Maryland MTA GIS for Baltimorelink

Past, Present and Future

Brad Davis

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Note

- At the time I was asked to come to MSGIC, I was working with MES to help MTA projects and had been doing so since 2013
- Have since moved to Philadelphia and am working on projects in the utility sector, but still like to come to Maryland
- Any statements expressed are my own, as I am not here representing either MTA or MES

BaltimoreLink and the rise of analytical maturity

Divisions Involved:

Planning
Service Development
Executive
Operations
Safety
Police
IT

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October 2015

The Challenge:

Governor Hogan announces that the MTA will **completely re-design the Baltimore bus network** based on a backbone of 12 high-frequency routes that will completely change how the MTA operates service; **start 3 new Express BusLink routes**; **hold several successful rounds of workshops**, outreach, and formal public hearings around the region; **design and install dedicated bus lanes, transit signal priority, and new transfer facilities**; **replace over 5,000 bus stop signs** with a brand new design; completely **re-brand MTA's core services**; **start new commuter bus routes**; and **install bikeshare near rail stations.**

Time to Prepare:

20 months

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HOW IT WAS DESIGNED

Development of Prior Planning and Analysis Efforts:

Several Previous Efforts for redesign of the system, but none were able to completely come to fruition

Chief Goals Realized:

Fewer routes going all the way through the city (smaller more manageable routes)

More frequent service

More realistic schedules with better on-time service

Better use of limited resources (operators, buses etc.)

Transit Lanes Downtown

New Express Bus Service around the beltway and to Annapolis and Kent Island

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WE NEEDED LOTS OF NEW TOOLS TO PULL THIS OFF…

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Technical Design Tools

- Trapeze-Scheduling tool currently used for existing system, can construct routes and
- Remix-Web-based tool for evaluating route changes
- Sugar Access/Cube-Tools to promote economic equality of the designed system
- BMC Custom Transportation Models-BMC utilized modifications of their existing models that describe travel among the TAZs

Trapeze™

remix

CITILABS

Baltimore Metropolitan Council

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General Spatial Design Tools

- **ArcGIS-Used for distributing database revisions of the system (a new one came out every week for over a year)**

- **Analysis and Mapping performed in ArcGIS utilizing community data, transportation data, Network analyst for transit walksheds and connections.**

- **GTFS Data supplied on our website in both static and real-time flavors. Used for in house analysis of routes and stops served, also freely given to be consumed by independent app developers**

Other Design Tools And Guides

- **Custom Websites Built separate, independent BaltimoreLink site to share information with the public and provide as much routing, scheduling and planning information as possible.**

http://baltimorelink.com/

http://baltimorelink.com/interactive-tools/trip-planner

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Example of change

Former route is dashed
Longer, schedule based

Current route is composed of shorter, more frequent lines

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BUT WHAT ABOUT PUBLIC IMPACT?

METRICS

Variety of Metrics Created by Multi-Agency Team:

Consultants, Maryland Department of Planning (MDP), Baltimore Metropolitan Council (BMC) and many departments in MTA formed a metrics analysis group.

Goals were to determine the effects positive and negative of the system on riders and the general community.

Activity Centers, which were defined as hubs based on a high level of economic activity such as the TowsonTown Center Area, Arundel Mills Mall, and Amazon Warehouses.

METRICS

Variety of Metrics Created by Multi-Agency Team:

Metrics focused on determining how much access potential there was between the existing system and the future system.

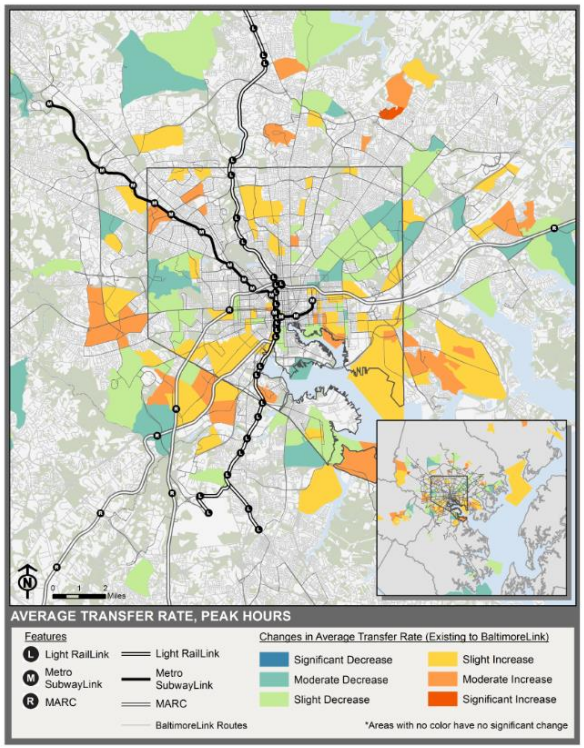
How many people were able to get to a job center within 15, 30 and 45 minutes?

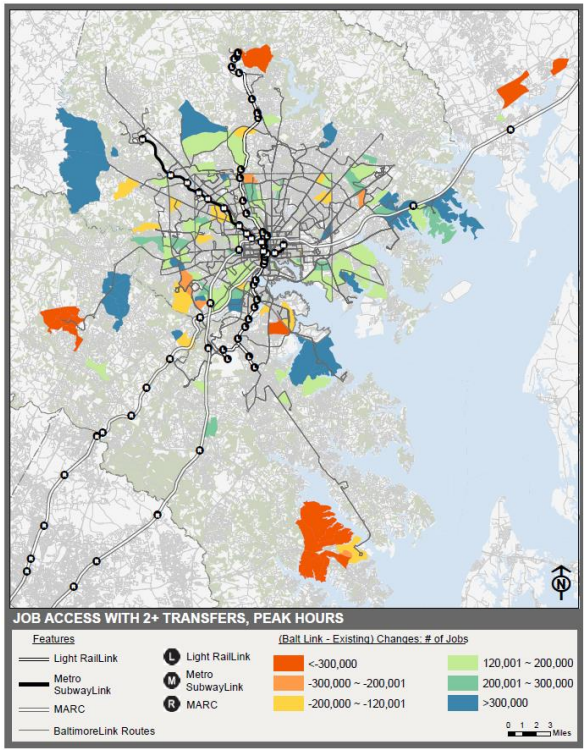
How many grocery stores were accessible within given time and distance intervals?

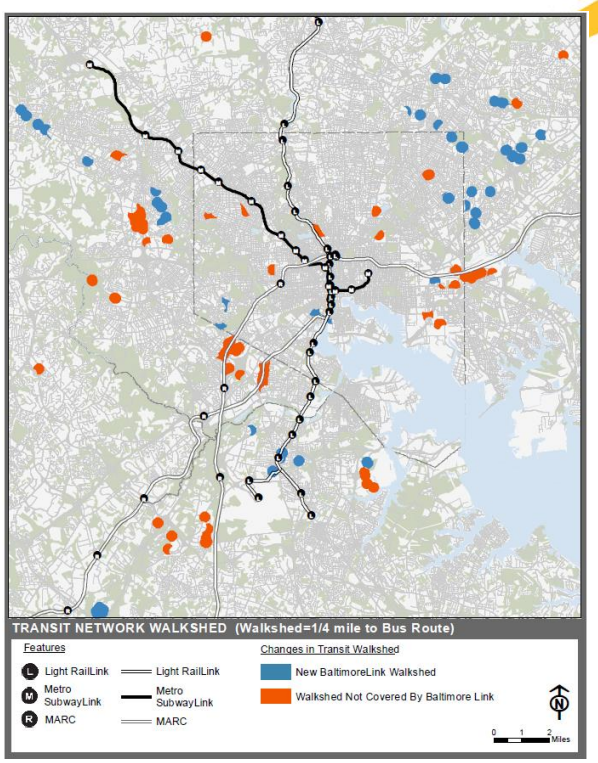
How many medical centers could patients get to by using the transit system?

METRICS

Variety of Metrics Created by Multi-Agency Team:







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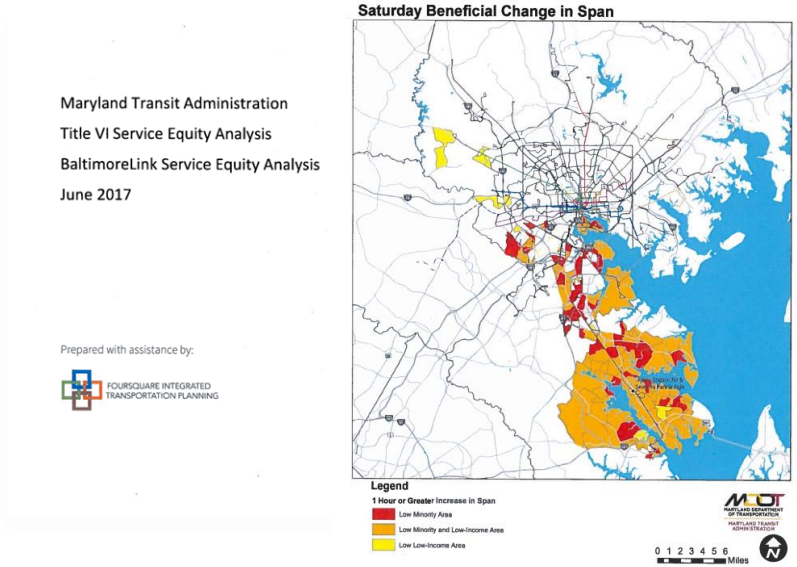
TITLE VI

Analysis of Civil Rights Act Impact:

- Two Separate Efforts
  - Assess the current system
  - Assess the future system
- System Designated By Full Coverage of Served Area
  - Data for each Block Group
- Data processed and released in Title VI Report



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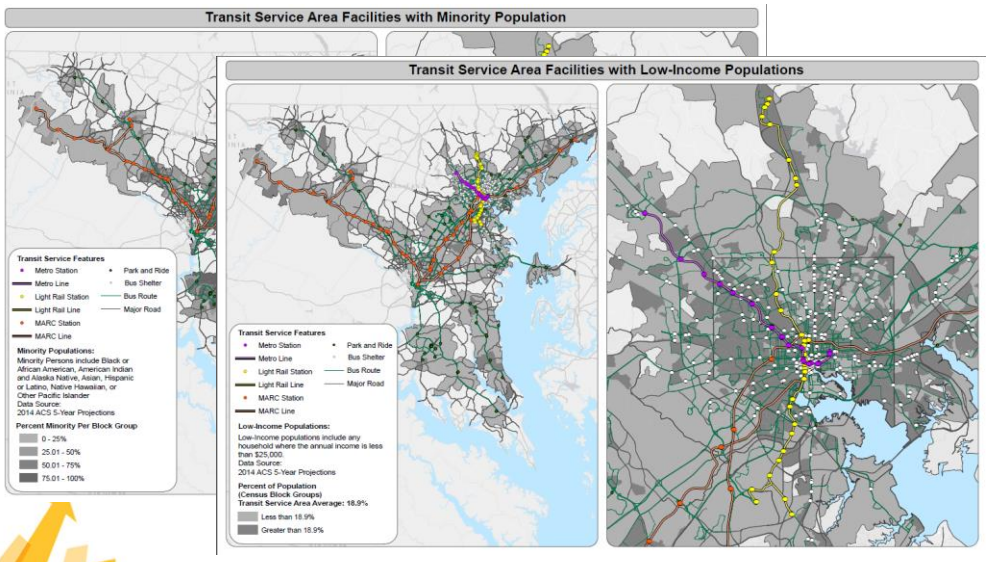
TITLE VI

Analysis of Civil Rights Act Impact:

- Low Income Populations
  - Household Income Under $25,000
  - Data Taken from 2014 American Community Survey 5 Year Projections
- Minority Populations
  - All groups except non-Hispanic whites
- Non-English Speaking Populations



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GIS TOOLS TO MAKE OVER THE SYSTEM

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Bus Stop Sign Removal - Overview

Stops to Remove: *4,129*

Workforce: *35 2-person crews*

Typical Install = 15 min (12 min install + 3 min travel)

Typical Removal = 6 min (3 min removal + 3 min travel)

- *10 removals per hour X 12 hours = 120 per team*
- *4,200 stops/120 =* ***35 Teams***

Timeline: *8pm – 8am Sat/Sun*

- *Crews will be in location prior to 8pm*

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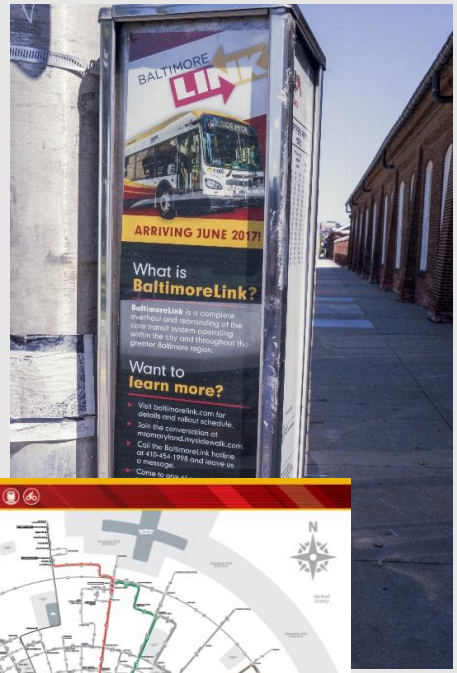
Bus Stop Sign Removal – In The Field

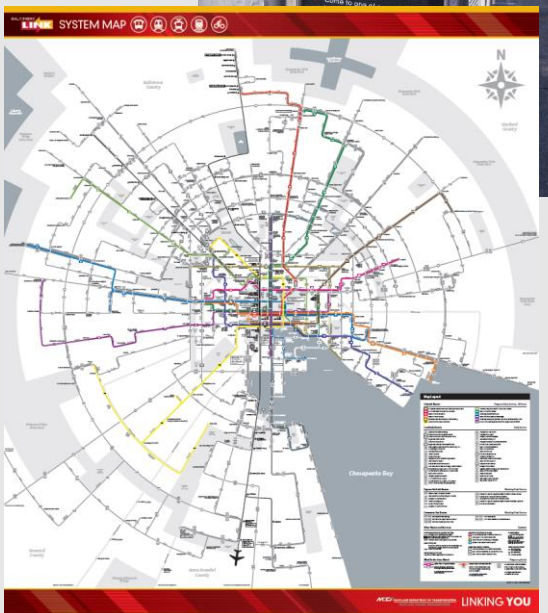
- 35 Teams/crews:
  - One Driver, One remover
- Quadrants were grouped by quantity not geography
- Removal recorded on Collector App provided
  - Dedicated tech support throughout the night

Infobox /Shelter Maps

- Infoboxes
  - 678 Infoboxes in system
  - Located Using Upgraded GIS Data Points from Bus Stop Surveys

- Shelter Maps
  - 406 currently in system needed replacement maps
  - Data for maps from GIS integration efforts and design staff modified projections, added many unique details for an iconic look

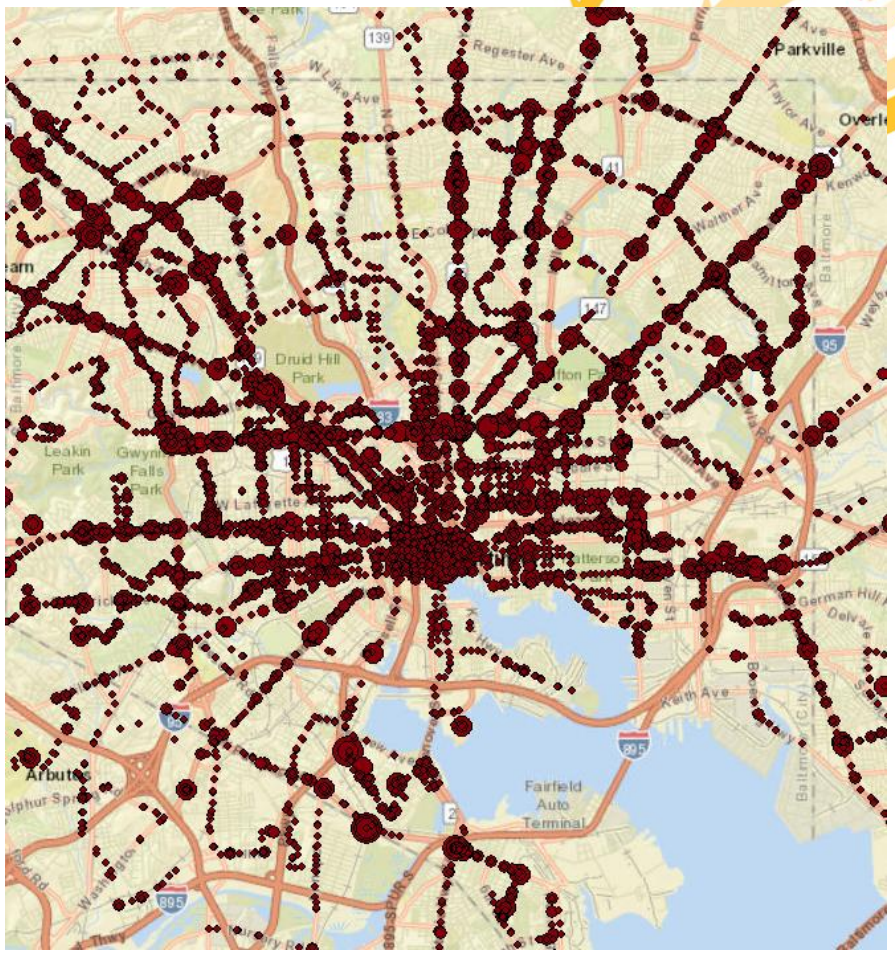




STREET TEAM AND TRANSIT AMBASSADOR DEPLOYMENT

On-Street Customer Service: MTA Ambassadors

- Deployed in pairs
- At as many bus stops as possible
- Round-the-clock presence after launch
- Training and specialized printed information for each location.



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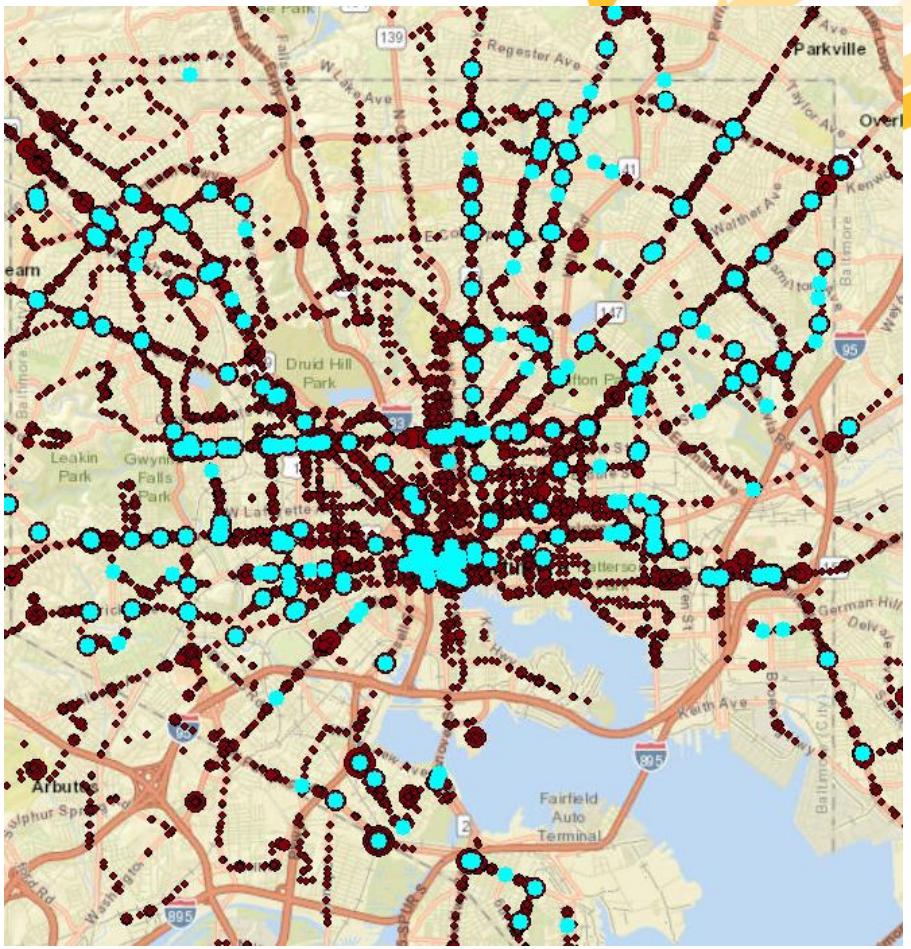
On-Street Customer Service: MTA Ambassadors

- Deployed in pairs
- At as many bus stops as possible
- Round-the-clock presence after launch
- Training and specialized printed information for each location.
- Found the most active spots through prior work tabulating ridership
- Reassigned as new staff came
- Smaller effort for school changes in September



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Performance Studies and Management

Divisions Involved:

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Data Sources

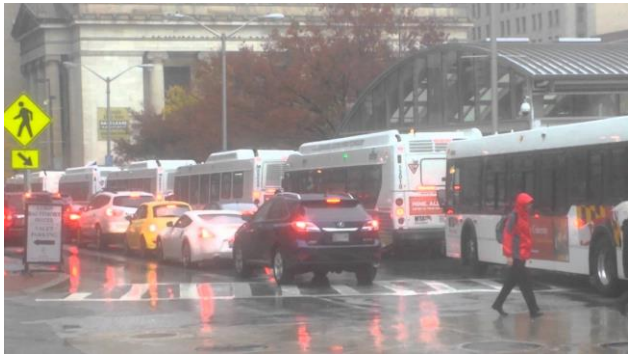
- Radio Based Bus Location
- Door Sensors
- Manual Observation
- Swiftly Data
- Each has its advantages and drawbacks

Bus Bunching Data Extraction and Reports

- After BaltimoreLink was put in place experimentation and studies were done to verify bus behavior
- Especially important was the issue of bus bunching and bus gapping

Bus Bunching Data Extraction and Reports

- Example of Bus Bunching
- http://setosa.io/bus/



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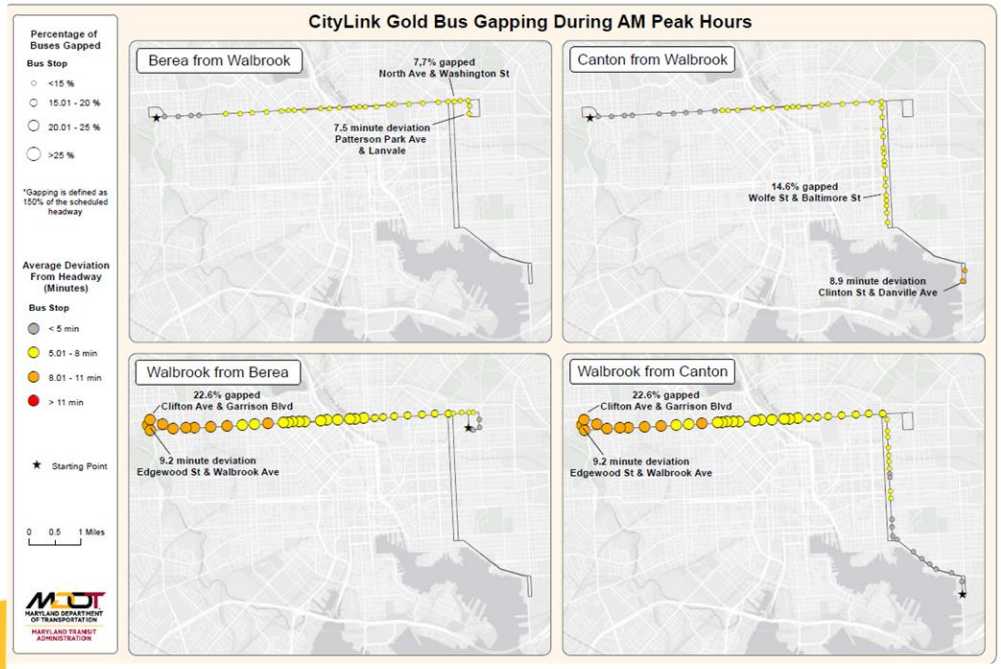
Bus Bunching Data Extraction and Reports

- Made use of GIS and extracts from Swiftly to determine the level of bus bunching at different locations along routes



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Bus Bunching Data Extraction and Reports

- Automated Scripts in R to build Spacetime Diagrams to reveal what each bus was doing along the route:

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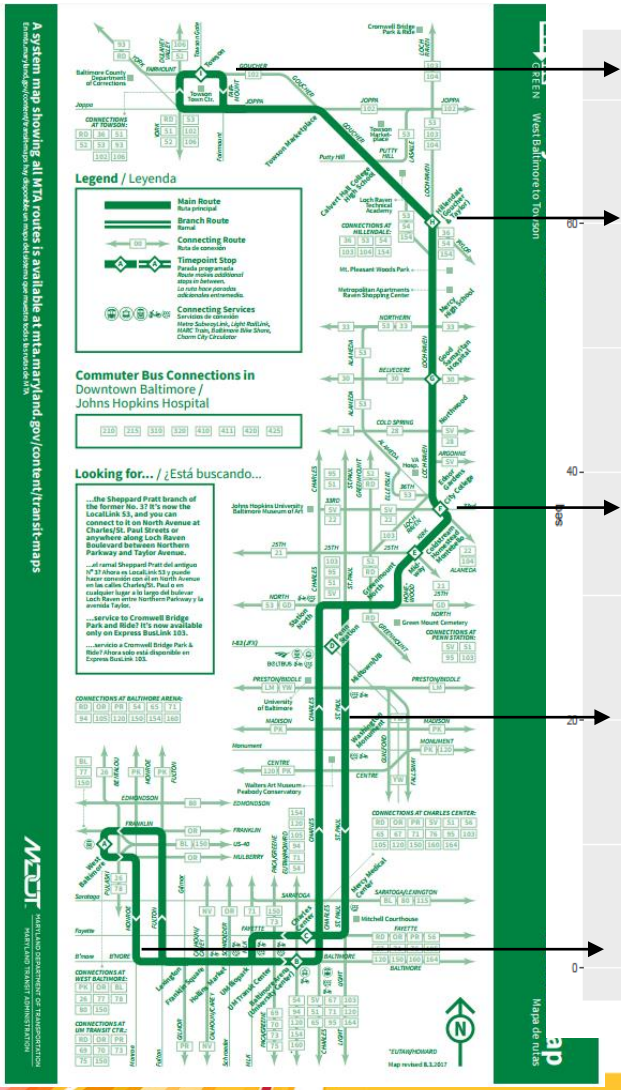
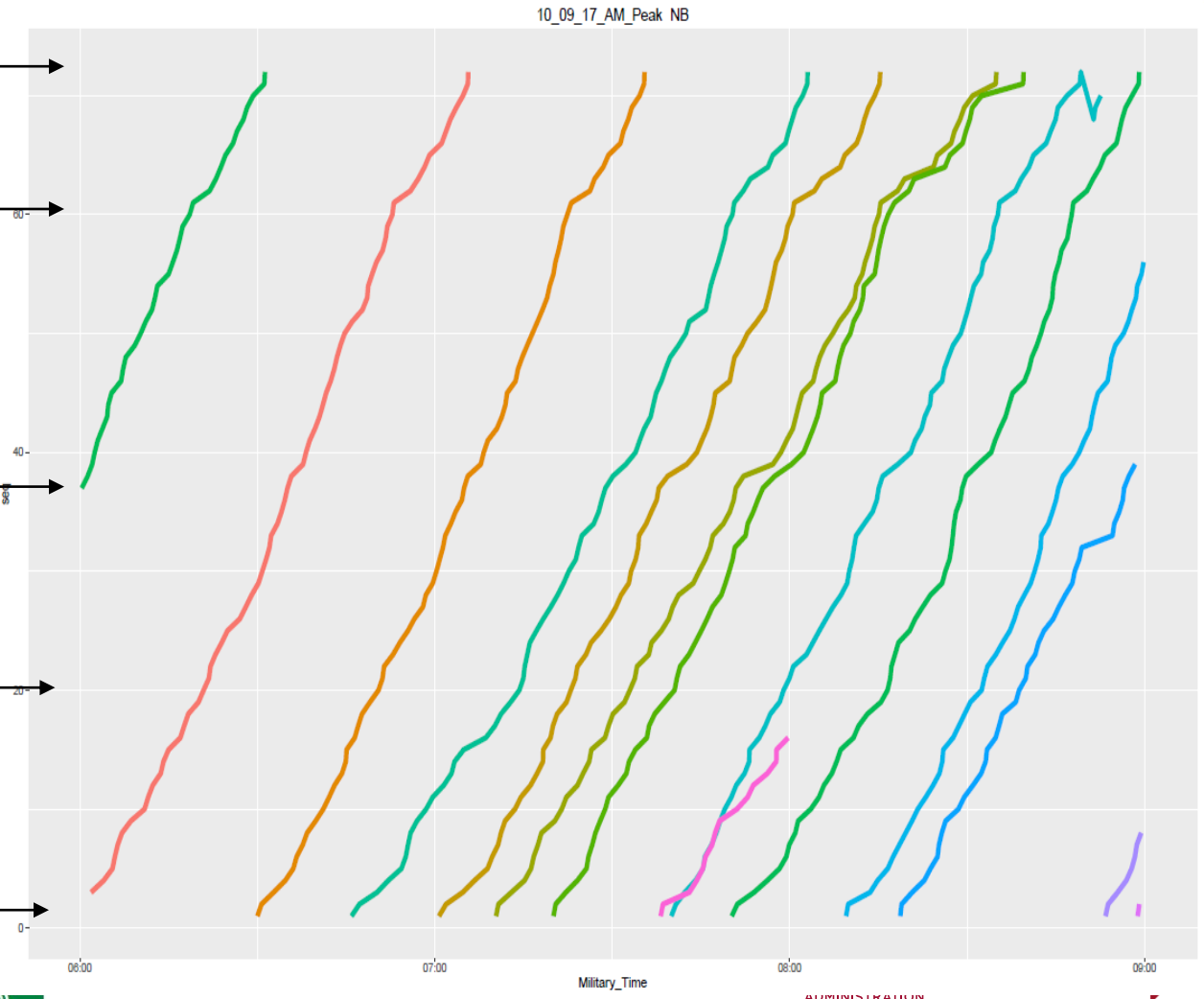
Bus Bunching Data Extraction and Reports





Internal models for bunching metrics

- Created various definitions of bunching and gapping and the user experience
- Chiefly related to expected customer wait times
- Tried to work on the relationship between gapping and bunching
- Bunching is the visible sign of a troubled pattern, gapping the real impact for the public
  - Gapped buses mean longer expected customer wait times
- GIS and GTFS feed info used to create list of stops and their order on each studied route (Citylinks)
- Exported lists into Excel (only temporary, being pushed into Access)

Internal models for bunching metrics

- Excel models look at the time between visiting buses for a given stop
- These stop by stop gapping figures are then applied summed for the entire route/pattern
- Charted week over week

- Median gapping calculated, then these metrics used against a set of possible factors (system stressors)
  - Time of day
  - Direction of travel
  - Weather conditions
  - Emergency Calls
  - Wheelchair Assists
  - Ridership levels
  - Accidents with injury
  - Minor Accidents
  - Construction Delays
  - Special Events
  - Detours

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Findings

- Multiple Linear regression models, Spline Models various other techniques in R developed to try to model behavior of the gapping
- Ultimately, data too limited for statistically significant results, but some informal results can be provided:
  - Strong effect
    - Driver Absenteeism
    - Accidents with injury
    - High Ridership
  - Weak or unclear effect
    - Wheelchair access
  - No relationship
    - Weather (surprising, but there may be reasons for this)

More detailed analysis

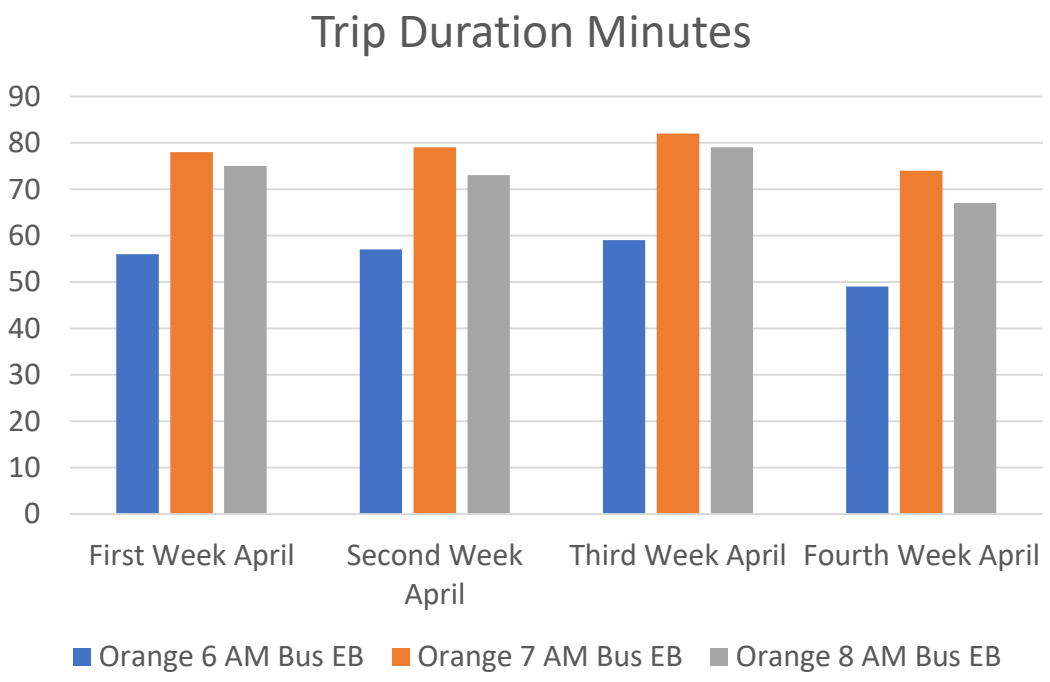
- Work so far has been for overall system or along a single route, what about individual trips?
- To get enough detail for individual trips we needed to access the newly available Swiftly data
- This provided real time positions for most Citylink buses, approval granted for all buses and should be in place in near future
- Example of Swiftly Data derived from App: https://www.goswift.ly/swiftly-insights

Example Swiftly data

block_id	trip_id	route_id	route_sho	direction_	stop_id	headsign	vehicle_ic	driver_id	sched_adhere	scheduled_dat	scheduled_ti	actual_date	actual_time	is_arrival
323029	1997417	9563	102	0	395	102 White	13046		230.5	8/1/2017	6:37:00	8/1/2017	6:40:50	FALSE
323029	1997417	9563	102	0	10396	102 White	13046		230.5	8/1/2017	6:39:00	8/1/2017	6:42:50	FALSE
323029	1997417	9563	102	0	398	102 White	13046		230.5	8/1/2017	6:39:43	8/1/2017	6:43:33	FALSE
323029	1997417	9563	102	0	10680	102 White	13050		427.522	8/1/2017	6:44:38	8/1/2017	6:51:45	FALSE
323029	1997417	9563	102	0	12558	102 White	13050		398.791	8/1/2017	6:45:56	8/1/2017	6:52:34	FALSE
323029	1997417	9563	102	0	14135	102 White	13050		865.967	8/1/2017	6:46:00	8/1/2017	7:00:25	FALSE
323029	1997417	9563	102	0	3125	102 White	13007		80.237	8/1/2017	7:05:15	8/1/2017	7:06:35	FALSE
323029	1997417	9563	102	0	3130	102 White	13007		120.924	8/1/2017	7:06:09	8/1/2017	7:08:09	FALSE
323029	1997417	9563	102	0	3134	102 White	13007		139.088	8/1/2017	7:07:28	8/1/2017	7:09:47	FALSE
323029	1997417	9563	102	0	3136	102 White	13007		131.141	8/1/2017	7:08:00	8/1/2017	7:10:11	FALSE
323037	1997415	9563	102	0	14135	102 White	11013		-0.855	8/1/2017	8:27:00	8/1/2017	8:26:59	FALSE
323037	1997413	9563	102	0	3125	102 White	13034		604.442	8/1/2017	10:42:15	8/1/2017	10:52:19	FALSE
323037	1997413	9563	102	0	3130	102 White	13034		658.513	8/1/2017	10:43:09	8/1/2017	10:54:07	FALSE
323037	1997413	9563	102	0	3134	102 White	13034		688.303	8/1/2017	10:44:28	8/1/2017	10:55:56	FALSE

Can compute Total trip length and speed along routes

- Scripts developed in R to feed in lengths between stop segments
- Combined with stop by stop timings, average speeds can be given which results in mapping of average speeds for each route
  - Also, can be done for trip Id's (basically regularly scheduled bus trips)



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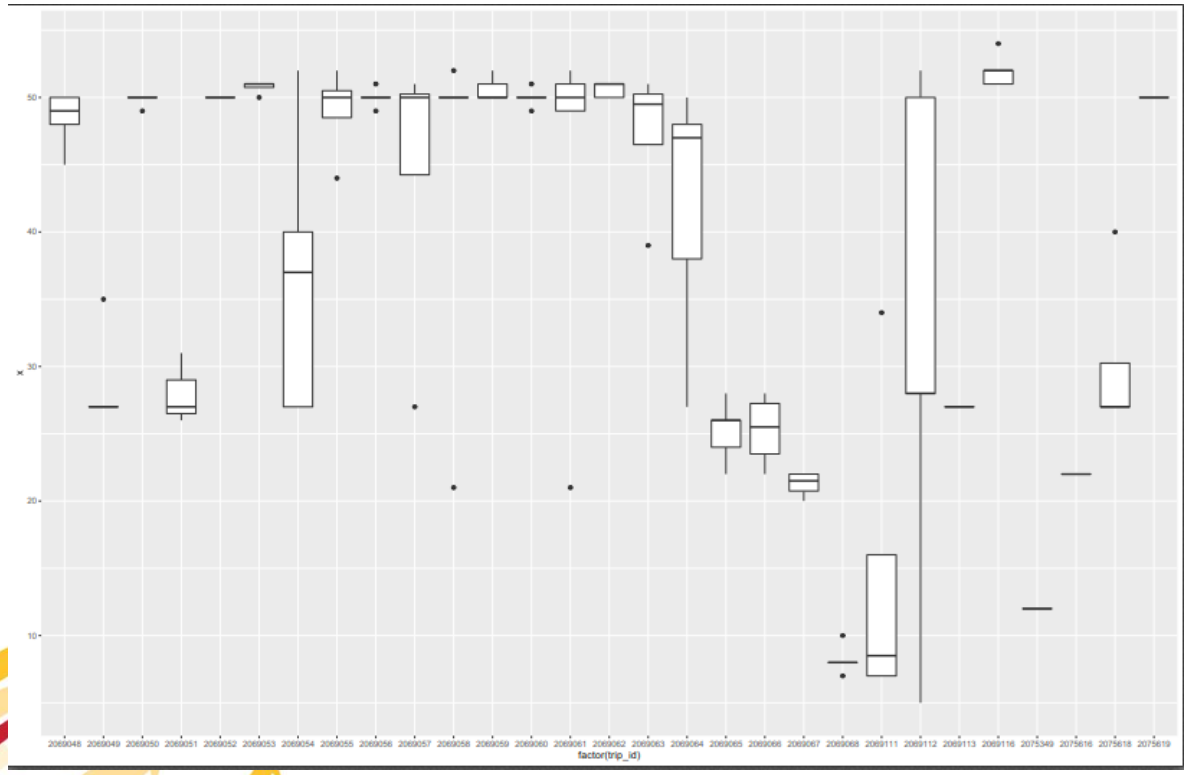
Also show trip by trip analysis



First, data quality check. Distribution Plots generated to show incomplete or suspect data

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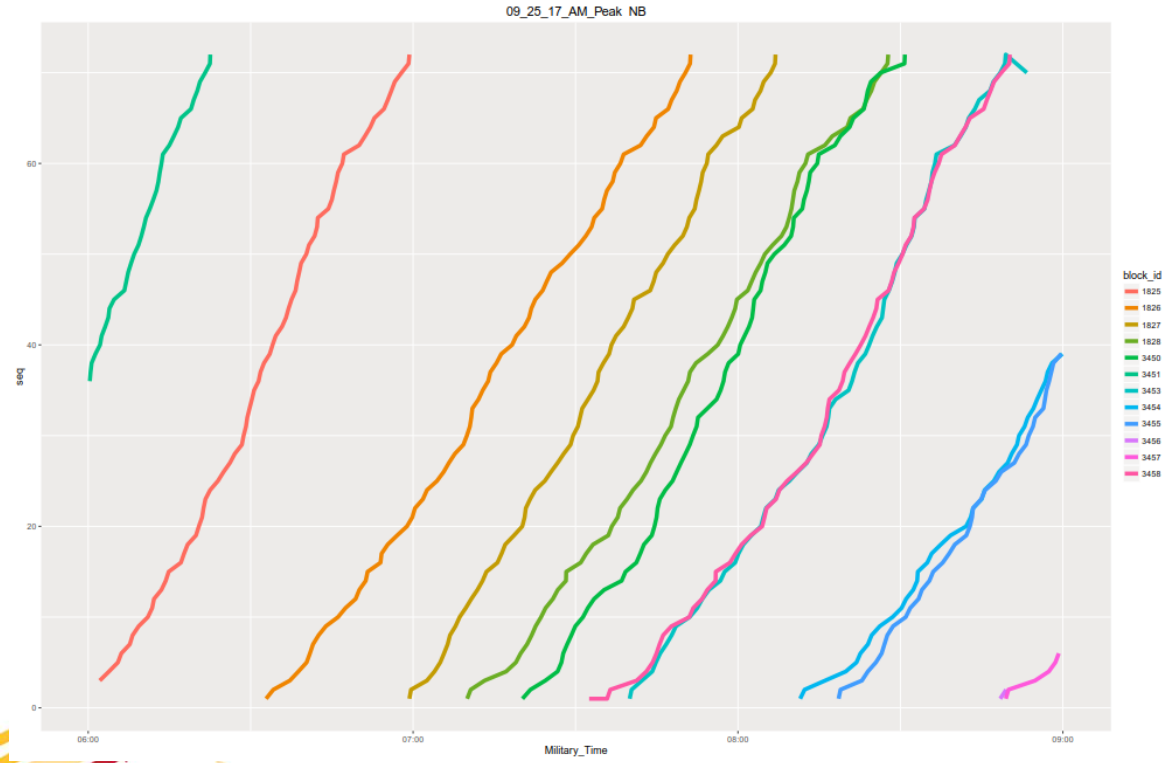
Trip by trip analysis



- Then, able to create plots of every direction for every example of time bucket

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Questions?

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