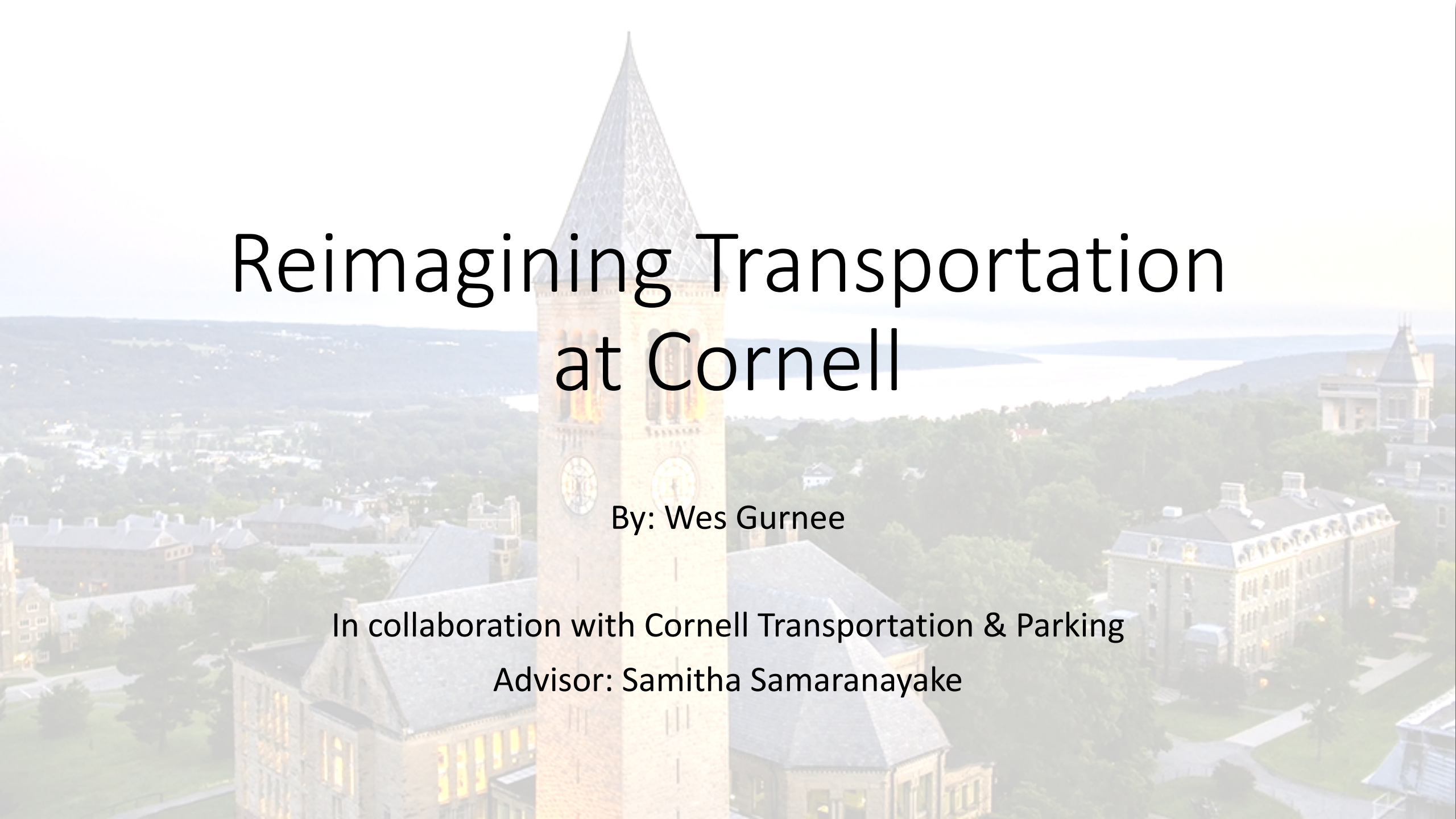


Reimagining Transportation at Cornell

By: Wes Gurnee

In collaboration with Cornell Transportation & Parking

Advisor: Samitha Samaranayake

Motivation

- Cornell Carbon Neutral Campus Initiative
- Reduce the need for parking
- Reduce congestion and other externalities associated with car traffic
- Reduce costs for commuter

My Research

- Determine the existing transit coverage
- Explore the sensitivity of the coverage to different parameters
- Propose better alternatives
  - New routes
  - New services (e.g. micro transit)
- Build the road network
- Build the bus network
- Merge the two
- Analyze the current coverage
- Build simulation, modeling, and optimization tools

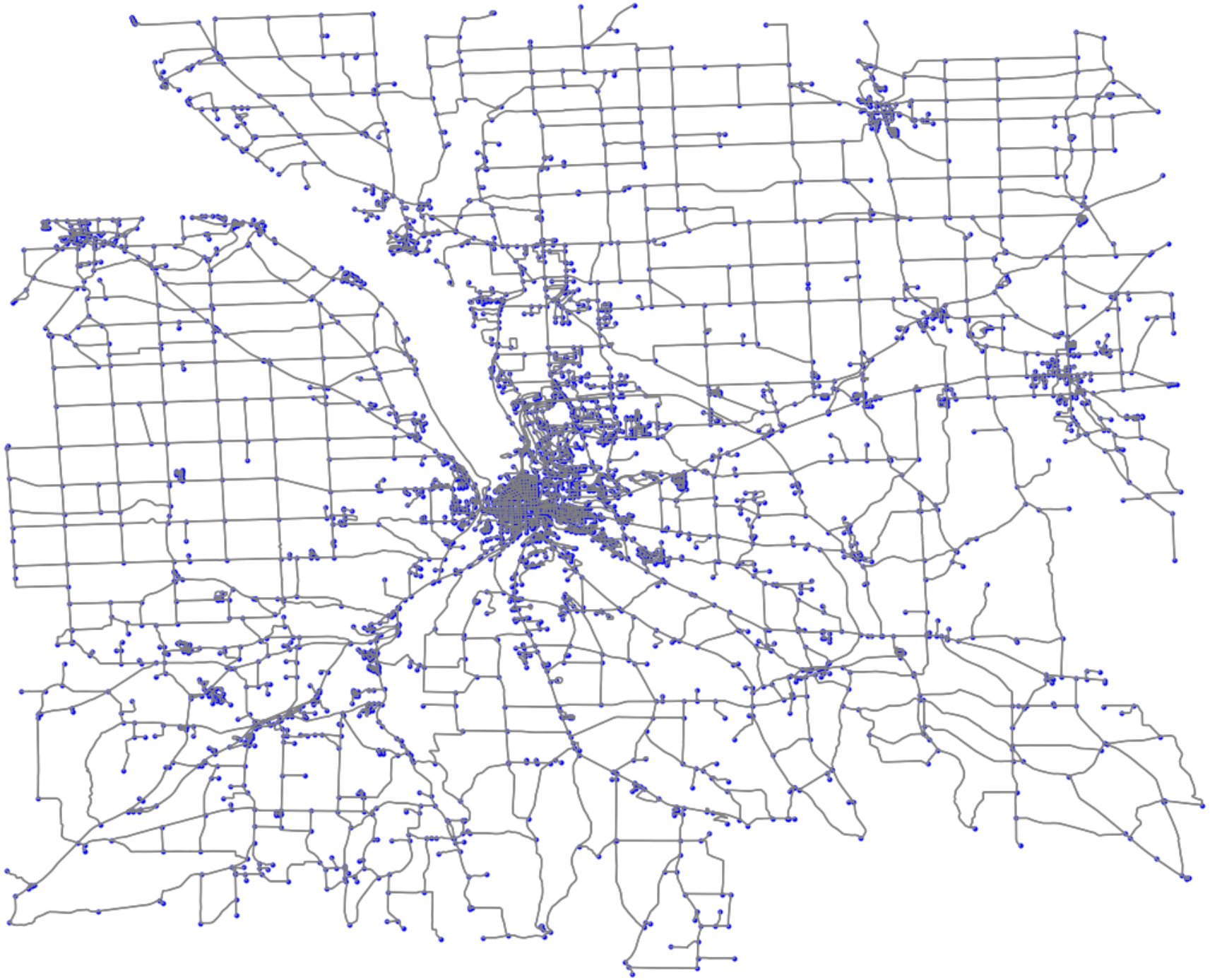
The Road Network

- Package in Python queries Open Street Map for data and constructs road network
- Every road has a “type” (motorway, primary, tertiary, residential, etc.)
- We can map types to speed limits

Capabilities:

- Geospatial object that encodes the real road geometry
- The ability to determine the time it takes to get from point A to B

The Road Network



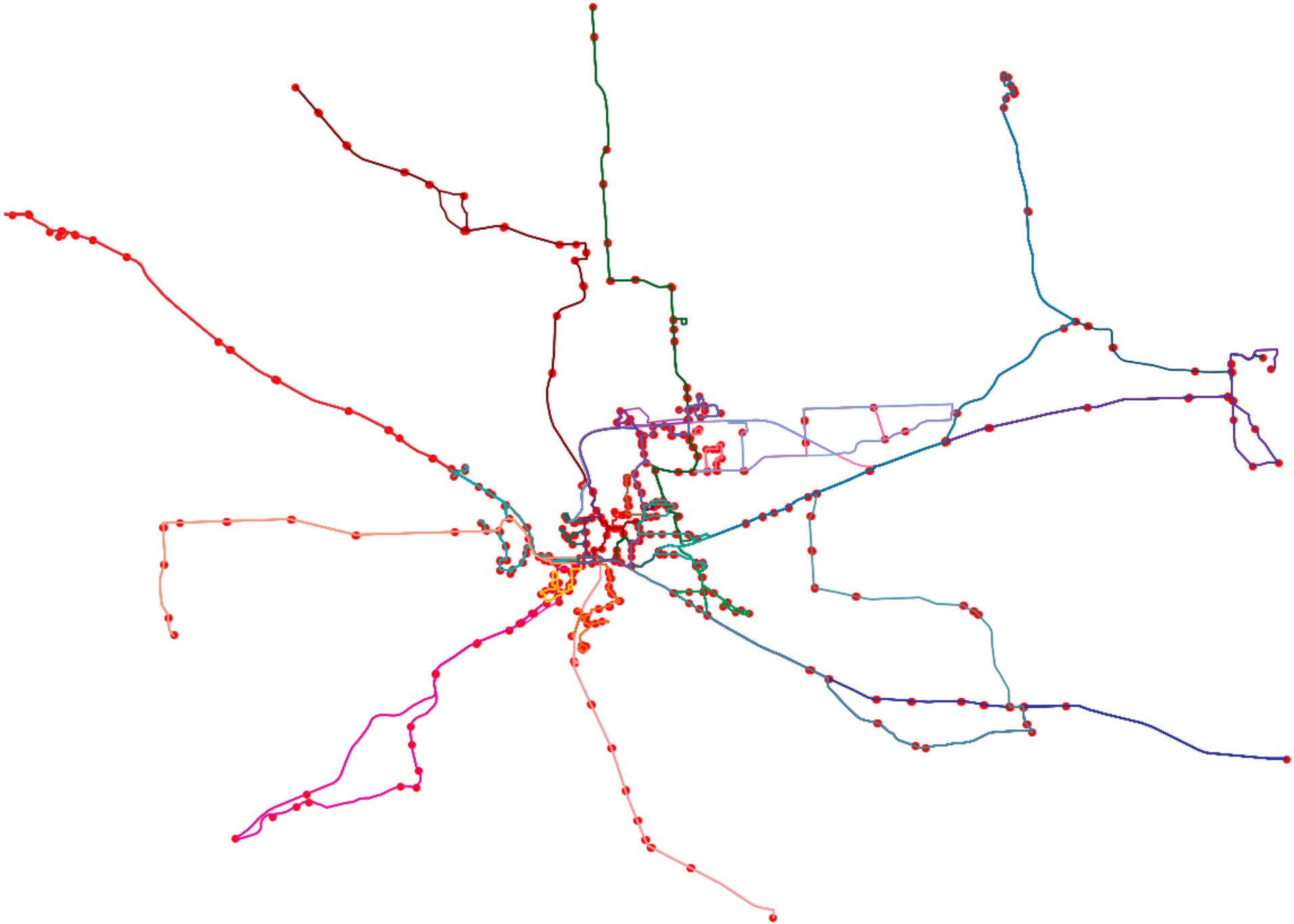
The Bus Network

- Load TCAT static GTFS feed into a database
  - GTFS is a google created format for transit data/schedules
- GTFS feed gives all stops, route geometries, schedules, etc.

Capabilities:

- Accurately simulate and model TCAT service
- Determine the precise access one has to TCAT transit

The Bus Network

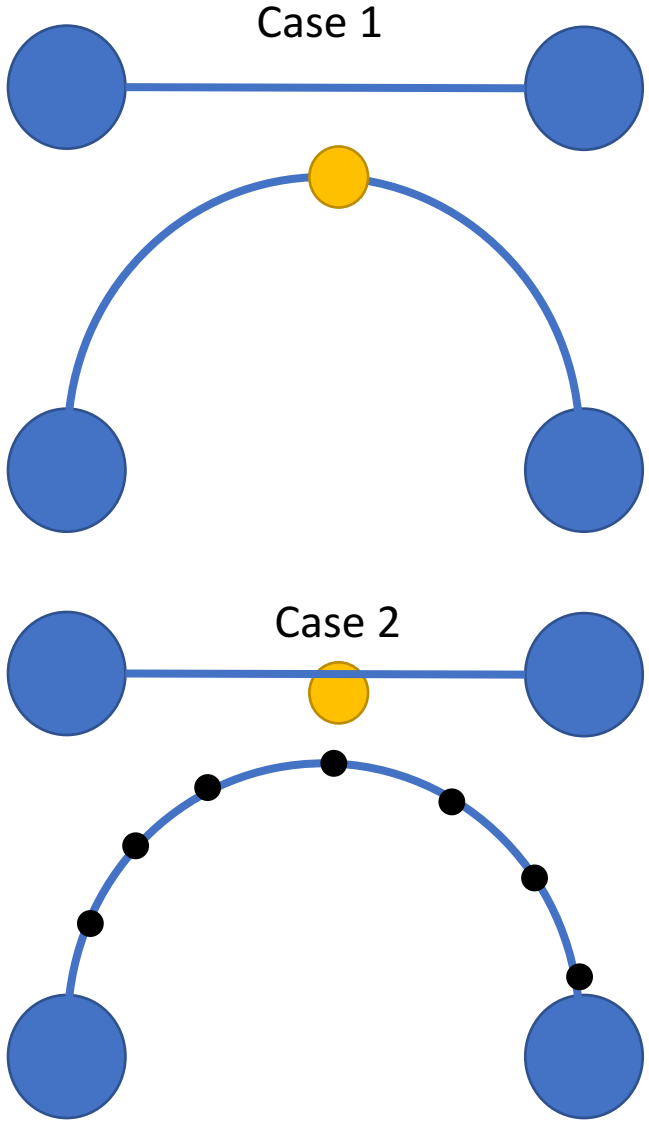


Merging the Bus and Road Network

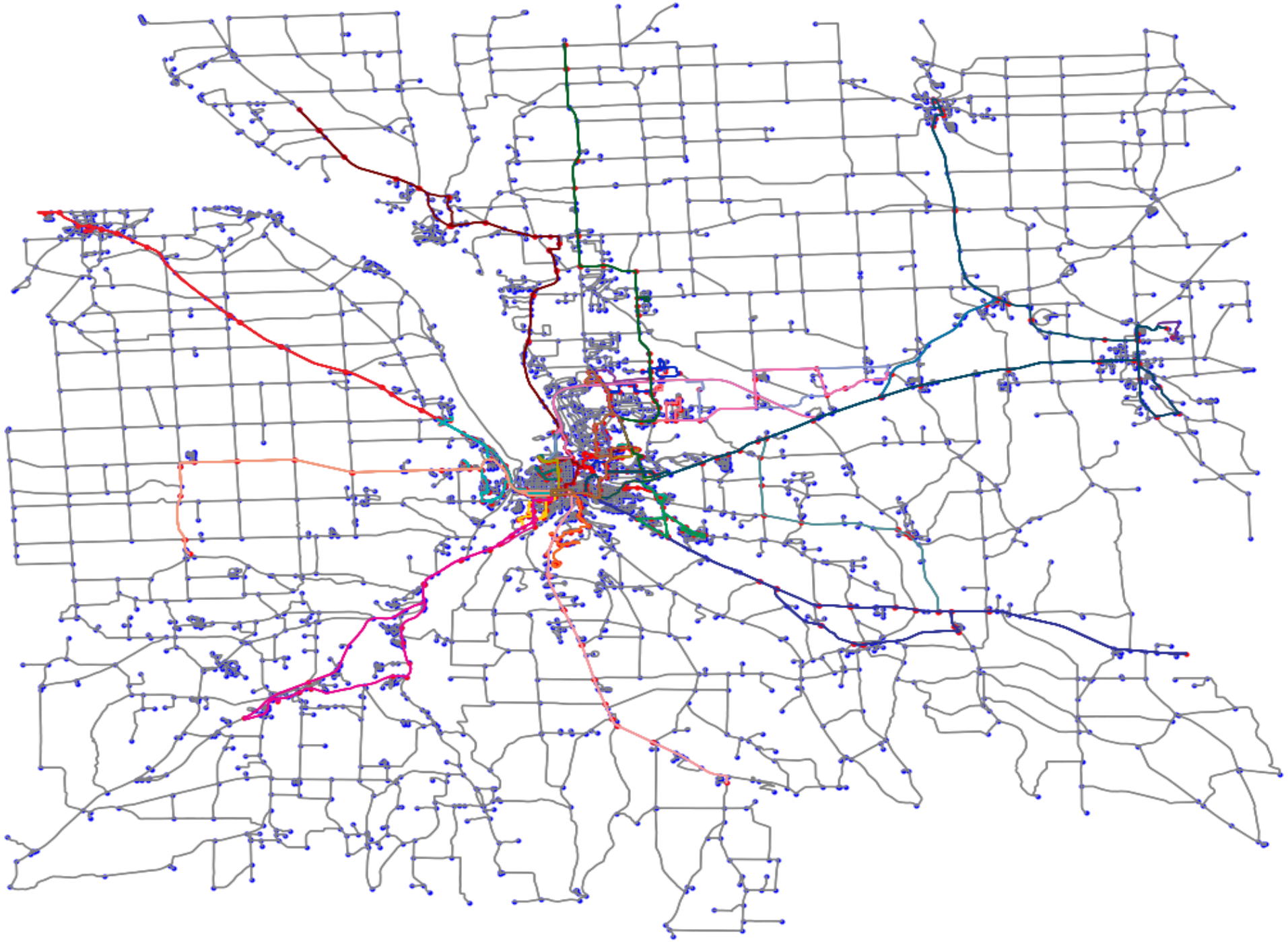
- We have geospatial data from both
- Must link the two
- Complication: (Blue = roads, yellow = bus stop)

Solution: Map matching

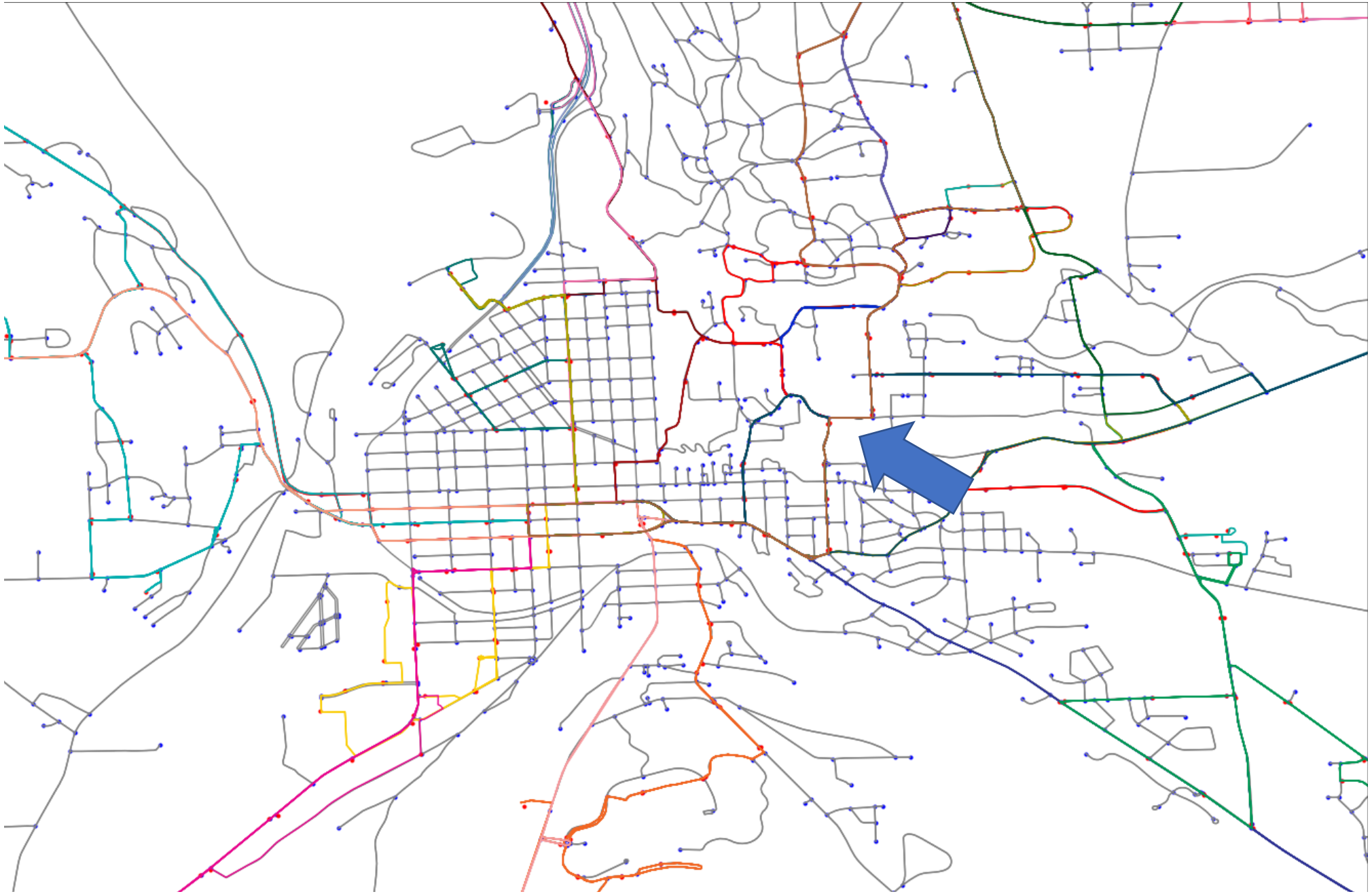
- If less than 20m from a node, map to node, else:
- Interpolate edge geometries between nearby nodes
- Select closest one
- Create node to represent bus stop



Merged Network



Ithaca Merged Network



Analyzing Coverage

- What determines if an individual is covered?
  - Proximity
    - How close is the closest bus stop
  - Convenience
    - How much longer does it take to commute via bus than by car
  - Frequency
    - How often do busses come

*There are many other factors that contribute like weather or the need for child care but we lack the data to do this analysis

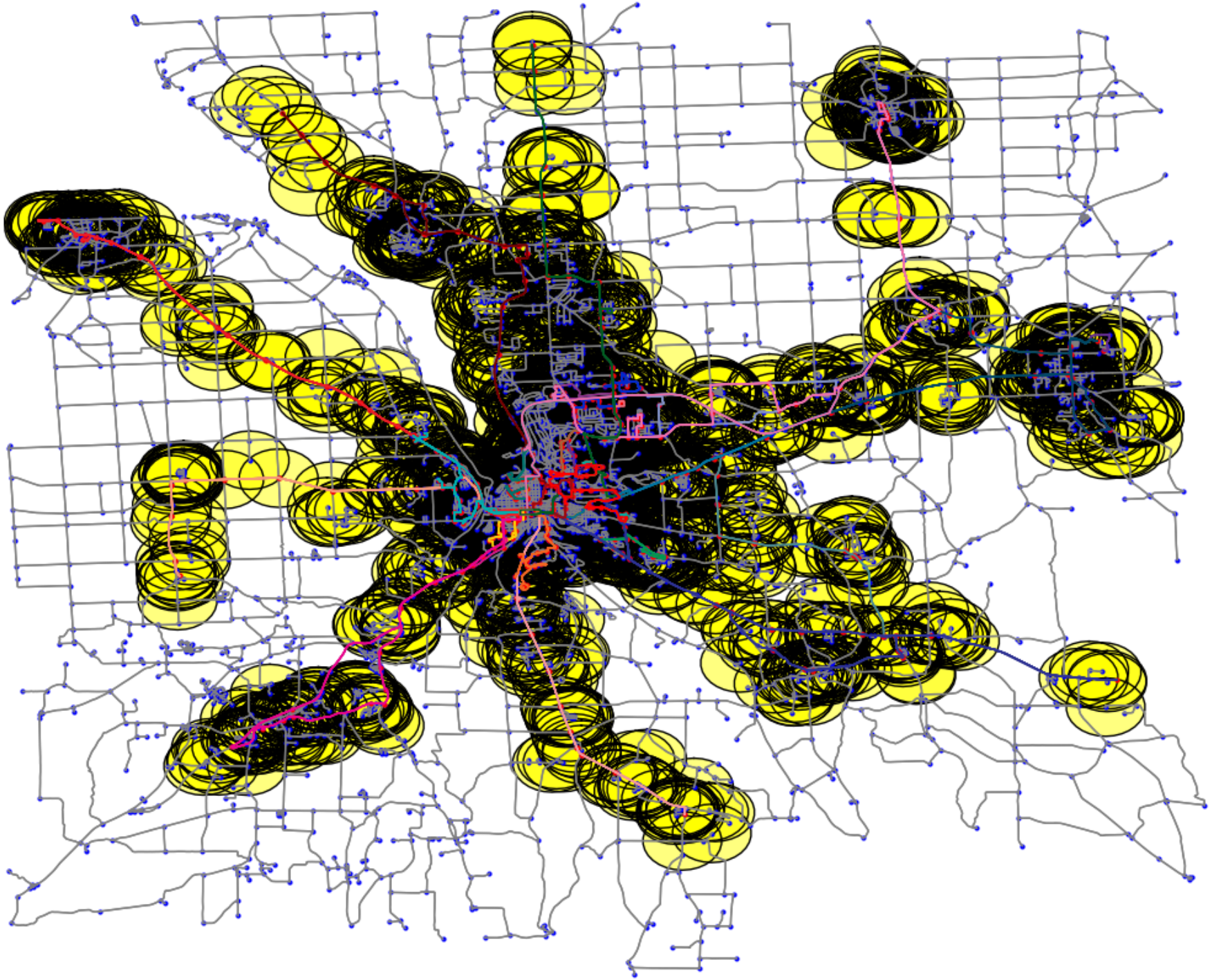
Feasibility Constraints

- Distance
  - Must be a stop (or multiple) within the coverage radius of the origin
- Convenience
  - The time has to be less than the time it would take to commute to campus via car multiplied by a scaling factor
  - 15min; t<10min: t*2; t<20min: t*1.75; t>20min: t*1.5
- Frequency
  - Requires a certain number of bus trips from origin to Cornell between 7:00 and 10:00am
  - Requires a certain number of bus trips from Cornell to origin between 4:00 and 7:00pm

Loosest Constraints

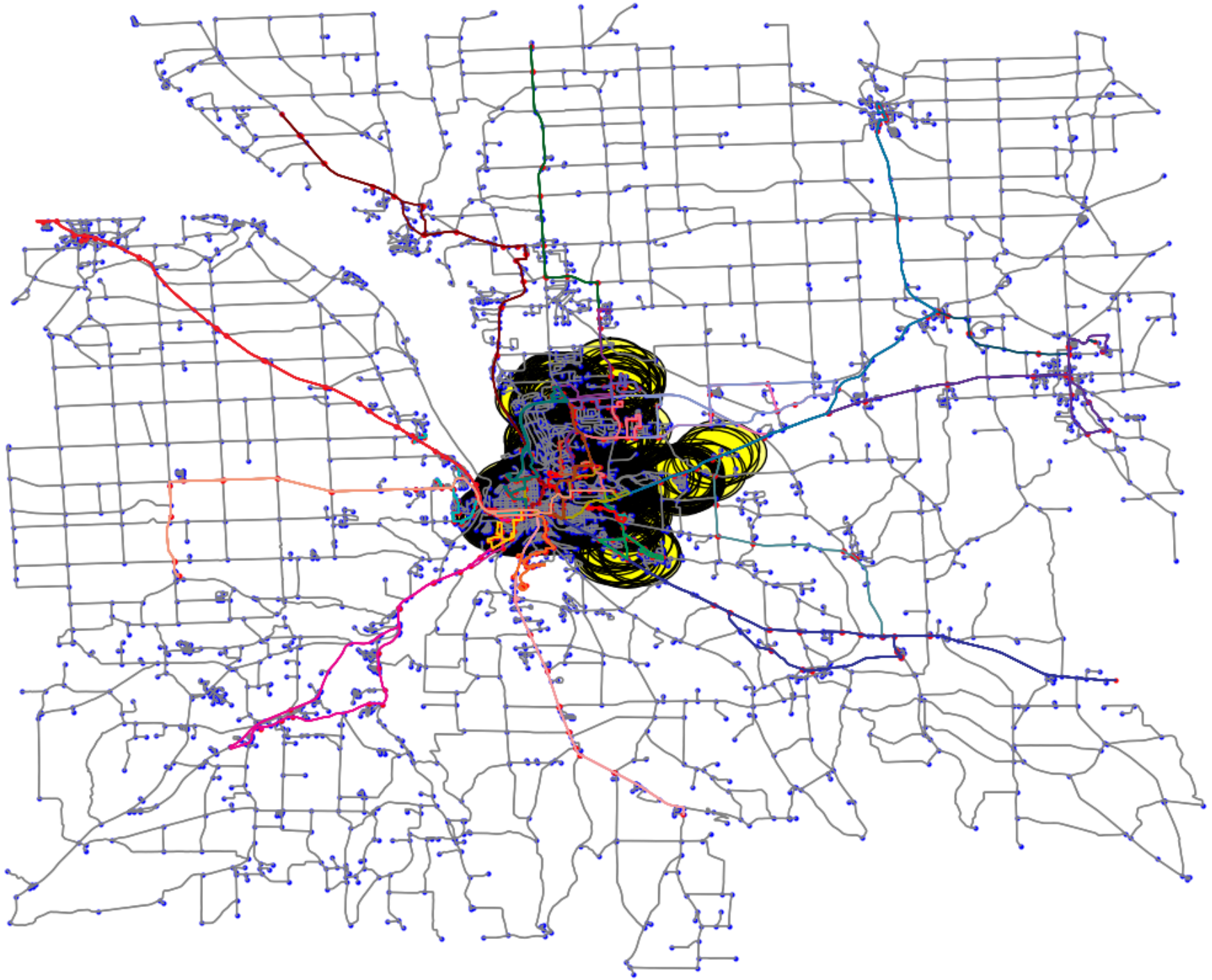
- 1200m coverage radius
- 1 stop in morning
- 1 stop in afternoon

*80% coverage of Cornell faculty and staff



Tight Constraints

- 500m coverage radius
- Every 30 minutes
- 15min; t<10min: t*2; t<20min: t*1.75; t>20min: t*1.5



Results

Coverage Radius/ Frequency	250 meters	500 meters	750 meters	1200 meters (¾ mile)
Every 30 min	13.6%	31.6%	42.0%	50.4%
Every 20 min	10.3%	26.0%	33.4%	43.9%
Every 15 min	8.4%	20.0%	30.4%	42.8%

*Only Cornell Faculty and Staff
**Household locations are mapped to nodes

Next Steps

- Make the model more robust using permit data to account for walking/parking time
- Create predictive model on whether or not someone takes transit
  - Will allow us to predict whether or not someone will commute in a new system we design
- Continue refining optimization framework; add new capabilities
  - Shuttles
    - Fixed Routes
    - On demand

Goal

Design a system that is sufficiently convincing for TCAT or Cornell to launch a pilot program based on our results