Simulating the Port of Dover

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Presentation Overview

• Port of Dover
  – Overview
  – Existing Data
• Capture of new data
• VISSIM simulation
  – Existing Scenario
  – Future Scenario
• Future Research
• Conclusions
Port of Dover
Port of Dover

• Most important trading route between the UK and mainland Europe
• Intricate and multi-levelled
• Over the past 20 years, the number of road haulage (RHVs) vehicles has doubled
• 3 million tourist vehicles and > 2 million RHVs each year and growing
• Frequent congestion issues
Why is an Accurate Simulation Needed?

• Changes currently implemented in an Ad-Hoc manner
• Changes that could benefit include:
  – Planning/Timing for Terminal 2
  – Optimising preferential lane policy
  – Automated check-in Impact
  – Ticketing policies
  – Security checks
• Real-Time operator support
Currently Available Data

• CCTV camera data
  – Automatically or manually extract vehicle type and times

• Weighbridge Data
  – Vehicle type, time, weighbridge number

• Passenger Check-in
  – Ferry company, vehicle type, time

• Anything we capture ourselves!
> Million entries, 1 year

Weighstation Jan-Dec
1 266519
2 303828
3 272255
4 185986
5 166385

printer
L 960878
R 234095

15:45 - 16:00
High
19847
~ 4 per minute

Annual Sum HGVs per 15 minute bin

02:00 - 02:15
Low
4755
1 per minute

15 minute bins (00:00-00:15 —> 23:45-24:00)
CCTV footage -> Arrival Data
Video Derived Arrival Times

Issues:
- Repeat counts.
- Human error.
- Obstructions
- Camera angle
- Changes
Video Capture Test

Cumulative Interarrival Time

Interarrival Time (seconds)

90 Minutes 1-2:30am

104HGVs
32Cars
70Vans
3Other

Interarrival Time (seconds)

25.7799 average
140 max
4 mode
27.25608 stdev
12 median

Off Peak
Peak Time
Tourism Check-in

~800 Values over 2 days for each desk

Most frequent bin 50-60 seconds
# Bluetooth Monitoring

## Bluetooth Devices List

<table>
<thead>
<tr>
<th>Device Name</th>
<th>Description</th>
<th>Address</th>
<th>Major Device Type</th>
<th>Minor Device Type</th>
<th>First Detected On</th>
<th>Last Detected On</th>
<th>Detection Counter</th>
<th>Connected</th>
<th>Remembered</th>
<th>Authenticated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nokia 3100c</td>
<td>Nokia 3100c</td>
<td>0x:24:03:b2:51:39</td>
<td>Phone</td>
<td>Cellular</td>
<td>18/08/2010 14:26:53</td>
<td>18/08/2010 14:26:56</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>LG GS290</td>
<td>LG GS290</td>
<td>6e:0c:8a:94:8a:c2</td>
<td>Phone</td>
<td>Cellular</td>
<td>18/08/2010 14:27:33</td>
<td>18/08/2010 14:27:33</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Nokia N95 8GB</td>
<td>Nokia N95 8GB</td>
<td>0x:7e:23:69:4c:bc</td>
<td>Phone</td>
<td>Cellular</td>
<td>18/08/2010 14:35:07</td>
<td>18/08/2010 14:35:07</td>
<td>1</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Nokia N95 8GB</td>
<td>Nokia N95 8GB</td>
<td>0x:0e:04:42:6c:70</td>
<td>Phone</td>
<td>Smart</td>
<td>18/08/2010 14:36:36</td>
<td>18/08/2010 14:36:36</td>
<td>1</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>80:0a:3a:2e:29:92</td>
<td>Unclassified</td>
<td>80:0a:3a:2e:29:92</td>
<td>Unclassified</td>
<td></td>
<td>18/08/2010 14:37:51</td>
<td>18/08/2010 14:37:51</td>
<td>1</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>00:10:07:e8:8f:2</td>
<td>Audio</td>
<td>00:10:07:e8:8f:2</td>
<td>Hands Free</td>
<td></td>
<td>18/08/2010 14:39:22</td>
<td>18/08/2010 14:39:22</td>
<td>1</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Impact of Location on BT Monitoring

• 2 Locations – After Customs Control and Ticketing
• 796 vs 125 unique IDs over 4 hours.
• Differences due to:
  – Driver Speed
  – Range
  – Windows
  – Canopy
• 103 coinciding IDs
Bluetooth measured Trip-times
VISSIM – Micro Scale Simulation
Driver Behaviour

• The “Wiedemann” Approach
• Free Driving, Approaching, Following, Braking
• Each driver parameterised from a distribution
  – Acceleration
  – Look ahead
  – Headway distance
  – Braking
  – Lane change
  – Desired speed
Monitoring Points

Trip Times

Weighbridge Queues
Sensitivity to initial conditions

Exact arrival data cannot be used in VISSIM

Exact numbers can be represented distributions in small time windows

BUT even at small time windows (2 minutes), probabilistic system very sensitive
Effect of random seed on trip time

![Graph showing the effect of random seed on trip time. The graph plots average trip time against time, with two different random seeds represented by blue and red markers.](image-url)
Weighbridge Algorithm

- Probabilistic vs Vehicle Intelligence selection
  - Probabilistic – Decisions made based on random numbers
  - Vehicle Intelligence – Decisions made based on VISSIM driver lane selection model
## Capture Methods vs Simulation

<table>
<thead>
<tr>
<th></th>
<th>Trip time data (seconds)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simulation</td>
<td>Bluetooth</td>
<td>Camera</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>319</td>
<td>358</td>
<td>343</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>291</td>
<td>301</td>
<td>306</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>110</td>
<td>181</td>
<td>137</td>
<td></td>
</tr>
<tr>
<td>Max</td>
<td>729</td>
<td>1250</td>
<td>860</td>
<td></td>
</tr>
</tbody>
</table>

![Histogram of trip time data](image)
Automated Ticketing – A Future Scenario Example

- Addition of up to 5 extra lanes for computerised ticket issuing
- 6 options presented, 2 analysed in depth.
- Several assumptions made for simulation
  - Same processing time distribution (n-77, 50)
  - Existing 90 minute peak flow used
  - Single lane filter with fixed decision point
VISSIM – Option 1, All vehicles
Option 1, All Traffic. (Means)
Option 1, All Traffic
Option 4, Cars only

Average trip times (in 400 second bins) for different fractions of Automated ticketing
Where Next?

• Replicate/repeat
• Real Time Support
• Impacts of using Alternatives to VISSIM
  – Anylogic, non-visual approach
• Other Ports
• (More) Intelligent Agents
Neural Drivers?

- Decisions:
  - Driver Inputs
  - Driver Output
  - Correct Algorithm
Problems with Using More Intelligent Agents

• Computation
  – Current “simple” systems very hardware intensive
  – Online ANN learning for large number of agents prohibitive, but hardware improvements, GRID and P2P will help.

• Transparency
  – Believing simulation at least as important as simulation performance

• Occam’s Razor
  – Only add complexity if required
Conclusions

• Wireless protocol sniffing a viable option (now and in the future) but placement is important

• Visual Capture of Arrival Processes Viable:
  – Most assume events occur continuously and independently of one another (Poisson).
  – Finer grain arrival windows more bursty

• Danger of Over Calibration (ie. Weighbridge Stats)

• ‘State of the Art’ Driver (agent) behavior currently quite simple