Using an Agent-based Model to Explore Alternative Modes of Last Mile Parcel Delivery in Urban Contexts

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Parcels market and carrier operations

- **£7-8 billion** and ~2 billion parcels/packages in 2015
- Annual revenue per parcel ranges
- Rising light goods vehicle (LGV) traffic in London and nationally
- HGVs and LGVs are relatively significant in influencing road traffic, CO\(^2\) emissions, air pollutants, and road traffic casualties
- LGVs include servicing vehicles as well as goods transport
- A lack of LGV activity data is available to the public
Online sales as a percentage of total retail spending in the UK, 2007-2016

Note: data is for end of July in each year.
Source: produced from data provided in ONS (2016)
New problems in managing last mile parcel logistics

• **Increase in demand** for deliveries
  - Small van traffic growing in urban areas
  - Less-than-van loads increasing with ‘same-day’ delivery
  - Product return and delivery failure rates

• **Competitive** industry
  - Lots of small players
  - Ease of entry
  - Lots of inefficiencies
  - **Overcapacity = downward price pressures**
  - ‘Free’ delivery options used to attract custom means growth in demand but lower average revenues per parcel

• Need for **investment in infrastructure and planning**
  - Worsening road conditions in busy urban areas
  - **Difficulties in finding suitable kerbside parking space**
  - Lack of affordable land for logistics depots in urban areas - **forcing depots further from inner central urban area** (logistics sprawl)
  - Land use planning not accounting for new e-commerce trends
  - **Pressure to reduce CO₂ emissions and target contributors**
Project

Goal: “help urban freight carriers understand the way they plan routes, coordinate pickups, and deliver packages in cities, and how they can adapt to urban areas which continue to grow and sprawl.”
The data
Sample of Parking and Delivery points

<table>
<thead>
<tr>
<th>No.</th>
<th>Parking point</th>
<th>Parking Lat</th>
<th>Parking Long</th>
<th>Delivery point</th>
<th>Delivery Lat</th>
<th>Delivery Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Depot</td>
<td>51.5231</td>
<td>-0.2609</td>
<td>Depot</td>
<td>51.5231</td>
<td>-0.2609</td>
</tr>
<tr>
<td>2</td>
<td>1-12 rigmount garden (1)</td>
<td>51.5211</td>
<td>-0.1322</td>
<td>2 rigmount gardens (2)</td>
<td>51.5212</td>
<td>-0.1323</td>
</tr>
<tr>
<td>3</td>
<td>next to craft beer on hulbert</td>
<td>51.5211</td>
<td>-0.1355</td>
<td>22-24 Torrington place (2nd floor)</td>
<td>51.5213</td>
<td>-0.1343</td>
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<tr>
<td>4</td>
<td>21 bloomsbury street</td>
<td>51.5184</td>
<td>-0.1283</td>
<td>21 bloomsbury street, WC1B 3HF (3rd floor)</td>
<td>51.5182</td>
<td>-0.1283</td>
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<tr>
<td>5</td>
<td>next to Blake rubber stamps</td>
<td>51.5183</td>
<td>-0.1243</td>
<td>14 bury place, London WC1A 2IL</td>
<td>51.5183</td>
<td>-0.1244</td>
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<tr>
<td>6</td>
<td>13 russell square</td>
<td>51.5228</td>
<td>-0.1265</td>
<td>10-12 russell square, London WC1B 5 EN</td>
<td>51.5229</td>
<td>-0.1264</td>
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<tr>
<td>7</td>
<td>UHC macmillan centre, mortimer market</td>
<td>51.5239</td>
<td>-0.1353</td>
<td>UHC Macmillan cancer centre, hulbert street, London WC1E 6AG</td>
<td>51.5232</td>
<td>-0.1351</td>
</tr>
<tr>
<td></td>
<td>Shropshire house, 1-20 capper micro dept, London WC1E 6IA</td>
<td>51.5225</td>
<td>-0.1350</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Opposite &quot;nurses home&quot;, hulbert street</td>
<td>51.5228</td>
<td>-0.1353</td>
<td>UCL (hulbert street, infection and immunity room, cruciform building Del, London WC1E 6AF)</td>
<td>51.5240</td>
<td>-0.1351</td>
</tr>
<tr>
<td>9</td>
<td>The Hatter cardiovascular institute</td>
<td>51.5299</td>
<td>-0.1338</td>
<td>UCL (The Paul O’gorman Building, Chenies news WC1E 6HX)</td>
<td>51.5232</td>
<td>-0.1347</td>
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<tr>
<td>10</td>
<td>Whitting house, alfred place WC1</td>
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<td>-0.1339</td>
<td>Whitting house, 15-30 alfred place, London WC1E 7EA</td>
<td>51.5204</td>
<td>-0.1327</td>
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<tr>
<td>11</td>
<td>whitting house place</td>
<td>51.5201</td>
<td>-0.1329</td>
<td>13 alfred place, London WC1E 7EB</td>
<td>51.5203</td>
<td>-0.1332</td>
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<tr>
<td>12</td>
<td>37 store street, London WC1E</td>
<td>51.52</td>
<td>-0.1308</td>
<td>37 store street, London WC1E 7BS</td>
<td>51.5200</td>
<td>-0.1308</td>
</tr>
</tbody>
</table>

Part of the Collected Data (Oct 27th 2016)

Include:
- Delivery requests: 104 (140 items)
- Delivery points: 53 (3*)
- Collection point: 3* (6 items)
- Parking points: 50

Total of 9 working hours:
- Driving: 4 (hrs)
- Delivery: 3.9 (hrs)
- Idle: 1.1 (hrs)

Vehicle parked 60% of the time.
Walking versus Driving

- **Parked time (h)**
- **Driving time (h)**
- **Walked (km)**
- **Driven (in delivery area only) (km)**

![Bar chart showing comparison between parked time, driving time, walked, and driven distances in rounds A, B, and C.](chart)
The model
Current Implementation

Drivers
• Create an ordering of the parcels in a round
• Attempt to deliver individual parcels
• Move vehicles around
• Return undelivered parcels to the depot
• Report on time and distance driven/walked for each round

Depots
• Batch parcels into rounds
• Distribute sets of parcels to drivers
• Limit driver access based on number of bays
Some experiments

- Many small, central depots versus large, suburban depots
- Courier behaviour
- Alternative modes of transit (e.g. cargo cycles)
- Shared spaces/conglomeration
- Policy changes (e.g. Ultra Low Emission Zone)
Thank you!

Questions?
Check out
http://ftc2050.com