

Introduction to the Trace Model

Catherine Vanderwaart

May 17, 2019



Overview

- The Trace Model
 - Why do we need Trace?
 - What is the model?
 - How does it work?
- Applications



The Trace Model

Why Are We Here? What We Don't Know:

Our existing data sources haven't given us a deep, robust understanding of how our passengers move through the system, and the conditions they experience.

How crowded was the platform?

How many were on-board?

How long did this person wait?

Where did this person transfer?

Was the train too full to board?



How do people pay at this stop?

Where do customers get off the bus?

Is this person transferring?



Trace Combines Data Sources to Fill the Gaps

SmarTrip® Records

Fare system records:

- Rail entry and exit times and locations
- Bus entry time, vehicle ID, and route



Vehicle Location Data

- Rail platform berths
- Bus location data



Inferences About...

Rail:

- Train & platform each passenger used
- Route through the rail system

Bus:

- Boarding & alighting times & locations

Bus and Rail:

- Which trips were linked together

Trace is a nightly data processing service provided by **KORBATO**

Combine Inferences About All Passengers to Get

- Train and bus crowding
- Platform occupancy, bus stop usage



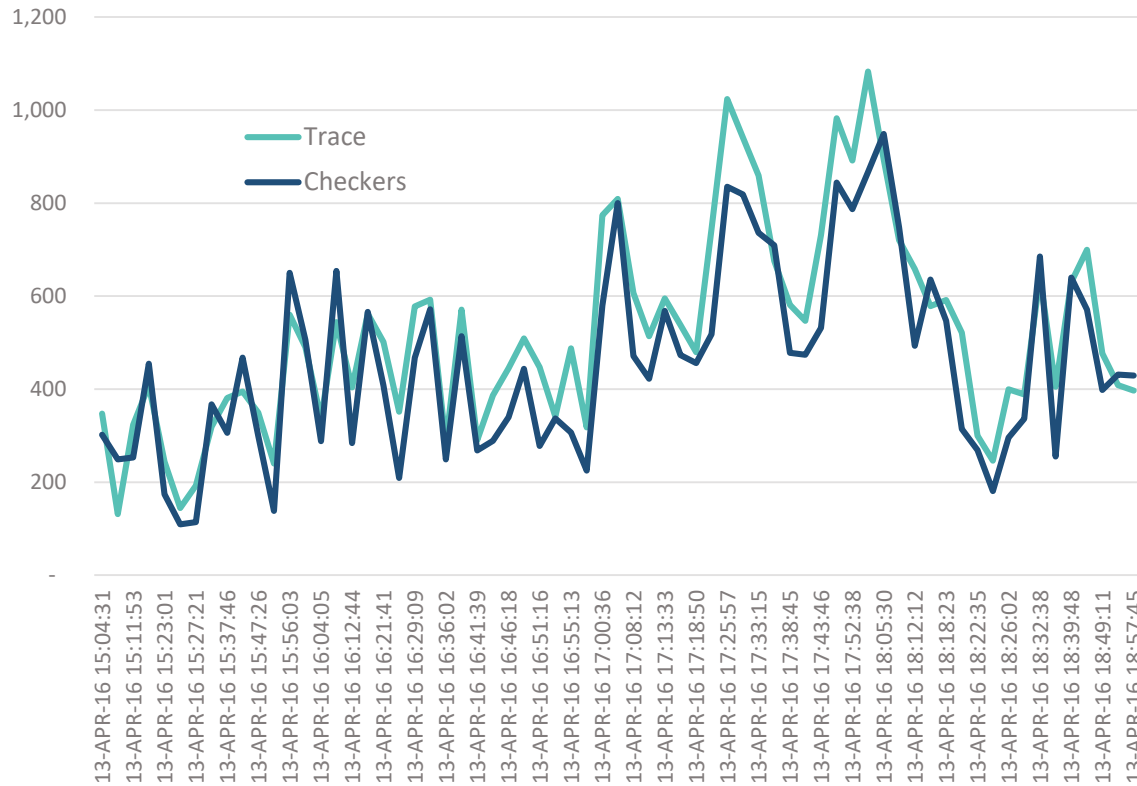
How does it work?

- On rail, consider which trains and paths were possible based on the passenger's tap-in and tap-out time
- On bus, look at the next transaction on the card to infer where the passenger alighted, within constraints
- Use spatial and temporal constraints to determine when two trips are linked by a transfer (not just fare system time windows)
- Korbato's algorithms based on a growing body of academic research:
 - Gordon, J. B., Koutsopoulos, H. N., Wilson, N. H. M., & Attanucci, J. P. (2013). Automated Inference of Linked Transit Journeys in London Using Fare-Transaction and Vehicle Location Data. *Transportation Research Record*, 2343(1), 17–24. <https://doi.org/10.3141/2343-03>
 - Sánchez-Martínez, G. E. (2017). Inference of Public Transportation Trip Destinations by Using Fare Transaction and Vehicle Location Data: Dynamic Programming Approach. *Transportation Research Record*, 2652(1), 1–7. <https://doi.org/10.3141/2652-01>

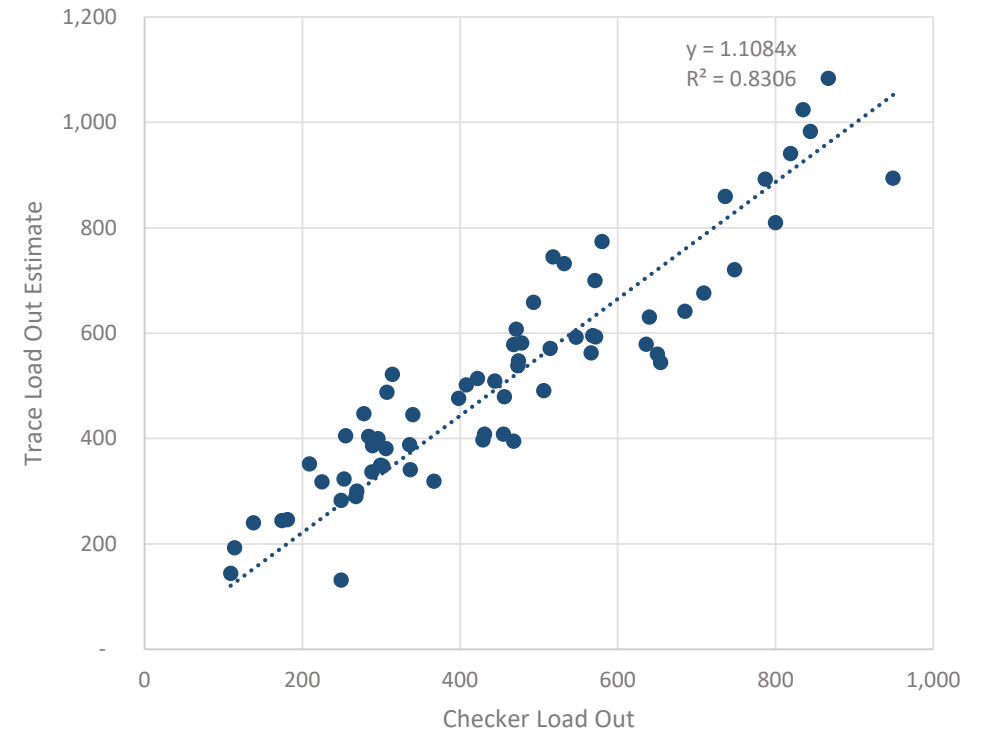
How Do We Know This is Accurate?

Validation against other data sources, when available

Checker vs. Trace Load by Train, A01-1 PM Peak, 4/13/2016



A01-1 PM Peak

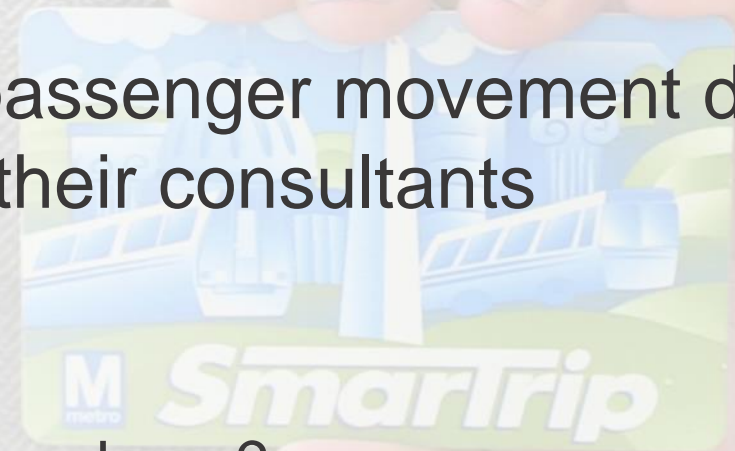


Challenges

- Train assignment around extreme crowding, e.g. the Women's March, 4th of July
- About 50% of bus destinations are inferred
 - Most common reasons for low inference are customers paying in cash, evading the fare, or only making one trip per day
 - Scaling to account for partial inference is straightforward on the route level, harder for network-level OD matrices
- All bus data is based on farebox records
 - Includes operator-reported fare evasion, but may not match the automatic passenger counters.

Accessing Trace data

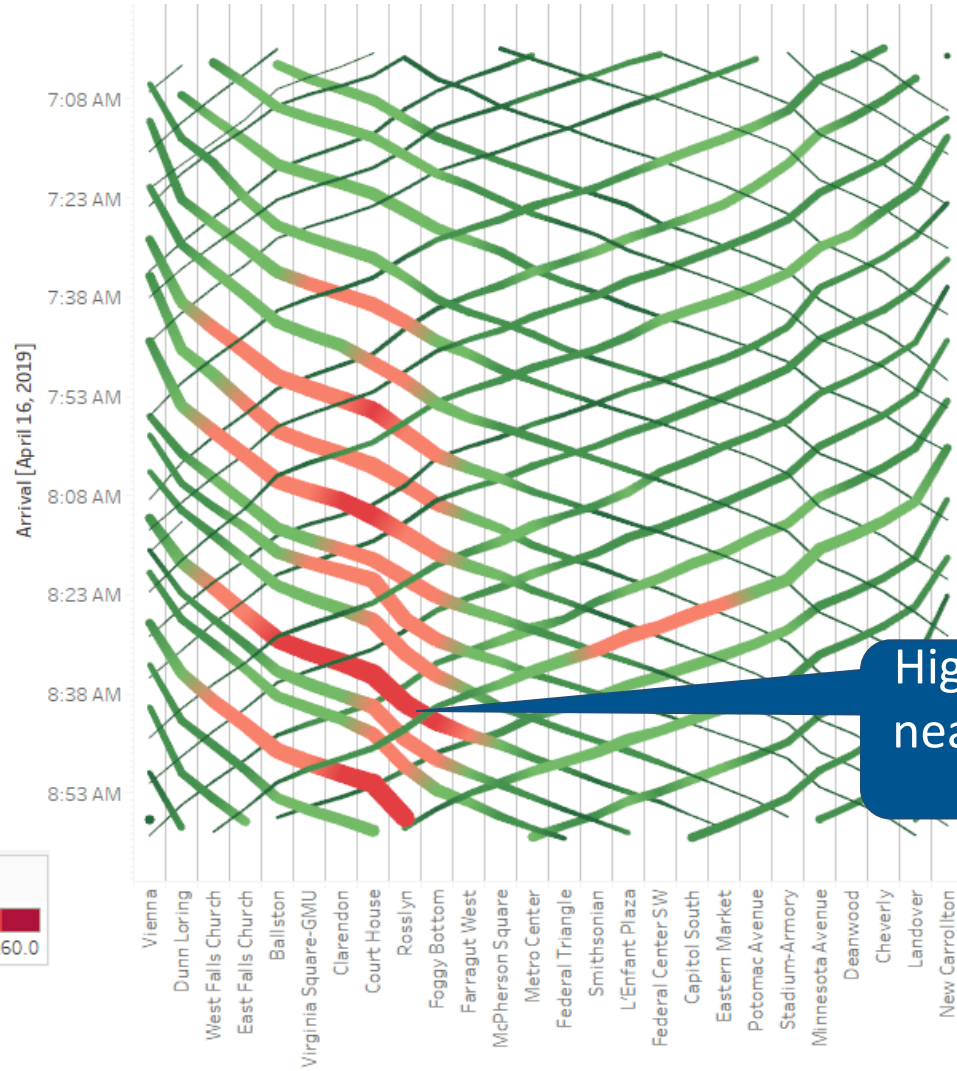
- Database tables
- Korbato user interface and visualizations
- Tableau Server visualizations
- Vehicle movement data and aggregated passenger movement data can be shared with partner agencies and their consultants
 - Corridor studies and sector plans
 - Metrorail capacity questions
 - Regional and sub-regional model validation, perhaps?



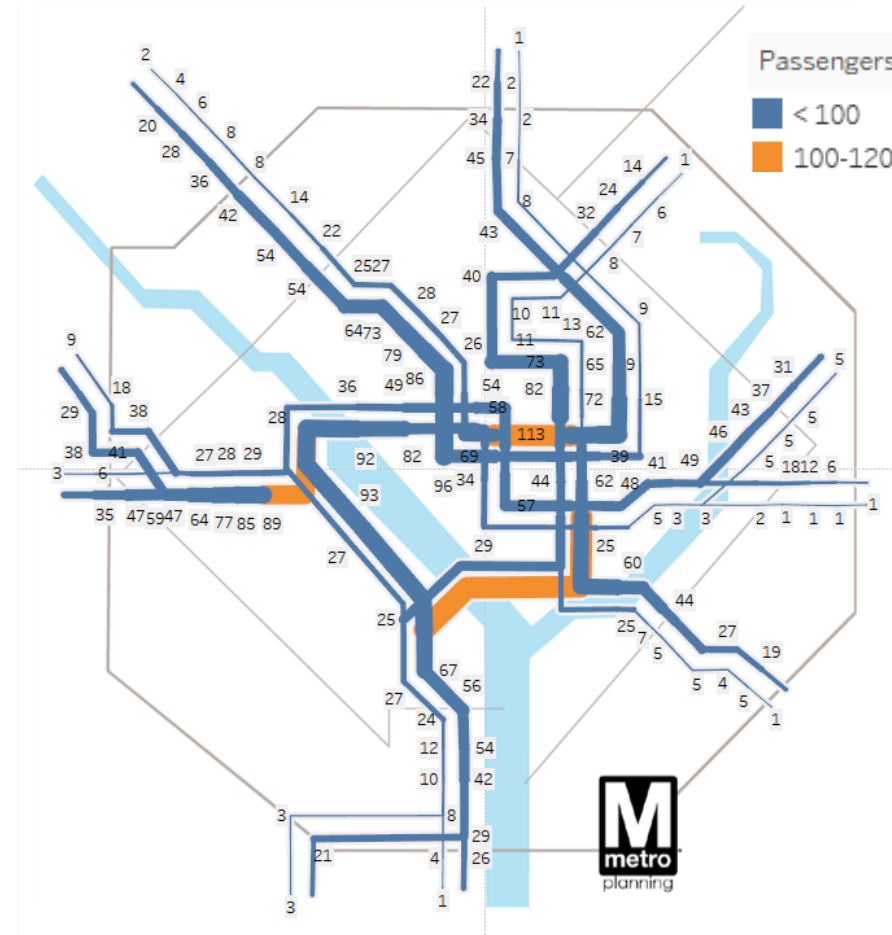
Applications

Understanding Train Loads

Time-Space Diagram, Orange Line, April 16, 2019 AM Peak

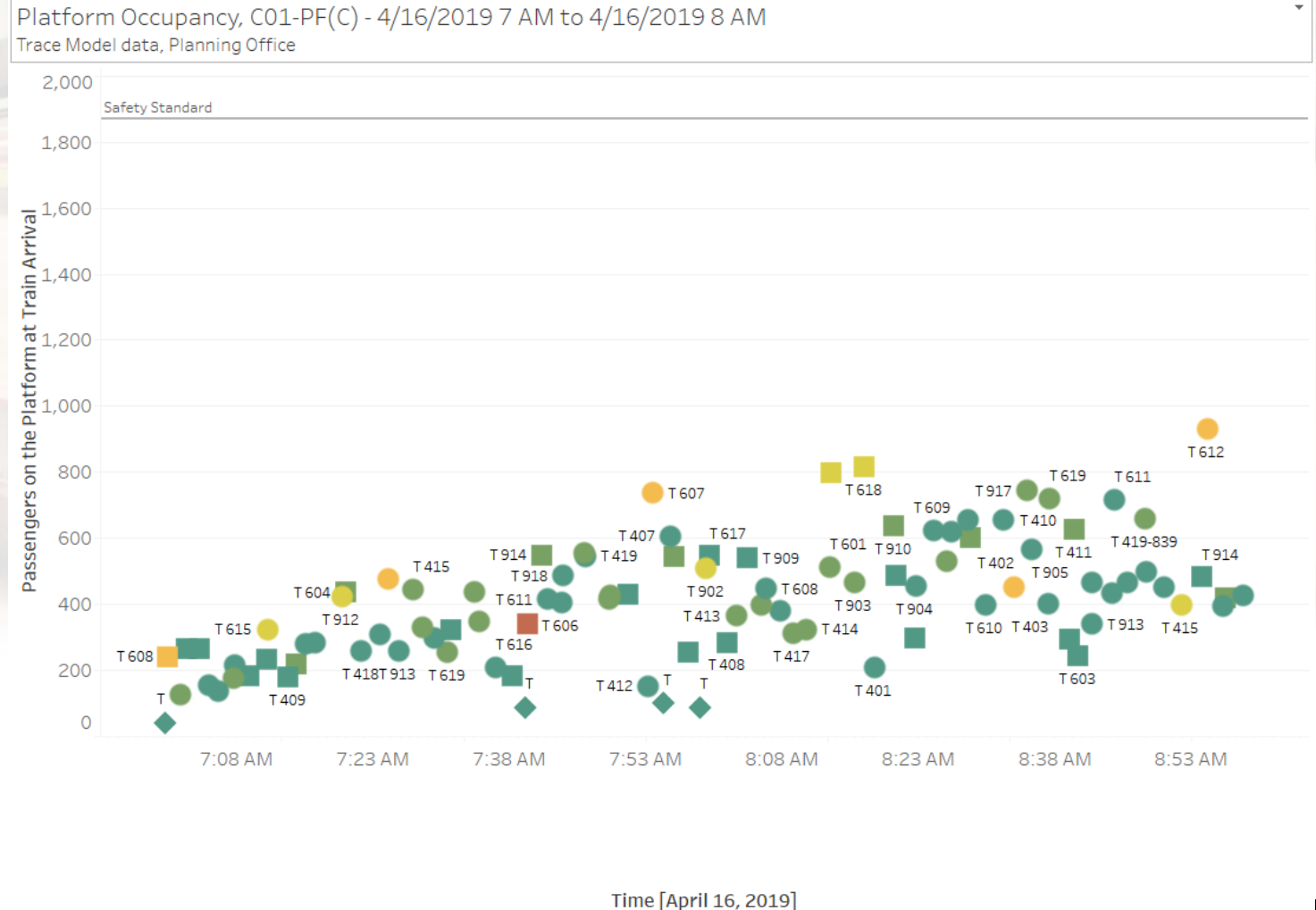
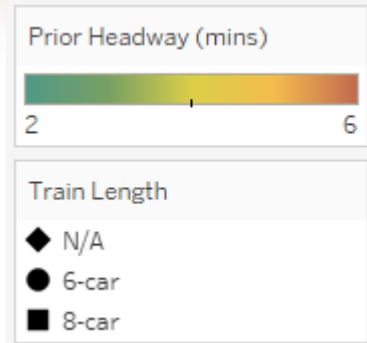


Average passengers per car, April 16, 2019, 8 a.m. hour



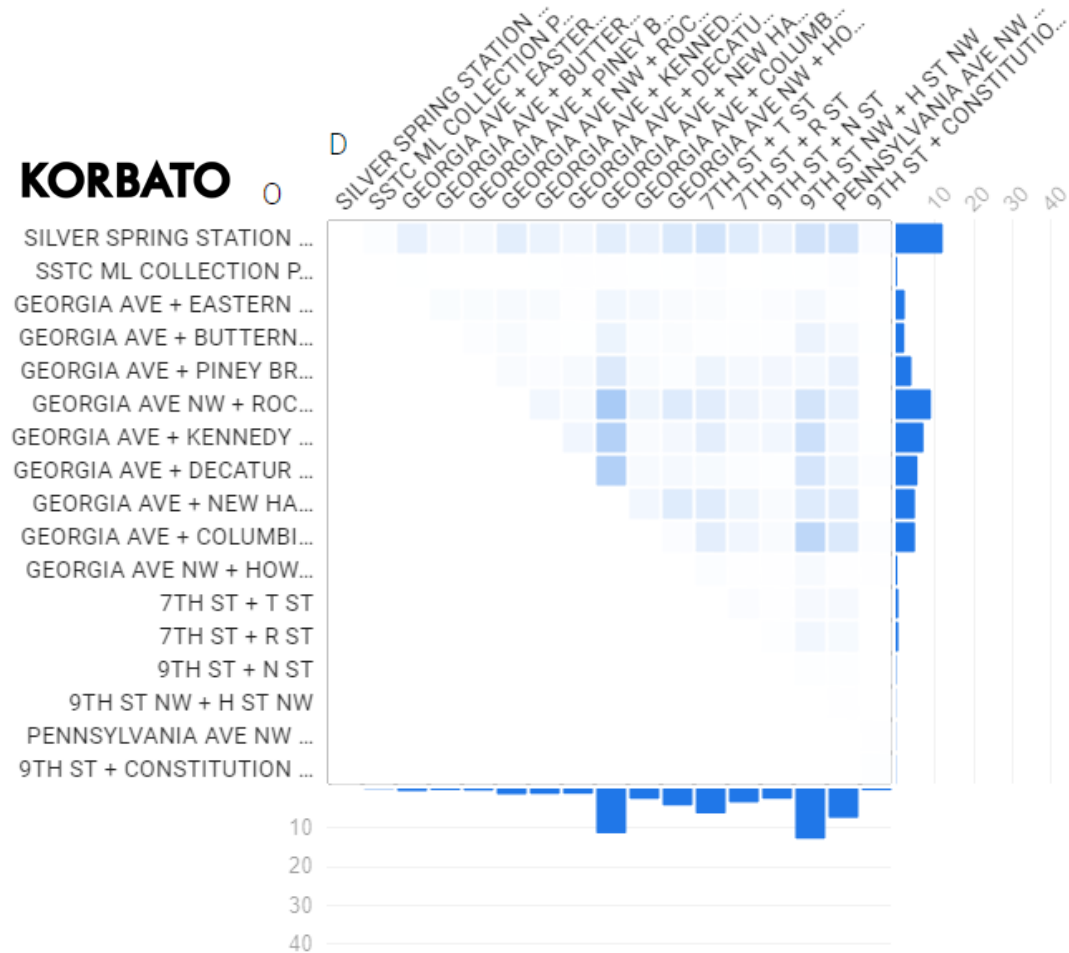
Platform Occupancy

- Number of people on the Metro Center lower platform, April 16, 2019 AM Peak
- Analyze by length of trains and actual headways – do small gaps in service lead to crowding?



Bus Load Profiles and Origin-Destination Matrices

KORBATO



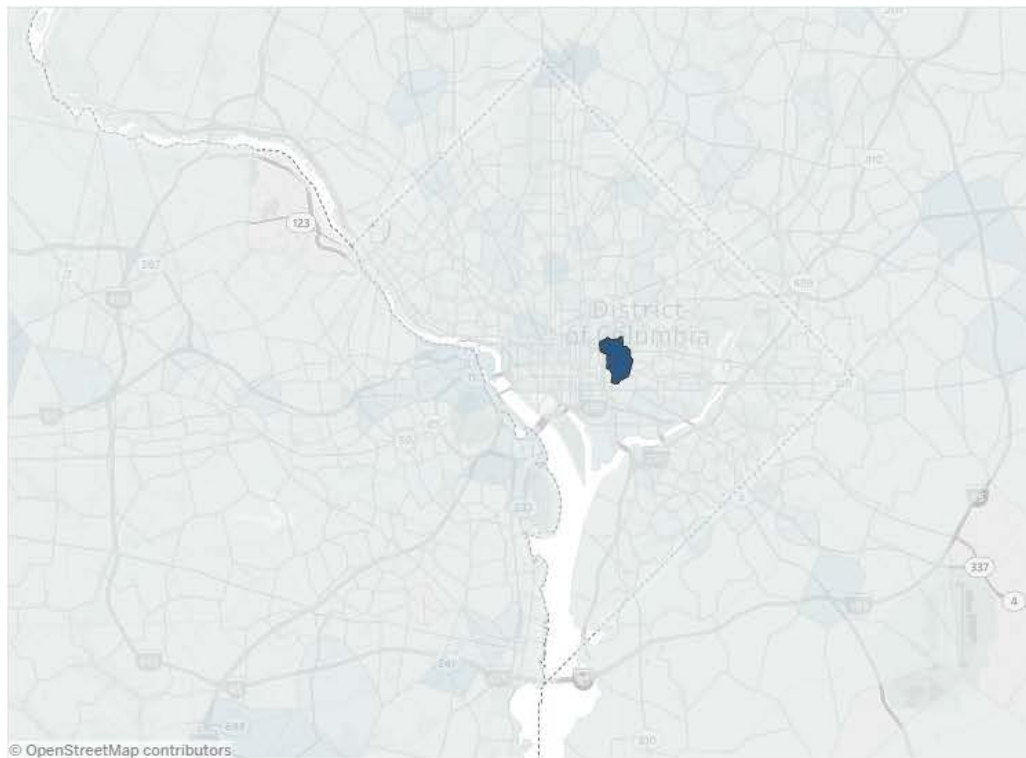
Route 79 South AM Peak Average Trip, 4/29/19 – 5/3/19



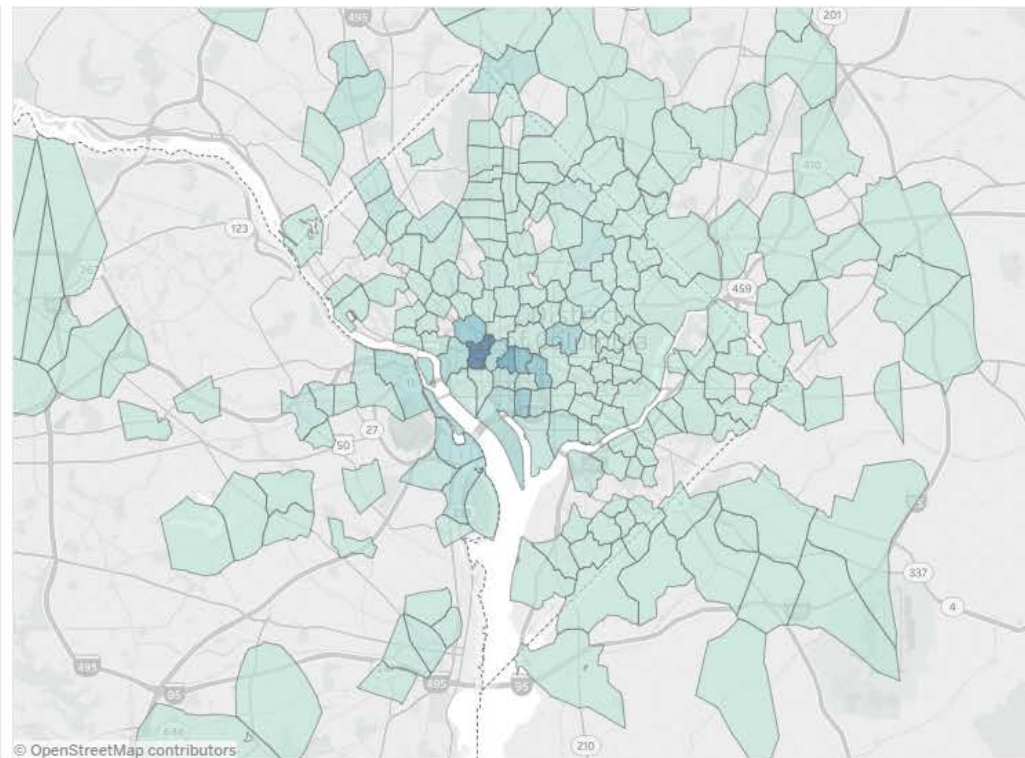
Full System Origin-Destination Data

Origins of passengers with destinations near Union Station on weekday mornings

Select an origin zone or a group of origin zones



Select a destination zone or a group of destination zones



Trips per day
0 7,380

Filter by any combination of the following:

Origin Subsystem

- (All)
- Metrobus
- Metrorail

Destination Subsy (All)

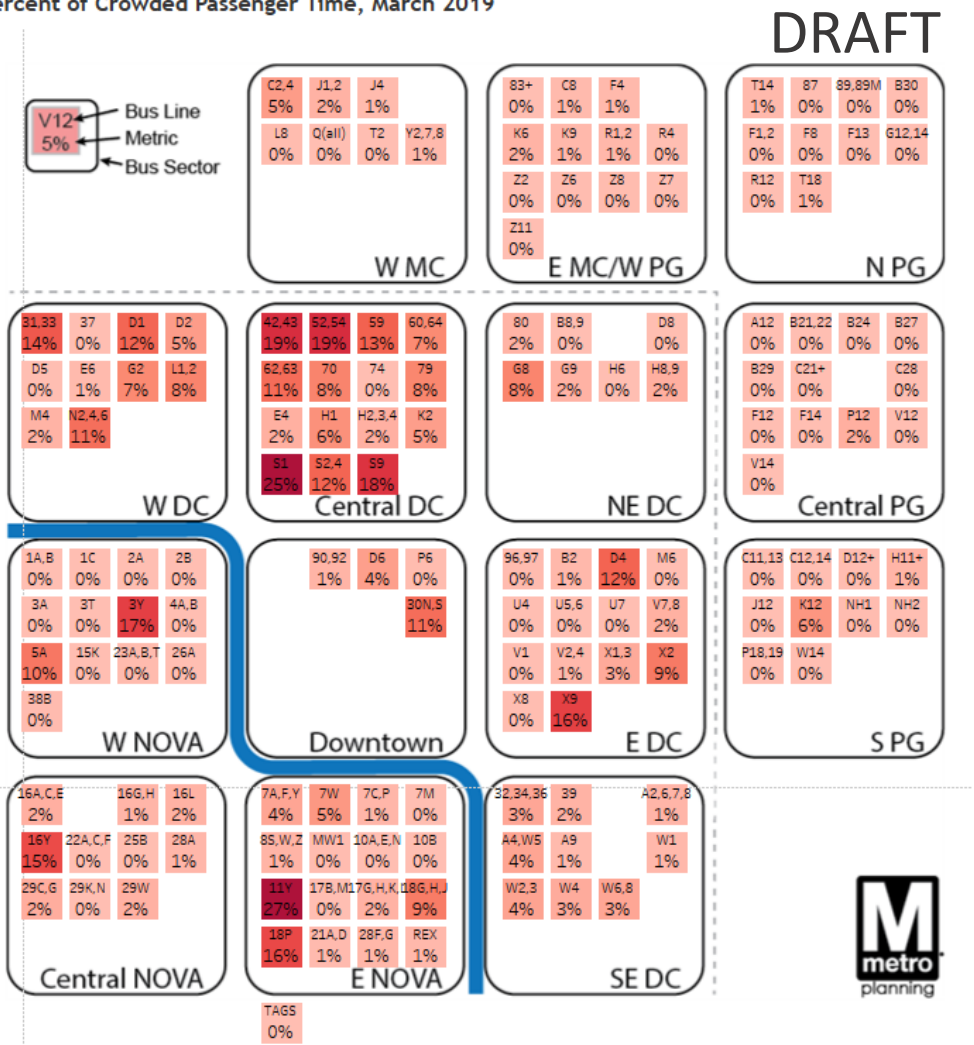
- Metrobus
- Metrorail

Hour starting at
6 9

Number of Stages
1 3

Bus Crowding

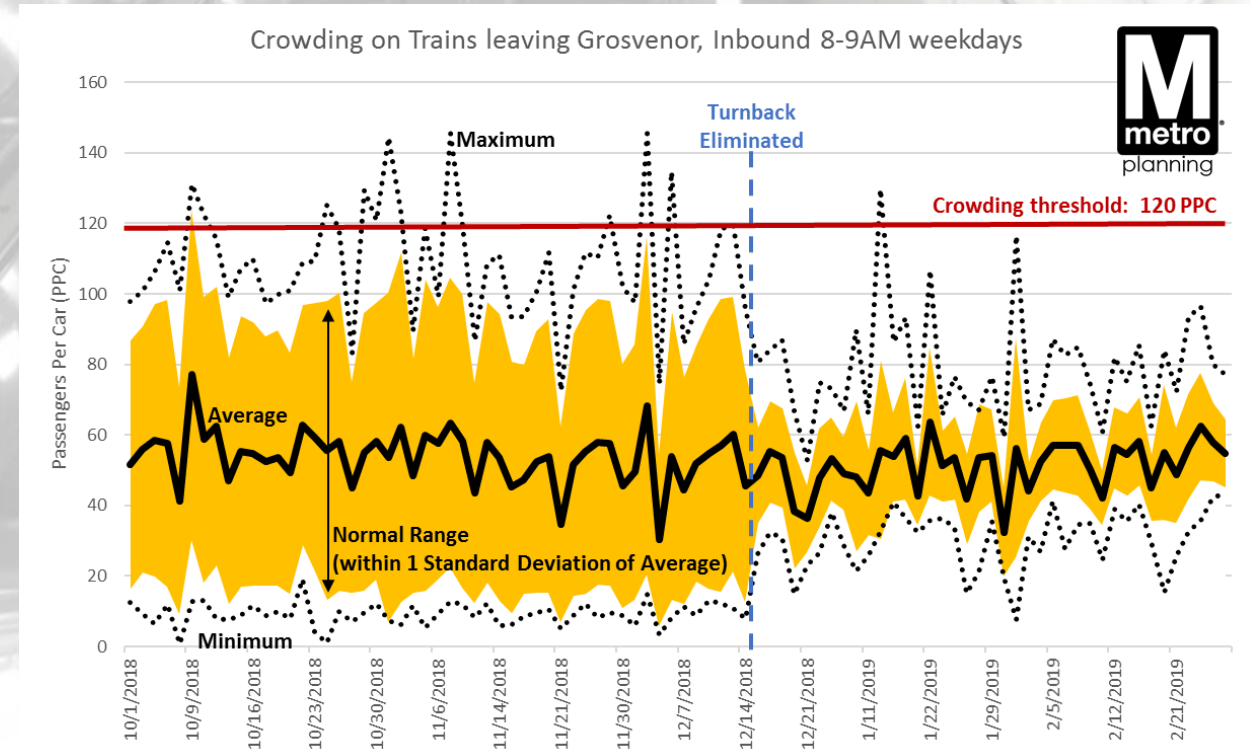
Percent of Crowded Passenger Time, March 2019



- What percentage of the time customers spend on the bus is above our crowding guidelines?
- Trace provides bus passenger loads for all stops on every trip, allowing a more granular look at crowding than existing averages from automatic passenger counters.

Other Applications

- Which stops have the most weekly bus pass use? As the price changes, where do we need targeted outreach?
- How have train loads changed since the elimination of the Grosvenor turnback?
- Vertical circulation: are the escalators at a particular station near capacity in peak hours?
- What was the impact of last weekend's track work on crowding?



Future Applications

- Additional bus and rail service planning insights
 - Where and when do we need extra trains for sports games or special events?
 - How many customers would benefit from short turn trips on a particular bus route?
- Rail station and bus route capacity analyses
- Customer experience monitoring and communications
- Mode choice analysis: where are customers taking bus where rail is an option?

Questions?