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Sponsor: MIT Megacity Logistic Lab

Drone Delivery in last-mile distribution

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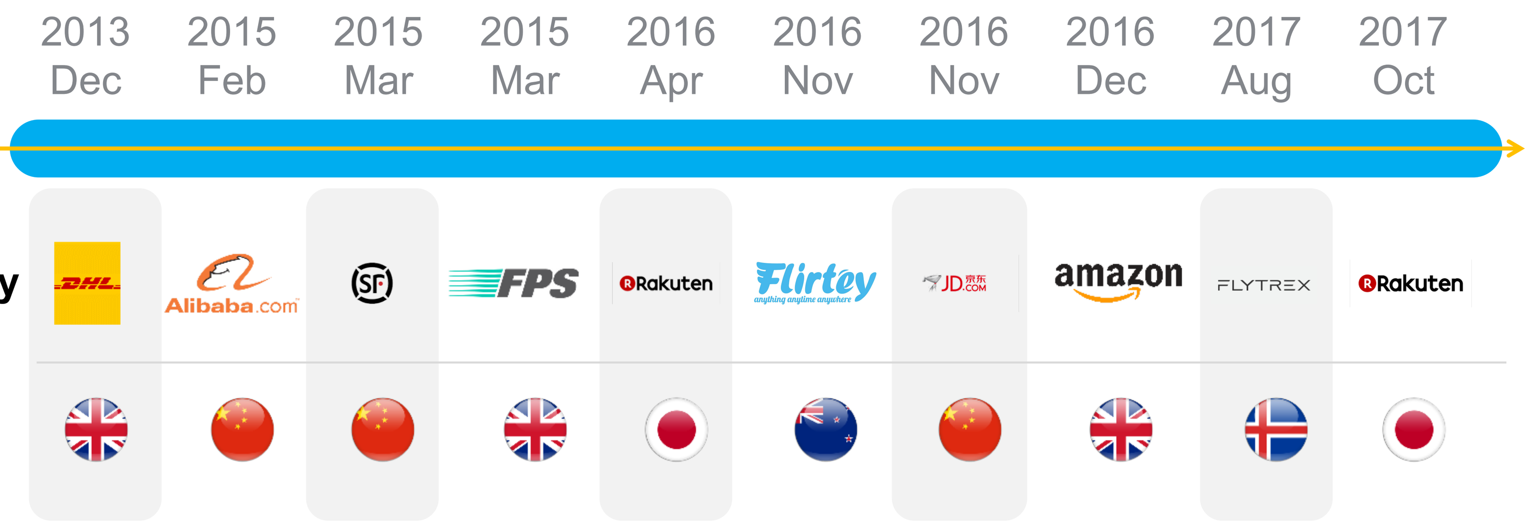
January 2019 Poster Session

Motivation / Background

Drone has emerged as an innovative and viable business solution for commercial last-mile distribution due to lower cost structure (~80% cost reduction), **reduced delivery time**, **farther reach** in poor infrastructure areas and **less CO2 emission**.

Drone delivery is relevant for e-commerce as **~80% of packages delivered by e-commerce weigh less than 5 lbs.** Over the past 5 years, **major logistic and e-commerce companies have been experimenting with drones as last-mile delivery system**

Major companies that tested drone as last mile delivery



Key Question / Hypothesis

Problem statement resembles classic routing problem: "**Find the optimal set of routes for a fleet of trucks and drones to serve a set of customers**"

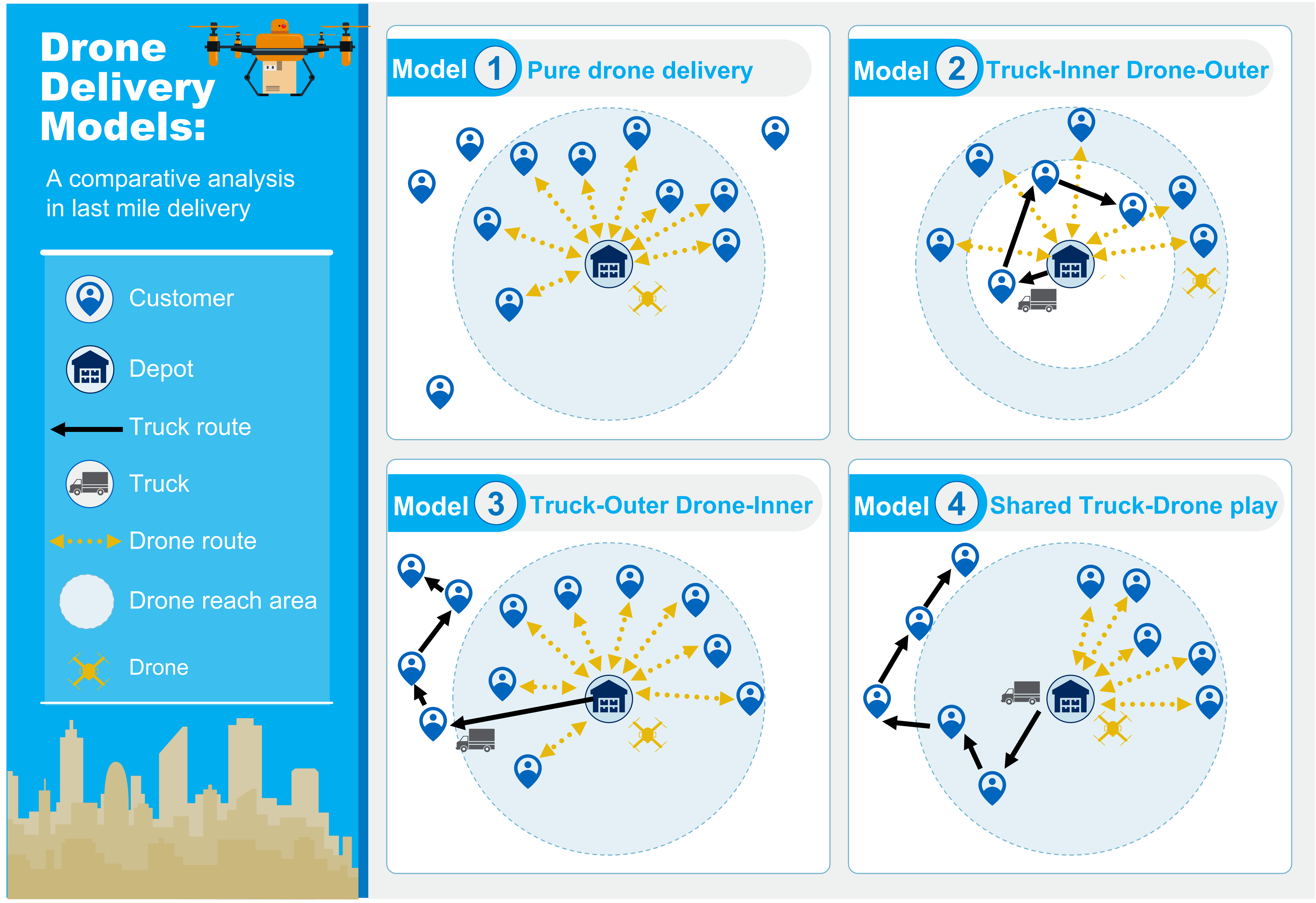
Drone routing problem is more complicated than classical Vehicle Routing Problem (VRP) due to **drone-specific constraints**, such as **drone operational limit** (e.g. distance covered, drone endurance, payload) and unique **technical characteristics of drone delivery** (e.g. one package per trip, no pick-up, no night-time operation).

Relevant Literature

Murray C., Chu A. 2015. *The flying sidekick traveling salesman problem: Optimization of drone-assisted parcel delivery.* Transportation Research Part C 54 (2015) 86-109

Kim S., Moon I. 2018. *Traveling salesman problem with a drone station*. IEEE Transactions on Systems, Man, and Cybernetics: Systems PP (99) (2018) 1-11

Ham A. 2018. *Integrated scheduling of m-truck, m-drone and m-depot constrained by time-window, drop-pickup, and m-visit using constraint programming.* Transportation research part C 91 (2018) 1-14



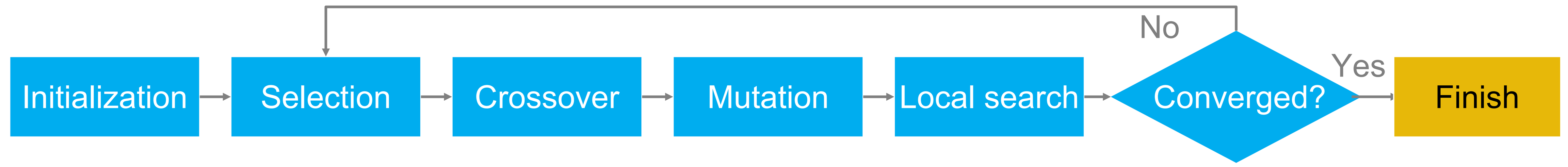
Methodology

Our project will evaluate the optimal design and operational performance of **four different drone delivery models**, using real-life last-mile truck delivery data.

A **Memetic Algorithm**, an extension of Genetic Algorithm, is developed and used to **optimize delivery routes of drones and trucks in all the four models**.

3 different objective functions (e.g. minimize return time, last customer wait time and total waiting time) and **different operating parameters** (e.g. drone range, # of drones/trucks) are run to identify the **optimum routes.**

Memetic Algorithm flowchart

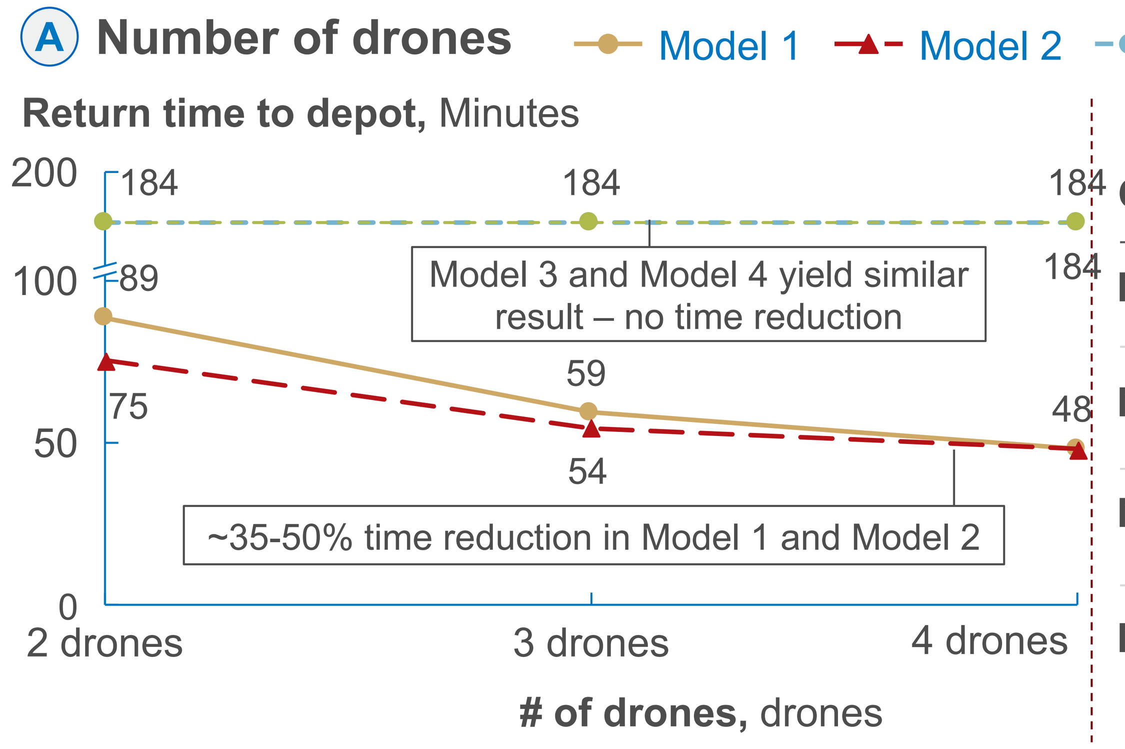


Initial Analyses and Results

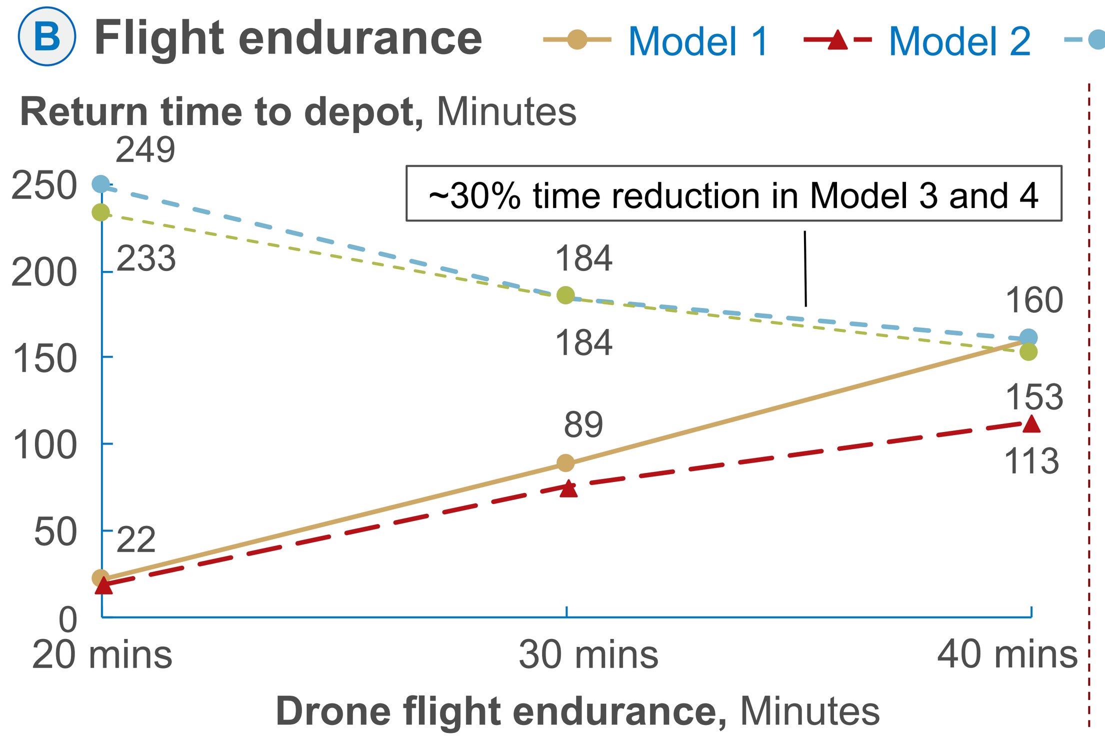
Initial analyses were run on a reduced dataset to **minimize return time to depot,** based on different # of drones and flight endurance.

Baseline scenario: 2 drones, 1 truck & 30 mins flight endurance.

Sensitivity analysis



Customers served, %	
Model 1	50%
Model 2	50%
Model 3	100%
Model 4	100%



Customers served, %	
Model 1	25-100%
Model 2	25-100%
Model 3	100%
Model 4	100%

Expected Contribution

Sensitivity analyses based on **Memetic Algorithm for 4 different drone delivery models** with different objective functions

Reference framework for drone application in last-mile delivery.

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