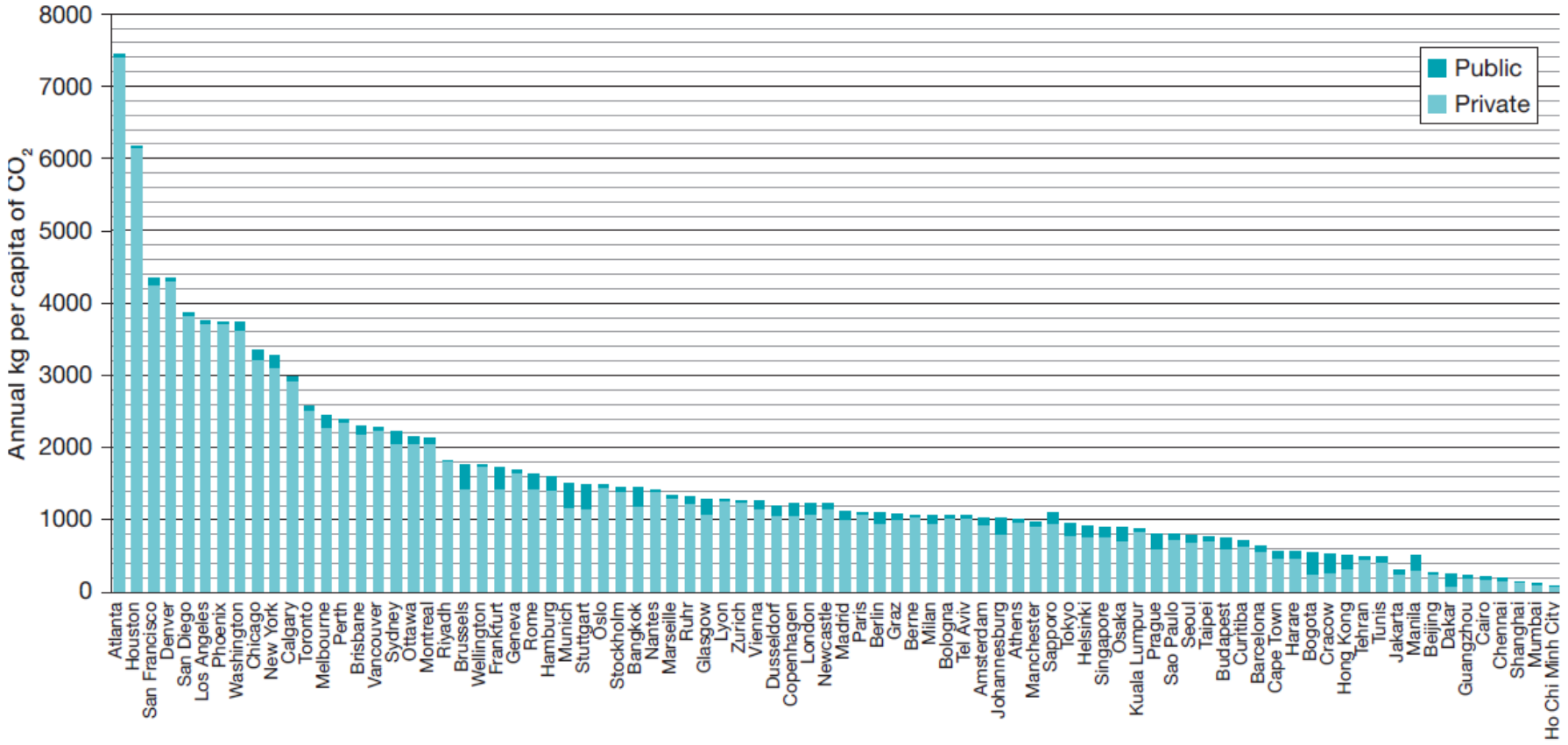
Using Technology to Transform Multimodal Transportation

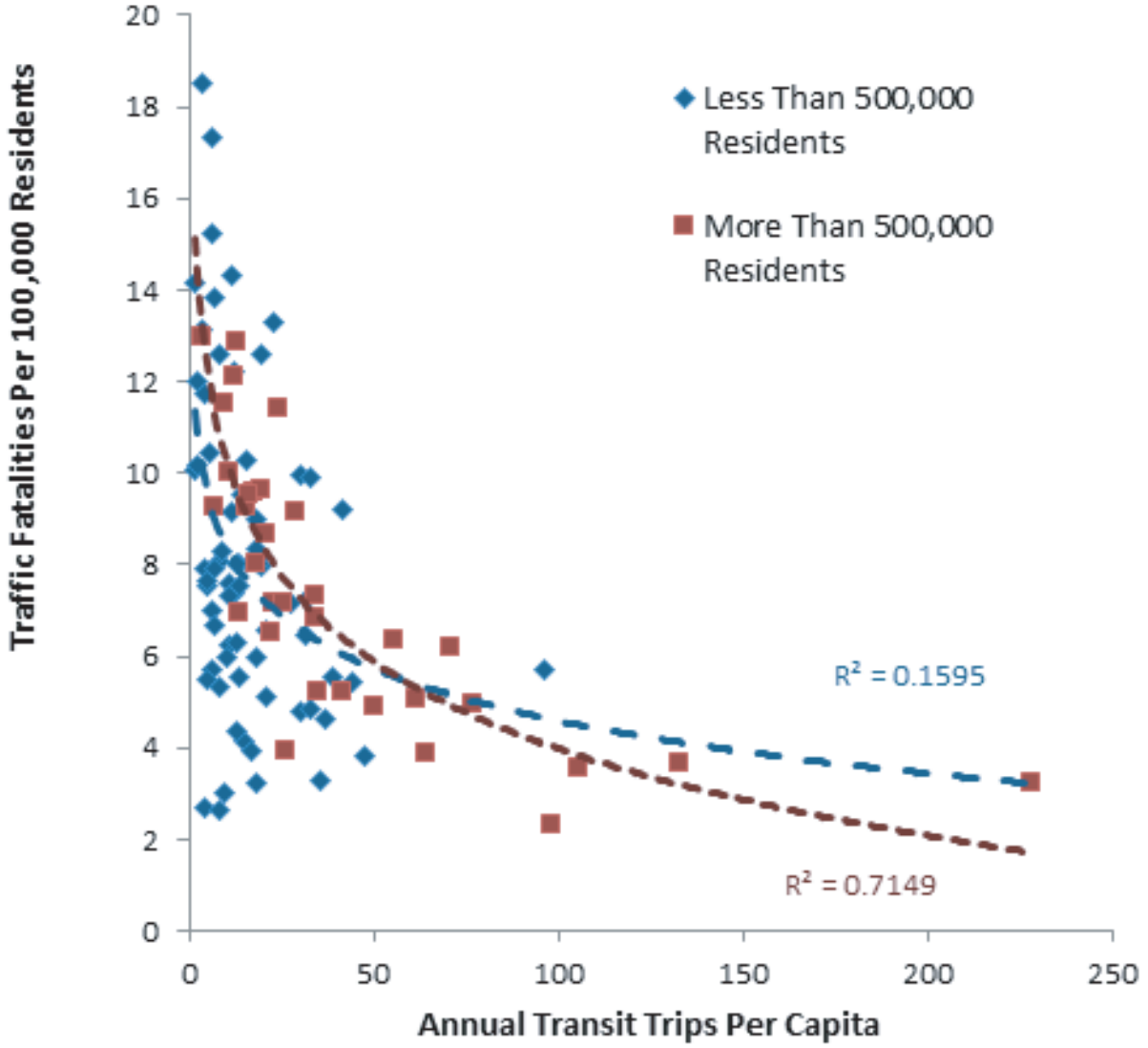
Dr. Kari Edison Watkins
Civil & Environmental Engineering, Georgia Tech
Georgia Smart Communities
Nov 14, 2019


DELTA
Xpress
Xpress

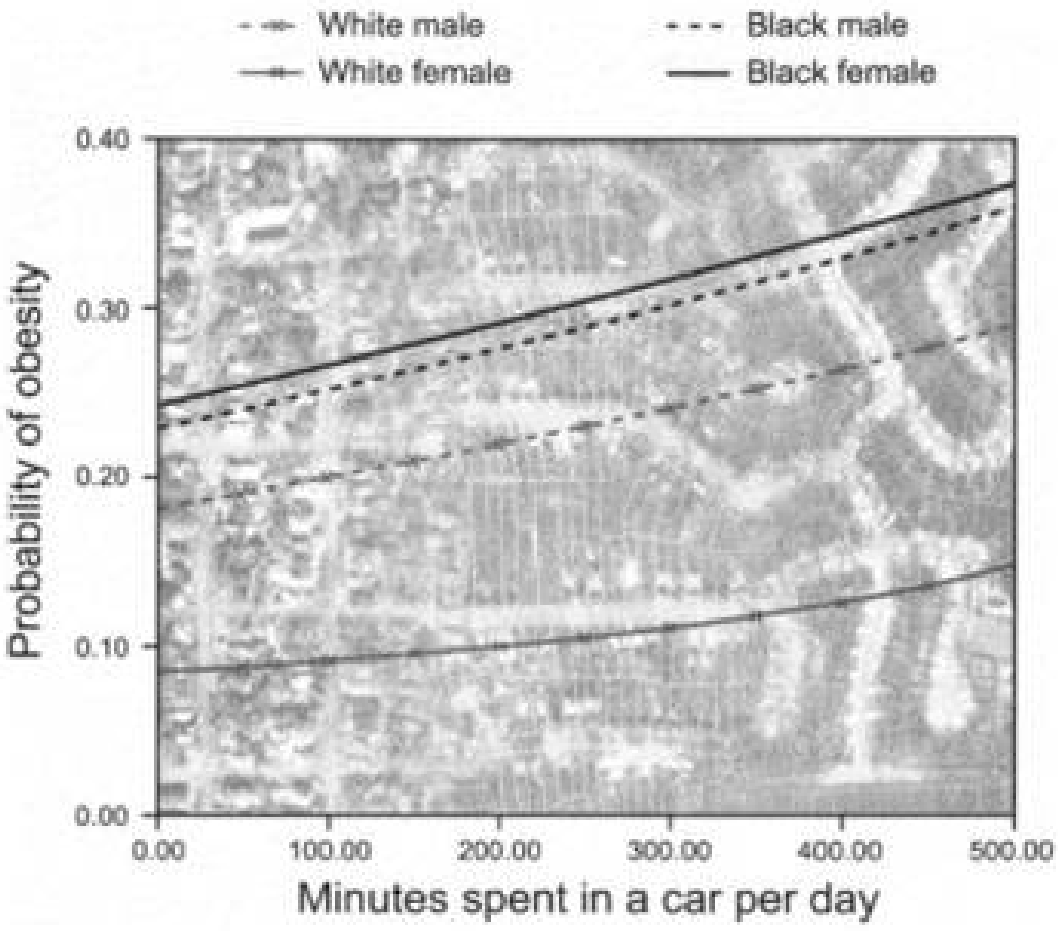
Per Capita Emissions of CO2 from Transport



Traffic Fatalities vs Transit Trips



The risk of obesity increases 6% with every additional hour spent per day commuting in a car



Frank, L., Andresen, M. & Schmid, T. (2004). Obesity Relationships with Community Design, Physical Activity and Time Spent in Cars. *American Journal of Preventative Medicine 27*(2).

All I really need to know I learned in Kindergarten

1. Share everything.
2. Play fair.
3. Don't hit people.
4. Put things back where you found them.
5. CLEAN UP YOUR OWN MESS.
6. Don't take things that aren't yours.
7. Say you're SORRY when you HURT somebody.
8. Wash your hands before you eat.
9. Flush.
10. Warm cookies and cold milk are good for you.
11. Live a balanced life - learn some and drink some and draw some and paint some and sing and dance and play and work everyday some.
12. Take a nap every afternoon.
13. When you go out into the world, watch out for traffic, hold hands, and stick together.
14. Be aware of wonder. Remember the little seed in the Styrofoam cup: The roots go down and the plant goes up and nobody really knows how or why, but we are all like that.
15. Goldfish and hamster and white mice and even the little seed in the Styrofoam cup - they all die. So do we.
16. And then remember the Dick-and-Jane books and the first word you learned - the biggest word of all – LOOK.

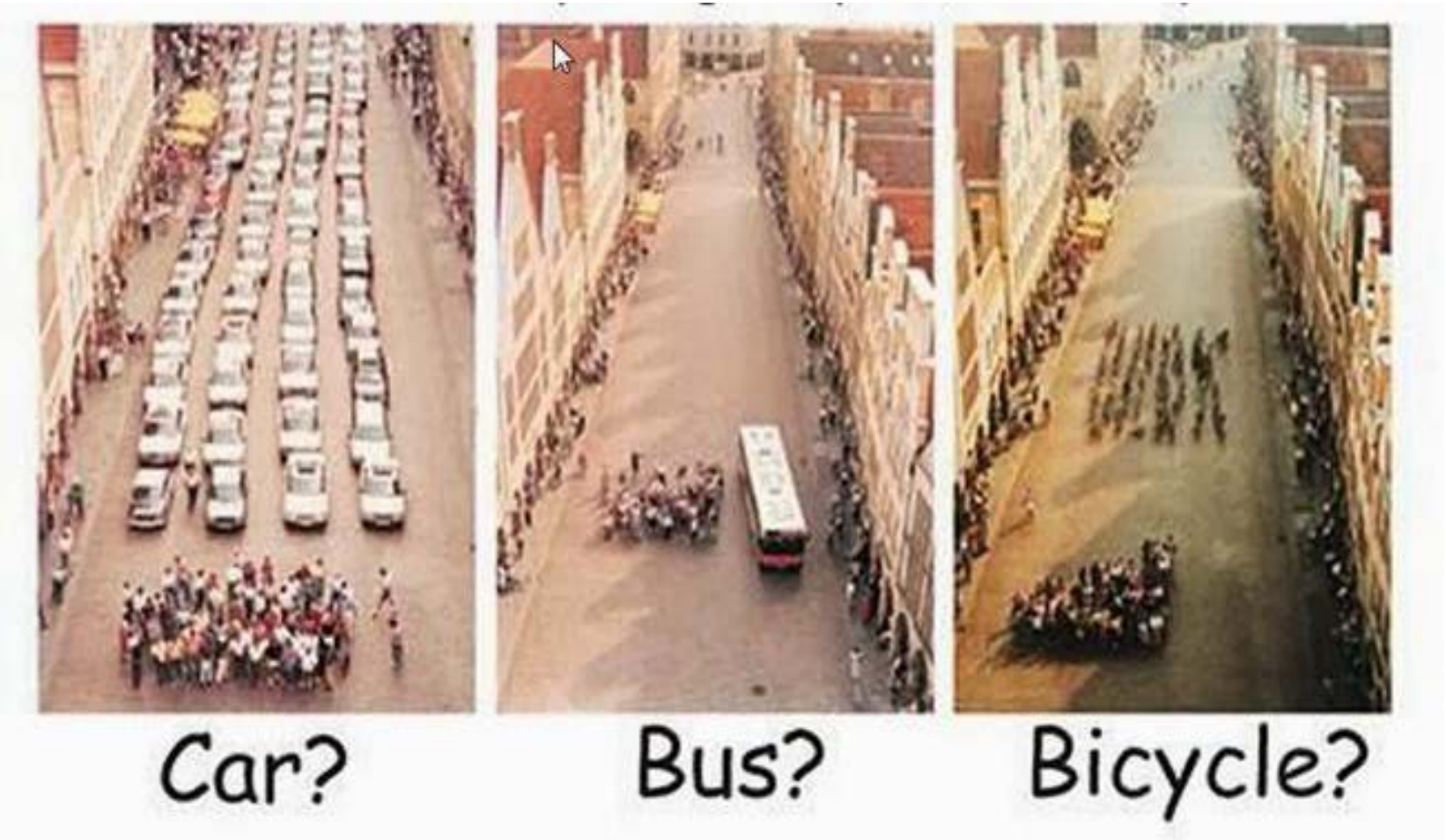
Sharing Economy

The **sharing economy** refers to economic and social systems that enable shared access to goods, services, data and talent.

These systems take a variety of forms but all leverage *information technology* to empower individuals, corporations, non-profits and government with information that enables distribution, sharing and reuse of *excess capacity* in goods and services.

-Wikipedia

Why Shared Transportation?



Source: City of Muenster, Germany

When I say “**Future of Transportation**”, what do you think of?

How do you think we are planning to get around in 20 years?

Solutions:

Self-driving cars

TNC's (Uber and Lyft)

Possible Autonomous Futures

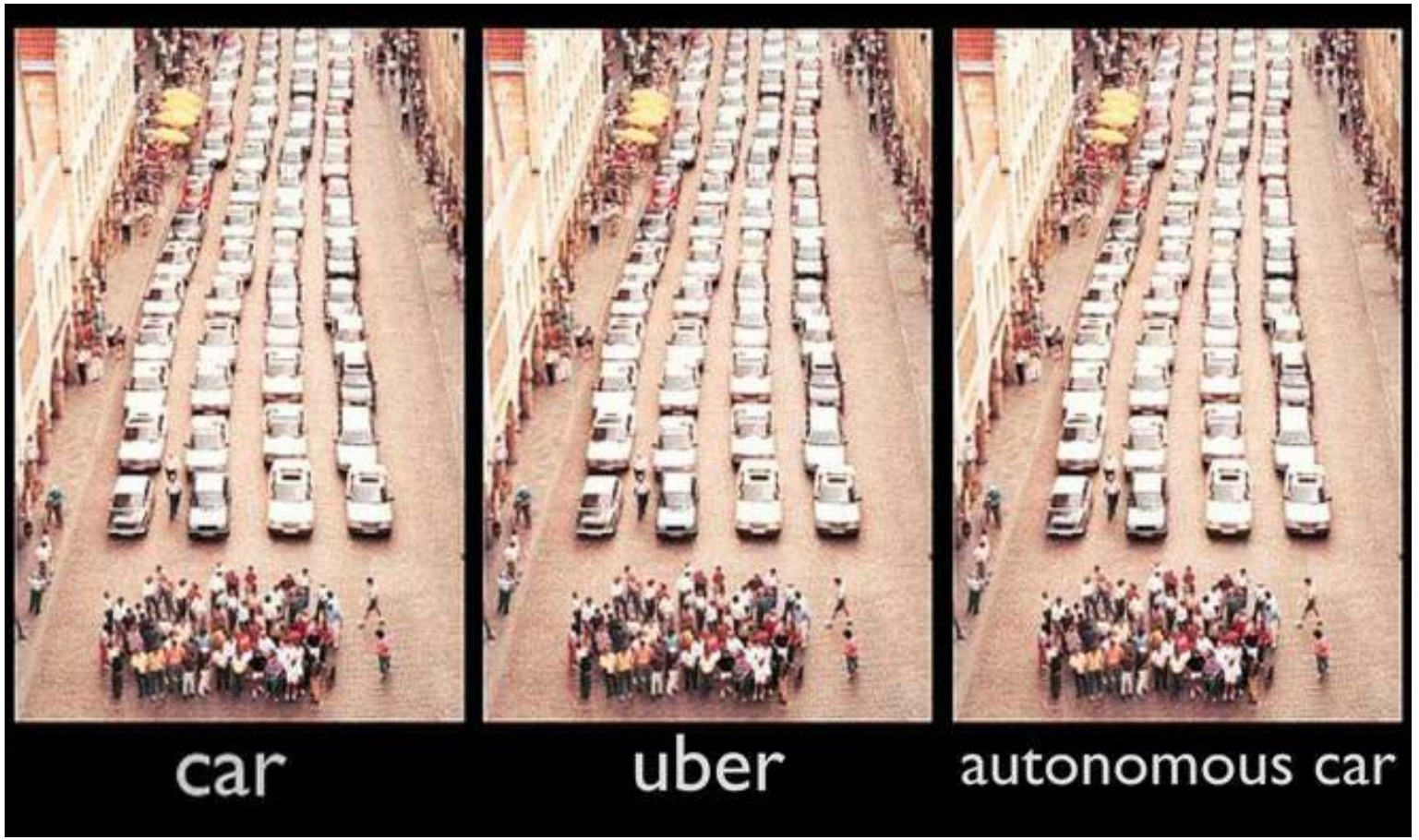
1. Personal autonomous vehicle ownership
   - Typical driver only able to afford one vehicle - sized to maximize usefulness
   - Zero-occupant trips

2. Single occupant ride-hailing
   - Circling to wait for pick-ups
   - Passengerless delivery trips
   - Increased travel demand

     Dinner in Chattanooga?

3. Shared usage of mobility services

Future of Transport



Source: Jon Orcutt, via Treehugger

How can we ensure a livable and effective future transportation system?

Future of Public Transport

1. **If travel is a utility, then mobility must be a service**

2. Spatial priority must be given to collective transportation modes

3. Focus first on service, then on technology

4. **“Scientia potentia est” - knowledge is power**

Future of Public Transport

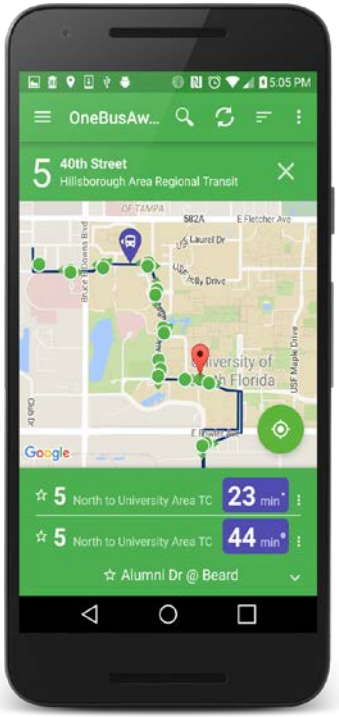
If travel is a utility, then **mobility must be a service**

- Seamless travel with collective transportation as the backbone
  - Best of high capacity public transportation for the bulk of travel distances
    - Travel collectively = system efficiency
  - Localized services for short trips and first-mile, last-mile connectivity
    - Individual needs for origin to destination
- Mobility must be transformed to be seen more like a high quality utility
  - Connection from one service to another must be efficient and pleasant
  - Good information and minimal delay

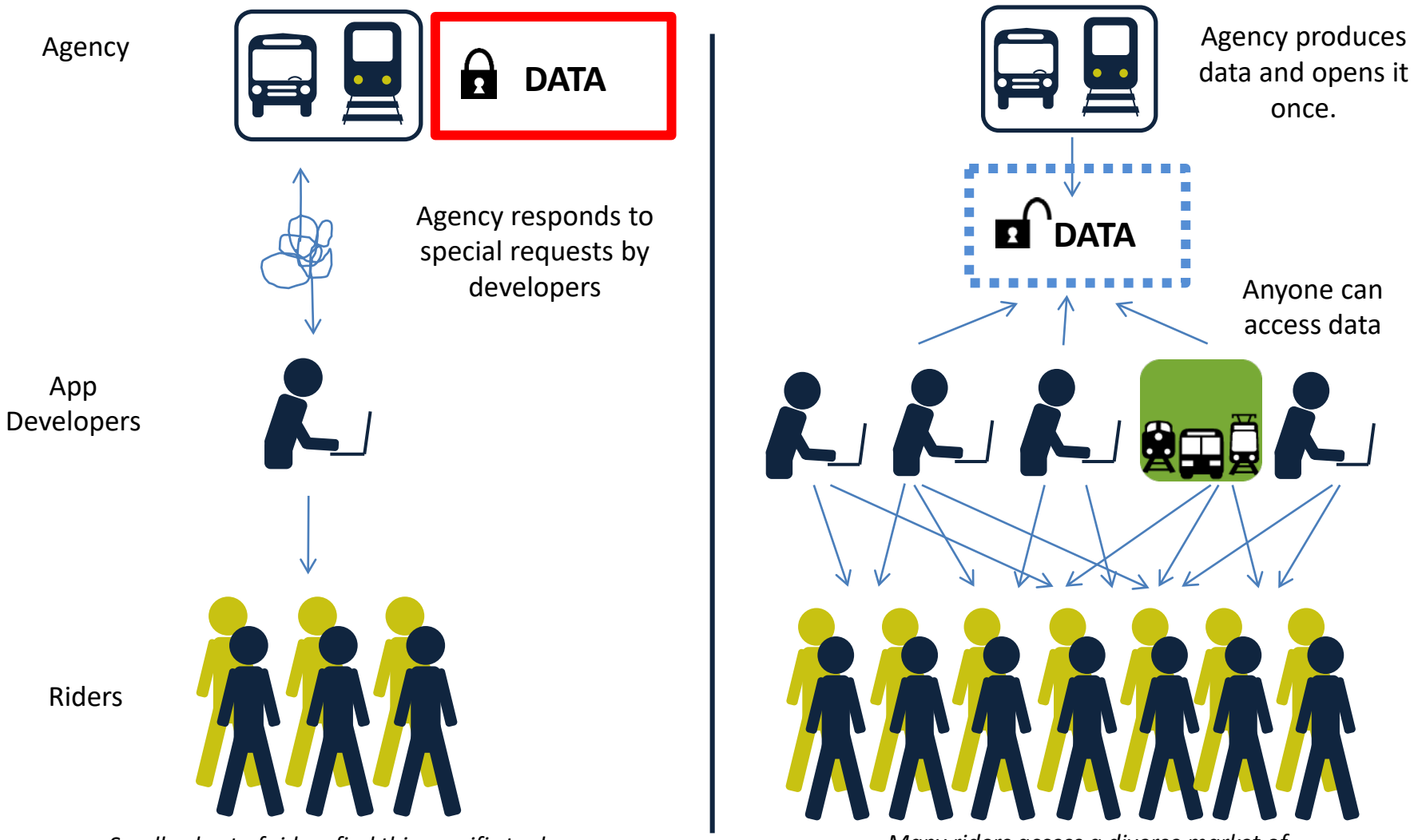
Future of Public Transport

"Scientia potentia est" - knowledge is power

- Use of technology and data to improve transit services has been far too slow for transit to compete
- Information intense society
  - Inform customers in real-time
  - Open data kept updated
  - Service disruption alerts
  - Customer feedback mechanisms



Open Data


Agency
DATA
Agency responds to special requests by developers
App Developers
Riders
Small subset of riders find this specific tool useful.
Agency produces data and opens it once.
DATA
Anyone can access data
Many riders access a diverse market of tools powered by GTFS.

Open Data Standards

GTFS

- General Transit Feed Specification

GTFS realtime

- Vehicle Position, Trip Updates and Alerts

OpenStreetMap

- Free editable map of the world

Shared Code = Open Source

- Open source products exist in many spheres
  - WordPress blogging platform
  - Web browsers Mozilla and Firefox
  - Postgres, MySql, Tomcat.
- Definition for open source:

  "Software with source code that anyone can inspect, modify and enhance."

Open Source

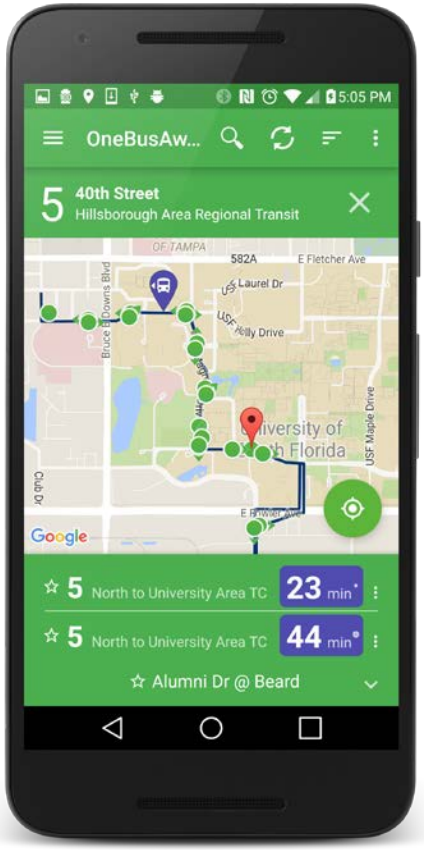
- Any agency can use without license fee and adapt to meet specific needs

- Installation can be run by
  - Agency IT department
  - Vendors
  - Independent Developers

What is OneBusAway?

- **What?** Suite of tools that provides real-time bus/train tracking information
  - Open source software
  - Native apps (iPhone, Android)
  - API for developers
  - Free to riders

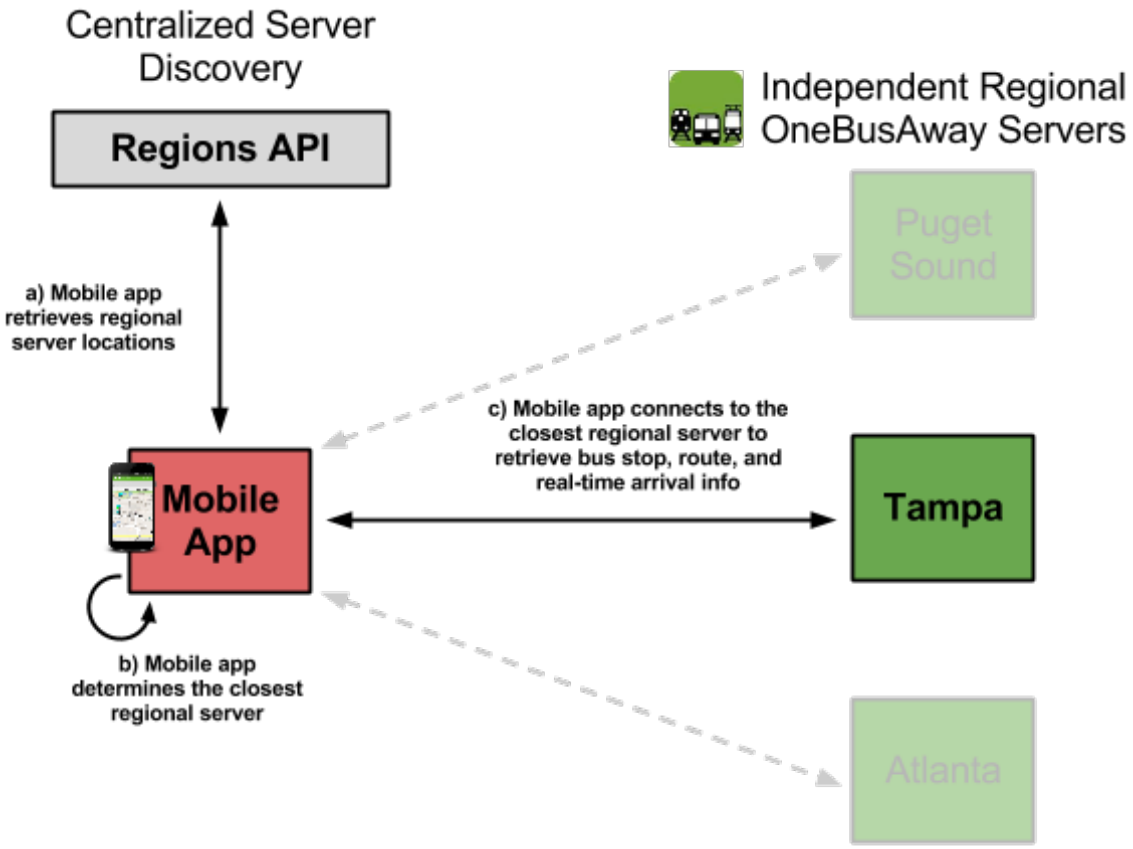
- **Why?** Make riding public transit easier by providing good information in usable formats
  - Research to evaluate the impacts



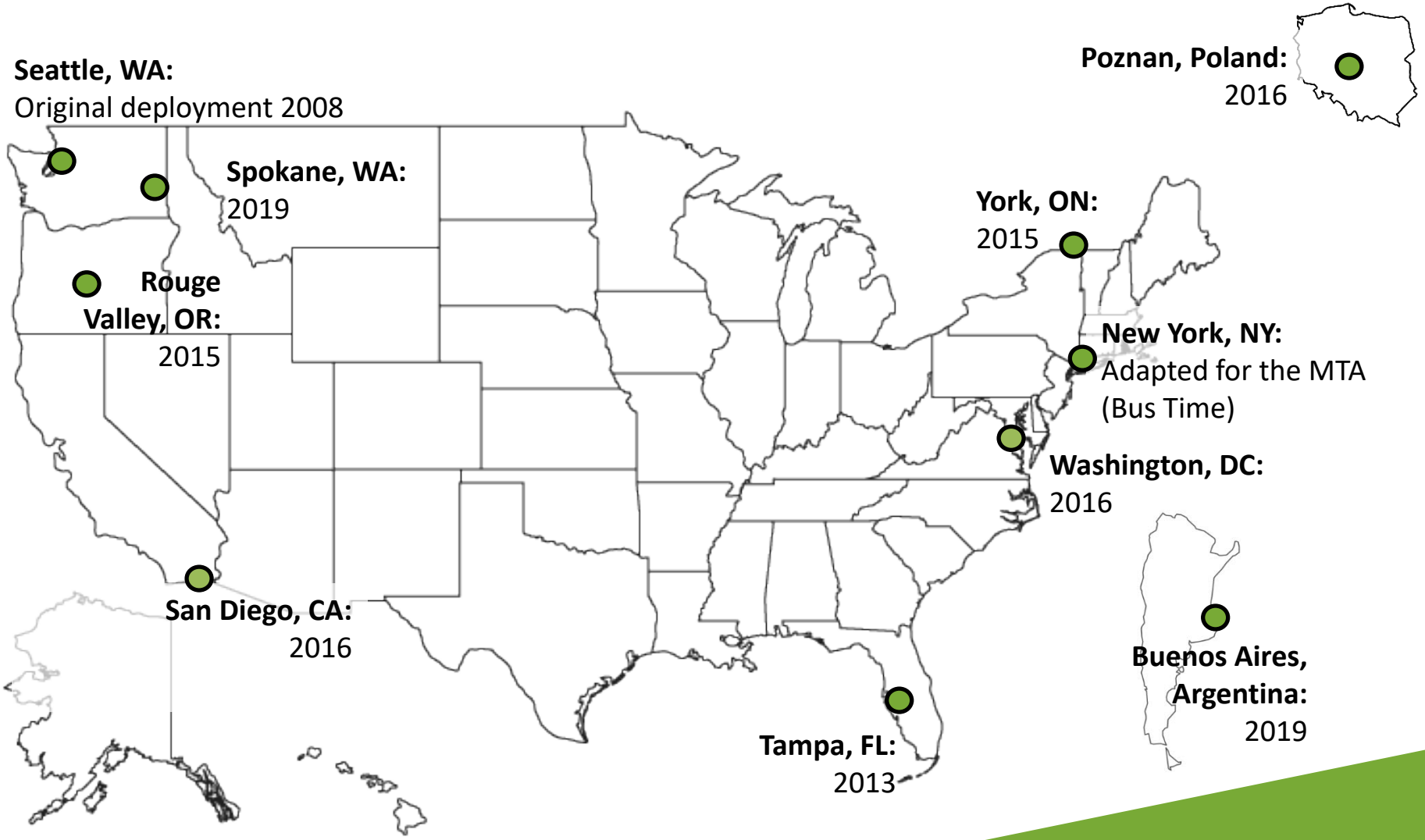
Georgia Institute of Technology

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

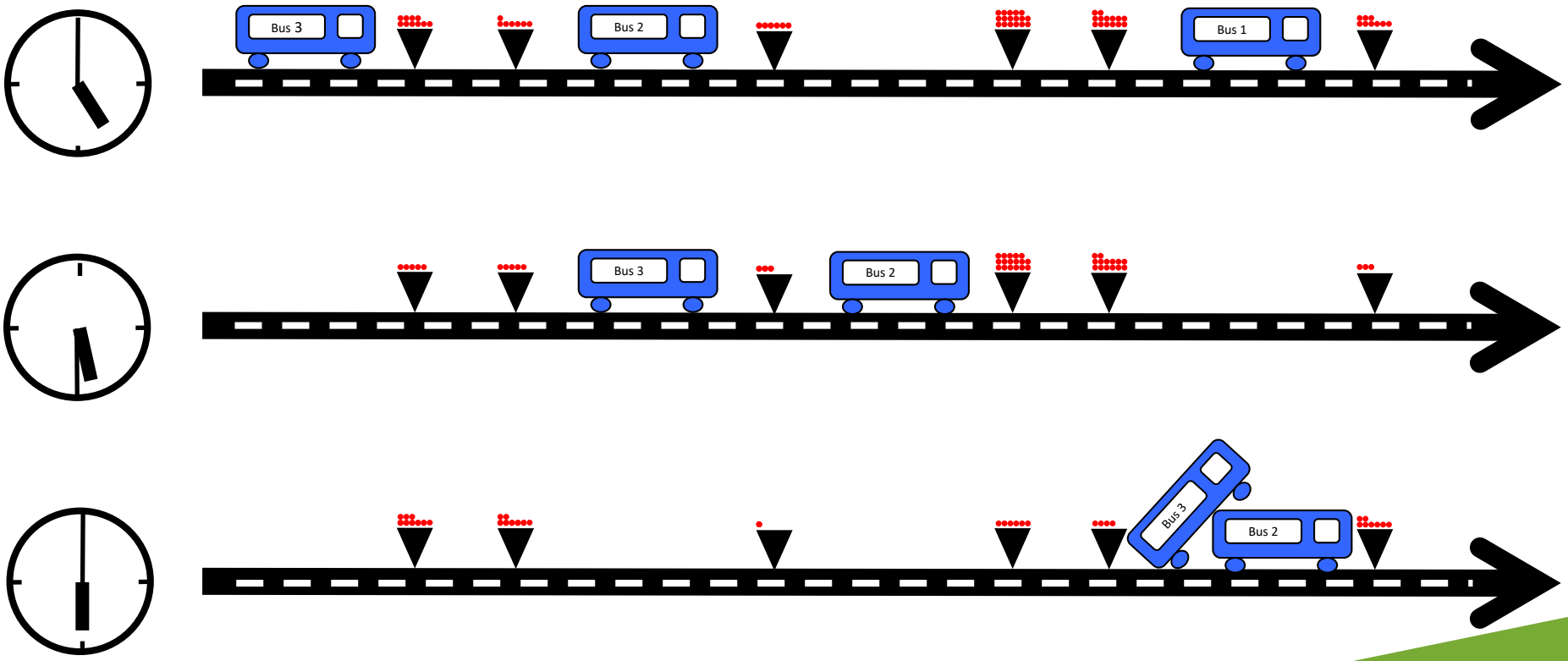


Where is OneBusAway?

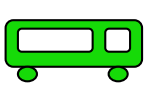


Georgia Institute of Technology

Unstable Headway Dynamics

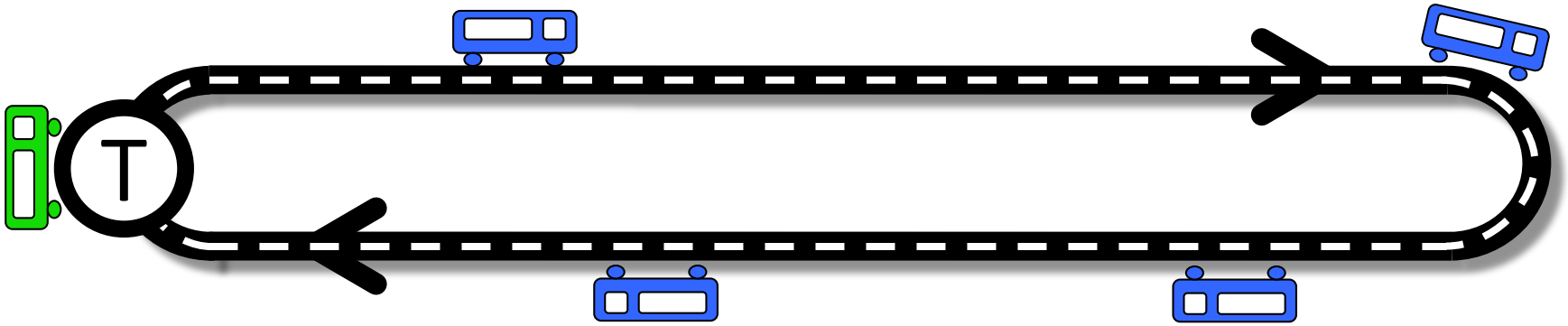


The Route and the Terminal Station(s)



Bus being held at terminal station

Bus running the route



Buses are held at one or several terminal stations

What is Transit Clock?

- **What?** Transit Clock records the real-time and historical movements of vehicles to predict arrival and departure times.
  - Provides predictions in GTFS realtime and SIRI format
  - Schedule adherence reports
  - Prediction analysis reports
  - 3rd Party predictions analysis
    - Web interface
    - API for developers
  - Auto assigns vehicles to trips based on GPS data
- **Why?**
  - To produce accurate arrival predictions to be displayed to passengers
  - To provide reporting on performance of transit systems and existing real-time infrastructure

Transit Clock:
Current Developments

Georgia Tech

transitimeExtension: Holding Times for ATLANTA STREETCAR

Remaining Holding Time

01:06

Vehicle ID	1003
Time of Arrival	6:21:18 PM
Time of Departure	6:26:45 PM
Next vehicle	1004
Predicted arrival	6:30:19 PM

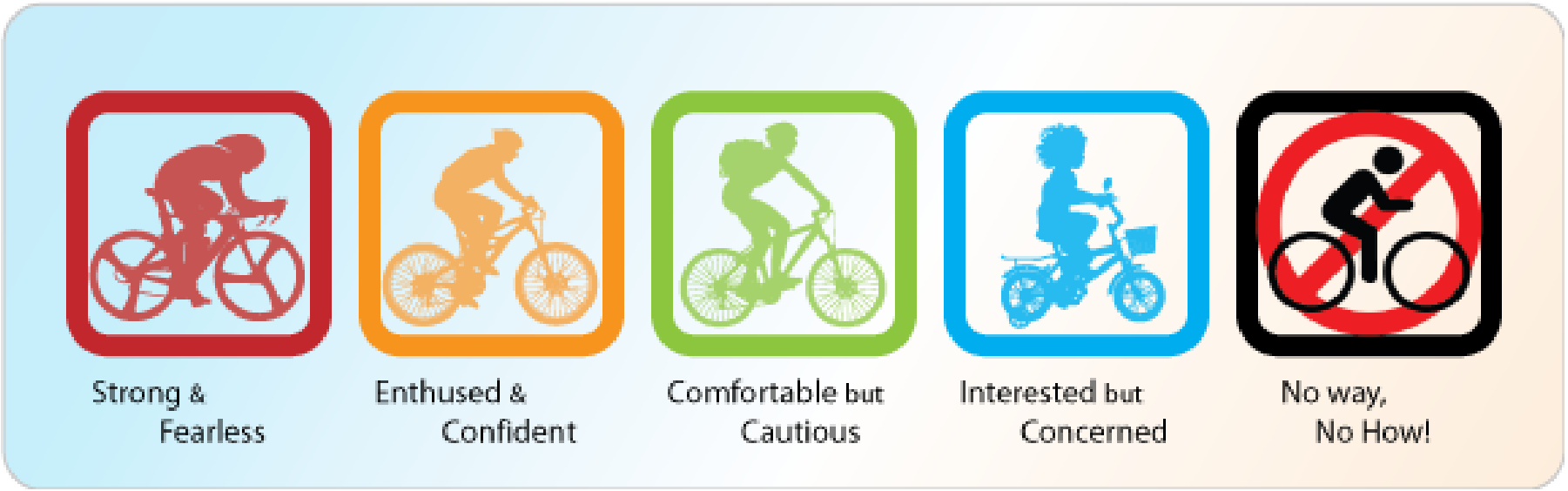
Developed by Sean Óg Crudden (og.crudden@gmail.com) and Simon Berrebi (simon@berrebi.net)

Real-Time Vehicle Location

Georgia Institute of Technology

How can we ensure a livable and effective future transportation system?

Rider Type


Strong & Fearless
Enthused & Confident
Comfortable but Cautious
Interested but Concerned
No way, No How!


Cycle Atlanta
AT&T 3G 10:52 AM
Record
00:00:00
elapsed time
0.0 mi
estimated distance
0.0 mph
estimated speed
Start
Save
Georgia Tech
Marietta Street Artery
Google
Instructions
Record
My Trips
Settings
AT&T 3G 3:07 PM
elapsed: 00:21:40 ~ Sep 14, 2012 8:39:40 AM
My Trips
3.3 mi ~ 9.1 mph
Ansley Park Historic District
Home Park
Midtown
Piedmont Park
Virginia Highland
Cenntenial Place
Google
Instructions
Record
My Trips
Settings

Bike Perception Survey

Bike lane

A bike lane is

mpletely agree

☐

☐

☐

Not sure

Buffered

A buffered bil

mpletely agree

☐

☐

☐

Not sure

Georgia Institute of Technology

What is Stress?

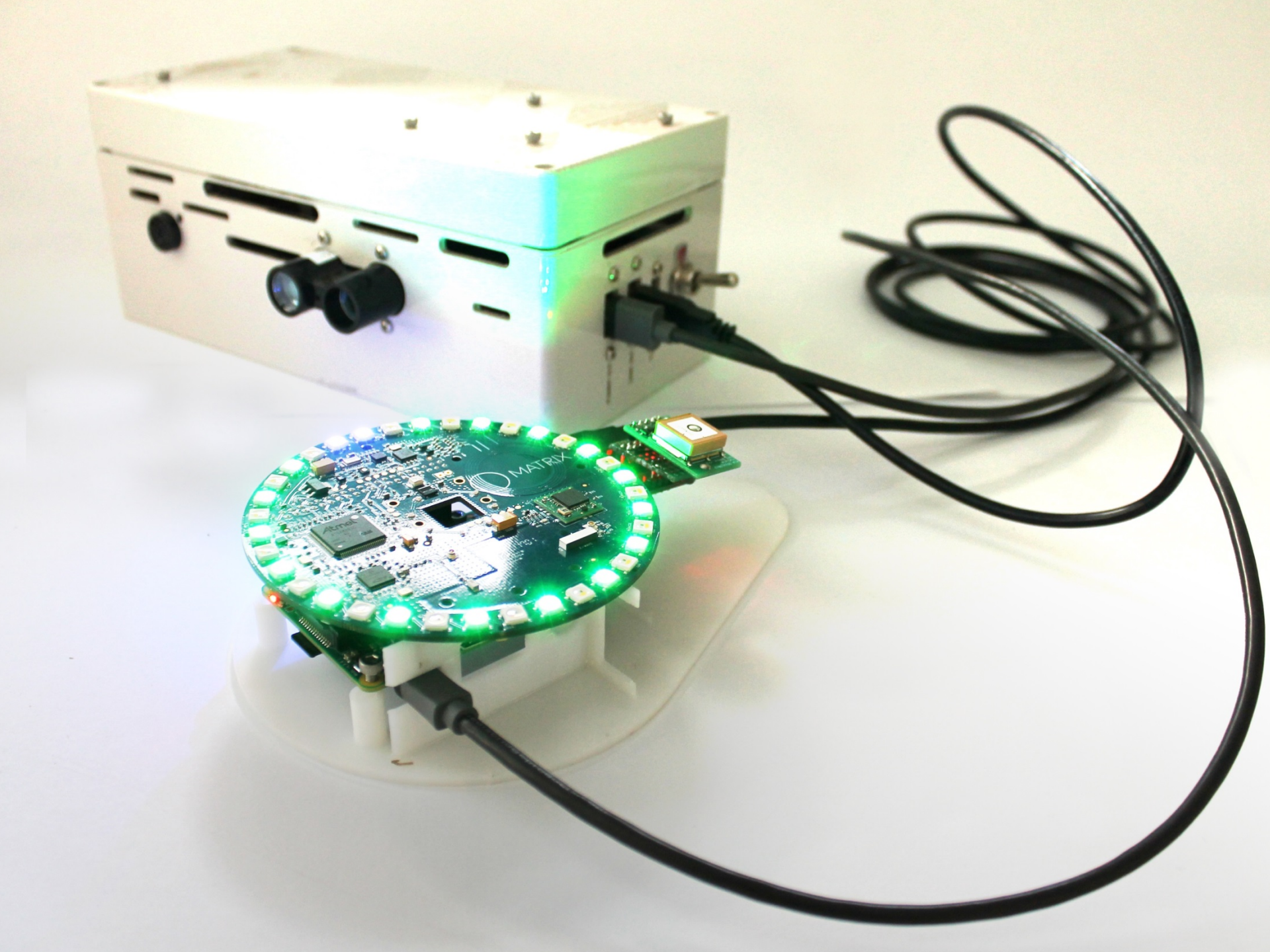
How could we measure stress?

- Non-invasive stress measures:
  - Heart rate variation
  - Breathing pattern
  - Blood pressure
  - Galvanic skin response
  - Brain waves
  - Eye-based measures

- Eye tracking is the most viable, likely a combination of measures

Pupil Labs Eye Tracking Glasses

Specification	Value
Gaze Accuracy	0.60 degrees
Gaze Precision	0.08 degrees
Pupil Tracking Technology	Dark pupil
Sampling Frequency (Eye)	200 Hz
Sampling Frequency (World)	Variable 30-120 Hz depending on light levels


MATRIX

Road

GPS
3D Accelerometer
3D Gyroscope
3D Magnetometer
Microphone array

Environmental

Temperature
Humidity
Barometer
UV

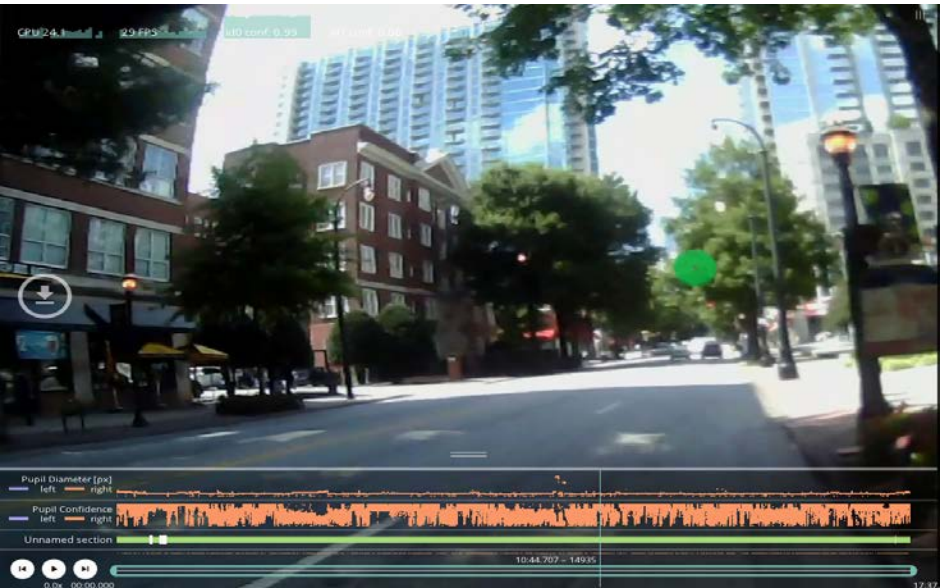
Ozone
Nitrogen Dioxide
Sulfur Dioxide
Carbon Monoxide
Particulate Matter

Traffic

2x Lidar Rangefinders
3x Ultrasonic Rangefinders

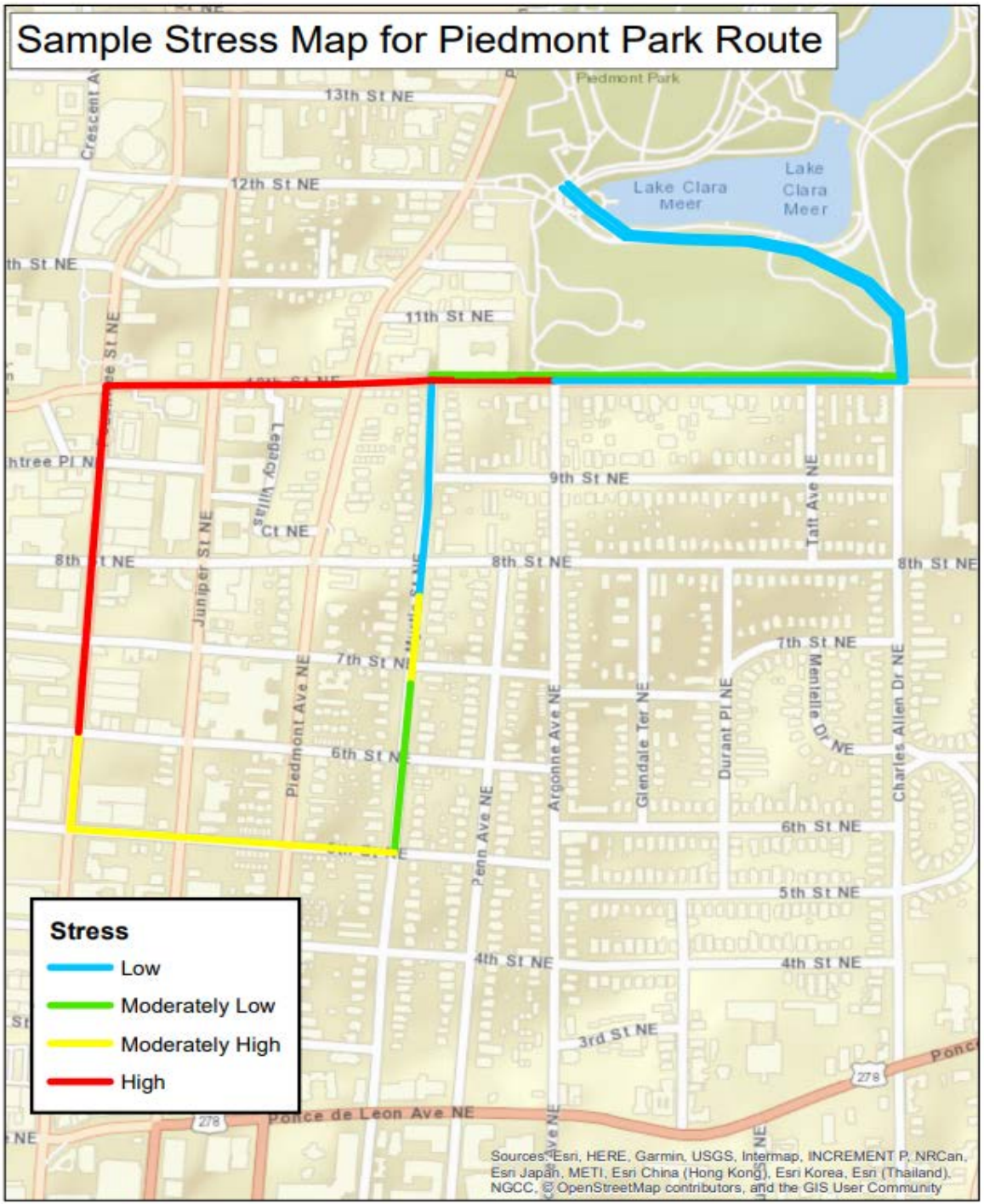
Initial Eye Tracking Tests

Confident



Timid

Example Completed Stress Map



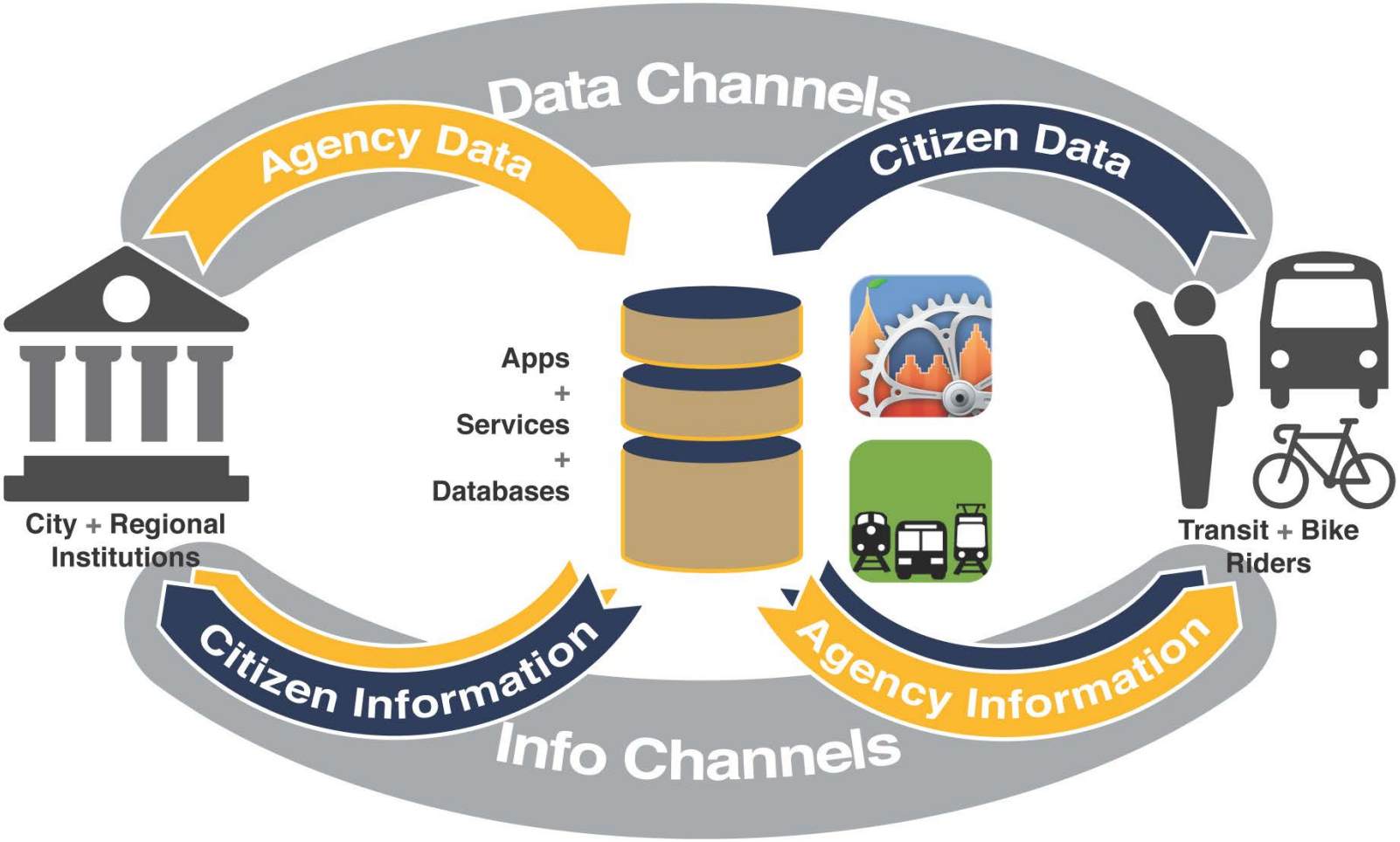
My Research

- Overcome barriers to transit and cycling with better information

- Need a good source of data
  - Open data
  - Crowdsourced data
  - Innovative data

- A way to get the information to people
  - Usable apps
  - Reliable sources
  - Multiple means of access

Urban Transportation Information



Thank You!

Dr. Kari Watkins
Frederick Law Olmsted Associate Professor
Civil & Environmental Engineering
kari.watkins@ce.gatech.edu
@transitmom