11-18-2022

# Moving from Probabilistic to Time-Based On-Time Performance (for practitioners)

Miles James Allen Crumley
*TriMet*

# Moving from Probabilistic to Time-Based On-Time Performance (for practitioners)

Miles J. Crumley, MS

Manager, Service Performance and Analysis

TRIMET

# Agenda

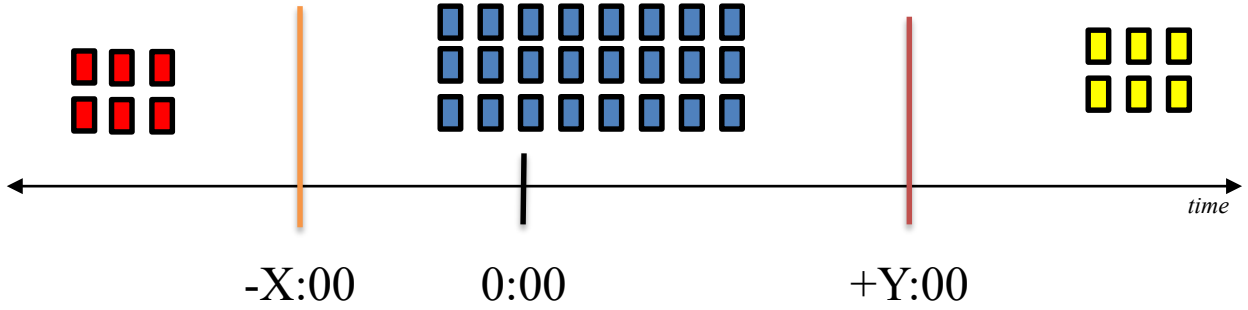
- Introduction
- On-Time Performance (OTP) – definition
- Challenges
- New Definition (work in progress)
- Data and Applications
- Limitations

# Introduction

- MS in Systems Science/Psychology (PSU)
- With TriMet 7+ years
- Started as a Bus Operator
- Manager, Service Performance And Analysis
  - Internal/External reporting and analysis
  - Published author in TRR and TRB
- Main Goal: make actionable metrics using systems science approach

# What is On-Time Performance?

On-time performance is defined as a bus arriving, passing, or leaving a predetermined bus stop along its route within a time period that is no more than *x* minutes earlier and no more than *y* minutes later than a published schedule time. The values of *x* and *y* vary across the transit industry. However, one minute and five minutes are the most common values used informally for *x* and *y*, respectively (*1*).




Guenthner, R. P. (1987, November 30). *DISTRIBUTION OF BUS TRANSIT ON-TIME PERFORMANCE*. https://trid.trb.org/view/302165

# This varies between agencies!

| | X | Y |
|---|---|---|
| **Agency** | **Early (minutes)** | **Late (Minutes)** |
| MTA New York City Transit (MTA measures Customer Journey Time Performance, rather than on-time performance) | 1 | 5 |
| Los Angeles Metro | 1 | 5 |
| Chicago Transit Authority | 1 | 5 |
| Southeastern Pennsylvania Transportation Authority (Philadelphia) | 0 | 6 |
| New Jersey Transit | 0 | 6 |
| MTA Bus Company (New York City) | 1 | 5 |
| Washington Metropolitan Area Transit Authority | 2 | 7 |
| San Francisco Muni | 1 | 4 |
| Massachusetts Bay Transportation Authority(for buses that come every 15 minutes or more frequent) (Boston) | 0 | 3 |
| King County Metro (Seattle) | 1 | 5 |
| Maryland Transit Administration (Baltimore) | 2 | 7 |
| Denver RTD | 1 | 5 |
| The Bus (Honolulu) | 2 | 5 |
| Houston METRO | 0 | 5 |
| TriMet (Portland) | 1 | 5 |
| Minneapolis Metro Transit | 1 | 5 |
| Miami-Dade Transit | 0 | 5 |
| Metropolitan Atlanta Rapid Transit Authority | 0 | 5 |
| Port Authority of Allegheny County (Pittsburgh) | 1 | 6 |
| RTC (Las Vegas) | 0 | 5 |

https://transitcenter.org/bus-time-even-mean/

Is this an arrival or departure time?

TriMet uses Departure

# On-Time Performance Probabilities

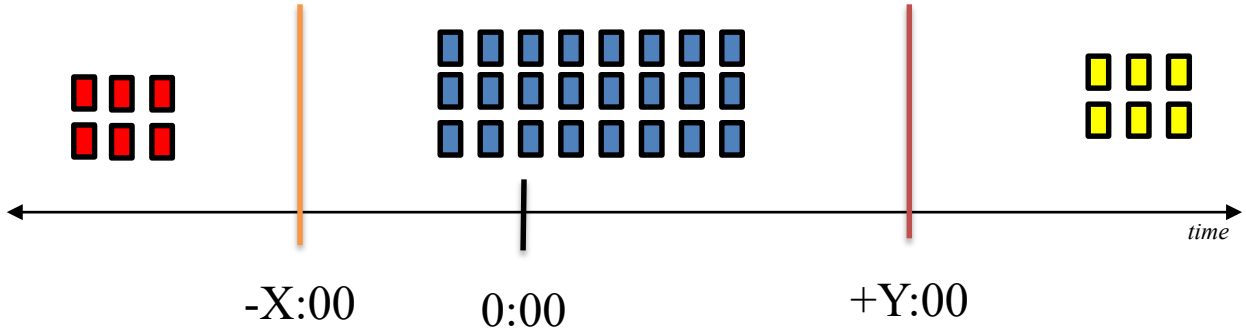
| Rank | Agency | Weekday on time performance for January 1-July 1, 2018 | Late | Early |
|---|---|---|---|---|
| 1 | Tri-County Metropolitan Transportation District of Oregon | 75% | 16% | 9% |
| 2 | Port Authority of Allegheny County (Pittsburgh) | 74% | 19% | 7% |
| 3 | Minneapolis Metro Transit | 73% | 19% | 8% |
| 4 | Denver RTD | 71% | 19% | 10% |
| 5 | Regional Transportation Commission of Southern Nevada | 68% | 23% | 9% |
| 6 | Metropolitan Atlanta Rapid Transit Authority | 66% | 27% | 7% |
| 7 | Los Angeles Metro | 64% | 12% | 22% |
| 8 | Chicago Transit Authority | 62% | 15% | 23% |
| 9 | King County Metro (Seattle) | 60% | 29% | 11% |
| 10 | Houston METRO | 60% | 32% | 9% |
| 11 | The Bus (Honolulu) | 59% | 28% | 13% |
| 12 | AC Transit | 59% | 30% | 11% |
| 13 | Southeastern Pennsylvania Transportation Authority (Philadelphia) | 58% | 26% | 15% |
| 14 | San Francisco Muni | 56% | 20% | 24% |
| 15 | MTA Bus Company (New York City) | 45% | 37% | 19% |
| 16 | Massachusetts Bay Transportation Authority (Boston) | 44% | 38% | 14% |
| 17 | MTA New York City Transit | 48% | 30% | 22% |
| 18 | Maryland Transit Administration (Baltimore) | 44% | 39% | 17% |
| 19 | Miami-Dade Transit | *No Data* | *No Data* | *No Data* |
| 20 | Washington Metropolitan Area Transit Authority | *No Data* | *No Data* | *No Data* |

https://transitcenter.org/bus-time-even-mean/

Is this good:
3 out of 4 buses are on-time within a “6 minute” reporting window?

# Challenges with On-Time Performance

**It tells you nothing about timeliness – only the probability the vehicle will <u>depart</u> by a certain time!**



# Challenges with On-Time Performance

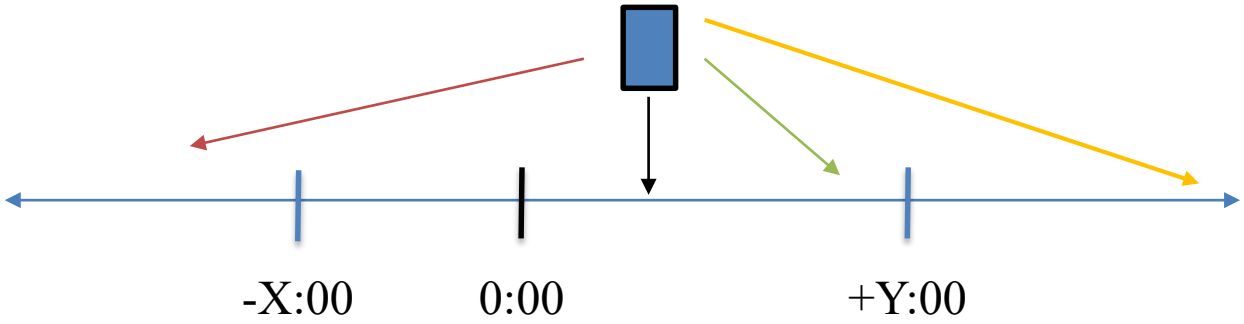
- If you hit 100% on-time performance, *what next*?
- Does not identify where the problem is with providing on-time departures?
  - Is it the schedule?
  - Is it the street?
  - Are the vehicles not reliable?
- The targets are also arbitrary and vary agency to agency
- What is a *good* on-time performance value?

| Rank | Agency | Weekday on time performance for January 1-July 1, 2018 | Late | Early |
|---|---|---|---|---|
| 1 | Tri-County Metropolitan Transportation District of Oregon | 75% | 16% | 9% |
| 2 | Port Authority of Allegheny County (Pittsburgh) | 74% | 19% | 7% |
| 3 | Minneapolis Metro Transit | 73% | 19% | 8% |
| 4 | Denver RTD | 71% | 19% | 10% |
| 5 | Regional Transportation Commission of Southern Nevada | 68% | 23% | 9% |
| 6 | Metropolitan Atlanta Rapid Transit Authority | 66% | 27% | 7% |
| 7 | Los Angeles Metro | 64% | 12% | 22% |
| 8 | Chicago Transit Authority | 62% | 15% | 23% |
| 9 | King County Metro (Seattle) | 60% | 29% | 11% |
| 10 | Houston METRO | 60% | 32% | 9% |
| 11 | The Bus (Honolulu) | 59% | 28% | 13% |
| 12 | AC Transit | 59% | 30% | 11% |
| 13 | Southeastern Pennsylvania Transportation Authority (Philadelphia) | 58% | 26% | 15% |
| 14 | San Francisco Muni | 56% | 20% | 24% |
| 15 | MTA Bus Company (New York City) | 45% | 37% | 19% |
| 16 | Massachusetts Bay Transportation Authority (Boston) | 44% | 38% | 14% |
| 17 | MTA New York City Transit | 48% | 30% | 22% |
| 18 | Maryland Transit Administration (Baltimore) | 44% | 39% | 17% |
| 19 | Miami-Dade Transit | *No Data* | *No Data* | *No Data* |
| 20 | Washington Metropolitan Area Transit Authority | *No Data* | *No Data* | *No Data* |

How can you mitigate an on-time performance issue without actual the “time” part of the metric?

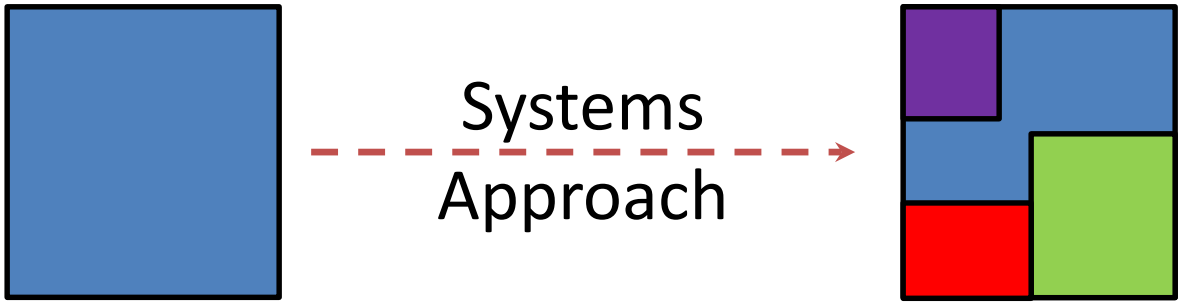
# New “Definition” (proposed)

On-Time Performance is the average deviation from schedule measured at timepoints for all trips/service provided to a route and direction…

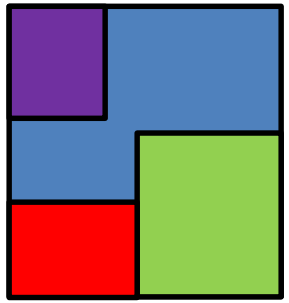


# New “Definition” (proposed)

…where *other* impacts to timeliness are considered. To get better “On-Time Performance,” you have to consider what else is going on within the operation **but** also give credit to the operators for providing this level of service!



# New “Definition” (proposed)



OTP is now disaggregated to account* for:

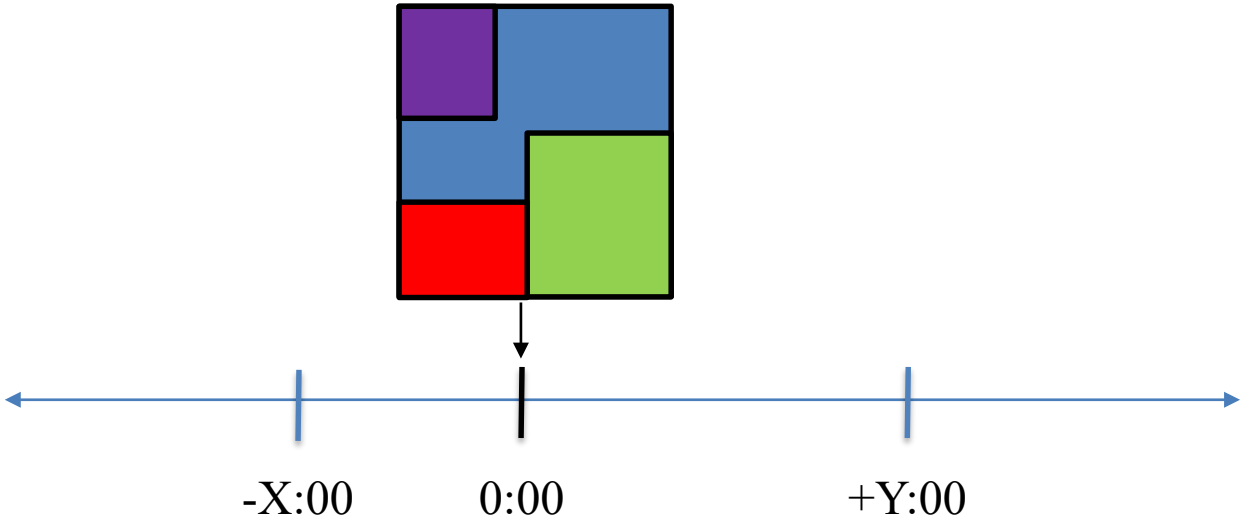
- Observed Ridership (boardings/alightings)
- Stop service
  - Number of stops serviced + Average Dwell time of Stops Serviced
- Ramp Deployments
  - Number of ramp deployments + Average Dwell of Ramps
- Service Delays

*accounting approach

# New target

## Instead of 85%, 95%, or 80%, on-time “targets”

The goal is to be as close to 0:00 departing from scheduled timepoints but not departing any earlier.




# In Practice – FX2 data, Fall 2022

# FX2 Specifications

- Fall 2022 data: Sept. 19-Nov. 11, 2022
- Weekdays Only
- Downtown to Gresham Transit Center
- 6 Time Point Segments

FX2-Division route

# FX2 Specifications

- 6 Time Point Segments
- Analysis collapses segments for overall OTP
- Themes for mitigation

# Ridership Impacts to OTP

| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Total Ons | Total Offs |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 659 | 442 |
| To Gresham | 0:08:00 | 0:07:06 | 159 | 352 |
| To Gresham | 0:11:00 | 0:05:17 | 1,305 | 2,820 |
| To Gresham | 0:12:00 | 0:03:49 | 66,969 | 64,096 |
| To Gresham | 0:13:00 | 0:04:30 | 2,040 | 3,134 |
| To Gresham | 0:14:00 | 0:03:45 | 497 | 1,059 |
| To Gresham | 0:15:00 | 0:03:08 | 61 | 197 |
| To Gresham | 0:20:00 | 0:02:27 | 4,689 | 4,434 |

*Headway corresponds to time of day

# Ridership Impacts to OTP

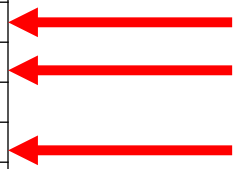
| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Total Ons | Total Offs |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 659 | 442 |
| To Gresham | 0:08:00 | 0:07:06 | 159 | 352 |
| To Gresham | 0:11:00 | 0:05:17 | 1,305 | 2,820 |
| To Gresham | 0:12:00 | 0:03:49 | 66,969 | 64,096 |
| To Gresham | 0:13:00 | 0:04:30 | 2,040 | 3,134 |
| To Gresham | 0:14:00 | 0:03:45 | 497 | 1,059 |
| To Gresham | 0:15:00 | 0:03:08 | 61 | 197 |
| To Gresham | 0:20:00 | 0:02:27 | 4,689 | 4,434 |

*Headway corresponds to time of day

This is pretty good given the ridership *but could be better*

# Ridership Impacts to OTP

| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Total Ons | Total Offs |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 659 | 442 |
| To Gresham | 0:08:00 | 0:07:06 | 159 | 352 |
| To Gresham | 0:11:00 | 0:05:17 | 1,305 | 2,820 |
| To Gresham | 0:12:00 | 0:03:49 | 66,969 | 64,096 |
| To Gresham | 0:13:00 | 0:04:30 | 2,040 | 3,134 |
| To Gresham | 0:14:00 | 0:03:45 | 497 | 1,059 |
| To Gresham | 0:15:00 | 0:03:08 | 61 | 197 |
| To Gresham | 0:20:00 | 0:02:27 | 4,689 | 4,434 |



These are areas to investigate further

*Headway corresponds to time of day

# Stop Service

| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Avg Stops Served (per segment) | Avg Dwell per Stop (per segment) (s) |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 4 | 0:00:18 |
| To Gresham | 0:08:00 | 0:07:06 | 4 | 0:00:16 |
| To Gresham | 0:11:00 | 0:05:17 | 3 | 0:00:16 |
| To Gresham | 0:12:00 | 0:03:49 | 4 | 0:00:18 |
| To Gresham | 0:13:00 | 0:04:30 | 3 | 0:00:17 |
| To Gresham | 0:14:00 | 0:03:45 | 3 | 0:00:18 |
| To Gresham | 0:15:00 | 0:03:08 | 1 | 0:00:25 |
| To Gresham | 0:20:00 | 0:02:27 | 3 | 0:00:23 |

*Headway corresponds to time of day

# Stop Service

Previous analysis
*Boardings 5-7 secs*
*Alighting < 1 sec*

| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Avg Stops Served (per segment) | Avg Dwell per Stop (per segment) (s) |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 4 | 0:00:18 |
| To Gresham | 0:08:00 | 0:07:06 | 4 | 0:00:16 |
| To Gresham | 0:11:00 | 0:05:17 | 3 | 0:00:16 |
| To Gresham | 0:12:00 | 0:03:49 | 4 | 0:00:18 |
| To Gresham | 0:13:00 | 0:04:30 | 3 | 0:00:17 |
| To Gresham | 0:14:00 | 0:03:45 | 3 | 0:00:18 |
| To Gresham | 0:15:00 | 0:03:08 | 1 | 0:00:25 |
| To Gresham | 0:20:00 | 0:02:27 | 3 | 0:00:23 |

*Headway corresponds to time of day

Further Investigation Needed

# What about Ramp Usage?

| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Avg Ramps Provided | Average Ramp Dwell (s) |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 2 | 0:01:06 |
| To Gresham | 0:08:00 | 0:07:06 | 3 | 0:00:54 |
| To Gresham | 0:11:00 | 0:05:17 | 3 | 0:01:05 |
| To Gresham | 0:12:00 | 0:03:49 | 4 | 0:01:02 |
| To Gresham | 0:13:00 | 0:04:30 | 4 | 0:00:52 |
| To Gresham | 0:14:00 | 0:03:45 | 1 | 0:00:40 |
| To Gresham | 0:15:00 | 0:03:08 | 1 | 0:00:48 |
| To Gresham | 0:20:00 | 0:02:27 | 2 | 0:01:10 |

*Headway corresponds to time of day

# What about Ramp Usage?

| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Total Ramps Provided | Average Ramp Dwell (s) |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 2 | 0:01:06 |
| To Gresham | 0:08:00 | 0:07:06 | 3 | 0:00:54 |
| To Gresham | 0:11:00 | 0:05:17 | 3 | 0:01:05 |
| To Gresham | 0:12:00 | 0:03:49 | 4 | 0:01:02 |
| To Gresham | 0:13:00 | 0:04:30 | 4 | 0:00:52 |
| To Gresham | 0:14:00 | 0:03:45 | 1 | 0:00:40 |
| To Gresham | 0:15:00 | 0:03:08 | 1 | 0:00:48 |
| To Gresham | 0:20:00 | 0:02:27 | 2 | 0:01:10 |

Note: the ramp physically takes 30 seconds to deploy and stow.

This is interesting given the buses have near-level boarding…

# What about operational delays?

Examples:
- Traffic
- Vehicle Failures
- Collisions
- No Operator
- Late Operator

| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Total Delays | Avg Delay (mm:ss) |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 2 | 0:03:29 |
| To Gresham | 0:08:00 | 0:07:06 | 4 | 0:08:49 |
| To Gresham | 0:11:00 | 0:05:17 | 0 | 0:15:39 |
| To Gresham | 0:12:00 | 0:03:49 | 1 | 0:12:23 |
| To Gresham | 0:13:00 | 0:04:30 | 2 | 0:13:19 |
| To Gresham | 0:14:00 | 0:03:45 | 1 | 0:12:06 |
| To Gresham | 0:15:00 | 0:03:08 | 1 | 0:18:19 |
| To Gresham | 0:20:00 | 0:02:27 | 0 | 0:05:48 |

*Headway corresponds to time of day

# What about operational delays?

| Direction | Scheduled Headway* | Avg OTP (mm:ss) | Total Delays | Avg Delay (mm:ss) |
|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 2 | 0:03:29 |
| To Gresham | 0:08:00 | 0:07:06 | 4 | 0:08:49 |
| To Gresham | 0:11:00 | 0:05:17 | 0 | 0:15:39 |
| To Gresham | 0:12:00 | 0:03:49 | 1 | 0:12:23 |
| To Gresham | 0:13:00 | 0:04:30 | 2 | 0:13:19 |
| To Gresham | 0:14:00 | 0:03:45 | 1 | 0:12:06 |
| To Gresham | 0:15:00 | 0:03:08 | 1 | 0:18:19 |
| To Gresham | 0:20:00 | 0:02:27 | 0 | 0:05:48 |

*Headway corresponds to time of day

When we have a delay, we lose the entire headway

# Putting it all together…

| Direction | Scheduled Headway | Avg OTP (mm:ss) | Total Ons | Total Offs | Avg Stops Served by Segment | Avg Dwell per Stop (mm:ss) | Avg Ramps Provided | Average Ramp Dwell (s) | Total Delays | Avg Delay (mm:ss) |
|---|---|---|---|---|---|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 659 | 442 | 4 | 0:00:18 | 2 | 0:01:06 | 2 | 0:03:29 |
| To Gresham | 0:08:00 | 0:07:06 | 159 | 352 | 4 | 0:00:16 | 3 | 0:00:54 | 4 | 0:08:49 |
| To Gresham | 0:11:00 | 0:05:17 | 1,305 | 2,820 | 3 | 0:00:16 | 3 | 0:01:05 | 0 | 0:15:39 |
| To Gresham | 0:12:00 | 0:03:49 | 66,969 | 64,096 | 4 | 0:00:18 | 4 | 0:01:02 | 1 | 0:12:23 |
| To Gresham | 0:13:00 | 0:04:30 | 2,040 | 3,134 | 3 | 0:00:17 | 4 | 0:00:52 | 2 | 0:13:19 |
| To Gresham | 0:14:00 | 0:03:45 | 497 | 1,059 | 3 | 0:00:18 | 1 | 0:00:40 | 1 | 0:12:06 |
| To Gresham | 0:15:00 | 0:03:08 | 61 | 197 | 1 | 0:00:25 | 1 | 0:00:48 | 1 | 0:18:19 |
| To Gresham | 0:20:00 | 0:02:27 | 4,689 | 4,434 | 3 | 0:00:23 | 2 | 0:01:10 | 0 | 0:05:48 |

# What's missing?

# What potential mitigations can be applied?

- All door boarding
- Near-/Level boarding
- Bridge Plates
- Stop Spacing
- Equipment Selection
- Transit Signal Priority
- Run Time Adjustments
- Others?

# Putting it all together…

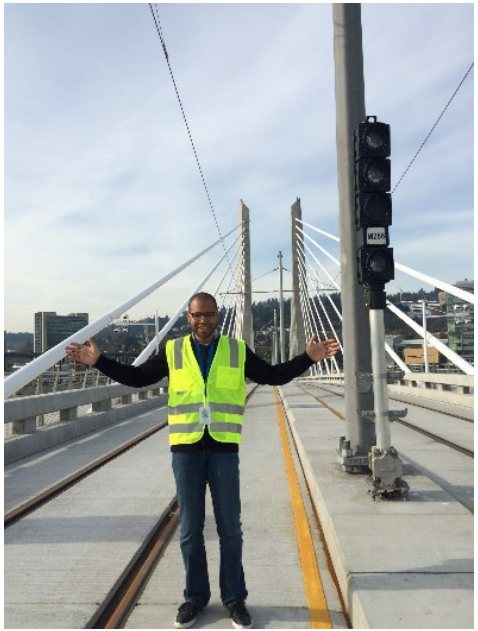
| Direction | Scheduled Headway | Avg OTP (mm:ss) | Total Ons | Total Offs | Avg Stops Served by Segment | Avg Dwell per Stop (mm:ss) | Avg Ramps Provided | Average Ramp Dwell (s) | Total Delays | Avg Delay (mm:ss) |
|---|---|---|---|---|---|---|---|---|---|---|
| To Gresham | 0:06:00 | 0:03:15 | 659 | 442 | 4 | 0:00:18 | 2 | 0:01:06 | 2 | 0:03:29 |
| To Gresham | 0:08:00 | 0:07:06 | 159 | 352 | 4 | 0:00:16 | 3 | 0:00:54 | 4 | 0:08:49 |
| To Gresham | 0:11:00 | 0:05:17 | 1,305 | 2,820 | 3 | 0:00:16 | 3 | 0:01:05 | 0 | 0:15:39 |
| To Gresham | 0:12:00 | 0:03:49 | 66,969 | 64,096 | 4 | 0:00:18 | 4 | 0:01:02 | 1 | 0:12:23 |
| To Gresham | 0:13:00 | 0:04:30 | 2,040 | 3,134 | 3 | 0:00:17 | 4 | 0:00:52 | 2 | 0:13:19 |
| To Gresham | 0:14:00 | 0:03:45 | 497 | 1,059 | 3 | 0:00:18 | 1 | 0:00:40 | 1 | 0:12:06 |
| To Gresham | 0:15:00 | 0:03:08 | 61 | 197 | 1 | 0:00:25 | 1 | 0:00:48 | 1 | 0:18:19 |
| To Gresham | 0:20:00 | 0:02:27 | 4,689 | 4,434 | 3 | 0:00:23 | 2 | 0:01:10 | 0 | 0:05:48 |

# What's missing?

# Agenda

- Introduction
- On-Time Performance (OTP) – definition
- Challenges
- New Definition (work in progress)
- Data and Applications
- Limitations


# Questions?



**Miles J. Crumley, MS**
**Manager, Service Performance and Analysis**
**TriMet**
**crumleym@trimet.org**
**503-962-3035**