Introduction

Over the last decade, the Greater Boston area has experienced significant growth both economically and demographically that has presented a variety of challenges to the transportation system. Increases in traffic congestion have contributed to increases in emissions, which in turn raise concerns about social equity as well as climate considerations. Air pollutants detrimentally affect our health, and highways are often centered near low-income communities that face greater health issues as a result.

These challenges have been further exacerbated over the last year due to the COVID-19 pandemic, highlighting that, at the core of addressing these challenges, the solutions must address income inequality, climate change, accessibility, education, access to healthcare and affordable housing while, at the same time, improving passenger experience. Public transit is a means to address congestion while improving environmental emissions, accessibility, and social equity. However, this will require significant capital investments at a time when operating and maintenance costs are projected to continue growing at an unsustainable rate.

Significant progress has been made over recent years with respect to technological enhancements, operational efficiencies, and cost controls across the MBTA organization. This paper seeks to explore the potential of further productivity improvements, made possible by smart capital investments and advancements in technology, in anticipation that operating cost growth will continue to be a challenge for the MBTA as it seeks to continue providing safe, reliable, and accessible transportation.

Ongoing Initiatives and Issues for Future Focus

Since the inception of the Fiscal and Management Control Board in 2015, the MBTA has explored several productivity improvement initiatives with the aim of both optimizing costs and improving passenger experience. The following are some forward looking initiatives and opportunities for transforming the MBTA's business model as made possible, in part, by advancements in technology.

Green Line Type 10 Vehicles

The MBTA is procuring a new kind of vehicle to serve the Green Line called the Type 10 Supercar. The Type 10 is an "off the shelf" vehicle that carries in one car the same number of passengers that the MBTA currently serves with two bespoke vehicles. From a passenger capacity standpoint, the new cars eliminate/reduce many of the most expensive components on a train, such as operators' cabs, brake components, and couplers. Fewer vehicles require fewer inspections and shorter preventative maintenance cycles. Using the latest propulsion and braking technology would enable more efficient energy consumption and therefore reduced utility costs. Additionally, system standardization and one-fleet operation would reduce maintenance and operations training costs as well as material costs. Finally, the Type 10 Supercars deliver the same carrying capacity and reliability with fewer operators. Each Supercar requires one fewer

operator than does a two-car legacy train. The MBTA is accepting and reviewing proposals from vehicle manufacturers in 2021.

Subway Automation/Driverless Trains

Over the years, the MBTA has gradually implemented operational changes and introduced vehicle fleets that incorporate technological enhancements that give operators, control center staff, and maintenance staff more information, creating safety enhancements and operational efficiencies. A byproduct of these enhancements is the ability to reduce the required staff required to operate each train. For example, subway trains once required as many as four employees onboard trains in operation, but the current fleet only requires one employee onboard. The next logical step, as technological advancement allows, would be automated, driverless trains that may create an opportunity to reduce or even eliminate the need for a human train operator. The MBTA has initiated a study to explore the state of the art for signal technology for future investments in the Blue Line signals system, the only signal system not currently undergoing investment, and included in the study is an assessment of levels of automation that are feasible, and in practice in the transit industry. That report is scheduled for completion in late 2021.

There are five grades of automation for train service, ranging from Grade 0, with on-site operations personnel, to Grade 4, with starting and stopping, operating doors, and handling emergencies all fully automated without any on-train staff. No U.S. transit system currently operates driverless trains; any system at Grade 2 or higher has a driver onboard to operate doors and ensure passenger safety in the event of an emergency. In order to meet standards for Grade 4 driverless trains, the MBTA must install platform edge doors at all stations, aligned with train door locations and capable of preventing unauthorized access to the right of way (ROW), and implement reliable remote health monitoring of critical infrastructure assets, integrated obstruction monitoring onboard with safety-certified operation, and uninterrupted real-time monitoring of all systems, vehicles, infrastructure, access, and ROW related to train operation and service conditions.

Fare Transformation

In November 2017, the FMCB voted to embark on a multi-year program to modernize fare collection at the MBTA to enhance policy flexibility, speed bus service, implement flexible contracting with lifecycle performance and cost assurances, and build a platform for future regional mobility options. In December 2019, after considering public feedback and MBTA staff analysis, the FMCB restructured the program to provide more opportunities for public input, enhance MBTA control over the point of sale network, significantly expand the future size of that network, address other rider concerns, and resolve commercial challenges.

The program is now in active development, with its first phase of improvements complete and the second underway. As it is rolled out, the project will provide lasting benefits to riders and the MBTA. More policy flexibility and regional mobility integration options will provide new revenue and partnership opportunities to the MBTA and new fare product options to riders and institutional customers. The future system will provide the MBTA the technology platform to

support policies that prioritize revenue, ridership, and equity goals over time. Increased payment convenience and improved bus service speeds will improve the customer experience, reduce barriers to ridership and expand mobility. All door boarding will reduce dwell times on bus, light rail, and regional rail. New fare media and tools will make fare inspection faster and more consistent across transit modes and payment methods. The new fare system also enables potential productivity improvement on regional rail, if combined with high-level platforms and automated doors, by changing the role of the conductor with regard to fare collection.

From a fiscal responsibility standpoint, the vast majority of payments to the key contractors will not be made until the technology is fully operational, and even then, payments are contingent on sustained excellent performance. Finally, strict contractual system reliability assurances for fare equipment will help reduce avoidable fare leakage.

Regional Rail Transformation

As the MBTA continues to transition and build back service following COVID-19 ridership and service reductions, it is necessary to ensure that improved passenger experience is at the forefront of planned improvements and Rail Transformation. With the pattern of service demand changing, the MBTA needs to evaluate transformation strategies that meet these new passengers' expectations. Improved productivity through the deployment of more modern and environmentally friendly technology can ensure that these strategies achieve the following key objectives:

- Provide service that accommodates new travel patterns and timing;
- Provide service at a cost which is competitive to car travel;
- Provide a viable alternative to attract single occupancy car drivers to help meet the Commonwealth's climate goals;
- Generate significant operational cost efficiencies.

Regional Rail Service

Travel patterns are continually evolving with the need for a purely commuter-oriented service slowly declining. Regional rail service is characterized by the following:

- Consistent bidirectional service throughout the day, moving away from focusing principally on commuter service during morning and evening peaks;
- More frequent service at consistent times past the hour to facilitate turn-up-and-ride journeys and bus schedule integration;
- Modern, electrified rolling stock coupled with accessible high-level platforms providing faster journey times through faster acceleration, step-free boarding, automatic doors and pre-boarding fare validation, reducing dwell times and increasing safety.

While passenger demands have evolved, the system has not. The current Commuter Rail is operating under the same service model as the 1950s. Regional Rail – approved by the FMCB in November 2019 – is a transformational restructuring of the Commuter Rail system into a more

productive, equitable, and sustainable system. Transforming into a Regional Rail service will allow the MBTA to better tailor the service, size of trainsets and staffing model employed (prioritizing customer service over fare collection) to better meet passenger demand.

A Regional Rail service model will ultimately result in greater operational efficiencies. These efficiencies include leveraging "short turns", in which not every train runs to the end of the rail line, and cross-platform connections/transfers, where passengers get off one train and can quickly board another to complete their journey. As such, there is (i) a need for fewer trainsets, (ii) modern electrified trainsets require less maintenance (and have monitoring, which enables more efficient predictive maintenance), (iii) a more efficient staffing model – all resulting in operations and maintenance cost savings.

Great strides have been made towards restructuring the service model; the Spring 2021 Regional Rail schedule shifted from focusing on AM and PM peak driven commuting demand to a more consistent service offered throughout the weekday. This more passenger-friendly schedule is not only responsive to ridership demands but maintains 93% of the weekday service hours from the old service model.

In order to maximize the utility and competitiveness of Regional Rail service and increase accessibility to all communities in the Boston area, MBTA needs to consider the current fare structure and create a cost-efficient system to provide services at a cost to the rider comparable to rapid transit. This will in turn attract a new and durable ridership, ultimately leading to generation of the revenue required to offset the costs of the increased service.

Transition to Electric Rail Fleet

To achieve these productivity improvements, the MBTA needs to identify and deliver key capital investments that can unlock these additional efficiencies. Investing in both the rolling stock and infrastructure will allow the MBTA to increase trips at more frequent intervals than the current Commuter Rail schedule. To support these efforts, investment will be needed in the complementary infrastructure such as high-level platforms.

Investing in an electrified rail fleet will enable the MBTA to provide a more efficient, customer-focused, and cost-optimized service with more frequent trips. There are various options that the MBTA may explore to procure the required fleet, including: purchasing new or used EMUs on the market; leasing the required rolling stock; requiring a future operator to provide trains.

The MBTA's existing Commuter Rail fleet is composed of 101 diesel-powered locomotives and 496 single and bi-level passenger coaches. These are not only outdated and detrimental to air quality but are expensive to operate. As the MBTA looks towards improving productivity and optimizing costs, modernizing the fleet to include more environmentally friendly electric or battery-electric powered rolling stock will allow the MBTA to realize Regional Rail transformation efforts while adopting practices in line with the Authority's peers and in turn, reducing running costs.

Electrification provides several advantages compared with diesel power, that will further support Regional Rail transformation efforts.

- **Long-term fuel cost savings**: the cost of renewable energy continues to decline, largely driven by improving technologies and a competitive supply chain. According to the U.S. Energy Information Administration (EIA), the cost of electricity as a transportation fuel source is projected to decline from 2020-2050 while the costs of diesel and gasoline are projected to grow. Entering into agreements with utility providers to lock in rates for a period of time presents potential cost savings to the MBTA and is in line with the MBTA's existing policy of purchasing renewable energy. Additionally, while purchasing renewable power supply, it is important to ensure that there is sufficient capacity. The two new 100% renewable energy contracts with BP Energy Company and Direct Energy LLC will reduce the MBTA's carbon footprint and save over $3 million per year. The additional benefit of improved efficiency results in further cost savings. Compared to diesel-powered trains which transfer 30-35% of energy generated to the wheels, overhead catenary transfers ~95% of energy to the wheels.

- **Lower fleet maintenance cost**: electric-powered rolling stock typically have fewer maintenance activities, resulting in a lower annual maintenance expense and time spent out of service in comparison with diesel-powered alternatives. The cost of maintaining an electric motor alone is approximately 25-35% less than that of a diesel engine. Electric Multiple Units (EMUs) have a higher degree of redundancy (failure of a single motor or brake does not significantly affect performance).

- **Reduction in emissions**: compared with diesel trains, and particularly as the electricity grid continues to de-carbonize, electric powered trains have significantly lower emissions, further demonstrating the MBTA's commitment to sustainability and reducing greenhouse gas emissions. This is in line with the MBTA's sustainability policies as well as the 2021 Roadmap for Massachusetts Climate Policy Act, which sets the state on a path towards net zero emissions in 2050.

- **Acceleration benefits**: Electric trains and particularly EMUs accelerate and brake more quickly and efficiently than the current fleet of diesel locomotives. This benefit of EMUs results in faster travel times, especially when making frequent stops especially on local trips

- **Operational Efficiencies:** the procurement of new rolling stock provides an opportunity to invest in operational measures that improve performance and reduce station dwell time. Automatic doors and positive train control are examples of technologies that are already partially deployed by the MBTA and can be further improved as older equipment is retired.

Given these advantages, more and more transit agencies, especially our peer agencies, have either adopted, or are exploring, electrification though the technological approach may vary. While some of the early adopters of electrification, such as SEPTA and Caltrain, utilize overhead contact systems (such as overhead catenary wire), other agencies are piloting programs to assess the feasibility of innovative technologies such as batteries and hydrogen fuel cells.

In the Northeast, both Long Island Rail Road (LIRR) and NJ Transit have announced pilot programs to assess the viability of battery powered trainsets. In partnership with Alstom, the LIRR is retrofitting existing EMUs with batteries; these battery-powered trains will then travel along diesel branches (~13 miles for the pilot program) to test the feasibility of battery technology for their operations. One of the benefits of this emerging technology is that battery electric trains can be used on partially electrified lines. As this market and technology evolve, the best-value approach is likely to be achieved by a mixture of catenary and limited catenary solutions.

In November 2019, the Board directed the General Manager to take the measures and steps needed to begin implementing the first phase of Rail Transformation: to electrify service along the Providence/Stoughton line, Fairmount line and Environmental Justice line ("EJ line", the section from North Station to Everett, Chelsea, Revere and Lynn).

There has already been great progress made with respect to planning for this Phase 1. MBTA is currently preparing a procurement for electrified rolling stock initially for the use on the Providence line but with options to purchase additional trainsets as the existing fleet reaches end of life. Amtrak electrified the express tracks on the Northeast corridor (NEC), which the Providence service uses, in 1995. Currently the 1.7 miles of catenary that is required to complete the electrification at Attleboro Station is being added (as Amtrak service currently skips this station), and an additional transformer feed would need to be added nearer to Boston to run expanded service.

Once that power upgrade has been completed, 6 miles of new catenary would be needed to connect Stoughton Station to the electrified NEC, and 10 miles to connect the Fairmount line. The capital investment required to electrify these branch lines connected the NEC would be limited and could also provide an opportunity to test battery-electric or other traction power technologies intended for use on the EJ line while the more extensive infrastructure upgrades for the EJ line were planned and implemented.

Onboard Productivity Improvements

Currently, staff members on board each train are responsible for fare collection. Many transit agencies have transitioned to a "proof-of-payment" fare collection service whereby riders purchase fare pre-boarding and are subject to random fare checks as determined by the transit agency. This model has several benefits, including increased efficiency, reduction in fare leakage, and reduction in fare collection costs. This process ultimately results in time savings and an improved service for passengers.

Under the current operating agreement with Keolis, there is a contractual requirement of 1 train staff for every 300 passengers. Generally, the regional rail model requires fewer staff, with 1 engineer to operate the train and 1-3 conductors for tickets. Automated doors and high platforms remove the need for staff to manually open doors and lower traps (currently the largest cause of staff injury). As such, the number of conductors and assistant conductors per passenger decreases. Following best practices in comparable systems, SEPTA plans to use one-person crews by converting to all high-level platforms and checking fares before boarding. From a

federal perspective, the Federal Railroad Administration ("**FRA**") does not plan on regulating minimum crew sizes. However, conversations with staff early on will be essential to the success of the implementation of these transformational strategies.

The reduction in operational needs to raise and lower traps between platforms, all doors opening automatically and pre-board fare checking will (i) reduce dwell time, (ii) increase transit speeds, (iii) improve boarding and alighting speed, (iv) free up staff to operate the (more frequent) trains – resulting in improved rail service for passengers, and (v) allow upskilling of conductors to do more responsible work.

Infrastructure Modernization

It is important that we invest in the infrastructure needed to support electrification and provide operational improvements such as reduced dwell time and passenger safety. These investments – that will ultimately result in an improved service for our passengers – include adding high-level, accessible platforms to all stations and converting single track pinch points to double track.

- **Updating low-level station platforms at stations**: As the MBTA introduces EMUs, we need to ensure that our station platforms, especially those with low-level platforms, are compatible with the entry level of the EMUs. A gradual phasing in of high-level platforms will ensure that new rolling stock, particularly those with automated doors, are compatible with our stations leading to an equitable improvement in ADA accessibility and ensuring unhindered access to transit services for all our passengers. The cost to upgrade these platforms currently ranges from $40-50m for a major station requiring elevators to $20-$25 million for a station which does not. While significant, upgrading these stations to be compatible with the fleet is critical to improved accessibility, service and safety. The MBTA is also studying ways to reduce the costs and carbon impact of these station projects through modularization, simplification, project bundling and other forms of procurement optimization.

  Station dwell times are highly correlated to both the platform level and the door layout. Ensuring that the platform levels are compatible with the door layout will therefore reduce and minimize dwell times – improving service and passenger experience. High level platforms are estimated to halve dwell times per passenger per lane compared to low-level platforms. In Toronto, GO Transit has cited plans to convert station platforms, allowing for level boarding.

  Finally, high-level platforms show health and safety benefits. In a study conducted by the Systems Engineering Department at the University of Pennsylvania, it was found that systems with one type of platform, i.e., high or low level, and remotely controlled doors had the lowest passenger and employee injury rates. It was found that compared to low-level platforms with remotely controlled doors, high-level platforms with remotely controlled doors had a lower injury rate. Injury rates were much lower than those with manually operated doors. As a matter of fact, Keolis reports that boarding/detraining

incidents, including operation and use of manual doors and traps, are the largest cause of staff and passenger injury.

- **Ensuring sufficient grid resilience and capacity**: Renewable energy sources generally are more resilient than traditional grid power supply. Building generation assets over time is critical to ensure that service disruptions are minimal and that there is backup in the case of emergency situations.

- **Maintenance and layover facility modernization:** To accommodate the electrified fleet, the MBTA needs to invest in its maintenance facilities to ensure that these facilities have the capability to service the new EMUs.

Bus Transformation

Similarly, there are potential productivity initiatives that may be considered with respect to the MBTA's bus service. Increasingly, across the United States, transit agencies are investing in their public bus programs to ensure that costs are optimized while addressing growing and changing ridership demands. Below are highlighted future productivity initiatives.

Bus Transit Priority

Bus Priority is one of the most powerful levers the MBTA and roadway owners (typically municipalities and other agencies) have to improve the bus experience. The MBTA has partnered with communities to implement Bus Transit Priority projects to increase and improve bus transit service in areas with significant congestion (and in turn, traffic delays) and high ridership.

Bus Priority projects include deploying dedicated bus lanes (of which nearly 20 miles are either actively used or under construction), as well as infrastructure like queue jumps and transit signal priority, which create an integrated system of enabling the MBTA bus network to provide faster, more reliable service and a better customer experience. Enhanced productivity is another benefit of Bus Priority; if buses can run faster and stay on schedule, it would allow the MBTA to provide more service with the same number of buses. As of 2021, 3% of rider mileage was in a bus lane and directly benefited from bus priority, and more than 40% of all rider mileage indirectly benefited from bus priority as faster, more reliable service positively impacts the whole bus network.

Transition to Electric Buses

Bus electrification is becoming increasingly popular nationwide as transit agencies begin transitioning to a battery electric bus ("BEB") fleet with the aim to improve service to passengers, reduce lifecycle costs, improve air quality, and achieve climate goals. The National Renewable Energy Laboratory estimates cost savings of over $0.20 per mile in maintenance

costs for a BEB compared to a diesel bus[1]. While the Commonwealth has a goal of 80% GHG emissions reduction by 2050, there is no direct mandate requiring agencies to electrify their fleets as is the case in California, for example. However, given the accelerating trend of renewables entering the power grid, transitioning transportation fleets to electricity is a key part of reducing emissions. Utilizing a combination of hybrid electric-diesel and battery-electric buses will ultimately reduce bus fleet emissions by 80% by 2032.

The use of BEB fleet will ultimately result in increased productivity and cost-optimization. Over the long-run, electric buses provide cost savings in comparison to diesel-powered buses. On an annual basis, electric buses may save up to $50,000 a year per bus in fuel and maintenance costs.[2] Electric buses generally have fewer parts and as such, fewer maintenance activities – resulting in maintenance and labor costs savings.

Supporting Infrastructure Investments

As the MBTA develops its plans for electrifying its bus fleet, consideration will need to be given to the critical infrastructure investments that are needed to support these efforts. The rate of transition and success of the program is largely dependent on the availability of maintenance and storage facilities that are equipped for electric vehicles. Currently, the MBTA operates 9 bus maintenance facilities, with the oldest dating back to 1904 and the newest to 2004. These facilities need to be renovated or replaced so the fleet of electric buses can be serviced and charged. The MBTA has taken significant steps in their planned renovation of the old Quincy facility which is slated to be operational by 2024 and can service and house up to 120 buses – these measures are needed to anticipate the arrival of the 80 electric buses which are due to arrive during fiscal year 2023 and 2024.

As the MBTA assesses the various funding opportunities available to put towards these facilities, there are various case studies from transit agencies that may offer some innovative solutions. The San Francisco Municipal Transit Authority (SFMTA) is in the process of procuring a private partner to design-build-finance-operate-maintain (DBFOM) the new Potrero Bus Yard which will have the capability to maintain and store electric buses as the agency acquires BEBs. Mixed-use development might help the MBTA to achieve its goals in this area.

There will be significant investment required for the charging infrastructure as well, which includes the chargers itself, grid connection upgrades and generation. The introduction of electric buses into the fleet necessitates sufficient grid capacity. It is important to have a clearly defined energy demand and use profile to ensure that there is sufficient capacity. This also results in greater cost certainty over the long-term. Additionally, electric grids provide greater resilience compared to traditional fuels.

Future Considerations

[1] https://afdc.energy.gov/files/u/publication/financial_analysis_be_transit_buses.pdf
[2] https://www.publicpower.org/periodical/article/electric-buses-mass-transit-seen-cost-effective

The significant impact to public transit due to COVID has accelerated the need for innovative strategies to transform and upgrade transit systems nationwide. The pandemic has significantly impacted ridership and in turn, fare revenues. The MBTA received one-time, federal relief funding through the CARES Act, the Coronavirus Response and Relief Supplemental Appropriations Act (CRRSAA), and the American Rescue Plan, totaling $1.9 billion. This one-time federal funding has been used to cover operating expenses during fiscal years 2020 and 2021, with the remaining funds allocated to fiscal years 2022 and 2023. While the MBTA anticipates spending these funds on operating expenses, in the event one-time funds are not allocated for operating expenses through FY 2023, the MBTA could potentially fund some early investments in its transformation programs.

Rail Vision has highlighted a funding need of up to $28.9 billion for the full, systemwide Rail Transformation. The estimated cost of the FMCB-approved Phase 1, which includes the Fairmount Line, the Providence Stoughton Line, and the Environmental Justice Corridor, is $3-3.5 billion. Bus Transformation costs are estimated at $4.5 billion to replace existing facilities to support phased introduction of BEBs, and $100-130 million annually to replace the bus fleets. While federal grant funding available through the MBTA's traditional capital planning process can be used for some early, no-regrets infrastructure investments, there is still a need for innovative and alternative sources of funding to deliver these unfunded transformation projects. While some other transit systems have pursued DBFOM contracts for projects of this magnitude, the MBTA does not currently have the authority to use this procurement tool. A legislative change is required to make this possible.

As the MBTA considers planning for these future productivity initiatives, the need to provide an equitable service ought to be at the forefront. The MBTA currently offers reduced fare programs for people with disabilities, seniors, and low-income young adults. There is a gap for non-disabled, low-income adults between 26 and 64 years of age. Other transit agencies have expanded their programs to include income-eligible adults of all ages[3] using other state benefits as a proxy for eligibility, which reduces the administrative burden on transit agencies.

Peer agencies are also exploring equitable transit in their plans. The SFMTA implemented a fare structure strategy to achieve four goals: (i) Incentivizing transit ridership, (ii) Incentivizing pre-payment, (iii) Enhancing customer convenience, and (iv) Promoting equity. SFMTA's ability to adjust citywide parking rates to achieve its goals has aided the success of the program. An example of SFMTA offerings are:

- Free Muni program providing eligible senior, youth, and mobility impaired passengers with free fares
- Reduced Dwell Times at Bus Stops via all-door boarding and a pre-payment discount incentive
- Random fare checks resulting in fines to reduce fare evasion

[3] Metropolitan Transportation Commission. **Regional Means-Based Transit Fare Pricing Study.** December 2016.

Since policy implementation, bus speeds increased by 2%, dwell times decreased by 37%, and fare evasion rates fell by up to 0.8%. The increased cost of enforcement was offset by revenue from additional fares (2% increase in ridership) and citations.[4]

Pursuing these productivity initiatives will ultimately move the MBTA towards delivering an improved customer experience while increasingly providing a more equitable and environmentally friendly service.

[4] National Association of City Transportation Officials. **Better Boarding, Better Buses: Streamlining Boarding & Fares**. February 2017

Appendix: Summary of Past Initiatives

When the Fiscal and Management Control Board began its term in 2015, the MBTA's operating costs were growing at an unsustainable rate, with a widening gap between projected costs and revenues. During its six years, the Board directed and oversaw a variety of productivity initiatives and cost control measures aimed at reigning in costs, improving productivity and setting the MBTA on a course to fiscal sustainability, while simultaneously improving service and investing in the system. Many recent productivity initiatives are underway. This is a sampling of some of the initiatives that the MBTA explored and implemented, with mixed success, during the six years of the FMCB.

Outsourcing Initiatives

Money Room and Warehouse Partnerships

The MBTA collects, counts, and deposits $110 million in cash and coins from MBTA vehicles and fare vending machines each year; under the legacy program, approximately 70 employees were responsible for this cash at a cost of nearly $11.8 million per year. Transitioning to a third party provider for cash management and logistics has reduced operating costs by $7-8 million annually, improved operations and reconciliation processes, and implemented more effective risk management and fiscal controls. Leveraging technology (Brinks iTrack and iCash, MBTA ServiceNow, and Namsys), along with improved timeliness of reporting, allows for more efficient monitoring of system-wide fare revenue collection activity and ensures any service that was scheduled was completed, processed, reconciled, and deposited within 24-48 hours. All completed Brinks activity including performance metrics is reviewed and reported weekly. Additionally, performance review meetings are conducted on a monthly and quarterly basis.

The transition also resulted in operational improvements, such as more efficient route scheduling for drivers who collect cash and more systematic maintenance of fare boxes and other equipment.

- **Cash Collection Route Scheduling** – Under the MBTA's legacy cash collection program, drivers would visit every fare vending machine on a set schedule, regardless of whether service was needed—an operation that involved 5-7 trucks per day. Today, Brinks collects the MBTA's cash with just 1-2 trucks per day by servicing fare vending machines only when needed, based on anticipated volume. Further efficiencies have been realized by scheduling required machine maintenance and regular cash collection service in the same trip.
- **Maintenance of Fare Boxes** – Implementation of a new internal money container inventory system has resulted in improved asset management focus. All containers are now tracked while in use and repair activity documented when removed from service for maintenance purposes. Additionally, the MBTA *ServiceNow* maintenance system provides a detailed history of all maintenance activity performed system-wide.

The MBTA also outsourced its Inventory Warehousing and Material Distribution in February 2017 in order to improve operational performance and reduce operating expenses. The provider, MANCON, has successfully opened a new warehouse in Stoughton and closed MBTA warehouses in Everett and Charlestown, resulting in vast improvement in materials management, logistics, and overall supply chain efficiencies and accountability. MANCON has achieved 98.9% overnight part delivery, 97% accurate inventory, and better performance than the legacy system at a lower cost.

- **Overnight Part Delivery** – In 2017, prior to the MANCON contract, average part delivery time was over 58 hours; today a material requisition is placed and the part is delivered and received by 10am the next day, with 99 percent reliability. This significant improvement also enables a productivity improvement for the men and women of the MBTA who directly maintain MBTA equipment.
- **Inventory Accuracy** – In 2017 inventory accuracy was reported at 61%; today inventory accuracy is 97% at Central Warehouse Operations under the MANCON contract.

Increased management oversight of the current inventory, valued at $64.9 million, has created an active inventory of 69% versus 2017, when MBTA reported 48% active inventory. Active inventory is defined as materials used within 24 months. Active inventory was increased 21% because of an initiative to institute best practices in reviewing and identifying obsolete inventory that was not categorized appropriately. The obsolete inventory was sold or donated, and today there is less than $500 thousand in obsolete inventory.

The financial analysis provided to FMCB in 2017 reflected a warehouse budget of $12.1 million, compared to a stabilized year calculation for FY 2020 operating expense actuals of $7.0 million, for an annual operating savings of approximately $5.1 million from the outsourcing of warehouse operations to MANCON.

Bus Maintenance Outsourcing

The MBTA's previous attempt to outsource bus maintenance did not result in an awarded contract, and the RFP was cancelled. This first attempt did not bundle maintenance and operations and proposed to hand off existing MBTA facilities and equipment with poor conditions to the vendor, who could have used the working condition as a reason not to meet performance standards. Further, the operation of the bus service was retained by the MBTA, which added further risk to the potential. Privatization of any activity needs to fully realize all ties to internal operations and minimize contact and conflict points. This requires risk allocation that needs to be clearly identified, assigned an owner, and considered in the evaluation of options.

None of this should imply that this cannot or should not be explored further. Future attempts at outsourcing bus operations and maintenance should consider incorporating some or all of the elements mentioned here and lessons learned from the previous attempt.

In FY 2016 the MBTA's total, all-in, cost of bus operations was $423.7 million. The T operated 2.3 million revenue service hours that year, for an annual cost per revenue hour of $181.

Through a combination of administrative controls, including tighter overtime management, more efficient materials and supply chain management, and a new staffing model to streamline the workforce, by FY 2018, the all-in cost was reduced to $412.5 million, and with increased revenue service hours of 2.8 million, the annual cost per revenue service hour was reduced to $148.

This is a remarkable achievement by the MBTA, but there is still room for additional productivity improvement. In FY 2018, Paul Revere Transportation's total, all-in, cost of contracted bus operations for the MBTA Winthrop Service was $1.9 million for 18,000 revenue service hours, for an annual cost per revenue service hour of $106. Some of the factors driving the lower cost of the Paul Revere operation include the small size of the service, new condition of the assets provided in the contract to perform the service, and the complete packaging of service and maintenance to the third party contractor, but the MBTA could benefit from understanding what productivity improvements and operational efficiencies may also be contributing to the lower cost of that service.

Business Enterprise Software

Procurement Platform Strategy

Prior to October 2016, the MBTA did not have an effective, competitive procurement strategy. The MBTA worked with the Commonwealth's Operational Service Division ("OSD") to adhere to state regulations for the Procurement of Commodities or Services (801 CMR 21.00) and related OSD policies. Working with OSD, the MBTA aligned its procurement program with the statewide contracts, procurement, and purchasing program, in order to utilize the COMMBUYS procurement system and associated OSD tools to deliver best value and a consistent approach with vendors to help achieve efficiencies and cost savings.

Leveraging OSD Statewide Agreements and COMMBUYS services provides MBTA two alternatives to augment MBTA procurement processes. Shifting appropriate purchases of goods and services to existing OSD statewide agreements simplifies the procurement and contract process, saving time and creating the ability to process procurements faster. COMMBUYS provides another robust bidding platform for the MBTA to use. In FY 2020, MBTA increased its use of COMMBUYS to 39% of procurement dollars flowing through the MBTA Procurement system, up from 12% in FY 2019, which led to more efficient processing of procurements. Average processing time for procurements over $50k decreased from 131 days in FY 2019 to 87 days in FY 2020.

In 2017, the MBTA also implemented a procurement platform called FairMkt, enabling small procurements to be bid more efficiently through a larger vendor marketplace. A vendor management initiative to ensure key contracts have Service Level Agreements with measurable KPIs was also launched that year. These changes have helped the MBTA reduce the number of sole- and single-source procurements by 9% and have cut the average processing time for small procurements down from 117 days to 58 days.

e-Builder

e-Builder is a complete Capital Programs and Project Management Office software that allows all Capital Programs functions, including Project Planning, Consultant Selection, Design, Bid-Phase, Construction and Project Closeout, to be digitized for more efficient delivery, monitoring, and reporting. e-Builder has also streamlined invoice processing, which will aid the MBTA significantly in receiving more competitive bids and having greater choice of and competition among contractors, as there is a direct correlation between invoice cycles and the quality of contracted services (Businesses pay attention to customers that pay on time). Anecdotally, agencies that have smaller invoice cycles (time between consecutive invoices) get better contractors and better bids, as timeliness assures the Construction and Professional Services firms of predictable revenues, thereby lowering financial risk.

COVID-19 necessitated a switch to digital processes, but the positive impact of e-Builder will go far beyond the end of the pandemic by allowing our employees to work remotely, reducing paperwork while migrating to electronic filing, and improving organizational efficiency, transparency, and engagement. All capital construction processes were fully digitized in e-Builder by September 1, 2020, and all professional services processes will be fully digitized by fall 2021. Future plans for e-Builder include turning the cost module on, enabling near real-time data sharing on capital spending with the Budget & Finance department, and full integration with the Financials & Materials Information System (FMIS), version 9.2, enabling project managers to see total budget spending, including labor costs, in near real-time.

The MBTA has now implemented the Oracle Primavera P6 Enterprise System, a software that allows cost and resource-loaded master schedules to be fully integrated with e-Builder. This will help standardize schedules, improve cash flow projections, and help manage resources efficiently. Better cash flow projections will help the Finance department improve accounting and help Capital Programs improve the planning and funding of the CIP. Cost- and resource-loaded schedules will allow the MBTA to coordinate Operations support to Capital Programs in an efficient manner by increasing reliability of schedules. The T will be able to realize significant savings through reducing schedule delays to its capital programs.

These process improvements will help the T create performance dashboards that will give staff near real-time metrics on the performance of the Capital Program. Other MBTA departments like Capital Planning, Office of the Chief Engineer, Finance, and Operations will have access to this data, thereby improving transparency in the organization. The end result will be better control over schedules and budgets. These are significant investments in Building a Better T.

Business Process Redesign

Human Resources

MBTA Human Resources recently redesigned its hiring process, which was identified in the Safety Review Panel report as a major obstacle to acquiring talent in key safety, engineering, and construction positions. These changes include decreasing the number of steps in the process, charting a collaborative review process with the MBTA's Office of Diversity & Civil Rights (ODCR) to streamline the overlap between workflows, engaging a trainer for the Applicant Tracking System NEOGOV to train recruiters and identify misuse of the product, training

recruiters on active recruitment and LinkedIn usage, and structuring the recruitment team so that each recruiter has an area of expertise or specialty. Lottery-based hiring for surface operators, motorpersons, fuelers, and track laborers was replaced with programmed hiring, which allows candidates to apply directly for jobs posted on MBTA.com and other job boards. These efforts – along with hiring a Recruitment Process Outsourcing (RPO) firm to supplement hiring – led the MBTA to hire over 700 employees in FY20, a record high.

The department also revamped its New Hire Orientation (NHO) to be shorter and more focused on safety instead of benefits administration and paperwork. The NHO is now conducted entirely online, and all documents are signed using DocuSign instead of physical signatures. Once public health precautions related to Covid-19 are lifted, future NHOs may include site visits to different MBTA facilities and additional safety trainings. These safety trainings and other training courses have been catalogued in a new Learning Management System (LMS), which allows managers to assign courses to employees and track performance KPIs.

Lean Program

The MBTA established the Lean Strategy Department to apply a globally-established continuous improvement methodology in order to address broken processes and inefficiencies. Over the last two years, the department has made significant progress on its mandate to empower employees at all levels of the organization to identify and implement process changes in order to work more safely and efficiently. The Lean Strategy team works primarily alongside staff to identify and implement process improvement initiatives and to establish a sustainable framework for continuous improvement within that department. While the specific goals of each initiative vary, the overarching objective is to improve the frequency and reliability of service by empowering frontline staff to implement a series of simple or low-cost improvements. These process changes, while small on their own, add up to significant service benefits to customers and cost savings for the MBTA.

The Lean Strategy team has worked on a number of case studies (detailed in the appendix), including at the Southampton Bus Maintenance Facility, Riverside Carhouse, and Everett Shops. These initiatives resulted in the creation of tools and review processes such as KPIs, dashboards, trackers and prioritization reviews that enable senior leaderships to drive accountability; the development of standard operating procedures (SOPs), checklists, audits, assessments, and quality assurances processes to ensure work can be do in a safe and efficient manner; and fostering of a Lean culture by providing formal training and coaching on how to participate in and lead improvement projects.

Revenue Initiatives

Advertising Contract Rebid

In 2016, the MBTA rebid its system-wide advertising concession and awarded a 5-year term with two 5-year options to Outfront Media with industry-leading terms including a 70% revenue share and the commitment of installing 700 digital advertising screens across the network. After an initial dip in revenues during the first year of the concession, the MBTA has enjoyed double

digit growth year over year with over 30% of revenue coming from the 600+ digital screens on the system. Revenue to the MBTA from the system-wide concession grew from $17.3M in FY 2017 to over $24M in FY 2019. Additionally, the digital advertising panels have enabled the MBTA to communicate disruptions, service changes, and other notices directly with customers on the system.

Outdoor Advertising Assets

In 2019, the MBTA procured an Outdoor Information Panels (OIPs) initiative. OIPs will selectively digitize roadside assets to support the critical need of real time travel information (RTTI) and customer communications along the most trafficked roadways in the Commonwealth, achieving new opportunities to reach the public with information about transit at critical decision-making points. Digital upgrades will sustain the RTTI through new advertising revenue and increased revenues up to ~$5 million per year.

Perq Program

Since 2018, the MBTA has actively worked to expand participation in the Perq for Work program, which enables employers to provide pre-tax benefits to their employees. Overall participation in the Perq program grew to 1,550 unique companies by March of 2020 resulting in $17.95M in monthly revenue that month. Since the fall of 2018, the program added a net 184 new companies and increased revenue by over 9% compared to September 2018.

In response to the Covid-19 pandemic, fare revenue through Perq dropped significantly. As new travel patterns emerge, the MBTA will continue to examine the performance of the fare products offered through Perq and pursue opportunities to expand participation in the program.

Parking Management Contract

In 2017, the MBTA rebid its Parking Management Contract and awarded a five-year term with two 5 year options to Republic. Under this new agreement, the MBTA reimburses Republic for all expenses incurred in the course of managing the MBTA parking system, plus a fixed management fee. This new contract model resulted in a more transparent and flexible contract scope and has enabled the MBTA to implement industry leading changes such as License Plate Recognition technology for more efficient and effective parking management, adapt staffing and scope of services to changing realities and customer needs, and introduce new tools and management practices more expeditiously. Additionally, this more flexible contract model has enabled the MBTA to implement (1) more efficient snow and ice contracts at parking facilities that deliver a higher standard of winter weather service, (2) uniformity and security in revenue collection across the system, (3) improved facility maintenance from continuously enhanced standards, and (4) more accurate data collection and real-time data sharing with customers.

Parking Pricing Policy

In 2018, the MBTA adopted a demand based parking pricing policy ending a decade long hiatus in parking pricing adjustments in the MBTA parking system. The principles of the MBTA Parking Policy, adopted by the FMCB on June 18, 2018 are:

1. Price parking according to demand.
2. Consider total trip cost (daily parking and round-trip fare costs together).
3. Monitor parking policies to ensure they support ridership goals.

In September of 2018, the pricing policy was operationalized with a system wide pricing update. The pricing update resulted in two positive outcomes: (1) gross facility revenues increased by ~6% in the twelve months post price change, (2) parking consumption across the network smoothed out as customers moved from more expensive, congested facilities to underutilized, less-expensive ones.

As trip making returns post-Covid-19, the MBTA will continue to pursue opportunities to maximize revenue and encourage access to the system through its parking facilities and pricing policy.