

# Measuring Subway Service Performance at New York City Transit: A Case Study Using Automated Train Supervision (ATS) Track-Occupancy Data

*Brian Levine, Alla Reddy*

Operations Planning, New York City Transit Authority

*Alex Lu*

Metro-North Railroad

Presented at the 92nd Annual Meeting  
of the Transportation Research Board  
Washington, D.C. (2013)

**Notice:** Opinions expressed in this presentation are those of the authors and do not necessarily reflect the official policy or position of the Metropolitan Transportation Authority, Metro-North Railroad, or New York City Transit Authority.



By Caseyjonz (Own work), via Wikimedia Commons



By TEK (Ocean Shores) (Own work), via Wikimedia Commons



# Presentation Outline

- Characteristics of NYC Subway
- Performance Indicator Program
- Wait Assessment – Algorithm & Standards
- Wait Assessment – Examples
- Wait Assessment – Track/Corridor
- Daily Reporting
- Conclusions

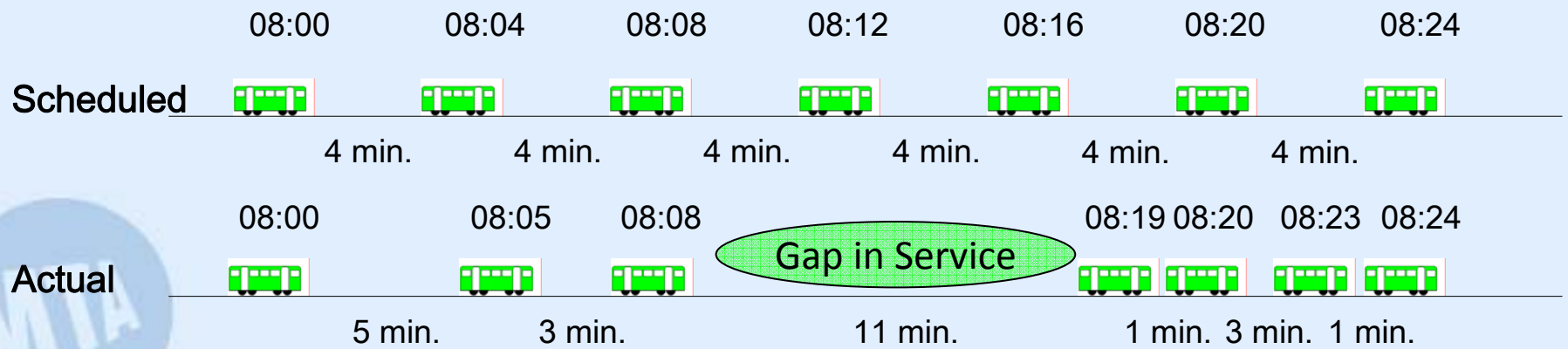


# Characteristics of NYC Subway

- Amalgamation of three independent systems
- Relay-based interlocking system
  - A Division: Centralized dispatching system & real time track occupancy
- Provides frequent service throughout the day over multiple interconnected routes
  - Rush Hour from 2-8 minutes
  - Off Peak every 10 minutes
  - Overnight 20 minute policy headway
- Rarely uniform headways on trunk lines

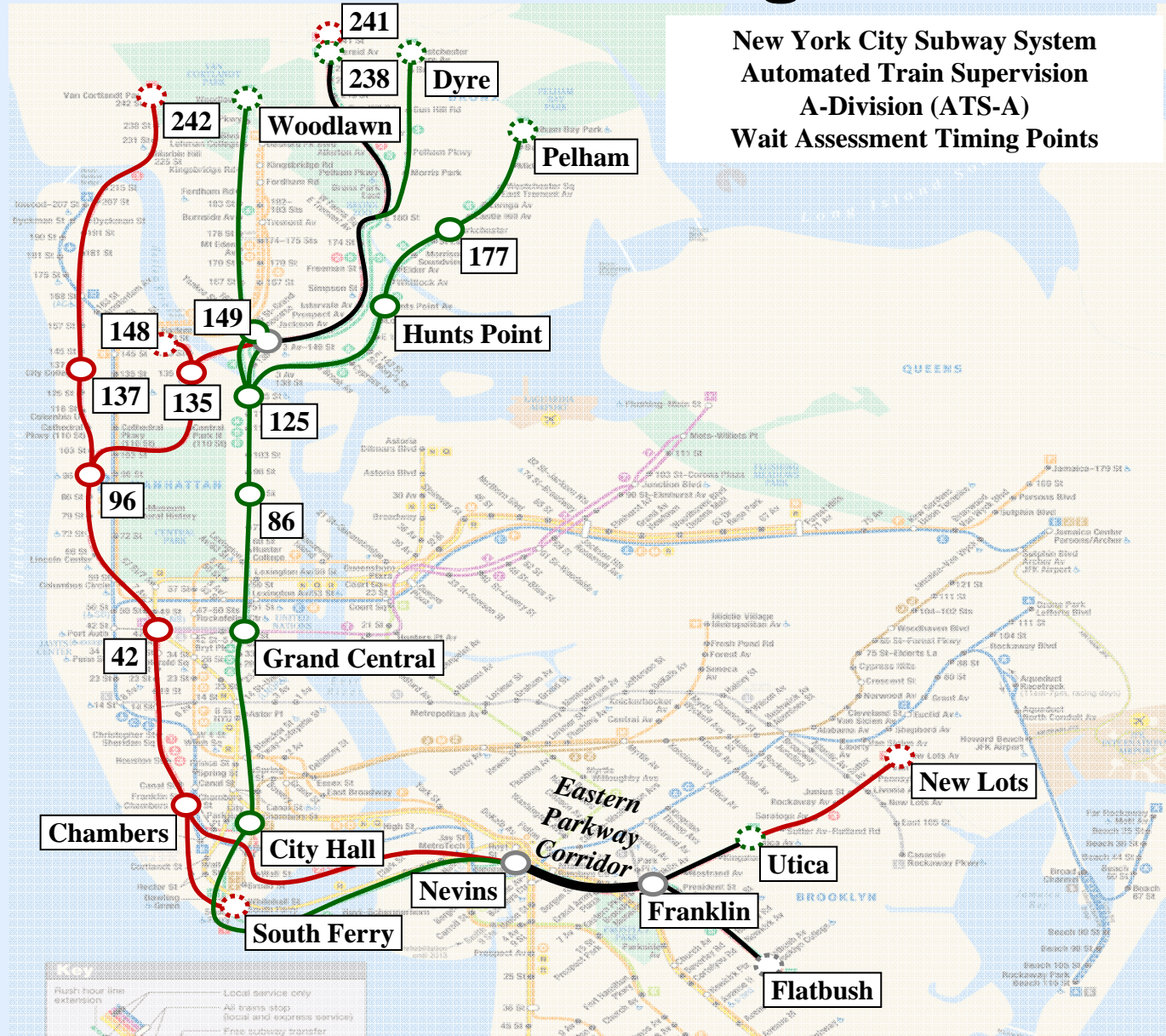
# Performance Indicators (PI)

- PI program established in 1994
- Wait Assessment (WA) developed
  - Measures time customers may wait for a given train
  - Compare successive train headways to standard
  - Worst-case scenario
  - Calculated at timepoint locations along the route



# A Division Timing Points

New York City Subway System  
Automated Train Supervision  
A-Division (ATS-A)  
Wait Assessment Timing Points



# B Division Timing Points (Sample)

SOUTHBOUND	A		C		B		D		BX
	○ 207TH INWOOD	○ 168th STREET	○ 145TH STREET	○ 125TH STREET	○ 125TH STREET	○ 125TH STREET	○ 125TH STREET	○ NORWOOD - 205 ST	
125TH STREET	125TH STREET	125TH STREET	125TH STREET	125TH STREET	125TH STREET	125TH STREET	125TH STREET		
59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.		
42ND PORT	42ND PORT	42ND & 6 AVE	42ND & 6 AVE	42ND & 6 AVE	42ND & 6 AVE	42ND & 6 AVE	42ND & 6 AVE		
WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST		
BROADWAY-NASSAU	BROADWAY-NASSAU								
JAY STREET-BORO HALL	JAY STREET-BORO HALL	DEKALB AVENUE /	PACIFIC STREET					Bkyn	
BROADWAY JCT	BROADWAY JCT	PROSPECT PARK /	36TH STREET- 4TH AVE						
NORTHBOUND	A		C		B		D		Q n s
	○ MOTT AVE	○ EUCLID AVENUE							
	○ ROCKAWAY PARY								
	○ LEFFERTS								
	BROADWAY JCT	BROADWAY JCT	○ BRIGHTON BEACH	○ STILLWELL AVE					B k y n
	JAY STREET-BORO HALL	JAY STREET-BORO HALL	PROSPECT PARK /	36TH STREET- 4TH AVE					
	BROADWAY-NASSAU	BROADWAY-NASSAU	DEKALB AVENUE /	PACIFIC STREET					
	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	WEST 4 ST	M h t n
	42ND PORT	42ND PORT	42ND & 6 AVE	42ND & 6 AVE	42ND & 6 AVE	42ND & 6 AVE	42ND & 6 AVE	42ND & 6 AVE	
	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	59TH ST.-COLUMBUS CIR.	
125TH STREET	125TH STREET	125TH STREET	125TH STREET	125TH STREET	125TH STREET	125TH STREET	125TH STREET		



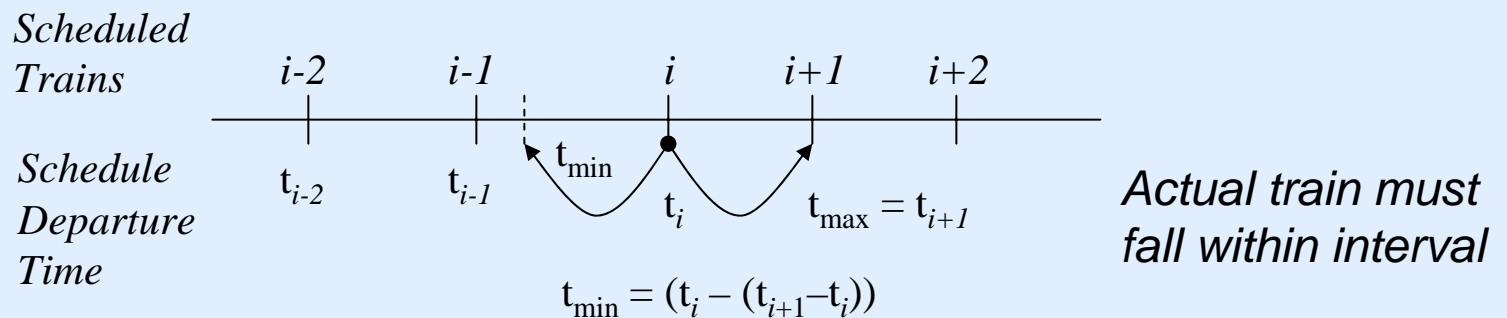
# Wait Assessment Algorithm (1 of 2)

- Train Matching
  - Actual departure headways matched to scheduled headways
  - Based on daily schedule (including supplements)
  - Signage in stations and advisories on the web alert customers of changes



# Wait Assessment Algorithm (2 of 2)

- “Reach” Criterion
  - Accounts for naturally occurring “drift” as actual service trains move out of scheduled slots



- Extra trains in given interval may not help
- Calculate WA result (Pass/Fail)





# Wait Assessment Current Standards

- Originally +2 minutes peak / +4 minutes off-peak
- Potentially poor dispatcher incentives
  - Frequent off peak “7” route headways 4-5 min
  - Achieve high WA results even when bunching occurs
- Revised Threshold
  - Within +25% of scheduled headway

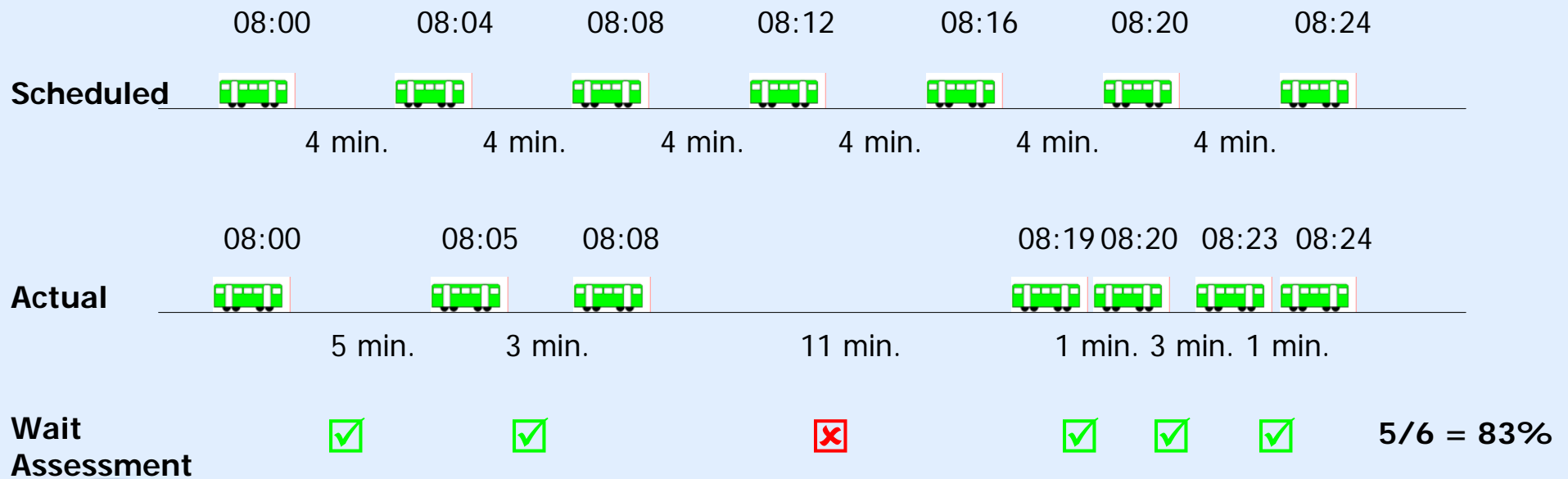


By TEK (Ocean Shores), via Wikimedia Commons



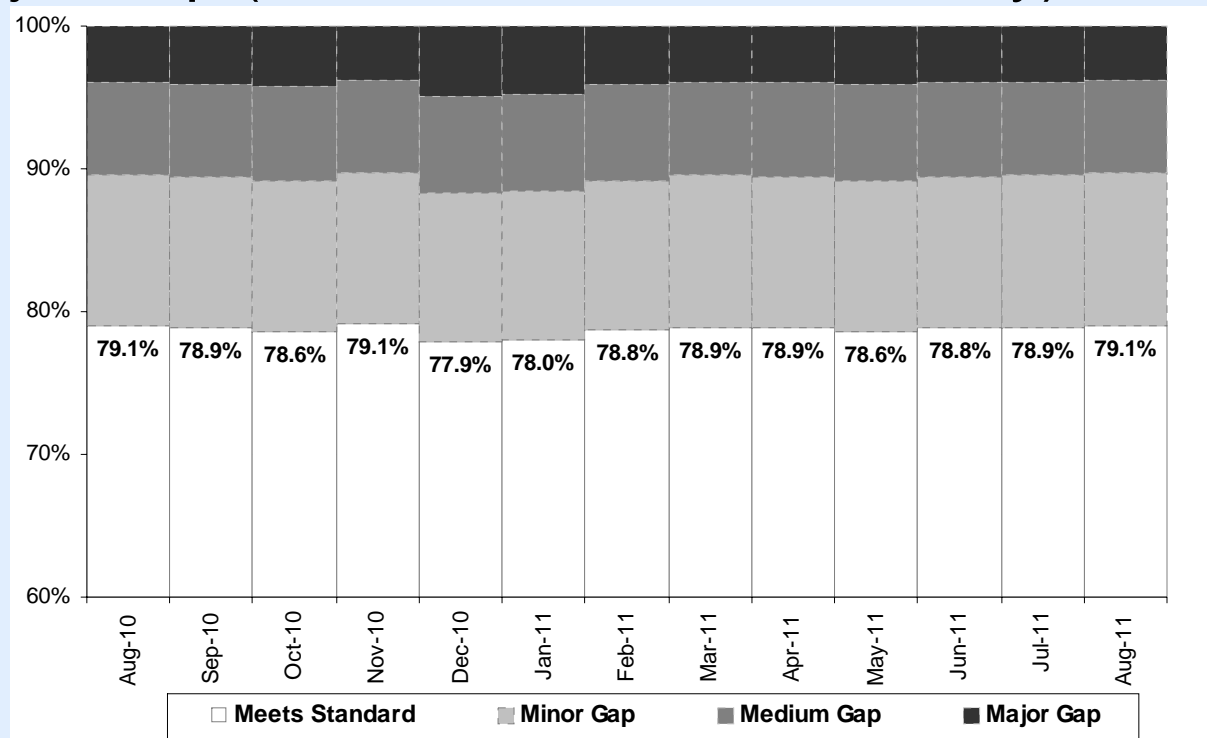
# Wait Assessment Example

- Service with 4 minute headway (e.g. E train)
  - Acceptable actual headway of 5 minutes



# Wait Assessment Gaps in Service

- Failing headways broken down into categories
  - Minor Gap (+25-50%), Medium Gap (+50-100%)
  - Major Gap (+100% more than headway)



# Measurement of Wait Assessment Route, Corridor, Track

- Route Based WA
  - Passengers waiting for a particular service
  - Example: passengers on 7<sup>th</sup> Ave Line in Manhattan going to New Lots Ave must wait for “3” route
- Corridor Based WA
  - Passengers using trunk service with multiple routes
  - Example: passengers on 7<sup>th</sup> Ave Line in Manhattan going from Chambers St to 72 St may take “2” or “3”
- Track Based WA
  - Express/Local track diversions



# A Division Timing Points – Eastern Pkwy Example

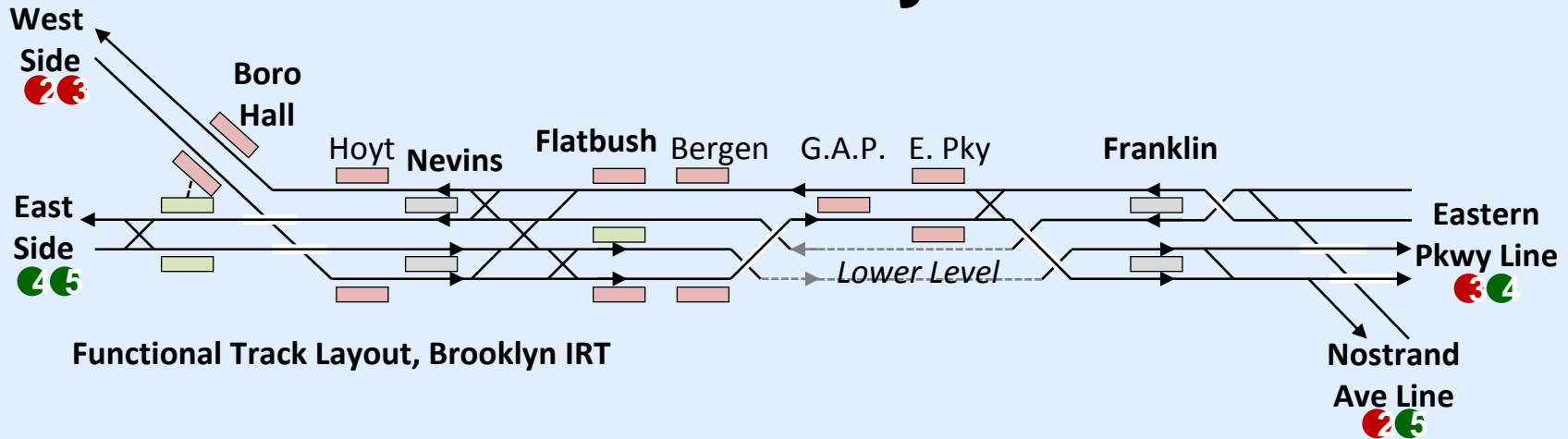
New York City Subway System  
Automated Train Supervision  
A-Division (ATS-A)  
Wait Assessment Timing Points

2/3  
Routes

4/5  
Routes



# Measurement of Wait Assessment Eastern Parkway Corridor



Functional Track Layout, Brooklyn IRT

	Route/Line	Scheduled Headways	Passing Headways	Percentage Passed
WA 25% 9/23/2011 at Atlantic Ave 1700-2100 Southbound	4	39	27	69.20%
	5	26	43	64.20%
	4/5 Corridor	67	43	64.20%
	4/5 Express Track	67	40	59.70%
	2	27	12	44.40%
	3	27	9	33.30%
	2/3 Corridor	56	23	41.10%
2/3 Local Track	56	25	44.60%	



# Wait Assessment Algorithm Results

ID	SCHD_TRAIN_ID	SCHD TIME	SCHD HDWY	MATCHED_TRAIN_ID	ACT TIME	ACT HDWY	WA 25%	WA 100%
8	02 1357+ 241/FLA	151300	480	02 1357+ 241/FLA	151112	715	FAIL	PASS
9	02 1405+ 241/FLA	152100	480	02 1405+ 241/FLA	152307	352	PASS	PASS
10	02 1413+ 241/FLA	152900	480	02 1413+ 241/FLA	152859	211	PASS	PASS
11	02 1421+ 241/FLA	153700	480	02 1421+ 241/FLA	153230	1411	FAIL	FAIL
<b>12</b>	<b>02 1431+ 241/FLA</b>	<b>154500</b>	<b>420</b>				<b>AUTO</b>	<b>AUTO</b>
13	02 1440+ 241/FLA	155200	600	02 1431+ 241/FLA	155601	82	PASS	PASS
14	02 1450+ 241/FLA	160200	420	02 1440+ 241/FLA	155723	860	FAIL	FAIL
15	02 1457+ 241/FLA	160900	390	02 1450+ 241/FLA	161143	300	PASS	PASS
16	02 1504 241/FLA	161530	510	02 1457+ 241/FLA	161643	406	PASS	PASS
<b>17</b>	<b>02 1512+ 241/FLA</b>	<b>162400</b>	<b>540</b>	<b>02 1504 241/FLA</b>	<b>162329</b>	<b>1224</b>	<b>FAIL</b>	<b>FAIL</b>
<b>18</b>	<b>02 1520+ 241/FLA</b>	<b>163300</b>	<b>630</b>	<b>02 1504 241/FLA</b>	<b>162329</b>	<b>1224</b>	<b>FAIL</b>	<b>PASS</b>
19	02 1528 241/FLA	164330	360	/2 1512+ 241/FLA	164353	224	PASS	PASS
20	02 1533 241/FLA	164930	300	02 1520+ 241/FLA	164737	82	PASS	PASS
				<b>02 1528 241/FLA</b>	<b>164859</b>	<b>232</b>		
21	02 1543+ 238/FLA	165430	330	02 1533 241/FLA	165251	365	PASS	PASS
22	02 1545 241/FLA	170000	390	02 1543+ 238/FLA	165856	99	PASS	PASS
23	02 1551+ 241/FLA	170630	420	02 1545 241/FLA	170035	408	PASS	PASS
24	02 1600+ 241/FLA	171330	390	02 1551+ 241/FLA	170723	1174	FAIL	FAIL
<b>25</b>	<b>02 1606+ 241/FLA</b>	<b>172000</b>	<b>510</b>	<b>02 1606+ 241/FLA</b>	<b>172657</b>	<b>1012</b>	<b>FAIL</b>	<b>PASS</b>
<b>26</b>	<b>02 1615+ 241/FLA</b>	<b>172830</b>	<b>420</b>	<b>02 1606+ 241/FLA</b>	<b>172657</b>	<b>1012</b>	<b>FAIL</b>	<b>FAIL</b>

# Daily Reporting Summary by Hour/Location

## Daily Wait Assessment by Hour and Location

DRAFT

Service Date

01/04/2013

Line ①

Direction S

Hourly Results at Gap Locations (Wait Assessment 25%/Throughput)

Station	AM Peak (0600-0859)			Off-Peak (0900-1559)						PM Peak (1600-1859)			Off-Peak (1900-2359)					Total WA/Hdwy	
	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22		23
51010 242 ST	100%/7	90%/10	100%/10	91%/11	100%/11	50%/10	90%/10	80%/10	73%/11	100%/11	100%/12	92%/13	91%/11	92%/12	90%/10	100%/8	100%/6	100%/6	90%/177
51130 137 ST	100%/8	86%/14	89%/18	92%/12	92%/12	30%/10	70%/10	100%/10	80%/10	92%/12	87%/15	85%/13	83%/12	75%/12	80%/10	89%/9	100%/6	100%/6	84%/198
51210 96 ST	100%/7	86%/14	89%/18	83%/12	83%/12	60%/10	50%/10	100%/10	100%/10	83%/12	73%/15	92%/13	75%/12	75%/12	70%/10	90%/10	100%/6	100%/6	83%/198
51280 42 ST	88%/8	100%/11	84%/19	77%/13	92%/12	70%/10	40%/10	90%/10	100%/10	75%/12	71%/14	86%/14	75%/12	83%/12	60%/10	100%/10	71%/7	80%/6	80%/199
51380 CHAM ST	88%/8	80%/10	59%/17	67%/15	92%/12	64%/11	40%/10	80%/10	90%/10	73%/11	77%/13	80%/15	67%/12	92%/12	73%/11	90%/10	75%/8	80%/6	75%/200
<b>Weighted Avg</b>	<b>95%</b>	<b>88%</b>	<b>83%</b>	<b>81%</b>	<b>92%</b>	<b>55%</b>	<b>58%</b>	<b>90%</b>	<b>88%</b>	<b>85%</b>	<b>81%</b>	<b>87%</b>	<b>78%</b>	<b>83%</b>	<b>75%</b>	<b>94%</b>	<b>88%</b>	<b>92%</b>	<b>82%</b>
<b>Time Period Avg</b>	<b>87%</b>			<b>79%</b>						<b>82%</b>			<b>85%</b>						

Direction N

Hourly Results at Gap Locations (Wait Assessment 25%/Throughput)

Station	AM Peak (0600-0859)			Off-Peak (0900-1559)						PM Peak (1600-1859)			Off-Peak (1900-2359)					Total WA/Hdwy	
	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22		23
51380 CHAM ST	86%/7	78%/9	73%/15	71%/17	92%/12	82%/11	60%/10	80%/10	90%/10	82%/11	83%/12	67%/15	85%/13	75%/12	82%/11	80%/10	89%/9	100%/6	79%/199
51280 42 ST	100%/6	100%/8	100%/14	72%/18	92%/13	100%/11	70%/10	80%/10	100%/10	82%/11	100%/11	86%/14	100%/14	92%/12	100%/12	90%/10	100%/10	100%/6	91%/199
51210 96 ST	100%/5	88%/8	92%/13	72%/18	100%/13	100%/12	100%/10	60%/10	100%/10	70%/10	92%/12	85%/13	87%/15	83%/12	92%/12	80%/10	90%/10	100%/7	87%/199
51130 137 ST	100%/5	86%/7	100%/9	76%/17	100%/14	100%/12	90%/10	60%/10	100%/10	60%/10	91%/11	62%/13	93%/15	100%/12	92%/13	90%/10	70%/10	100%/7	87%/194
<b>Weighted Avg</b>	<b>96%</b>	<b>88%</b>	<b>90%</b>	<b>73%</b>	<b>96%</b>	<b>96%</b>	<b>80%</b>	<b>70%</b>	<b>98%</b>	<b>74%</b>	<b>91%</b>	<b>75%</b>	<b>91%</b>	<b>88%</b>	<b>92%</b>	<b>85%</b>	<b>87%</b>	<b>100%</b>	<b>86%</b>
<b>Time Period Avg</b>	<b>91%</b>			<b>83%</b>						<b>86%</b>			<b>90%</b>						

Line WA25%: 84%

Note: Totals may not match due to rounding.



# Daily Reporting Outlier by Location

## Daily Flash Report: Outliers\* by Location by Hour DRAFT

Date 01/04/2013

Sample Period Begins 12/06/2012

Line and Service Type **1**

Direction S

Location	Time (Hour)	Today's WA25	Month Rolling Avg at This Location	# of Days
51010 242 ST	11 00	50%	86%	30
51130 137 ST	11 00	30%	85%	30
51210 96 ST	11 00	60%	82%	30
51210 96 ST	12 00	50%	83%	30
51280 42 ST	12 00	40%	79%	30
51380 CHAM ST	12 00	40%	74%	30

Line and Service Type **1**

Direction N

Location	Time (Hour)	Today's WA25	Month Rolling Avg at This Location	# of Days
51280 42 ST	12 00	70%	89%	30
51380 CHAM ST	12 00	60%	83%	30

# Conclusions & Future Research

- Wait Assessment attempts to capture performance from a customer's perspective
- Use of 100% Automated Data
  - Much lower lag time for compiling performance measures
  - Near term corrective action by operations supervisors
- Research programs at NYCT
  - Apply 100% data collection to bus service, some of which operate at frequencies higher than train
  - Determining travel path of individual passengers
    - Compute weighted waiting time measure more reflective of customer experience

