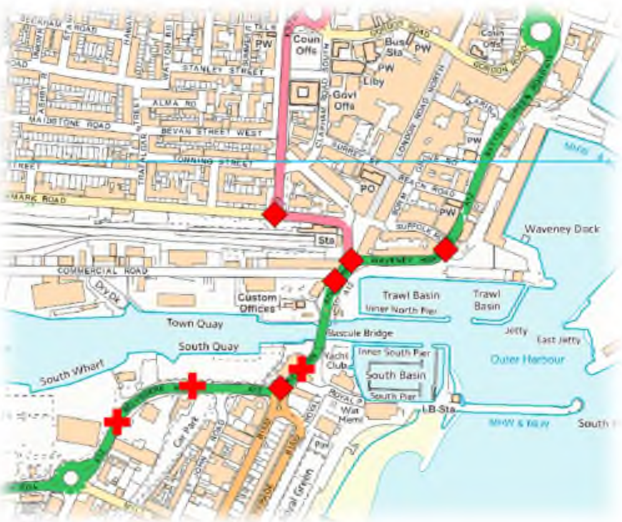
dynniq

Suffolk Highways
your roads, our business
follow us @suff_highways
report a fault highwaysreporting.suffolk.gov.uk
what's happening in my area? https://roadworks.org

Lowestoft Bascule Bridge –

Multiple Data Source and Control Strategy Benefits from Detection in Smart City Environments



Background

Lowestoft is a busy costal town, the north and south of the town are separated by a water way with two road routes crossing it. The busiest of these two routes is the A12/A47, this passes over the Bascule Bridge. To allow vessels to pass under it the Bascule Bridge must raise, these may or may not be scheduled opening. Each opening of the bridge last typically for 5 minutes but can be significantly longer if many vessels are passing or if a very large vessel needs to pass through. There is also a tidal flow system in operation across the bridge.

Situation

There were several issues that we were trying to resolve, but the most prominent was the need to stop the red light jumping at the wig-wags. After this there was a need to run an appropriate local plan at the junctions north and south of the bridge whilst the bridge was up, then a clearance plan once the bridge was back down, thus allowing the buildup of traffic to clear before finally reverting to scoot / local plans. In conjunction with this we wanted to trigger a message on the VMS signs around Lowestoft whenever the bridge was about to raise, this would give motorists an opportunity to consider using an alternative route.

Overview of the solution

The bridge is under the control of specialist equipment to raise the bridge in a safe manner by coordinating the required sub-systems, this is managed by the Port Authority. In addition to the systems required to raise the bridge, a traffic signal controller is used to manage the WIG-WAGS and the tidal flow indicative arrows. In order to isolate the critical control functions, an Intelligent Outstation was deployed to supply bits that could be monitored by external systems, such as fault reporting. The IOUT, in turn was connected to Suffolk's Traffic Management System (TMS) over an IP communications infrastructure which had control and managed the coordination of the surrounding junctions.

Working with the Port Authority it was possible to identify a number of data bits generated at various steps of the bridge raise and lower operation. The first bit (bit 27) is generated when the pumps that raise the bridge are started, this bit has been utilized to triggers stage 5 on either side of the bridge, stage 5 shows a red to all traffic heading towards the bridge and shows a green to traffic exiting the bridge. This bit being the very first bit to be generated in the process, was also selected to trigger an appropriate message on various VMS sign around Lowestoft, enabling driver to consider an alternative route. By using the pumps starting (bit 27) as the trigger for stage 5, the traffic is held back from the bridge prior to the wig-wags starting, this has prevented the red light jumping at the wig-wags.

The second step is triggered by the "bridge raise" bit (bit 8), the detection of this bit is only used by the port authority to trigger the wig-wags and the barriers, there is a fixed time delay between wig-wags coming on and barriers coming down, this is followed directly by the bridge going up. The trailing edge of this bit (detecting the loss of bit) is used by UTMC latter in the process.

The third step of the process is triggered by the trailing edge of the bridge pump bit (bit 27), once the barriers are locked in the down position bit 27 is dropped. The trailing edge of this bit is used to trigger local plans/scoot at junctions north and south of the bridge.

The forth step is triggered by the trailing edge of the "bridge raise" bit (bit 8), the loss of this bit occurs when the barriers are back up and the wig-wags are off. This trailing edge is used by UTMC to trigger recovery plans both north and south of the bridge. The recovery plan operates for 3 min before the strategy in WebOS instructs it to revert to local/scoot control.

There is also a maintenance bit (bit 25), this bit is active when the bridge is in maintenance mode. If WebOS detects bit 25 then the strategy for the bridge process will not run.

Implementation

The platform used to deliver this solution is the ImCity WebOS software. The option of running two separate strategies, one for determining signals operations and the other for driving the VMS signs was given consideration. The two separate strategies would have given the option of not running the vms signs element (turning off that strategy) if required. It was ultimately decided that in the event of the VMS element not being required it would not be too onerous to change an all-encompassing single strategy into two separate ones, consequently one single strategy was used.

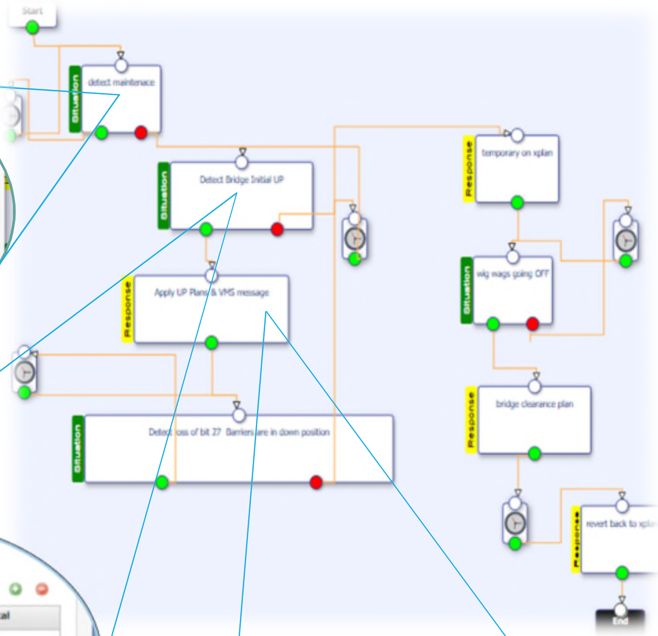
Strategies in WebOS are written using GUI, whereby flow charts are built up by a "drag and drop" function. The flow charts consist of "situation" and "response" elements, the "situation" element is where the trigger point is going to be described and the "response" element is where the required action is going to be described.

Bit Translation

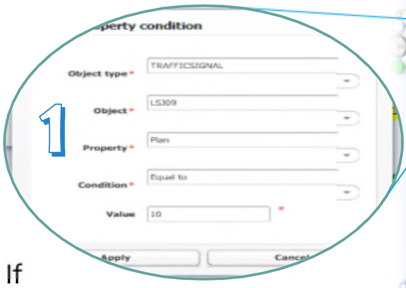
WebOS is unable to read the bits generated by the bridge controller, consequently a "virtual" controller was created (LSJ09). When LSJ09 detects bit 27 it triggers plan No 11, in this sense it is acting as a translation service between the bridge controller and the WebOS platform. By assigning a plan number to each of the bridge bits detected, WebOS only has to look at the "Virtual" controller LSJ09 to see what plan is running, this is then used to trigger the strategies in WebOS. A complication that arises from using this "translation" service (virtual controller) is when the need arises to have two or more bits detected simultaneously. Clearly the controller cannot run two different plans at the same time, to solve this problem an additional virtual controller was added.

Bridge process strategy explanation.

STEP 1 - *Detecting the maintenance bit.*



If the condition is detected, then a "wait" loop is utilized ensuring that the strategy will not run whilst the bridge is in maintenance mode. If the bit is not detected the then the strategy steps through to the next element.

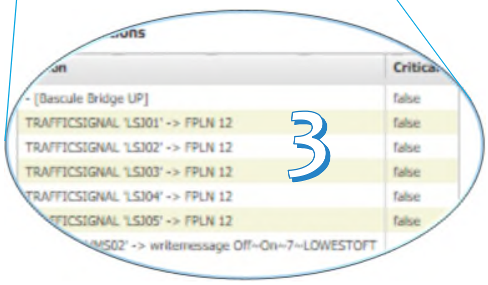


STEP 2 - *Detecting the Bridge Pump bit*

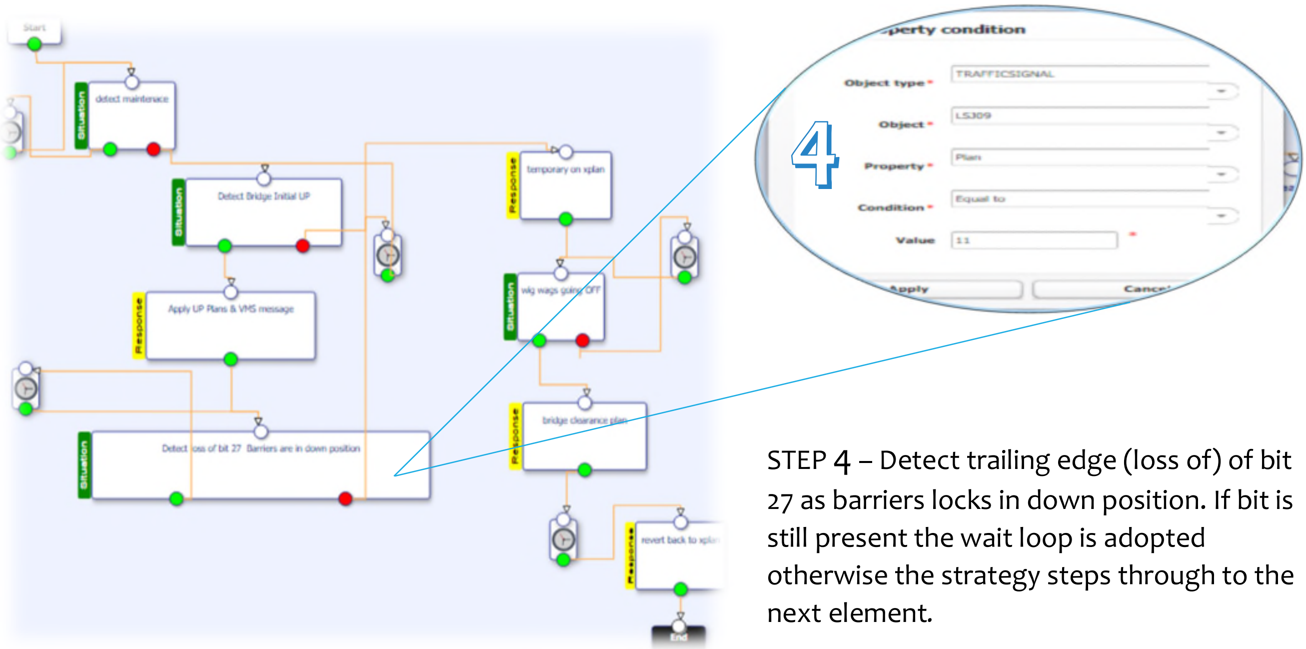
If the bridge pump bit is detected, then the strategy steps through to the next element, if not it goes around a wait loop.

STEP 3 – *Triggering Plans, alert to user and message to VMS*

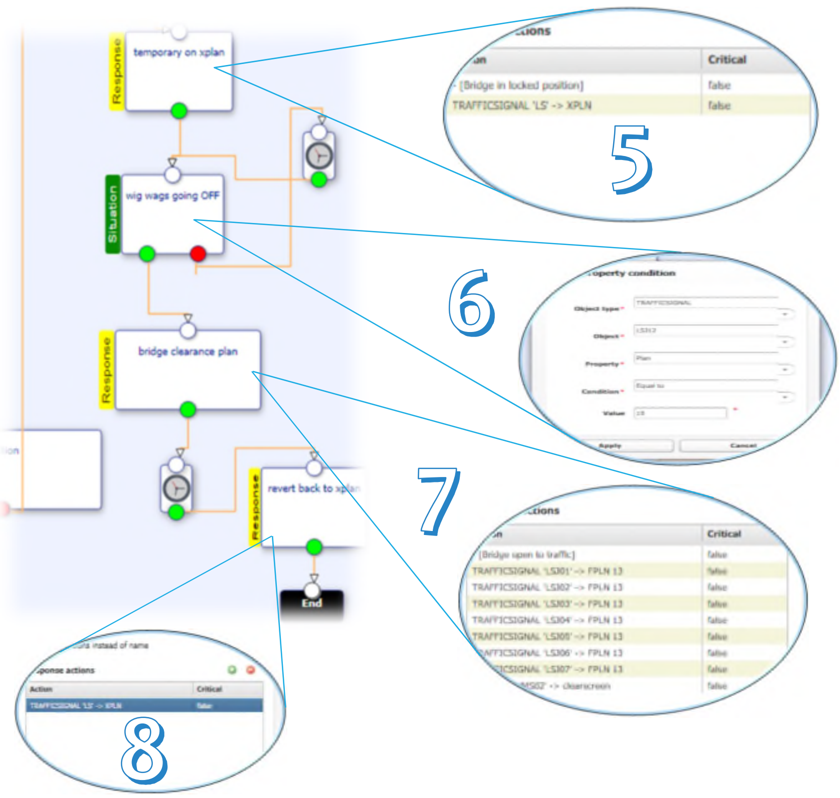
The first line sends a notification to all logged in users, the following five lines instruct plans to run at the associated controllers and the final line is sending a message to the VMS signs.



Bridge process strategy explanation- *continued*



STEP 4 – Detect trailing edge (loss of) of bit 27 as barriers locks in down position. If bit is still present the wait loop is adopted otherwise the strategy steps through to the next element.



STEP 5 – Triggers xplan (normal operation for that time of day) and sends notification to all logged in users.

STEP 6 – Detect trailing edge (loss of) of bit 8 as wig-wags switch off. If bit is still present the wait loop is adopted.

Trigger plan 13 to run in all controllers, sends all logged in user's notification and clears VMS message.

After waiting 3 minutes as determined by the preceding clock element, this response gets the network back to Xplan, that being normal operations for that time of day (typically scoot during the day).

The effect on street.

The moment that the bridge operator pushes the bridge "UP" button, the bridge pump starts and bit 27 is detected by WebOS. It should be noted that the bridge is hydraulic and there is an undetermined amount of time before the bridge starts to raise. There is however a fixed time of 30 second between bit 27 being detected and the wig-wags coming on, depending on where the signals are in the cycle, stage 5 (all red except green exiting the bridge) will be triggered within a maximum of 15 seconds. This leaves at least 15 seconds for cars to clear the wig-wags prior to them operating, in the vast majority of cases this appears to be sufficient time.

The message to the VMS signs, informing drivers of the bridge raise and suggesting drivers consider an alternative route is also triggered by bit 27 (bridge pump), thus enabling the message to be displayed at the earliest possible moment. At present the VMS element of this solution is not operational. Despite getting WebOS to work with a test Swarco sign, it appears the signs in Lowestoft are a latter model and it appears that this might be the issue, we are however confident that this will be resolved shortly. The request to send the message to the signs is built into the WebOS strategy so once this issue has been resolved the appropriate message should appear.

When this was initial set up, stage 5 was held on until the bridge was raised up into the locked position, this was holding all the traffic on red for longer than wanted. Hence the change was made to use the "barriers down" bit to trigger Xplan (normal working for that time of day). When the bridge is up clearly movement is extremely restricted. However, by using the "barrier down" bit any movements that are possible have now been brought forward, whilst still prevent wig-wag jumping i.e. the barriers are now down.

As soon as the bridge is open to traffic (bridge down, barriers up and wig-wags off) a clearance plan is triggered giving priority to the main route north and south, this runs for a fixed time of 3 minutes. The VMS signs are blanked at the same time.

Conclusion

At the start of this project there were three objectives, the most important and in fact the driver for the project was the request from the Port Authority to prevent the wig-wag jumping. The other two requirements were to improve traffic flow during and immediately after a bridge raise, and there was also a requirement to inform drivers of the bridge raise, thus enabling them to consider an alternative route.

As described in the "effect on street" section above the first objective, that being preventing wig-wag jumping has been fully realised, this problem has all but been eliminated.

The aim of improving traffic flows during and immediately after a bridge raise has been implemented as described in the above section. It appears that this is working as expected but further monitoring will be undertaken, and additional adjustment will be made if required.

The final element of this project was informing drivers of the bridge raise via VMS signs. Whilst this is working to the test site VMS sign, there has been complications with sending the message to the signs located at Lowestoft. We are confident however that this glitch will be resolved in the very near future.