**Developments in TOPAS Standards for Detectors**

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Abstract

Detection provides an essential source of traffic information to signal controllers. Historically inductive loops and the early above ground detectors all delivered a single output corresponding to a single detection zone. Traffic control algorithms were developed against this constraint.

New technologies can simultaneously monitor multiple areas or objects of interest and report on all of them. To enable the best use of these detectors TOPAS is developing standards for a communication protocol for detector to controller data transmission, which is currently at the field trial stage, and a standard for assessing the detection quality for multiple areas of interest to ensure users procure the right products for their needs.

## Introduction

Standards for the functionality of products often follow the arrival of such products in the marketplace. In the UK TOPAS, (Traffic Open Products And Specifications), manages a registration process and standards for traffic control and related equipment including detection.

Trends in camera and image processing-based detection and in related technologies such as radar and lidar have made it apparent that the existing UK TOPAS standards for detector performance could constrain the facilities of these new technologies and limit the benefits that they can provide. Accordingly, TOPAS is developing two new standards; one to define an open interface between detectors and controllers, the other to make a more quantified assessment of detector performance.

This paper presents a review of historical detection performance before addressing the current position of these standards and providing an update on their status.

Context

The Existing Standards and Legislation Position

Despite the importance of knowing about traffic on the network, at the international and European levels of ISO and CEN, standards for traffic detection equipment are surprisingly rare. The only known standard is referenced in the TOPAS interface standard.)

More generally the successors to detection standards are standards for self-reporting by connected vehicles. Here standards for reported data are prolific.

Given the migration towards connected vehicles, it is likely that the need for roadside detection will reduce over time, so it is unlikely that ISO or CEN will devote efforts to work in this area.

Recognising this trend the work within TOPAS on detection standards is aiming to support the convergence of data from the roadside with self-reported data to ease the implementation of new network optimisation processes and ensure safety is not compromised. Implementing compatible data formats in roadside equipment maximises the relevance and lifespan of roadside equipment, and aligns data from network users that do not and may never self-report, e.g. pedestrians.

UK legislation is silent on the functionality of detection, so within the UK the highest level of definition for functionality and performance is the four TOPAS standards for detector products. These TOPAS standards each came into being as successive technologies emerged, (often through the as transfer of technical functionality from other sectors). Each detection technology stimulated and so underpinned one or more traffic control algorithms or optimisers, often in response to government policies or initiatives.

How Detectors Shaped Algorithms

As traffic engineers applied each technology, this firmed up the understanding of what each traffic control situation (e.g. VA, MOVA, etc.) required from the detection it was using and so led to a series of requirements for that type of detection. MOVA required IN and X detection, i.e. it needed or was designed to work with small spatially well-defined detection zones placed back from the stop line. Contrast this with detection for inserting a VA demand which can work with a large detection zone close to the stop line, thereby maximising the probability of achieving a detection.

Consequently there are standards for on-crossing detection (TOPAS 2506), kerbside detection of pedestrians waiting at a crossing (TOPAS 2507), vehicles at or close to a stop line (TOPAS 2505) and detection at points at a distance (TOPAS 2512).

This development of standards to provide the data for specific control functions is explicit in the appendices of 2505 and 2512, where requirements for particular uses of detection are laid down.

An unintended consequence of this history is that detector requirements have become entrenched according to the algorithm(s) they support. This reaches back to the very earliest standards for detection. MCE 0100 “Inductive loop vehicle detection equipment” dates to the 1970s. The most recent incarnation, TOPAS 2512 is titled “Performance Specification for Below Ground Vehicle Detection Equipment” but as noted above, it contains appendices for specific traffic control functions. Because of the way these standards came into being they acquired titles and content that was proscriptive and did not encourage experimentation or alternate applications.




*Figure 1 Inductive loops*

Returning to the history of detection standards, while multiple loops had been used for X/Y/Z and VA systems of control and were already defined in TOPAS 2512, new technologies covered the whole space of interest with only one device, and furthermore this required little if any civils work or TM to install and commission and a corresponding standard Performance Specification for Above Ground Vehicle Detector Systems for use at Traffic Signal Installations” came into being. Today this is TOPAS 2505B.




*Figure 2 Above Ground Vehicle Detection*

As technologies other than loops became widespread the DfT urged that users of detection give serious thought to occlusion and other potential ways in which over ground technologies differ from inductive loops. There was particular concern that SD/SA, (and arguably MOVA IN,) detection specifically alters signal timings to minimise the risk of vehicles being in the dilemma zone on approaches to pedestrian crossings and initially these technologies were precluded from being use for SD/SA applications. (Hence the 60m limitation and exception for Scotland in TOPAS 2505B.) Chapter Six of the DfT Traffic Signs Manual has subsequently gone silent on this topic but designs including SD/SA or MOVA IN facilities require careful thought as to the effects of loss of visibility and how the controller DFM responds to detector error.

Titling detector standards by their application and location on the carriageway has limited their adoption. This situation remained manageable while each detector only monitored one zone and provided one corresponding output for any object that it was required to detect that zone.

The advent of multi-object and/or multi-zone detection has led to products where a single detector provides several discrete outputs for different detection functions that can inform different parts of the traffic signal controller or optimiser algorithms.

These detectors have become attractive to users as they offer economies of equipment, spares, etc, and more explicitly opened up possibilities for different ways of monitoring and thereby controlling traffic on the network.

They do however come with their own potential issues. When a detector is dedicated to one specific function then it will be deployed, mounted, commissioned, etc. with that specific objective in mind. When a single detector can service several different traffic-control needs then any configuration or set up that may need to be made to support all those jobs at the same time should not compromise the performance of any one of the individual functions. Further, grouping of multiple functions into one unit does introduce a single point of failure with a larger impact on the operation of the site or network.

Convergence with Connected Vehicle Data

The use of multi-zone detectors places a significant burden on the controller manufacturers as they are often required to implement adaptors and interfaces to take streams of data and extract specific content and present this to the controller. The situation has been compounded in that each detector manufacturer has solved this

problem in their own way, and these diverse solutions are bespoke to the manufacturer, which reduces interoperability, which in turn adversely affects spares, upgrades, training and maintenance on sites that multi-zone detection would otherwise address.

The problem is compounded by the simplicity of the current interface (as defined in TOPAS 2523) between detection and controllers. This interface only allows for the simple message "Does the zone contain an object of the intended type Yes/No? Current detectors can now provide the location of each object, (relative to the detector), its direction of travel, its speed, acceleration or deceleration and other parameters. They also typically assign a unique identifier to each object, classify it and give a probability of the classification. These criteria closely align with the self-reporting by connected vehicles of their trajectory and their own characteristics, thereby keeping open the possibility of roadside detection being fused with self-reported data to enable network optimisation processes that can transition from roadside technology to connected vehicle technology with the minimum of disruption. The interface standard TOPAS 2545 discussed below has this convergence and alignment as one of its basic tenets.

Faults

There is another facet to detection that is already partially addressed by controller manufacturers but is not formalised in TOPAS 2500. Detector fault monitoring historically operated on the basis that if a detector either 'stuck' in the detection state for more than a pre-determined period, or failed to report any events for a different, and typically longer, period, then the controller would mark it as faulty. Faults on safety-critical detection such as SD/SA might be latched for investigation, while other faults can be cleared if detection resumes, BUT while the fault is present the absence of good detection compromises the algorithmic processes trying to get the best operational efficiency from the network leading to reliance on historical data or other compromises.

For inductive loops, where failure modes tended to due to cable breaks, so detection is usually lost once-and-for-all in a single event, this fault monitoring and response was an effective strategy. It has worked tolerably well with single zone detection, albeit short term occlusion is not accommodated, but the loss of power to a multi-zone detector can be substantially worse for the control of the site as many sources of data could be lost simultaneously. The implementation of a new protocol for communication between detector and controllers opens up ways to report degradation of performance for pre-emptive maintenance, thereby reducing the risk of loss of detection and consequent loss of optimisation.

To get the best from the current generation of detection the standards need to provide an understanding of, and then challenge, how well multi-zone detection simultaneously detects across many zones AND it needs to have a single open way of getting not just

the detection data, but also all the other content that these detectors can report, back to the controller.

Configuration

As with any new technology, the benefits don't come without some level of effort. Any detector that is covering multiple zones also has to be configured for the specific location where it is deployed. While TOPAS is not currently addressing the standardisation of detector configuration, users should be aware of the implications on information management and maintenance processes of necessarily having a site-specific configuration in a detector. In the event of a detector failure a replacement unit of the same type has to be installed in the same place, with the same orientation and with multiple other parameters correctly set. If a different product is used as a replacement then the full installation and commissioning process will need to be undertaken. There is scope for manufacturers and other interested parties to put effort into reviewing this problem and considering possible mitigations, perhaps through a process of learning and self-calibration. However, this topic is not in-scope for this paper.

The Difference Between Sensing and Detection

The last general point that warrants coverage is the difference between what a detector can 'see', and what it then reports. A detector may well be capable of sensing vehicles out to 150m, but if it is configured to only report vehicles out to 60m then the ability to sense further and to decide what it needs to report i.e. what the controller thinks has been detected is good as it means the detector has probably monitored the vehicle for 90m gaining in confidence that it is indeed a vehicle before reporting this to the controller.

The New Standards

Several years ago TOPAS recognised the problems and issues that the burgeoning range of detection was causing and initiated the development of two new standards with the aim of achieving:-

a) interoperability and open interfaces between detectors and traffic signal controllers (TOPAS 2545)
   and
b) Classification of how well multi-zone detectors achieve detection of different objects at different locations on the street at the same time from one device optimally located at the roadside. (TOPAS 2547)

This paper will now report on the scope of each of these standards, how their objectives will be validated, and what this means for the design, procurement, deployment and

support of detection on the network, or more succinctly “what detectors can see and how they tell the controller”.

What Detectors Can Detect and How Well They Do This - (TOPAS 2547 Performance Classification for Detectors)

The advent of new technologies may remove or reduce some of the constraints of earlier solutions, but they also bring with them their own issues.

For multi-zone detection, one of the attractive features is the ability for one detector to deliver multiple streams of traffic data from multiple zones. However, a detector that is mounted optimally for say on-crossing detection may detect buses at 100m poorly or not at all because it has not been set up to look in the right direction or only has a small part of its total image, radar view, or LiDAR scan (to name a few) covering the region of interest.

Put another way, if only 1000 pixels of an image cover a zone compared to 2,000,000 then it is likely that the 2,000,000 pixel zone will give data that allows better decision making and detection.



*Figure 3 Puffin Crossing Showing Vehicle, Kerbside and On-Crossing Detection*




*Figure 4 As Figure 3 but seen from a single camera/detector (left) and diagrammatic extracted content (right)*




*Figure 5 Detail from Figure 4 showing reported parameters*




*Figure 6 Typical Scope of Coverage and Extent of Information to be Reported from a Video Detector*

The key point about multi-zone detectors is that, to be useful, they must capture the presence and other characteristics of all the objects simultaneously for all locations in their field of coverage at an acceptable level of performance.

Accepting that no detector achieves 100% detection nor can deliver complete rejection of unwanted clutter then the challenge is to set acceptable levels of performance and then show that these are being met.

Existing Detection Technology Performance

Up to now the detection standards have used terms like “Must Detect”, “May Detect” and “Must Not Detect” to provide a level of spatial tolerance on zone boundaries, and set speed criteria or size criteria for the objects to be detected. These absolute definitions do not align well with real-world data. Real-world data ground-truthed to a human observer checking video suggests many detectors run at ~80% detection accuracy. Technology to technology comparisons often show both over- and under-counting (when compared with each other) at different times of day and under different traffic conditions, suggesting the two technologies (to name but one case a ‘simple’ radar and inductive loops) are both prone to substantial error and this error depends on specific circumstances, so cannot be corrected by a simple weighting factor.

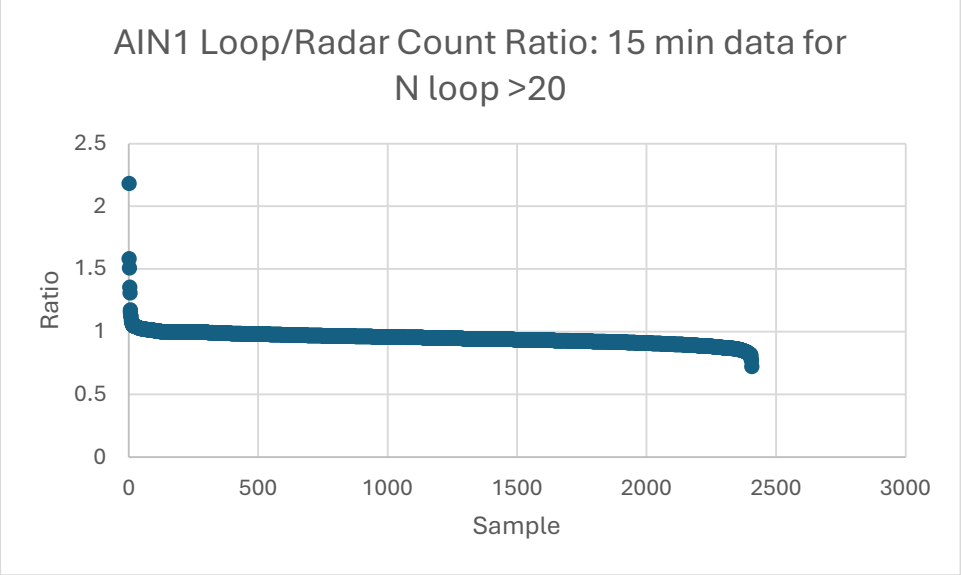



*Figure 7 Comparative Detector Performance Showing Over and Under Counting Ratio*

Recognising these factors the forthcoming standard TOPAS 2547 "Performance Classification for Detectors" differs from many TOPAS standards in that it defines a test method. This method comprises of

- A set of requirements for the test location
- A set of criteria for the levels of data to be gathered
- It defines the pass-fail criteria
- It provides a process for capturing the reference and device under test, data and securely generating pass-fail flags for us in TOPAS registration applications
- And it shows how detector registrations will appear on the TOPAS register.

Standardising the test process and performance reporting allows users a meaningful way to compare different detectors.

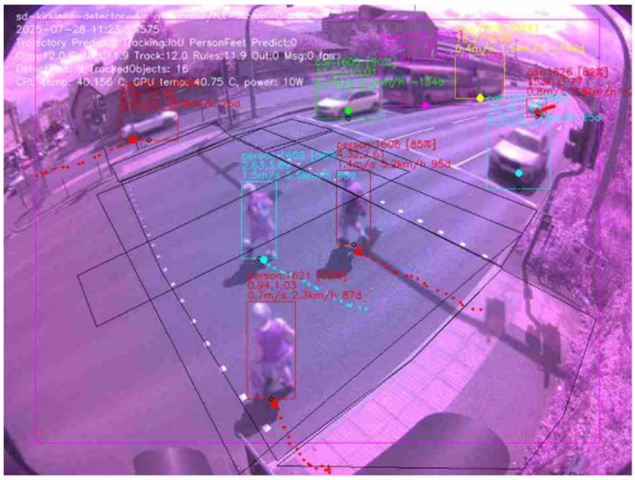


*Figure 8 Processed Detector Output showing object type and confidence of identification, recent trajectory.*

It is important that all testing is performed to the same minimum levels and has statistical validity. Five minutes on a dry May day is not a rigorous test. Six weeks of testing spread across day and night, in all weathers with minimum numbers of test objects having to pass by, offers more confidence. Accordingly, the test criteria below identify the minimum number of vehicles of each type that have to pass through each area of coverage where detection is intended (detection zone) in order to develop a sufficient level of statistical confidence in the performance. Furthermore, the detection rate and false detection maximum acceptability criteria both have to be met throughout the test period. These factors are examined further below.

Trial Sites

It is not the intention of TOPAS that there can only be one test location, so the standard dedicates a substantial amount of content to defining the criteria of a test location: Flat straight approaches with little clutter, cycle lanes and ASLs, pedestrian facilities, indicative right turns. That is, the relative locations of signal poles and other typical detector mounting locations relative to the spaces with the vehicle and pedestrian traffic travel are stable and well defined and likely to be common at many other sites. There are sufficient sites that are likely to meet the criteria that many local authorities could, if they wished, identify a site that could be used for testing. For example, on the approaches to Lincoln there are two candidates. Newark Rd/Station Rd/Moor Lane and further in Newark Rd Tritton Rd.

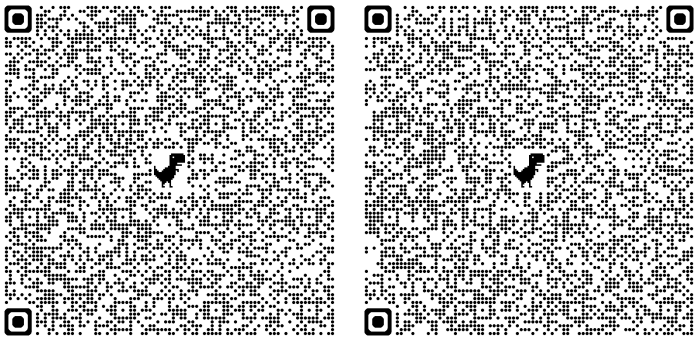


*Figure 9 QR Codes for Street views of Candidate Trial Sites Newark Rd/Station Rd/Moor Lane and further in Newark Rd Tritton Rd. Lincoln*

Walcot Terrace and Cleveland Place in Bath is also a workable candidate.

The assessment process defined in the standard requires that the location, mounting height, and orientation of the detector are captured as is the configuration file for the detector. This is saying that, when the detector is placed and set up in the specific way identified in the technical file then it can achieve these levels of performance.

Trial Site Data Gathering

The methodology requires that a reference system of detection is also deployed at the site. This is the 'ground truth' against which the detection rates and other performance criteria of the detector being assessed will be measured. The ground truth processing is accessed by the applicant during their own product development process, and when they are ready to start a test run they initiate a test process that generates a uniquely identified set of results to TOPAS so the results that they provide to the Technical Assessor as part of their registration can be verified as those from the test period. Various issues of GDPR etc. are also managed for the test process.

Performance Thresholds

The other part of the standard relates to the setting of performance criteria. This is based on the current use cases of detection. For each use case the types of object that are required to be detected are specified, and the level of detection, range of operation, and levels of false positive detection (i.e. getting a detector output when no object is present) are all defined.

The current values for performance thresholds for different use cases of detection are shown in Table 1 below. Examination shows that the criteria for more disruptive events such as emergency vehicle detector are set at higher thresholds than detection of general traffic. To miss one emergency vehicle has substantial negative outcomes as does falsely detecting and reporting an emergency vehicle that is not there. By contrast failing to detect one vehicle in a platoon while seeing all the others, or report an additional vehicle that is not present to an existing platoon is far less disruptive, so the detection performance criteria are set lower.

The intention in presenting the performance in this way is that

a) It supports users and designers to identify which detectors are able to provide inputs to existing traffic control processes and
b) It allows future instances of the standard to be extended to accommodate new use cases as these emerge, stimulated by new technologies.

| | | | DETECTION THRESHOLD VALUES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Object Type | | | | | | | | |
| Item | Traffic Function/Controller Facility Requiring the Input | Function Detection Range[8] (m) | Private Light Goods (PLG) | HGV | Bus | Emergency Vehicle | Powered Two Wheeler (PTW) | Cycle | Pedestrian [1] | Micro-mobility | False Positive [6] Rate (/hr) |
| 1 | Stopline [10] | 8 | y 95 | y 95 | y 95 | y 95 | y 90 | y 90 | N | y 90 | 20 |
| 2 | System D Z [10] | 12 | y 95 | y 95 | y 95 | y 95 | y 90 | des | N | des | 20 |
| 3 | System D Y | 25 | y 95 | y 95 | y 95 | y 95 | y 90 | des | N | des | 20 |
| 4 | System D X/ MOVA X[9] | 39 | y 95 | y 95 | y 95 | y 95 | y 90 | des | N | des | 20 |
| 5 | VA (TOPAS 2505) | 60 [2] | y 95 | y 95 | y 95 | y 95 | Y[2] | Y[2] | N | Y[2] | 20 |
| 6 | MOVA IN | 80 - 110 | y 90 | y 90 | y 90 | y 90 | y 90 | des | N | des | 2 |
| 7 | Kerbside (TOPAS 2507) | 8 | n/a | n/a | n/a | n/a | n/a | y 90 | y 90 | y 90 | 2 |
| 8 | On-Crossing (TOPAS 2506) | 12 | des | des | des | des | des | y 90 | y 90 | y 90 | 2 |
| 9 | Right Turn Call Cancel | 20 | y 95 | y 95 | y 95 | y 95 | y 90 | y 90 | N | y 90 | 2 |
| 10 | Cycle advanced stop line | 12 | N | N | N | N | N | y 90 | N | y 90 | 2 |
| 11 | Cycle lane | 20 | N | N | N | N | N | y 90 | N | y 90 | 2 |
| 12 | Bus Priority | 110 | N | N | Y 90 | N | N | N | N | N | 0.5 |
| 13 | SCOOT | 100 | y 95 | y 95 | y 95 | y 95 | y 90 | des | N | des | 2 |
| 14 | MIDAS | 120 | y 95 | y 95 | y 95 | y 95 | y 90 | n/a | n/a | n/a | 20 |
| 15 | Stopped Vehicle | 0 - 120 | y 95 | y 95 | y 95 | y 95 | y 90 | n/a | n/a | n/a | 2 |
| 16 | All Red Extension (e.g. Shuttle Working) | 120 | y 95 | y 95 | y 95 | y 95 | y 90 | y 90 | N | y 90 | 0.5 |
| 17 | SD/SA [7] | see notes | y 95 | y 95 | y 95 | y 95 | y 90 | n/a | N | n/a | 20 |
| 18 | Fixed Time UTC | 18 | y 95 | y 95 | y 95 | y 95 | y 90 | n/a | N | n/a | 20 |
| 19 | Emergency Vehicle Priority | 110 | N | N | N | y 95 | N | N | N | N | 0.05 |
| 20 | Cycle Platoon [11] | tbd | N | N | N | N | N | y 90 | N | N | 0.1 |
| 21 | Count/Flow | 50 | y 95 | y 95 | y 95 | y 95 | y 95 | y 95 | y 95 | y 95 | 20 |
| 22 | Classification | tbd | y 95 | y 95 | y 95 | y 95 | y 95 | y 95 | y 95 | y 95 | N/A |

| Notes | |
|---|---|
| 1 | Range of pedestrian sizes as per TOPAS 2506, 2507, see text for details |
| 2 | Range for PTW, Cycles as per TOPAS 2505 |
| 3 | Cells coloured green are require that the product MUST meet the stated threshold for that vehicle type. |
| 4 | Cells coloured red are excluded from that function AND MUST NOT BE DETECTED |
| 5 | Cells coloured blue are optional for that function and no specific detection threshold is required. |
| 6 | False positives are detections reported by the product in the absence of a valid object in the required detection space. See Clauses x.xx for more detail. |
| 7 | Double Vehicle Extension with SD 79m, Triple Vehicle Extension with SD 91m & 151m, Double Vehicle Extensions with Speed Assessment 151 m |
| 8 | Ranges are measured from the stopline with the detector mounted at the primary signal pole location. |
| 9 | System D 39m, MOVA X distance = 3.5x cruise speed (in m/s) + 5m |
| 10 | UD functionality may be applied at either of these detection locations |
| 11 | Projected requirement |

*Table 1 Detection Performance Criteria Draft Version*

Detector Performance Representation in Registrations (Table 1)

Currently the intention is that a detector would be registered to TOPAS 2547 and the registration would include a list of numbers, correlated to the use cases. For example, a detector appearing on the register as TOPAS 2547 (5,7,8) would deliver kerbside, on-crossing and VA functionality when mounted and configured correctly. That is, the user could have a high level of confidence that particular product would be useful at signalised crossings. The same detector mounted and configured differently might also appear on the register as TOPAS 2547 (12,13,15) BUT it has **not** been shown to deliver the functions and 5, 7, 8 AND 12,13,15 from a single set up or configuration. The objective in using this classification is that the maximum amount of support is given to users with the minimum additional procurement effort. This keeps access to the market open.

Reflecting on the burden of effort for the manufacturer, a manufacturer will develop a strong understanding of the capabilities and limitations of their product during its development and may well have targeted specific use cases as design requirements. When the manufacturer reaches that point in the development programme where TOPAS registration is sought they may deploy one or more instances of their product on a test site, and for each deployment, identify the use cases that they are seeking to meet. That is, they would not need to do the data gathering for different use cases serially.

Detector Configuration

In developing this standard there have been questions about how detectors are configured, how configuration data is stored and made accessible to users and maintainers, and how it can be transferred into a new detector when incident or age require replacement of a unit, particularly how the configuration data can be transferred between different manufacturers. TOPAS recognises this question, and while it is a seen as falling beyond the definition and testing of the devices, the question has been raised by the user community often enough that it warrants some discussion here.

As with the current position with traffic signals controller configurations, on which subject the DCIS paper will comment, detectors are configured with bespoke tools.

Two possible routes to minimise the adverse effect of this on users, and thereby even increase take-up of these products are proposed below.

a) Development of a generic open format for common detection parameters which can be exported from and imported into different manufacturer's products. This may endow compliant products with some better level of interoperability.

b) Each manufacturer publishes one or more standard configurations based around well-defined mounting locations and hardware positioning that give a high probability of delivering coverage of the right zones for the right reasons.

With the advent of powerful machine learning there is also scope for detectors to self-calibrate, compiling their own interpretation of wait zones, on-crossing spaces, lanes and approaches.

Ideally we would reach a position where the set-up instruction is something like, “Look along the corner of the housing and align that with the centre of the first lane 15m back from the stop line.” This was quick, simple and easily taught and worked well for the first generation of microwave doppler radar products.

Future Extension of TOPAS 2547

Perhaps the last area of discussion in respect of TOPAS 2547 is to look at the extent to which it is future-proof. The tabular nature of the performance criteria allows for extension of both rows/use cases and columns/vehicle types. Certain use cases may require that the performance criteria have to be finessed beyond those of Table 1. While classification is implicit in some of the current use cases, it may require further definition for a classification-based use case. Traffic characteristics that relate to two or more objects, e.g. near miss, wait zone density, queue length will need definition of acceptable tolerances on the criteria. For example, the near miss distance threshold may have a tolerance of +/- 10 cm, The Wait zone density may have a tolerance of +/- 1 person per meter squared, etc. The notes to, for example, appendix A of TOPAS 2130 shows that there is a workable precedent to accommodating such tolerances.

The previous sections have discussed how a detector can be assessed for its ability to detect. For the detection information that is gathered to be useful it has to be reported to the traffic signal controller (or other users of the data). The next section reviews and presents the status of the TOPAS standard TOPAS 2545 that defines an open protocol for communicating detection information.

<u>How Detectors Tell Other Equipment What They Are Responding To - (TOPAS 2545 Detector Interface Protocol)</u>

This standard is likely to be re-titled as “Detector to Traffic Signal Controller Interface Protocol” as the first port-of-call for the data from a detector, and the location that needs this data in a timely manner is the traffic signal controller. Once the data arrives there it may be forwarded on to other systems. TOPAS activity in the area of UTMC development has already started to accommodate this.

Accommodating Existing Interface Requirements

Currently the multi-object, multi-zone detectors support an interface or facility that allows them to locally determine objects in zones and activate a simple volt-free (relay) output that complies with TOPAS 2523 and which can be consumed by traffic signal controllers. However, in reducing the data stream to one bit of binary vast amounts of useful data are lost.

Using All the Data from the Detector

Multi-object, multi-zone detectors all have the ability to provide an output data stream that conveys everything they can infer about the objects in their field of view. Vehicle/object type, direction, speed, acceleration, confidence in identification, and more. Imagine the benefits of having a detector that could generate total delay, queue length, platoon clearance, through locally (pole top or signal controller) interpreting the data it is sensing. (See the data in Figure 4 to Figure 8.)

An Orderly Transition from Current infrastructure to New Technology

The main purpose and main benefit of implementing this standard is to set out a communication link from pole top to controller that is a natural evolution of the current cabling and layout of signal-controlled sites, and that may use the existing cabling.

The communication protocol follows the ISO seven-layer open systems interconnection (OSI) model as originally defined in ISO 7498.

TOPAS 2545 is aiming at a protocol for conveying rich detector data in a standard form over legacy cabling. Single pair ethernet (802.3 cg - https://standards.ieee.org/ieee/802.3cg/7308/) has been identified as an effective standard for the underlying communications, (i.e. the OSI physical layer). Considering this from the perspective of traffic signalling sites, 10BaseT-10L is intended for long communication paths up to 1000m. Field evidence suggests that 100m of 1.5mm$^2$ twisted pair can convey 10Mb/s.

Selection of this physical interface provides a way to re-purpose the ‘relay common’ and ‘relay normally open’ cores of cables currently used to transfer data from detectors to cabinets. This gives the maximum opportunity to users to deploy new technology on existing sites and thereby gives the manufacturers the maximum market access, so the maximum revenue, which giving users the minimum disruption to adopting these devices. There is an added benefit that chipsets for implementing 802.3 cg are readily available, so the impact on product designs and implementation are modest.

Standard connectors will be defined. These will differ from those used for TOPAS 2523 interfaces to minimise the risk of misconnection.

Data Standards

The protocol for the data payload is based on ISO 10711:2012 (Intelligent Transport Systems — Interface Protocol and Message Set Definition between Traffic Signal Controllers and Detectors). During the work to develop TOPAS 2545 errors were found in this standard, suggesting that it had never been implemented in real use. Representation are being made, via BSI to ISO to make corrections. The scope of the new draft is

> "ISO 10711:2012 defines protocols and message sets between traffic detectors and traffic signal controllers. It is applicable to the various types of traffic detector technologies currently in use for real-time traffic signal controls.
>
> It defines message sets that contain data collection and control protocol for three different types of detectors of traffic signal control systems:
>
> detectors that deal with occupancy information;
>
> detectors that deal with image information; and
>
> detectors that deal with vehicle identification.
>
> ISO 10711:2012 is limited to parameter generation to be used for traffic signal controls and for the interface between traffic signal controllers and detectors."

Communication of Data Quality And Fault Reporting

This standard allows the packaging of data content to meet current UK signal control algorithms and is extensible to allow new and emerging solutions to also be serviced.

An important point to note here is the real time nature of this interface. While network monitoring services are tolerant of latency or missed messages, systems that control the network need timely and reliable messaging.

A larger message from detector to controller also allows other information beyond that relating to the objects detected to also be passed to the controller. Detectors can monitor, diagnose and report their own condition to assist in maintenance. For example, as the distance to the first detection falls, or detection confidence trends decrease there may be a need for a maintenance visit to clean a window in front of a camera or take other action.

The Current Position

A desk-top assessment of the interface has been performed, and work is now in hand to field test the effectiveness of the proposed interface at a site in Poole. (Cabot Lane) offered courtesy of BCP.




*Figure 10 TOPAS 2545 Field Trial Site (50.743918,-1.9946978)*

Participants in this test will deploy detectors running their instances of the protocol so that the performance of the comms links can be assessed.

The trial will also allow an assessment to be made of the architecture and changes required at the signal controller to consume the data.

Format of the Standard

The standard will be implemented in two parts, one following the pattern of existing TOPAS standards, a numbered document defining the physical interface, the second part will be a soft representation of the protocol. It is projected that, in order for users to confirm that they achieve operational compatibility, there will also be test harnesses that replicate the ideal detector test harness (to allow controllers to confirm correct implementation of the receipt of the messages) and an ideal controller test harness, to allow detector manufacturers to ensure that they are communicating effectively. These harnesses will be structured to provide status reports for connected devices under test.

Unlike the definitions and testing of the real-world, noisy process of sensing objects on pavements, cycleways and carriageways, once the data is extracted from the analogue world reporting it is far more deterministic, and lends itself to comparison with other critical data reporting situations and the methods used to achieve the required performance levels.

Summary

The emergence and take up of configurable multi-object, multi-zone detection is currently constrained by the defined operational requirements and interfacing definition.

For these technologies to deliver wider benefits there needs to be confidence in how well they detect and confidence that they can report what they do detect.

Further, if both performance and communication are characterised by open standards then systems consuming this data will be best placed to work inter-operably with different manufacturer's products.

As connected vehicles increasingly report their position, direction, speed etc. i.e. they perform 'self-detection', then aligning the structure of data from static roadside devices with that from connected vehicles smooths the transition of traffic control systems.

In an area of traffic control where there are few international standards or mandated criteria TOPAS is implementing two standards for detection. One to assess how well such devices address multiple detection challenges for current traffic control algorithms simultaneously and the other to maximise the reporting not only of detection data but also detector status data.