Signalized Arterial Performance Measures
(using trajectory data from 3rd parties)

BRTB Traffic Signal Subcommittee
Gregory Jordan
CATT Laboratory

Enabling agencies through better communication, data-based decision making, advanced insights discovery, and enhanced operations and planning capabilities.
Background

What is trajectory data?
• Time stamped location data from GPS-enabled devices
• Data is collected on individual trips
  • Departure time and location (trip origin)
  • Route selection and travel time
  • Arrival time and location (trip destination)
  • All personally identifiable info is removed
Challenges

• Big data
  • 4 Months of Data for MD
    • 20 Million trips
    • 1.4 Billion waypoints
    • 112 GB of data

• Data cleaning
  • Snapping
  • Routing
One day in D.C.

05:00 am
Trajectory Data for Signals

Mid-block travel time analysis...

Turning Movement support...

O-D, trips, marketing, etc...
### Ranked intersection movements in the 10011 zip code for the date range of 05/06/18 through 05/12/18

<table>
<thead>
<tr>
<th>Rank</th>
<th>Map</th>
<th>Intersection</th>
<th>Approach</th>
<th>Movement</th>
<th>Volume</th>
<th>User Delay Cost</th>
<th>Average Travel Time</th>
<th>25th Percentile</th>
<th>75th Percentile</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>8th Ave at W 23rd St</td>
<td>Northbound</td>
<td>Left</td>
<td>489</td>
<td>$4,235.00</td>
<td>5.5 mins</td>
<td>7.2 mins</td>
<td>7.2 mins</td>
<td>7.5 mins</td>
<td>7.5 mins</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>W 20th St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>761</td>
<td>$4,194.00</td>
<td>5.2 mins</td>
<td>2.1 mins</td>
<td>6.9 mins</td>
<td>1.4 mins</td>
<td>7.1 mins</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>W 19th St at 9th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>504</td>
<td>$4,895.00</td>
<td>5.0 mins</td>
<td>2.1 mins</td>
<td>6.8 mins</td>
<td>1.4 mins</td>
<td>6.9 mins</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>W 23rd St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>210</td>
<td>$2,305.00</td>
<td>4.9 mins</td>
<td>1.7 mins</td>
<td>7.1 mins</td>
<td>1.2 mins</td>
<td>7.2 mins</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>W 20th St at 8th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>354</td>
<td>$3,204.00</td>
<td>4.7 mins</td>
<td>1.8 mins</td>
<td>6.6 mins</td>
<td>1.3 mins</td>
<td>6.8 mins</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>7th Ave at W 17th St</td>
<td>Southbound</td>
<td>Through</td>
<td>159</td>
<td>$2,987.00</td>
<td>4.7 mins</td>
<td>1.5 mins</td>
<td>6.3 mins</td>
<td>1.2 mins</td>
<td>6.6 mins</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>W 15th St at 11th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>263</td>
<td>$2,516.00</td>
<td>4.5 mins</td>
<td>1.4 mins</td>
<td>6.0 mins</td>
<td>1.1 mins</td>
<td>6.5 mins</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>W 19th St at 6th Ave</td>
<td>Westbound</td>
<td>Right</td>
<td>186</td>
<td>$1,425.00</td>
<td>4.4 mins</td>
<td>0.8 mins</td>
<td>5.8 mins</td>
<td>0.6 mins</td>
<td>6.2 mins</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>W 14th St at 7th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>218</td>
<td>$1,546.00</td>
<td>4.3 mins</td>
<td>1.5 mins</td>
<td>5.6 mins</td>
<td>1.0 mins</td>
<td>6.0 mins</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>W 21st St at 10th Ave</td>
<td>Eastbound</td>
<td>Left</td>
<td>135</td>
<td>$1,204.00</td>
<td>4.0 mins</td>
<td>0.7 mins</td>
<td>5.5 mins</td>
<td>0.5 mins</td>
<td>6.0 mins</td>
</tr>
</tbody>
</table>

### Average Travel Time

- **25th Percentile**: 7 mins
- **50th Percentile**: 25 mins
- **75th Percentile**: 52 mins
- **95th Percentile**: 69 mins

### User Delay Cost

- **8th Ave and W 23rd St**: $4,235.00

### Total Trips

- **1 to 200**: 10
- **201 to 400**: 20
- **401 to 600**: 30
- **601 to 800**: 40
- **801 to 1000**: 50

### Travel Time

- **Free Flow Time**: 1 min
- **5 mins**: 10
- **10 mins**: 20
- **15 mins**: 30
- **20 mins**: 40
- **25 mins**: 50
- **30 mins**: 60
- **35 mins**: 70
- **40 mins**: 80
- **45 mins**: 90
- **50 mins**: 100
- **55 mins**: 110
- **60 mins**: 120
- **65 mins**: 130
- **70 mins**: 140
- **75 mins**: 150
- **80 mins**: 160
- **85 mins**: 170
- **90 mins**: 180
- **95 mins**: 190
- **100 mins**: 200

### Time of Day

- **All Hours**

### Map Display

- **8th Ave and W 23rd St**
  - **Travel Time**: 4.4 mins
  - **Total Trips**: 10
  - **Average Travel Time**: 25 mins
  - **User Delay Cost**: $4,235.00
Ranked intersection movements in the 10011 zip code for the date range of 05/06/18 through 05/12/18

| Rank | Map | Intersection     | Approach | Movement | Volume | User Delay Cost | Average Travel Time | 25th Percentile | 75th Percentile | 95th Percentile | 5th Percentile | 90th Percentile |
|------|-----|-------------------|----------|----------|--------|-----------------|---------------------|-----------------|----------------|----------------|----------------|----------------|----------------|
| 25   |     | W 21st St at 10th Ave | Northbound | Left     | 489    | $4,235.20       | 5.5 mins            | 2.5 mins        | 7.2 mins        | 1.5 mins        | 7.5 mins        |                 |
| 26   |     | W 23rd St at 6th Ave | Eastbound | Through  | 761    | $4,194.00       | 5.2 mins            | 2.1 mins        | 6.9 mins        | 1.4 mins        | 7.1 mins        |                 |
| 27   |     | W 19th St at 6th Ave | Westbound | Left     | 504    | $4,895.00       | 5.0 mins            | 2.1 mins        | 6.8 mins        | 1.4 mins        | 6.9 mins        |                 |
| 28   |     | W 19th St at 6th Ave | Eastbound | Through  | 210    | $2,305.00       | 4.9 mins            | 1.7 mins        | 7.1 mins        | 1.2 mins        | 7.2 mins        |                 |
| 29   |     | W 20th St at 8th Ave | Westbound | Left     | 354    | $3,204.00       | 4.7 mins            | 1.8 mins        | 6.6 mins        | 1.3 mins        | 6.9 mins        |                 |
| 30   |     | 8th Ave at W 23rd St | Westbound | Through  | 159    | $2,987.00       | 4.7 mins            | 1.5 mins        | 6.3 mins        | 1.2 mins        | 6.6 mins        |                 |
| 31   |     | W 19th St at 9th Ave | Westbound | Left     | 263    | $2,516.00       | 4.5 mins            | 1.4 mins        | 6.0 mins        | 1.1 mins        | 6.5 mins        |                 |
| 32   |     | W 19th St at 6th Ave | Westbound | Right    | 186    | $1,451.00       | 4.4 mins            | 0.8 mins        | 5.9 mins        | 0.6 mins        | 6.2 mins        |                 |
| 33   |     | W 20th St at 9th Ave | Eastbound | Through  | 218    | $1,546.00       | 4.3 mins            | 1.5 mins        | 5.6 mins        | 1.0 mins        | 6.0 mins        |                 |
| 34   |     | W 21st St at 10th Ave | Eastbound | Left     | 135    | $1,204.00       | 4.0 mins            | 0.7 mins        | 5.5 mins        | 0.5 mins        | 6.0 mins        |                 |

Average Travel Time:
- 25th Percentile: 25 mins
- 75th Percentile: 21 mins
- 5th Percentile: 69 mins
- 95th Percentile: 72 mins

Travel Time:
- 1.9 mins
- 3.7 mins

Note: The table and map data provide specific information about traffic volumes, user delay costs, and average travel times for various intersections in the specified Zip Code area.
## Ranked Intersection Movements in the 10011 Zip Code for the Date Range of 05/06/18 through 05/12/18

<table>
<thead>
<tr>
<th>Rank</th>
<th>Map</th>
<th>Intersection</th>
<th>Approach</th>
<th>Movement</th>
<th>Volume</th>
<th>User Delay Cost</th>
<th>Average Travel Time</th>
<th>25th Percentile</th>
<th>75th Percentile</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td>W 21st St at 10th Ave</td>
<td>Northbound</td>
<td>Left</td>
<td>489</td>
<td>$4,235.20</td>
<td>5.5 mins</td>
<td>2.5 mins</td>
<td>7.2 mins</td>
<td>1.5 mins</td>
<td>7.5 mins</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>W 23rd St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>761</td>
<td>$4,194.00</td>
<td>5.2 mins</td>
<td>2.1 mins</td>
<td>6.9 mins</td>
<td>1.4 mins</td>
<td>7.1 mins</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>W 19th St at 8th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>504</td>
<td>$4,895.00</td>
<td>5.0 mins</td>
<td>2.1 mins</td>
<td>6.8 mins</td>
<td>1.4 mins</td>
<td>6.9 mins</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>W 19th St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>210</td>
<td>$2,305.00</td>
<td>4.9 mins</td>
<td>1.7 mins</td>
<td>7.1 mins</td>
<td>1.2 mins</td>
<td>7.2 mins</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>W 20th St at 8th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>354</td>
<td>$3,204.00</td>
<td>4.7 mins</td>
<td>1.8 mins</td>
<td>6.6 mins</td>
<td>1.3 mins</td>
<td>6.8 mins</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>8th Ave at W 23rd St</td>
<td>Westbound</td>
<td>Through</td>
<td>159</td>
<td>$2,987.00</td>
<td>4.7 mins</td>
<td>1.5 mins</td>
<td>6.3 mins</td>
<td>1.2 mins</td>
<td>5.6 mins</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>W 19th St at 8th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>263</td>
<td>$2,516.00</td>
<td>4.5 mins</td>
<td>1.4 mins</td>
<td>6.0 mins</td>
<td>1.1 mins</td>
<td>6.5 mins</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>W 19th St at 8th Ave</td>
<td>Westbound</td>
<td>Right</td>
<td>186</td>
<td>$1,45.00</td>
<td>4.4 mins</td>
<td>0.8 mins</td>
<td>5.9 mins</td>
<td>0.6 mins</td>
<td>6.2 mins</td>
</tr>
<tr>
<td>33</td>
<td></td>
<td>W 20th St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>218</td>
<td>$1,546.00</td>
<td>4.3 mins</td>
<td>1.5 mins</td>
<td>5.6 mins</td>
<td>1.0 mins</td>
<td>6.0 mins</td>
</tr>
<tr>
<td>34</td>
<td></td>
<td>W 21st St at 10th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>135</td>
<td>$1,204.00</td>
<td>4.0 mins</td>
<td>0.7 mins</td>
<td>5.5 mins</td>
<td>0.5 mins</td>
<td>6.0 mins</td>
</tr>
</tbody>
</table>

### Map

- **8th Ave at W 23rd St**

### Travel Time

- **8th Avenue**
  - AM Peak: 1.9 mins
  - PM Peak: 3.7 mins
  - Midday: 5.2 mins
  - Weekends: 4.1 mins

### Total Trips

- **8th Ave**
  - 4.1 mins
  - 4.5 mins
  - 5.0 mins
  - 5.5 mins
  - 6.0 mins
  - 6.5 mins
  - 7.0 mins

### Travel Time Distribution

- **0.0** mins
- **0.5** mins
- **1.0** mins
- **1.5** mins
- **2.0** mins
- **2.5** mins
- **3.0** mins
- **3.5** mins
- **4.0** mins
- **4.5** mins
- **5.0** mins
- **5.5** mins
- **6.0** mins

**Free Flow**: 1 mins
### Ranked Intersection Movements in the 10011 Zip Code

<table>
<thead>
<tr>
<th>Rank</th>
<th>Map</th>
<th>Intersection</th>
<th>Approach</th>
<th>Movement</th>
<th>Volume</th>
<th>User Delay Cost</th>
<th>Average Travel Time</th>
<th>25th Precinct</th>
<th>75th Precinct</th>
<th>5th Precinct</th>
<th>95th Precinct</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>8th Ave at W 23rd St</td>
<td>Eastbound</td>
<td>Through</td>
<td>489</td>
<td>$4,235.00</td>
<td>5.5 mins</td>
<td>2.5 mins</td>
<td>7.2 mins</td>
<td>1.5 mins</td>
<td>7.5 mins</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>W 20th St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>354</td>
<td>$4,194.00</td>
<td>5.2 mins</td>
<td>2.1 mins</td>
<td>6.9 mins</td>
<td>1.4 mins</td>
<td>7.1 mins</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>W 19th St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>504</td>
<td>$4,895.00</td>
<td>5.0 mins</td>
<td>2.1 mins</td>
<td>6.8 mins</td>
<td>1.4 mins</td>
<td>7.2 mins</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>W 23rd St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>210</td>
<td>$2,305.00</td>
<td>4.9 mins</td>
<td>1.7 mins</td>
<td>7.1 mins</td>
<td>1.2 mins</td>
<td>7.2 mins</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>W 20th St at 8th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>354</td>
<td>$3,204.00</td>
<td>4.7 mins</td>
<td>1.8 mins</td>
<td>6.6 mins</td>
<td>1.3 mins</td>
<td>6.8 mins</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>7th Ave at W 17th St</td>
<td>Southbound</td>
<td>Through</td>
<td>159</td>
<td>$2,987.00</td>
<td>4.7 mins</td>
<td>1.5 mins</td>
<td>6.3 mins</td>
<td>1.2 mins</td>
<td>6.6 mins</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>W 15th St at 11th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>263</td>
<td>$2,516.00</td>
<td>4.4 mins</td>
<td>1.4 mins</td>
<td>6.0 mins</td>
<td>1.1 mins</td>
<td>6.5 mins</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>W 19th St at 6th Ave</td>
<td>Westbound</td>
<td>Right</td>
<td>186</td>
<td>$1,425.00</td>
<td>4.4 mins</td>
<td>0.8 mins</td>
<td>5.8 mins</td>
<td>0.6 mins</td>
<td>6.2 mins</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>W 14th St at 7th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>218</td>
<td>$1,546.00</td>
<td>4.3 mins</td>
<td>1.5 mins</td>
<td>6.6 mins</td>
<td>1.0 mins</td>
<td>6.0 mins</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>W 21st St at 10th Ave</td>
<td>Eastbound</td>
<td>Left</td>
<td>135</td>
<td>$1,204.00</td>
<td>4.0 mins</td>
<td>0.7 mins</td>
<td>5.5 mins</td>
<td>0.5 mins</td>
<td>6.0 mins</td>
</tr>
</tbody>
</table>

### User Delay Costs
- **Average Travel Time**:
  - 25th Percentile: 7 mins
  - 75th Percentile: 17 mins
  - 5th Percentile: 7 mins
  - 95th Percentile: 17 mins

- **Travel Time**:
  - Average: 7 mins
  - 25th Percentile: 7 mins
  - 75th Percentile: 17 mins
  - 5th Percentile: 7 mins
  - 95th Percentile: 17 mins

- **User Delay Costs**:
  - $4,235.00
  - $4,194.00
  - $4,895.00
  - $2,305.00
  - $3,204.00
  - $2,987.00
  - $2,516.00
  - $1,425.00
  - $1,546.00
  - $1,204.00
### Ranked intersection movements in the 10011 zip code for the date range of 05/06/18 through 05/12/18

<table>
<thead>
<tr>
<th>Rank</th>
<th>Map</th>
<th>Intersection</th>
<th>Approach</th>
<th>Movement</th>
<th>Volume</th>
<th>User Delay Cost</th>
<th>Average Travel Time</th>
<th>25th Percentile</th>
<th>75th Percentile</th>
<th>5th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td>W 21st St at 10th Ave</td>
<td>Northbound</td>
<td>Left</td>
<td>489</td>
<td>$4,235.20</td>
<td>4.5 mins</td>
<td>2.5 mins</td>
<td>7.2 mins</td>
<td>1.5 mins</td>
<td>7.5 mins</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>W 23rd St at 6th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>761</td>
<td>$4,194.00</td>
<td>4.2 mins</td>
<td>2.1 mins</td>
<td>6.9 mins</td>
<td>1.4 mins</td>
<td>7.1 mins</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>W 19th St at 6th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>504</td>
<td>$4,895.00</td>
<td>4.0 mins</td>
<td>2.1 mins</td>
<td>6.8 mins</td>
<td>1.4 mins</td>
<td>7.1 mins</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>W 19th St at 6th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>210</td>
<td>$2,305.00</td>
<td>3.9 mins</td>
<td>1.7 mins</td>
<td>7.1 mins</td>
<td>1.2 mins</td>
<td>7.2 mins</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>W 20th St at 8th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>354</td>
<td>$3,204.00</td>
<td>3.7 mins</td>
<td>1.8 mins</td>
<td>6.6 mins</td>
<td>1.3 mins</td>
<td>6.8 mins</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>8th Ave at W 23rd St</td>
<td>Westbound</td>
<td>Through</td>
<td>159</td>
<td>$2,987.00</td>
<td>3.7 mins</td>
<td>1.5 mins</td>
<td>6.3 mins</td>
<td>1.2 mins</td>
<td>6.6 mins</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>W 19th St at 9th Ave</td>
<td>Westbound</td>
<td>Left</td>
<td>263</td>
<td>$2,516.00</td>
<td>3.5 mins</td>
<td>1.4 mins</td>
<td>6.0 mins</td>
<td>1.1 mins</td>
<td>6.5 mins</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>W 19th St at 6th Ave</td>
<td>Westbound</td>
<td>Right</td>
<td>186</td>
<td>$1,425.00</td>
<td>3.4 mins</td>
<td>0.8 mins</td>
<td>5.8 mins</td>
<td>0.6 mins</td>
<td>6.2 mins</td>
</tr>
<tr>
<td>33</td>
<td></td>
<td>W 20th St at 8th Ave</td>
<td>Eastbound</td>
<td>Through</td>
<td>218</td>
<td>$1,546.00</td>
<td>3.3 mins</td>
<td>1.5 mins</td>
<td>5.6 mins</td>
<td>1.0 mins</td>
<td>6.0 mins</td>
</tr>
<tr>
<td>34</td>
<td></td>
<td>W 21st St at 10th Ave</td>
<td>Eastbound</td>
<td>Left</td>
<td>135</td>
<td>$1,204.00</td>
<td>3.0 mins</td>
<td>0.7 mins</td>
<td>5.5 mins</td>
<td>0.5 mins</td>
<td>6.0 mins</td>
</tr>
</tbody>
</table>

### Average Travel Time

- **25th Percentile**
  - 42 mins
  - 40 mins
  - 39 mins
  - 37 mins
  - 34 mins

- **75th Percentile**
  - 21 mins
  - 21 mins
  - 21 mins
  - 18 mins
  - 14 mins

- **50th Percentile**
  - 25 mins
  - 21 mins
  - 17 mins
  - 15 mins
  - 10 mins

- **95th Percentile**
  - 69 mins
  - 68 mins
  - 66 mins
  - 65 mins
  - 60 mins

### Travel Time Breakdown

- **8th Ave at W 23rd St**
  - Average: 4 mins
  - 4.4 mins
  - 4.1 mins
  - 2.3 mins

- **Total Trips**
  - 0.5 - 2.5 mins

- **Free Flow**
  - 0.5 - 1.5 mins
  - 1.5 - 3 mins
  - 3 - 5 mins
  - 5 - 6 mins
  - 6+ mins