Real-time Transit Information: Uses and Impacts

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With credit to Candace Brakewood, Aaron Gooze, Landon Reed and Sarah Windmiller
Benefits of Transit

• Societal Benefits
  – Congestion reduction
  – Reduced gasoline consumption
  – Reduced emissions
  – Mobility to non-drivers
  – Compact sustainable communities

• BUT to customer - transit must be fast, comfortable and reliable
Problems with Transit

- Reliability is a key issue (Li et al. 2010; Walker 2012)

MARTA’s Bus On-Time Performance

- DEC 2012: 77.11%
- DEC 2013: 78.20%
- FY 2013 To-Date: 76.40%
- FY 2014 To-Date: 77.13%

* System-wide value
Strategies to Address Unreliability

• Traditional methods of improving reliability are expensive, supply-side approaches, including:
  – Dedicated right-of-way
  – Service planning

• An inexpensive, demand-side approach is providing riders with real-time information (Carrel et al. 2013; Schweiger 2011).
ENABLERS OF REAL-TIME ARRIVAL INFORMATION
Enablers

• Increasing use of Automated Vehicle Location (AVL)
• Prevalence of Mobile Devices
• Open Standardized Data
Phone Ownership

- Cell Phone
- SmartPhone
Transit Data Consumption

Paper Schedules | Digitization | Interactivity

Schedule | Schedule | 10
9:36
What is OneBusAway?

• **What?** Suite of tools that provides real-time bus/train tracking information
  - Open source software
  - API for developers
  - Free to riders

• **Why?** Make riding public transit easier by providing good information in usable formats
  - Research to evaluate the impacts
Website Interfaces

OneBusAway

Serving up fresh real-time transit information for the region.

onebusaway.org
Mobile App Interfaces

Support user location, route, stop contextual/personalized information
All OPEN-SOURCE!
How to use OneBusAway
Mobile App Features

• Location-aware
• Bookmarking
• Service alerts
• Problem reporting
OneBusAway Multi-region

- Created centralized server directory
- Modified apps to find cities using directory
- Add a new city by adding a record in the directory
IMPACTS OF REAL-TIME ARRIVAL INFORMATION
Impacts

• Riders are more satisfied
• Riders feel safer
• Riders wait less time

• Do they take more transit trips?
Where is OneBusAway?

Seattle WA: Original deployment

York, ON: Official launch this month

New York, NY: Adapted for the MTA (Bus Time)

Washington, DC: In testing

Atlanta, GA: Launched in early fall 2013

Tampa, FL: Launched in late summer 2013
Change in Satisfaction

“I no longer sit with pitted stomach wondering where is the bus. It's less stressful simply knowing it's nine minutes away, or whatever the case.”
Perception of Safety

- Perception of Safety
  - 79% no change
  - 18% somewhat safer
  - 3% much safer

- Safety correlated with gender
  - $\chi^2 = 19.458$
  - p-value = 0.001
Wait Time

- Without real time, perceived wait > actual wait
- With real time, perceived wait = actual wait
- Value of real time >> more frequent service

<table>
<thead>
<tr>
<th>Group</th>
<th>Real Time</th>
<th>Schedule</th>
<th>Difference</th>
<th>T-stat (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Typical Wait</td>
<td>7.54</td>
<td>9.86</td>
<td>2.32</td>
<td>5.50 (0.00)</td>
</tr>
<tr>
<td>Aggravation Level</td>
<td>3.35</td>
<td>3.29</td>
<td>-0.05</td>
<td>-0.24 (0.81)</td>
</tr>
<tr>
<td>Actual Wait Time</td>
<td>9.23</td>
<td>11.21</td>
<td>1.98</td>
<td>2.17 (0.03)</td>
</tr>
</tbody>
</table>
Increased Transit Usage

**Number of "Other" Trips**

- 2009:
  - 3 or fewer trips: 80%
  - 2 fewer trips: 70%
  - 1 fewer trip: 60%
  - No change: 50%
  - 1 more trip: 40%
  - 2 more trips: 30%
  - 3 or more trips: 20%

- 2012:
  - 3 or fewer trips: 70%
  - 2 fewer trips: 60%
  - 1 fewer trip: 50%
  - No change: 40%
  - 1 more trip: 30%
  - 2 more trips: 20%
  - 3 or more trips: 10%

**Number of Work or School Trips**

- 2009:
  - 3 or fewer trips: 90%
  - 2 fewer trips: 80%
  - 1 fewer trip: 70%
  - No change: 60%
  - 1 more trip: 50%
  - 2 more trips: 40%
  - 3 or more trips: 30%

- 2012:
  - 3 or fewer trips: 80%
  - 2 fewer trips: 70%
  - 1 fewer trip: 60%
  - No change: 50%
  - 1 more trip: 40%
  - 2 more trips: 30%
  - 3 or more trips: 20%
Before-After Control Group Research Design

- **Motivation:** HART provided USF & Georgia Tech special access to real-time data

- **Recruitment:** HART website/email list (Incentive of 1 day bus pass)

- **Measurement:** Web-based surveys

- **Group Assignment:** Random number generator

- **Treatment:** OneBusAway

Limiting the Treatment: iPhone & Android Apps
Tampa

• Significant improvements in the waiting experience
  – Decreases in self-reported usual wait times
  – Increases in satisfaction with wait times and reliability

• Little evidence supporting a change in transit trips
  – Approx. 1/3 of RTI users stated they ride the bus more frequently, perhaps because of:
    • Affirmation bias of respondents
    • Scale of measurement (trips per week)
  – Only riders within sphere of transit agency
New York City

#1. February 2011: Brooklyn Pilot (B63)

#2. February 2012: Staten Island Launch

#3. November 2012: Bronx Launch

#4. October 2013: Manhattan Launch

#5. March 2014: Queens + Brooklyn Launch

#2. February 2012: Staten Island Launch

#1. February 2011: Brooklyn Pilot (B63)
New York City

• **Method**
  • Comparison of multiple panel regression techniques in a well-suited natural experiment

• **Conclusions**
  • Real-time Information as a single variable
  • Average increase of ~115 rides per route per weekday (median of 1.6%), similar to previous Chicago study
  • Real-time Information by route size
  • Average increase of ~338 rides per weekday on the largest quartile of routes (median of 2.3%)

• **Limitations**
  • Short Timescale
  • Aggregate Analysis
• **Data Collection**
  - Web-based survey conducted first week of May 2014

• **Recruitment**
  - Both real-time information (RTI) users and non-users

• **Matching with Smart Cards**
  - 669 participants entered survey software
  - 538 provided a 16 digit smart card number
  - 494 matched usable, active smart cards
Atlanta

- Has using an app with real-time information changed the NUMBERS OF TRIPS that you take on MARTA TRAINS?*
  - I ride much more often: 5%
  - I ride somewhat more often: 11%
  - I ride about the same: 76%
  - I usually don't check train RTI: 5%
  - I usually don't ride MARTA trains: 3%

- Has using an app with real-time information changed the amount of time you spend WAITING for MARTA TRAINS?**
  - I spend about the same amount of time waiting: 24%
  - I spend somewhat less time waiting: 53%
  - I spend much less time waiting: 18%
  - I usually don't check train RTI: 5%

- Has using an app with real-time information changed how SATISFIED you are with MARTA TRAIN service?
  - I feel much more satisfied: 13%
  - I feel somewhat more satisfied: 47%
  - I feel about the same: 26%
  - I feel somewhat less satisfied: 3%
  - I feel much less satisfied: 8%
  - I usually don't ride MARTA trains: 0%
## Comparison of Key Findings

<table>
<thead>
<tr>
<th></th>
<th>New York City</th>
<th>Tampa</th>
<th>Atlanta</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transit Agency</strong></td>
<td>MTA New York City Transit</td>
<td>HART</td>
<td>martta</td>
</tr>
<tr>
<td><strong>Methodology</strong></td>
<td>Natural experiment with panel regression</td>
<td>Behavioral experiment with a before-after control group design</td>
<td>Before-after analysis of transit trips</td>
</tr>
<tr>
<td><strong>Key Finding</strong></td>
<td>Average weekday route-level increase of (~115) rides (median of (1.6%)); Average weekday increase of (~338) rides on the largest routes (median of (2.3%))</td>
<td>Little evidence supporting a change in bus trips; Significant improvements in the waiting experience, particularly wait times</td>
<td>Little evidence supporting a change in bus/train trips; Perceived improvements in wait times and overall satisfaction with MARTA</td>
</tr>
</tbody>
</table>
Simon Berrebi

USING REAL-TIME INFO TO PREVENT BUS BUNCHING
Content

I. Characteristics of a high-frequency route
II. How bus bunching happens
III. Real time control
IV. Simulation on BRT
V. Conclusion
High-Frequency Route

• For passengers, high frequency = freedom
  o They can travel when they want
  o They can make spontaneous travel decisions
  o They don’t have to rely on a schedule

• Research shows random arrivals for headways < 12 minutes

• Transit agencies strive to minimize the waiting time of these passengers
Unstable Headway Dynamics

- Passenger waiting
- Bus stop
Offset of Bus Bunching

Station Number

Offset of Bus Bunching

15:30
16:30
17:30

Time of day

Graph showing the offset of bus bunching with time of day on the x-axis and station number on the y-axis.
Schedules/Blocks

Tell operators when to start their route

- Help maintain stable headways
- Should include enough layover for buses to start on time
Cycle Time

Operator who finish too late will have to start next assignment late without break.
Real-Time Control

Using real-time information, it is possible to predict when buses will return late at the terminal.

- We can *space out* departures to maintain stable headways.

<table>
<thead>
<tr>
<th>Time</th>
<th>Status</th>
<th>Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:16</td>
<td>Blue Stinger</td>
<td>1</td>
</tr>
<tr>
<td>15:18</td>
<td>Blue Stinger</td>
<td></td>
</tr>
<tr>
<td>15:25</td>
<td>Blue Stinger</td>
<td>7</td>
</tr>
<tr>
<td>15:34</td>
<td>Blue Stinger</td>
<td>16</td>
</tr>
<tr>
<td>15:46</td>
<td>Blue Stinger</td>
<td>28</td>
</tr>
<tr>
<td>15:48</td>
<td>Blue Stinger</td>
<td>30</td>
</tr>
</tbody>
</table>

Load more arrivals
Proposed Policy

Cumulative Number of buses

Time

Frequency

Schedule
Simulation

We tested the real-time dispatching method on Line A in Seattle, WA

• 10 minute headways
• Repeated block in PM the afternoon (3-6 pm)
• Dedicated right-of-way
Number of Dispatches

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Number of Buses</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:15:00</td>
<td>15</td>
</tr>
<tr>
<td>15:45:00</td>
<td>14</td>
</tr>
<tr>
<td>16:15:00</td>
<td>13</td>
</tr>
<tr>
<td>16:45:00</td>
<td>12</td>
</tr>
<tr>
<td>17:15:00</td>
<td>11</td>
</tr>
<tr>
<td>17:45:00</td>
<td>10</td>
</tr>
</tbody>
</table>

- Scheduled departure time
- End time of last assignment
- Departure time (proposed)
- Departure time (current)
Headway Recovery

Number of buses dispatched

Headway (mm:ss)
Conclusion

• On high frequency routes, some passengers care more about headways then schedules

• Buses that start their route late often bunch because they get more passengers

• Using real-time information we can space out bus departures to keep stable headways
NEXT STEPS FOR YOU
What can an agency do?

• Customer focus
• Consider installing AVL
• Convert schedule data to GTFS
• Open up data
General Transit Feed Specification

- routes.txt
- agency.txt
- trips.txt
- stops.txt
- stop_times.txt
- calendar.txt
- shapes.txt

GTFS
Open Data

Agency

Agency responds to special requests by developers

App Developers

Any one can access data

Riders

Small subset of riders find this specific tool useful.

Agency produces data and opens it once.

Many riders access a diverse market of tools powered by GTFS.
How to open your data?

From http://www.gtfs-data-exchange.com/how-to-provide-open-data:

1. Publish your schedule data as a GTFS feed. Google publishes instructions on how to create GTFS feeds.
2. Provide an official URL where your feed can be downloaded. This can be a URL on your agency site or a URL to a third-party authorized to host your feed. Note: a simple way to provide an official URL is to upload your feed to GTFS Data Exchange and use the provided url.
3. Send email to transit-developers@googlegroups.com with the URL of your feed. Note: this is a public mailing list.
4. Submit GTFS feed location for inclusion on GTFS Data Exchange. This helps developers find the URL where your data is published.
References


THANKS!

http://onebusaway.org

- **Funding partners** = NSF, US DOT, NCTSPM, CUTR, GVU Center, IPAT
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- **Research partners** = Dr. Brian Ferris, Dr. Alan Borning (UW), Dr. Sean Barbeau (USF), independent developers

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