



# Dubuque Smarter Travel

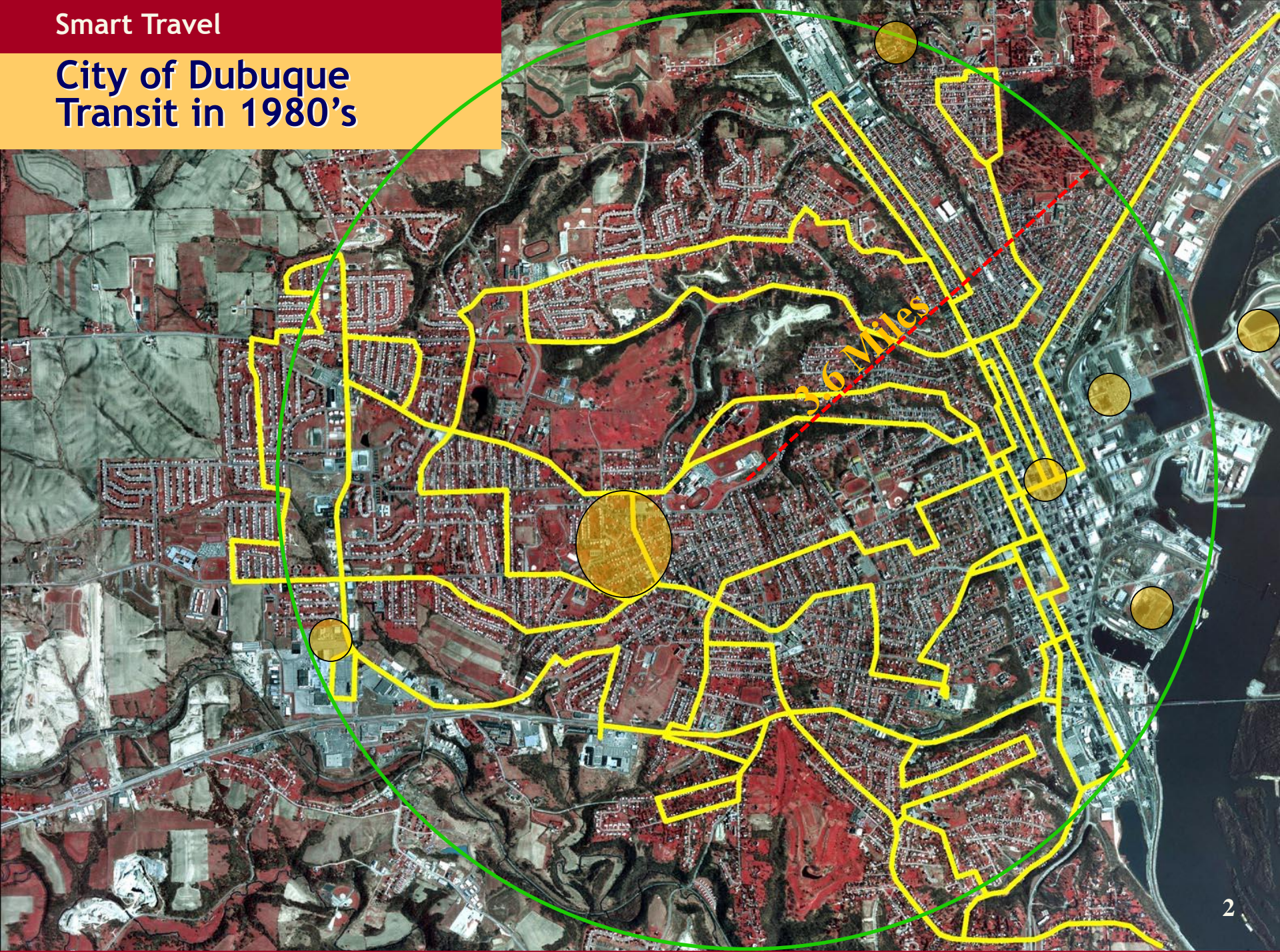
## TRB Tools of The Trade

07/2016



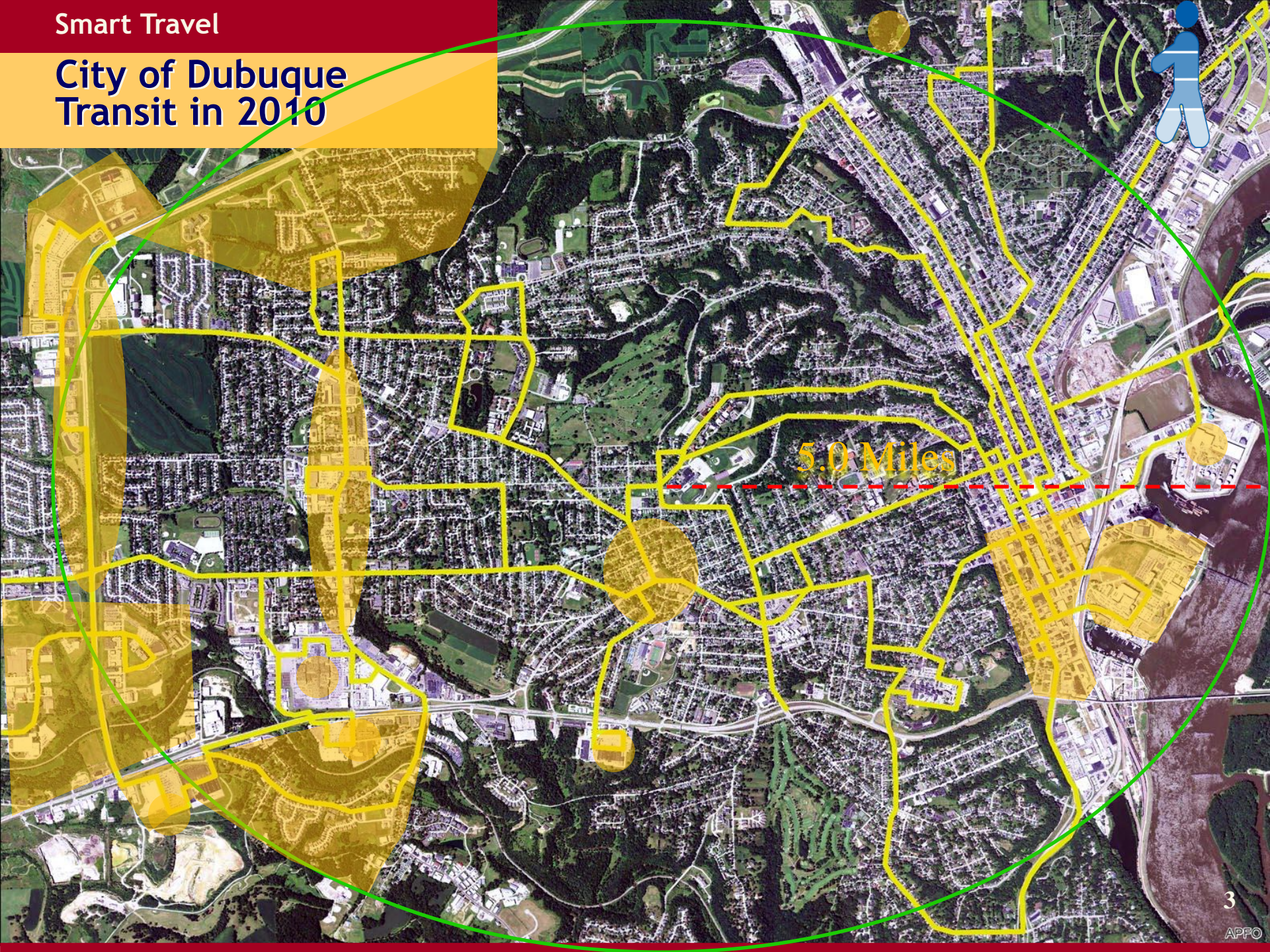


# City of Dubuque Transit in 1980's





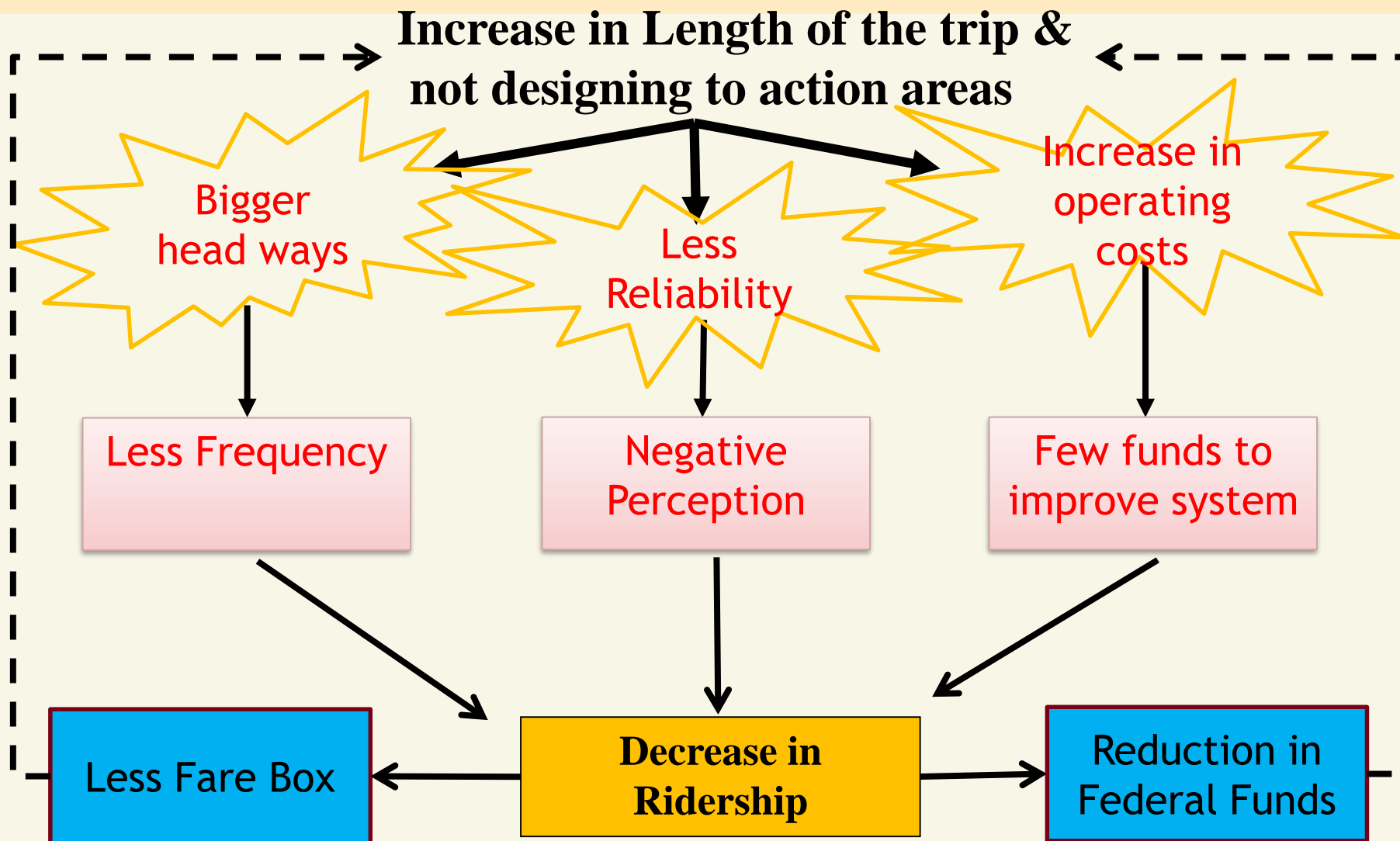
# City of Dubuque Transit in 2010





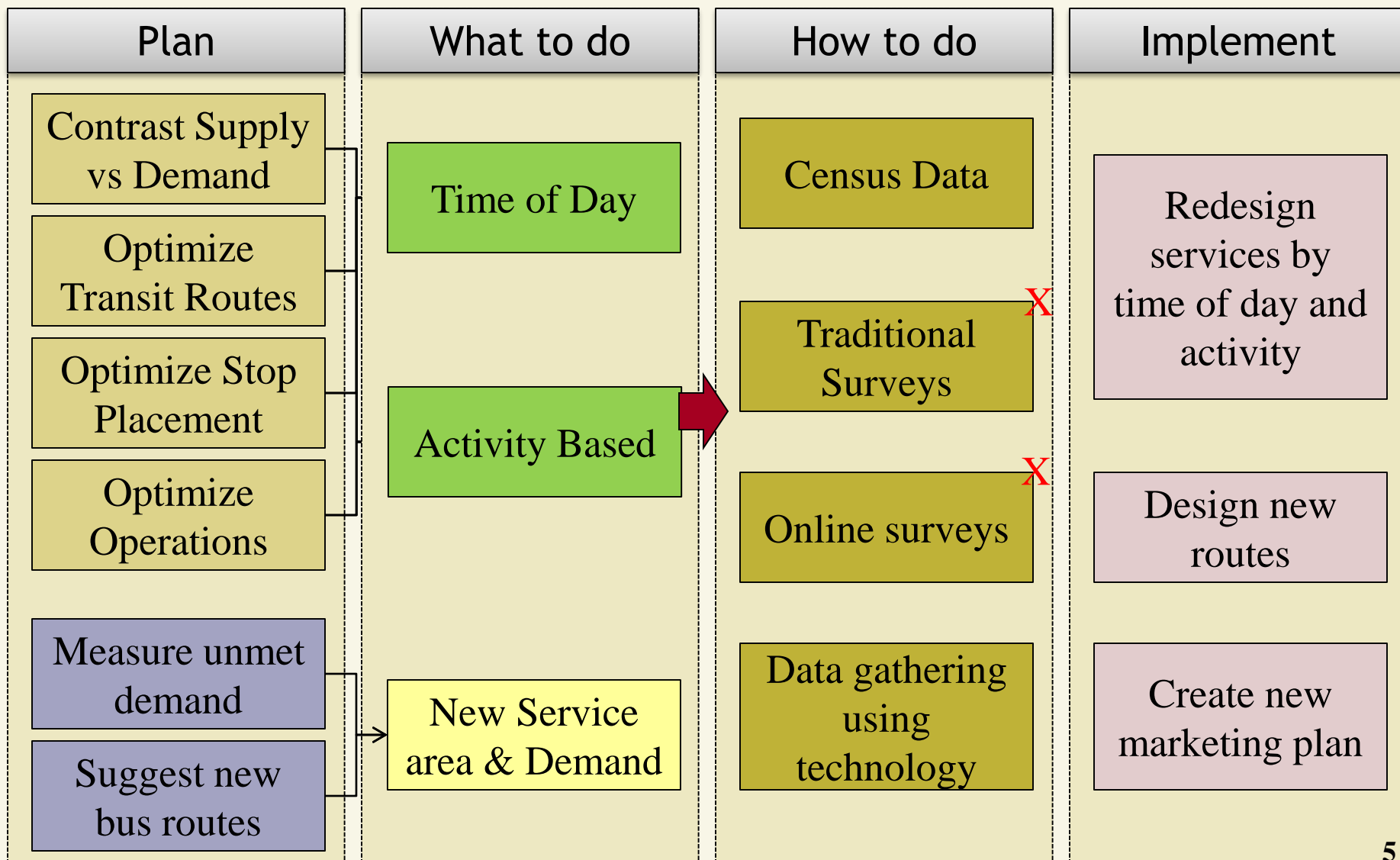


# Impact of Route changes on Jule Transit





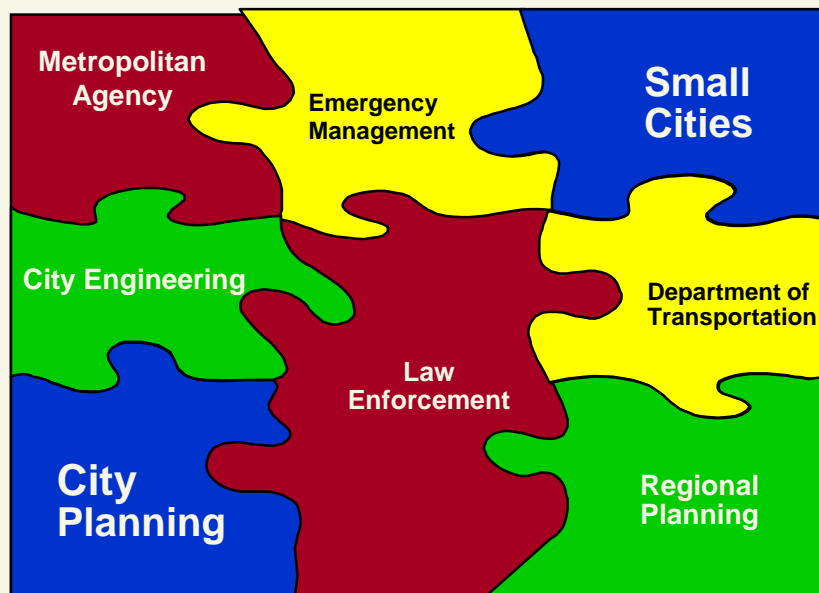
# Process to Improve Jule Transit





# Project Description

- Project Goal
  - Develop, test, and validate an integrated platform to leverage data captured from mobile devices complemented with travel diary surveys to generate information about travel patterns of citizens in the City of Dubuque, Iowa.
- Data Generated
  - O/D Matrices
  - Corridor Speed
  - Meaningful Locations
  - Travel Modalities
  - Trip Purpose, etc.
- Project Outcome
  - Primary - Public Transit Route Optimization
  - Secondary – Adjust Signal Timing, Reduce Accidents, Resource Planning, etc.







## Project Sample Size

The project will have approximately 750 households recruited.

Time Period	Number of Households (approx.)
May, 2015 to August, 2015	250
February, 2016 to April, 2016	250
November, 2016 to January, 2017	250

Total Study Area Households : 39,046

## Volunteer Requirements

- Transmit data from smart phone for 14 days.
- Complete travel diary for three consecutive weekdays.





# Sampling Plan and Travel Diary

## Sampling Plan

How do we pick people to participate in the study?

- Household Demographics
  - Household income
  - Number of people in the household
  - Number of Workers in the household
  - Transit rider

TOTAL Household					
Household Income	Household Size				Total households
	1-person	2-person	3-person	4-or-more persons	
Less than \$25,000	35	14	5	2	<b>56</b>
\$25,000 - \$49,999	22	32	9	10	<b>73</b>
\$50,000 - \$74,999	7	22	8	15	<b>52</b>
\$75,000 or more	3	26	14	26	<b>69</b>
<b>Total</b>	<b>67</b>	<b>94</b>	<b>36</b>	<b>53</b>	<b>250</b>

Number of Workers	
No Worker Households	67 Households
1 or more worker Households	183 Households

Transit Riders
10-20 households making at least one trip today

# Mobile Application



## Infrastructure

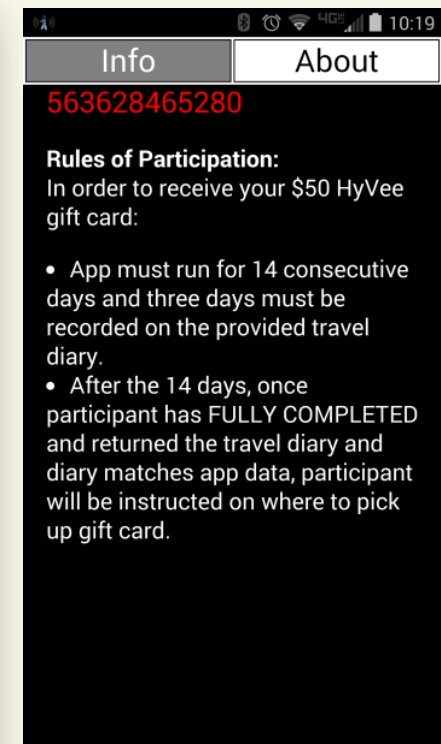
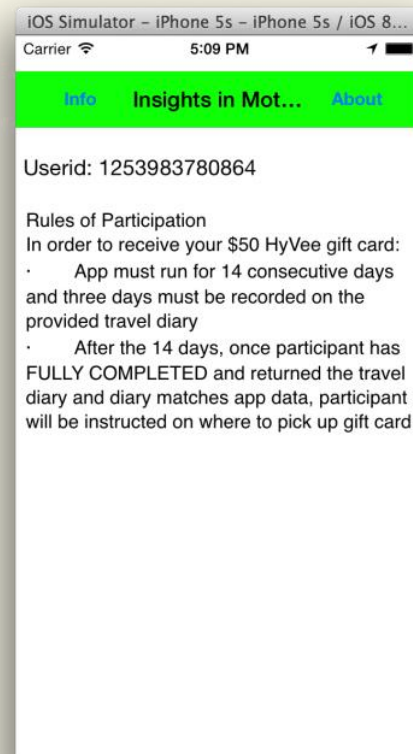
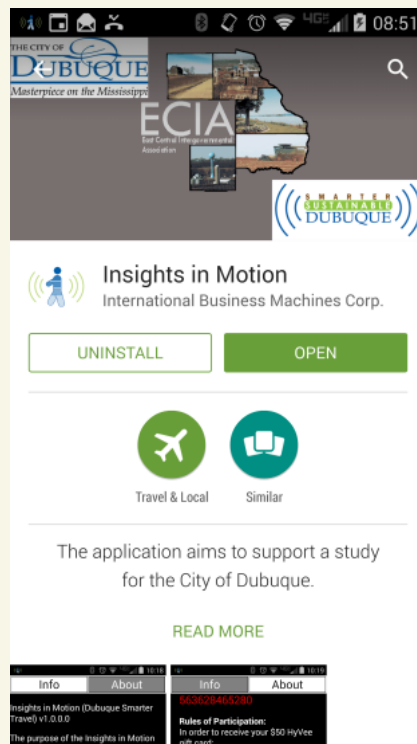
- Private IBM cloud
- Secure and anonymized transmission of samples
- Integration with other datasets

## Supported Platforms

- iOS 7.1.1+
- Android 4.3+

## User Experience

- Periodic uploads
- Battery-optimized sampling
- Accuracy enhance sampling
- Client notifications







# Data Analytics

- Remove erroneous data points
- Identify stops and trips
  - Rule-based approach
- Compute average corridor speed
  - PWL extrapolation and integration
- Find meaningful locations
  - Clustering stops
- Generate O/D matrix
  - Map to TAZ
  - Normalized via scaling factors derived from volunteer's socioeconomic data and census data.



# Trip Purpose Classification and O/D from Travel Diary

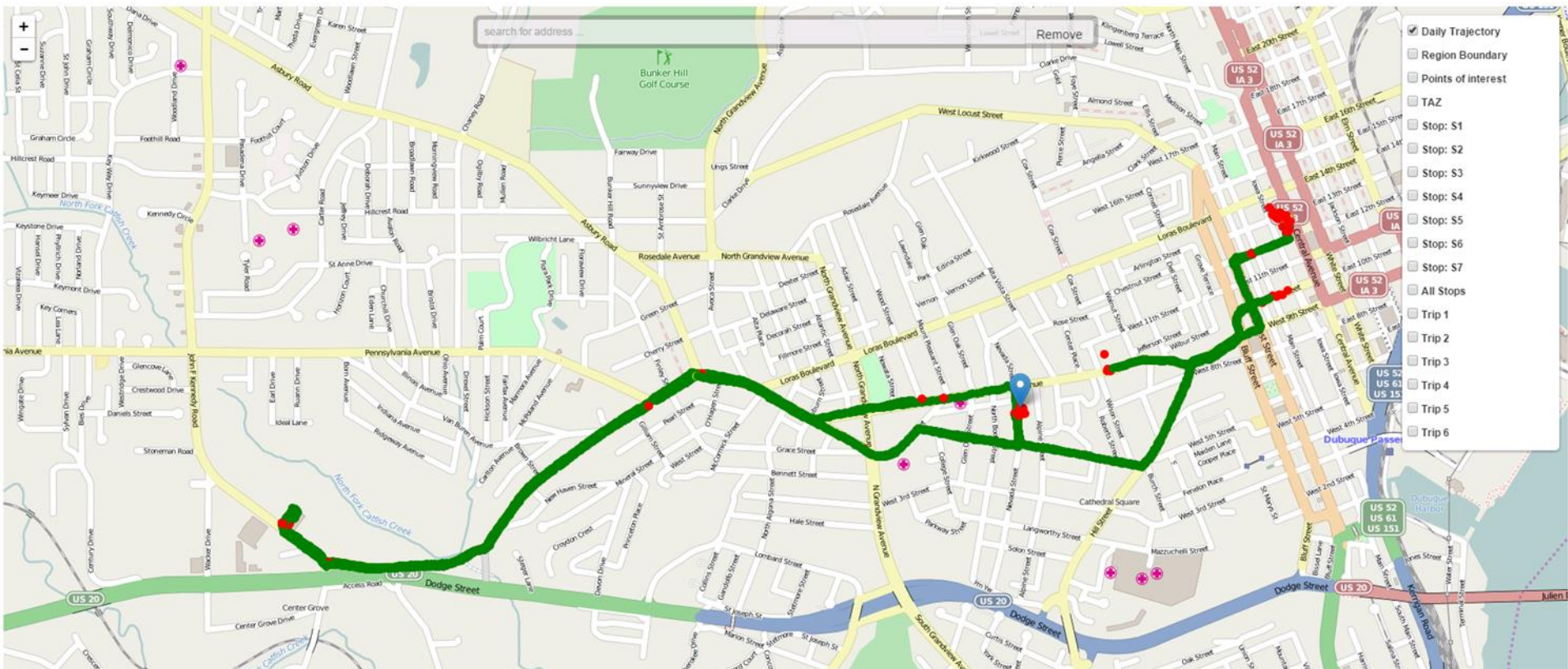
Trip #	Where Did You Go?	What About Your Route?	What Did You Do?	What Was The Time?	How Did You Get There?	How Many Traveled?
#1  The First Place I Went	<b>Hy-Vee</b> _____ Name or Description of Place  <b>Locust Street</b> _____ Address (or nearest intersection) include suffix (St., Ave., lane, etc.)  <b>Dubuque</b> <b>IA</b> City                                      State <b>52001</b> Zip (if known)	<b>On your way to this location did you cross the Mississippi River?</b> YES      NO  <b>If YES: Which highway/road bridge did you use to cross the river?</b> _____	<b>What did you do at this location?</b> (check all that apply) 01 Working at Home 02 Other Home activities 03 Work/Job (at work location) 04 Work/Business related 05 School 06 Change Mode (e.g., car to bus) 07 Dropped off passenger from car 08 Picked up passenger from car 09 Personal business 10 Health care (doctor, dentist) 11 Civic/Religious activities 12 Eat meal outside of home 13 Recreation/Entertainment 14 Visit friends/Relatives 15 Other, Specify - Groceries	<b>What time did you ARRIVE at this location?</b>  Time: <u>9</u> Circle one:                      AM      PM  <b>What time did you DEPART this location?</b> (enter NA if you ended your travels for the day here)  Time: <u>9:45</u> Circle one:                      AM      PM	<b>What was the primary type of transportation you used?</b> o Walk o School Bus o Bike o <b>Auto, Van, truck</b> o Transit Bus (Route: _____) Other _____  <b>If you used a car, van, or truck for this trip, were you the:</b>  <b>Driver</b> OR      Passenger  <b>Please indicate the following about the vehicle:</b> Year: <u>2004</u> Make/Model: <u>Toyota Prius</u>  <b>Was this your household's vehicle? YES      NO</b>	<b>Including you, how many people made this trip?</b>  _____ <b>1</b> _____  <b>Including you, how many people from YOUR HOUSEHOLD were on this trip?</b>  _____ <b>1</b> _____  <b>What were the ages of the other household members traveling with you?</b> _____



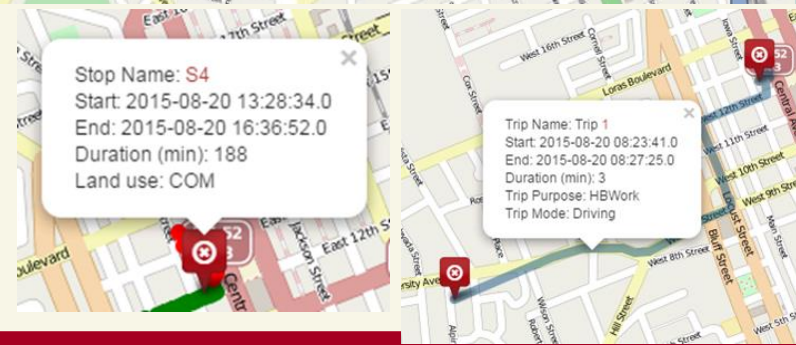
# Trip Segmentation Analysis



Map view of 1261720961024 activity on 2015-08-20



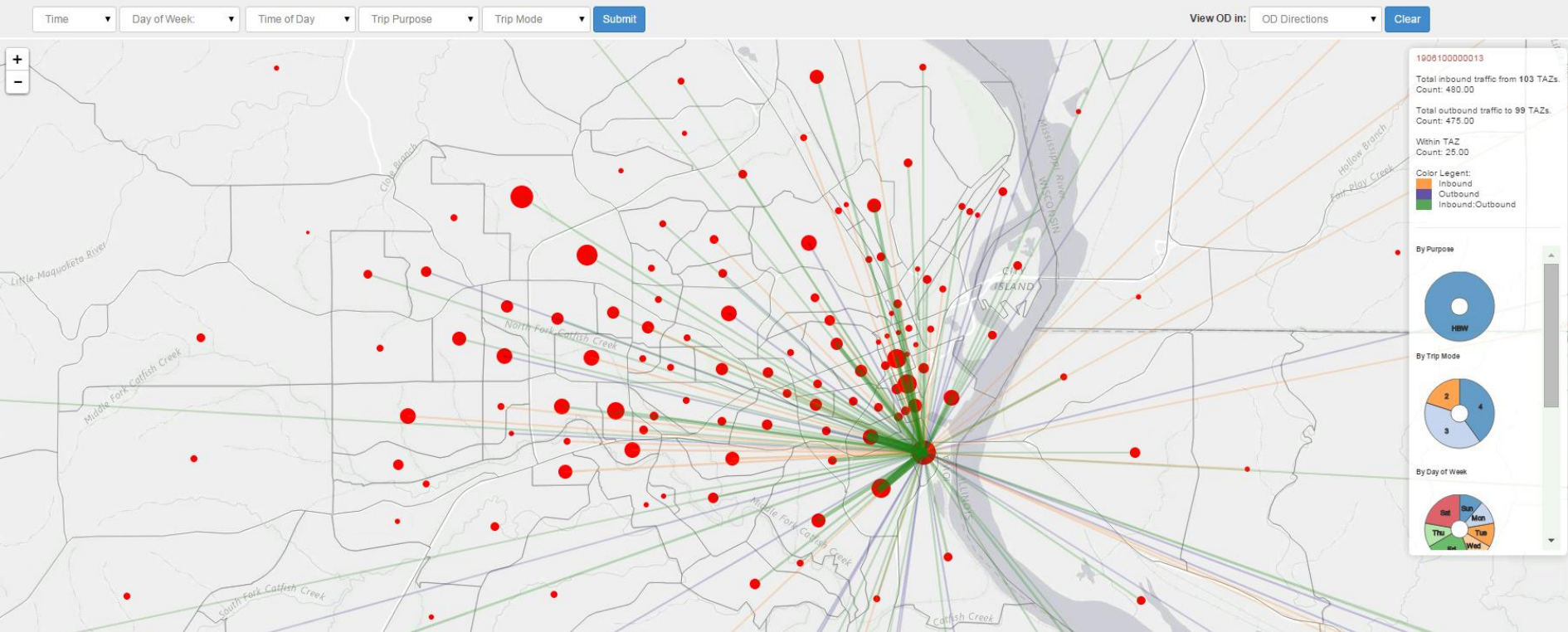
- Display daily trajectories.
- Display stops and trips. Clicking on each stop or trip will display its properties, such as starting/stopping time, duration, land use, trip purpose and trip mode.
- Ability to pin custom locations on the map.



# Trip Purpose Classification and O/D Matrix



Analyze origin-destination matrix using data collected from smart phones.



- 3 categories of POIs (schools, shopping/restaurants, other)
- Classify work and home locations based on duration of stay and time of day
- Trip purpose: home-based work, non-home-based work, home-based school, non-home-based school, home-based shopping, non-home-based shopping, home-based other, and non-home-based other. These categories will be used to partition the O/D matrix
- The O/D matrix is aggregated between all the users and for different time intervals





# Validation of Smartphone and Travel diary data

The Smarter phone data and Travel Diary data are compared at different levels.

## Level 1: Data collection

The Smartphone data and Travel Diary data are compared to check accuracy of

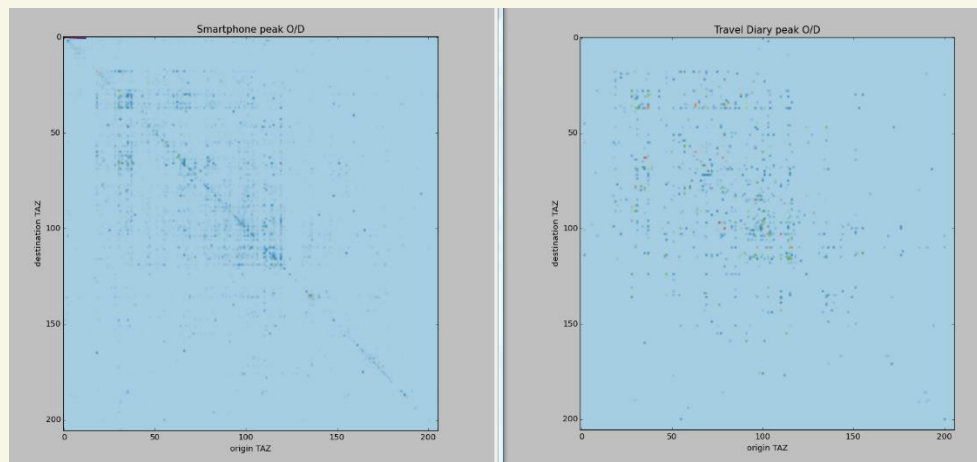
- Location
- Missing trips
- Mode choice

## Level 2: Trip purpose

The Smart phone data is compared to Travel Diary data to check purpose of the trip

## Level 3: Origin/Destination matrix

The origin/Destination matrix from both sources are compared to each other once the survey sample is extrapolated to MPO



Smartphone peak O/D

Travel Diary peak O/D



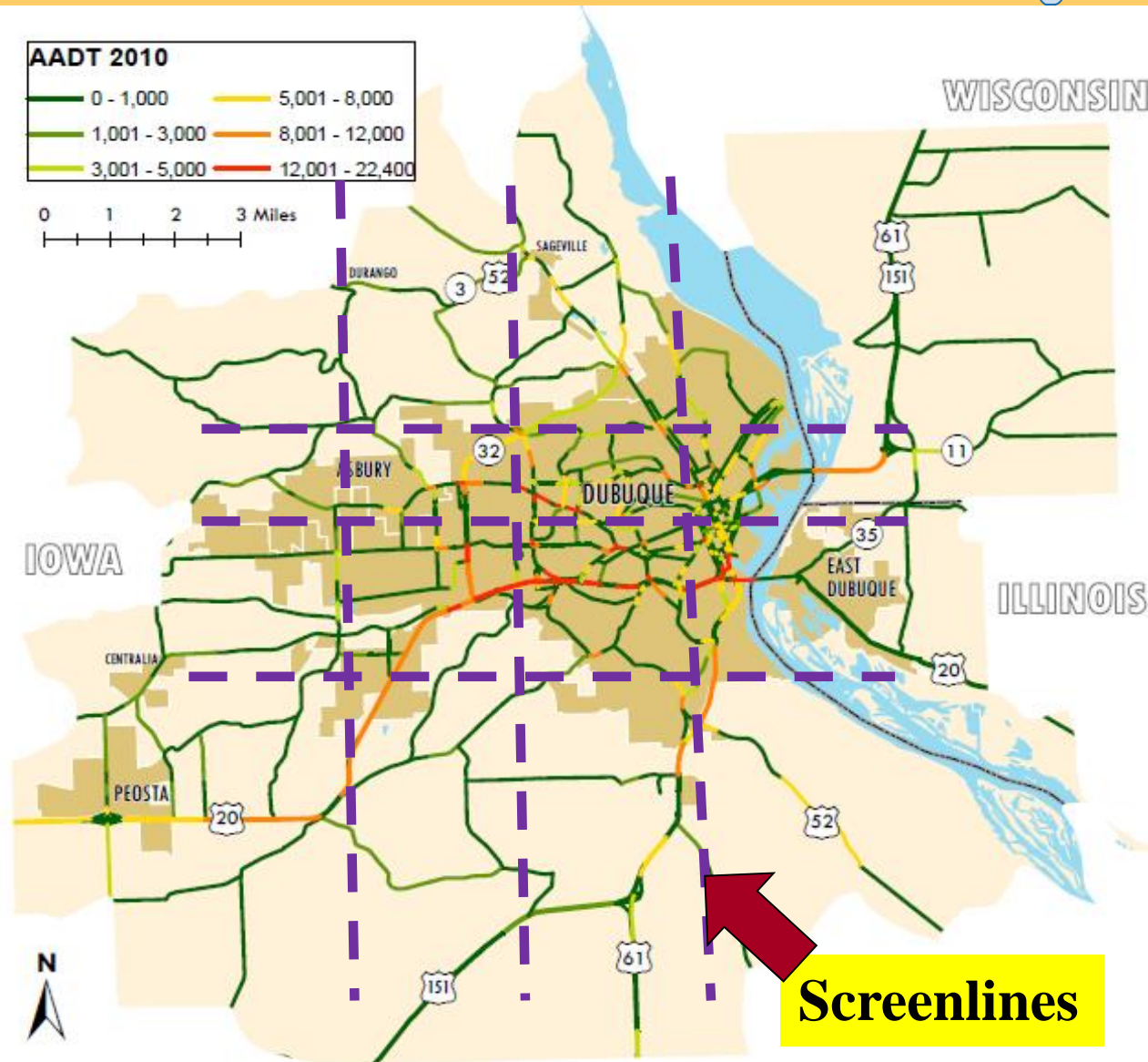
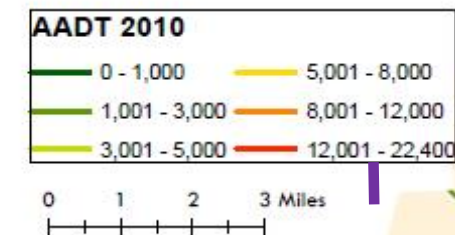
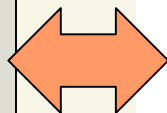
# Screenline Test of O/D Data

**O/D data for the  
region**

**Travel Diary**

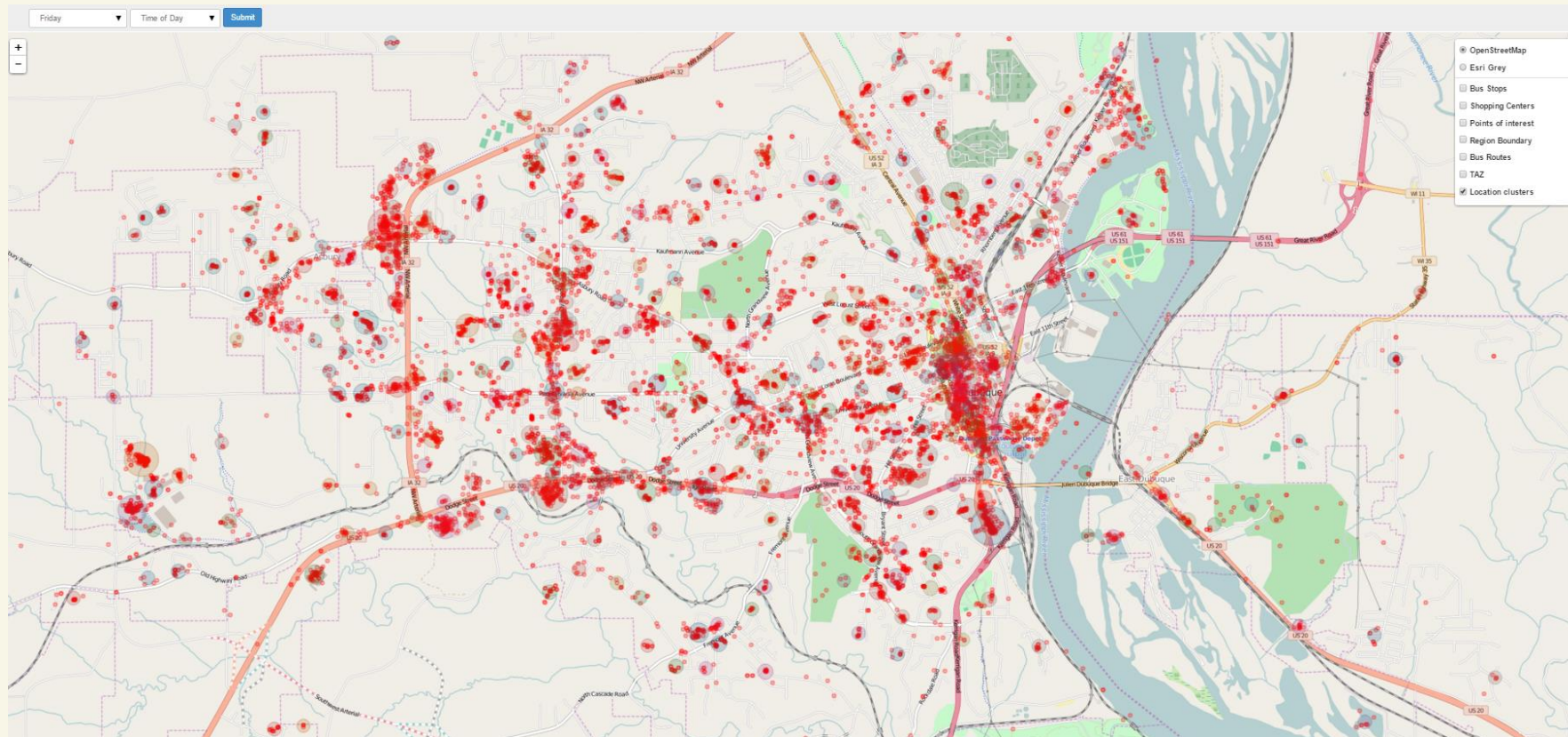
**Smartphone**

**Airsage**



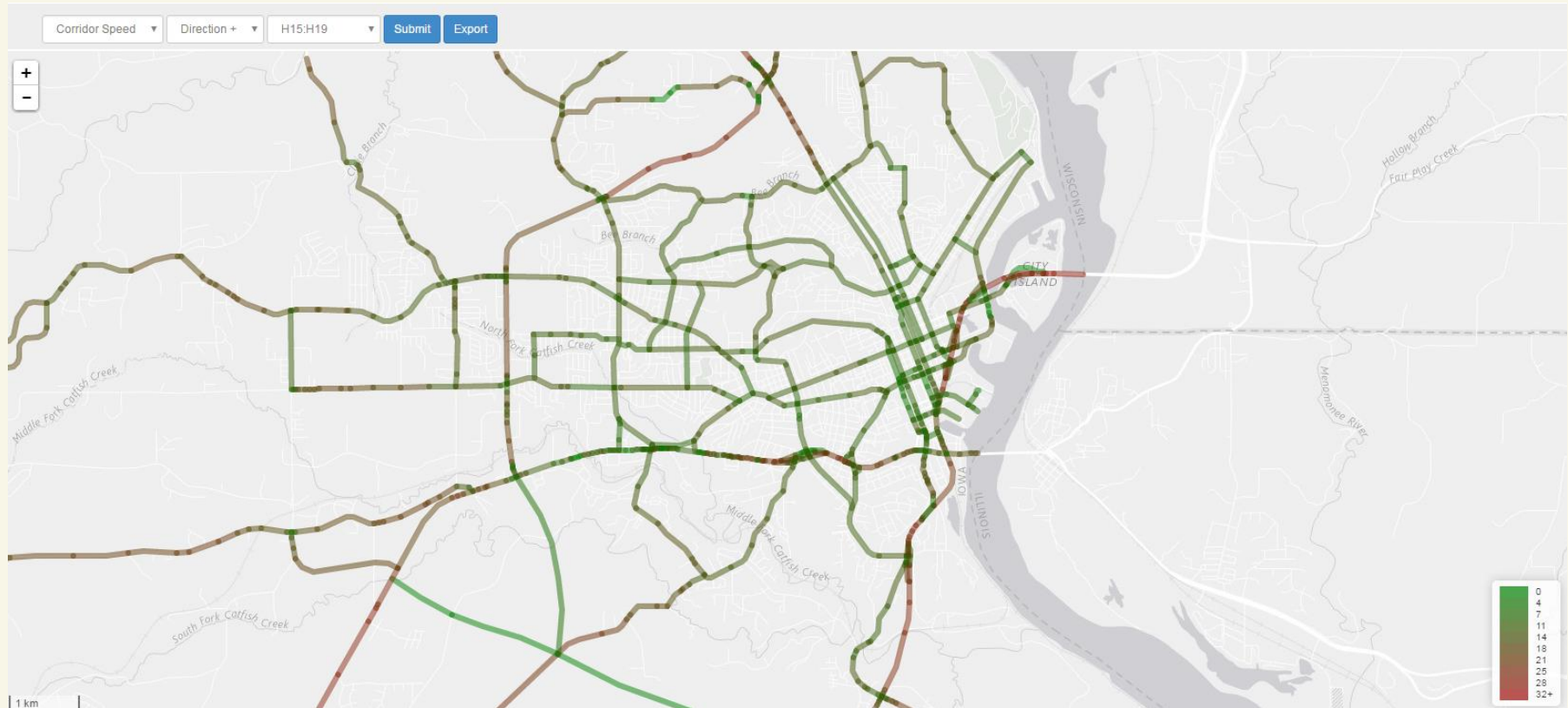


# Meaningful Location



- Time options: days of week, all weekends, all weekdays and all days of week.
- View data in time periods.
- Overlay location clusters.

# Corridor Speed and Travel Time



- Corridor speed or travel time
- Time options: Time of Day
- Direction of Travel.



# Bus Route Optimization approach

- Input data:
  - Street intersections and street links
  - Travel time of various travel modes on each link
  - Maximum number of buses and bus capacities.
  - O/D matrix
  - Additional constraints/requirements
- Generate a set of candidate routes
  - Can include constraints such as hubs, limited change from current routes, etc.
- Choose an optimal set of routes minimizing average travel time by formulating objective function and optimization problem as an mixed integer program (MIP).
- Solve MIP using 2 types of algorithms: CPLEX and Volume algorithm
- Routes are adjusted based on feedback and expert guidance from Jule

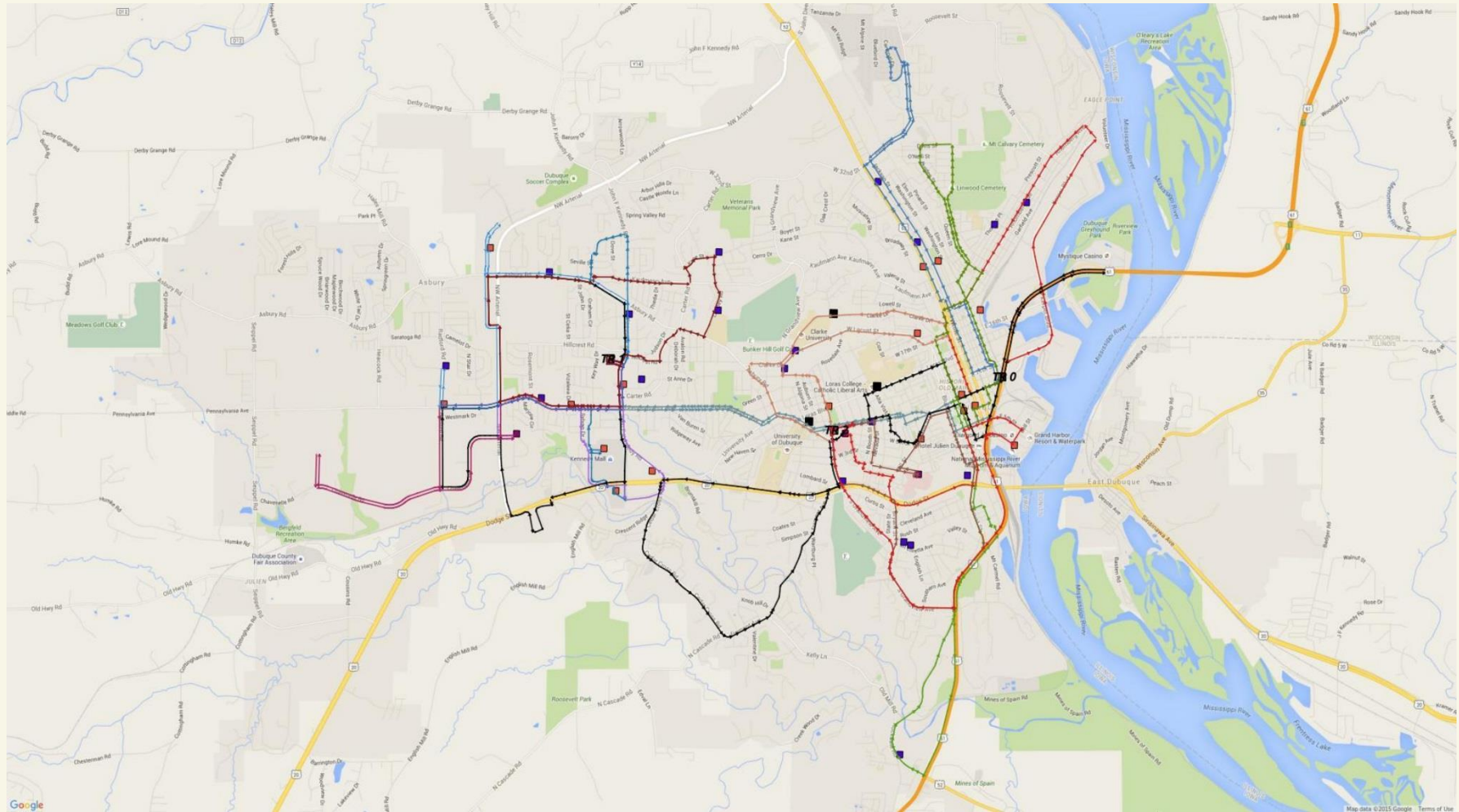
Generate  
candidate  
routes



Select  
optimal set  
of routes



# Optimized Bus routes



Bus routes based on peak period O/D



# Questions

## Contacts

### **Chandra Ravada**

Director of Transportation Department  
East Central Intergovernmental Association  
ph.: 563-556-4166  
e-mail: [cravada@ecia.org](mailto:cravada@ecia.org)

### **Chai Wah Wu**

IBM T. J. Watson Research Center  
P. O. Box 218  
Yorktown Heights, NY 10598, U. S. A.  
ph.: 914-945-1567  
e-mail: [cwwu@us.ibm.com](mailto:cwwu@us.ibm.com)

## Web Sources

<http://www.cityofdubuque.org/1496/Smarter-Travel>

<http://www.eciatrans.org/DMATS/SmarterTravel.cfm>