



# An algorithm for the network flow problem with multi-transport modes and time window constraints

Chaojie/Jasmine Guo  
PhD Candidate  
Transport Group  
Department of Infrastructure Engineering

## Challenge:

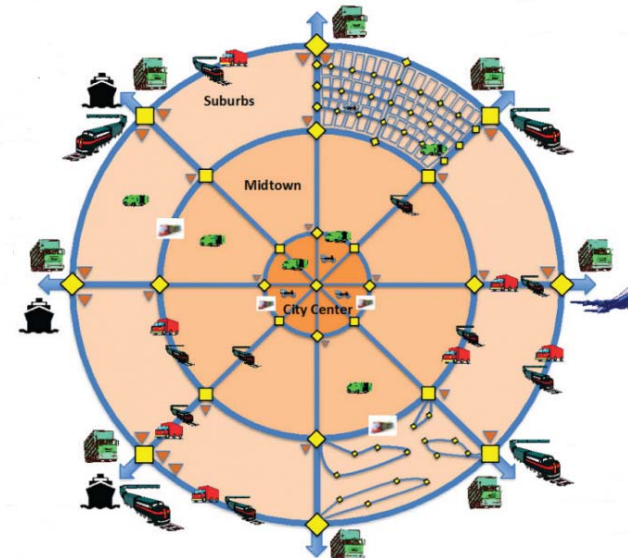


Congestion

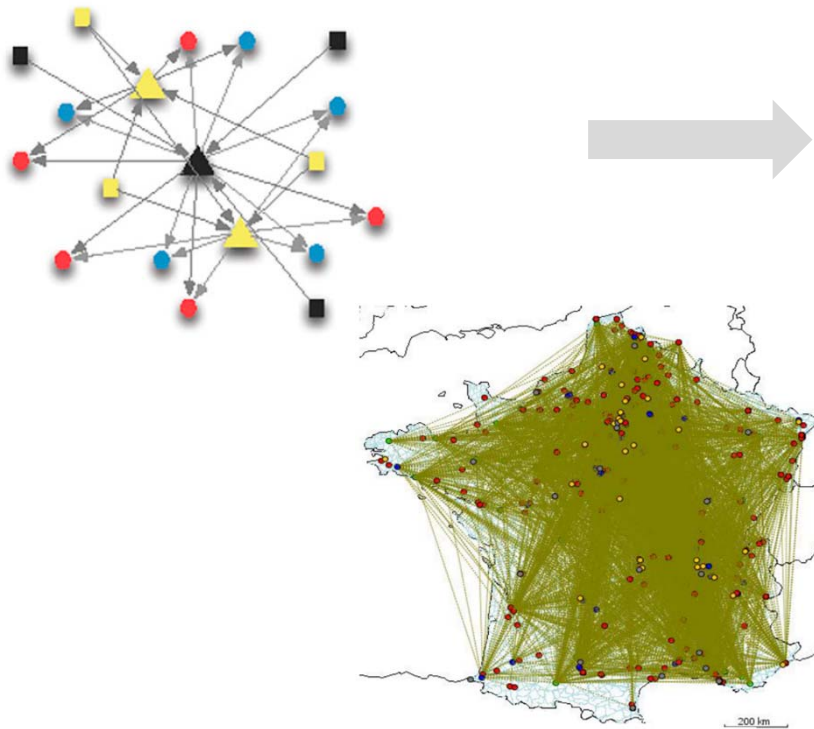
Pollution

Delay

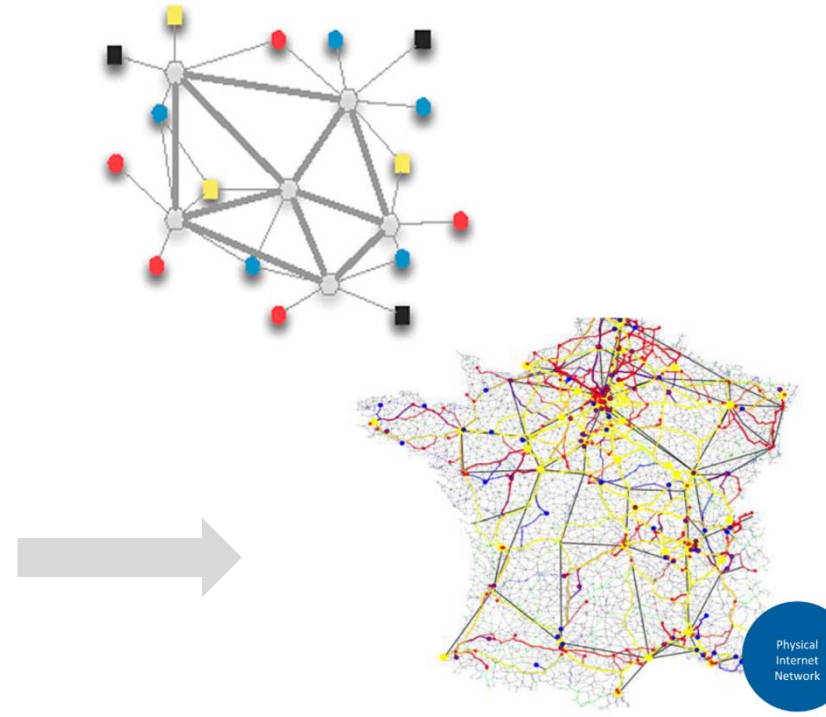
The **Physical Internet** is a new concept for freight transportation and logistics aiming to improve the economic, environmental and societal efficiency and sustainability of the way physical objects are moved, stored, realized, supplied and used all across the world (Montreuil 2011).



# Introduction

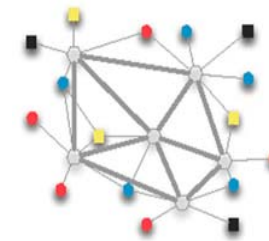


Overlapping yet disconnected logistics networks



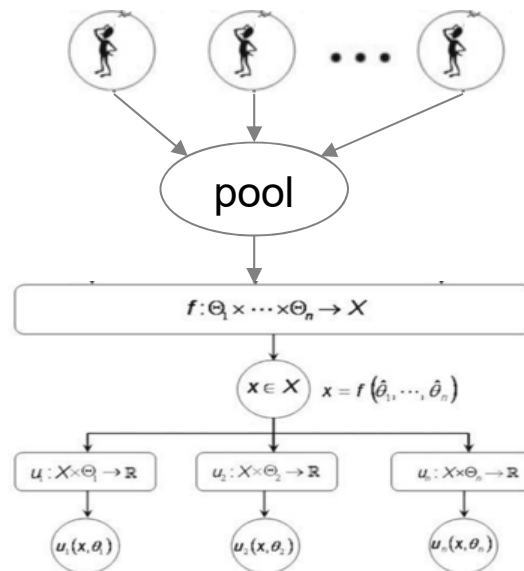
Interconnected logistics networks

# Introduction



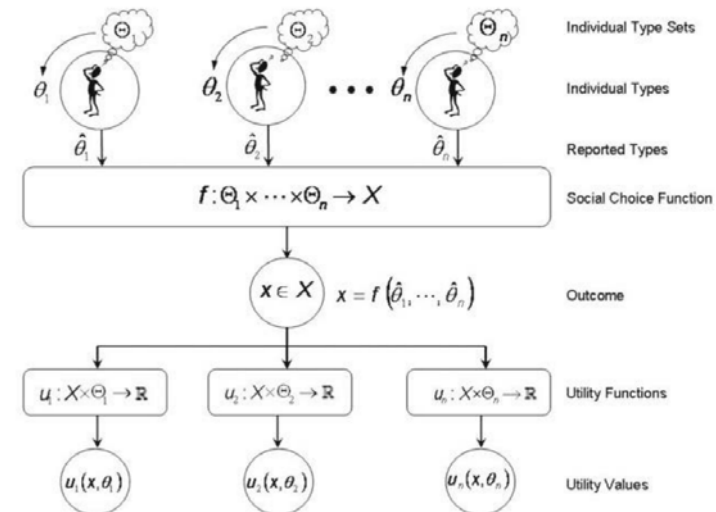
Private companies	Warehouse	Independent	Shared
	Vehicles	Independent	Shared
Public transport facilities		-----	Active
	Network	Overlapped & Fixed	Consolidated & Dynamic
	Contractual term	Fixed/long term	Flexible
	Ownership	Own resources	Flexible

- Centralized



Minimize total cost

- Decentralized



Maximize self profits

The current research about transport collaboration on operational level can be classified into three types:

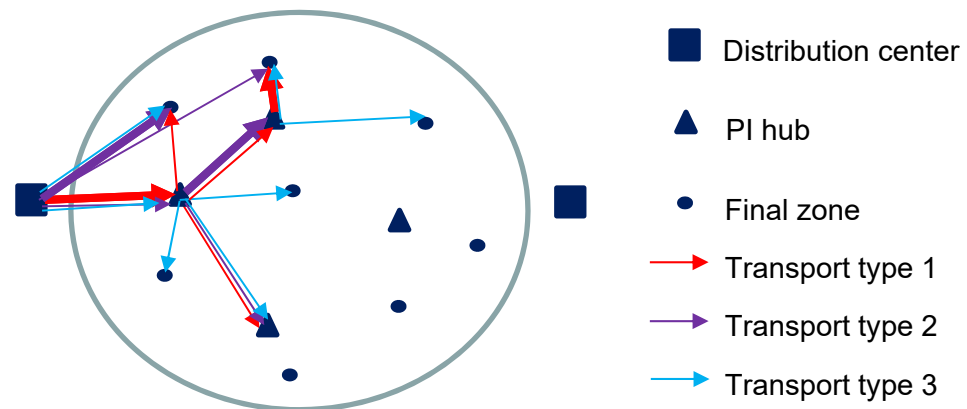
1. **Freight task exchanging:** Dai and Chen (2012), Houghtalen (2007), Lozano et al. (2013)
2. **Distribution center sharing:** Furtado and Frayret (2014), Wang et al. (2015), Dai and Chen (2015), Hezarkhani et al. (2016)
3. **Routing merging:** Ergun et al. (2007), Berger and Bierwirth (2010), Agarwal and Ergun (2010), Zakharov and Shchegryaev (2015)

**Contribution:**

1. A combination of these three collaborative types.
2. Alternatives for freight transport: public facility & temporary outsourcing

# Model formulation

- ❖ Features: **multi-transport modes, transit hubs**
- ❖ Constraints: capacity, time window.
- ❖ Objective: minimize operational cost
- ❖ Decision variables: the transport flow between two nodes.
- ❖ Solution approach: **hub-insertion heuristic**.



## Step 1: warehouse deployment

Clustering.

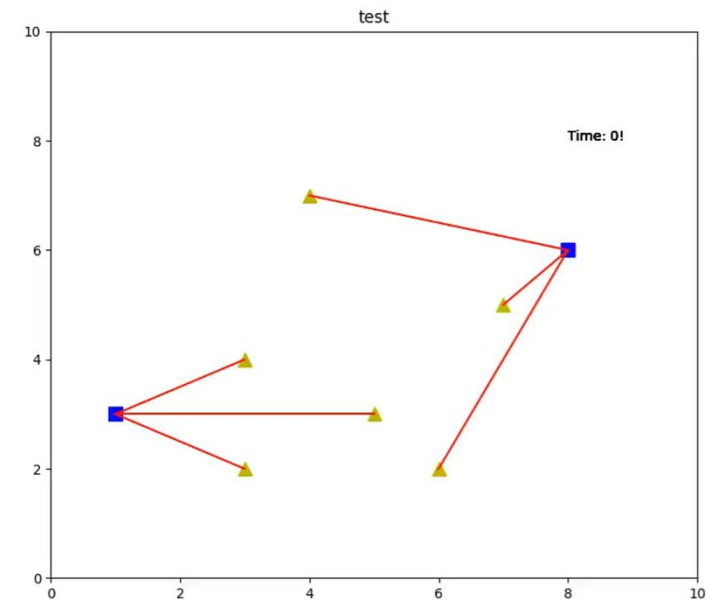
## Step 2: initial solution

Initial route of each demand is from warehouse to the target customer directly.

## Step 3: insert a hub into the network

Re-arrange each demand's route - choose a proper point to insert this hub into its route or do not insert the hub (similar to insertion-heuristic(Solomon 1987))

Step 4: repeat step3 until all the hubs have been checked.







Thanks