Design Considerations for Real-time Arterial Performance Measurement Systems Using Transit Bus Probes

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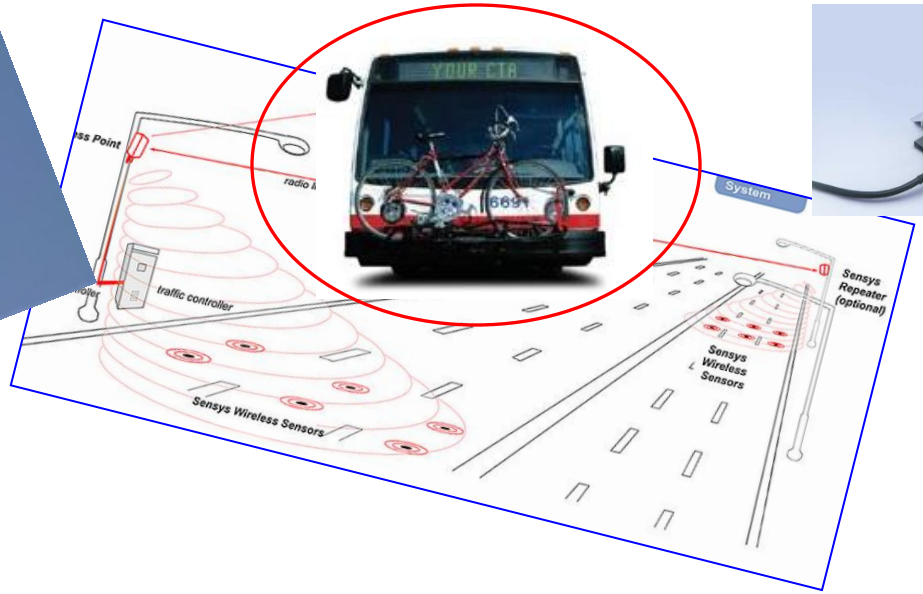
Project Goals

- Estimate traffic conditions on 300 miles of strategic arterials in Chicago
- Inform public and emergency responders of current traffic conditions
- Mitigate congestion by diverting traffic away from congested street segments

Many Possible Data Sources



- Bus data is readily available and easily accessible at the least cost to the city

Key Features

INPUT

- Bus reports its location, odometer speed and a few other parameters every 30 seconds to a central server
- Real-time data from over 2,300 buses provides reasonable coverage of city's principal arterials

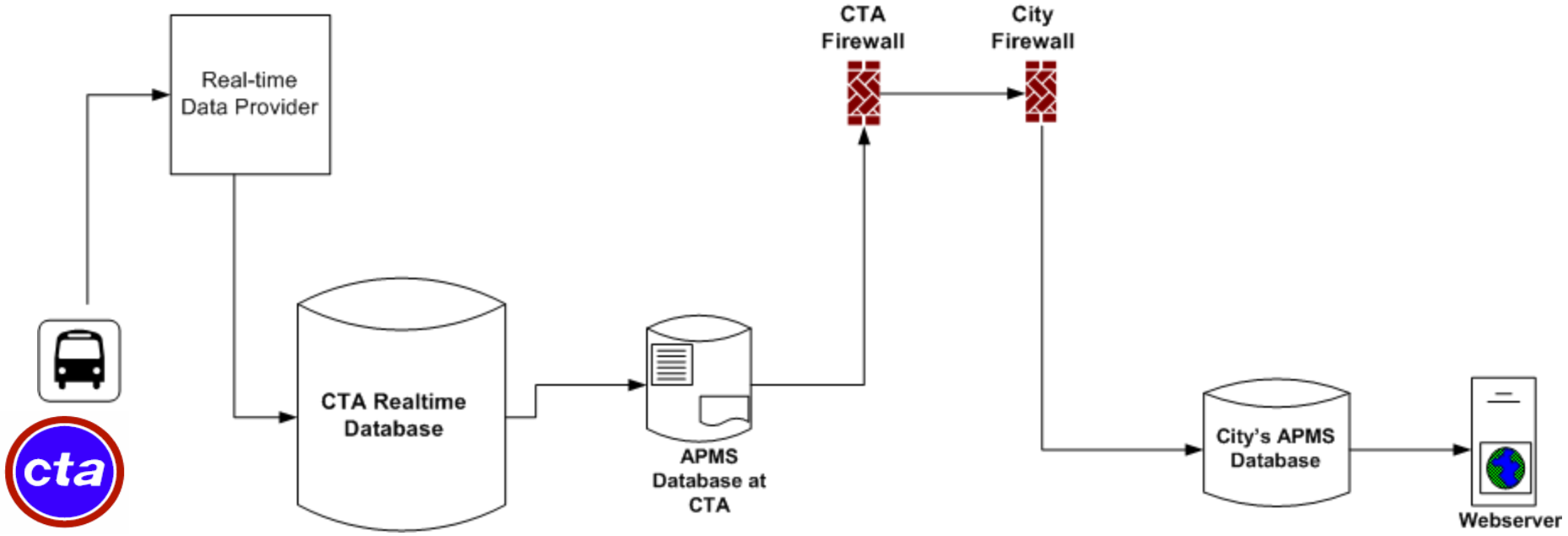
PROCESS

OUTPUT

- Generate congestion map
- Compute travel times for traffic alerts and Variable Message Signs

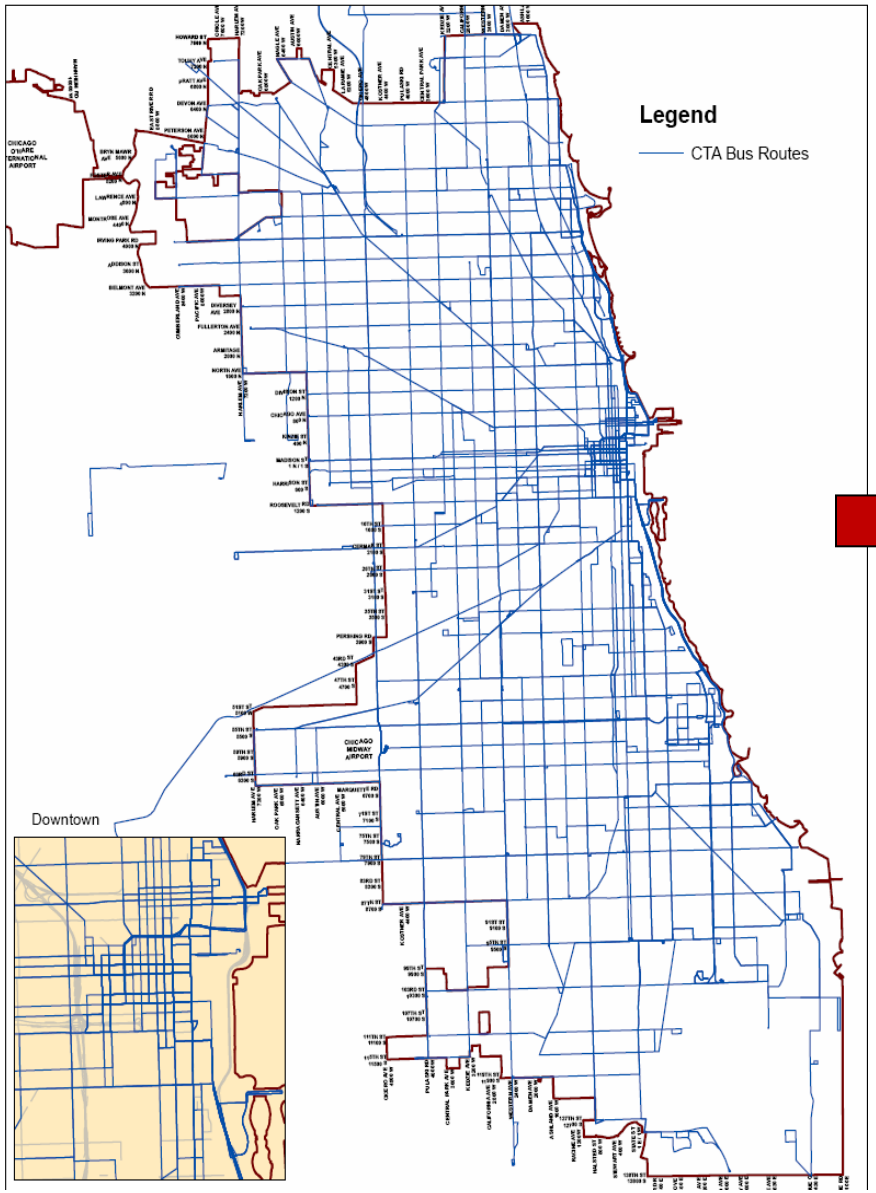
Data Source

- Data Collected by CTA for Bus Tracker System
- Leveraged network connection between City & CTA

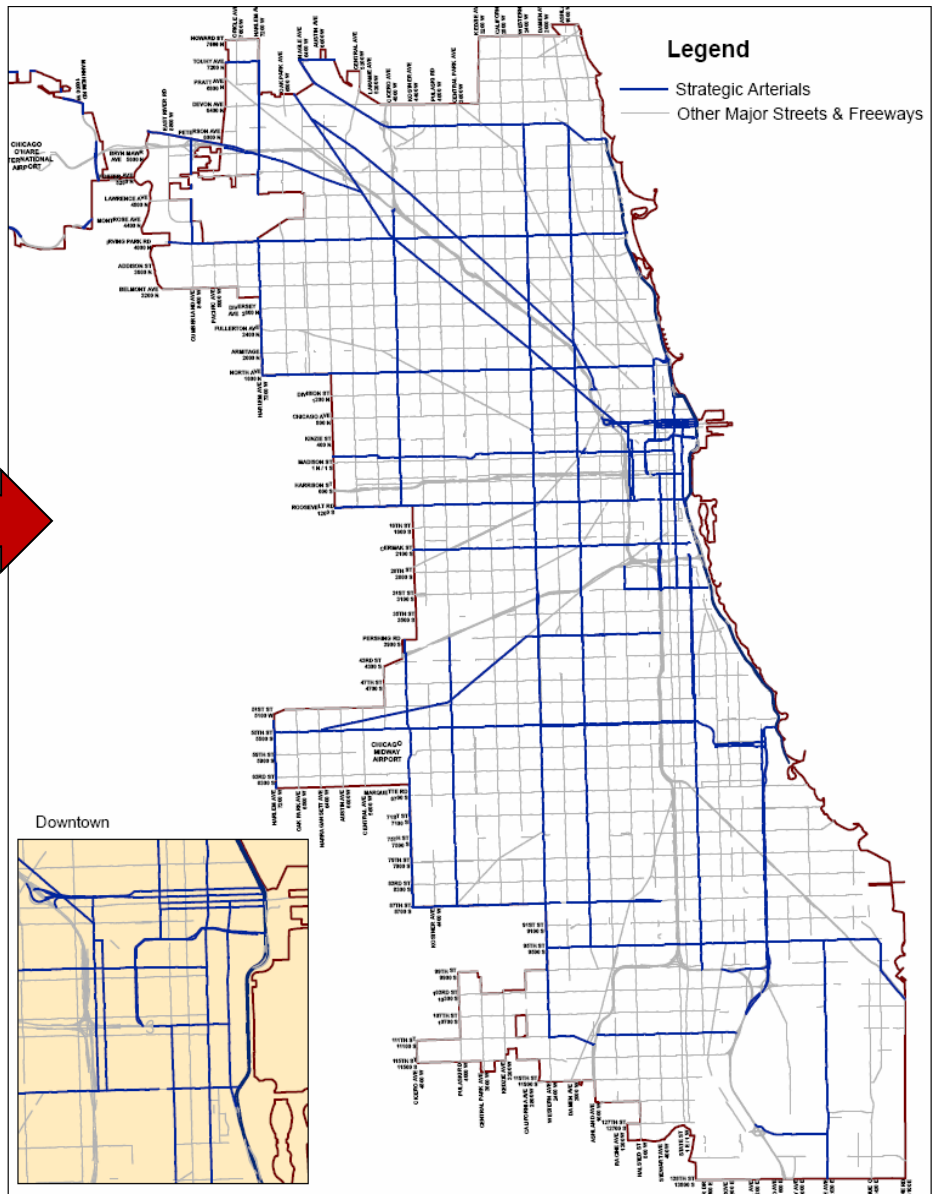


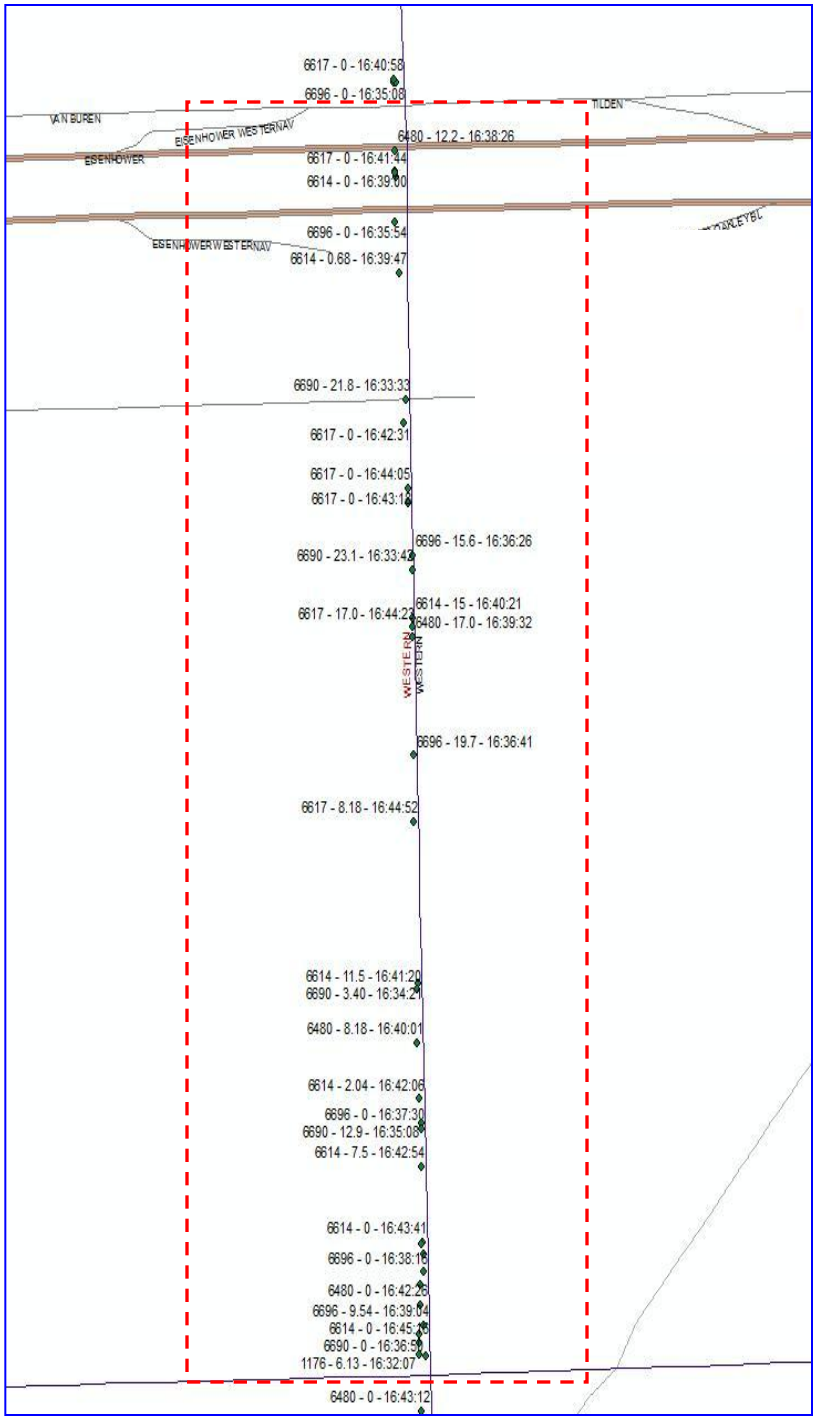
Route Selection

CTA Bus Routes



Chicago Strategic Arterial Network

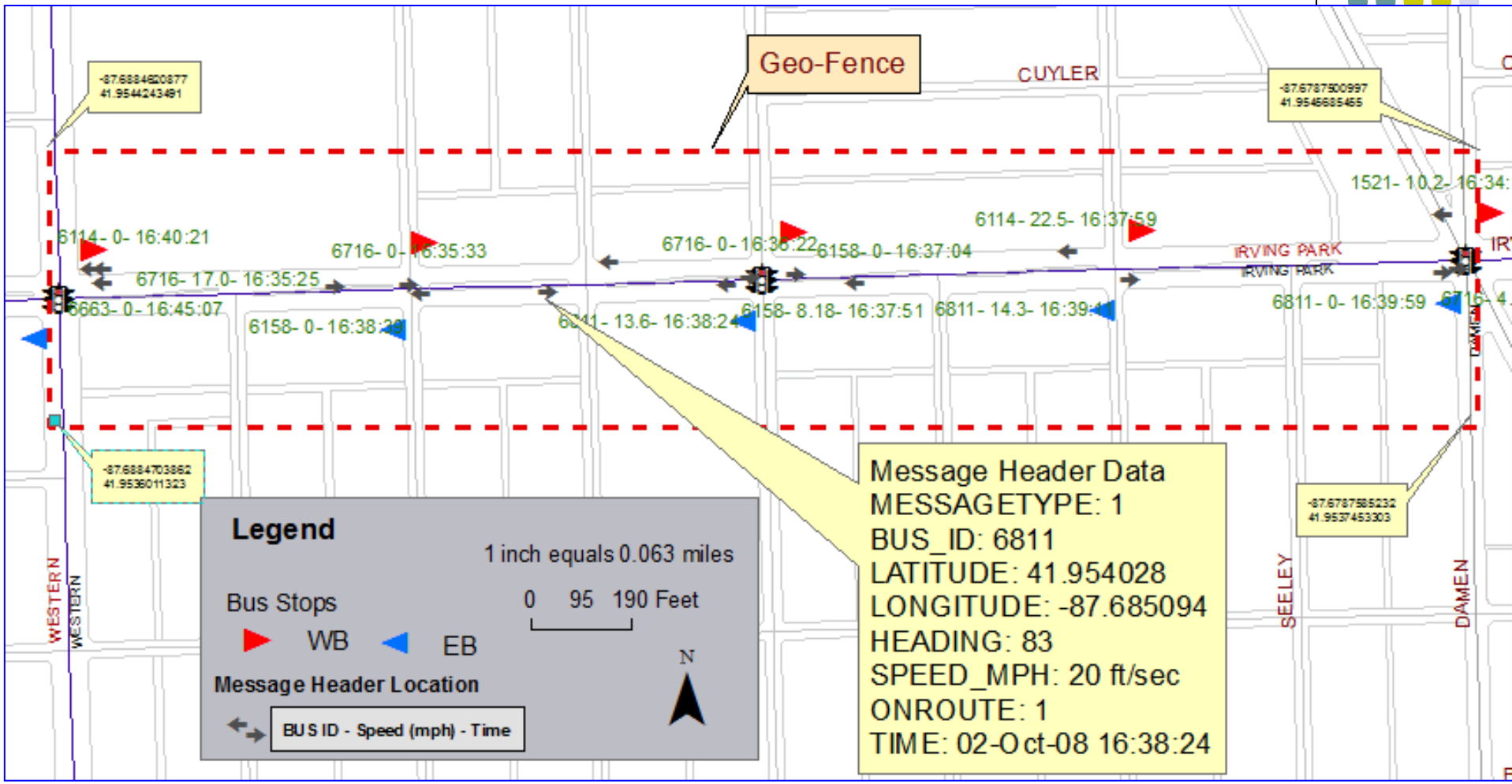




Segment the Network

- Roughly half mile segments
- One segment for each direction of travel
- 300 * 1/2 * 2 = 1,200 segments
- Determine latitude and longitude boundaries for each segment (“GEO-FENCE”)

Identify buses on each segment

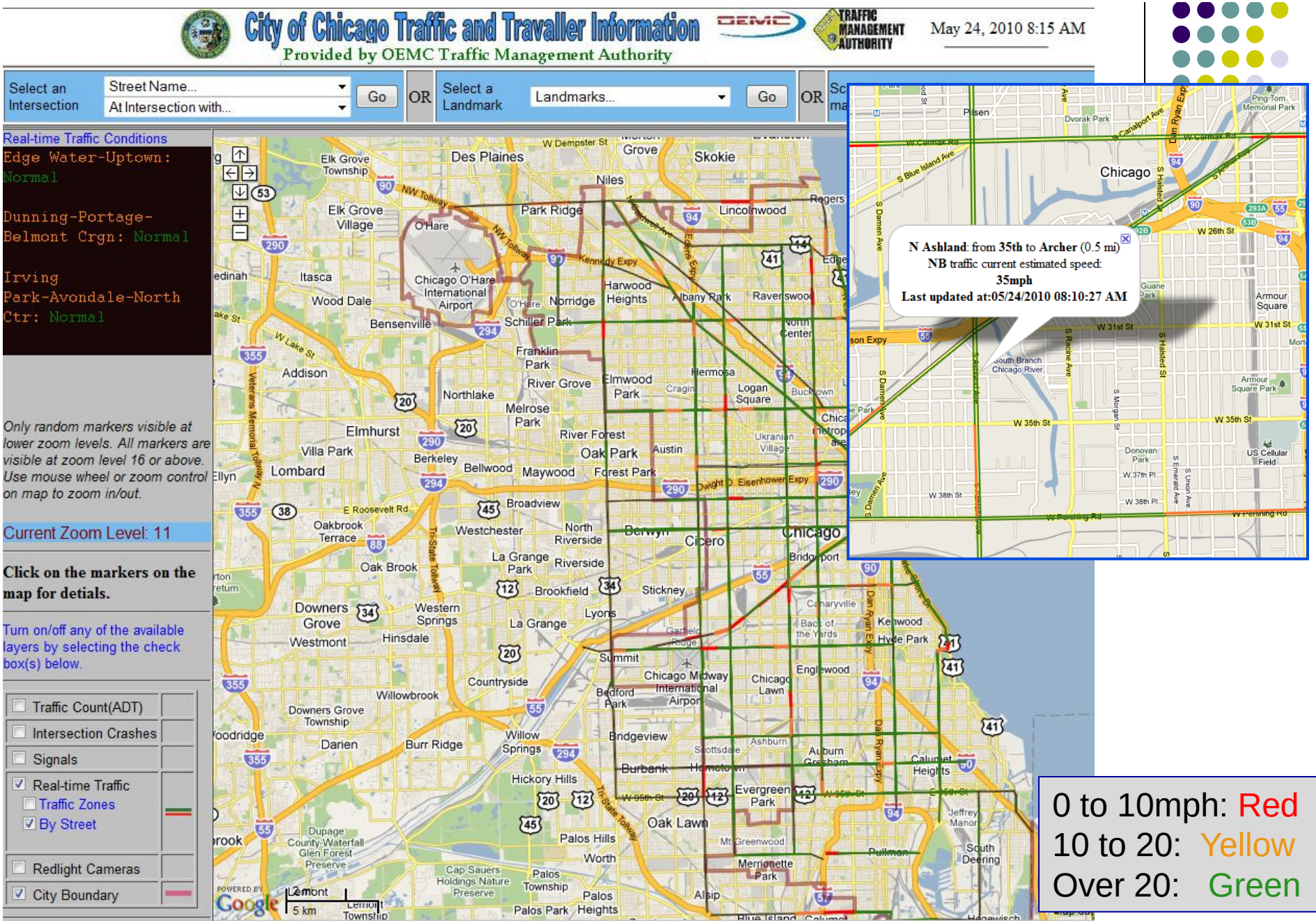


- Bus reports its position (lat/long) & direction of travel
- Each segment has its lat/long boundary

Convert Bus Data to Congestion Estimation

- Based on the travel the buses made on the segment in the last 10 minutes
- On average about 8-10 bus reads per segment
- Convert bus data to traffic condition
  - Extension of the Portland State University method (max odometer speed from all the bus reads on a segment is roughly equal to the speed of cars on the segment)
- Estimated speed on a segment is compared to city speed limits on that segment to determine congestion

Color Coded Map



Travel Time Estimation

- Congestion Estimation process calculates speed on each segment
- Length of each segment and traffic signals on the segment are known
- Signal delay is added to (60/Speed)* Length to estimate the travel time for the segment
- Travel time on all segments on the route is added to get the trip travel time

Alerts via Emails and Variable Message Signs

- Users can configure trip, route and segments
- An upper and lower travel time threshold can be set
- When trip travel times fall outside the set limits an email alert is send to the user
- Variable Message Signs can be updated to show current travel times
- Database jobs are scheduled to check for user configured alert threshold periodically

Alerts can be scheduled for set time of the day or based on a travel time threshold

Registered User,

Based on current traffic conditions we estimate your trip " Trip to Office" from 87th ST & Western to CERMAK & RACINE will take 41 minutes 33 seconds if you start your trip at 10:48 AM on 04/06/2010.

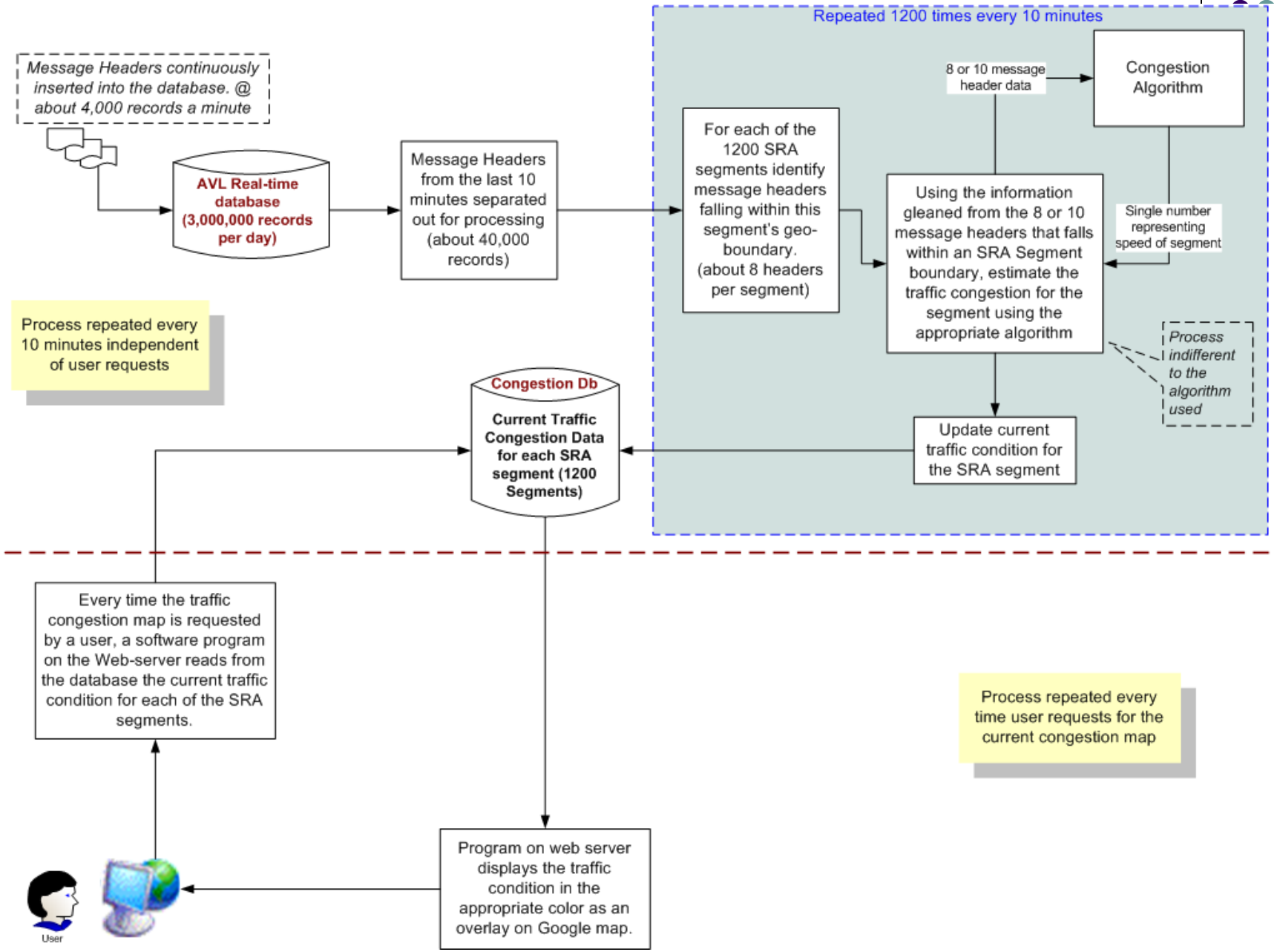
Below is the break-up of travel times on each segment of your trip:
87th ST EB from Western to Damen, L = .50mi, Speed= 27mph, Signals= 1, Travel Time= 1min 31 sec
87th ST EB from Damen to Ashland, L = .50mi, Speed= 27mph, Signals= 2, Travel Time= 1min 55 sec
Ashland NB from 87th St to 83rd St, L = .50mi, Speed= 22mph, Signals= 2, Travel Time= 2min 22 sec
Ashland NB from 83rd St to 79th St, L = .50mi, Speed= 27mph, Signals= 2, Travel Time= 1min 55 sec
Ashland NB from 79th St to 71st St, L = 1.00mi, Speed= 18mph, Signals= 3, Travel Time= 4min 50 sec
**Ashland NB from 71st St to 67th St, L = .50mi, Speed= 20mph, Signals= 2, Travel Time= 2min 30 sec
Ashland NB from 67th St to 63rd St, L = .50mi, Speed= 22mph, Signals= 2, Travel Time= 2min 22 sec
Ashland NB from 63rd St to 59th ST, L = .50mi, Speed= 20mph, Signals= 2, Travel Time= 2min 30 sec
Ashland NB from 59th St to 55th ST, L = .50mi, Speed= 20mph, Signals= 2, Travel Time= 2min 30 sec
Ashland NB from 55th ST to 51st ST, L = .50mi, Speed= 22mph, Signals= 2, Travel Time= 2min 22 sec
Ashland NB from 51st to 47th St, L = .50mi, Speed= 26mph, Signals= 4, Travel Time= 2min 45 sec
Ashland NB from 47th St to 43rd St, L = .50mi, Speed= 27mph, Signals= 4, Travel Time= 2min 43 sec
Ashland NB from 43rd St to Pershing, L = .50mi, Speed= 31mph, Signals= 2, Travel Time= 1min 46 sec
Ashland NB from Pershing to 35th, L = .50mi, Speed= 33mph, Signals= 2, Travel Time= 1min 35 sec
Ashland NB from 35th to Archer, L = .50mi, Speed= 32mph, Signals= 3, Travel Time= 1min 56 sec
Ashland NB from Archer to Cermak, L = 1.00mi, Speed= 32mph, Signals= 4, Travel Time= 3min 12 sec
Cermak EB from Ashland to Racine, L = .50mi, Speed= 29mph, Signals= 2.00, Travel Time= 1min 50 sec

This message is automatically generated from the Chicago Arterial Performance Monitoring System.

NOTES:
Travel Time = Estimated travel time for the segment; calculated as (60/Current Speed)*Length of the Segment + Signal Delay.
Signals Delay = At segment speed below 8mph 1 min for each signal on the segment. At speed between 8mph and 16mph #Signals/1.5, 16-24: #Signals/2, 24-32: #Signals/2.5, 32-40: #Signals/3, above 40mph #Signals/4.
L = Length of the segment in miles
Speed = Current estimated average speed for vehicle on this segment
Signals = Total number of traffic signals on the segment.
Read Count = the number of GPS reads from all buses on this segment.
Bus Count = the number of buses on the segment for the last 10 minutes.
** Current traffic condition not available for this segment. Speed defaulted to 20 mph.
* Current speed reported as "0" for this segment. Speed defaulted to 5 mph.

15 MINUTES TO 55TH ST
35 MINUTES TO MADISON

System Design



Segment Level Traffic Condition has Short Term Validity

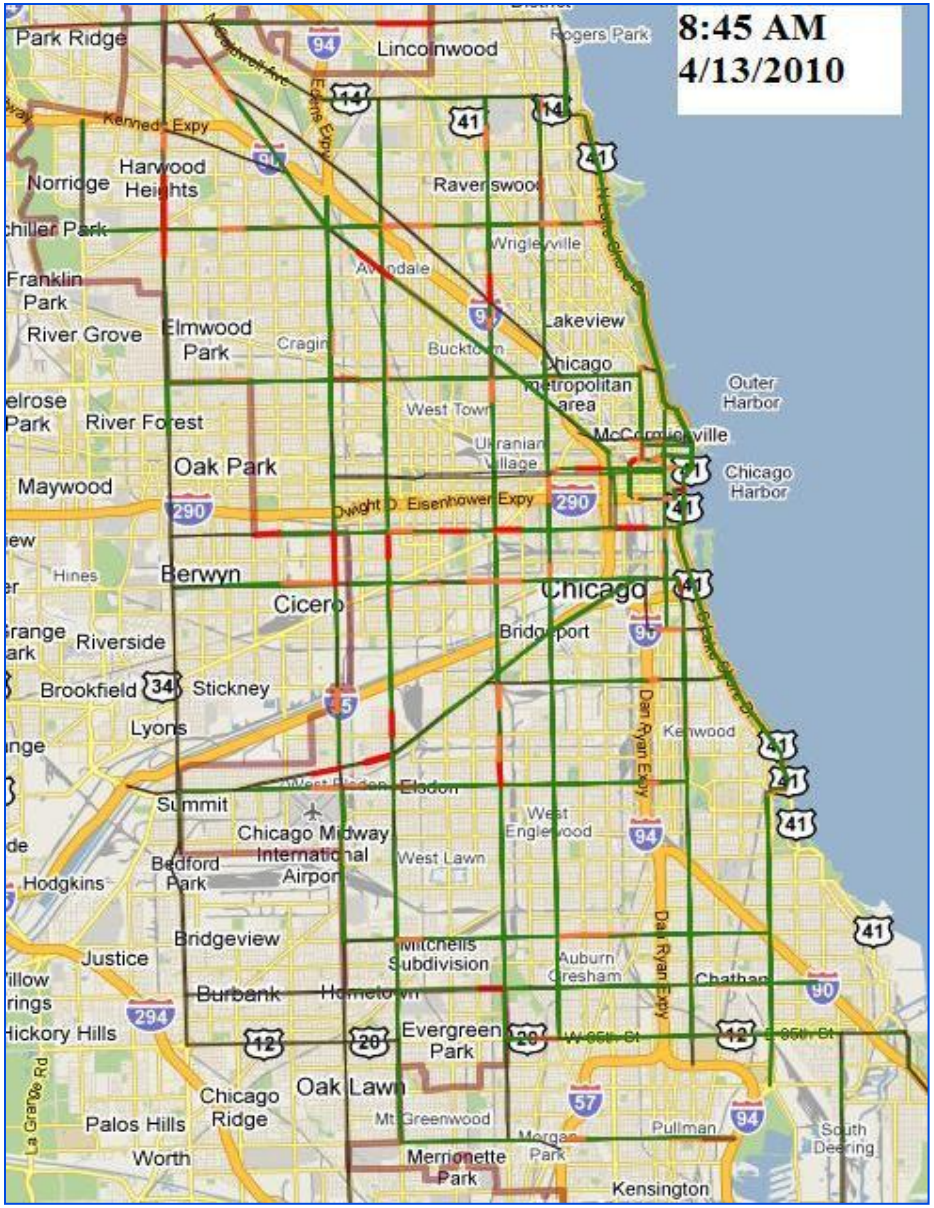
- Unlike freeways, arterial travel conditions tend to change frequently
- Segment speed and travel time estimation is valid for only a shorter time period
- Travel is not limited to the principal arterials we are monitoring
- Does not provide a good indication on congested sections of the city

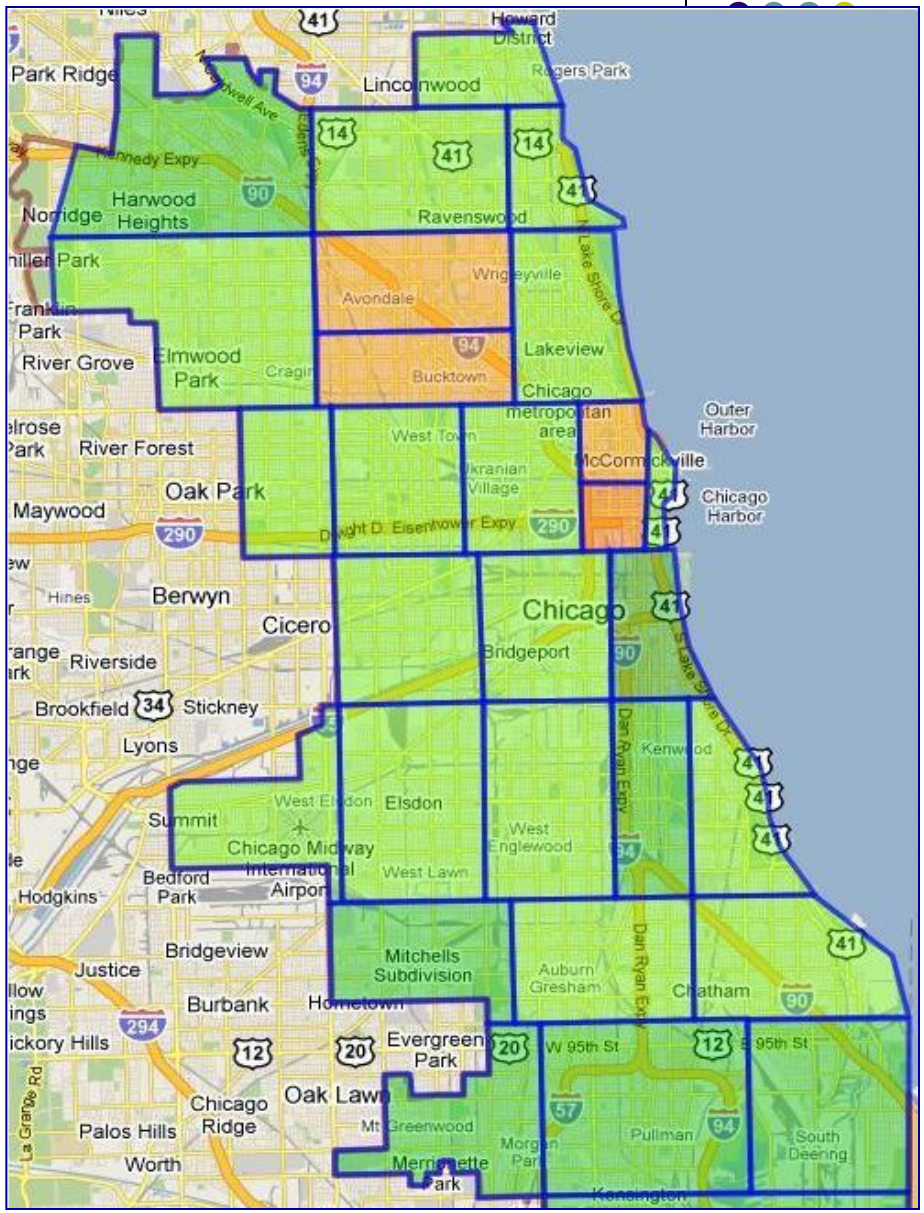
Traffic Zone level map for understanding city wide traffic conditions

- In an urban traffic grid, traffic conditions on major arterials in a particular section of the city is indicative of average traffic conditions in that part of the city

- Generalized traffic condition in a section of the city is valid for longer periods compared to traffic on individual segments

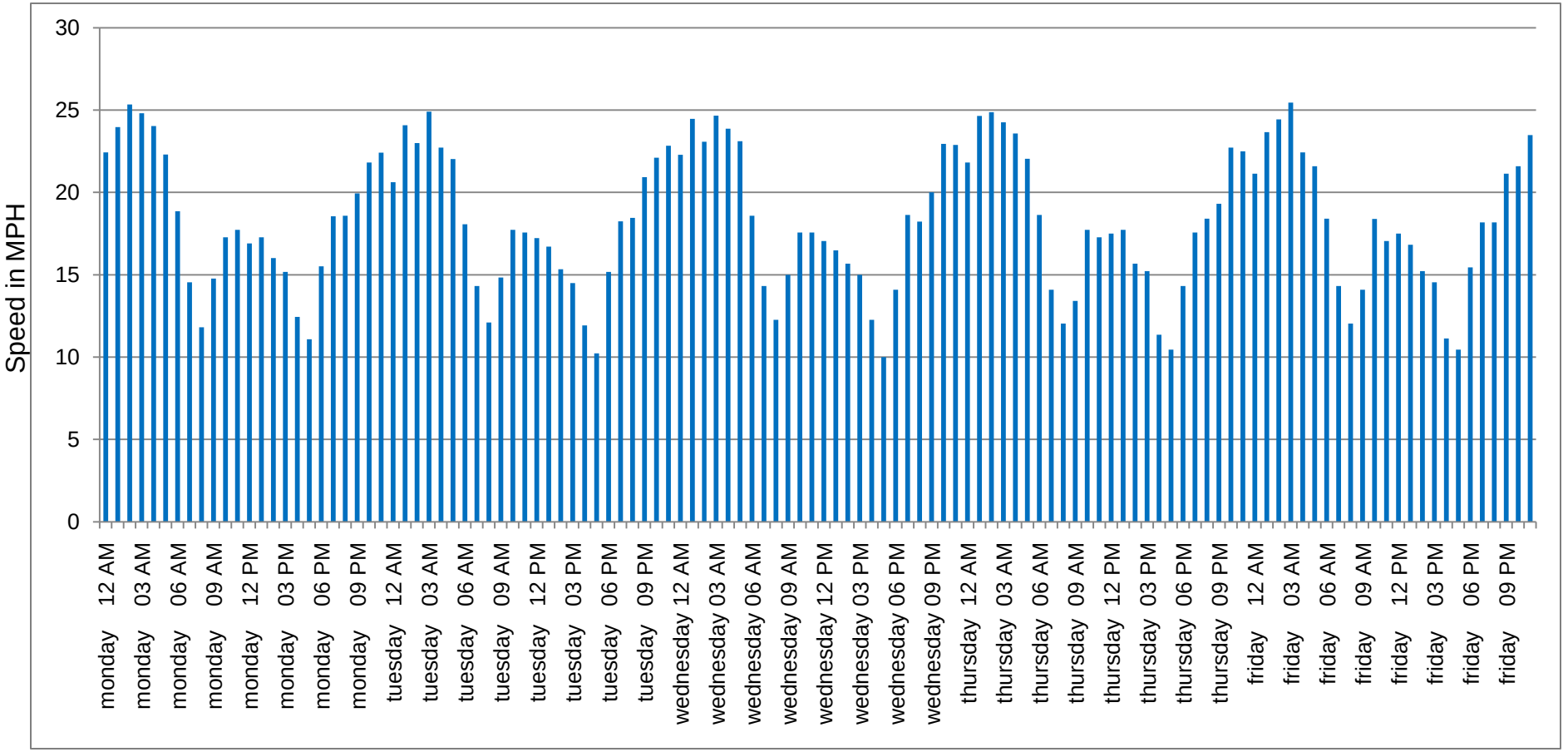
Traffic Zone Level Map





Unlike the segment map, Zone map identifies congested sections of the city

Downtown (loop) Average Traffic Speed By the Hour of the Day



Data from 5/1/2010 to 5/26/2010

Additional Data Sources

- City is currently in discussion with PACE buses, Taxi Cabs, City of Chicago Mobile Asset Tracking System, Airport Express and other possible data providers to supplement data from CTA
- In the future data from cameras and other detection devices on the streets will be incorporated for more comprehensive coverage

Questions?

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