Impact of Autonomous Delivery on Last-Mile Logistics

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Objective: Explore impact of autonomous/driverless vehicles on home delivery
Hypothesis: High labor cost of driver-based home delivery major reason for customer pickup at stores
Methodology: Propose design for public logistics network that would allow consolidated-load delivery to the home
Results: At scale, cost of on-demand driverless-based home delivery same as current driver-based delivery
Conclusion: Driverless-based home delivery can eliminate need for all non-recreational shopping, which is especially important for the disabled and elderly

Dirt-to-Dirt Logistics Costs

Containers pay DC for storage time

- Containers in local load
- Local load to home and linehaul loads to other DCs
- Loads in a lane ordered by decreasing bid
- Driverless-based home delivery can eliminate need for all non-recreational shopping, which is especially important for the disabled and elderly

Home Delivery Alternatives

- Customer Supervised: +Time-sensitive driver-based (plate)
- Driver vehicle (manual unloading)
- Unattended (packed/container): +Aerial drone
- +Time-intensive driver-based (UPS, USPS, FedEx)
- Driverless vehicle (auto unloading)

Logistics Network for Consolidated-Load Home Delivery

- DCs covering Raleigh-Durham metro area
- Delivery of four orders to a home

Network Coordination: Develop mechanism to coordinate operation of each container, vehicle, and DC in the network

- Separate firm can own each DC and vehicle → coordination more difficult than private network
- DC load is a single shipment
- Containers in linehaul load part of different shipments each owned by a separate firm
- Containers pay DC for storage time

Example: 2-D Load Formation

1. Select Containers: Sorted based on decreasing per-unit bid value; selected until cumulative area = 50 (capacity of module array)
2. Order Containers: Sequence based on length, width, bid; may not be feasible to fit (pack) all containers into array (bin)

Example: 1-D Load Bidding

- Load bid is sum of container bids in load
- Loads in a lane ordered by decreasing bid
- Containers bid for services of the vehicles used for their transport
  - Containers going to same DC compete to be in next transported load
  - Loads to different DCs competing to be selected by vehicle
  - Vehicles competing with each other to select loads

Example: Unloading and Loading Operations at DC

- Diseconomies of Scale: Yellow containers spend/bid less on a per-unit basis to join a load leaving earlier due to their smaller size

Storage System Control:

- Module ≤ Container ≤ Shipment ≤ Load
- Each container assigned a unique priority that determines its planning sequence

Example: Unloading and Loading Operations at DC

- UD (loading dock)
- Containers move to staging area
- Storage System Control
- Load Planning and Control
- Inventory Management
- Load Sorting and Handling
- Storage Coordination
- Container delivery to staging area

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