Hyperconnected Last-Mile Delivery of Large Items in Urban Area

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Last mile delivery of large items such as furniture and large appliances typically requires larger vans and its routing faces a lot smaller delivery density than parcel deliveries. Such deliveries in an urban area often creates economic, environmental and social issues especially when the large vans need to be parked in front of houses during delivery and installation. The need for improving the last mile delivery of large items in a city area is growing as urban population is expanding.

Currently, most of the furniture and large appliances retailers serve a city area independently from their distribution centers (DCs) located in a suburb area where the rent is cheaper. However, such a system offers limited potential for improvement in efficient distribution and deployment due to sparse delivery density. In this context, Goyal et al. (2016) and Kim and Montreuil (2016) demonstrated the potential of hyperconnected distribution and deployment inspired by Physical Internet (PI) to improve last mile delivery of large items in an urban area. We extend the previous research by exploring various logistics network structure scenarios with PI hubs on different city configurations.

The simulation-based experiment is constructed around scenarios combining two alternative threads: delivery and distribution. Along the delivery thread, there are three alternatives: (1) deliveries done independently by each retailer by routing its fleet of vans; (2) deliveries openly shared among retailers by routing multi-retailer vans; (3) deliveries openly shared among retailers, exploiting intra-city hubs for openly consolidating flows, with products sent to the PI hubs in larger vans from the DCs and sent from hubs to clients in smaller trucks. Along the distribution thread, there are also three alternatives: (a) products of a retailer stored in its dedicated peri-urban distribution center; (b) products from any retailer can be openly stored in any of the peri-urban distribution centers; (c) products from any retailer can be openly stored in any of the intra-city and peri-urban distribution centers, with the former being more expensive. Scenario 1a corresponds to the most common current operation based on independent delivery and distribution, as such it is the baseline for comparing the other more hyperconnected scenarios. Different combination of delivery threads 1, 2 and 3 and distribution threads a and b have previously been investigated in exploratory mode by our team, as reported in Goyal et al. (2016) and Kim and Montreuil (2016).

Scenarios are run and simulation results are contrasted in terms of induced costs, distance travelled, energy consumption, greenhouse gas emission, and delivery service, subject to stochastic demand.

Figure 1 illustrates some of the investigated logistic structure and last-mile operations, where logistic facilities and delivery locations are identified, and potential last-mile routes are illustratively displayed for the red retailer.

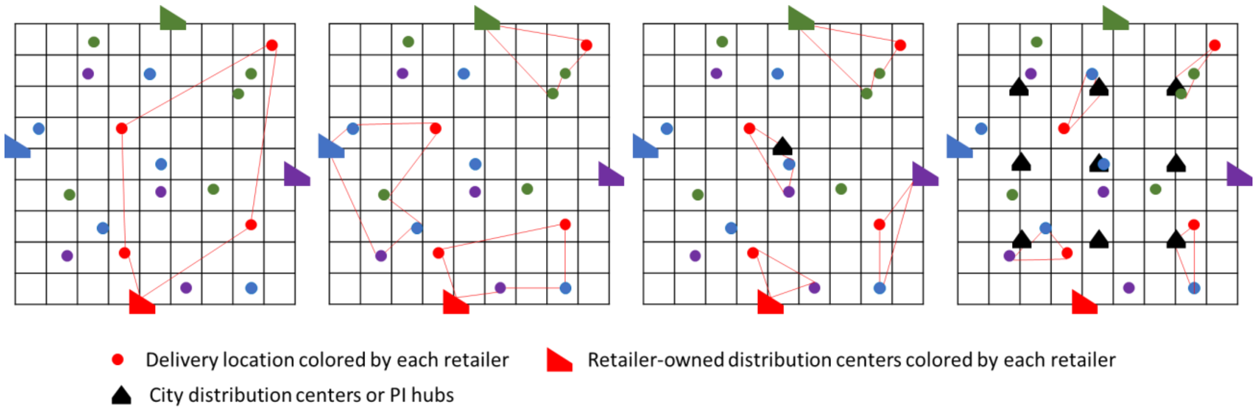

Figure 1. Illustrating a sample of investigated logistic structure and last-mile operations: current disconnected operation, openly-shared distribution through peri-urban DCs, openly-shared distribution with an intra-city DC, and openly-shared delivery with PI-hubs (from left to right)

In all scenarios, agents are embedded in the simulator to dynamically optimize delivery assignment, routing and product deployment decisions. In scenario threads b and c, we also seek for optimal redeployment policy by adjusting redeployment frequency. Also, these scenarios are assessed with different city configurations by demand distribution to represent different types of cities. We consider 4 types of demand distributions over a city as described in Figure 2: uniform, center-concentrated, suburb-concentrated, and double centered.

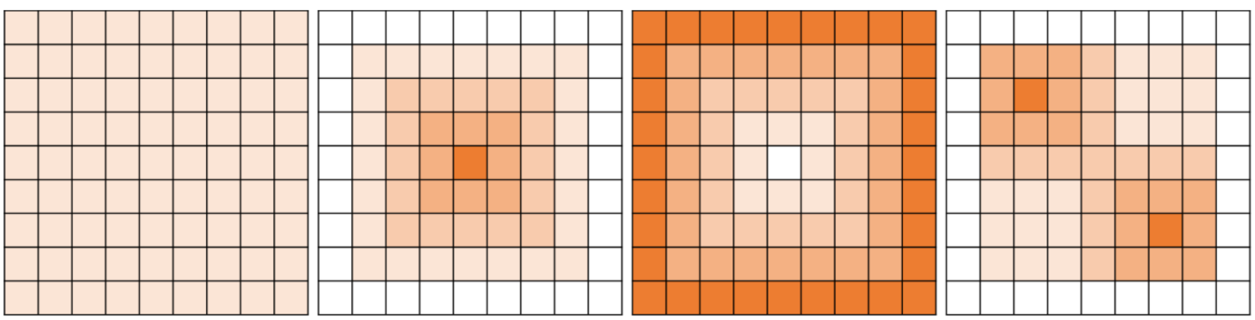

Figure 2. Demand distributions over a city: uniform, center-concentrated, suburb-concentrated, and double centered from left to right

References

Goyal, M., Cook, J., Montreuil, B., Kim, N., & Lafrance, C. (2016). Hyperconnected City Logistics for Furniture and Large Appliance Industry: Simulation-based Exploratory Investigation, 2016 3rd International Physical Internet Conference

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