AI-Enhanced Traffic Management in Barnsley Using AwareAI

Nick Rule – Principal Engineer, Yunex Traffic

Daniel Ellis – Engineer, Traffic Signals, Barnsley Metropolitan Borough Council

Abstract

This paper describes the deployment of awareAI at two signal-controlled junctions in Barnsley to address operational challenges that could not be effectively resolved using conventional traffic detection technologies. The first application utilised pedestrian classification to provide demand-responsive pedestrian green extensions at a school crossing operating under MOVA control. The second application utilised vehicle classification to eliminate false demands at a heavily pedestrianised town centre location integrated with a security bollard system. Both deployments were implemented using minimal changes to the existing signal infrastructure and demonstrated how AI-based detection can be integrated with established traffic signal control strategies to improve operational performance.

Introduction

This paper describes the implementation of awareAI at two signal-controlled junctions in Barnsley. The schemes were developed to address site-specific operational challenges that could not be efficiently resolved using conventional detection technologies. By leveraging AI-based video analytics, the schemes delivered adaptive control improvements that enhanced the accommodation of vulnerable road users whilst maintaining efficient operation of the wider highway network.

What is awareAI?

awareAI is an AI-enabled traffic detection and control solution designed for traffic signal installations. It uses cameras and edge AI processing to provide functions useful for traffic engineering purposes. Key features include:

- Detection and classification of vehicles, pedestrians, cyclists, buses and other road users
- Supports multimodal traffic signal control through the provision of mode-specific detection outputs that can be utilised within signal controller logic.
- Provides turning counts, vehicle counts, occupancy data, speed measurements and movement tracking.
- Supports bus priority and active travel schemes.

In addition to supporting new traffic management applications, awareAI can be deployed as a direct replacement for many conventional traffic signal detection technologies. Depending on the application, the system can replace or supplement inductive loop detection, pedestrian kerbside detection, pedestrian on-crossing detection, all-red detection queue detection and other above-ground vehicle detection systems. This enables existing signal installations to benefit from AI-based classification and detection without extensive modifications to the existing controller infrastructure.

The system is fully scalable and supports up to six cameras and 32 digital outputs.

Case 1 – Bridgend, Penistone

The first site is a busy T-junction with a far-sided pedestrian facility across one approach. The site operates under MOVA control and is located adjacent to Penistone Grammar School. The site is subject to high pedestrian activity during school term time around start and finish times. Available footway width is constrained, limiting opportunities for traditional infrastructure improvements.

The primary operational challenge was accommodating significant fluctuations in pedestrian demand associated with school start and finish times whilst minimising unnecessary impact on vehicular capacity during periods of lower demand.

Solutions previously considered include varying the pedestrian minimum green time using a timetabled approach. This requires the use of holiday clocks which would require updating at least annually to accommodate changes to the school calendar.

Volumetric kerbside detection was another solution considered. These typically provide three outputs, low, medium or high with the selected output being related to the number of pedestrians waiting to cross. These outputs can then be used within the traffic signal controller to adjust the minimum pedestrian green time. A potential limitation of this approach was considered to be the physical size and positioning requirements of the detection zones within the constrained footway environment. The advantages and disadvantages of the assessed solutions are shown in Table 1.

Option	Benefits	Disadvantages
Timetabled operation	Simple implementation	Requires ongoing maintenance of holiday calendars
Volumetric kerbside detection	Established technology	Restricted by available footway space
awareAI	Dynamic operation based on actual demand	Requires camera installation and configuration

Table 1 - Advantages and Disadvantages of Proposed Solutions

Due to the high pedestrian activity at the site, there was an aspiration to develop a fully automated solution. The traffic signal team at Barnsley is small so solutions requiring minimal future resource were desirable.

Whilst awareAI may initially appear to be a more complex solution than the alternatives considered, the system offers significantly greater flexibility and future expandability. In addition to the pedestrian demand functionality implemented as part of this project, the platform has the capability to provide vehicle detection, replace failed inductive loops, support bus priority measures, deliver kerbside and on-crossing pedestrian detection, provide queue detection and collect classified traffic and turning

movement data. These additional capabilities were considered beneficial when assessing whole-life value.

Solution

The automated solution dynamically adjusts the pedestrian green time during periods of high pedestrian activity. Due to the crossing being far-sided, it was considered preferable to extend the pedestrian green time rather than increase the interstage periods between pedestrians and vehicles. The awareAI hardware requirements for implementation were minimal for this application and consisted of a single wide-angle camera and awareAI rack fitted with a digital output card providing 16 outputs.

Implementation

The implementation comprised four principal stages:

1. Configuration of the awareAI system.
2. Modification of the traffic signal controller to receive additional digital inputs.
3. Amendment of the MOVA dataset to utilise the new demand information.
4. Validation and commissioning of the complete system.

awareAI Configuration

Following installation of the hardware, the awareAI system was configured using the web-based management portal. For this application, two kerbside pedestrian detection zones were configured to monitor pedestrian demand on each side of the crossing facility. Details of the configured zones are shown in Figure 1.



Figure 1 - awareAI Penistone Kerbside Detection Zones

Following creation of detection zones, a series of rules were configured to define the conditions required to operate each output. These rules are fully configurable within the system and can be used on a range of criteria including road user classification, events and logical operators. Multiple conditions can be combined to create more complex detection requirements where necessary.

A threshold of five pedestrians was selected following site observations. This threshold was chosen to balance the provision of additional crossing time during periods of high pedestrian demand while avoiding unnecessary intervention during normal operation.

The rule configured for the south kerbside detection zone is shown in Figure 2. The image on the left shows the detection conditions required to generate an output, while the image on the right shows the digital output assigned and its associated logical state. A corresponding rule is also required to deactivate the output. For this application, the output is cleared when fewer than five pedestrians are detected within the zone, as shown in Figure 3.

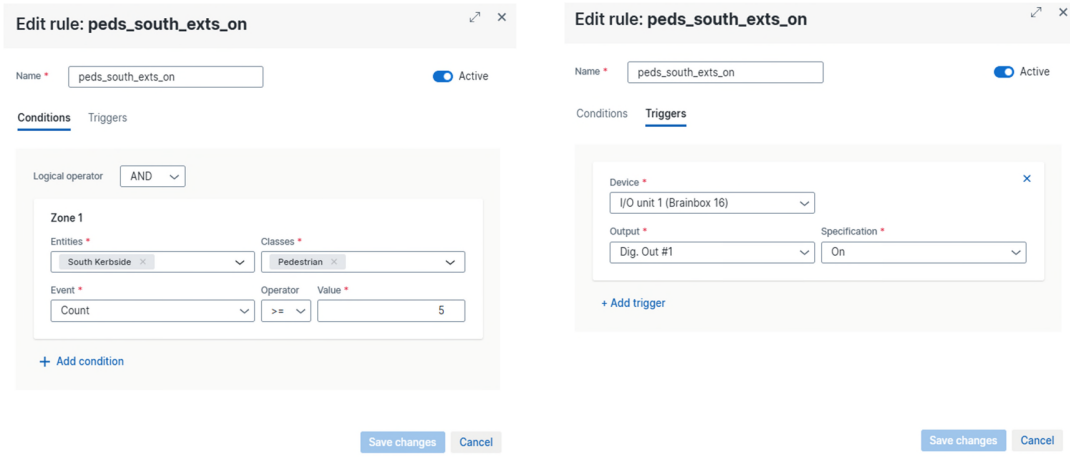


Figure 2 - awareAI Kerbside Detection On Rule

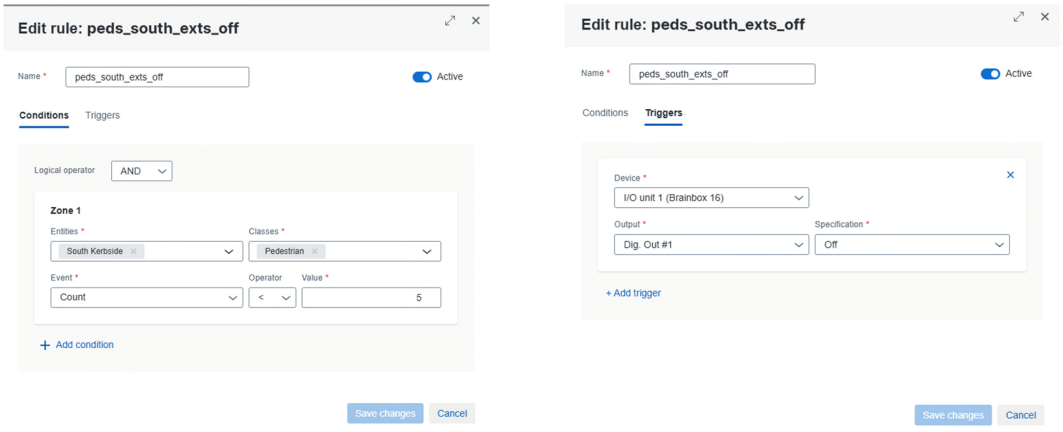


Figure 3 - awareAI Kerbside Detection Off Rule

The configured detection zones and associated outputs were validated using the awareAI validation interface. This provides a real-time view of detected road users, zone occupancy status and digital output states.

Validation activities included:

- Confirmation that pedestrians were correctly detected within each kerbside zone.
- Verification that digital outputs operated when the pedestrian threshold was exceeded.
- Verification that outputs cleared correctly once pedestrian demand reduced.
- Observation of system performance during varying pedestrian demand conditions.
- Verification of corresponding controller and MOVA responses.

The awareAI validation interface is shown in Figure 4.

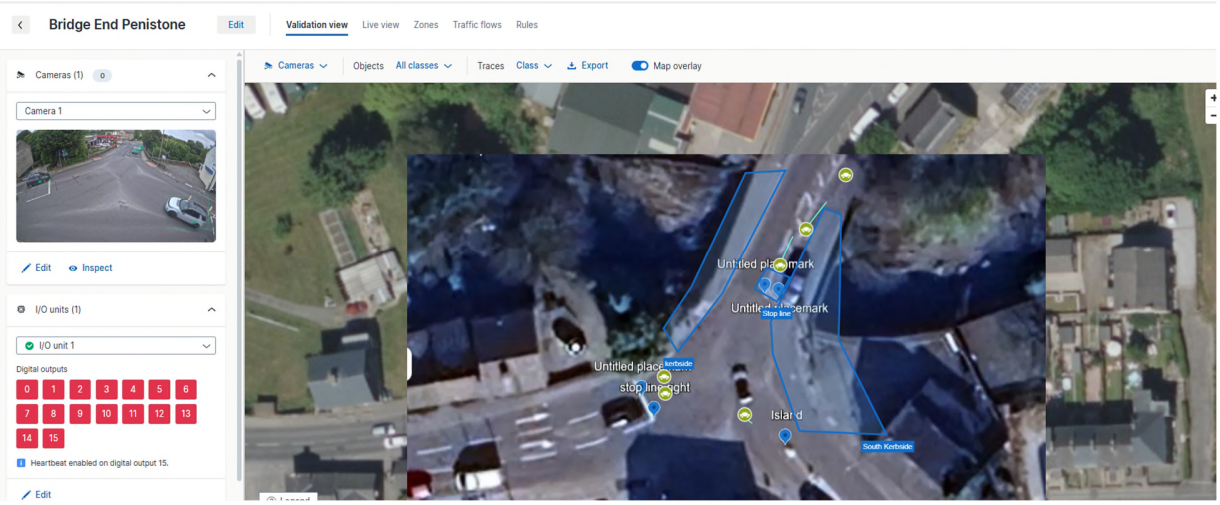


Figure 4 - awareAI Validation Interface, Penistone

Controller Modifications

The site is controlled by an ST800 traffic signal controller. The controller was modified to incorporate two additional inputs configured to receive the awareAI pedestrian demand outputs. The controller logic was amended to allow dynamic adjustment of the pedestrian green time when the configured demand threshold was exceeded.

The minimum pedestrian green time was reduced from 10 seconds to 6 seconds. Under normal operating conditions, the pedestrian stage continues to operate using the standard timings. However, when an awareAI input becomes active, a pedestrian green extension is applied, allowing the pedestrian stage to extend up to its configured maximum time.

Under Vehicle Actuated (VA) operation, the awareAI input directly triggers an extension to the pedestrian green time. Under MOVA control, the inputs were assigned to dedicated MOVA detector channels, enabling pedestrian demand information to be incorporated within the MOVA optimisation process. This allows increased pedestrian green times to be provided when increased levels of demand are detected, while maintaining the overall optimisation of traffic signal performance.

MOVA Modifications

The site operates under MOVA 8 control. The MOVA dataset was modified to incorporate additional priority links associated with the awareAI pedestrian demand inputs. These links were configured with a 10-second hold period, equivalent to the former fixed pedestrian minimum green time. A one-second extension was also configured, allowing the pedestrian green to extend beyond 10 seconds when continued pedestrian demand was detected.

The configured priority links enabled pedestrian demand information from the awareAI system to be considered within the MOVA optimisation process. When the configured pedestrian threshold was exceeded, the corresponding priority input became active, allowing MOVA to provide additional green time where appropriate.

No stage skipping or stage truncation facilities were configured as part of this trial. However, these features could be investigated in future deployments to assess any additional operational benefits that may be achieved through further optimisation of pedestrian and vehicle demand.

A link diagram detailing the MOVA configuration is shown in Figure 5. As shown in Figure 5, links 6 and 7 were configured as pedestrian extension inputs associated with the north and south kerbside awareAI detection zones respectively.

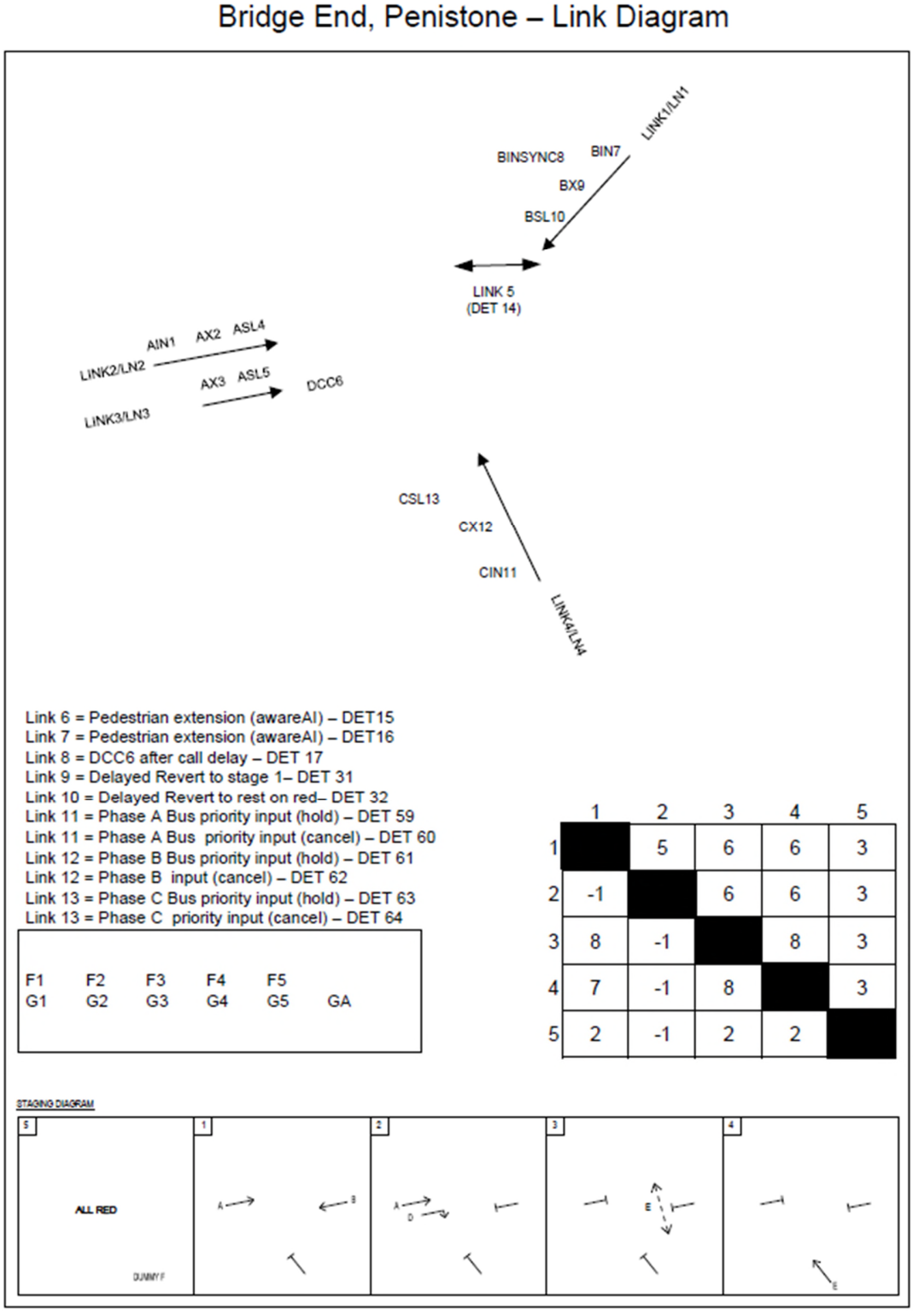


Figure 5 - MOVA Link Diagram

Validation and Commissioning

Following completion of all site modifications, the operation of the system was validated under live traffic conditions to confirm correct interaction between the awareAI system, traffic signal controller and MOVA.

During periods of low pedestrian demand, the pedestrian green time operated at the configured minimum duration of 6 seconds. During periods of increased pedestrian activity, the system responded as intended, providing the extended pedestrian green times when the configured awareAI pedestrian thresholds were exceeded.

Figure 6 shows a period of high pedestrian demand during the morning school arrival period. The image on the left shows the MOVA Messages display, while the image on the right shows pedestrians waiting to cross.

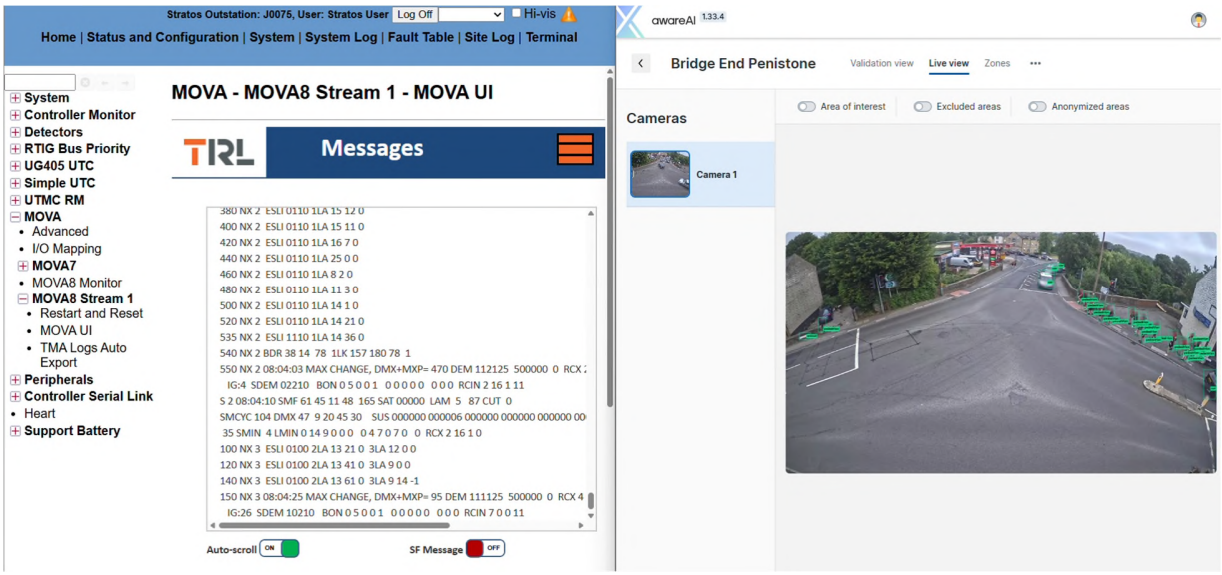


Figure 6 - awareAI Detection Increased Pedestrian Activity

Figure 7 shows pedestrians crossing during an active pedestrian stage. The MOVA Messages display shown on the left confirms that the pedestrian green time has been extended in response to the detected demand, demonstrating successful operation of the awareAI-enhanced pedestrian extension strategy.

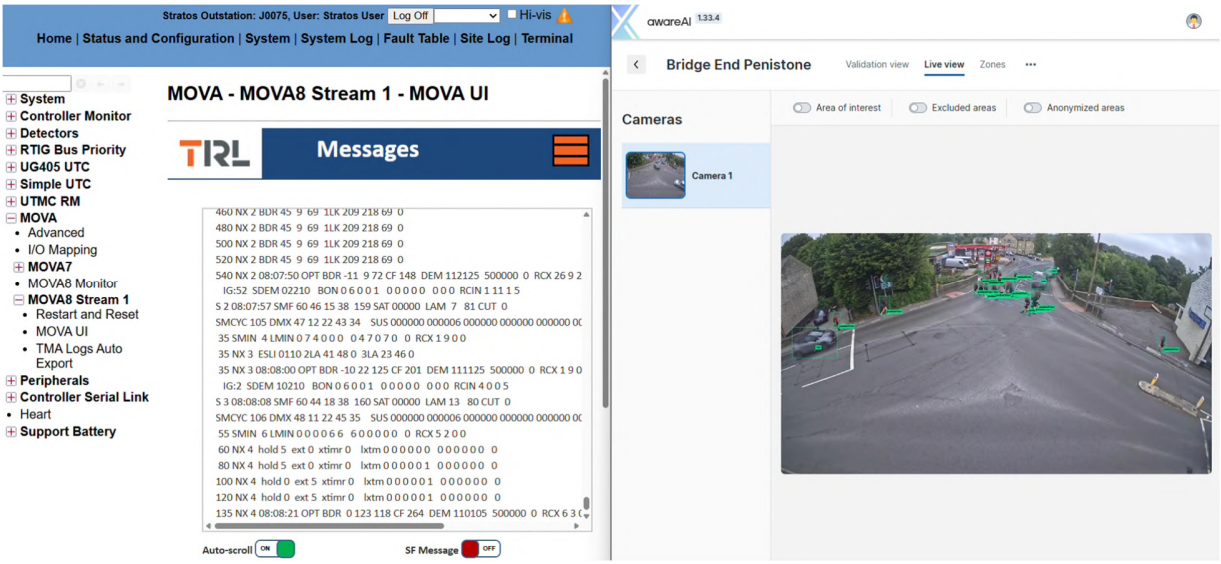


Figure 7 - awareAI Detection Extending the Pedestrian Green Time

The validation exercise confirmed that awareAI pedestrian demand detection operated as intended and integrated successfully with both the ST800 and MOVA. The system was able to maintain efficient operation during periods of low pedestrian demand while automatically providing additional pedestrian green time during peak demand periods. This demonstrated the ability of the solution to improve pedestrian accommodation without reliance on timetable-based control strategies or the installation of additional kerbside detection equipment.

During site observations, the awareAI system consistently identified periods of elevated pedestrian demand and applied pedestrian green extensions as intended, whilst allowing the crossing to operate using the minimum green times during lower demand periods.

Operational Benefits

This trial demonstrated that AI-based pedestrian demand detection can be successfully integrated with existing controller and MOVA infrastructure, delivering a demand-responsive solution without requiring significant changes to the existing signal strategy. The deployment demonstrated several operational benefits:

- Dynamic allocation of pedestrian green time based on observed demand rather than predefined time schedules.
- Reduced reliance on holiday calendars and associated maintenance activities.
- Improved accommodation of school-related pedestrian flows.
- Retention of efficient operation during periods of lower pedestrian activity.
- Provision of a scalable detection platform capable of supporting future applications including bus priority, vehicle detection and traffic data collection.

Whilst this application focused on pedestrian demand-responsive control, the flexibility of the awareAI platform also enables more advanced applications. The second case study demonstrates how the same technology was used to address a different operational challenge through adaptive vehicle detection and signal control.

Case 2 – Peel Square, Barnsley Town Centre

The second site is a traffic signal-controlled junction located in Barnsley town centre. In addition to controlling conventional highway approaches, the site also controls vehicle egress from the town centre market square.

The market square is a heavily pedestrianised area, and as part of a wider package of security measures, a Matador bollard system has been installed to prevent unauthorised vehicle access. The Matador system is directly integrated with the traffic signal controller, allowing controlled egress movements to operate safely alongside pedestrian activity.

The junction is connected to Barnsley's Urban Traffic Control (UTC) system and can operate under SCOOT control. However, due to the generally low levels of vehicular demand, the site normally operates under Vehicle Actuated (VA). This operating mode provides efficient performance under typical conditions.

When the site was originally designed, inductive loop detection was considered unsuitable for the market square egress due to the high-quality paving materials used within the public realm. A radar-based above-ground detection system was therefore installed to detect vehicles waiting to exit the market square.

Whilst the radar detector performed adequately from a vehicle detection perspective, it was unable to consistently distinguish between vehicles and pedestrians within the busy town centre environment. This resulted in frequent false vehicle demands being generated by pedestrian activity around the bollards and the detection zone. A call delay function was included to reduce unwanted activations; however, this did not fully resolve the issue.

These false demands initiated the bollard opening sequence despite no vehicle being present. As the market square demand was configured as an unlatched demand, the demand could cancel before the market square stage was served. The demand was intentionally configured as unlatched to prevent the controller becoming committed to serving the market square under abnormal or fault conditions. Since the bollard closing sequence was initiated by termination of the market square green signal, the bollards could remain open until a subsequent valid demand cycle occurred. The frequency of these false demands increased during periods of peak pedestrian activity, when groups of pedestrians were congregating in the vicinity of the bollards.

Whilst appropriate safety interlocks remained in place, the arrangement reduced the effectiveness of the market square egress control system and highlighted the need for a more reliable method of distinguishing between vehicles and pedestrians.

The issue was therefore not the ability to detect the presence of an object, but the ability to reliably distinguish between vehicles and pedestrians within a heavily pedestrianised environment.

Solution

The primary requirement was to provide reliable vehicle-only detection capable of distinguishing between vehicles and pedestrians within a heavily pedestrianised environment, whilst integrating with the existing traffic signal and bollard control arrangements. The solution also needed to avoid intrusive civil engineering works due to the high-quality paving materials within the market square.

awareAI was selected due to its ability to accurately classify road users and generate outputs based upon specific user types. This enabled vehicle demands to be generated exclusively from classified vehicle detections, preventing pedestrian activity from initiating false calls. In addition, the platform provided a flexible and scalable detection solution that could support future traffic management applications if required.

The solution implemented at this site was simpler than that described in Case Study 1. The awareAI hardware requirements for implementation were minimal and consisted of a single wide-angle camera and awareAI rack fitted with a digital output card providing 16 outputs.

As the traffic signal, UTC and bollard systems were already operating satisfactorily, the implementation was limited to replacing the existing vehicle detection method for the market square egress. Consequently, the deployment comprised only two principal stages:

1. Configuration of the awareAI system.
2. Validation and commissioning of the complete system.

awareAI Configuration

Following installation of the hardware, the awareAI system was configured using the web-based management portal. For this application, a single detection zone was configured. Details of the configured zone are shown in Figure 8.



Figure 8 - awareAI Peel Square Vehicle Detection Zone

Following creation of the detection zone, rules were configured to define the conditions required to operate the output.

As this was a simple case of detecting vehicles waiting to egress the market square, a simple count using a value of one or more vehicles was used. The rule configured for the vehicle detection zone is shown in Figure 9. The image on the left shows the conditions required to generate the output, while the image on the right shows the digital output assigned and its associated logical state. A corresponding rule is also required to deactivate the output. For this application, the output is cleared when there are no vehicles present in the detection zone, as shown in Figure 10.

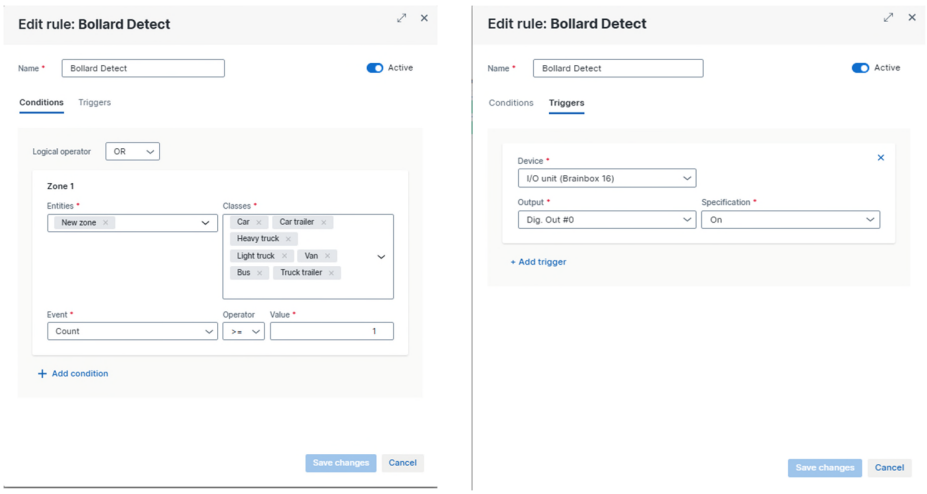


Figure 9 - awareAI Peel Square Vehicle Detection On Rule

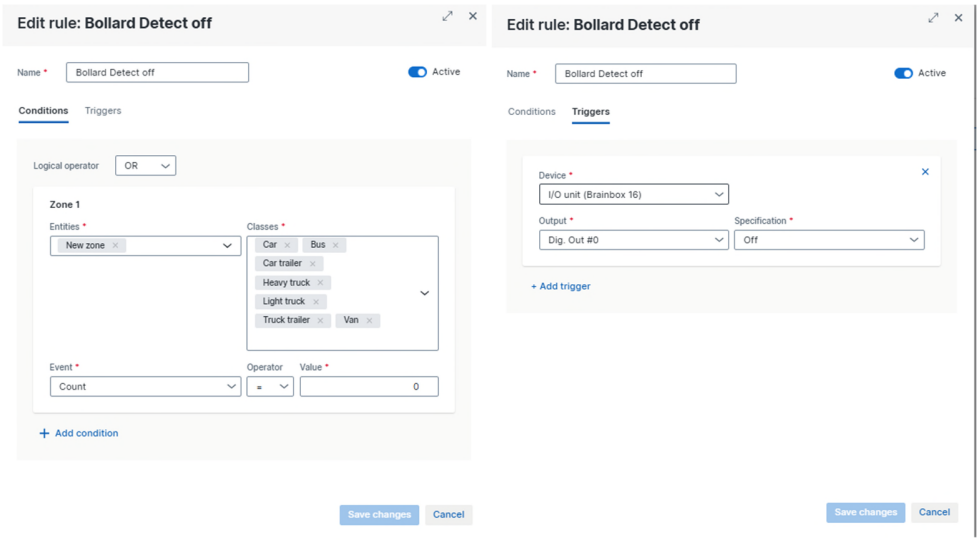


Figure 10 - awareAI Peel Square Vehicle Detection Off Rule

As in Case Study 1, the configured detection zone and associated output were validated using the awareAI validation interface.

Validation activities included:

- Confirmation that vehicles were correctly detected within the detection zone.
- Verification that the digital output operated when activated.
- Verification that the output cleared correctly once vehicles had exited the detection zone.

The awareAI validation interface for Peel Square is shown in Figure 11.

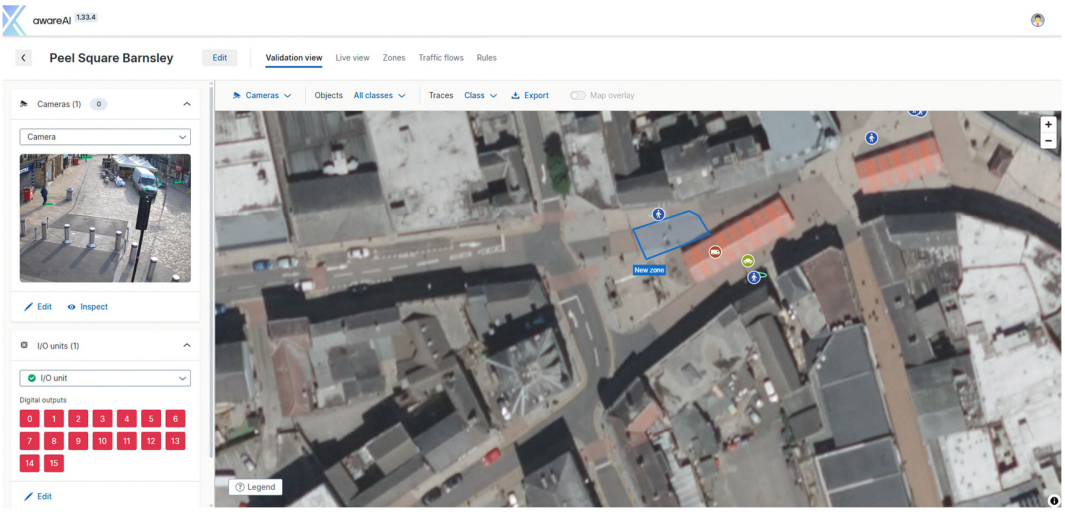


Figure 11 - awareAI Validation Interface, Peel Square

Validation and Commissioning

Following installation of the awareAI hardware, the operation of the system was validated under live traffic conditions to confirm correct interaction between the awareAI system, traffic signal controller and the bollard system.

Validation activities confirmed that vehicle demands were generated only when vehicles were present within the configured detection zone. Pedestrian movements in the vicinity of the bollards did not generate false demands, demonstrating successful classification of vehicles and pedestrians by the awareAI system.

Operational Benefits

The validation exercise confirmed that awareAI successfully eliminated the false vehicle demands that had been experienced with the previous method of detection whilst maintaining reliable operation of the traffic signal and bollard interfaces. The deployment demonstrated several operational benefits:

- Reliable vehicle-only detection within a heavily pedestrianised environment.
- Elimination of false vehicle demands caused by pedestrian activity.
- Improved operation of the integrated traffic signal and bollard control system.
- Retention of existing public realm without the need for intrusive civil engineering works.
- Reduced reliance on detector timing adjustments and call-delay functions.
- Provision of a scalable detection platform capable of supporting future traffic management applications.

Conclusion

The two case studies presented within this paper demonstrate the flexibility of awareAI as a traffic detection and control platform capable of addressing a range of operational challenges that are difficult to resolve using conventional detection technologies.

At Bridgend, Penistone, awareAI was successfully deployed to provide demand-responsive pedestrian control, allowing pedestrian green time to be dynamically adjusted in response to observed demand. The solution improved the accommodation of school-related pedestrian flows whilst maintaining efficient operation of the wider highway network during periods of lower demand.

At Peel Square, Barnsley Town Centre, awareAI was used to address a fundamentally different challenge. By classifying road users and distinguishing between vehicles and pedestrians, the system eliminated false demands associated with a conventional radar-based detection system operating within a heavily pedestrianised environment. This improved operation of the integrated traffic signal and bollard control system without requiring intrusive changes to the existing public realm.

A common theme across both schemes was the ability of awareAI to provide reliable, classification-based detection using a relatively small amount of hardware and minimal changes to the existing traffic signal infrastructure. In both cases, the solution was successfully integrated with established traffic signal control strategies and delivered operational benefits that would have been difficult to achieve using traditional detector technologies alone.

As local authorities continue to balance the needs of pedestrians, cyclists, public transport, security measures and general traffic within increasingly complex urban environments, AI-based detection technologies have the potential to provide a valuable additional tool for traffic engineers. Beyond the applications described in this paper, the flexibility of awareAI provides opportunities for a wide range of future uses, including vehicle detection, bus priority, active travel schemes, traffic data collection and the replacement of ageing detection infrastructure.

Whilst the case studies presented in this paper focused on pedestrian demand-responsive control and vehicle classification, the deployments also demonstrated the wider potential of awareAI as a replacement for conventional traffic signal detection infrastructure. The platform can be utilised to replace or supplement inductive loops, kerbside and on-crossing pedestrian detectors, all-red extension detection and queue detection systems, whilst providing the additional benefit of AI-based road user classification. This flexibility enables local authorities to address both operational and maintenance challenges using a common detection platform.

The deployments in Barnsley have demonstrated that AI-enabled detection can be successfully incorporated into existing traffic signal installations, delivering targeted operational improvements whilst providing a scalable platform capable of supporting future innovation.