Goals of the Presentation

• Provide briefing on heavy rail fleets and facilities by line
  • Current state of assets
  • Ridership demand
  • Future capacity
  • IFFP investments
• Highlight implementation of Reliability Centered Maintenance (RCM)
Aligned with MBTA Strategic Vision - Focus40 Planning

*The MBTA plans to execute the commitments made in the FMCB Strategic Plan

**MBTA Strategic Plan**

**Focus40**: Meeting the Needs of the Region in 2040

- **Blue Line Resiliency Planning**
- **Green Line Capacity Study**
- **Orange Line Capacity Study**
- **Mattapan High Speed Line Study**
- **Commuter Rail Vision**
- **Bus Service Plan**

**Heavy Rail Fleet & Facilities**

**Project Development**

**5-Year Capital Investment Plan**

**20-Year Capital Investment Plan**

**IMPLEMENTATION**
Approach for Fleet Inventory and Condition

- Fleet and facilities inventory and condition assessment activities performed between January and March 2017
- Consistent with MBTA asset management plan and strategy (MAP-21)
- Physical assessments utilized the FTA 1-5 condition rating scale
- Report cards were prepared summarizing key findings for fleets and facilities

---

### Asset Report Card - Rail

<table>
<thead>
<tr>
<th>Property</th>
<th>MBTA</th>
<th>Average Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation Year</td>
<td>2017</td>
<td>3.1</td>
</tr>
<tr>
<td>Est. Next Renew</td>
<td>2005-2009 (32yr)</td>
<td></td>
</tr>
<tr>
<td>Quantity</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>Last Overhaul</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>Location(s)</td>
<td>Crolley</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Asset Type</th>
<th>New Type</th>
<th>Current Condition</th>
</tr>
</thead>
</table>
| Light Rail | Electric | Light Rail
| Light Rail | Diesel | Diesel Rail
| Light Rail | Bi-Modal | Light Rail
| Light Rail | Straight Rail | Light Rail
| Battery | Battery | Battery
| Battery | Battery | Battery

<table>
<thead>
<tr>
<th>Current Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Systems</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>- A new vehicle procurement for replacement cars is in progress.</td>
</tr>
</tbody>
</table>

---

**Assumptions based on FTA 1984 (1981)**

**CH2M**

**APRIL, 2017**

**Draft**
Blue Line
Fleet and Facilities
Inventory and Condition – Blue Line

Blue Line Fleet

<table>
<thead>
<tr>
<th>Fleet</th>
<th>Age (Years)</th>
<th>Total Cars</th>
<th>Condition Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 5</td>
<td>12</td>
<td>94</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Orient Heights Maintenance Facility

<table>
<thead>
<tr>
<th>Facility Age</th>
<th>63 Years</th>
<th>Hoists</th>
<th>4</th>
<th>Lifts</th>
<th>2</th>
<th>Pits</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior</td>
<td>3.4</td>
<td>Shell</td>
<td>4.0</td>
<td>Substruct.</td>
<td>3.5</td>
<td>Electrical</td>
<td>3.1</td>
</tr>
</tbody>
</table>

- Significant upgrades performed at time of Blue Line Fleet procurement (2007)
- Facility continues to be well maintained, with relatively minor issues observed
Heavy Rail Ridership – Blue Line

Ridership by Transit Mode
Average Weekday, October 2016 to September 2017

Thousands of Riders

Red Line: 281,284
Orange Line: 203,442
Blue Line: 69,475

Source: MBTA Back on Track Data
Heavy Rail Peak Capacity and Demand – Blue Line

BLUE LINE PASSENGER FLOW & POLICY CAPACITY
8:00-8:30 AM, WEEKDAYS - WINTER 2017

The dotted line shows policy capacity, assuming one train every 4.5 minutes, even distribution of passengers and even headways.
Blue Line Future Capacity

- Existing operations at 4.5 minute headway provides a 10% room for capacity growth
- Utilizing the existing fleet, an additional 15% capacity could be added by:
  - Expanding trainsets
  - Further decreasing headway to 4 minutes
  - Resulting in 25% overall growth
- MassDOT Planning to monitor the pace of corridor development and ridership growth to determine if additional capacity is warranted, outside the existing scope of the IFFP
Blue Line Reliability Centered Maintenance (RCM)

- RCM has been implemented on Blue Line since 2014
  - Successful RCM program should allow MBTA to avoid a major midlife overhaul
  - Blue Line program will be a template for new fleets moving forward
  - Approach will be applied to other modes once robust processes are established

What is RCM?...
Reliability Centered Maintenance – Philosophy

- **Comprehensive data based approach maintenance structure**
- **Diagnostics to predict impending failures**
- **Conditional approach to drive maintenance behavior**
- **Planned time and date based maintenance**
- **Run to failure**
Reliability Centered Maintenance – Benefits

- RCM allows us to control the following
  - Scheduling
  - Planning
  - Costs
  - Monitor program performance

- RCM includes the following
  - Monitor overall fleet performance
  - Recording & evaluating Failures in Service
  - Develop mitigation programs
Integrated Fleet and Facilities Plan (IFFP)

Blue Line RCM Impacts

- RCM implemented 2014
- Data focused approach
- Reliability increased 68% since implementation
- Failures in services reduced 40%
- Annual, 4, 8, and 10 year programs

Blue Line Average MMBF

Average MMBF by Calendar Year

MMBF Goal
Blue Line Fleet and Facility Investment Plan

- Delivery of 94 cars: 2004 - 2005
- RCM program: Ongoing
- Light Overhaul of Blue Line cars: 2019 - 2021
IFFP Blue Line Investment Impact

Reliability Centered Maintenance Program

- Increase fleet reliability
- Reduce lifecycle costs
- Eliminate major fleet overhauls

Ongoing

Light Overhaul

- $54M (Unfunded)
- FY2019 – FY2021
- Targeted major systems overhaul
- Increase fleet reliability
- Reduce lifecycle maintenance costs
- Maximize asset lifecycle
Orange Line
Fleet and Facilities
Inventory and Condition – Orange Line

Orange Line Fleet

<table>
<thead>
<tr>
<th>Fleet</th>
<th>Age (Years)</th>
<th>Total Cars</th>
<th>Condition Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 12</td>
<td>38</td>
<td>120</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Wellington Maintenance Facility

<table>
<thead>
<tr>
<th>Facility Age</th>
<th>Hoists</th>
<th>Lifting Equip.</th>
<th>Total Cars</th>
<th>Condition Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>42 Years</td>
<td>2</td>
<td></td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Interior</td>
<td>Shell</td>
<td>Substruct.</td>
<td>Electrical</td>
<td>Fire Prot.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HVAC</td>
<td>Plumbing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Convey.</td>
<td>Shop Equip.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maint. Bays</td>
<td>Site</td>
</tr>
<tr>
<td>3.0</td>
<td>1.8</td>
<td>3.0</td>
<td>3.0</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.0</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

- Overhead cranes and doors are unreliable; heating system prone to frequent failures
- Failing roof system is leaking in several locations
- Significant upgrades are currently underway
Heavy Rail Ridership – Orange Line

Ridership by Transit Mode
Average Weekday, October 2016 to September 2017

<table>
<thead>
<tr>
<th>Transit Mode</th>
<th>Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Line</td>
<td>281,284</td>
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<tr>
<td>Blue Line</td>
<td>69,475</td>
</tr>
</tbody>
</table>

Source: MBTA Back on Track Data
Heavy Rail Peak Capacity and Demand – Orange Line

ORANGE LINE PASSENGER FLOW & POLICY CAPACITY
8:00-8:30 AM, WEEKDAYS – WINTER 2017

The dotted line shows policy capacity, assuming one train every 4.5 minutes, even distribution of passengers and even headways.
Orange Line Future Capacity

- Existing operations at 6 minute headway
- Currently operating at or above capacity
- Delivery of new cars and infrastructure investments provides the opportunity for:
  - 4.5 minute headway
  - 10 – 14 trainsets per hour (peak)
  - 40% capacity increase
Orange Line Fleet and Facility Investment Plan

- Delivery of Pilot Cars: December 2017
- Maintenance facility investment program: 2018 – 2021
- Development of RCM program: Underway
- Delivery of 152 new cars: 2018 – 2021
- Reliability Centered Maintenance Program: 2019 – 2032
- Light Overhaul of Orange Line Cars: 2030+
### Orange Line Infrastructure Programs

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Scope</th>
<th>Current Status</th>
</tr>
</thead>
</table>
| **Wellington Yard Expansion Tracks 33 to 38**             | The project will provide additional vehicle storage at Wellington Yard for the expanded Orange Line fleet. Work includes upgrades to track, traction power and signals. | Construction NTP – December, 2016  
Construction Substantial Completion – June, 2018 |
| **Orange Line Test Track at Wellington Yard**             | Upgrade the existing Orange Line Test track to support testing of the Orange Line vehicles. | Construction NTP – June, 2017  
Construction Substantial Completion – April, 2018 |
| **Wellington Maintenance Facility**                       | Expand and modernize the existing maintenance facility. Work includes a new electronics room, carwash, MEP systems, lighting, doors, windows, and specialty equipment. | Construction NTP – June, 2017  
Construction Substantial Completion – February, 2021 |
| **Wellington Yard Rebuild**                               | Full yard rebuild; including track, traction power and signal upgrades. | Advertisement – December, 2017  
Construction NTP - March, 2018  
Construction Substantial Completion – March, 2021 |
## IFFP Orange Line Investment Impact

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
<th>Details</th>
</tr>
</thead>
</table>
| **152 New Cars** | $1,010M (CIP funded, Red/Orange) | • Increase passenger capacity  
• Improve headways  
• Increase fleet reliability  
• Improve customer experience |
| **Maintenance Facility Modernization** | $257M (CIP funded) | • Increase fleet reliability  
• Reduce maintenance costs  
• Improve technical capabilities |
| **Reliability Centered Maintenance Program** | | • Increase fleet reliability  
• Reduce lifecycle costs  
• Eliminate major fleet overhauls  
Scope under review |
| **Light Overhaul** | $232M (Unfunded, Red/Orange) | • FY2030+  
• Targeted major systems overhaul  
• Increase fleet reliability  
• Reduce lifecycle maintenance costs  
• Maximize asset lifecycle |
Red Line
Fleet and Facilities
Overhead cranes and doors are unreliable. The facility heating and electrical systems are in poor condition and unreliable. Significant upgrades are currently underway.

### Red Line Fleet

<table>
<thead>
<tr>
<th>Fleet</th>
<th>Age (Years)</th>
<th>Total Cars</th>
<th>Condition Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type # 1</td>
<td>48</td>
<td>70</td>
<td>2.9</td>
</tr>
<tr>
<td>Type # 2</td>
<td>30</td>
<td>58</td>
<td>3.3</td>
</tr>
<tr>
<td>Type # 3</td>
<td>24</td>
<td>82</td>
<td>3.1</td>
</tr>
<tr>
<td>Fleet</td>
<td>34</td>
<td>210</td>
<td>3.1</td>
</tr>
</tbody>
</table>

### Cabot Maintenance Facility

- Overhead cranes and doors are unreliable
- The facility heating and electrical systems are in poor condition and unreliable
- Significant upgrades are currently underway
Heavy Rail Ridership – Red Line

Ridership by Transit Mode
Average Weekday, October 2016 to September 2017

Source: MBTA Back on Track Data
Heavy Rail Peak Capacity and Demand – Red Line

RED LINE PASSENGER FLOW & POLICY CAPACITY
8:00-8:30 AM, WEEKDAYS – WINTER 2017

The dotted line shows policy capacity, assuming one train every 4.5 minutes, even distribution of passengers and even headways.
Red Line Future Capacity

- Existing operations at 4.5 minute headway
- Currently operating at or above capacity
- Delivery of new cars and infrastructure investments provides the opportunity for:
  - 3 minute headway
  - 13 – 20 trainsets per hour (peak)
  - 50% capacity increase
Red Line Fleet and Facility Investment Plan

- Delivery of Pilot cars: March 2019
- Maintenance facility investment program: 2019 – 2022
- Development of RCM program: Underway
- Delivery of 252 new cars: 2019 – 2023
- Reliability Centered Maintenance Program: 2020 – 2032
- Light Overhaul of Red Line cars: 2031+
Red Line Infrastructure Investment Programs

**Red Line Test Track**
**Scope:** Construct a 2,500’ Test Track to support the testing of the new Red Line vehicles. Work includes new track, traction power and a Vehicle Testing Facility.

**Current Status:**
Construction NTP – December, 2017
Substantial Completion – March, 2019

**Cabot Maintenance Facility**
**Scope:** Modernize the existing maintenance facility. Work includes a new electronics room, carwash, MEP systems, lighting, doors, windows, and specialty equipment.

**Current Status:**
Advertisement – January, 2018
Construction NTP – April, 2018
Substantial Completion – December, 2021

**Cabot Yard Rebuild**
**Scope:** Full yard rebuild; including track, traction power and signal upgrades.

**Current Status:**
Advertisement - January, 2018
Construction NTP - April, 2018
Substantial Completion – May 2022
**IFFP Red Line Investment Impact**

- **252 New Cars**
  - $1,010M (CIP funded, Red/Orange)
  - Increase passenger capacity
  - Improve headways
  - Increase fleet reliability
  - Improve customer experience

- **Maintenance Facility Modernization**
  - $242M (CIP funded)
  - Increase fleet reliability
  - Reduce maintenance costs
  - Improve technical capabilities

- **Reliability Centered Maintenance Program**
  - Scope under review
  - Increase fleet reliability
  - Reduce lifecycle costs
  - Eliminate major fleet overhauls

- **Light Overhaul**
  - $232M (Unfunded, Red/Orange)
  - FY2031+
  - Targeted major systems overhaul
  - Increase fleet reliability
  - Reduce lifecycle maintenance costs
  - Maximize asset lifecycle
Key Takeaways

- Red and Orange Line fleet and facility assets are in need of significant investment, which are being addressed by programs currently underway.

- Red and Orange Line programs will increase fleet size and help to address current capacity constraints and Focus40 projections.

- Potential future growth on Blue Line based on Focus40 projections. Some capacity can be added using existing assets.

- Blue Line RCM program has resulted in improved fleet reliability and will be used as a model for future vehicle programs.

- Critical maintenance system updates at Wellington and Cabot will improve maintenance efficiency and capacity to support new fleets.
Upcoming Presentations *(Update)*

- Bus – December 4th
- Commuter Rail, Ferry, and Paratransit – December 11th
- Light Rail (Green Line and Mattapan) – December 18th