‘Minimising the Impact of Street Works and Roadworks:

Portable Traffic Signals operated under fixed time UTC or full SCOOT control.’

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Executive Summary

For traffic control centres around the country, two main causes of congestion are collisions and roadworks. Roadworks with temporary traffic signals are a major source of frustration and delay for drivers, and when they are operated in sensitive parts of the network, their impact can be very high. This is especially problematic where the temporary signals are in the middle of a UTC or SCOOT controlled network.

It is largely not possible to integrate temporary traffic signals into existing urban traffic control systems. In practice, this means that at highly sensitive sites, Traffic Management (TM) companies are instructed to manually control the signals during the peaks. Officers within the traffic control centres then call the on-site operatives and ask them to adjust the signal timings as required.

This is problematic for the TM companies and contractors due to the staffing cost and for control rooms because coordination between sets of signals is not possible. Also, there can be difficulties in getting hold of the on-site operatives when needed.

Pike have been working to develop a set of temporary traffic signals that operate under UTC control via 3G, 4G or ADSL. These signals are capable of operating under UTC fixed time plans, or as part of a SCOOT node. This provides a specialist solution, suited to highly traffic sensitive sites or long term works which allow the signals to be fully integrated into the urban network.

These traffic signals have been trialled in Bristol and the main findings of the trial are as follows. The time commitment for traffic control staff is similar to that for the management of the impact of locally controlled signals. The signals improved traffic flow and maximised capacity effectively, minimising the traffic impact of the works. There were issues with the reliability of the 3G communications, which was problematic. However, this can be managed by the use of multi-operator SIM cards and robust router configuration.

In conclusion, following completion of the trials Bristol City Council was satisfied that the use of UTC temporary signals is beneficial in terms of reducing delay and

improving the management of roadworks. The council has therefore agreed to support the use of UTC controlled temporary signals at appropriate sites in the future.

This type of temporary traffic signals offers a robust alternative to regular temporary traffic signals at problematic sites that are within, or impact on, urban networks.

Introduction

A key aim for Traffic Control Centres is to secure the expeditious movement of traffic on the authority's road network and to facilitate the expeditious movement of traffic on neighbouring highway authority's networks, as per our obligation under the Traffic Management Act (2004).

This aim is met by utilising leading urban traffic control (UTC) and intelligent transport systems (ITS) technologies. Bristol utilises technologies including SCOOT traffic signal control, car park guidance, variable message signs and social media to make drivers aware of issues as they arise.

For traffic control centres around the country, leading causes of congestion include incidents and roadworks. Roadworks with temporary traffic signals are a major source of frustration and delay for drivers, and when they are operated in sensitive parts of the network, their impact can be very high. This is especially problematic where the temporary signals are in the middle of a UTC or SCOOT controlled network.

In the past, it has not been possible to integrate temporary traffic signals into existing urban traffic control systems. In practice, this has meant that at highly sensitive sites, TM companies are instructed to manually control the signals during the peaks. Officers within the traffic control centres then call the on-site operatives and ask them to adjust the signal timings as required.

This is problematic for the TM companies due to the staffing cost and for control rooms because coordination between the temporary and permanent sets of signals is not possible. There can also be difficulties in getting hold of the on-site operatives when needed.

Therefore, the deployment of portable signals has always caused issues for local authorities, as whilst required to maintain safety at the locality, the knock on effect to traffic flow is ultimately problematic. The TOPAS and HE approved Pike solution facilitates for portable signals to be integrated into the highway authority's

UTC systems and to react and perform as a standard permanent installation (within its limitations), offering a solution to the traffic control team.

Where can they be used?

In Bristol, this type of temporary traffic signal has been considered where either of the following criteria is met:

- The works are on a traffic sensitive road or on a road that will impact onto a traffic sensitive area and are expected to have a significant impact.
- The works will run for a prolonged period, causing disruption for more than a few days.

In addition to the above, in order to manage the signals remotely, staff need access to CCTV to monitor the works area. In Bristol, there are several hundred CCTV cameras which make most of the sensitive areas of the network viable for this type of temporary signals.

Furthermore, this system provides an alternative when considering TM for a junction replacement or refurbishment. When using a 'pole in barrel' system, the existing permanent signal heads are placed into barrels and existing cabling remains in place to power them. This can make the installation of the cabling for the new site problematic.

The use of the Pike UTC temporaries can allow for the old signals and all cabling to be removed from the existing ducting. In some cases, this may allow for the existing ducting to be re-used by the new cabling, where this may otherwise not have been possible. This could reduce cost and works duration.

How it works

On Street:

In essence, the Pike controller has an extra layer of logic, allowing it to be controlled remotely. So instead of an operative on site controlling the signals, the UTC network controls them remotely.

The system comprises three main components:-

- The Pike Evo UTC controller
- The Pike O.T.U
- The telecommunications equipment (3G/ 4G/ ADSL)

Figure 1: The Pike Evo Controller, O.T.U & Communications aerial.

Prior to on-site installation, the controlling authority will have supplied the O.T.U configuration to the TM operatives on a memory stick. This can be completed by the use of a set-up wizard, populated by the control room operator.

The TM operatives will set the signal heads up on site as per the site drawing provided, then will enter the intergreen and minimum/ maximum stage lengths as normal. The only addition to the set-up would be the Pike UTC controller pod or cabinet. The Pike UTC controller will be configured to work as the 'master' unit on site. The usual procedure is that the TM operatives will need to plug in the memory stick to upload the O.T.U configuration. Also, the UTC control button is pressed allowing the site to be operated under independent (VA/local) control or UTC control.

If no commands are received from UTC via the O.T.U, the lights will operate in the conventional (VA/local) manner. Once a command is received from UTC via the O.T.U, the Pike Evo controller will service these commands. If communication from UTC ceases or is lost, the signals will revert back to standard local operation, utilising the timings entered by the TM operatives.

As with regular permanent signals, the UTC system is unable to override any safety critical timings, such as the intergreens or minimum greens set by the TM company. The Evo controller will not service any demands that are in conflict with its' own safety protocol.

The Pike O.T.U receives the communications from UTC via 3G/ 4G or ADSL, then passes these commands on to the Pike controller, which carries out the requests when safe to do so. The Pike controller will then reply to the Pike O.T.U and the O.T.U in turn sends the information back to the UTC In-Station. Due to the monitoring capabilities of the Pike Evo controllers, faults such as lamp/ battery faults/ non conformities with commands can also be related back to UTC.

At the In-Station end:

In order for the UTC system to control the Pike temporary traffic signals, they must be configured within UTC.

The temporary signals are set up as an O.T.U & junction in the usual way within UTC. This involves creating the IP address, bit pattern and other communications information for the O.T.U and the staging and timing data for the junction. This will allow the junction to be controlled using fixed time plans which can be amended on a timetable as appropriate. All of the data required to set up the junction should be on the standard drawings provided by the contractors to both the TM operative and the local authority in their temporary traffic signals applications.

The main differences in setting up these temporary signals are as follows:

- 5 seconds must be added to the all red time to derive the intergreen. It is also worth setting up a tolerance of ±1 second as the junction replies are slightly variable.
- The minimum green for each traffic stage is 12 seconds.
- Temporary signals do not have demand dependent stages. The force bit acts like a force and demand bit, so no demand bits are needed in the bit pattern. Likewise, the plan lines do not contain demands either.
- The Pedestrian green man time is fixed at 7 seconds, with variable black-out and all red time. The information on times will need to be obtained from the contractors. Pedestrian stages are demand dependant, so plan lines will still need to contain the two second 'window period'. The demand dependent decision to change is made in the controller in the first 2 seconds after the force bit is sent to the controller.

It is also possible to set up the UTC temporary signals as a SCOOT node, using existing detectors, or supplementary/ proxy detectors to obtain the traffic flow data required. This will improve the efficiency of the temporary signals by allowing them to respond to traffic demand on street. It may also be possible to insert the temporary signals into the adjacent SCOOT region, so that offsets between the permanent and temporary sets of signals can be established. All of the above is dependent on the characteristics of each site, such as:

- The cycle time required by the temporary signals.
- Whether the temporary signals are replacing a set of permanent signals during a period of works.
- The location of any detection and whether they will be damaged by the works, i.e, will historic data be required.
- The importance of offsets between the temporary and permanent signals.

Limitations of the temporary signals:

The equipment is not designed to replace a permanent installation and as such cannot carry out many of the functions a permanent controller is capable of. This means the signals will be unable to operate right turn indicatives, filters or short intergreens. This solution is designed to offer a cost effective, quick to deploy, simple solution where UTMC integration remains important during disruptive works. As the system is entirely cable free (dependent on the feed to the O.T.U), it facilitates a quicker, less labour intensive solution to the market.

The Pike system works with any compatible UTC system, running full UTMC type 2 communications (FULL MIB/ Time Stamped Data). However, if an authority is using pre-UTMC (Tele-8 and Tele-12) communications, Pike have the ability to use the customers' existing O.T.U and convert the outputs by using a Pike serial card interface. If another communications system is in use, the Pike O.T.U could be made to interface with it dependent on the number of units required.

The trial sites:

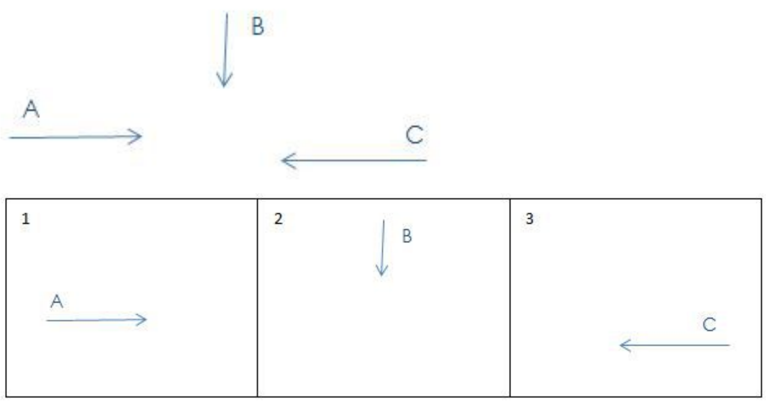
Two trials have been completed to date, these are:

- Victoria St/ Counterslip Junction
- Fishponds Rd/ Alexandra Park Junction & pedestrian facility

A third trial site is in progress at the junction of Coronation Rd/ St Johns Road.

Victoria St/ Counterslip Junction

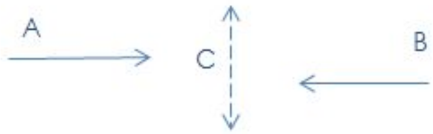
The temporary signals required at this site were a three stage set, with a dual head on phase B, a controller unit and 3G communications. A site schematic is shown below:

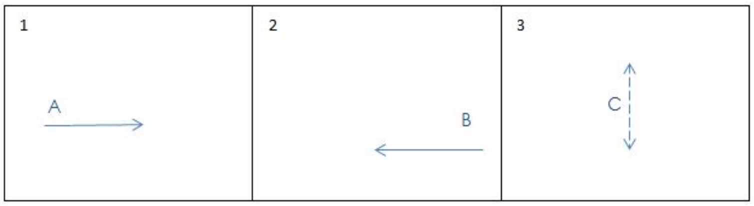


In order to assist pedestrians to cross at the junction, longer intergreens were used, resulting in a high cycle time. For this reason, the junction was put into its' own SCOOT region with a maximum cycle time of 144 seconds. The detection used for the permanent junction at the same location was used to supply detection data to the SCOOT model for each of the three approaches. This meant that the SCOOT model was able to adjust stage splits and cycle times, but not generate an offset with adjacent traffic signals.

Fishponds Rd/ Alexandra Park Pedestrian facility

This site required two traffic stages and a pedestrian stage, as shown below:





At this site, the permanent puffin crossing was switched off and two way temporary signals incorporating a pedestrian crossing were used instead. The site was very close to another junction, making the offsets vital to the efficiency of the signals. Therefore, the site was inserted into the SCOOT model in place of the permanent pedestrian signals. This meant that the maximum cycle time the site could run was 120 seconds due to the other sites within the SCOOT region. The SCOOT model then calculated stage splits, cycle times and offsets for the temporary site.

The Results

Time commitment required by traffic control staff.

The sites took around 15 minutes to set up within the UTC system. After that, the validation data from the corresponding permanent link was entered into the SCOOT model along with any additional parameters needed. The site was then monitored to ensure the model was accurate. This process took a further 15-30 minutes. After this process was completed, the site was left to run and only regular fault monitoring was required. At the end of the trial (which ran for around a month), the changes were removed from the UTC system, which took around 10 minutes.

To manage non-UTC controlled temporary signals, officers at Bristol monitor the sites on CCTV closely throughout the period of works. When any issues arise, staff then contact the on-street operatives and ask for any changes required. The site operatives then make the changes as soon as possible. The close monitoring is disruptive to UTC work, the process of contacting the site operatives takes around 5-10 minutes each time there is a problem, often there is a significant delay before changes can be implemented and frequently, further changes are needed. Furthermore, the work involved in adjusting surrounding traffic signal timings to mitigate the effects of the congestion caused, can take a significant amount of further time.

When comparing the time commitment required for each method of control, UTC control is more labour intensive at the start, but after this, almost no input is needed. For longer term roadworks (of more than a week or so), this makes the UTC controlled method less labour intensive for control room staff.

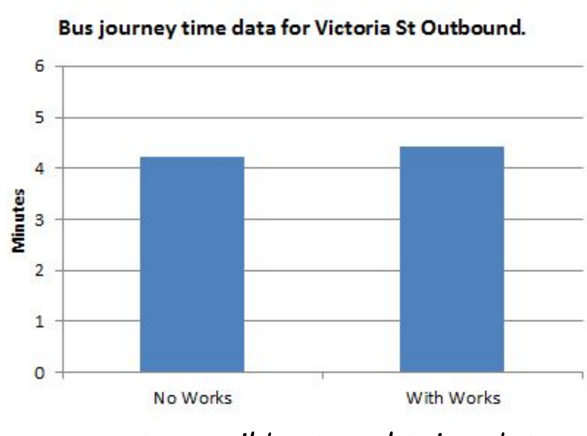
UTC Control compared to Local Control

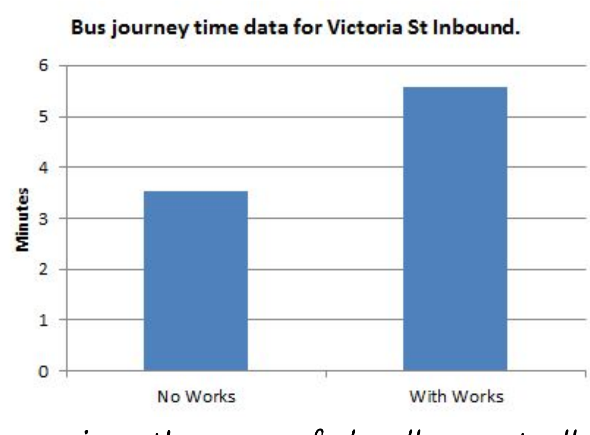
Observations of the trial sites under SCOOT control showed that they did behave like permanent sites. I.e, the cycle times were reduced at quiet times and increased during the peaks, reducing delay for drivers whenever possible. The use of real time traffic data meant that the SCOOT model was adjusting the stage splits and maximising the use of the available green time. This maximised the capacity of the sites and observations indicated that it reduced the level of delay caused by the signals, when compared to local (VA) control.

For the Victoria St trial, some bus journey time data was available. Graphs 1 & 2, below, compare weekday bus journey time data for a period in July 2014, when there were no roadworks, compared to weekday data in July 2015, with the roadworks in place.

The data shows almost no difference in bus journey times for the outbound approach caused by the roadworks. The SCOOT model was set up to bias the green split to the outbound approach, as this approach has in the past caused major delays by exit blocking the city centre area. The data supports that the SCOOT model has effectively managed this. On the inbound approach, bus journey times are increased by around 2 minutes. The temporary signals were operating longer intergreens and a longer cycle time, which reduced the green time available and meant that the SCOOT model was unable to calculate offsets with the upstream traffic signals. For this reason, the site was around 15-20% less efficient than the permanent signals, so some increase in delay was inevitable. The data are displayed below.

Graph 1: Victoria St trial site data (Outbound) **Graph 2: Victoria St trial site data (Inbound)**



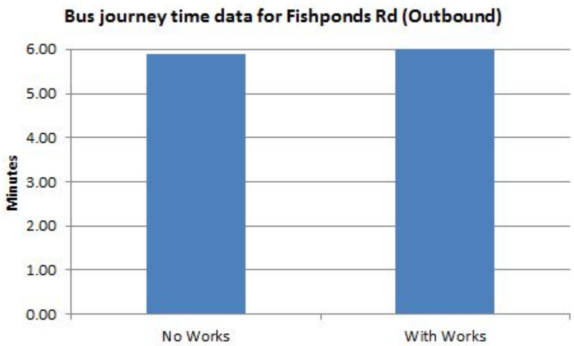


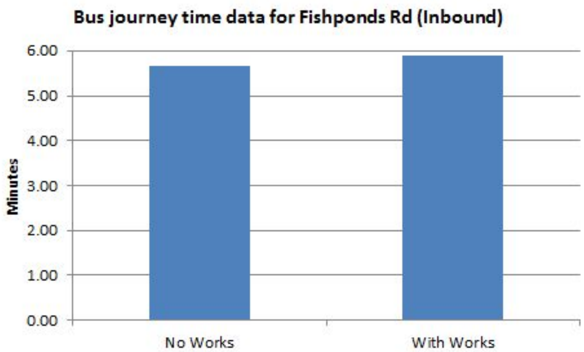
It was not possible to obtain data comparing the use of locally controlled temporary signals with the UTC controlled temporary signals. However, the observations and views of a range of stakeholders were gathered. The service delivery manager for First Bus and the network management officer for the area both stated that the roadworks at Victoria St were noticeably less disruptive than during the previous period of roadworks at the same location, when non-UTC controlled works caused severe delays on both the inbound and outbound approaches.

At the Fishponds Rd site, the ability to run the temporary signals in coordination with the nearby SCOOT junction meant that SCOOT could calculate and implement optimum offsets. Observations showed that when the site was operating under SCOOT control, the offsets were effective and did significantly reduce exit blocking issues, preventing the roadworks area from becoming blocked. Again, SCOOT control maximised the capacity of the signals and was observed to reduce delay caused by the roadworks area becoming blocked by queuing traffic.

ANPR based traffic journey time data were available for this trial site, allowing the impact of the roadworks to be quantified. The average journey time data were compared with the actual data for the period of the works. Again, it was not possible to compare locally controlled temporary signals with UTC controlled signals. The results available showed that over the four day period the works lasted for, the journey time impact of the works was an average additional delay of 18 seconds per vehicle to the outbound movement and 22 seconds per vehicle to the inbound movement. The data are displayed below in graphs 3 and 4.

Graph 3: Fishponds Rd St trial site data (Outbound) **Graph 4: Fishponds Rd trial site data (Inbound)**





This low impact was likely to be partly due to the reduced traffic flows at the start of the school holidays and partly due to the improved coordination between the sets of signals. Overall, on-site operatives and control room staff observed that the UTC temporary signals were noticeably more effective than the usual local control method and made the traffic flow more smoothly.

The ability to manage incidents and issues on the network was also enhanced. During the trials, there were two incidents that caused a significant increase in traffic at the Victoria St site. The SCOOT model detected the increase in traffic and automatically increased the green time of the affected approach, preventing the queue from reaching back to the critical Baldwin St/ City Centre node. Under local control, a significant amount of manual intervention would have been required and there would have been a far greater time delay in managing the problem.

Communications Issues

The method of communications in use needs to be robust, because UTC control is replacing manual control at these sites. This means that if the site becomes isolated from UTC for a prolonged period, an operative will need to be sent to the site to manually control the signals. The time delay and expense involved in doing this is problematic. This is because one of the main benefits of the UTC controlled temporary signals from the perspective of the contractors is that they don't have to pay for manual control. Therefore if the communications fail and manual control is required, the main benefit for the contractors is lost.

The temporary signals trialled in Bristol were using 3G communications which can be problematic for UTC control and initially, there were some issues with the communications. At the Victoria St trial site, which lasted for roughly 6 weeks, there were 8 periods of isolation where the site failed to reconnect and manual intervention was required to bring the site back on-line. At the Fishponds Rd site, which lasted for 4 days, there were two periods of isolation on the first day, then no issues at all for the remainder of the trial.

The 3G issues were examined and a range of different factors were identified. Changes were made to the router configurations and the SIM cards in use. Following these changes, the 3G communications improved significantly. The amendments made to the communications equipment were:

- Router changes that ensured the ping reboot and remote SMS reboot functions were operational. This ensured that the 3G communications can reboot and reconnect without the need for a site visit.
- To use a specialist multi-operator SIM card.
- To use smart cluster software via Mobius networks and Adey electronics. This facilitates the use of this equipment in varying locations, meaning that the highway authority concerned is only required to initially download one operator authentication certificate.

In addition to the router and SIM card changes, a button for restarting the O.T.U was added to the units. This allowed the O.T.U to be manually restarted easily by any operative on site if there was a need.

Finally, there were also two instances at the Victoria St site where the communications between the temporary heads were affected. These issues were sight and intermittent, and would have affected the signals whether or not they were operating under UTC control. When this happened, the signals fell back to local control via an all red stage, as per the safety protocols built into the controller. There were therefore no safety concerns when this happened.

Conclusions & Recommendations

Overall, Bristol City Council's view of the signals was favourable. There was a noticeable reduction in the level of disruption caused by the UTC controlled signals over locally controlled ones. At Fishponds Rd, the coordination between the permanent and temporary signals reduced the impact of the signals dramatically, and at Victoria St, the optimisation of the stage lengths and cycle time improved the efficiency of the signals. Also, it was possible for control room staff to intervene immediately there was a need to, improving the overall efficiency of any interventions required. After the initial set up, the work involved for the control room operator was less than that involved in managing the traffic impact from a regular set of temporary signals. Finally, provided the communications are set up robustly, the signals offered a significant improvement over standard temporary signals.

Bristol's street works contractors also reacted positively to the trials, with a number of on-site operatives stating that the signals offered an improvement over the usual method of control. Contractors were keen to explore the options for using the new technology and reducing the cost of on-site staff. Bristol Water stated that "As part of the Bristol Code of Conduct for street works and roadworks, we are always looking for innovations to reduce the unfortunate congestion our works may cause. Therefore Bristol Water and its contractors were more than happy to be involved in this trial of the Pike temporary traffic signals system that directly interfaces with Bristol City Council's UTC system to manage the traffic flows".

The main issue encountered by the trials were with the 3G communications. However, these issues can be minimised by using multi-operator SIM cards, and by ensuring that the router configurations used are as robust as possible.

Following completion of the trials, Bristol City Council was satisfied that the use of UTC temporary signals is beneficial in terms of reducing delay and improving the management of roadworks. The council has therefore agreed to support the use of UTC controlled temporary signals at appropriate sites in the future.

This type of temporary traffic signals offers a robust alternative to regular temporary traffic signals at problematic sites that are within, or impact on, urban networks.

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