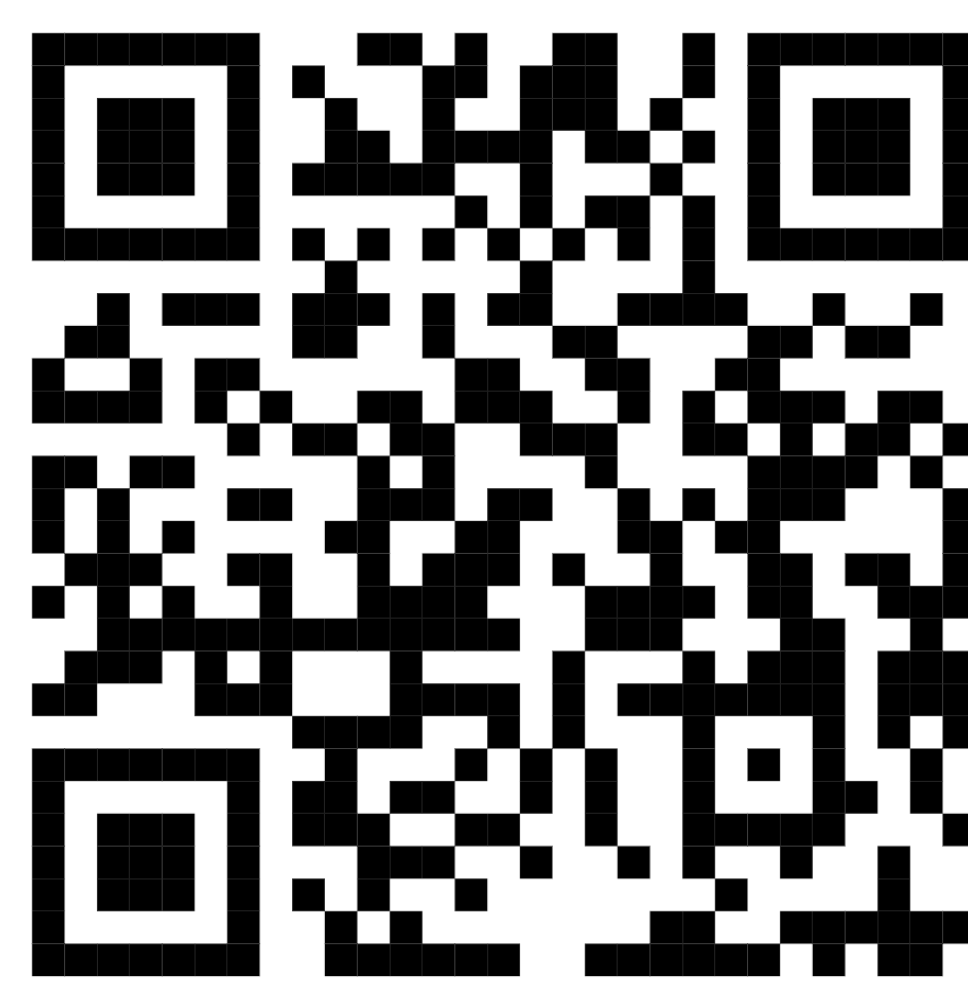
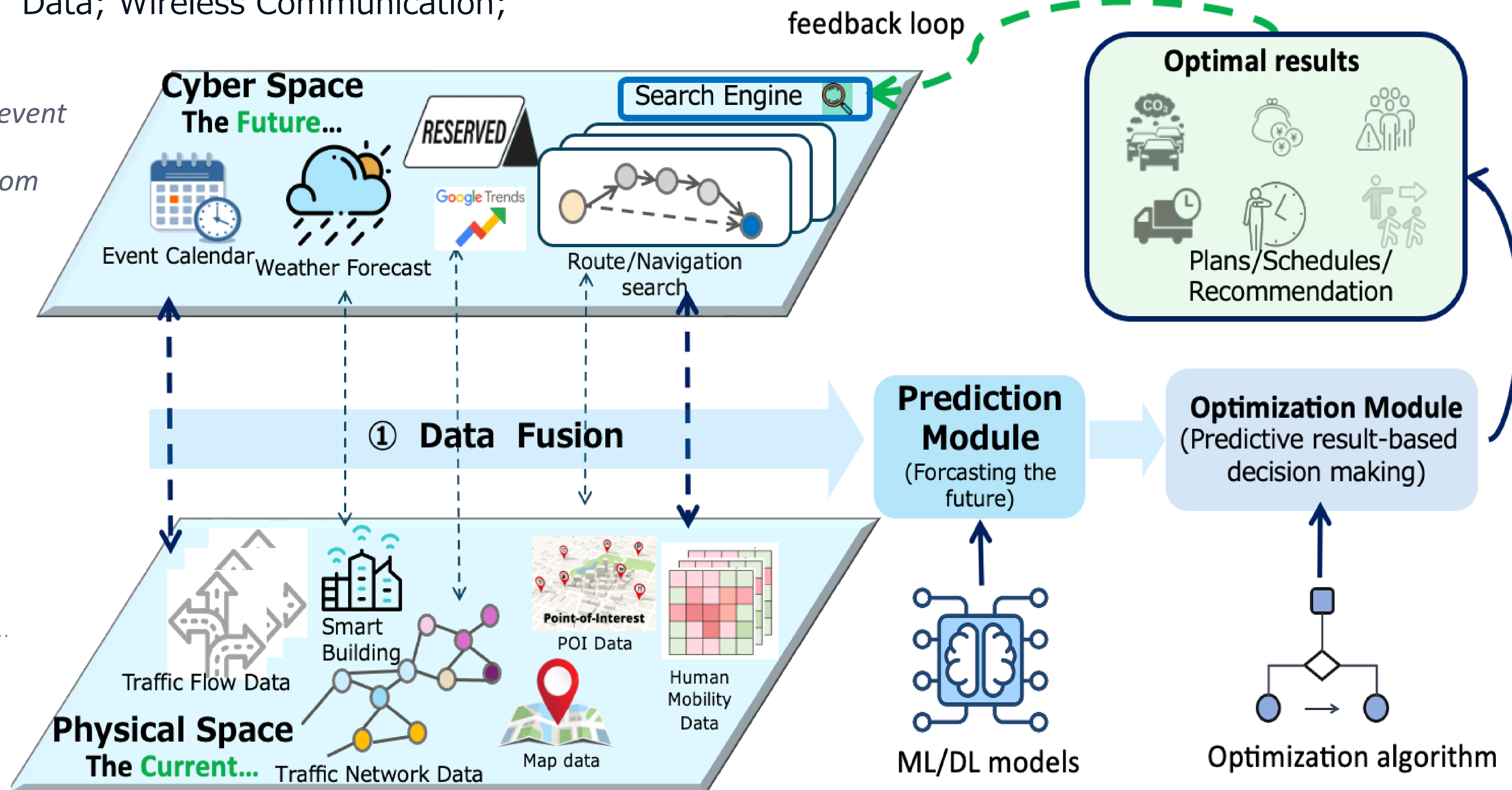
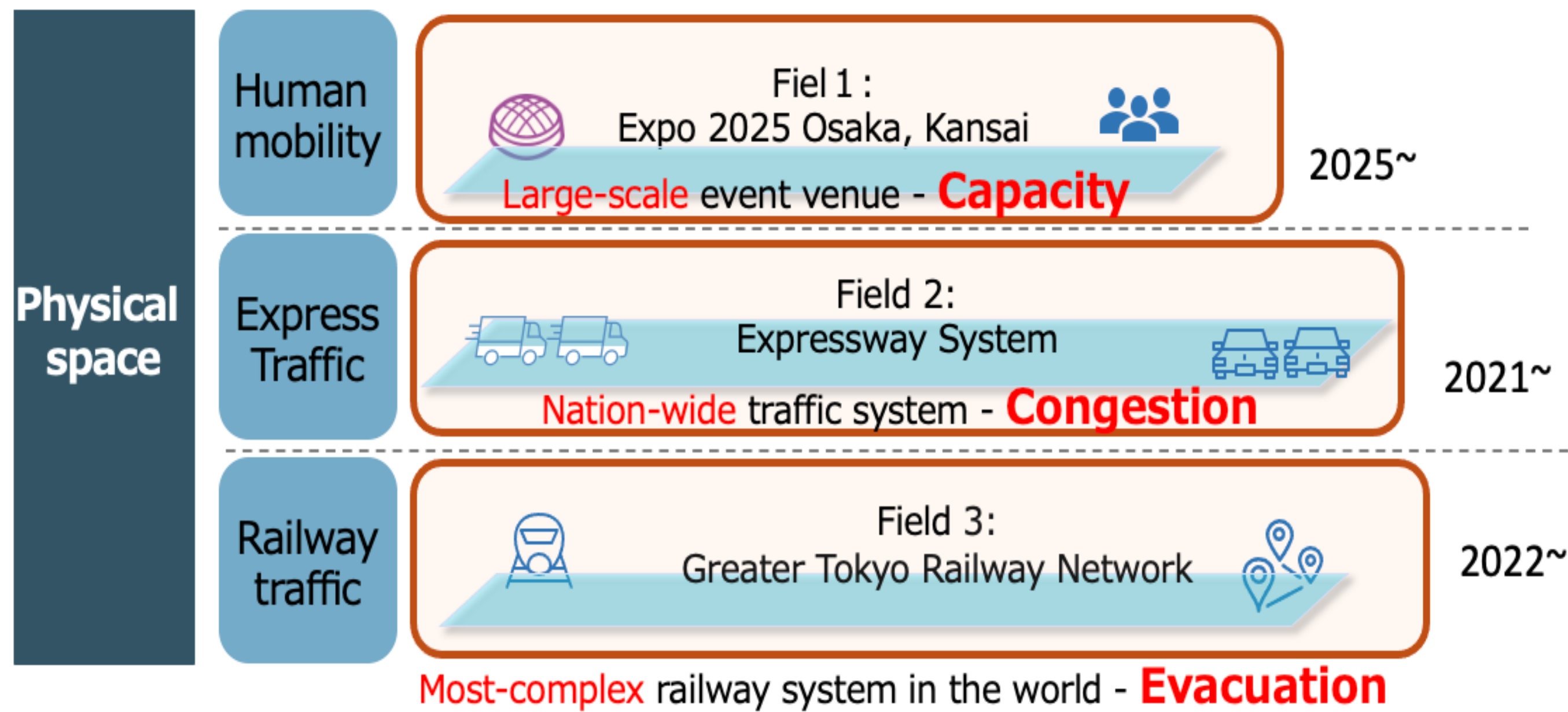




Hangli Ge | Project Associate Professor | Phd of Information studies
Interdisciplinary Information studies (III) , The University of Tokyo
Internet of Things (IoT); Smart City; Urban Resilience; Spatio-temporal Big Data; Wireless Communication;

Motivation

- Cyber-space leading signals : search, reservation records, weather forecast, event calendar, fuse with physical-space sensing through an AI prediction engine
- A closed optimization loop that feeds back into the search engine, scaling from smart buildings to smart-city mobility and urban resilience.
 - Cyber-Physical Big Data for Traffic & Mobility Prediction
 - Complex Dynamic Systems for Urban Resilience
 - Next-Generation Computing for Large-Scale Optimization



Three Field Experiments

From nationwide highways, to the world's most complex rail network, to a mega-event

FIELD 1

EXPO 2025 Osaka, Kansai

Mega-Event Capacity Management

1.55 km² site · 2 entrances · Apr–Oct 2025
avg 105,423 / day · max 176,587 (Jun 28)

FIELD 2

Nationwide Expressway System

Congestion Prediction · with NEXCO EAST, 2021–

¥10–12 trillion/yr economic loss · ~40 hrs/person/yr lost
2/3 of congestion caused by traffic concentration, not accidents

FIELD 3

Greater Tokyo Railway Network

Resilience & Evacuation · 2022–

2,200+ stations · 150 lines · 40 operators
41M people served (30% of Japan) · 48% ride daily

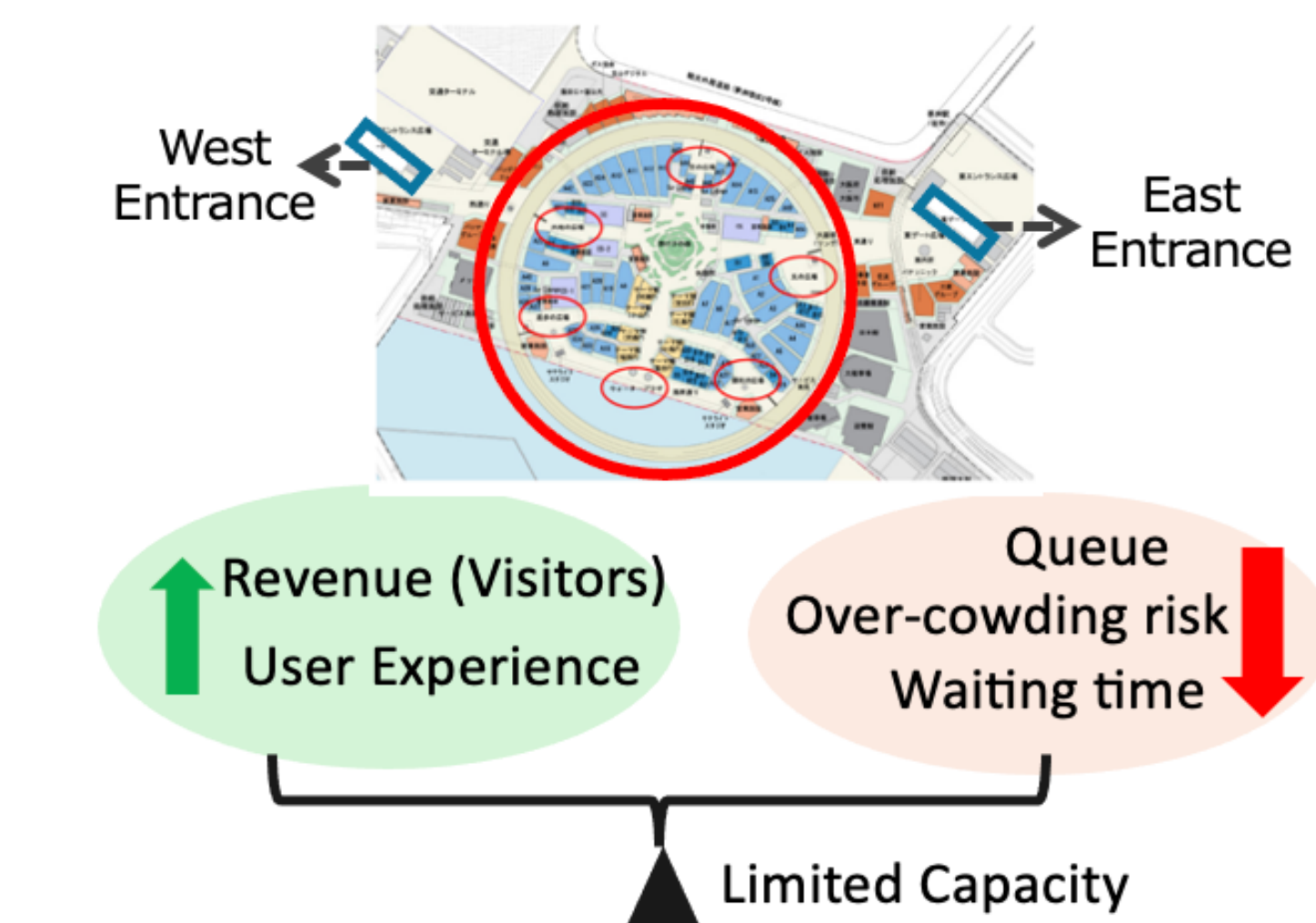
INDUSTRY R&D PROJECTS

- Mitsui Fudosan × UTokyo Lab 2020–23
Wireless communication, human-flow prediction, City OS
- NEXCO East Japan 2021–
Expressway congestion prediction, and traffic control
- Hitachi × UTokyo Lab “Habitat” Phase 3 2023–
Smart-city data platform
- Expo 2025 Osaka, Kansai 2025–26
AI prediction models for visitor attendance and crowding
- SoftBank 2025–present
Data Space + AI, data interoperability, federated learning.
- Daiwa House 2026–present
IoT, Sensor Network, Smart-building

Overview

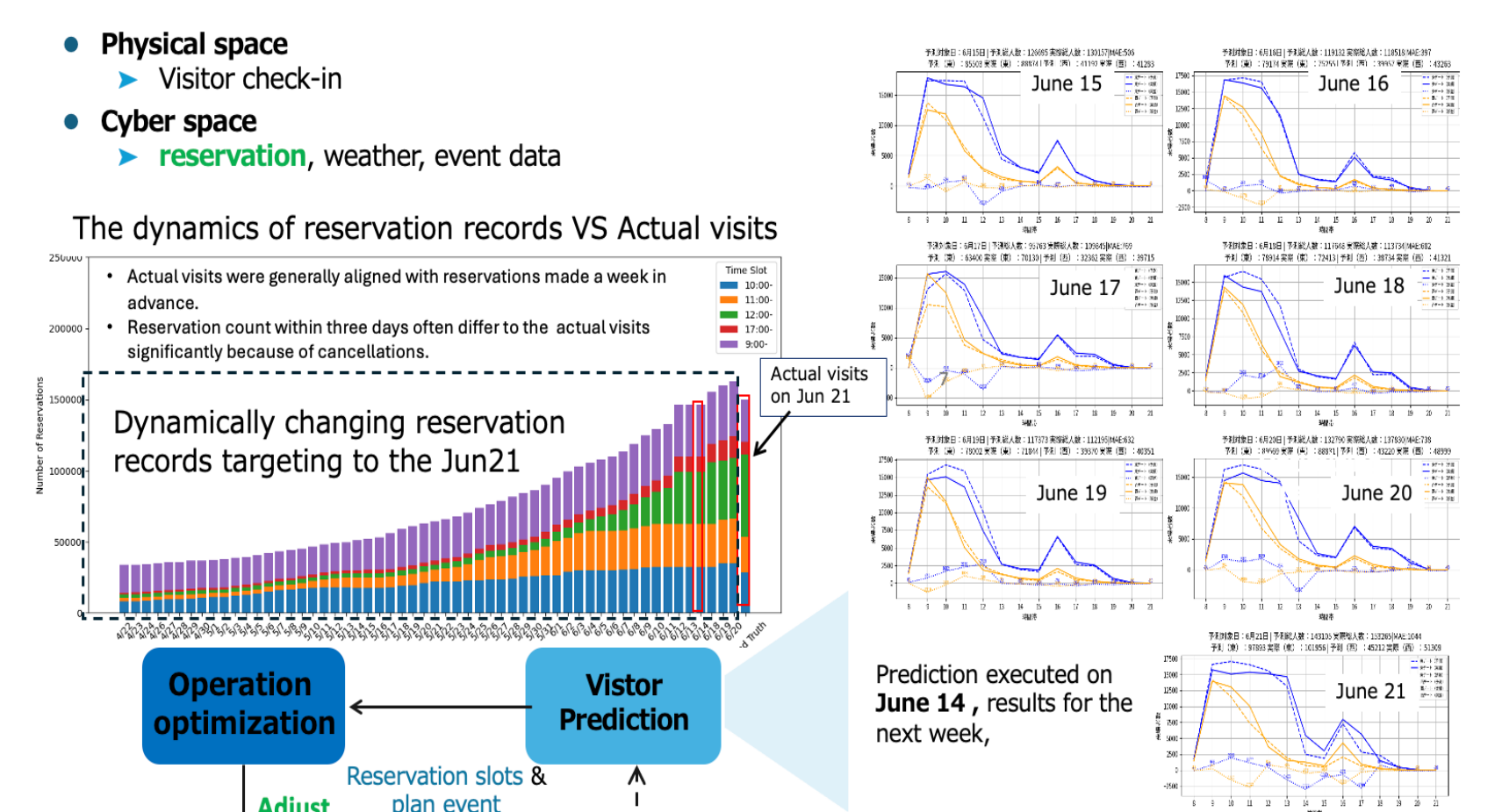
Collaboration with EXPO council and providing data-driven backend support
Operation for optimizing multiple objectives

- Physical space
Visitor checkin, crowding map, POS billing records, metro traffic, etc.
- Cyber space
reservation, weather, event calendae, etc



Visitor forecasting

One-week-ahead reservations track actual turnout closely; last-minute (<3-day) bookings diverge due to cancellations → dynamic reservation-slot adjustment.



Wait-time estimation

Fuses Metro Station ride-off traffic flow with gate check-in traffic flow (first-in-first-out model) to recover true arrival & wait

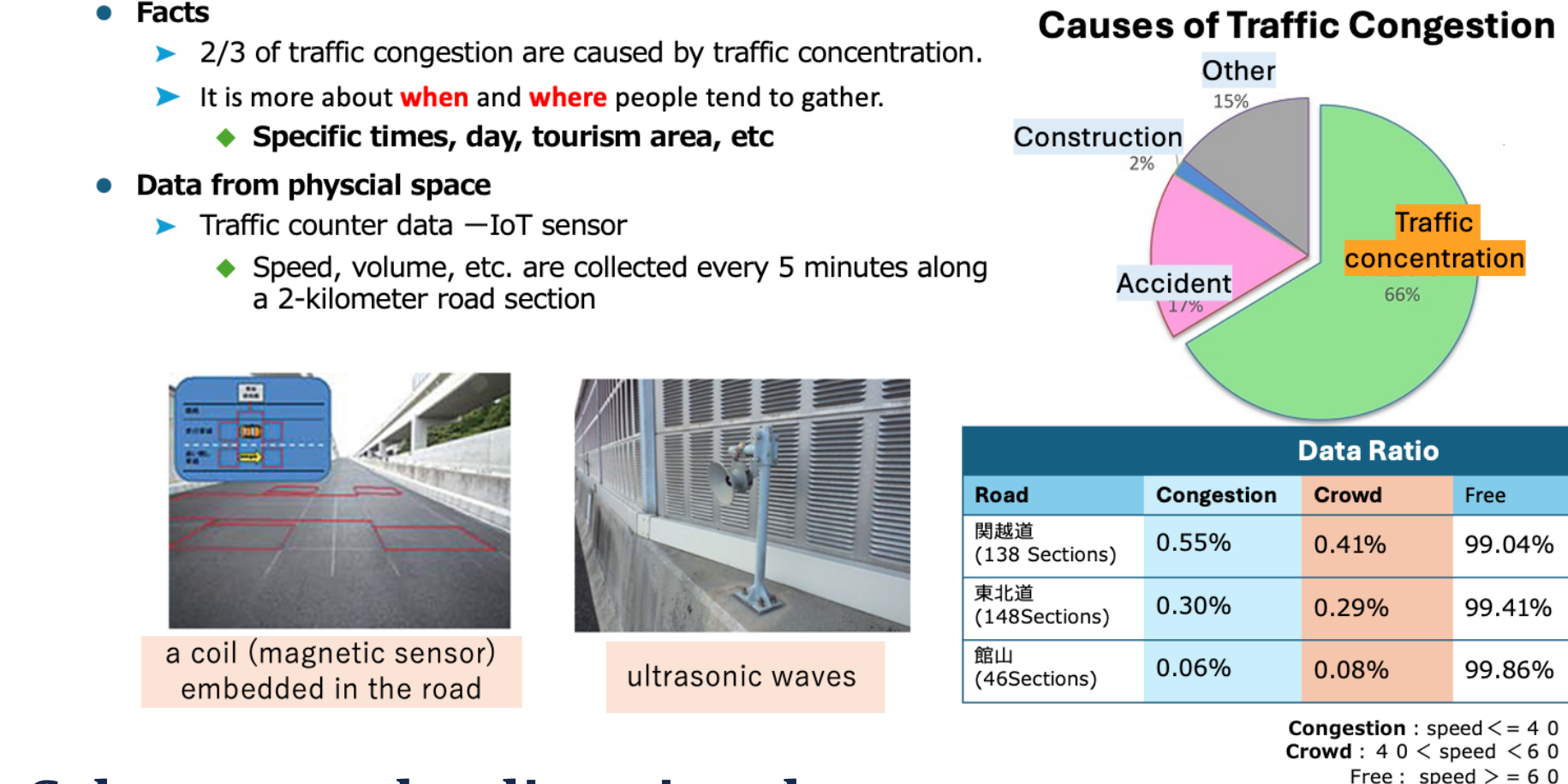
- Problem: Uncertainty in Waiting Time in morning time**
 - Only the check-in timestamp
 - Missing Information: exact arrival time of visitors
- Proposal: Data fusion approach**
 - Track the metro **ride-off** traffic flow



- Quantify the effect of Operation optimizations:**
 - Early gate: Open from around 8:50
 - Expand the reservation slots of west gates
 - Shuttle bus for guiding visitors from east entrance to west

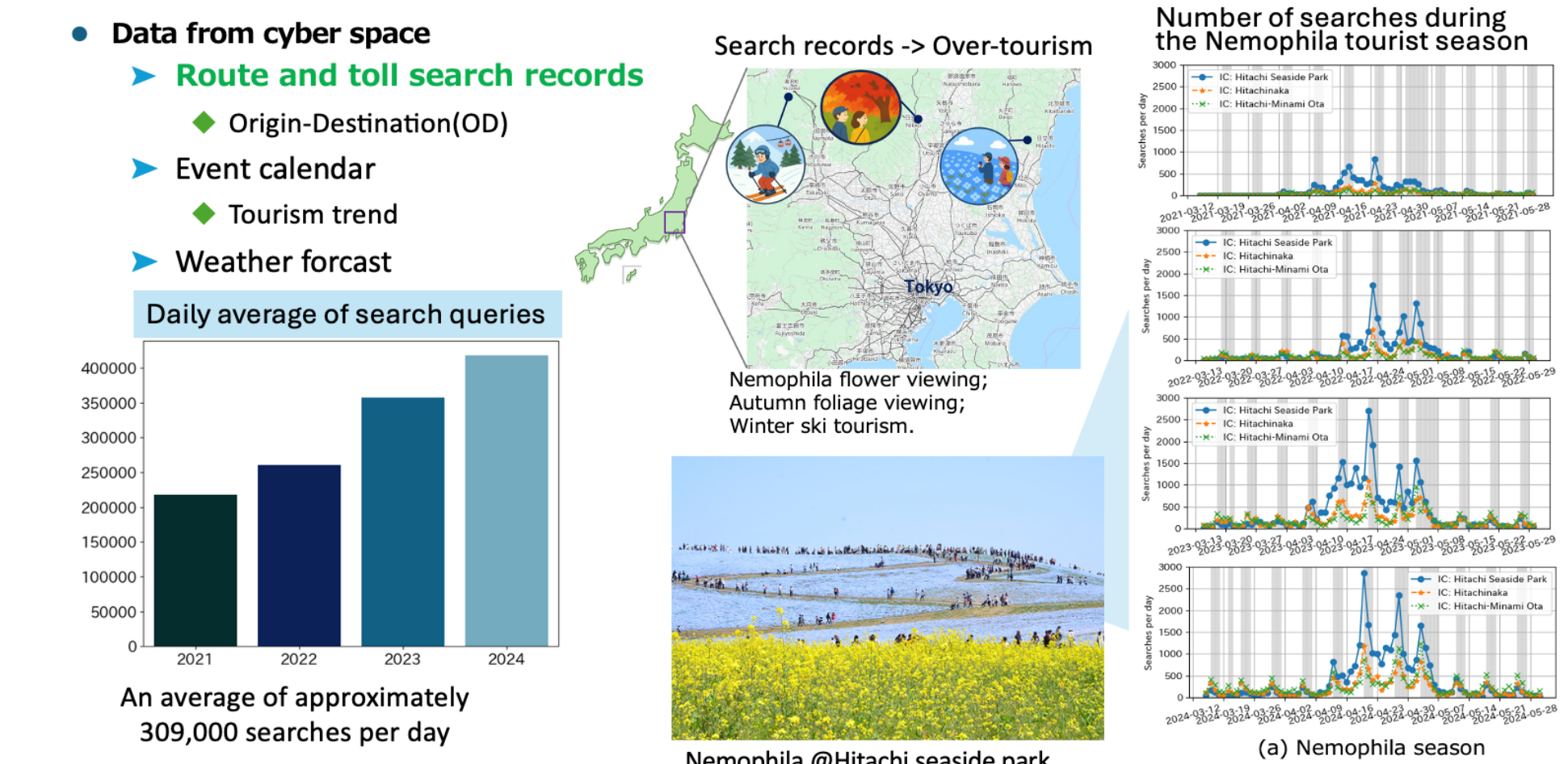
Physical-space sensing

IoT sensors log speed and volume every 5 minutes along 2 km road segments.

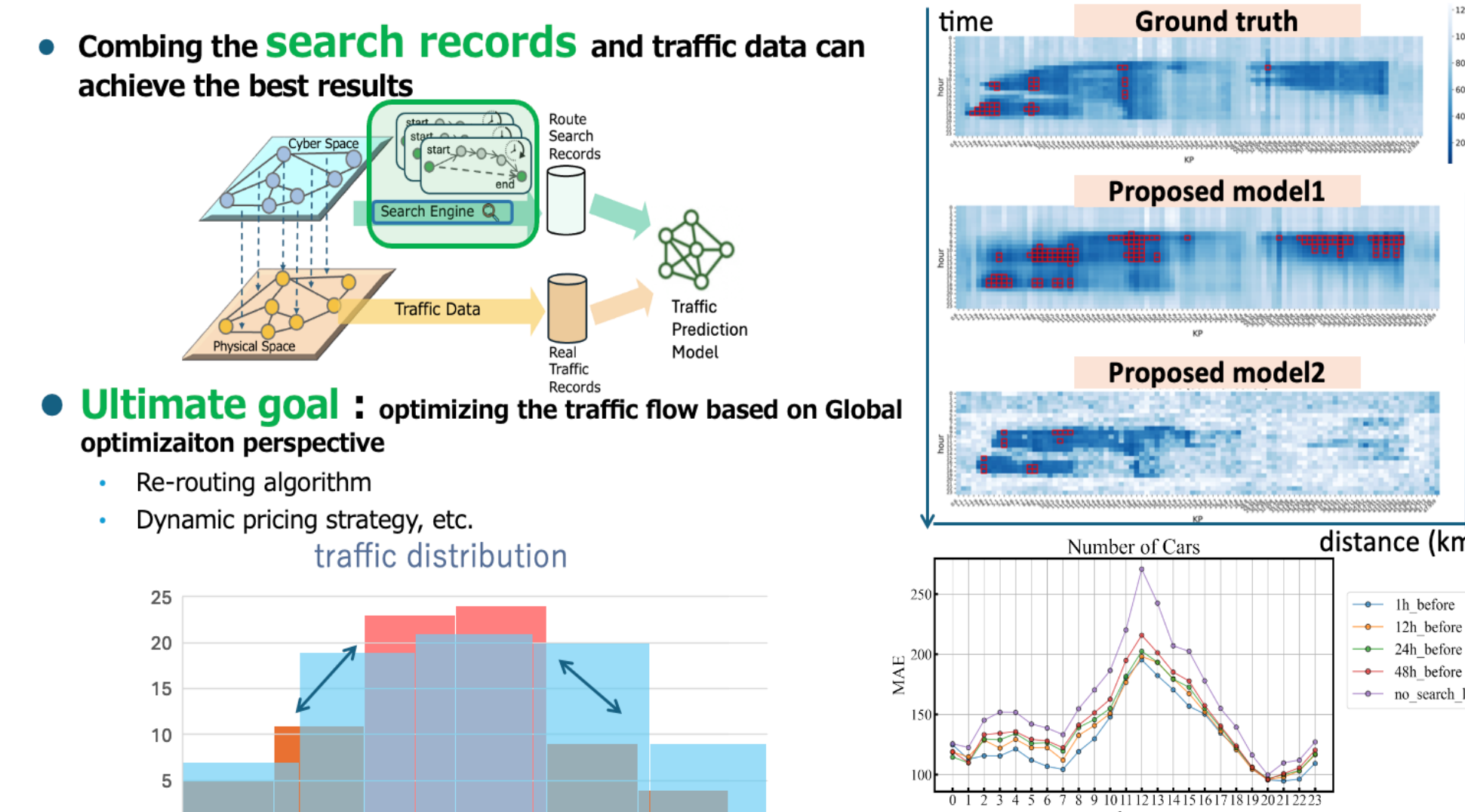


Cyber-space leading signal

Route & toll search volume rises ahead of real traffic, e.g. Nemophila flower-season searches surge before interchange traffic does, improving forecast accuracy at weekly/monthly scale.

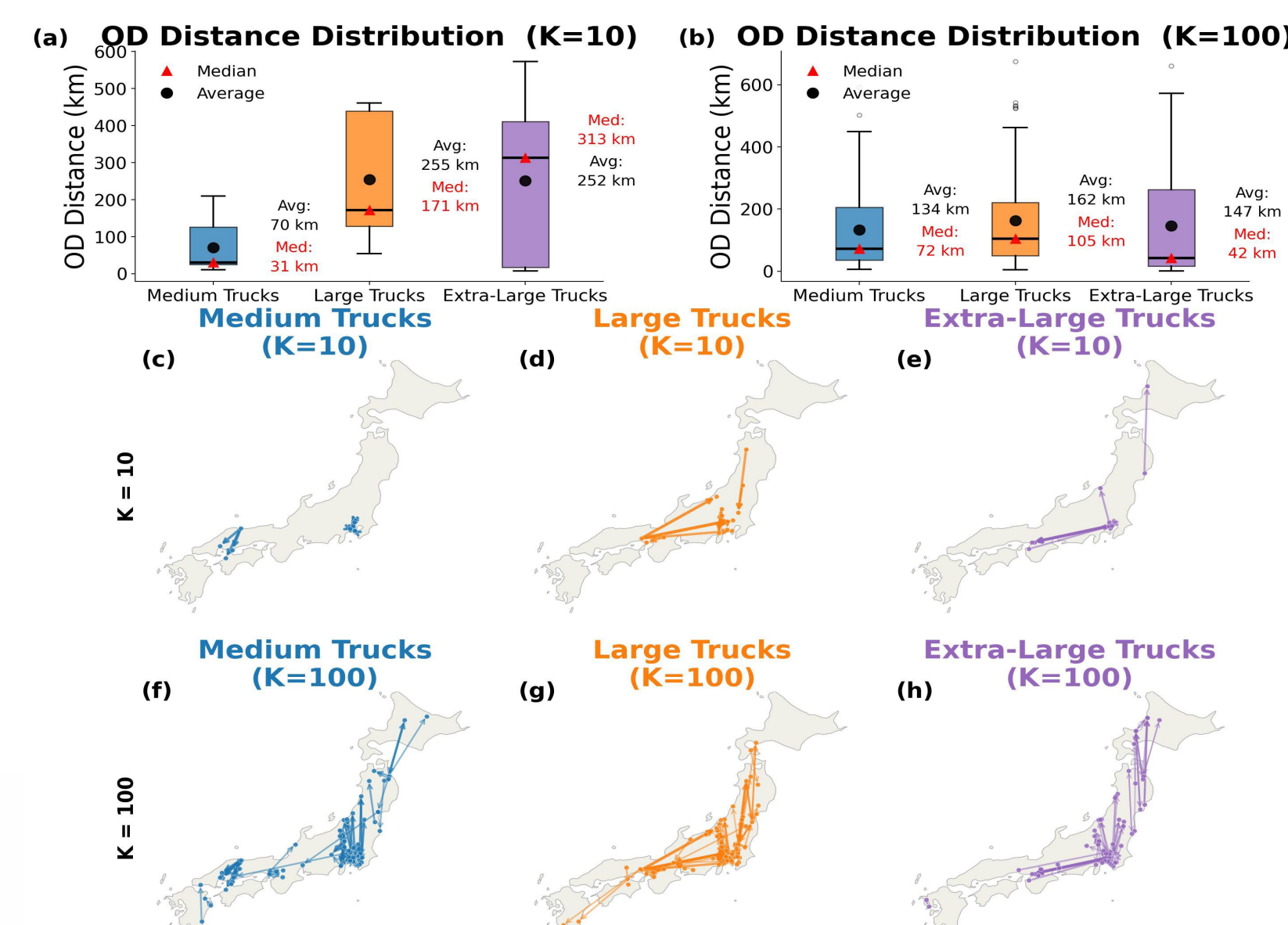


AI Models for Congestion Prediction



Freight topology

Vehicle-type search records alone (no ETC/GPS) reveal freight topology : port containers, long-haul trucks, regional delivery



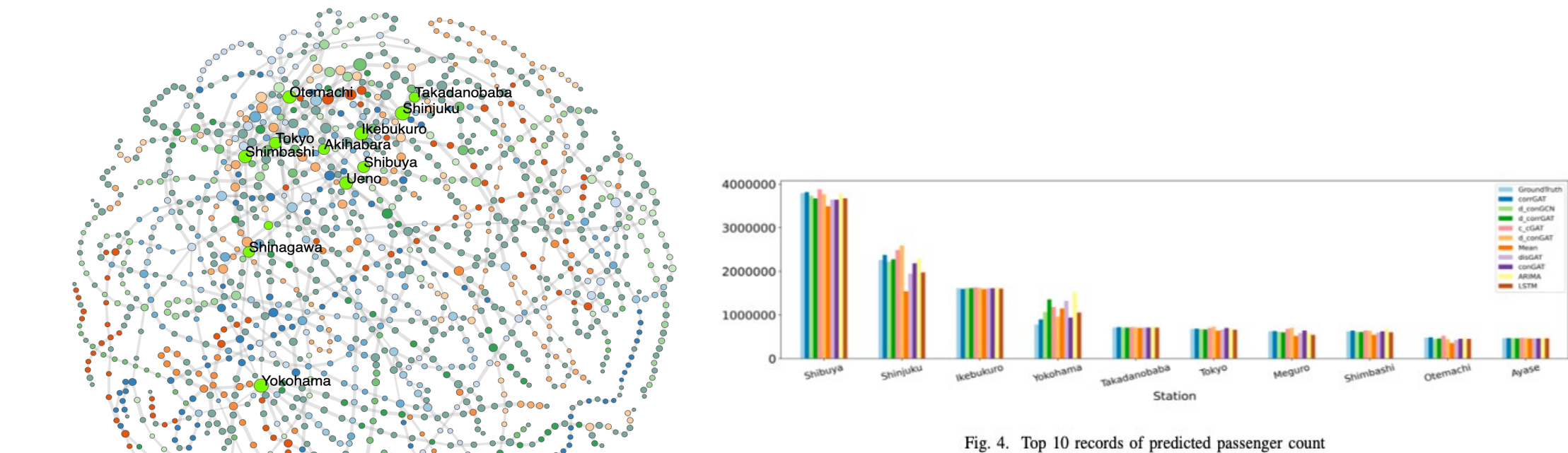
Overview

- The **most complex** railway system in the world!
 - Tokyo, Saitama, Chiba, and Kanagawa, around 30% of Japan's total population, 41 million in 2024
 - 48%** of the area population use railway daily
 - Over 2200** station nodes | 150 lines | 40 operator companies
- The vulnerability under emergency, disasters, accidents, or operational failures

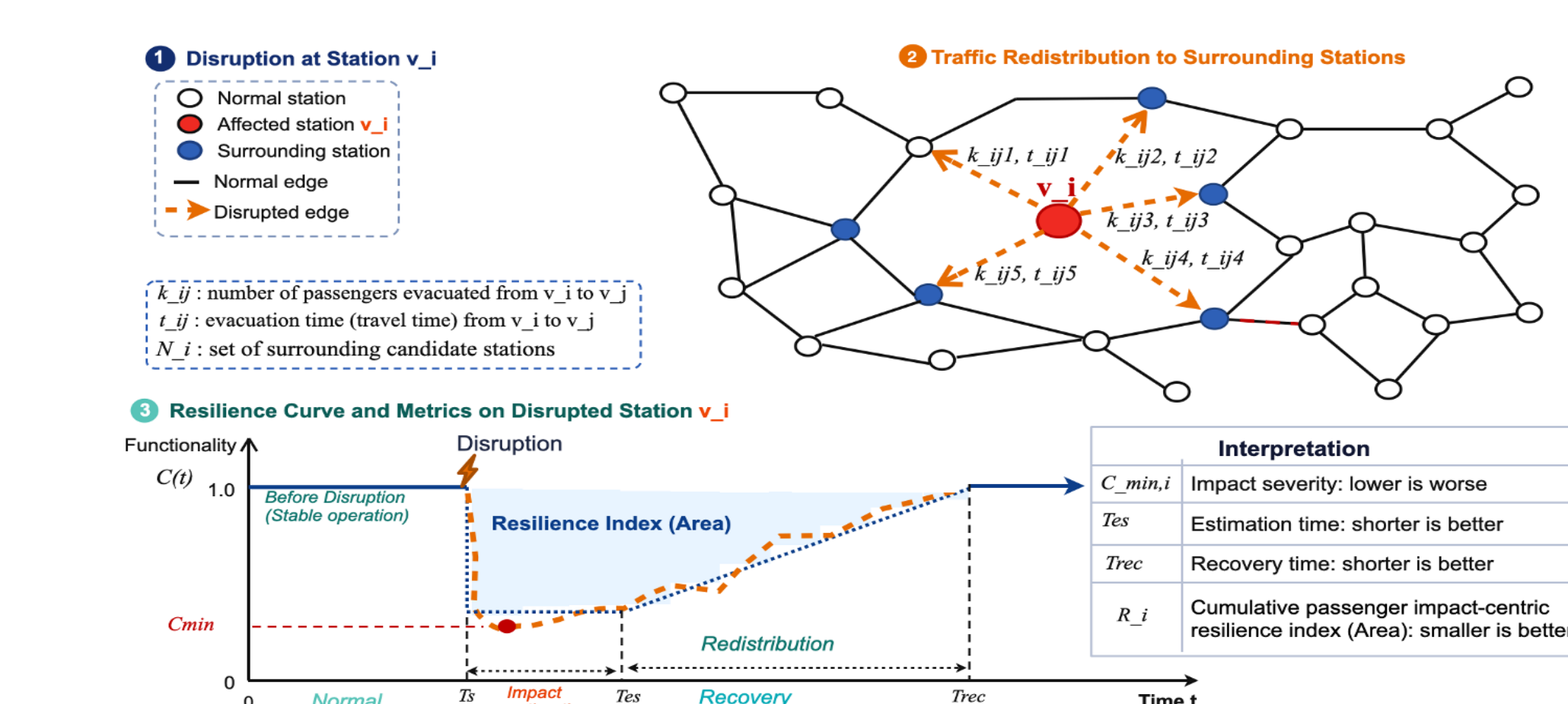


Passenger-count forecasting

Multi-weighted graph neural network — 6 relation types (connectivity, distance, transfer, area similarity, time pattern, landmark proximity) with GCN/GAT.

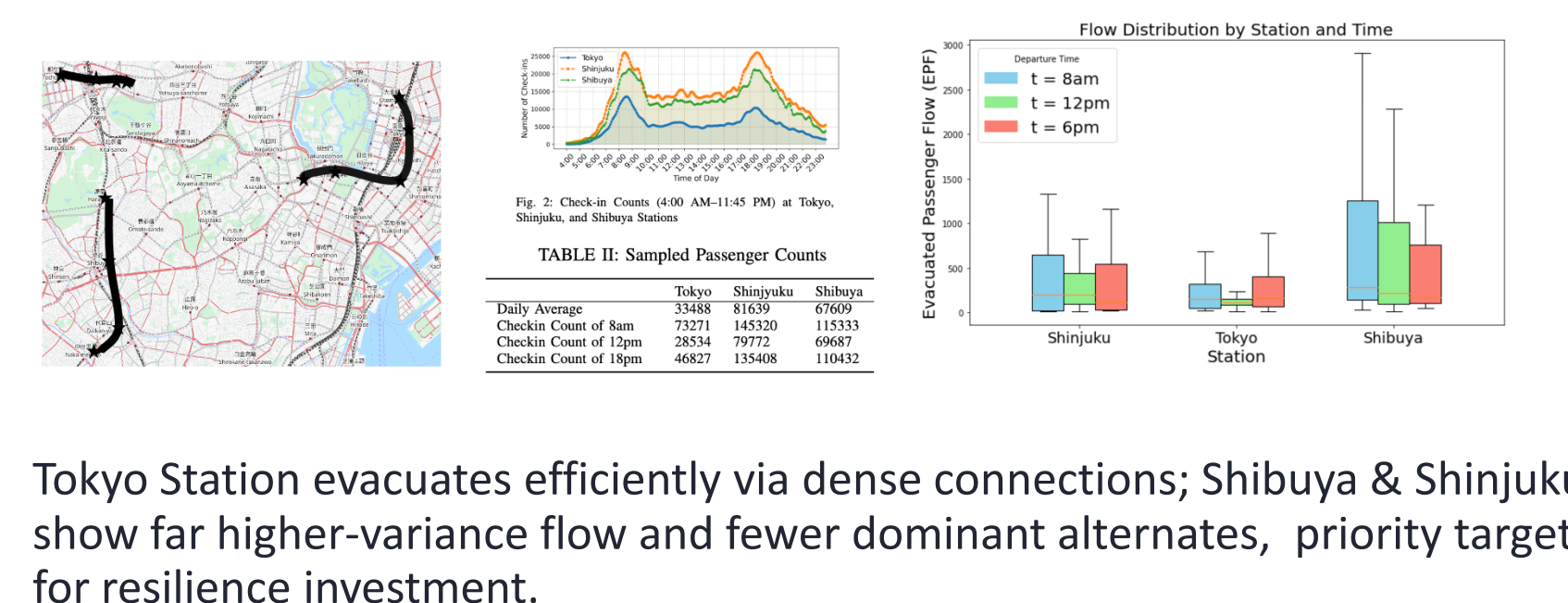


Quantifying Resilience for Railway Disruption Management



Simulation

Models disruption at any station/line, including the Tokyo, Shinjuku and Shibuya terminals; evaluates Evacuated Passenger Flow (EPF) & Average Travel Time (ATT); graph-partitioning tames the exponential computation.



Problem: Exponentially increase of computation complexity
Solution: graph partition strategy

Organizers

