Autonomy-enabled Shared Vehicles for Mobility on Demand and Urban Logistics

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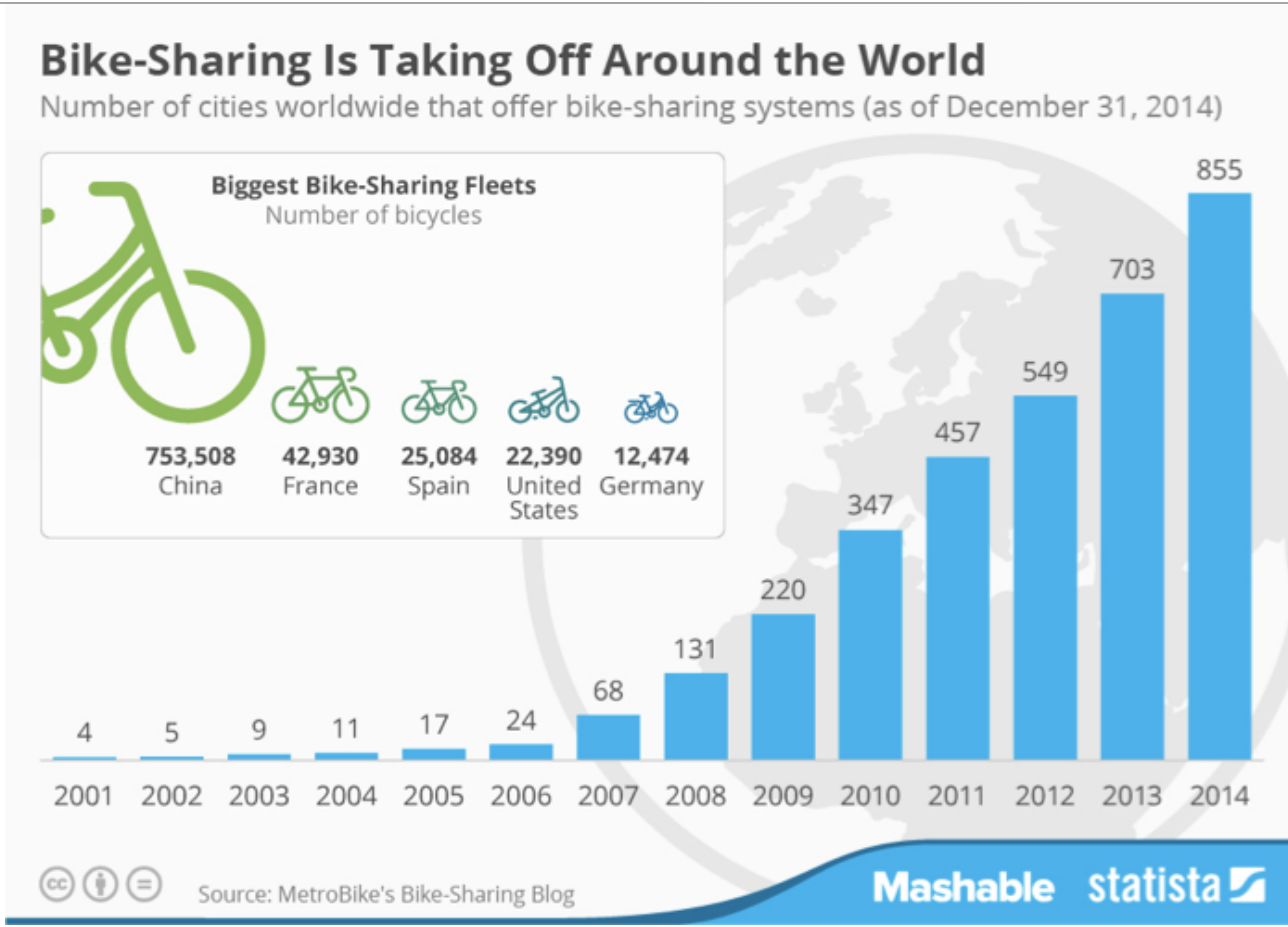
MIT AEROASTRO

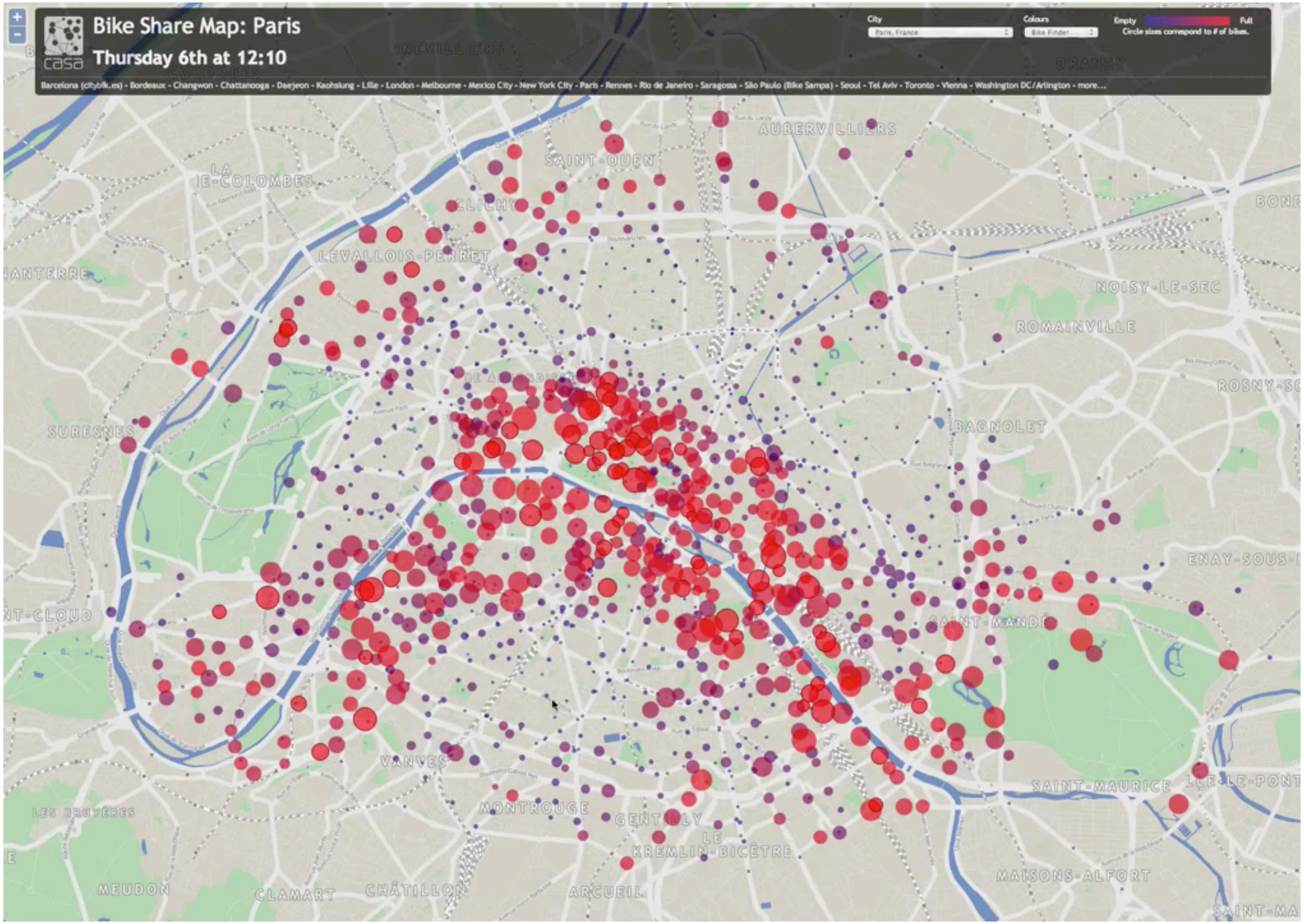
- 20th-century cities of the USA: The suburban sprawl.
- Enabled by a 20th century invention: The affordable car.

- New services enabled by 21st century technologies, e.g., smart phones, online services, sharing economy.
- Major needs:
  - **Mobility on demand:** Access to mobility whenever, wherever need.
  - **Urban logistics:** Rapid delivery of goods.

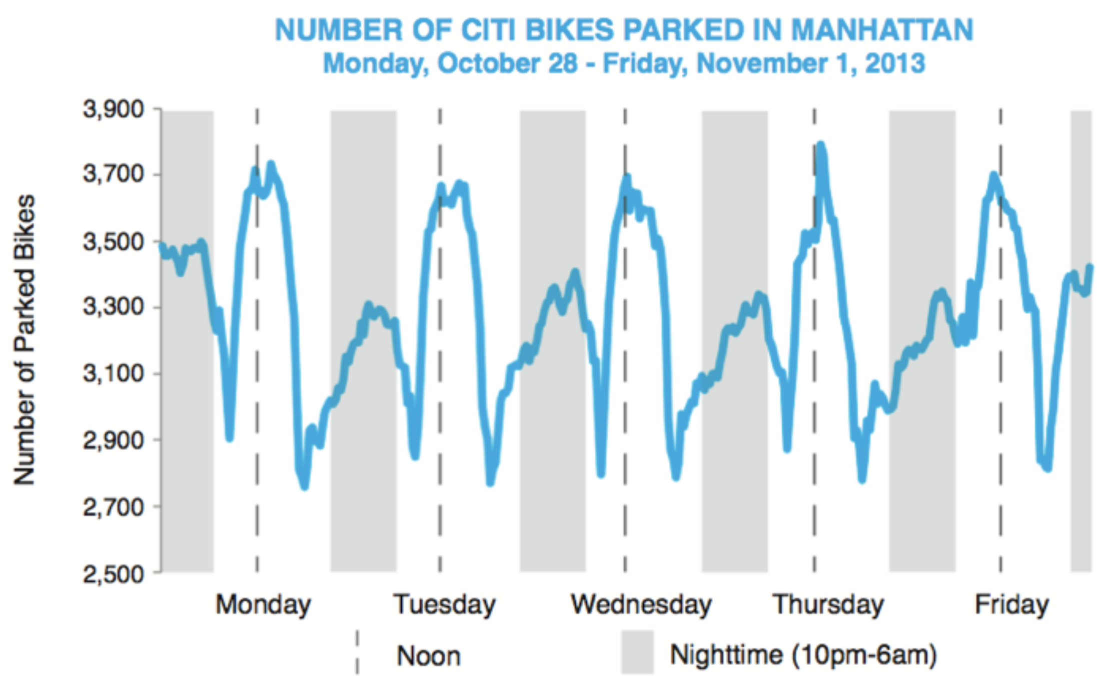
Existing Solutions for **Mobility on Demand:** Bike Sharing Programs

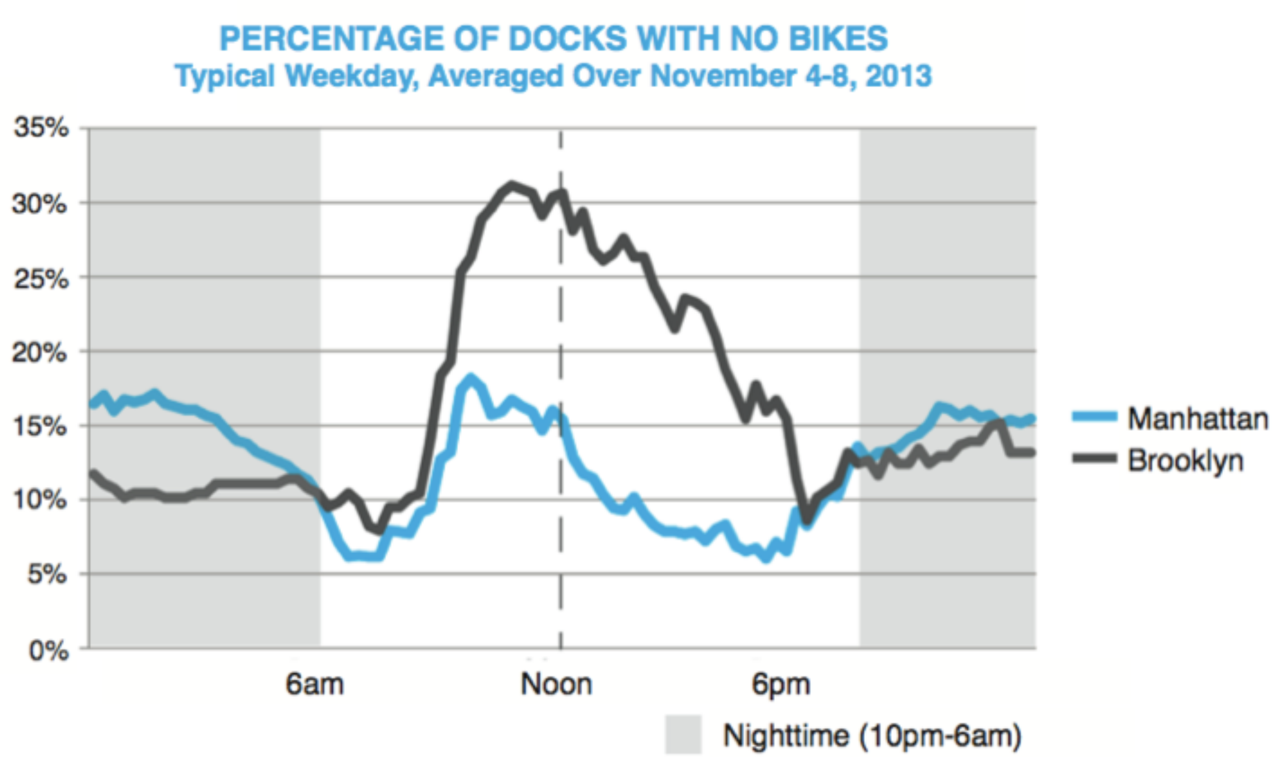


Existing Solutions for **Mobility on Demand:** The Paris Bike Sharing Program



Existing Solutions for **Mobility on Demand:** The Manhattan Bike Sharing Program





- Existing programs suffer from availability, rebalancing, and infrastructure costs.

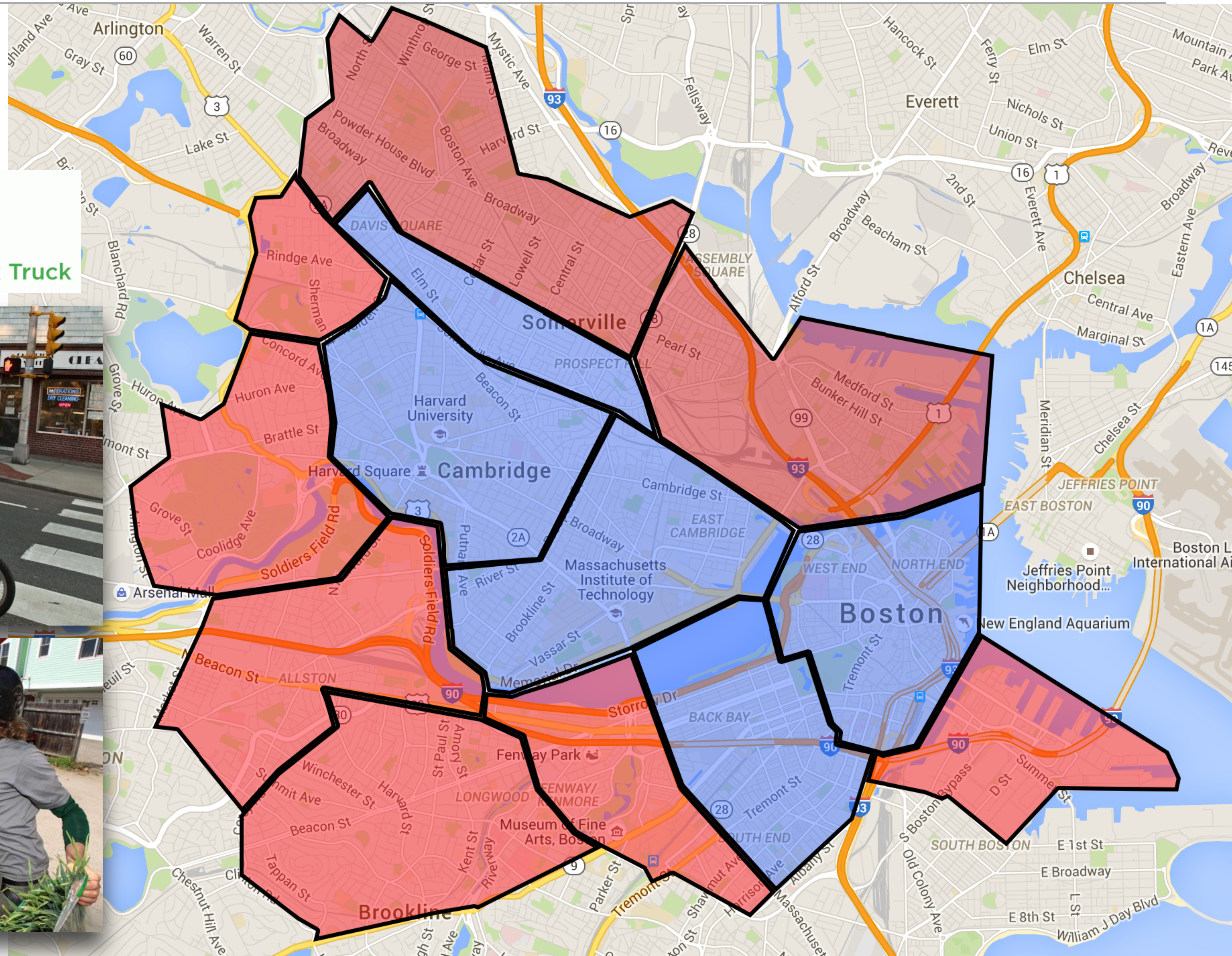
Existing Solutions for **Urban Delivery:** Delivery for Small Businesses in Manhattan

Existing Solutions for **Urban Delivery:**
A Trike Delivers a Better Tomorrow

Existing Solutions for **Urban Delivery:**
Boston’s Parcel Delivery with Bicycles

METRO PEDAL POWER

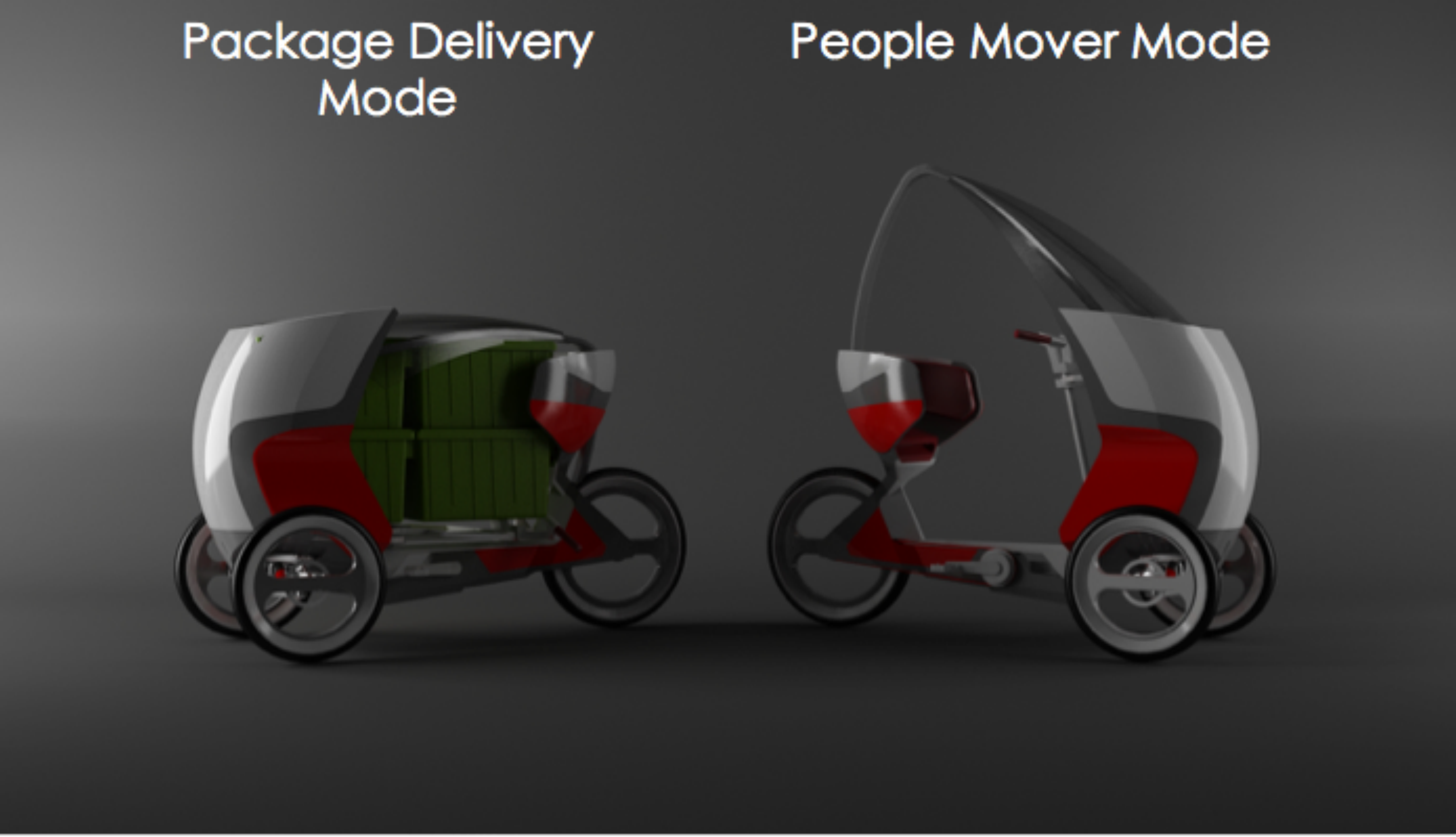
Think Outside The Box Truck



Wild Ideas: Mobility on Demand with Self-driving Cars

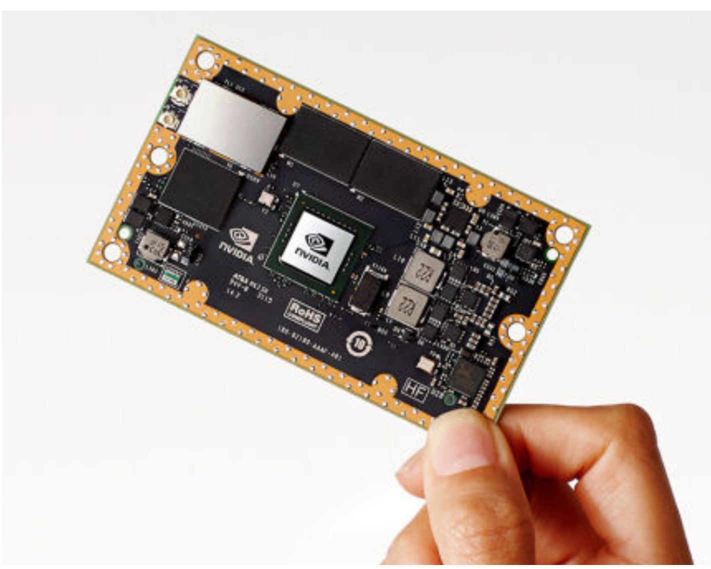
Wild Ideas: Same-hour Delivery with Drones

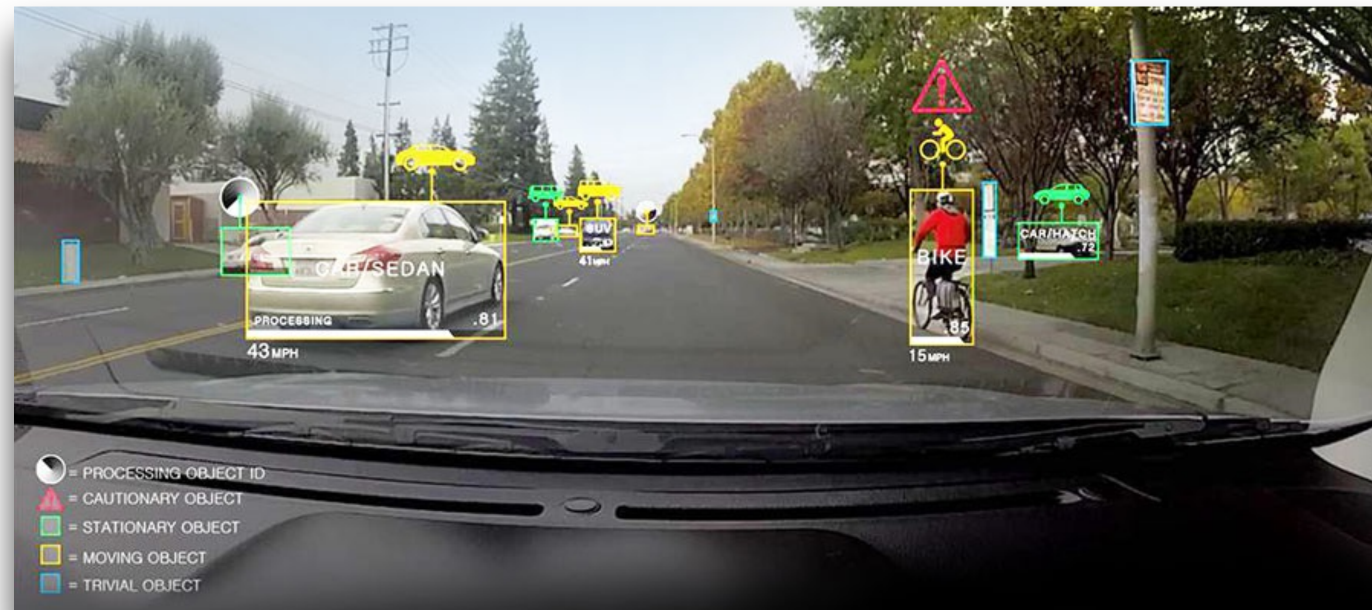
Autonomous Persuasive Electric Vehicle (PEV) concept



Autonomous Persuasive Electric Vehicle (PEV) concept

Challenges and Opportunities: Vehicle Level





The nvidia Jetson embedded supercomputer

- Affordable and safe autonomy becoming feasible for slow-moving vehicles.
- Technical problems in decision making and control under uncertainty.

Challenges and Opportunities: Systems Level

- Design and analysis of networks of autonomous tricycles for mobility on demand and urban logistics, for instance using network/connection science.

Our Team

- The team brings together diverse expertise co-located in the Boston area.

Kent Larson
& Ryan Chin
The Media Lab
Massachusetts Institute of Technology

Sertac Karaman
Laboratory for Information and Decision Systems
Massachusetts Institute of Technology

Mathias Winkenbach
& Edgar Blanco
Center for Transportation and Logistics
Massachusetts Institute of Technology

Chris Osgood & Nigel Jacob
New Urban Mechanics Group
City of Boston

Massachusetts Institute of Technology
and the City of Boston

Foundations of Autonomous Systems Technology Group
at MIT Laboratory for Information and Decision Systems

MIT's Participation in the DARPA Urban Challenge

Sertac Karaman
Laboratory for Information and Decision Systems
Massachusetts Institute of Technology

Autonomous golf carts in Singapore

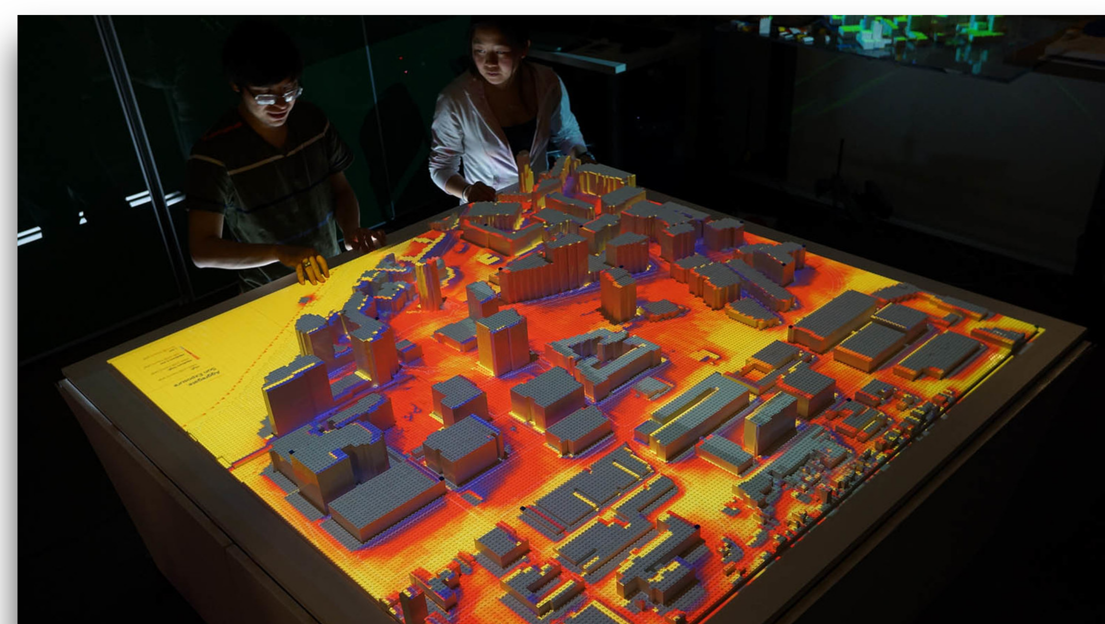
Changing Places Group
at MIT Media Lab

The CityCar

Kent Larson & Ryan Chin
The Media Lab
Massachusetts Institute of Technology

MIT MEDIA LAB

Urban Modeling and Simulation

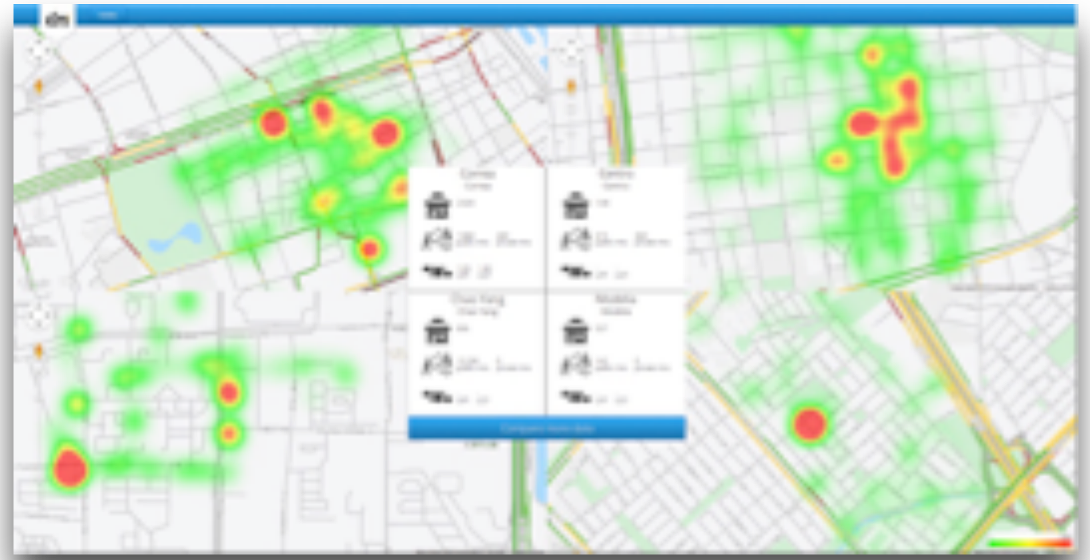


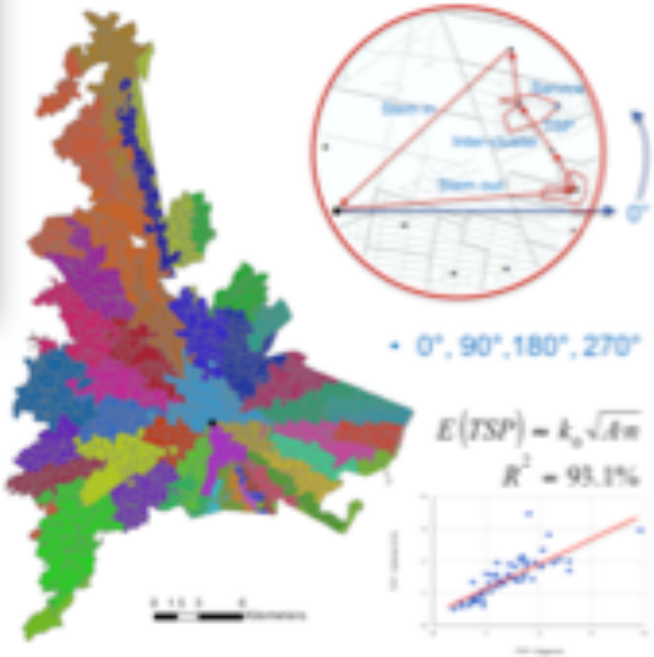
Megacity Logistics Lab
at MIT Center for Transportation and Logistics

Matthias Winkenbach & Edgar Blanco
Center for Transportation and Logistics
Massachusetts Institute of Technology

Last Mile Operations & Policy Design

Open source Urban Logistics Atlas





Future Urban Logistics Networks Modeling and Optimization

New Urban Mechanics Group
at City of Boston

Projects built on "participatory urbanism"

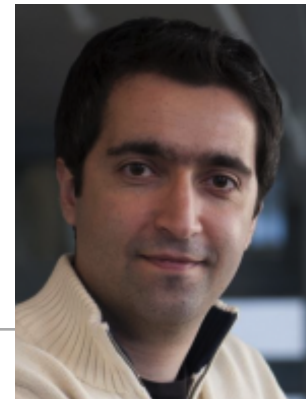
More than 20 small projects supported
visit: http://newurbanmechanics.org

Nigel Jacob & Chris Osgood
New Urban Mechanics Group
City of Boston

Flu Shot App

Mobile FabLab

Our Team


Sertac Karaman


Kent Larson


Mathias Winkenbach


Edgar Blanco

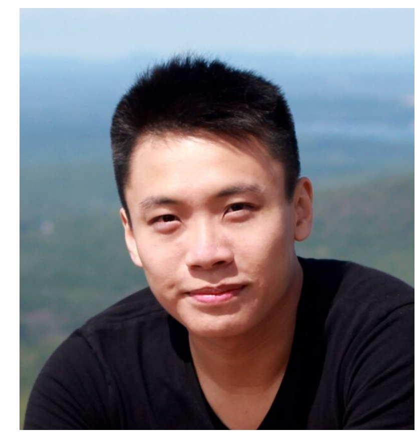

Nigel Jacob

Chris Osgood

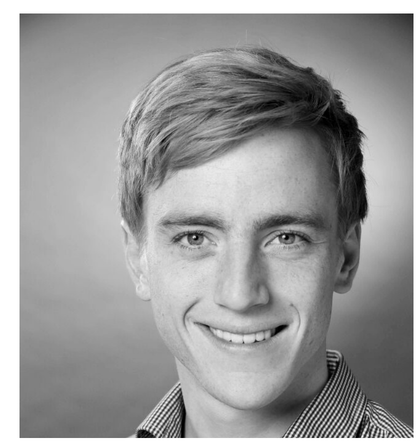
Graduate Students


Abhishek Agarwal


Michael Lin


Fangchang Ma

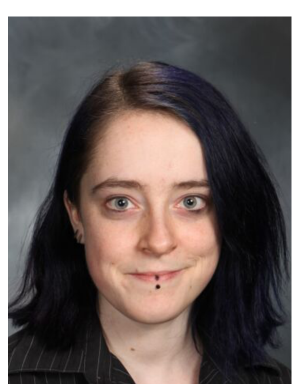

Veronica Lane

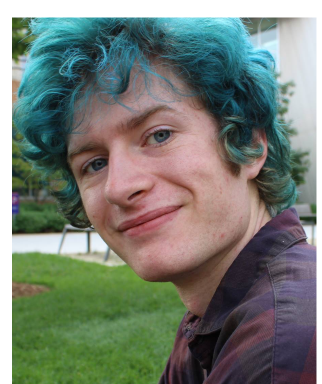

Franziskus Wiedemann


Daniel de Oliveira Mota

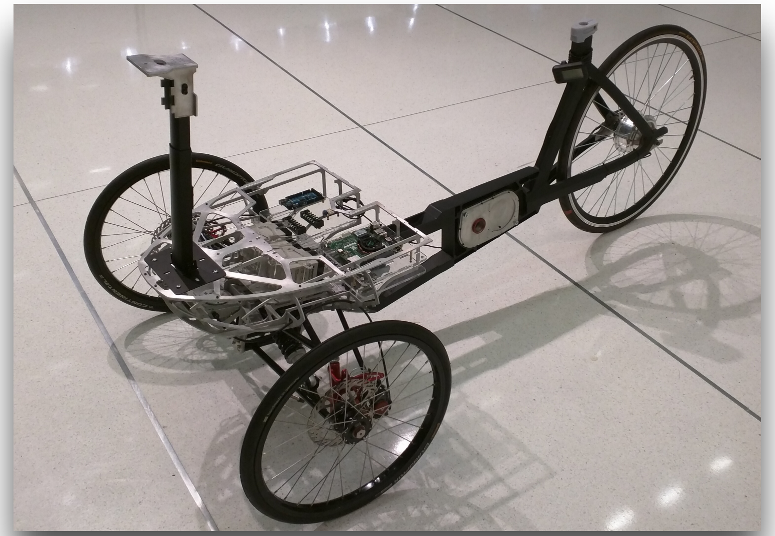
Undergraduate students

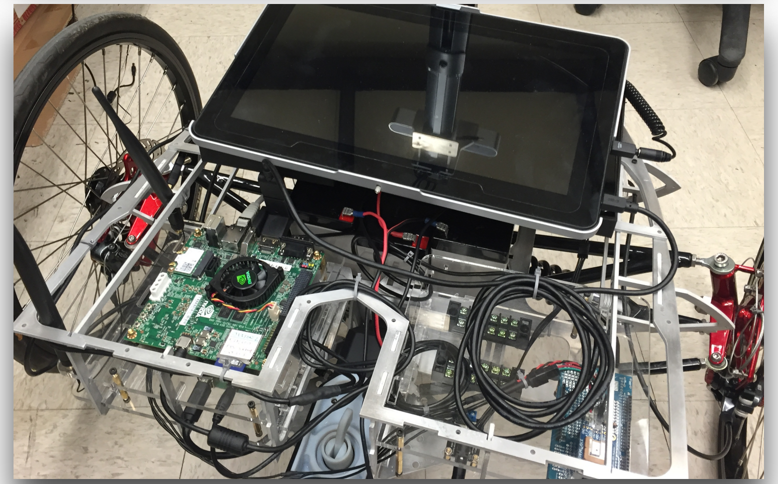

Ostin Zarse


Syler Wagner


Chris Desnoyers

Prototype

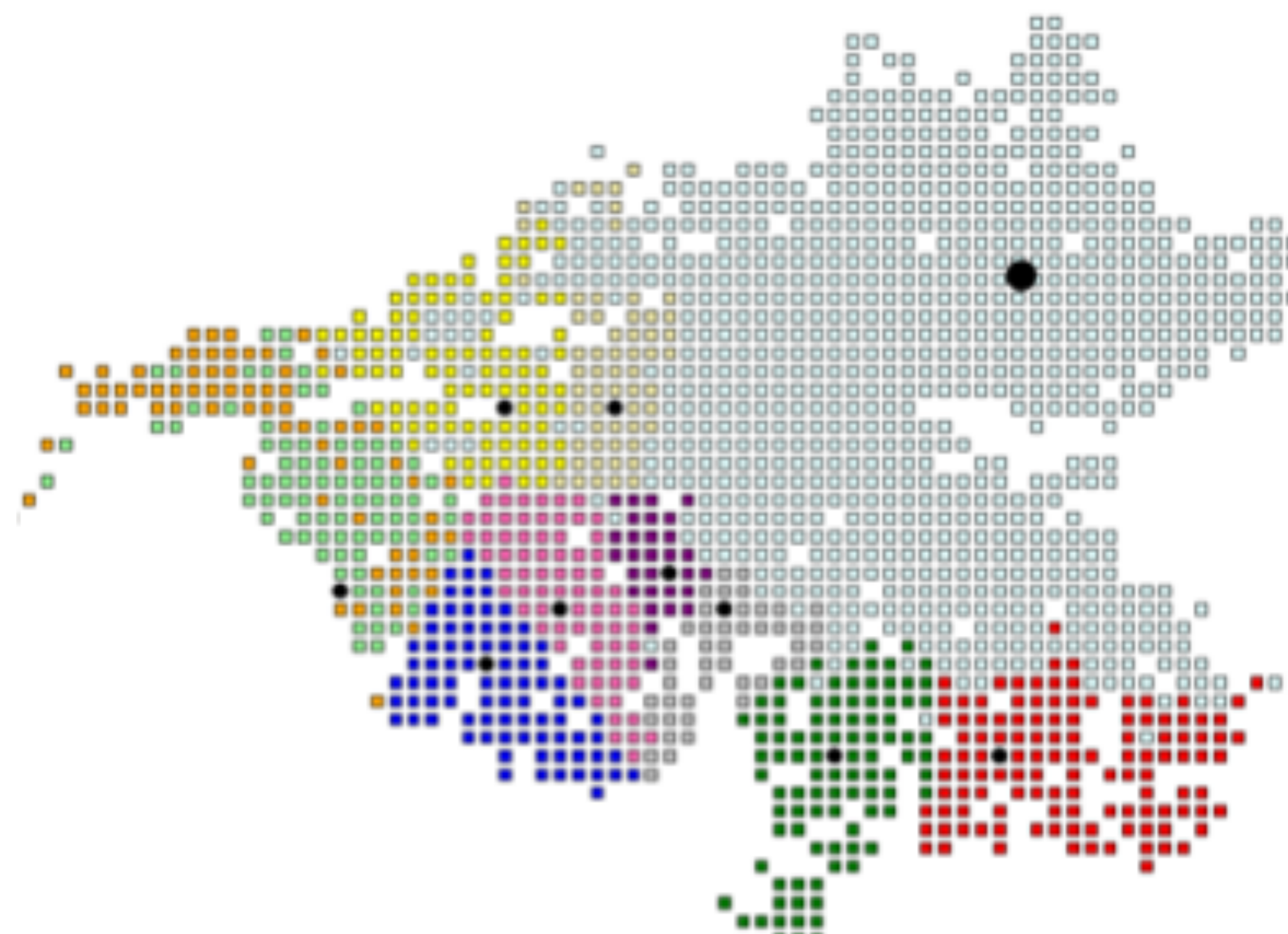




Simulation Study: Autonomous Tricycles in Nantes, France for Package Delivery

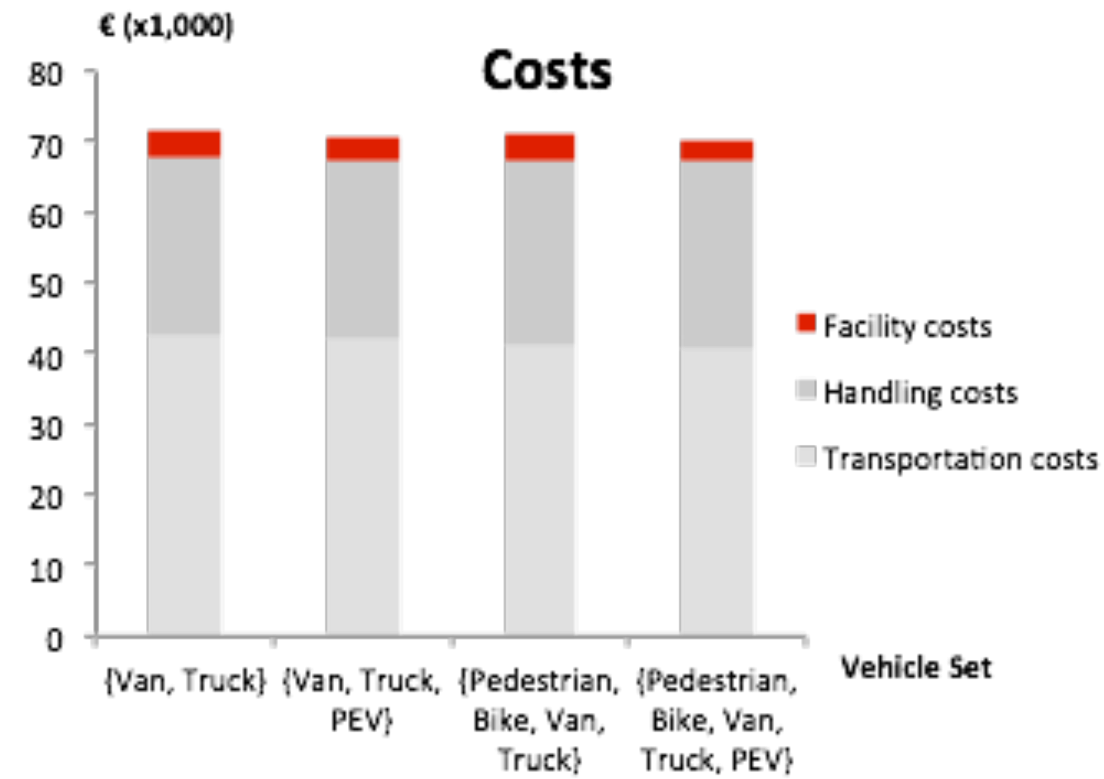
- 600,000 inhabitants in 400 km^2
- 30,000 packages per day

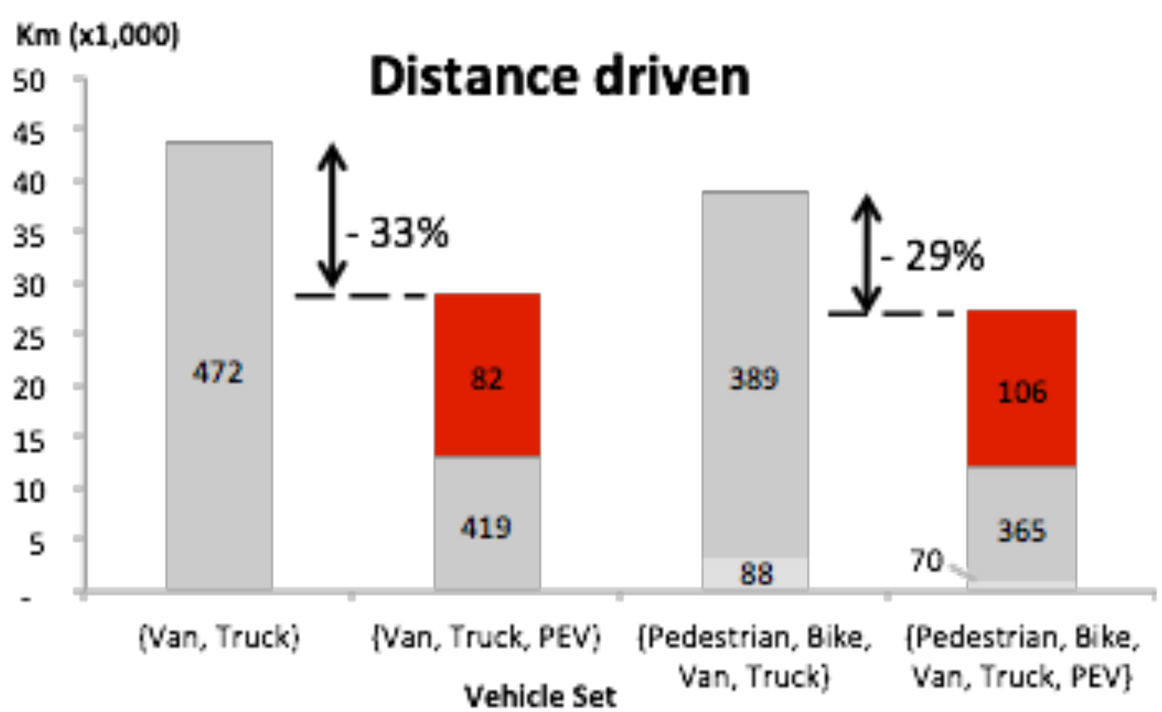
- Facilities:
  - City Distribution Center (CDC)
  - Intermediate Depots (ID)
- Vehicles:
  - Pedestrian, Bike, Van, Truck

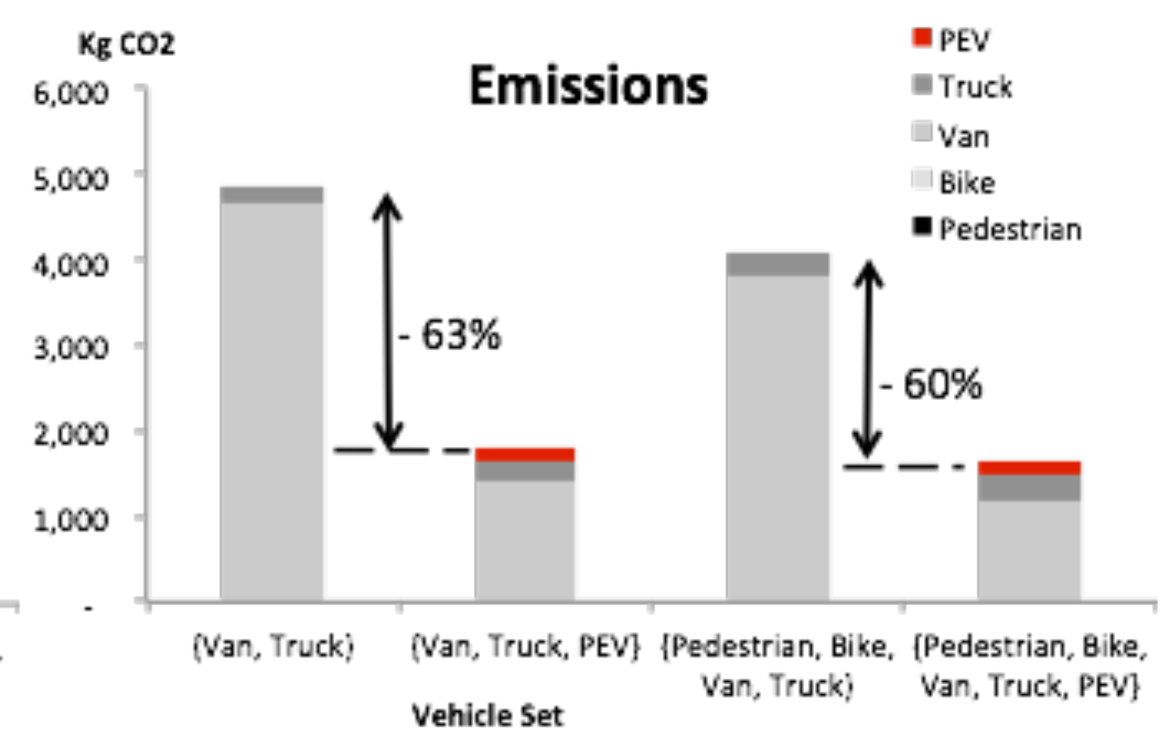


Simulation Study: Autonomous Tricycles in Nantes, France for Package Delivery

- With the same cost, the PEV integration cuts emission by 60%.

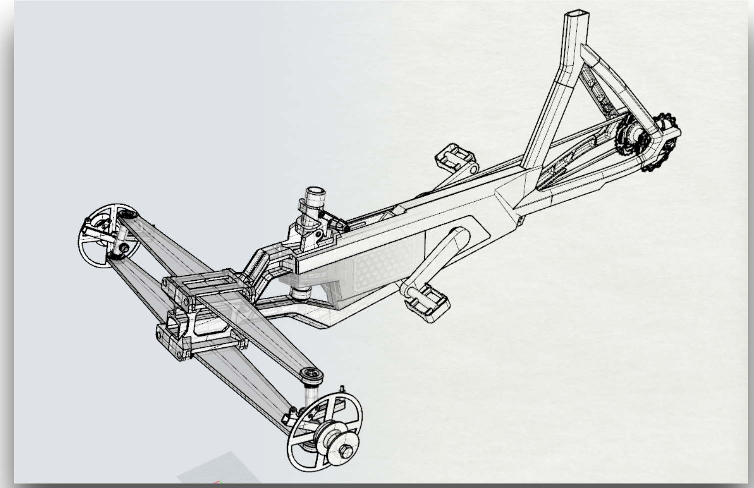


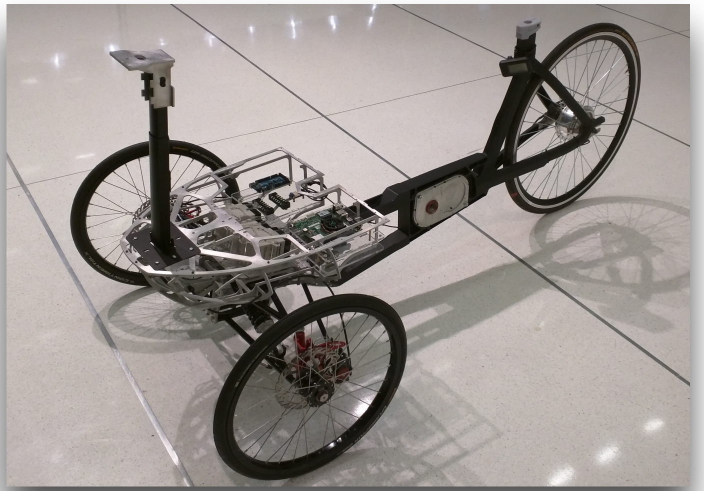




Next Steps

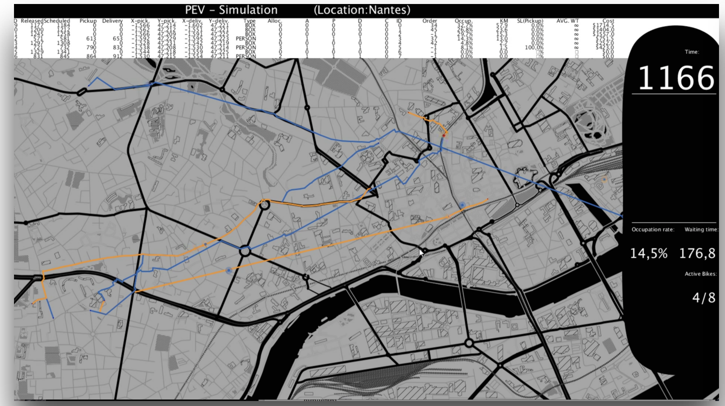
Design & build
the final prototype

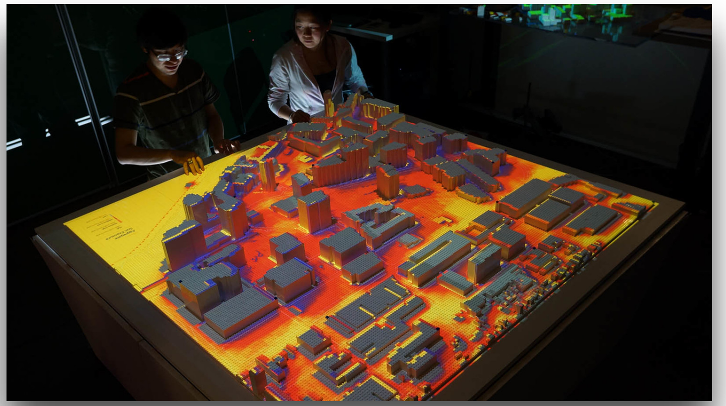




Design & implement algorithms
that enable affordable autonomy
for vehicles on bike lanes

Simulations of potential deployment
and visualization of simulation results

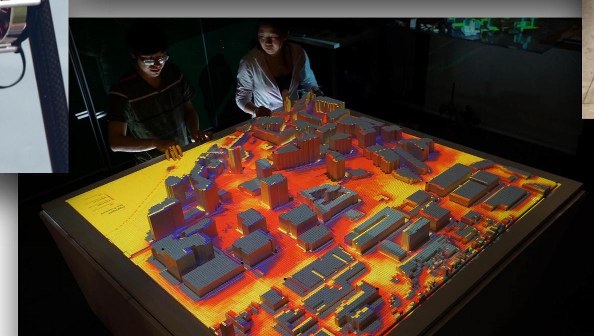




Summary & Remarks

- **Challenge**
  - Algorithmic methods to enable affordable autonomy on bike lanes
  - Design and analysis of transportation networks involving autonomous trikes

- **Scientific Impact**
  - Algorithms for decision making and contro in CPS, under substantial uncertainty.
  - Advance network science to understand the potential impact of autonomous CPS



- **Solution**
  - Use stereo cameras and massively parallel computation for decision making and control under uncertainty.
  - Use network science and simulation studies to understand the potential impact of a fleet of autonomous vehicles.

- **Broader Impact**
  - Clean transportation for people and goods, if the project is successful.
  - An understanding of the impact of autonomous vehicles on moving people and goods.

http://racecar.mit.edu

MIT’s Robotics Course: Racing in MIT’s tunnels with autonomous mini race cars

- Each team of 5 given the race car platform.
- Students learn basics of algorithmic robotics in 7 special lectures.
- Students design and implement their algorithms in a 2-day hackathon
- http://racecar.mit.edu