New approaches to Transit
Real-Time Passenger Information
and Service Analysis

Ritesh Warade
Associate Director, IBI Group
Transit Data and Technology Specialist

Ohio Transportation Engineering Conference (OTEC)

October, 2015
Multi-disciplinary professional services firm

2,500+ staff in 75+ offices including Westerville, NYC, Boston, Toronto

Decades long experience with transit technology

Increasing focus on transit real-time systems for passenger information and analytics
Background
Transit Data

Types:

- Vehicle Locations
- Arrival/Departure Predictions
- Passenger Counts
- Fare Collection
- Service Alerts
Increasingly:

- Collected automatically
- Accessible in real-time
- Available in large quantities
Useful for:

- Passenger information
- Service analysis / performance measurement
Transit Data

Standards:
- GTFS
- GTFS-realtime
Real-Time Passenger Information
Customers Expect

Accurate and up-to-date real-time information

At all stages of their journey

Through a variety of media
Vehicle Locations

**Where** is the bus/train?

Arrival Predictions

**When** is it going to get here?

Service Alerts

**Why** is it delayed?
Vehicle Locations
- GPS-Based
- CAD/AVL
- Train Tracking

Arrival Predictions
- Schedule Adherence
- CAD/AVL
- In-house Algorithm
- NextBus

Service Alerts
- In-house System
- CAD/AVL
Challenges

Consistency across modes, inputs sources
Consistency across output channels
Quality
Easy access
MBTA-realtime

Client: MBTA (Boston)

MBTA-realtime (TRANSIT-realtime) is a system to manage all of MBTA’s real-time passenger information.
Proprietary feed

Bus

Proprietary feed

Subway/LRT

Proprietary feed

Commuter Rail

Apps

MBTA Customers
Bus

Subway/LRT

Commuter Rail

MBTA-realtime

Google/Apps

Developers/Apps

GTFS

MBTA Customers
Welcome to the MBTA-realtime developer portal. MBTA-realtime is the MBTA's premier alert and real-time information interface for third-party developers.

As of June 4, 2013, MBTA-realtime alert and schedule data is live and in production. Real-time commuter rail and subway data to follow at a later date. Other data remains available on the general MBTA Developers Page.

Getting started is as easy as 1, 2, 3.
GTFS-RT

Trip Updates (arrival/departure predictions)

Vehicle Positions
Route Structure
- Routes
- Stops by Route
- Routes by Stop
- Stops by User Location

Schedule
- Schedule by Stop
- Schedule by Route
- Schedule by Trip

Predictions
- Predictions by Stop
- Predictions by Route(s)

Vehicle Locations
- Locations by Route(s)
Internal Systems

Website
Electronic Signs
Performance Reporting

MBTA-Realtime

GTFS-RT

MBTA Customers

MBTA Mgmt.

GTFS

Subway

Commuter Rail

Bus
Case Study

Traveler Information System

Client: RTD (Denver)

IBI Group: Strategy, Design, and Testing
Commuter Rail

Light Rail

Bus

Google
3rd Party developers
PIDS
RTD Mobile Website
RTD Website
GIS-System Map
IVR
Internal Apps
Trip-Planner

RTD Customers
Service Alerts
Vehicle Locations
Where is the bus/train?

Arrival Predictions
When is it going to get here?

Service Alerts
Why is it delayed?
Service Alerts

Is there something I should know?
Challenges

- Easy entry
- Quick dissemination
- Legible messages
- Consistency
MBTA-alerts

Client: MBTA (Boston)

Vision

**MBTA-alerts (TRANSIT-alerts)** is a system to manage all of MBTA’s service alerts.
### Affected Services

- **Route:**
  - Newburyport/Rockport Line
  - Haverhill Line
  - Lowell Line
  - Fitchburg Line
  - Framingham/Worcester Line
  - Needham Line
  - Franklin Line
  - Keolis Line

- **Direction:**
  - Both Directions
  - Inbound
  - Outbound

- **Trip(s):**
  - All Trips
  - 344 (9:30 pm from Lowell)
  - 346 (10:36 pm from Lowell)

- **Stop(s):**
  - All Stops
  - Lowell
  - North Billerica
  - Wilmington
  - Anderson/ Woburn
  - Mishawum
  - Winchester Center

### Time Range

- **Effect Period:**
  - From: now
  - Until: Wed Oct 07, 2015 11:14 PM

### Description

- **Cause:** Construction
- **Severity:** Moderate
- **Message:** Lowell Line Train 344 (9:30 pm from Lowell) delayed today between Lowell and Wilmington due to construction

- **Include Additional Information:**
- **Affected direction:** Inbound
- **Affected stops:**
  - Lowell
  - North Billerica
  - Wilmington
Lowell Line Train 344 (9:30 pm from Lowell) delayed today between Lowell and Wilmington due to construction

Affected direction: Inbound

Affected stops:
- Lowell
- North Billerica
- Wilmington

Affecting: Lowell Line, Inbound, 344 (9:30 pm from Lowell); Lowell, North Billerica, Wilmington

Cause: construction

Effect: Delay

Alert Time Type: One-time

Effect Period: 10/07/15 10:38:43 PM until 10/07/15 11:14:00 PM

Recurrence Period:

Recurrence Days:

Recurrence Time:

Notification: 10/07/15 10:38:43 PM until 10/07/15 11:14:00 PM

Severity: Moderate

Created on: 10/07/15 10:38:43 PM by test sysadmin

Last Modified on: 10/07/15 10:38:43 PM by test sysadmin

Tags:

Service Alert on MBTA.com

T-Alert Subscriber E-mail

T-Alert Subscriber SMS

Tweet

Lowell Line delay

Lowell Line Train 344 (9:30 pm from Lowell) delayed today between Lowell and Wilmington due to construction

Affected direction: Inbound

Affected stops:
- Lowell
- North Billerica
- Wilmington

Last updated: Oct 07 2015 10:38 PM

Lowell Line Train 344 (9:30 pm from Lowell) delayed today between Lowell and Wilmington due to construction #MBTA
Lowell Line (route_id: CR-Lowell)

Train 344 (9:30 pm from Lowell): (trip_id: 344)
delayed: (effect: DELAY)
today (effect_period: 1444309200 till 1444314600)
between
Lowell (stop_id: st_lowell)
and
Wilmington (stop_id: st_wilmington)
due to construction (cause: CONSTRUCTION)
<table>
<thead>
<tr>
<th>Id</th>
<th>Message</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>95045</td>
<td>Bowdoin will be closed from start to end of service on Oct 10-11, 17-18, 24-25, and 31-Nov 1. Please boa...</td>
<td>Oct 10</td>
<td>Nov 02</td>
</tr>
<tr>
<td>97359</td>
<td>Silver Line - SL2 detoured due to Cruise Ship: Omitting 88 Black Falcon Pier. Connect at Northern Ave</td>
<td>6:21 AM</td>
<td>later today</td>
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<tr>
<td>93384</td>
<td>Beginning at the start of service on Monday, October 5, Courthouse Station’s south entrance/exit will be closed.</td>
<td>Oct 05</td>
<td>unknown</td>
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<td>91730</td>
<td>At Hyde Park board the following inbound trains on the outbound platform: 800 (6:01am), 802 (6:21am), 9...</td>
<td>Aug 31</td>
<td>unknown</td>
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<td>90293</td>
<td>Providence/Stoughton: Route 128 elevators are back in service. Route 128 escalators out of service until...</td>
<td>Aug 18</td>
<td>unknown</td>
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<tr>
<td>74220</td>
<td>Needham Line schedule will be modified beginning Monday, April 27, 2015, due to Amtrak repairing the si...</td>
<td>Apr 27</td>
<td>unknown</td>
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<td>70691</td>
<td>Fitchburg Line. Service suspended along the entire line every Saturday and Sunday beginning Saturday, ...</td>
<td>Jul 26</td>
<td>Nov 23</td>
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<tr>
<td>91160</td>
<td>Haverhill Line Commuter Rail service between Boston and Reading Stations will be suspended beginning ...</td>
<td>Aug 25</td>
<td>Oct 24</td>
</tr>
<tr>
<td>97648</td>
<td>Providence/Stoughton Line Train 825 (8:15 pm from South Station) delayed today due to mechanical pro...</td>
<td>8:37 PM</td>
<td>10:55 PM</td>
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<tr>
<td>88365</td>
<td>Elevator 851 DOWNTOWN CROSSING - Oak Grove-bound platform to Franklin and Washington Streets i...</td>
<td>Aug 10</td>
<td>unknown</td>
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<tr>
<td>94765</td>
<td>Escalator 336 DAVIS SQUARE - Landing to College Ave unavailable due to maintenance</td>
<td>4:01 PM</td>
<td>unknown</td>
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<tr>
<td>96492</td>
<td>Escalators at ROUTE 128 are unavailable until further notice while Amtrak repairs them.</td>
<td>Sep 25</td>
<td>unknown</td>
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<tr>
<td>97454</td>
<td>Escalator 405 AQUARIUM - Unpaid Lobby to Street unavailable due to maintenance</td>
<td>2:33 PM</td>
<td>unknown</td>
</tr>
<tr>
<td>93383</td>
<td>Elevator 939 COURTHOUSE - Lobby to the south headhouse on Seaport Blvd is unavailable beginning M...</td>
<td>Oct 05</td>
<td>unknown</td>
</tr>
<tr>
<td>89517</td>
<td>Escalator 417 COURT HOUSE - Outbound to South unavailable due to maintenance</td>
<td>Aug 11</td>
<td>unknown</td>
</tr>
<tr>
<td>97036</td>
<td>Escalator 511 PORTER SQUARE - Mezzanine to the paid lobby is unavailable from Monday, October 12...</td>
<td>Oct 12</td>
<td>Oct 17</td>
</tr>
<tr>
<td>94272</td>
<td>Buses replacing Red Line service between JFK/UMass and Quincy Center Stations on October 10-11, 24...</td>
<td>Oct 10</td>
<td>Oct 17</td>
</tr>
<tr>
<td>94478</td>
<td>Buses replacing Orange Line service between Oak Grove and Sullivan Stations on Oct 7-8, 11-15, 19-22,...</td>
<td>8:37 AM</td>
<td>Oct 16</td>
</tr>
<tr>
<td>92997</td>
<td>Buses replacing Orange Line service between Forest Hills and Ruggles Stations on October 17-18 from s...</td>
<td>Oct 17</td>
<td>Oct 19</td>
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<tr>
<td>97339</td>
<td>Route 77 detoured from 12:00 PM to 2:00 PM on Sun Oct 11 due to the HONKH Parade from Davis to Har...</td>
<td>Oct 11</td>
<td>Oct 11</td>
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<tr>
<td>97338</td>
<td>Routes 71 and 73 detoured from 12:00 PM to 2:00 PM on Sun Oct 11 due to the HONKH Parade from Dav...</td>
<td>Oct 11</td>
<td>Oct 11</td>
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<tr>
<td>97341</td>
<td>Routes 72, 75 and 78 detoured from 12:00 PM to 2:00 PM on Sun Oct 11 due to the HONKH Parade from Dav...</td>
<td>Oct 11</td>
<td>Oct 11</td>
</tr>
</tbody>
</table>
### Subway Service Alerts

<table>
<thead>
<tr>
<th>Line</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Line</td>
<td>Regular</td>
<td>2 Upcoming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This Weekend: All passengers will board and exit on the westbound platform at Bowdoin Sept 19-20, 25-27, and Oct 3-4 from start to end of service.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Starting October 19: Bowdoin will be closed all day on Oct 10-11, 17-18, 24-25, and 31-Nov 1. Please board and exit the Blue Line at State during the closure.</td>
</tr>
<tr>
<td>Green Line</td>
<td>Regular</td>
<td></td>
</tr>
<tr>
<td>Orange Line</td>
<td>Regular</td>
<td>2 Upcoming, 1 Ongoing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Starting Later Today: Buses replacing Orange Line between Oak Grove and Sullivan Stations on Oct 1, 4-8, 11-15, 18-22, and 25-29 from about 8:45pm until closing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>October 17-18: Buses replacing Orange Line service between Forest Hills and Ruggles Stations on October 17-18 from start to end of service.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ongoing: Downtown Crossing. The Franklin St entrance will be closed on Mon, Aug 10, and will remain closed until Summer 2016 due to construction.</td>
</tr>
<tr>
<td>Time</td>
<td>Event</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>12:57</td>
<td>56 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red Line towards Ashmont</td>
<td></td>
</tr>
<tr>
<td>1:29</td>
<td>Park Street</td>
<td></td>
</tr>
<tr>
<td>1:35</td>
<td>Temple Pl @ Washington St</td>
<td></td>
</tr>
<tr>
<td>1:54</td>
<td>Dudley Station</td>
<td></td>
</tr>
</tbody>
</table>

**Service Change**

Due to track work, temporary schedule for the Fram/Worc Line goes into effect on Monday, June 8, affecting some weekday and weekend trains.

The following weekday train numbers are modified:
- 518, 520, and 524
- 511, 515, and 519

The following weekend trains are modified:
- 1502, 1504, and 1506
- 2502, 2504, and 2506
- 1509, 1511, 1513, 1515, and 1517
- 2509, 2511, 2513, 2515, and 2517

Please see the below link for full information.

Posted on Jun 18, 2015, 11:55 AM
Source: MBTA

**Stop Cancelled**

Wellesley Hills Station will be temporarily closed on Wednesday, June 17, Thursday, June 18, and Friday, June 19, from 10:30 am to 4:00 pm due to construction.
Route 110 detour
June 19, 2015 at 8:08 AM

Route 110 detoured due to construction at Broadway & Park Ave at the Fire Station. Connect on Central Ave or Park Ave.

Affected direction: Outbound

Bypassed stop: Broadway @ Park Ave

Connections can be made at:  
40 Park Ave  
49 Central Ave

Last updated: Jun 19 2015 08:06 AM
Service Analysis
Questions

What is the quality of service provided?

What is the quality of service experienced?
Approaches

Using archival data

Using real-time data
Goal

Understand where City of Cambridge can make infrastructure changes to improve transit service.
Use APC data to identify issues at a stop-to-stop segment level:

- Excess running times
- Excess passenger travel time
- Unreliability introduced

Generate and map composite metric
<table>
<thead>
<tr>
<th>daymoyr</th>
<th>VEHNO</th>
<th>ROUTE</th>
<th>DOW</th>
<th>BLOCK</th>
<th>DIR</th>
<th>TRIP</th>
<th>STOP_ID</th>
<th>STOP_SEQ</th>
<th>STOP_NAME</th>
<th>ARRIVE</th>
<th>DEP_DOOR</th>
<th>DEP_MOVE</th>
<th>ON</th>
<th>OFF</th>
<th>LOAD</th>
<th>LAT</th>
<th>LONG</th>
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<tr>
<td>27-Mar-12</td>
<td>1206</td>
<td>28</td>
<td>1</td>
<td>10001</td>
<td>1</td>
<td>508</td>
<td>18511</td>
<td>0</td>
<td>MATTANAP - SOUTH BUS</td>
<td>5:05:34 AM</td>
<td>5:07:09 AM</td>
<td>5:07:52 AM</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>42.26742</td>
<td>71.09223</td>
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<td>1</td>
<td>508</td>
<td>1722</td>
<td>1</td>
<td>1624 BLUE HILL AVE MATTAPAN</td>
<td>5:08:27 AM</td>
<td>5:08:27 AM</td>
<td>5:08:36 AM</td>
<td>2</td>
<td>0</td>
<td>9</td>
<td>42.26665</td>
<td>71.09365</td>
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<td>508</td>
<td>1723</td>
<td>2</td>
<td>BLUE HILL AVE BACSON ST</td>
<td>5:08:53 AM</td>
<td>5:08:53 AM</td>
<td>5:08:53 AM</td>
<td>0</td>
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<td>9</td>
<td>42.27007</td>
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<td>508</td>
<td>1724</td>
<td>3</td>
<td>BLUE HILL AVE OPP WOODHAVEN</td>
<td>5:09:19 AM</td>
<td>5:09:19 AM</td>
<td>5:09:19 AM</td>
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<td>1458 BLUE HILL AVE OPP ALMON</td>
<td>5:09:27 AM</td>
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<td>BLUE HILL AVE NORFOLK ST</td>
<td>5:10:05 AM</td>
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<td>BLUE HILL AVE WILMORE ST</td>
<td>5:11:02 AM</td>
<td>5:11:02 AM</td>
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<td>BLUE HILL AVE EVELYN ST</td>
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<td>BLUE HILL AVE WESTVIEW ST</td>
<td>5:15:04 AM</td>
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<td>1736</td>
<td>14</td>
<td>BLUE HILL AVE OPP HEALTH CTR</td>
<td>5:15:48 AM</td>
<td>5:16:05 AM</td>
<td>5:16:05 AM</td>
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<td>2</td>
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</tbody>
</table>
Next Steps

Expand to 5 more ‘key routes’

Also analyze

Route level

Stop level

Before and after

Create scripts to run this analysis automatically
Case Study

MBTA-performance

Client: MBTA (Boston)

Vision

MBTA-performance (TRANSIT-performance) is a system to measure performance in real-time.
<table>
<thead>
<tr>
<th>Passengers Waits</th>
<th>Passenger Travel Time²</th>
</tr>
</thead>
<tbody>
<tr>
<td>87% &lt; Headway</td>
<td>96% delayed &lt; 3 min.</td>
</tr>
<tr>
<td>Goal: 90%*</td>
<td>Goal: TBD</td>
</tr>
<tr>
<td></td>
<td>97% &lt; Big Gap</td>
</tr>
<tr>
<td></td>
<td>delayed &lt; 6 min.</td>
</tr>
<tr>
<td>Goal: 98%*</td>
<td>Goal: TBD</td>
</tr>
<tr>
<td></td>
<td>100% &lt; 2X Headway</td>
</tr>
<tr>
<td>Goal: 100%*</td>
<td></td>
</tr>
</tbody>
</table>

Compare can to range for each metric over prior 6 months (red bar is today, dark grey is worse than median, light grey is better)

* Goals are tentative, may be changed
Headway Performance (measured at Park Street)

Southbound

<table>
<thead>
<tr>
<th></th>
<th>Early AM</th>
<th>AM Peak</th>
<th>Midday</th>
<th>PM Peak</th>
<th>Eve.</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headway [min/veh]</td>
<td>8.3</td>
<td>4.8</td>
<td>7.1</td>
<td>5.4</td>
<td>4.8</td>
<td>7.3</td>
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<tr>
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<td>+2.3</td>
<td>+0.3</td>
<td>+0.7</td>
<td>+0.9</td>
<td>-1.4</td>
<td>+1.3</td>
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</table>

Northbound

<table>
<thead>
<tr>
<th></th>
<th>Early AM</th>
<th>AM Peak</th>
<th>Midday</th>
<th>PM Peak</th>
<th>Eve.</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headway [min/veh]</td>
<td>7.9</td>
<td>4.8</td>
<td>7.7</td>
<td>6.5</td>
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<td>7.5</td>
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<td></td>
<td>+1.9</td>
<td>+0.3</td>
<td>+0.7</td>
<td>+1.0</td>
<td>-0.5</td>
<td>+1.6</td>
</tr>
</tbody>
</table>
Running Time Performance by Segment

Southbound

Northbound

Highlighted times are 16% higher than the median for the period

1. The standard for a big gap is either 1.5 times or 1.0 minutes greater than the scheduled headway, whichever is lower.
2. Passenger flow rate is based on average passenger demand rates per period, i.e., “5000 people entering a station during the peak is a demand rate of 5000/hr or 100/hr which is further divided by destination, The rate is multiplied by the headway of a train to get the number of people boarding that train. If a train takes more than 3 minutes more than normal between any two stations, the passengers on that train are considered celeyed if it does not account for people not being able to board a train due to crowding.
3. We tried average headway accounts for the fact that fewer people end up experiencing a short headway than a long headway, since fewer passengers arrive between trains.
MBTA Customers

MBTA Mgmt.

MBTA Customers

Bus

Subway/LRT

Commuter Rail

MBTA-realtime

GTFS-RT

API

MBTA-performance
## Daily Performance

**Passengers Waits**

<table>
<thead>
<tr>
<th>Date</th>
<th>Headway</th>
<th>Big Gap</th>
<th>2X Headway</th>
<th>delayed &lt; 3 min.</th>
<th>delayed &lt; 6 min.</th>
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</thead>
<tbody>
<tr>
<td>Monday 06/01/15</td>
<td>88%</td>
<td>95%</td>
<td>98%</td>
<td>96%</td>
<td>100%</td>
</tr>
<tr>
<td>Tuesday 06/02/15</td>
<td>88%</td>
<td>95%</td>
<td>98%</td>
<td>96%</td>
<td>99%</td>
</tr>
<tr>
<td>Wednesday 06/03/15</td>
<td>87%</td>
<td>94%</td>
<td>98%</td>
<td>96%</td>
<td>100%</td>
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<tr>
<td>Thursday 06/04/15</td>
<td>86%</td>
<td>94%</td>
<td>98%</td>
<td>94%</td>
<td>99%</td>
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<tr>
<td>Friday 06/05/15</td>
<td>89%</td>
<td>95%</td>
<td>98%</td>
<td>99%</td>
<td>100%</td>
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<tr>
<td>Saturday 06/06/15</td>
<td>89%</td>
<td>95%</td>
<td>98%</td>
<td>99%</td>
<td>100%</td>
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<tr>
<td>Sunday 06/07/15</td>
<td>89%</td>
<td>95%</td>
<td>99%</td>
<td>98%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Passenger Travel Time**

- 96% delayed < 3 min.
- 100% delayed < 6 min.

Headways at Park St. Station towards Harvard Station on 6/3/2015

API: [http://bit.ly/1HklT2q](http://bit.ly/1HklT2q)
Travel Times from Park St. Station to Harvard Station on 6/3/2015

API: http://bit.ly/1JZgDSO
Dwell Times at Park St. Station towards Harvard Station on 6/3/2015
Daily Performance

Red Line

Passenger Wait Time\textsuperscript{2}  
\begin{align*}
84\% & < \text{Headway} \\
94\% & < \text{Big Gap}\textsuperscript{1} \\
98\% & < 2X \text{Headway}
\end{align*}

Passenger Travel Time\textsuperscript{2}  
\begin{align*}
99\% & < 3 \text{ minute delay} \\
100\% & < 6 \text{ minute delay}
\end{align*}

Headway Performance (measured at ParkStreet)

http://bit.ly/1jB9YpN
So what does this mean for transit agencies?
Takeaways

Use data in new and interesting ways
Focus on real-time
Be data-driven
Build on standards
Release data/information to the public
Thank You,

Questions?

IBI

ritesh.warade@ibigroup.com | 617.699.944