London’s Bus Priority at Traffic Signals in a Worldwide Context

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Overview

• Introduction
• UITP study
• Bus priority at traffic signals
• Worldwide context
• London’s bus priority at traffic signals
• Concluding Comments
UITP study

- UITP Working group on Interaction of buses and signals at road crossings
- Goals:
  - Review of worldwide systems and general practice
  - Identify best practice
  - Lessons learned from existing installations

- Website
Bus Priority at Traffic Signals

- Traffic signals
  - Fixed time/ Vehicle actuated
  - Isolated/Co-ordinated systems

- Bus priority
  - Buses detected at the approach of a traffic signal
  - Green extension or green recalls
  - Priority to buses with minimal impact on other road traffic
Worldwide context

• Bus priority at traffic signals is widespread across the world

• Substantial variations in the systems
  - Bus detection technology
  - Priority request communication
  - Priority architecture
  - Priority benefits
Technologies used for Bus Priority

- **GPS**
- **Loop**
- **Beacon**
- **UTC**
- **Priority algorithm AVL**
- **Signal controller**
- **Radio poll and priority request**
- **Location/time**
- **Signal status, priority request (optional), etc.**
- **Roadside beacon**
- **Signal controller**
- **Priority implement**
- **Location/time**
- **Signal controller**
- **Priority request**
- **GPS**
- **(odometer, route matching)**

Signal controller → Bus detection → Loop → UTC → Priority algorithm AVL → Radio poll and priority request → Location/time → Signal controller → Priority implement → GPS → Location/time → Signal controller → Priority request → Roadside beacon → Signal controller → GPS
Architecture examples

- UTC
- Traffic signals
- Bus

- UTC
- AVL
- Traffic signals
- Bus

- UTC
- Traffic signals
- Bus

- UTC
- AVL
- Traffic signals
- Bus
Architectures used for Bus Priority

King County – Decentralised

Toulouse – Centralised

Source: metro.kingcounty.gov/up/archives/2001/tsp.html
Source: www.trg.soton.ac.uk/priscilla/deliverables.htm
<table>
<thead>
<tr>
<th>City</th>
<th>No. of signal equipped</th>
<th>No. of equipped buses</th>
<th>Bus detection technology</th>
<th>Priority request communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aalborg</td>
<td>51</td>
<td>249</td>
<td>GPS + Odometer</td>
<td>Centralised</td>
</tr>
<tr>
<td>Cardiff</td>
<td>46</td>
<td>191</td>
<td>GPS</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Genoa</td>
<td>84</td>
<td>500</td>
<td>GPS</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Geneva</td>
<td>263</td>
<td>420</td>
<td>GPS + Odometer</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Glasgow</td>
<td>241</td>
<td>500</td>
<td>GPS</td>
<td>Centralised</td>
</tr>
<tr>
<td>London</td>
<td>3200</td>
<td>8000</td>
<td>GPS + Odometer + map matching</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Prague</td>
<td>65</td>
<td>352</td>
<td>Beacon</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Stuttgart</td>
<td>34</td>
<td></td>
<td>Beacon and GPS</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Toulouse</td>
<td></td>
<td>160</td>
<td>GPS + Odometer</td>
<td>Centralised</td>
</tr>
<tr>
<td>Auckland</td>
<td>174</td>
<td>734</td>
<td>GPS</td>
<td>Centralised</td>
</tr>
<tr>
<td>Brisbane</td>
<td>11</td>
<td>205</td>
<td>Loop</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Portland</td>
<td>250</td>
<td>650</td>
<td>Beacon (Opticom)</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>654</td>
<td>283</td>
<td>Loop &amp; transponder</td>
<td>Decentralised</td>
</tr>
</tbody>
</table>
## Example of reported benefits

<table>
<thead>
<tr>
<th>City</th>
<th>Bus delay savings</th>
<th>Travel time</th>
<th>Variability</th>
<th>Patronage</th>
<th>General traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aalborg</td>
<td>5.8 sec/jun</td>
<td>4% reduction in average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiff</td>
<td>3-4% reduction</td>
<td>Reduced</td>
<td>1-2% increase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genoa</td>
<td>7-10% reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gothenburg</td>
<td>13-15% decrease</td>
<td></td>
<td></td>
<td>5-10% savings</td>
<td></td>
</tr>
<tr>
<td>Helsinki</td>
<td>11% reduction</td>
<td>11% up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>London</td>
<td>9 sec/jun (isolated)</td>
<td>3-5 sec/jun (SCOOT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prague</td>
<td>2% reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southampton</td>
<td>9.5 sec/jun</td>
<td></td>
<td></td>
<td>Increased by 3.8 sec/veh/jun</td>
<td></td>
</tr>
<tr>
<td>Stockholm</td>
<td>10% savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turin</td>
<td>12% reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>King County</td>
<td>25-34%</td>
<td>Reduced by 5.5-8%</td>
<td>Reduced by 35-40%</td>
<td>Minimal effect</td>
<td></td>
</tr>
<tr>
<td>Los Angeles</td>
<td>Reduced by 6-8%</td>
<td>Up by 1-13%</td>
<td></td>
<td>Increased by 1 sec/veh/jun</td>
<td></td>
</tr>
</tbody>
</table>
Some Lessons Learned

• Bus priority cost effective from small towns to big metropolitan cities
• Use technology appropriate to requirements, with potential for upgrading
• Include policy-responsive strategies
• Most effective with traffic responsive control.
• Bus priority implementation seems most effective in regulated environments (security of investment and operations).
London’s buses

• London bus network
  - over 8000 buses; 6 million passengers; over 700 routes every weekday

• Bus priority facilities: bus lanes, red routes, priority at traffic signals

• Recent initiatives
  - modern fleet; improved ticketing; congestion charging; new AVL system

• iBus system for fleet management, passenger information and bus priority at traffic signals
London’s iBus system

Key

1. Bus priority fault detection and performance monitoring reports
2. System databases
3. Bus priority radio link
4. Bus processor (located within traffic signal controller)
5. Traffic signal controller
6. Bus detection points
7. Bus door sensor
8. GPS receiver
9. Central system server (located remotely)
10. iBIS plus unit
11. GPS satellites
12. Bus garage (when bus is in garage, it is linked to the central system server to send and receive bus priority data)
GPS based bus priority

- SCOOT UTC
  - Priority implement
  - Signal controller
- GPS
  - Location
- AVL centre
  - Location/time
  - (odometer, route matching)
  - Priority request
iBus project

- Replacement for existing beacon AVL, Radio and Loop systems
- Siemens VDO awarded contract
  - design
  - rollout
  - maintenance service
- GPS based AVL system supporting more than 8000 buses and 3200 signals
Advantages of using iBus

- Reduced cost of rollout per junction – most junctions cost-effective
  - Reduced roadside infrastructure requirement
  - Increased speed of rollout
- Increased reliability and decreased maintenance costs
- Future proofing the system
- Potential expansion to other modes of transport (e.g. freight, Olympic traffic, TRAMs)
Bus priority using iBus

• Bus detection using “virtual detector
  - No roadside equipment installation
  - More than one virtual detectors can be used
  - Easy relocation
  - Longer distances possible
• Priority based on schedule/headway information
• Next steps
  - Differential priority
  - Cancel detection
  - Predictive priority
Next steps - Differential priority

• Priority is given according to the individual requirements of buses
• Varying levels of priority given depending upon the need (e.g. late bus)
• To improve punctuality/regularity and reduce passenger waiting times
• Benefits
  - Higher priority to the buses in need
  - Improved performance criteria
  - Less disruption to non-priority traffic (as fewer buses awarded priority)
Next steps - Predictive priority

• An extra detector (secondary detector) in addition to a primary detector
• Extra priority may be cancelled using a cancel detector at the stopline
• The combination of primary, secondary and exit detectors found beneficial
• The combination is increasingly useful as bus journey time variability increases
Predictive priority

**Primary detector (U)**
- Estimates bus arrival at stopline
- Bus priority is given accordingly

**Secondary detector (D)**
- Re-estimates bus arrival at stopline
- Bus priority given earlier is amended accordingly

**Exit Detector (E)**
- Cancels any remaining priority extension
Concluding comments

- Transport is about the movement of people and goods, not just the movement of vehicles.
- Bus priority at traffic signals adopted across the world.
- Systems vary in size, technology and architecture.
- Reported benefits - typical bus delay savings of 4-10 secs/junction, a 3-16 months payback period and environmental benefits.
- Bus priority system outcome is influenced by policy objectives (journey savings, regularity).
- New technologies are supporting increasing levels of innovation - London’s iBus is a prime example!
Thank You!