Improving the Bus Network through Traffic Signalling

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Introduction

Transport for London (TfL) operates the most frequent and extensive bus network in the world with around 675 routes and 9,300 vehicles. This service is vital to the economic and social wellbeing of London with 2.32 billion bus journeys made in London last year.

This paper will highlight how TfL is helping to improve the bus network through the use of technology at traffic signals. It will show how priority is given at junctions to buses to reduce delay, as well as how this has contributed to slowing the decline of bus journey times over the past year.

TfL has created a programme to make buses more reliable and develop methods to prioritise them at junctions to enable a smoother journey. This was achieved using traffic signal technology and as part of the annual traffic signal review programme.

1) iBus

iBus transponder units were fitted on all London buses in 2009. Using GPS technology, these allowed TfL to know the exact location of each bus at all times. It also enabled the electronic countdown signs at bus stops to be accurate and provided data for the automatic vehicle announcements on board the bus to allow passengers to travel in confidence even when they are in an unfamiliar area.

It is this technology that has now been adapted to work with bus priority at traffic signals. The iBus units communicate with virtual detector points along bus routes to help alter signal timings to favour a smooth journey for buses and minimise delay as much as possible.

2) Bus Priority

Bus Priority (BP) at junctions works by either extending the current green signal time at the end of a stage to allow a bus through, or by shortening opposing stages to get the approach that the bus is on back to green in a shorter period of time by using Selective Vehicle Detection (SVD). Each bus on the network is fitted with an iBus transponder and this broadcasts the location of the bus when it gets to a virtual detection point (VDP). The UTC controlled junction then uses the information to implement one of four possible scenarios:

1. The bus arrives at a green light; therefore it travels straight through the junction with no delay.

2. The bus arrives at the end of green signal and an extension to the green time is given to allow the bus to proceed without stopping. This is the most beneficial priority as it has minimal disruption and saves a whole cycle where the bus would be stationary. It is the least frequent type of BP to occur as a bus has to arrive in the final few seconds of green to activate an extension.

3. The bus could arrive at a red light and a recall occurs. This method of priority shortens the opposing green times if the traffic on those approaches is below a specific threshold. This brings the stage that the bus is on back to green in a shorter amount of time so it can continue on its journey. Recalls can be disruptive to a junction due to lowering the green time of other stages and disrupting offset linking.

4. The bus arrives on red and all the opposing arms are too busy (saturated) therefore no other stages can be shortened or extended and the bus will have to wait with no priority given.

Implementing bus priority gives an average benefit of 2 to 4 seconds per bus per junction. However BP is not suitable for all junctions, for this system to work the junction needs between 20 and 40 buses to pass through it per hour and needs to have spare green signal time. This meant TfL had to look at an alternative method to give priority to buses as many of London's junctions are running at high degrees of saturation with a large volume of buses.

This came in the form of Differential Bus Priority (DBP) and focuses on prioritising only delayed buses. This allows an increased amount of priority to be given to late buses.

There are four different priority levels that exist to categorise the bus and get it through a junction, they are:

- Level 0 – A bus that is early or within one minute of schedule runs on normal SCOOT.
- Level 1 – A bus that is one to three minutes behind schedule can have extensions when arriving at the end of green.
- Level 2 – A bus that is three to five minutes behind schedule can have extensions and recalls.
- Level 3 – A bus that is over five minutes behind schedule can receive extensions and recalls with greater priority to try and gain as much time back as possible.

DBP has the greatest benefit when there are 40 to 100 buses per hour at the junction and where the junction is running at capacity with very little spare green time. The average benefit for DBP junctions has been found to be 2 to 5 seconds per bus per junction.

3) Timing Reviews

As part of our annual timing review programme that reviews 1,200 of the 6,300 traffic signals in London, 200 reviews are specifically focused on improving bus performance. Bus Focused Timing Reviews involve looking in depth at specific routes that are frequently delayed, and finding ways to improve the speed of the bus. A variety of options can be considered to speed up buses in these situations, with the correlation of freeing up capacity at a junction improving the speed of buses.

A favourable solution used in some scenarios is to combine traffic signal stages into one (such as side roads if they are quiet enough to have give-way right turns). The example below (figures 3, 4 and 5) depicts a junction along Waterloo Road where a bus performs a U-turn on its route. Stages three and four were combined into one stage (three) to save time, during which a bus had to previously wait to turn. The technique of combining stages can always be used for specific times of day to allow maximum flexibility. This results in one less stage green time and interstage duration, which gives more time to the main bus route or lowers the cycle time to get around the stages quicker (this also helps with recalls in Selective Vehicle Detection SVD).

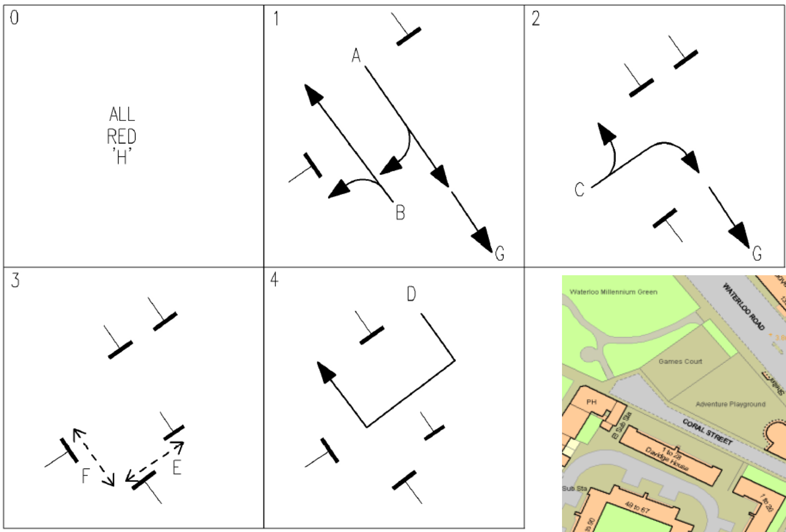

Figure 3

Figure 4

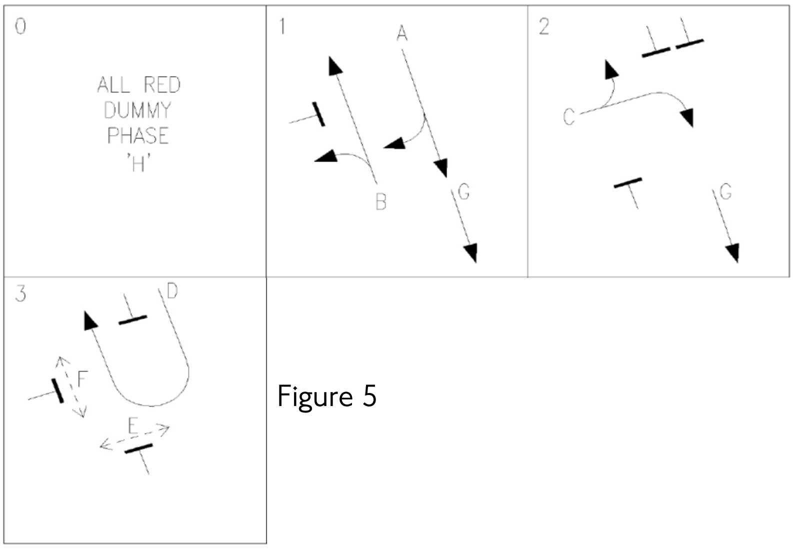

Figure 5

4) Call-Cancel

TfL have looked at how pedestrians are influencing traffic signal timings. It is a frequent occurrence that a push button will be pressed, on a demand dependant stage, which will call in the pedestrian stage when the pedestrian has already crossed in a gap in the traffic meaning the invitation to cross is no longer required. This has an impact on buses and traffic in general as they are stopped at a crossing when it is not required causing unnecessary delay. Pedestrian call-cancel has been implemented at junctions where this was a key issue and it allows for the demand for the pedestrian stage to be cancelled if demand is no longer needed.

This technology works by using sensors directed at the kerb waiting area to detect when someone is waiting to cross the road and when there is no one there. Call-cancel was tested to determine the benefits and there was an average 4% reduction of call rate in the morning peak which equates to 150 seconds saved per hour and given back to buses and general traffic. There was also a 2.3% reduction in call rate during the evening peak which saves 90 seconds per hour. Due to call-cancel being successful in giving longer green signal time while still maintaining a pedestrian crossing it has been introduced in suitable locations where data shows buses were not as reliable as previously.

5) 4G Resilience

As the majority of London traffic signals operate under the SCOOT system, loss of computer control can be the cause of significant delays.

To improve resilience to junctions dropping offline from our central computer and to maintain UTC (Urban Traffic Control) function, TfL have been exploring new technology. 4G communication equipment is being installed at junctions that are in critical locations and need linking operationally. This allows them to still communicate with the UTC system if the standard data transmission fails providing a useful backup feature. This means that our traffic signal engineers are still able to control junctions, and key features such as SCOOT and Bus Priority can still operate effectively.

Case Study – Differential Bus Priority

TfL carried out a trial in Wandsworth to investigate the benefits of Differential Bus Priority in comparison to standard SCOOT operation and SVD BP operation. Wandsworth was chosen because it had a significant number of bus routes and was a large area to carry out this test. The area consisted of 14 signal controlled junctions, 10 of which operated SVD Bus Priority.

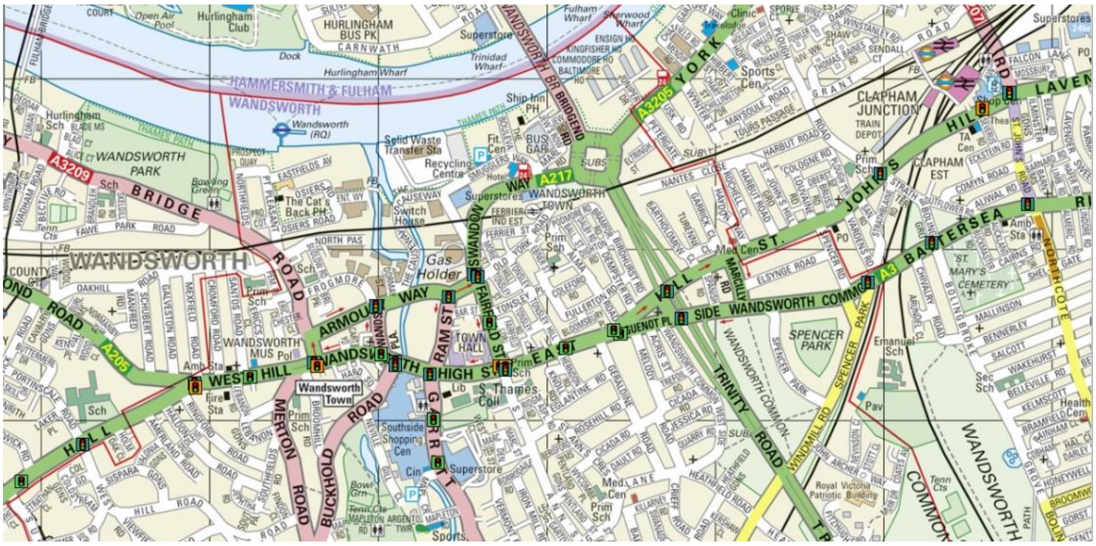

Figure 6 – Wandsworth Trial Area

The SCOOT data analysis after the trial showed that it is possible to selectively improve individual bus journeys through the network. The average benefit given to those priority buses was greater when under DBP than Standard Bus Priority.

Figure 7 shows the proportion of buses that went through Wandsworth during the trial that were on time as well as the different levels of delay. It shows that when DBP is used, 60 per cent of buses that arrive on a junction on average are not considered and continue their journey through the network, with the extra capacity gained targeted at the delayed vehicles. The 13 per cent of buses with over a five minute delay are where the real gains can be made with DBP. If a number of junctions are enabled along a bus route it can have a cumulative input on decreasing the journey time.

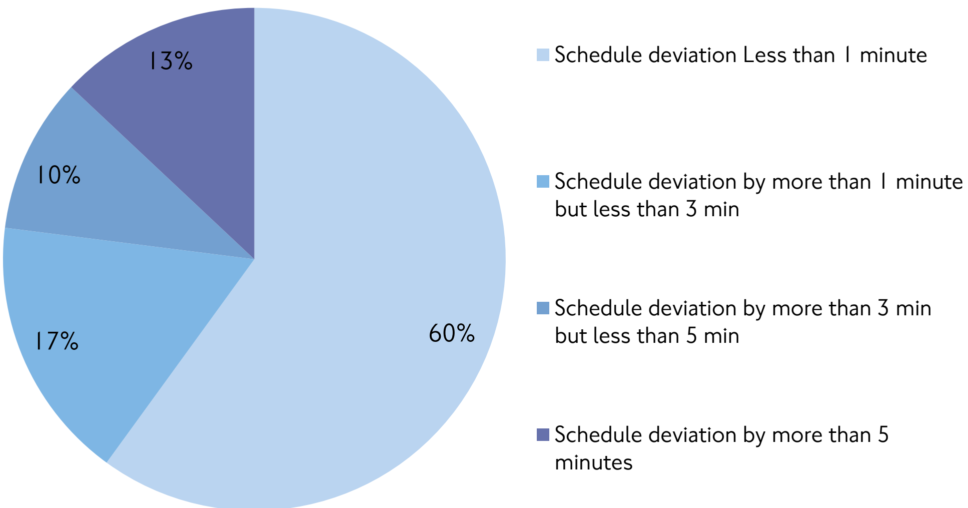

Figure 7

After the trial, it was recommended that DBP should be used to prioritise buses intelligently across the network at appropriate locations. TfL have developed a programme for this roll out, specifically targeting low bus speed areas.

Conclusion

In addition to improving bus speeds through traffic signalling, Transport for London also have a Bus Reliability programme that looks at a variety of on street measures to improve bus performance. These can include changes to bus lanes and stops, road layouts, changing loading bay restrictions or removing parking bays. Last year 148 schemes were delivered, with 100 minutes of bus journey time saved over the year. It is forecast that by 2021/22 3,000 minutes of additional bus journey time will be saved across the AM peak hour (78 seconds per bus on average).

Data has been collected to allow comparison of speeds and passenger figures over the past few years. This gives us an indication as to how effective schemes have been and shows TfL are making progress towards improvements.

This graph (figure 8) indicates that as a result of targeting junctions and getting bus priority in place that the rapid decline of bus speeds has been halted. The addition of DBP has also contributed to a reduction in delays and central London is now being targeted for improvements.

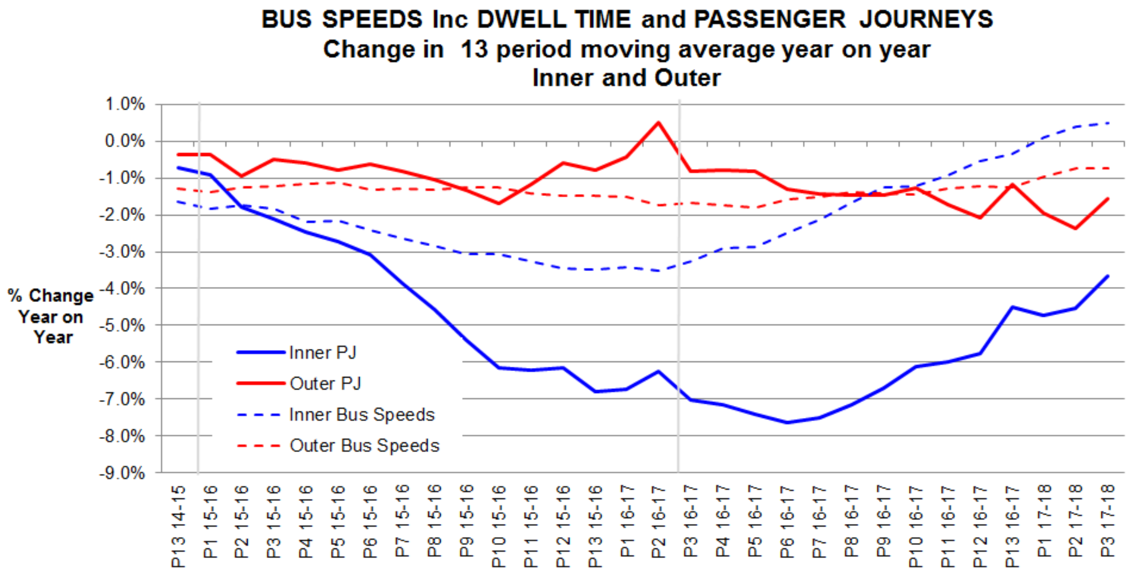

Figure 8

Bus speeds are still low in inner London however TfL are looking to continue to improve bus speeds and are considering different solutions, including Differential Bus Priority but also taking into account the number of passengers within a vehicle and potentially prioritising the buses with more passengers.

This will support the new Healthy Streets approach to London as detailed in the Mayor of London's draft Transport Strategy and continue to improve the reliability of TfL's bus network.

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