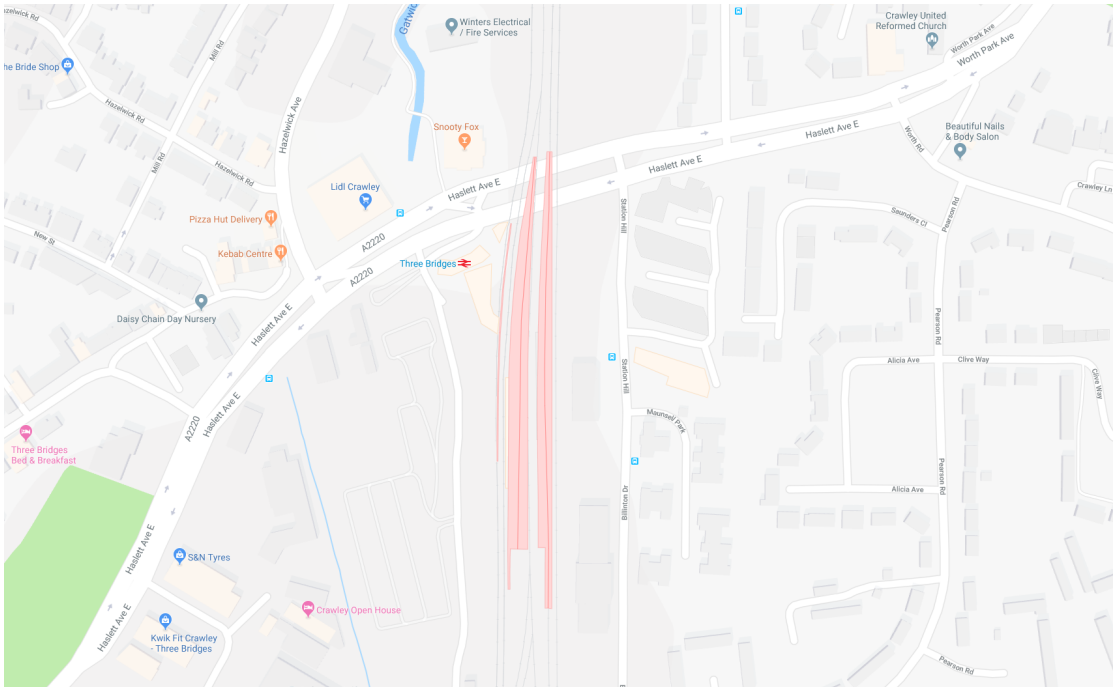
Get Notted!

A Technique for C*orridor Management under MOVA Control.*

Introduction

There are seven junctions in the Three Bridges area of Crawley in close proximity to each other that have been suffering from queueing over the last few years due to increasing demand. WSCC has also received a constant stream of requests for updated pedestrian facilities due to the high volume of pedestrians using the Three Bridges train station. As well as being an important link to the train station It is also a main route in/out of Crawley town and also a highly populated residential area.
Due to these factors, the junctions have very unpredictable demand often with a sudden surge of vehicles and pedestrians running for a specific train, or school drop off/pick up times as well as 'normal' commuter and peak traffic flows. The Corridor has a series of shorter, heavier mini-peaks with almost instant increase in demand which would change daily as opposed to a more predictable flow of vehicles through a longer, less variable and linear peak. This makes it incredibly difficult for the corridor to run effectively and be set up well to cater for the fluctuating and unpredictable demand. Often an initial sharp peak would leave a residual problem so that the next increase in traffic would add to that demand and cause long queues on some approaches.



Integrated Traffic Services Ltd
62 Fruitlands, Malvern, Worc's, WR14 4XA. Registration – 04541812, VAT - 800 2049 90
Telephone – 07966 663503 E-Mail – dan.preece@integratedtrafficservices.com

Previously the junctions all ran under SCOOT control which on the face of it would be the obvious choice as SCOOT has a proven track record of working well when a combination of both adaptive and coordinated control is required. SCOOT was set up and validated by a number of people over the years in an attempt to get a best fit solution and whilst at times the system would work OK it could often struggle due to the dynamic nature of the demand and the issues with the junctions and their proximity to each other. CLF was also implemented, again, this did work well at certain times but not all the time. It would have taken a multitude of plans and some plan selection logic to get close to the level of flexibility required.

As some of the infrastructure was becoming old and there was a need to upgrade the signals and also improve pedestrian facilities due to local pressure. A programme of works was created to upgrade the equipment and look at improving opperation.

Barry Edmunds (TS Manager at West Sussex CC) approached me as he had thought of MOVA control for these junctions. Barry's team and I have had a lot of success in West Sussex with MOVA control. Some of this work was also on corridors where we gained benefits using linked MOVA strategies. As three Bridges was the only remaining SCOOT network in West Sussex Barry was keen if possible to try to replace it with a localised system rather than attempt to enhance it to better control the corridor. I went out and had a look at the sites, I knew the junctions from driving through the area but not well enough to make a good assessment. After spending some time out there I became quite sceptical about putting it under Linked MOVA control. It was obvious that linking needed to be rigid but at the same time the junctions would require a degree of flexibility. Rigid linking across more than 2 junctions can be difficult, it can also be time consuming to setup (in general 2 junctions is easy, 3 is hard and any more than that is asking for trouble!).

Normally for linked MOVA that required rigid linking you would have an output per stage or phase that needed to be linked to drive MOVA detectors with a variety of associated timers, an example of this for a single phase is below.

LK4 = (P) from Phs J, MOVA Det.6
Phase J moving to ROW start delay timer (0s) timer expires set MOVA Det6 for 1 second. Timers are reset when Input goes inactive.

LK5 = (H) from Phs J, MOVA Det.7
Phase J moving to ROW start delay timer (0s) timer expires set MOVA Det7. Phase losing ROW starts hold timer (0s) timer expires unset detector. Override timer (90s) is required, timer started from phase moving to ROW. All timers are reset when Input goes inactive.

The example above is for a single phase, on a junction there would normally be several phases to be linked like the link table shown below.

LK9 = (P) from Phs B, MOVA Det.19
LK10 = (H) from Phs B, MOVA Det.20
LK11 = (P) from Phs J, MOVA Det.21
LK12 = (H) from Phs J, MOVA Det.22
LK13 = (P) from Phs H, MOVA Det.23
LK14 = (H) from Phs H, MOVA Det.24
LK15 = (ST) from Phs D/F, MOVA Det.25

This needs to be included for all nodes or junctions so the list of detectors and timers can build up quite quickly. Whilst this is fine for 2 junctions or perhaps 4 or 5 nodes on a roundabout, when looking at 7 junctions and needing to pass influence between all of them it would be quite a task.

After a lot of discussion Barry talked me into giving it a go and I set about trying to work out exactly how I was going to Link 7 junctions under MOVA control in a way that would be easy to set up on site but still offer benefits and coordinate well. In addition to this we were going to lose a lane at a busy part of the corridor due to some improvements to pedestrian facilities as part of the refurbishment works.

Initial Observations

After spending some more time observing the area and vehicle movements through the corridor it became apparent that most of the issues were caused by the main road (Haslett Avenue) not clearing or being slow to clear. Drivers seemed to be sluggish whilst driving through the corridor. This meant that approaches gaining green would be slow to discharge or the platoon would get caught up with the last platoon and the corridor would become inefficient. I kept coming back to a CLF solution and thought that using MOVA in the off peak with CLF plans switched based on flow or queue triggers would be the way forward. It looked like the main road just needed to run enough green in a coordinated way to clear traffic through each cycle. I thought about how this could be achieved under MOVA control in a simple way and came up with the idea of using MOVA to control the approaches and then initiate a fixed clearance stage to keep the main corridor clear enough to keep vehicles moving. MOVA control but with a synchronised fixed stage.

Design Goals

I set about designing a bespoke system for this corridor based on my observations and came up with a series of desires as follows:

Fully adaptive on all external approaches, cycle by cycle.

Lost time would be recovered from approaches and put back into the main road as clearance.

Main Road should have a coordinated fixed clearance period.

Limit the number of bits between junctions.

Make the system as easy to set up on street as possible.

Junctions should be easily isolated from control as required by TOD or Flow/Queue

It MUST be easy to implement and set up.

The solution I came up with effectively stripped down and flipped upside down more conventional Linked MOVA logic. Instead of having an output for each stage move driven from the stage being at ROW I had the idea to monitor when a single nominated stage was NOT @ ROW. I worked very closely with Dave Lawrence from TCT to get the logic to work correctly. Dave has a massive amount of experience in realising design ideas within controller special conditioning and his input was invaluable.

Logic

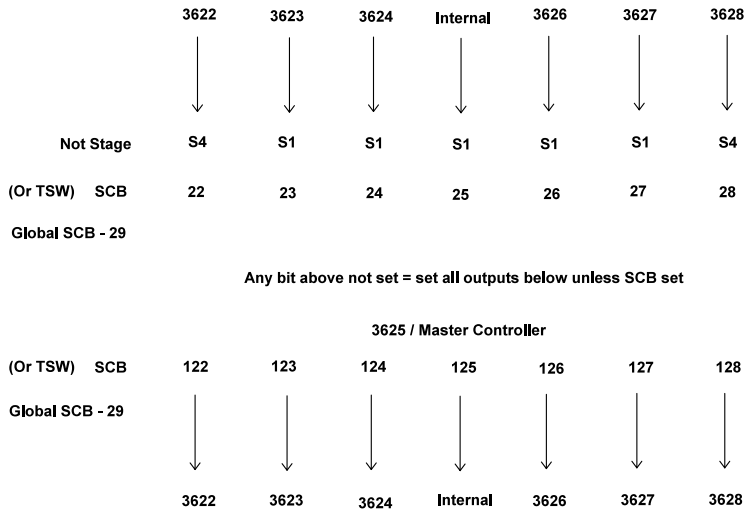
All sites have new Telent ELV Optima controllers configured with integral MOVA V7. The central site (3625) is the master which controls the other six sites. The master has an input from each of the other sites to indicate when their nominated stage is running, and it sends a hold output back to each of them. All linking inputs/outputs are passed (buffered) through the I/O of intervening controllers to aid testing/fault finding, as shown in the linking diagram below.

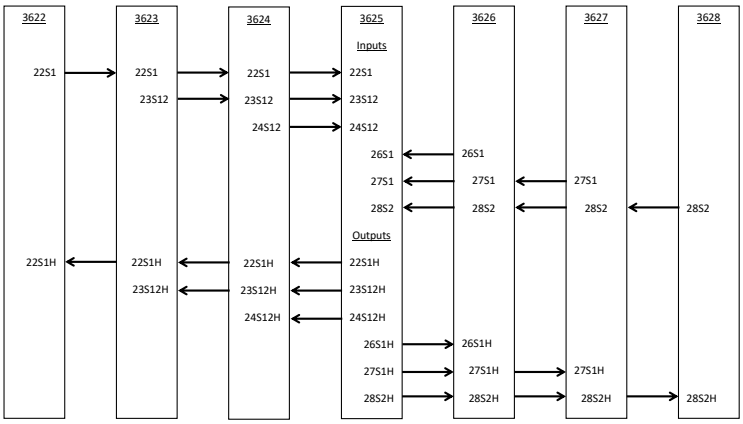
The master controller sends a hold output to each site until all sites are running their nominated stage at which point the output is removed. The linking only operates during MOVA mode so careful consideration was given to enabling individual sites to be discounted from the hold logic, (e.g. when not running MOVA mode or if switched off). This is achieved by setting the output whilst the nominated stage(s) is running during MOVA mode or by setting it permanently whilst not in MOVA mode (this also covers signals off as CRB would be removed). To prevent any potential problems with sites that have no power these outputs are configured as normally closed, open for active. This means that they appear to be running their nominated stage when the controller has no power as all relay outputs go open circuit under this condition.

In addition, the master controller is configured with a number of handset adjustable special conditioning bits (SCB command) and timetable event flags to provide the following:

1. Global disable of all linking inputs (and hence outputs).
2. Disable individual site linking inputs.
3. Disable individual site linking outputs.

When a slave site receives its hold input from the master site a MOVA hold detector is set; a) if running the nominated stage and there are no demands for any other stages OR b) if not running the nominated stage. As the MOVA detector only holds the nominated stage if there are other demands present when the hold input goes active these will be serviced first and when right of way returns to the nominated stage, which has a permanent demand, the hold will be applied. When the hold input from the master site is removed another MOVA hold detector is set for one of two fixed clearance durations, depending on the setting of a timetable flag.





So, we send a bit if it's Not Notted and then when it becomes Notted we hold the Notted stage……

 Simples!!

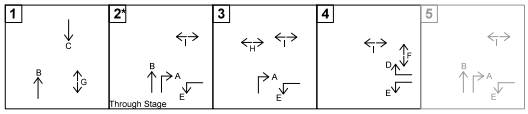
MOVA Linking

OK, so the logic doesn't initially sound that simple, but when you break it down it is actually quite basic. All we are looking at is if the nominated stage (stage 1 at most junctions) is at ROW or not. If it is at ROW then we set an output back to the master controller, if any junction is NOT at ROW to the nominated stage the master controller sends an output to all junctions. When all junctions are at the nominated stage then the output is removed, and a timer is started at each junction.

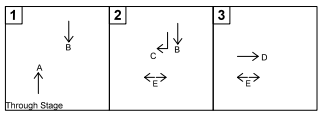
So what is this doing in MOVA? Well that's the really simple part, there are only 2 MOVA detectors at each site to control the linking. One detector holds the stage waiting for all junctions to line up and the next detector controls the minimum stage length of the nominated stages. The Emergency/Priority model in MOVA is used to control the linking as it would in any other linked dataset. The first EM/PR detector at each site is active while the output from the master controller is on and holds the nominated stage. When All stages are in line the second EM/PR detector is active while the timer is running and further holds the nominated stage. This timer is local to each site and can be set independently. PRX MAX value is set high so that the priority hold does not time out if the max time has expired. The use of MOVA and its priority features allows us to run highly adaptive green times on the external approaches but maintain coordinated greens through the corridor. In doing this traffic demand controls the effective staging between the sites. If an approach becomes busy and has a higher green than other approaches require then while it is running its higher green the other junctions are held in the nominated stage once it appears so that the busiest approach or approaches can clear. If green time is consistent between approaches, then clearance is achieved with the minimum nominated stage clearance time. This allows a lot of flexibility where any green time allocated to the approaches that can be recovered is transferred to the clearance stages allowing vehicles to progressively clear the internals until the whole corridor is open and a final clearance can be run.

Three Bridges – Stages

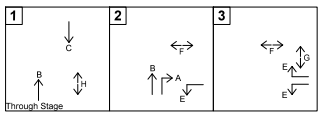
3628



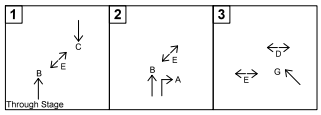
3627



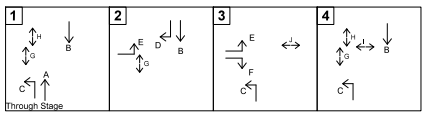
3626



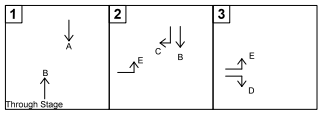
3625



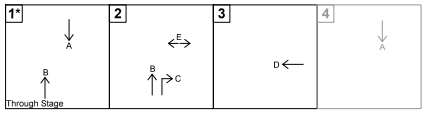
3624



3623



3622



3628 – Worth Avenue

3627 – St Mary's Road

3636 – Station Hill

3625 – Station Forecourt

3624 – Hazelwick Road

3623 – Three Bridges Road

3622 – Stephenson Way

Integrated Traffic Services Ltd
62 Fruitlands, Malvern, Worc's, WR14 4XA. Registration – 04541812, VAT - 800 2049 90
Telephone – 07966 663503 E-Mail – dan.preece@integratedtrafficservices.com

Putting It into Practice.

This was a concept, and not anything that I am aware has been done before. Whilst I had gone over it with Barry, Jamie and Dave and we all agreed it made sense, we didn't know how well it would work in practice. Ideally, we would have modelled the junctions in Vissim and run them up on PC MOVA but this would of taken a lot of programming to emulate the logic. A couple of months after the sites went live TRL released PCMOVA 3 which has MOVA V8, this would of made using Vissim and PCMOVA more viable for this project. MOVA V8 has a special conditioning model built in.

After enabling MOVA on all sites and loading datasets with rough starting parameters we set about turning the linking on between the sites. We initially chose the sites adjacent to the master controller on each side to test the datasets and get a feel for how well it worked. Initial findings were good and linking to the remaining junctions was switched on. This revealed a couple of teething issues with the link cable that was quickly sorted, then we had chance to sit back and assess operation. Everything looked pretty good and the sites were coordinating. It was at this time that I was struck by how easily everything had gone and that I had time to watch operation and think about changes to the datasets. Usually when first initiating linked MOVA sites there is a flurry of activity in setting things up and getting offsets correct. We only had a single timer to think about to control the fixed green duration when all nominated stages are in line. More emphasis is placed on getting stage max times and validation parameters correct. It was essential to set MOVA up to be sympathetic to the overall methodology. Approaches that were less busy were set to be quite aggressive so that the nominated stage could appear sooner allowing the currently busier approaches to clear. Balancing green between all of the junctions was the main task. You really needed to think of the corridor as a whole system.

One interesting finding was that we didn't need a lot of fixed stage minimum other than at the Station Forecourt junction (Master Controller 3625). This junction required approx. 30s of hold time to allow for clearance (Other junctions had between 0s and 15s). This is due to almost all traffic going through this part of the corridor, it is also partly due to the issues with a busy right turn at Hazelwick Avenue. It is at Hazelwick Avenue where the right turn had to be reduced from 2 lanes to a single lane to improve pedestrian facilities. Despite this we managed to improve queueing and operation though it does get busy and blocks back through Station Forecourt at the busiest periods. We did try a couple of things like letting it move through stage 2 which was the right turn when the hold output is present but this effected coordination of the rest of the network, it was better to tolerate a queue back and then manage clearance.

After looking at the junctions and observing driver patterns we decided to include a second alternate stage hold timer that could be altered via time of day. This was so that we could adjust for the tidal flows and stagger the stage holds westbound during the AM peak and eastbound during the afternoon and PM peak periods.

One major change that had to be made was that the clearance was working so well we didn't need the extra clearance stages that were included at Worth Avenue and Stephenson Road at either end. Stephenson Road was changed so that stage 1 was the nominated stage and Hazelwick Avenue (3628) had Stage 2. Stage 2 was chosen at 3628 as Hazelwick Avenue is generally busier than Haslett Avenue. Doing this allowed very good clearance of that approach while the junctions lined up.

Station Hill showed impressive benefit as part of the scheme, along with Hazelwick Avenue this approach used to queue during the peaks. Under the new linked MOVA operation there is no longer any queueing.

The junctions are linked from 06:00 through 20:00. Datasets are switched during the day for Morning and Afternoon operation along with the alternate nominated stage hold timers.

There is still work to be done with adjusting the datasets and stage holds. This will be done towards the end of September following the end of School holidays with traffic returning to normal. This would also have given a few months in which drivers could get used to operation. It is encouraging that as well as our own observations of operation being significantly improved we have also had positive feedback from users in the local area.

Summary

This is an interesting technique that I think will be a useful tool in the box for future schemes. I have already used similar logic on other sites. The logic and basic methodology can easily be adapted for different scenarios and junction layouts.

To be able to link 7 sites under a fully adaptive local system with such ease and using only 1 input, 1 output and 2 MOVA detectors per site extends the use of MOVA to be able to be deployed on a variety of multi-site corridors. There is potential for this to be a problem solver for area's that don't have a SCOOT system but maybe have a corridor with signals that need to be coordinated. It can also be easily deployed using wireless technology as the number of bits required is minimal so buffering between sites is less of an issue.

Whilst easy to setup there was of course still a lot of MOVA validation required. This technique made it much easier to deploy over traditional methods of linking as you could concentrate on green splits between the approaches and normal validation parameters. What is reduced is the time spent worrying about offsets and windows and the margin for error.

Thanks

I would like to take this opportunity to thank the following people that have worked on and given assistance to this project.

West Sussex County Council
Barry Edmunds
James Lightfoot

TCT
Dave Lawrence

Dan Preece