A63 Hull – Temporary MOVA using SRL Urban64 Signals

Highways England had planned significant improvements to the A63 Roger Millward Way roundabout in Hull (Figure 1), which would see it converted from a conventionally signalised roundabout to a signalised hamburger.

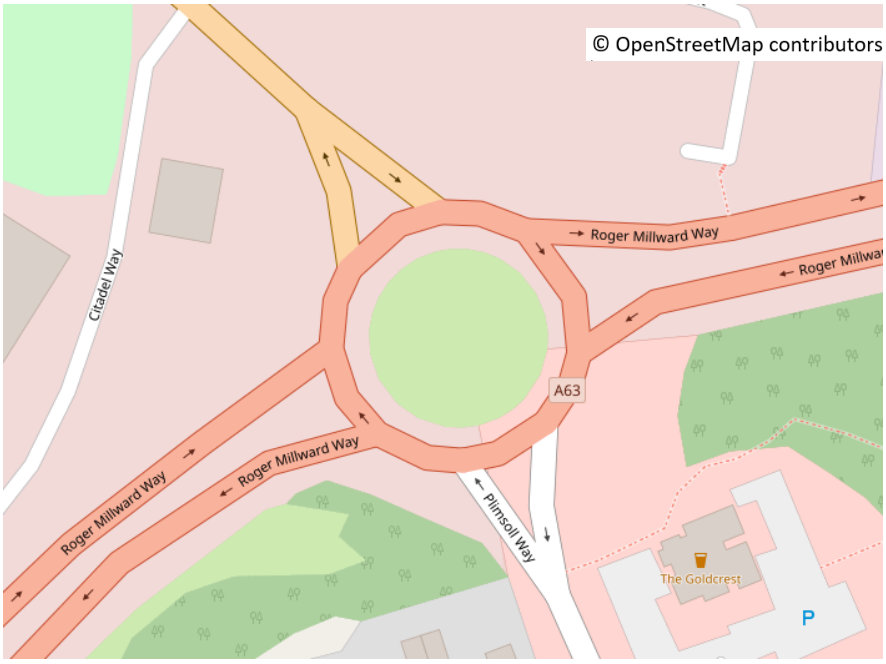

Figure 1 Location plan

In discussions during the early project planning phase, A-one+ (Highways England's managing agent for Area 12), Interserve (the main contractor for the improvement scheme) and SRL (temporary traffic signal manufacturer and supplier) developed the idea of using the SRL Urban64 temporary traffic signal system during construction. Due to the large volumes of traffic using the site, including many HGVs from the nearby port, maintaining proactive traffic control and management, including retaining controlled pedestrian crossings, was critical during construction. The Urban64 signals would allow the existing signals to be decommissioned, clearing the site to ease construction and give a safer way of working.

Through further discussions, the team then developed the idea of operating MOVA control on the Urban64 system. This innovative approach would allow the intelligent traffic signal control benefits associated with MOVA to be brought to temporary signal installations, until now only available to permanent installations.

Highways England approved and funded the proposed project and to turn those innovative ideas into reality, SRL teamed with 4way Consulting to design, install and validate the MOVA traffic signal control system.

This paper expands on the problems identified and overcome at the site, the design features used in the signal operation and highlights the benefits realised from using MOVA signal control at temporary traffic signal installations.

SRL Urban64 Traffic Signals

The Urban64 temporary traffic signal system is more akin to permanent traffic signals than traditional temporary solutions. The signal controller is able to replicate the TR2500/TOPAS2500 facilities utilised by permanent signals, whilst being 'stand-alone' with no below ground infrastructure. See Figure 2.

To achieve this, Urban64 signal poles are installed into dedicated above ground foundation blocks and use above ground cabling from pole to pole. Vehicle detection is achieved using Flir Traficam video detection and a Dynniq Chameleon OTU provides options for UTC connectivity and now MOVA operation.

For further details on the Urban64 system, please contact SRL.

Figure 2 Urban64

A63 Hull – The Site

Whilst a four arm roundabout, originally only the two A63 arms were signalised, with signals on the A63 approaches, conflicting circulatory arms and with pedestrian crossing over A63 exit arms. (See Figure 3 for indicative layout of the original signals). The two A63 approaches operated under MOVA control as independent streams, with some cross stream MOVA linking in operation.

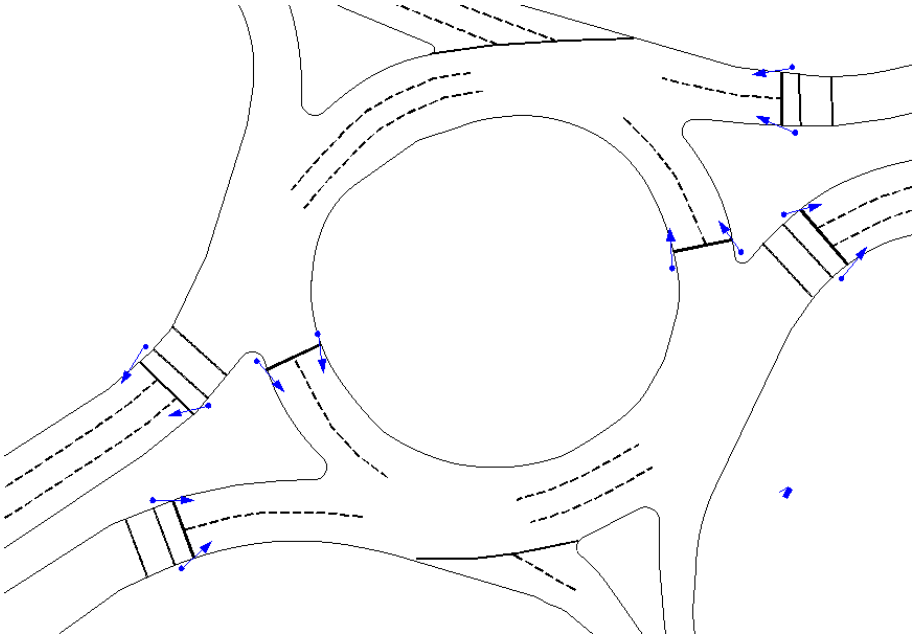

Figure 3 Indicative original site layout

The two side roads joined the roundabout through give way arrangements with the northern side road being noticeably busier than the southern.

The heaviest traffic movements were the east/west movement following the A63, with minimal levels of traffic turning from that road. Destinations from the side roads were more variable, but there was a significant movement from the northern side road, turning right to join the westbound A63. Pedestrian flows were relatively light.

There were a number of known issues with traffic performance at the site, which included:

- Westbound exit blocking in morning peak periods.
- Circulatory blocking, preventing other movements on A63 and causing queues. This particularly affected the north east corner of the site.
- General lack of progression through the signals and general lack of capacity.

As part of Highways England's programme of major improvement works on the A63 corridor, Roger Millward Way Roundabout was to be converted into a 'hamburger' style signalised roundabout to improve the existing junction and relieve congestion.

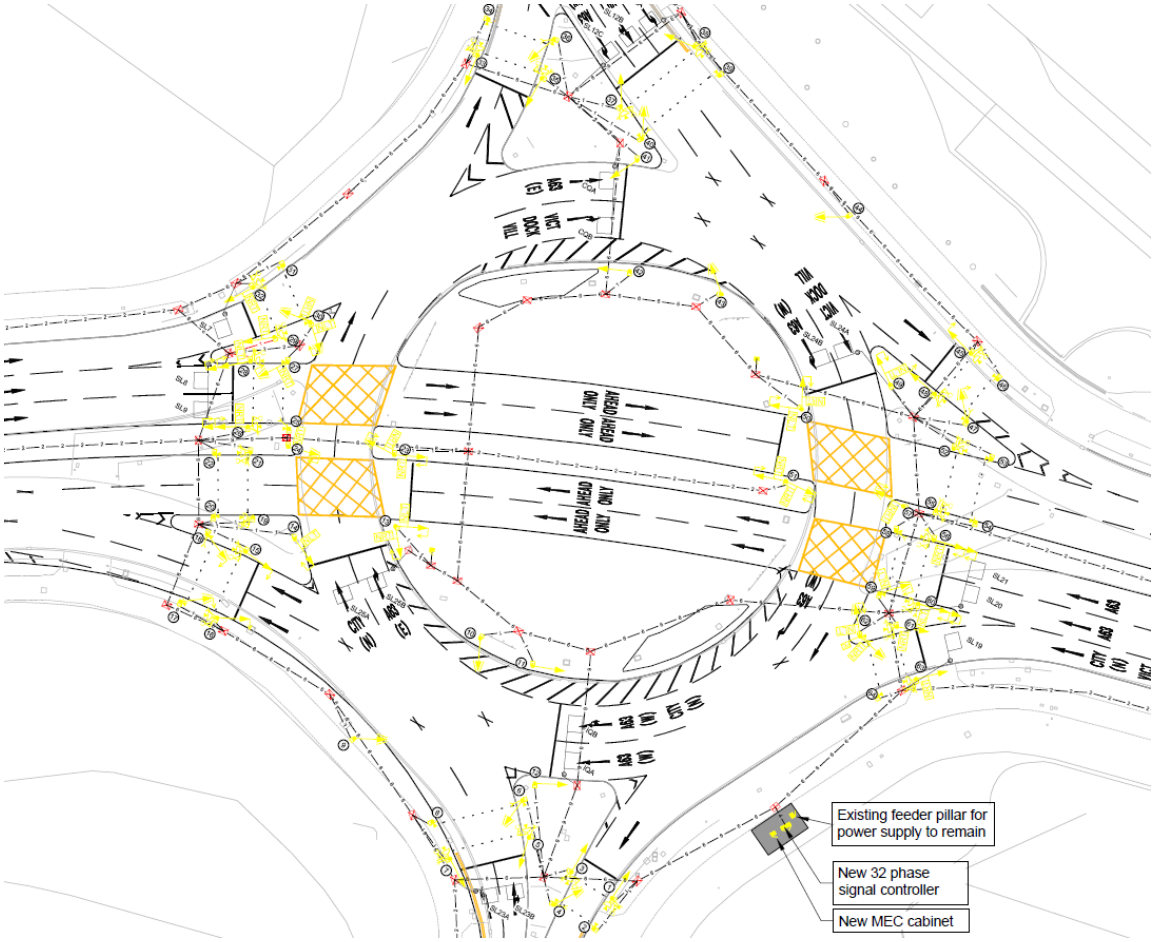

Figure 4 Proposed final hamburger layout

To facilitate construction works it was necessary to totally remove the existing traffic signals and replace them during construction with the temporary Urban64 system. This was planned to be in two phases:

1. Temporary signal layout largely matching original signal layout (only A63 approaches signalised on a conventional roundabout), but with two A63 approach lanes in either direction rather than three.
2. Temporary signal layout largely matching hamburger arrangement, but with two A63 approach lanes in either direction rather than three and with a more limited number of pedestrian facilities.

Phase 1 – SRL Urban64, Mimicking Original Signal Layout

The initial Urban64 installation was designed to physically mimic the original signal layout, signalising the two A63 approaches as separate streams and providing controlled pedestrian movements over both east and west side of the site. SRL installed the Urban64 signals whilst the original permanent signals were still in operation and then a 'simultaneous switch-over' occurred: The permanent signals were switched off and literally 10s later the Urban64 signals were operational, minimising downtime at the site.

During design, the first plan had been to make MOVA operational on the Urban64 signals at switch on and like the physical layout, mimicking the original MOVA operation. However this was quickly discounted, due to time limitations:

The existing controller included significant quantities of complex cross stream MOVA linking that was going to need considerable reverse engineering. The time involved in achieving this and then transferring it to the Urban64 was not available prior to switch on.

Therefore, at first switch on of the Urban64 signals, the site was set to run CLF control, which was validated by the 4way Consulting team.

That CLF validation process released some interesting information about the site that was not previously known:

Whilst an issue with circulatory blocking of the original signals was known, the reasons for it, nor the 'ciritcalness' of the blocking, were not seemingly well understood. During the CLF validation it became clear that the way the unsignalised movements joined the roundabout during gaps was the primary cause of the blocking, as they overfilled spaces available to them. This blocking then led to some queues, which seemingly frustrated drivers and led them to be less cooperative and led to more blocking. Which then led to more queues and so on.

By amending the CLF operation on the Urban64 signals the team were successfully able to control when the unsignalised movements could join the roundabout and also ensure that when they did join, the downstream circulatory was at green to allow them to progress and clear the roundabout. As a result, the circulatory blocking was virtually eliminated.

In fact, the resulting CLF operation was so good, that by local reports and reputation, the performance of the Urban64 signals operating CLF with only two approach lanes on the A63 was better than the previous permanent signals operating MOVA with three A63 approach lanes.

From this, we must be careful not to draw the conclusions that CLF is better than MOVA, nor that the original MOVA operation was in itself poor. Whilst this project did not involve assessing the original MOVA operation, it is thought that it was most likely good at the time of the original validation. It is believed that that original validation took place a number of years previously, possibly during or around the recession when traffic volumes could have been considerably less. Especially with unsignalised movements, growth in traffic and a small number of MOVA detector faults on the original system seemed to have reached a critical point where considerable congestion occurred.

The control system techniques used in CLF could have been transferred into the MOVA operation to give both the flexibility of MOVA with the circulatory queue control developed during CLF. However, for this project, the very good performance of CLF left the Urban64 signals operating that mode and MOVA was never implemented on this layout.

A significant conclusion can be drawn from the above: To get the best performance from signals, the signal control must be appropriate to traffic conditions at that time. Whilst intelligent adaptive systems will give the best opportunity to have good long term performance, over time that performance can deteriorate. Therefore, it is essential that the performance of signals is continually reviewed and where issues arise, the root cause of those issues is established and the signal control amended to resolve those issues. Essentially, time and skill spent getting a technology working properly is more valuable that the specific technology itself.

Phase 2 – SRL Urban64, Hamburger Layout

With construction works progressing, a planned switch over from the conventional roundabout layout to the hamburger layout was needed. Again, this was to be serviced with the Urban64 signals whilst final construction was completed. This time, the switch over between layouts happened during a total closure overnight, as the rest of the entire street-scene was moved over to the new layout.

A few minor 'teething troubles' prevented MOVA operation immediately at switch on, but shortly after, these were resolved and MOVA was operational and being validated by 4way Consulting. From that point forwards, MOVA operated correctly, reliably and responded well to changes in traffic conditions – Basically it worked just like MOVA on a permanent installation.

A second significant conclusion can be drawn: The SRL Urban64 signals can successfully operate MOVA control, and the benefits typically released with MOVA control of intelligent, adaptive control are now available on these temporary signals. [The 'teething troubles' on this project are expected to be a one-off and are now fully understood and resolved.]

To get to the point where MOVA was up and running on the Urban64 did take some planning, as there was one specific need that is not always associated with MOVA control on such sites: Simplification.

For the temporary solution that the Urban64 system is, here intended to be in use for 3-6 months, it was essential that MOVA was to operate well, yet it was also essential that it could be configured quickly and cost effectively, installed quickly and cost effectively and validated quickly and cost effectively. To achieve this need for speed and cost effectiveness, it was essential that the MOVA design was simplified.

To aid the MOVA design for the Urban64, a partial design package for the permanent signals was available for review. This permanent MOVA design showed that the permanent signals were intended to have:

- 28 detector loops, covering IN, X and stop line detection. (This value compares 'like for like' and assumes only two A63 approach lanes. The permanent signal design also incorporates 6 further loops for the third lane in both directions).
- 2 signal controllers.
- An expected need for considerable special conditioning and cross stream and cross controller MOVA linking.

To simplify the MOVA design for the Urban64 it was essential that the design had a greatly reduced number of detectors, only a single controller and with the minimum of special conditioning.

Urban64 MOVA Detection:

The Urban64 signals use Flir above ground Traficam video detectors. The simplified MOVA design for the site called for 6 physical detectors, giving a total of 10 detection zones. This is approximately 40% of the quantity specified on the permanent signals.

IN and X detection was retained on the main A63 approaches, along with single X detectors on the side roads, see Figure 5. No stop line or queue detection was provided at any location across the site.

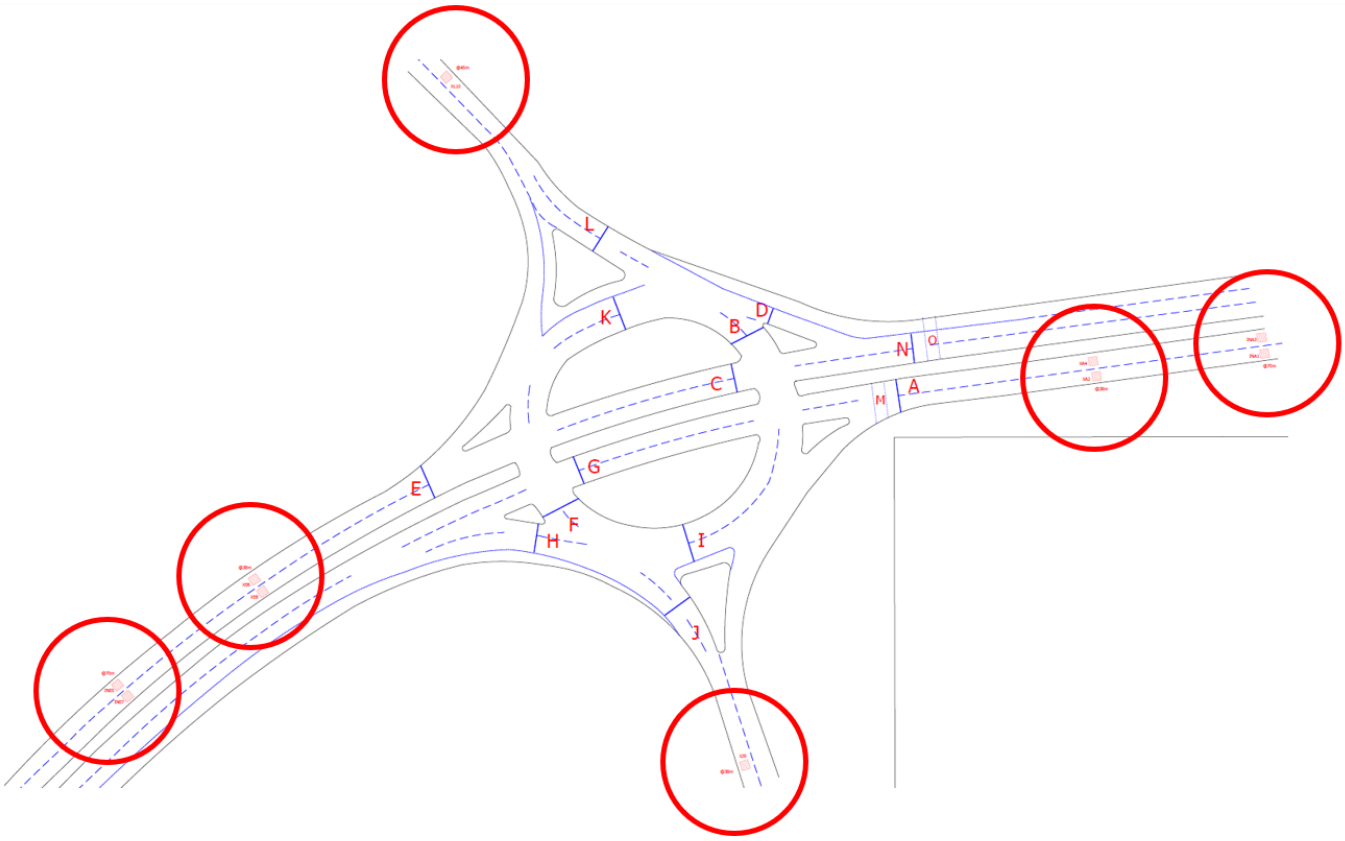

Figure 5 Urban64 MOVA Detector Locations

Urban64 Controller:

A single controller was used, operating a single stream for the main 'heart' of the hamburger and a simple second stream to operate the pedestrian crossing on the eastbound, east side exit of the roundabout.

The use of the single stream for the main hamburger allowed a simplified stage sequence, removing the need for any cross stream linking in MOVA. Figure 6 gives the stage sequence used:

- Stage 1 was the primary east/west A63 stage, at the termination of which, conventional phase delays were used to ensure vehicles cleared the internal roundabout reservoirs.
- Stage 2 was essentially a pedestrian stage, operating only when the eastbound exit side pedestrian phase was demanded. Due to visibility concerns onto the pedestrian phase signal heads (phase N), traffic on the northern side road (phase L) were held at red whilst pedestrians crossed the road. When no pedestrian demand was present, this stage was omitted from the stage sequence
- Stage 3 served two primary purposes: It enables any right turning vehicles from the A63, then queuing on the circulatory to clear (phase B and F) and it enables the side roads (phase J and L) to receive green.
- Stage 4 was timetabled to operate only in the day time, from approximately 06:00-20:00. During these times, the flows on the northern side road (phase L) increase and have a predominate right turn movement, to join the westbound A63. Stage 4 terminates with a number of phase delays, allowing those right turners to clear the roundabout.

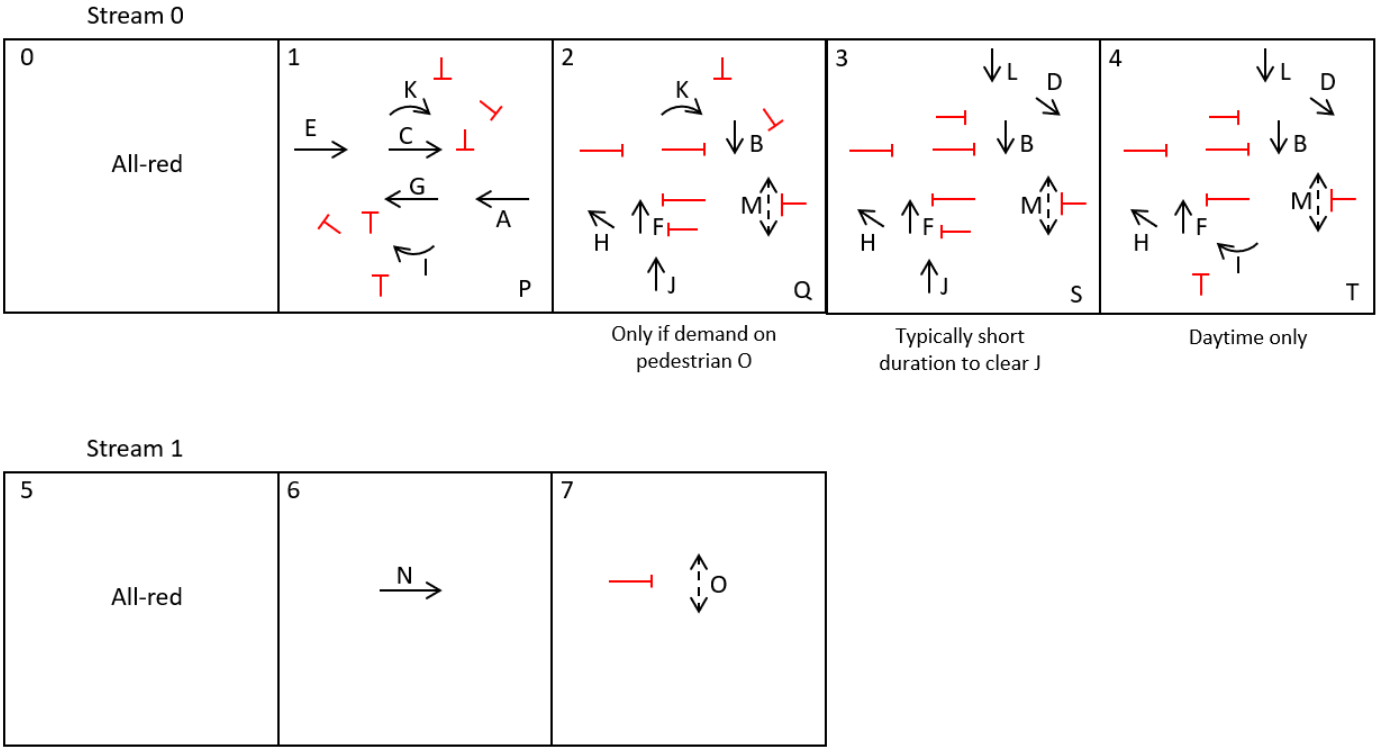

Figure 6 Urban64 MOVA Stage Sequence

The pedestrian crossing stream was controlled via a simple leaving amber link, giving straight forward coordination with the main roundabout at all times of day, with the minimum of complexity.

Urban64 Reduced Special Conditioning:

The use of the (primarily) single stream without MOVA linking meant the level of special conditioning required was greatly reduced. The remaining primary special conditioning functions were:

- To provide MOVA pedestrian wait lamp mimics, a very simple function.
- To provide leaving amber link functionality, again a simple and conventional function.
- To condition automatic stage cycling in VA mode and to provide virtual MOVA detectors to provide the same function in MOVA.

Due to the lack of stop line detection there was a small chance that some vehicles could become 'trapped' at a stop line without a demand being registered. To resolve this, the site was configured to always cycle from one stage to the next. So if the site was in stage 1, it automatically demanded a move to stage 3 (leaving stage 2 to be demanded by the pedestrian phase only). MOVA could then chose the appropriate change point to the next stage. When the controller was in stage 3, it then either automatically created a demand for stage 1 or stage 4 depending on the time of day.

The use of the forced stage cycling could be considered crude in behaviour, as it essentially means that at quiet times when there are no or very limited vehicle and pedestrian demands, certain movements will receive green with no one to benefit from that. Whilst true, the general volumes of users at the site between the very early morning (approximately 05:00) and very late evening (approximately 22:00) means the forced cycle is completely invisible: There are real demands for the stages as well as conditioned. Overnight, the clunkiness was apparent, but the minor downside of delaying a very small number of users by a very small number of seconds (as MOVA would then run unneeded stages to a minimum duration as well as choosing appropriate change points to them) had to be balanced against the positive aspects of the forced cycle: Increased simplicity, reduced cost and the ability to run MOVA. Traditionally, such an arrangement of temporary signals could be running fixed time control overnight, with much longer, fixed green durations.

Overall, the increased simplicity of the MOVA design and Urban64 installation has led to four key benefits:

- Reduced cost in design, installation and MOVA validation, making such an installation more viable for a relatively short period.
- Reduced time of installation, minimising the amount of equipment to be installed.
- Reduced time in validation, as there are a minimal number of MOVA links and facilities to be validated.
- Increased understanding of the system by users (ie drivers and pedestrians) and also the installer and maintainer.

It's also thought that the 'increased simplicity' techniques used could be applied to many permanent signal installations with MOVA too.

Conclusions

The project has demonstrated how the SRL Urban64 temporary traffic signal system can successfully operate MOVA control and how it can be used to reliably provide adaptive, intelligent signal control and release the benefits typically associated with MOVA.

It is anticipated that such MOVA control could be useful at many temporary installations where more traditional signal control may be used, such as VA or Fixed Time. Using MOVA could be anticipated to reduce delays to users, just as it is proven to do on permanent signals.

To achieve this in a cost effective way, with a swift installation and validation process, has meant that much of the complexity often associated with MOVA control on a scheme of this size was needed to be greatly reduced. These Urban64 signals make use of approximately only 40% of the traditional number of detectors for the site and with a single controller and primarily single stream operation, the level of controller special conditioning functions has been greatly reduced.

The project has also shown how spending time to fully understand and correctly diagnose signal control issues can lead to those issues being resolved, irrespective of the technology being used. For instance, here, well validated CLF, appropriate to the site was better performing than the original MOVA on the temporary signals which had seemingly not kept pace with changes in traffic conditions.

Thanks

Thanks must be given to the original team of Highways England, A-one+, Interserve and SRL who developed the concept of operating MOVA on the Urban64 signals at the site. It has proven possible to turn that concept into reality and release the benefits of MOVA to the site and travelling public.

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