

# Artificial Intelligence for Future of Travel Demand Modeling

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# Self Introduction



Shenhao Wang

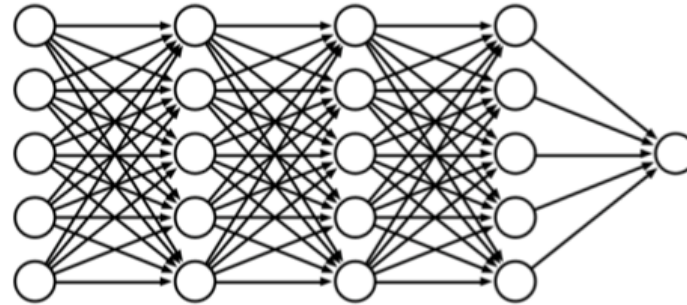
Assistant Professor (started 2022),  
Director for Urban AI Lab | Master of Urban Analytics  
Department of Urban and Regional Planning,  
University of Florida



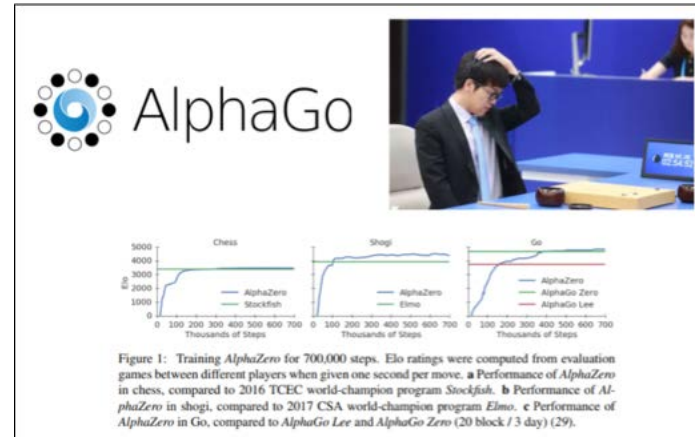
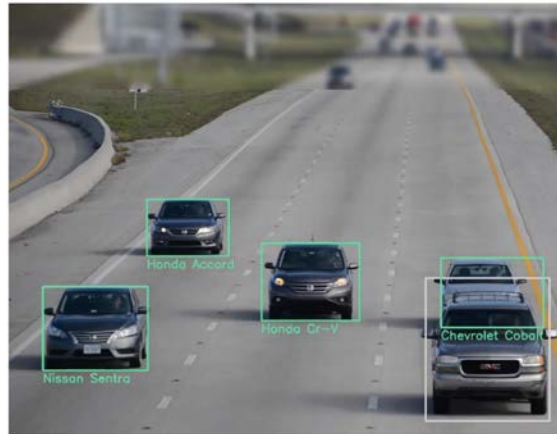
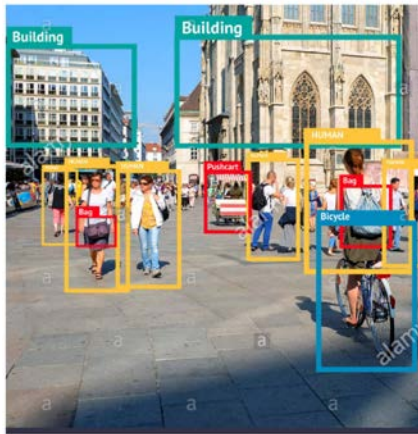
Website Link: [urbanailab.com](https://urbanailab.com)

# What is artificial intelligence?

Centered at the **Deep Learning** (Deep Neural Network Models)



Extremely broad applications



How to use AI to improve transportation?

**Project:** Transit-Centric Smart Mobility System (TSMS) for High-Growth Urban Activity Centers: Improving Energy Efficiency through Machine Learning

PIs: Jinhua Zhao (MIT), Haris Koutsopoulos (NEU), Shenhao Wang (UFL), Venu Garikapati (NERL)

Time period: 2020-2024

Industrial partner: Chicago Transit Authority

Pilot experiment: Chicago

Grant: \$2.2M

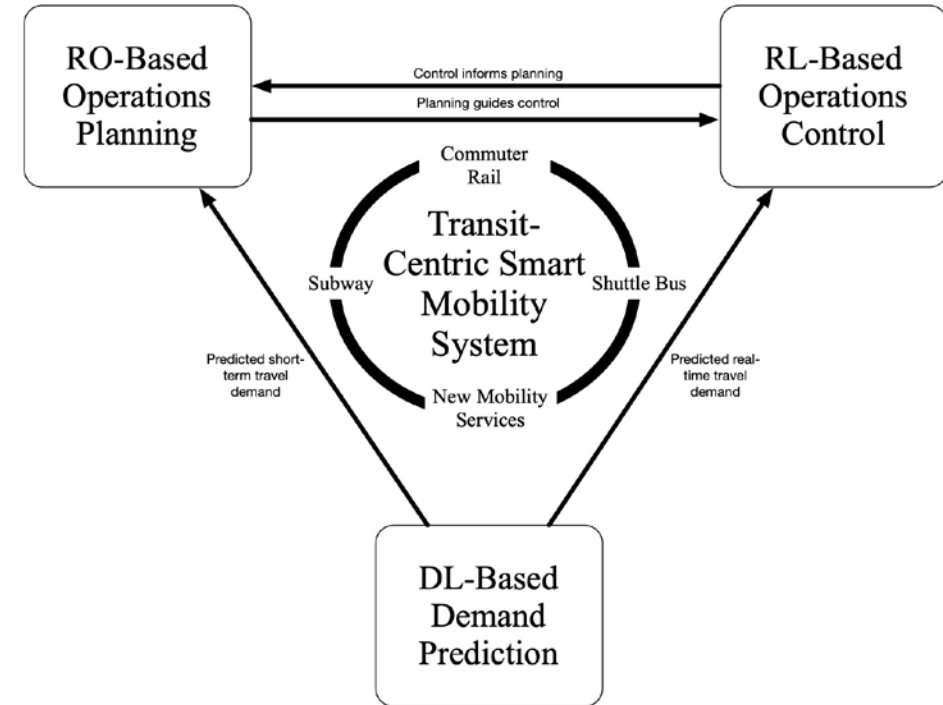
Sponsor: USDOE

# Scope of the TSMS project

**Goal:** Using **AI** to improve the **public transit**.

Three **technical pillars** for three **transit functions**

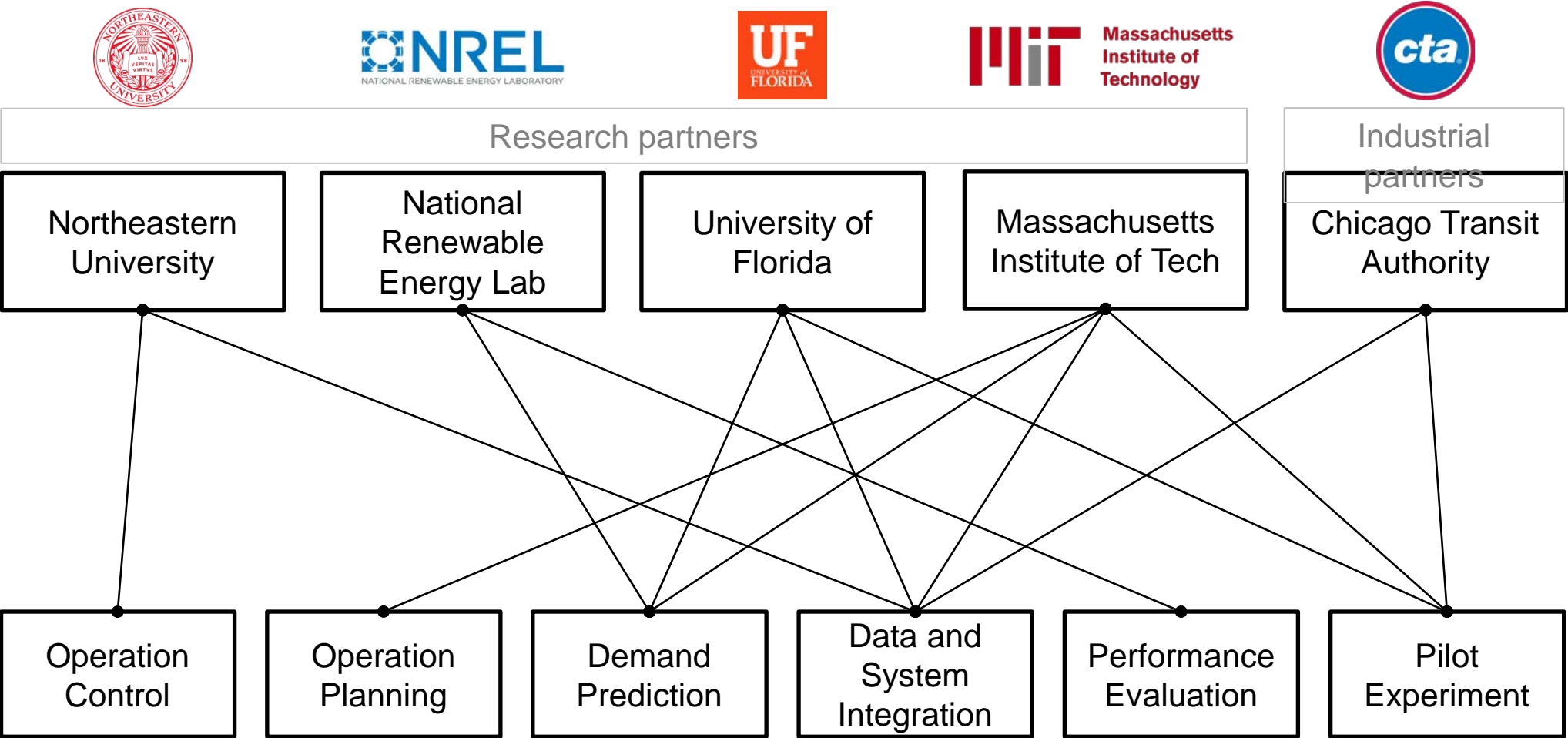
- **Deep learning (DL)** for transit demand prediction
- **Reinforcement learning (RL)** for transit operation control
- **Robust optimization (RO)** for transit operation planning



# Collaboration network

PARTNERS

TASKS

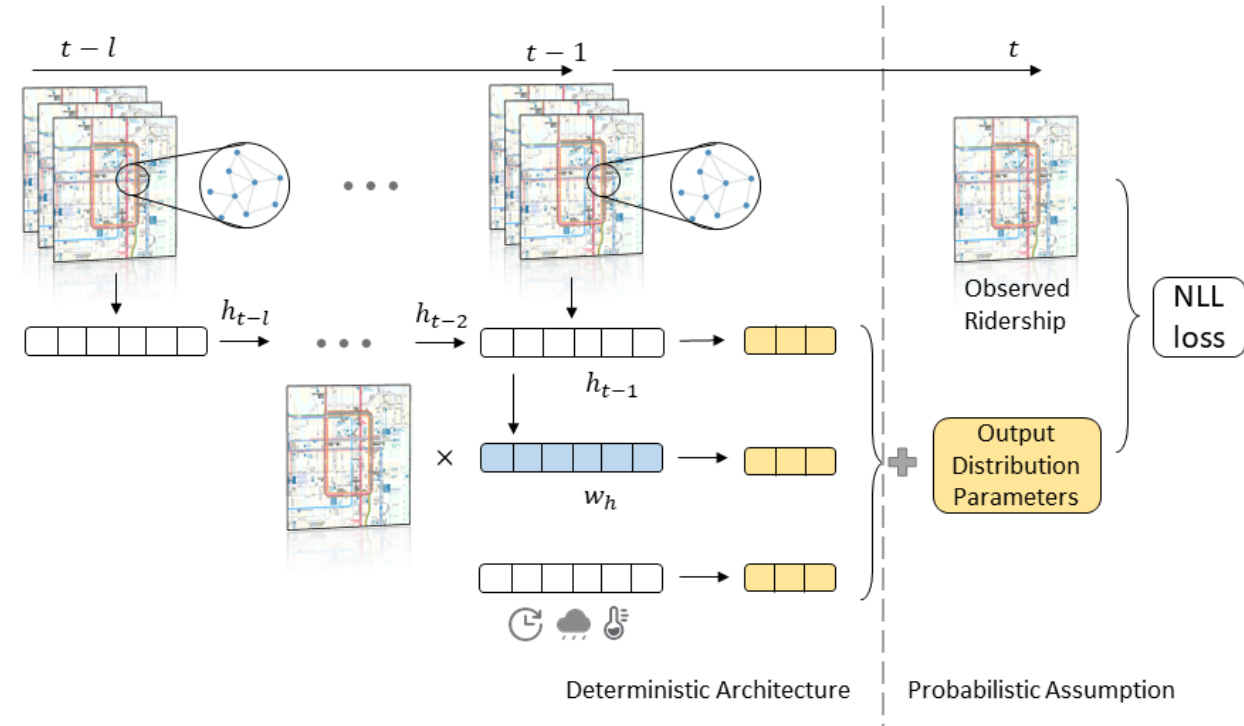


# Technical achievement 1. Designing probabilistic graph neural networks (GCNs) to predict spatiotemporal transit demand

## Technology innovation

1. Propose **probabilistic GCNs**, as opposed to deterministic GCNs
2. Apply the framework to quantify demand uncertainty
3. Predict spatiotemporal demand uncertainty with **>25% higher performance** than benchmarks

## Combining probabilistic and deterministic assumptions

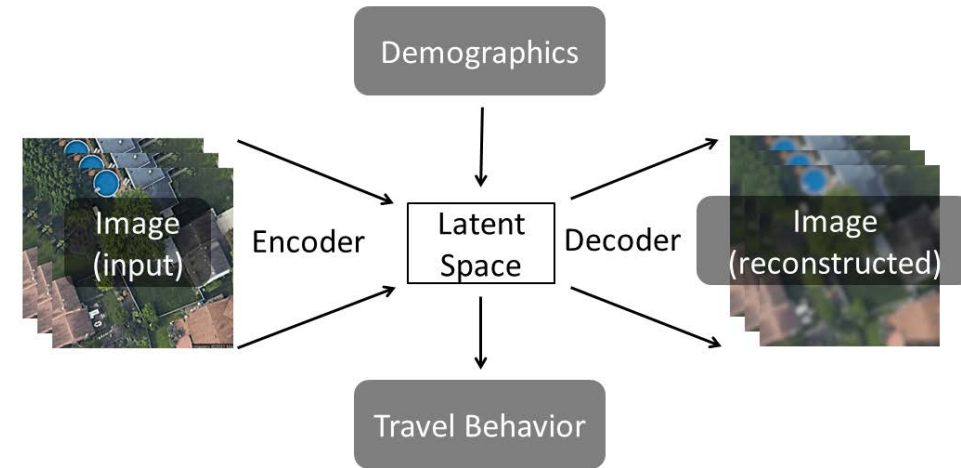


# Technical achievement 2: Using **urban imagery** to enhance travel demand prediction with $>5\%$ improvement

## Technology innovation

1. Create a **deep hybrid model** (DHM) for transit demand prediction with urban imagery
2. It improves accuracy by  **$>5\%$**  in demand prediction

Deep **hybrid** models combining data (numbers + imagery), and models (classical demand models + computer vision)





# Technical achievement 3: Designing a reinforcement learning (RL) framework for real-time bus controls

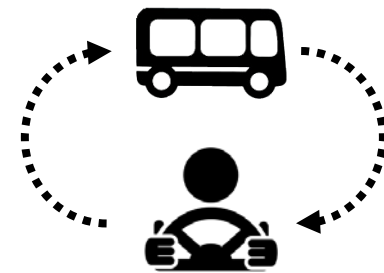
## Bus as a reinforcement learner



### Technology innovation – RL formulation

1. Agent: bus
2. State: local and neighboring buses
3. Action: holding and stop-skipping
4. Reward: waiting and riding time

Empirically, the RL approach reduces the waiting time by **4~8%**.

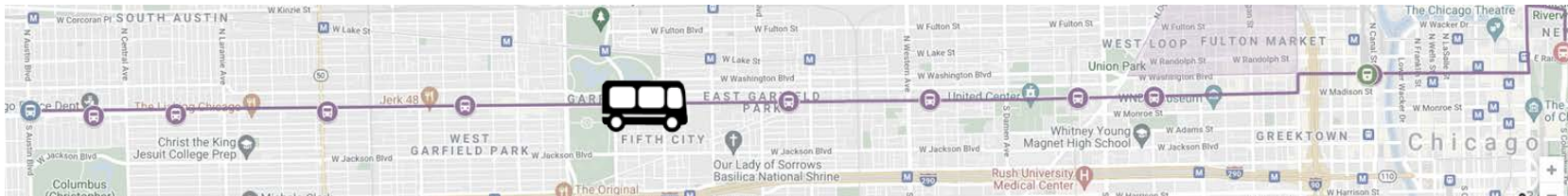


Human & Machine Interactions

An Important Question for the TSMS project

# How are the technical achievements translated into **practice**?

Using the technologies to conduct a **bus control pilot experiment** in Route-81, Chicago (2022 Fall)  
Collaborative work with Chicago Transit Authority (CTA)



# Motivation of the pilot

**Transit workforce shortage** in 2022: 84% of US agencies impacted



In **CTA**: Only **84%** services were delivered.

The status-quo control system is:

- Non-digitized
- Non-integrated
- Not effective

We demonstrate **how AI can address the transit operation challenges** in a pilot.

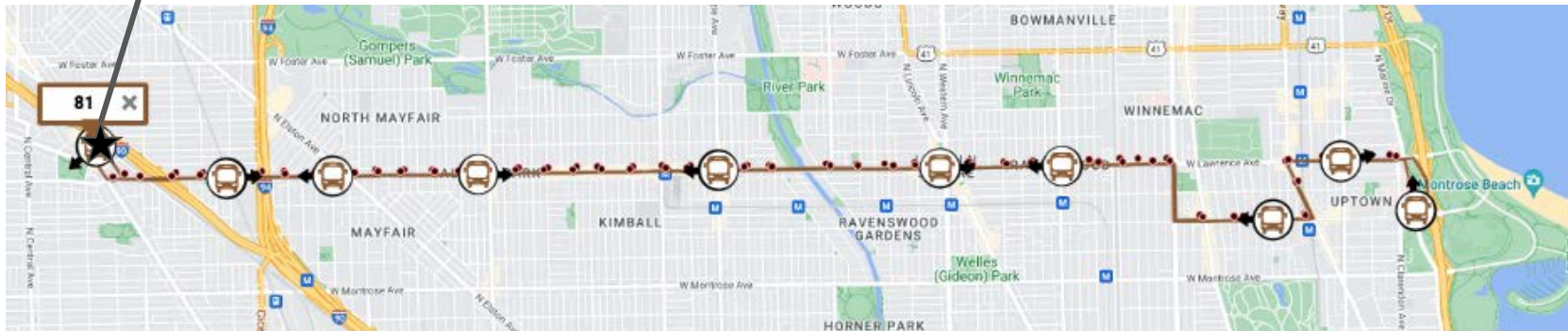
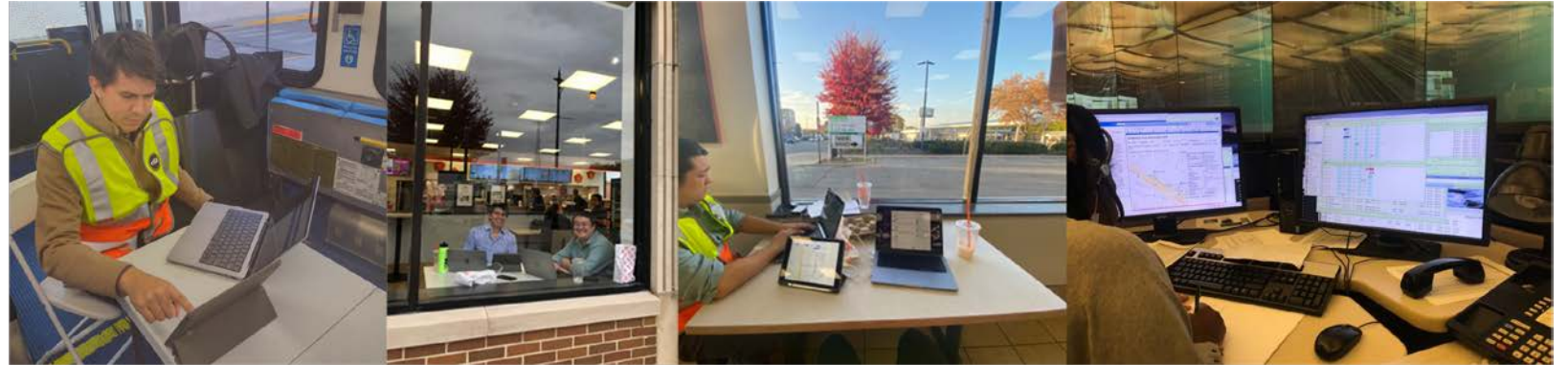
# Achievements in the pilot

1. Built a **real-time control dashboard** to streamline the information.
2. Implemented an **AI-empowered recommendation engine** to control bus dispatching.

**Terminal:** Jefferson Park



Students on the site

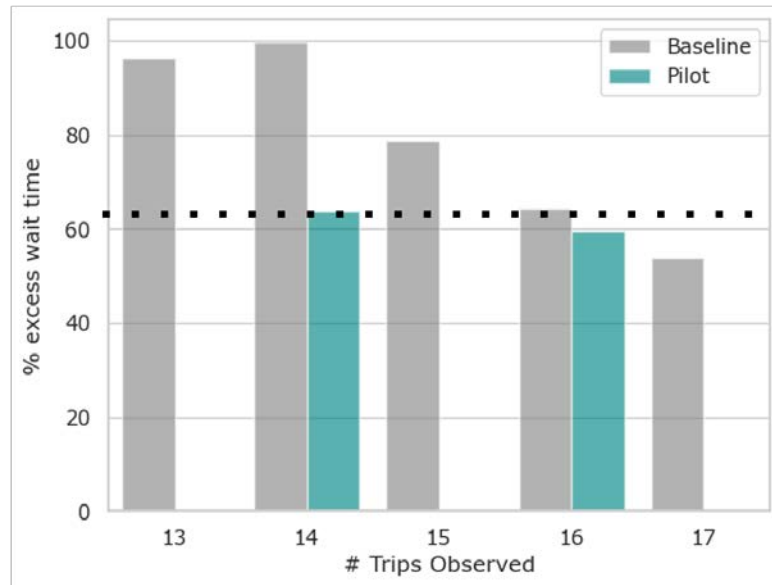




# Achievements in the pilot

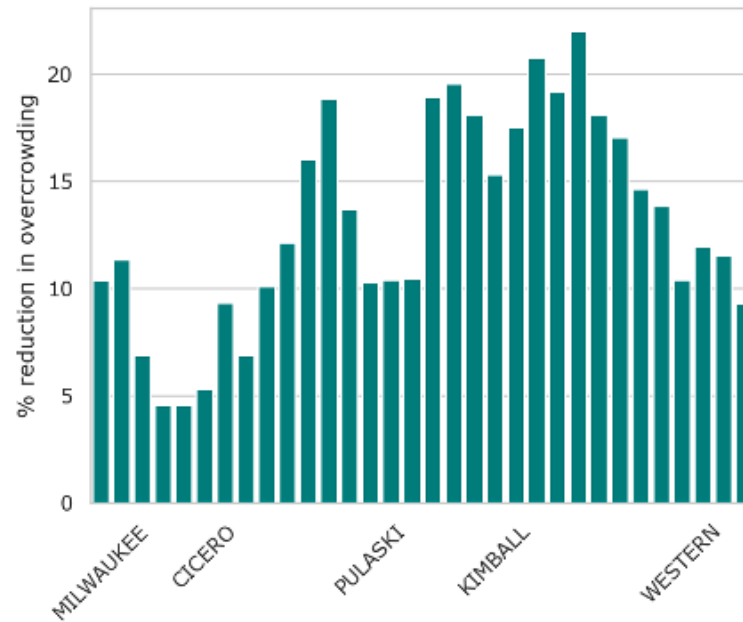
## Excess wait time by # of bus trips

37% reduction



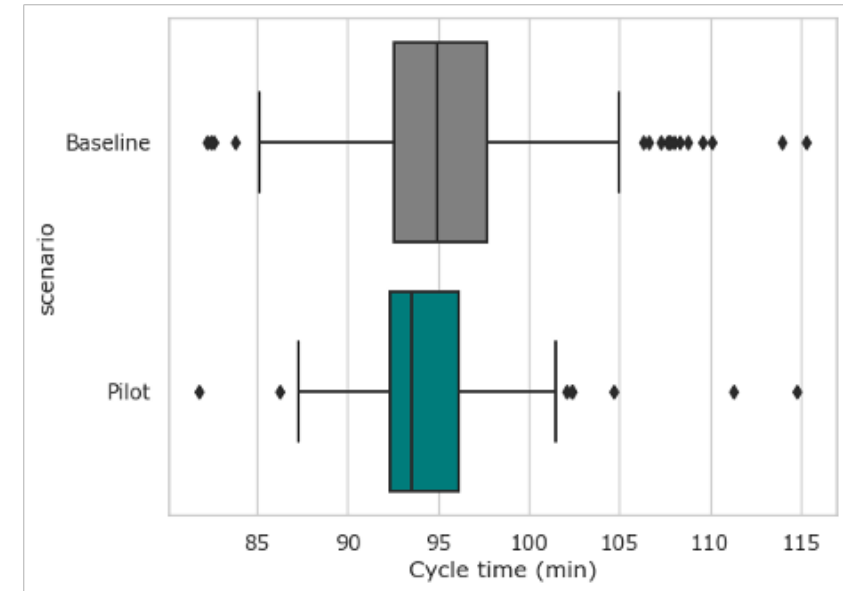
## Overcrowding by stop

5-20% reduction



## 90<sup>th</sup> Cycle times

2.4% reduction





# Thank You

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