changes to increase operating revenues, or through service changes to reduce operating expenses.

The following conclusions were drawn for each proposed concept:

- The rail extension concept would increase the net cost (costs minus revenue)
- The BRT corridor concept would decrease the net cost.
- The neighborhood services concept would decrease the net cost.

- The limited-stop corridor concept is structured to be revenue neutral, meaning that net costs should not change.

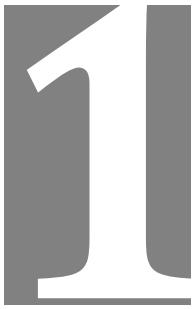
Reductions in the net cost of operations could address a portion of the average annual operations deficit that is projected for the next five years. If costs and revenues match MBTA budget projections, this average deficit would equal $186.3 million per year. Estimated annual reductions in the net cost of core transit services under the neighborhood services and BRT corridor concepts range from $79.9 million to $103.3 million, respectively.

S.3.5 Conclusions

The following conclusions were drawn from the study:

- The service standards currently used by the MBTA provide a satisfactory assessment of the existing level of service, although the MBTA might benefit from considering adding some standards used by peer agencies.
- A demographic analysis indicated that neighborhoods with the greatest existing and projected population and employment densities and number of zero-vehicle households are largely located in the urban core, in or near downtown Boston.
- An analysis of MBTA ridership trends showed increases in ridership on all modes up through 2010 and modeled projections of ridership increases that are even greater through 2030.
- An analysis of existing trips and the projected change in trips indicated that most trips occur within a neighborhood's boundaries or are between nearby neighborhoods, and that the neighborhoods with the greatest numbers of trip origins and destinations are primarily located in the urban core.
- While trips are generally projected to increase throughout the modeled area, certain neighborhoods, such as the Waterfront and East Somerville, have particularly large projected trip increases.
- An analysis of various level-of-service characteristics showed that lower transit costs are associated with shorter trips and trips within the urban core.
- Certain neighborhoods in the urban core, such as Chelsea, East Somerville, North Allston, and the Waterfront, have transit costs that are greater than those of their surrounding neighborhoods.

The study proposes four potential concepts for modifying and/or redesigning MBTA service delivery that reflect these conclusions. Each concept prioritizes different service standards, has a slightly different impact on the percentages of origins or destinations served by transit routes, and affects efficiency and the resulting systemwide net cost in a different way. Since each concept has positive and negative aspects, the choice of which concept to more fully study depends on which measures are prioritized.



Introduction

1.1 Background

The Massachusetts Bay Transportation Authority (MBTA) is the nation's oldest public transportation system. Much of the existing system has its origins as streetcar lines built before 1900. The MBTA currently operates three heavy rail rapid transit lines, five light rail rapid transit lines, four bus rapid transit lines, and nearly 200 bus routes. The heavy rail and light rail rapid transit system was completed in 1987 with the relocation of the Orange Line to the Southwest Corridor. Silver Line bus rapid transit routes were introduced to Boston starting in 2002. Over time, the bus system has grown in response to customer demand and now operates a large number of routes with high frequency service in dense urban areas and fewer routes with less frequent service in more suburban areas where auto ownership is greater.

The primary tool that the MBTA currently uses to guide the design and allocation of transit service within the Authority's service area and to measure service quality and productivity is the Service Delivery Policy, which establishes standards for coverage (how far a customer has to walk to reach a transit service), frequency and span of service (how often and the hours in which transit operates), vehicle loading (the number of passengers per vehicle), schedule adherence, and net cost per passenger. These standards have been used in the past to guide the provision of bus service; however, the MBTA currently faces a number of challenges that suggest that the existing standards and the services that they govern may need to change.

For MBTA services to remain viable, they must adapt to emerging development and trip patterns, as well as increasingly attract riders who have a choice between public and private transportation. In addition, changes in personal income, higher gas prices, and a growing awareness of the environmental impacts of driving may affect this

choice and will continue to change public attitudes about where and how transit services should be provided. These new expectations may lead to not only a different design of routes, but also perhaps different ways of providing service altogether.

The MBTA is also facing the prospect of increasing financial uncertainty. Sales tax revenues (the primary source of MBTA operational revenue) have consistently failed to meet expectations, resulting in deficits between operating revenues and expenses. Over the past several years, the MBTA has periodically raised fares to increase operating revenue. At the same time, the MBTA has also tried to address the need for additional service on some routes by reallocating service away from inefficient services (with the highest net-cost-per-passenger ratios). It is unlikely, however, that fares could be raised to the level necessary to eliminate annual operating deficits altogether, making it necessary to also rely on a combination of operating efficiencies, ridership increases on some routes, and possibly service cuts on others to address projected deficits.

Taken together, the conditions discussed above argue for a reevaluation of where and how the MBTA currently provides transit service, as well as a review of the Service Delivery Policy to determine whether existing service standards need to be revised to guide the efficient provision of future services.

1.2 Study Objectives

This study has three major objectives. The first is to review the Service Delivery Policy and determine whether existing standards should be revised and/or new standards should be added that would help to identify the most efficient or successful services. The second objective is to consider the MBTA system in light of these standards, as well as in light of development, travel, and financial patterns. The third objective is to propose concepts for how the system might be adjusted or potentially redesigned to respond to the prioritized service standards or demonstrated patterns.

1.3 Study Organization

The first chapter in this study reviews the existing service standards used by the MBTA and peer agencies. The rationale for using each type of service standard is discussed, as is the metric used to assess each standard and the implications of using various metrics or setting the

standard at certain levels. The performance of the existing MBTA system is then analyzed according to each of the service standards.

The second chapter evaluates trends and projections for several factors that are likely to affect MBTA ridership in the future and identifies both existing and future markets with an estimated high level of demand for transit services. Various indicators of transit demand are presented. Historical and projected trends in MBTA ridership are discussed for all bus and rapid transit routes. Existing and forecasted population and employment densities and concentrations of zero-vehicle households, as well as the location of major activity generators, are also identified. Finally, the Boston Region MPO's travel demand model set is used to estimate both existing trips and the projected change in trips between all neighborhoods in the study area. Summaries of trip origins and destinations and the respective transit costs indicate potential areas for transit improvements.

The third chapter develops several potential concepts for service delivery. Each concept is analyzed using the service standards from Chapter 1 and the trends and projections from Chapter 2. In addition, the financial situation facing the MBTA and the financial implications of each concept are discussed.