2016

ANPR / WIM System

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Introduction to CA Traffic

Initially formed in 1991, under the name Counters & Accessories Ltd (C&A Ltd), the company was set up with an aim to meet the needs of traffic engineers who require comprehensive and accurate vehicle data collection and offered a large range of traditional radar and detector loop based vehicle counting and classification equipment.

In February 2006, C&A Ltd was acquired by Hill & Smith Holdings Plc. to form part of their 'Infrastructure Product Group'. Since then the company has continued to grow with the addition of the more advanced counter and classification equipment and also the EVO8 fully integrated ANPR camera system. To reflect the growth of the company and the additional products, in June 2008 the company changed its name to CA Traffic Ltd.

CA Traffic Limited is the designer and Intellectual Property owner of all of its products. This allows the company to offer complete technical security for the support and further development of its products.

CA Traffic has a team of over 30 dedicated staff members who continue to ensure that the company's reputation for providing excellent service, and low cost easy to use products, is constantly maintained. As well as providing a full range of products and services, CA Traffic also invests heavily in developing intuitive and powerful software solutions to meet the growing demands of traffic engineers.

CA Traffic supplies virtually every local authority in the UK with counting and classification equipment, furthermore we have developed our own fully intelligent ANPR camera system which has been provided to a number of local authorities, car parking management companies and in excess of 20 UK Police forces, with orders for over 1,000 Intelligent ANPR Camera Systems over the last 2 years alone.

CA Traffic premises in Aylesbury, Buckinghamshire.

Weigh-In-Motion System Overview

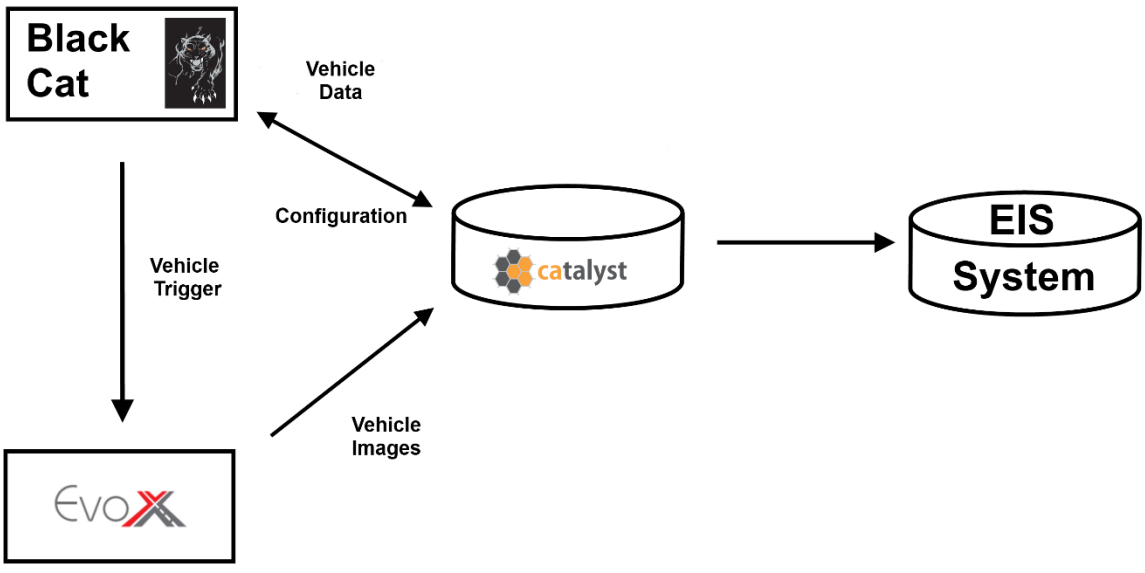
The CA Traffic Weigh-In-Motion (WIM) System combines two of CA Traffics existing products, the Black CAT traffic Monitor and EvoX ANPR camera, to provide a complete outstation solution for the pre-selection of overweight vehicles.

The nature of the system means that live retrieval of the overview images will be dependent on suitable communications being available between the EvoX and Catalyst.

For example on a busy road with poor 3G performance, the EvoX may struggle to send the overview images back to Catalyst quickly enough to allow the live data to be inserted into the EIS DB.

In this situation it may be necessary to lower the overview image quality or move to 4G communications if available in order to provide the necessary throughput for the images to be transferred back to Catalyst.

If the camera is to communicate via Ethernet and the existing router housed inside the cabinet, it is essential there are 2 available ports for sole use with the camera. 1 for camera communications and 1 for on-site diagnostics.



EvoX ANPR Camera System

Building upon the success of the market leading Evo8 intelligent ANPR camera system, the newly developed EvoX sets a new benchmark in intelligent ANPR cameras, features include:

- Full HD ANPR & Overview sensors
- Powerful Image Processing capabilities
- On-Board ANPR can capture 3 lanes from a single camera (9m + FOV)
- Multiple Simultaneous Plate Reads in each lane
- IP Video streaming from both sensors
- Motorised zoom lenses for both ANPR and overview sensors
- Second modem option for remote maintenance
- Optional PTZ control for CCTV operation, auto-return to ANPR mode
- Battery back up to send power outage alert and perform graceful shut down
- Configurable data sets and multiple host capabilities to send differing data to different end users

Specification

Monochrome IR camera resolution	1920 x 1080 pixels (progressive scan)
Nominal Field of view (ANPR)	9.5 metres (capture width)
Colour overview camera resolution	1920 x 1080 pixels (progressive scan)
Typical range (max)	up to 40 metres
Frame Rate	50 frames / sec
Integrated Illumination wavelength	760nm, 810nm, 850nm & 940nm options available
Lens focal length	10mm to 40mm zoom (motorised)
Maximum vehicle capture speed	155 mph (250 kph)
Maximum Mounting Angle	35°
Local non-volatile memory	Industrial SSD, 16GB to 64GB
Optional Cellular Communications	GPRS, Edge, 3G (HSPA+) & 4G (LTE)
Wireless LAN	802.11 b/g/n 300Mbps
Ethernet	IEEE802.3ab 1000BASE-T
Wired Serial communications	3-wire RS232, optional RS422
Power supply	48V dc (up to 200m cable length)
Maximum Power dissipation	30W
External Inputs / Outputs	4x Input / 4x Output (opto-isolated)
Ingress Protection Rating	Tested and certified to meet the water penetration requirements of HA spec. TR2130C. Designed to withstand temporary immersion in water between 0.15m & 1m
Operating Temperature range	-40° to +55° C (ambient)
Dimensions including sunshield	H:150 x W:190 x L:425 mm
Construction	Extruded aluminium chassis/moulded polyethylene cover
Optional Features Including:	* Encryption of data and images * User configurable metadata on images * Area of interest image cropping (reduced file size) * Day/Night sensor for night time overview images * GPS Module * Optional "night vision" illuminator 24x7 overview images * Optional second modem for remote servicing * Connectivity to laser speed measurement device * Connectivity to CA Traffic WIM system

The EvoX has been designed as a completely modular system enabling different modules to be fitted depending on the task.

This allows functionality to be tailored to individual end user requirements at the optimum price/performance point.

Sample Images

A sample of the overview images created by the EvoX. Note the extra resolution offered by the 1920 x 1080 pixel sensor and wide field of view offered by the camera.

Camera Name	Timestamp	Country	VRN	Overview Image
Lane Name	Speed (kph)	Confidence	Plate Patch	
Bucks A422 (R/B)	18/04/2015 18:22:01	GBR	LN55NFP	
A422 West		100	LN55 NFP	
Bucks A422 (R/B)	18/04/2015 18:21:58	GBR	KN61HDK	
A422 West		99	KN61 HDK	
Bucks A422 (R/B)	18/04/2015 18:21:52	GBR	KX57SZE	
A422 East		100	KX57 SZE	
Bucks A422 (R/B)	18/04/2015 18:21:50	GBR	OY14SUU	
A422 West		98	OY14 SUU	
Bucks A422 (R/B)	18/04/2015 18:21:32	GBR	NT08CSY	
A422 East		100	NT08 CSY	
Bucks A422 (R/B)	18/04/2015 18:21:11	GBR	KU53NXL	
A422 West		100	KU53 NXL	
Bucks A422 (R/B)	18/04/2015 18:21:09	GBR	N15DGB	
A422 East		98	N15 DGB	
Bucks A422 (R/B)	18/04/2015 18:20:38	GBR	KA04BJZ	
A422 East		100	KA04 BJZ	
Bucks A422 (R/B)	18/04/2015 18:20:28	GBR	MV10YWG	
A422 East		96	MV10 YWG	

The extra processing power offered by the EvoX enables traditionally hard to read plates, such as square and dirty plates to be read correctly in all lighting conditions.

The EvoX overview camera offers enhanced low light sensitivity, combined with an automatic day/night switch which switches the colour sensor to mono mode for enhanced contrast at night, enabling make and model to be ascertained from the overview images in total darkness.

Camera Name Lane Name	Timestamp Speed (kph)	Country Confidence	VRN Plate Patch	Overview Image
Bucks A422 (R/B) A422 West	17/04/2015 02:06:43	GBR 100	**DA05VTD**	
Bucks A422 (R/B) A422 West	17/04/2015 02:04:30	GBR 99	**EO63NGX**	
Bucks A422 (R/B) A422 West	17/04/2015 02:04:04	GBR 100	**YH63XMC**	
Bucks A422 (R/B) A422 West	17/04/2015 01:53:31	GBR 99	**WX11LVP**	
Bucks A422 (R/B) A422 West	17/04/2015 01:53:23	GBR 100	**P690RRT**	
Bucks A422 (R/B) A422 East	17/04/2015 01:52:48	GBR 99	**DG12BWZ**	
Bucks A422 (R/B) A422 West	17/04/2015 01:50:35	GBR 100	**BX63UEJ**	
Bucks A422 (R/B) A422 East	17/04/2015 01:48:48	GBR 99	**LB13HZW**	
Bucks A422 (R/B) A422 West	17/04/2015 01:47:38	GBR 100	**HK63LYJ**	

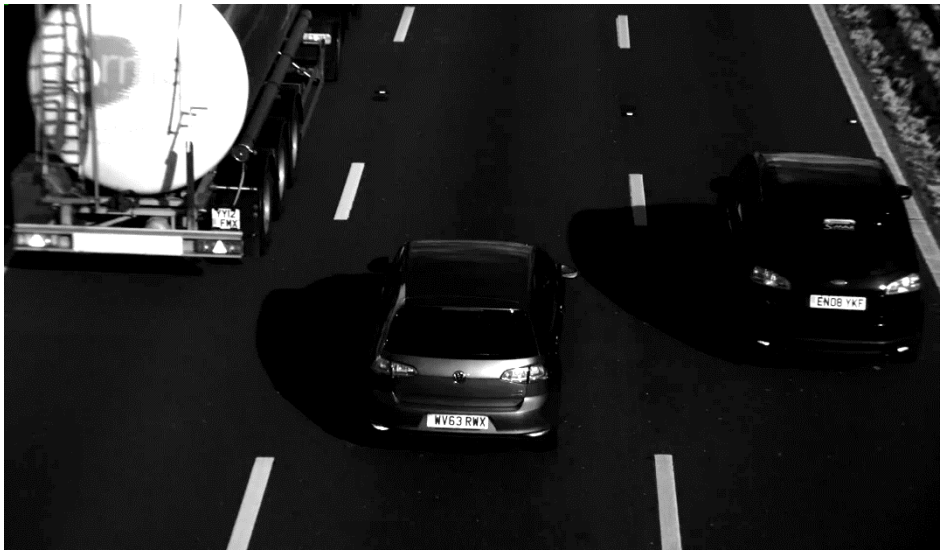


Image from the IR Plate reading sensor, showing 3 lane coverage

System Performance - NASP

Having supplied over 1,000 cameras to in excess of 20 UK Police forces, CA Traffic range of Intelligent camera systems have undergone extensive testing against the UK Police ANPR performance requirements (NASP).

A recent test was carried out by an independent body, ANPR Consulting Limited, during May and June 2014. The test camera was installed on an over-bridge where a 'Dual Lane' Evo8 was deployed on a bridge mount looking at two lanes of oncoming traffic. Results were as follows:

	Test 1	Test 2
Date	28th May 2014	3rd June 2014
Time	10:15 – 11:05	12:13 – 12:28
Weather	Overcast with drizzle	Sun / Dry Road
NASP Capture Rate	98.61% (two lanes)	98.74% (two lanes)
NASP read Rate	99% (two lanes)	99.61% (two lanes)

Selection of reads from the dual lane Evo8 camera showing location, date, time, country of origin, plate read, color overview image, plate patch, plate read and also confidence %. Note that all 5 vehicles are captured and read within a 4 second time frame.

Please also note the capture of the straddling vehicle in image 1 and that the Evo8 automatically crops the "area of interest" on the overview image and denotes which lane the vehicle is in.

Camera Name	Timestamp	Country	VRN	Overview Image
Lane Name	Speed (kph)	Confidence	Plate Patch	
A404_HenleyRd	22/04/2014 08:59:58	GBR	**SL10DLV**	
A404_HenleyRd outside		99		
A404_HenleyRd	22/04/2014 08:59:56	GBR	**YG58NJO**	
A404_HenleyRd inside		99		
A404_HenleyRd	22/04/2014 08:59:56	GBR	**FL08UWT**	
A404_HenleyRd outside		100		
A404_HenleyRd	22/04/2014 08:59:55	GBR	**PF63NBJ**	
A404_HenleyRd outside		100		
A404_HenleyRd	22/04/2014 08:59:54	GBR	**DK14UFU**	
A404_HenleyRd inside		99		

Dyfed Powys Police recently took delivery of an EvoX camera where initial tests were completed on a bi-directional camera, results over a 30 minute period were as follows:

Test Date/Time/Conditions: 29/02/16 – 16:00 hours – Overcast with heavy rain

Pembroke Dock A4139 Southbound Rear Plates 108 vehicles - 98.8%

Pembroke Dock A4139 Northbound Front Plates 100 vehicles - 100.0%

The Black CAT Outstation Platform

The Black CAT is the next generation in traffic monitoring and control. It has a modular design which allows new technology to be added, as well as allowing for custom builds to meet each customer's requirements. The versatility of the Black CAT makes it suitable for the majority of traffic monitoring and control applications. In its simplest form it can be used as a simple count classifier, collecting data for the traffic engineer right up to a system component allowing ITS solutions to be created that can act on the information provided to drive traffic signs or control traffic flows.

The Black CAT Oustation Platform is offered in three sizes, Compact, Midi and Rack, the options reflecting differing client requirements. Key to the Black CAT is continuity and flexibility with the modularity of the design allowing CA Traffic to produce a customisable unit that is built to meet the client's specific requirement.

With all traffic data collection devices the 'sensor' is of utmost importance. Built on CA Traffic's strength in providing highly accurate vehicle classification, the Black CAT Outstation Platform uses inductive loop technology as its primary detection methodology. Inductive loops provide the best vehicle data of any detection source. The detector PCB is a standard 8 channel build, coupled with the ability to interface with Piezo sensors full axle based class schemes are available. Furthermore, with the Midi and Rack units, interfacing to Class 1 Piezo and Kistler Lineas Quartz Sensors provides Weigh-in-Motion.

In addition to traditional sensor technologies the Black CAT can also be fitted with a Bluetooth detector card for detecting unique Mac addresses from any passing Bluetooth enabled device. These Mac addresses can then be matched at the end users instation for the generation of journey time information.

Furthermore the Black CAT can be connected to external devices such as ANPR cameras or Variable Message Signs to display / record live roadside data.

For the purposes of WIM systems the Black CAT Midi and Black CAT Rack can be utilised.

Black CAT-Midi

3 sensor card positions which can be populated with either 8 channel Inductive loop cards or 8 channel Piezo (axle) cards, a WIM card, Bluetooth card or switch I/O card for connecting to other devices such as ANPR cameras. A mix of cards can be installed to provide a customisable system capable of multiple tasks.

Communications options are GSM, GPRS, and Ethernet.

Power would be provided by permanent mains power connection. The Mains power supply has a battery back up facility that will allow the unit to continue to operate for up to 10 hours. This will allow the unit to cope with intermittent or short-term power supply connections. The mains power connection will provide confident supply to the more 'power hungry' sensor types such as Piezo and Kistler WIM.

Features

Data Collection and Reporting

The Outstation can collect multiple types of data simultaneously. The design allows for new data types to be added. Data types available include:

- Historical Binned. This is summarised data type that has to be requested by the user. Three types of data can be recorded, each supporting up to 30 bins. The reporting interval is configurable from 1minute to 60 minutes.
- Historical VBV. Each individual vehicle is recorded. The user can select which parameters are recorded, and to what resolution. This is particularly useful when data is being transferred via GSM. This data has to be requested by the user.
- Real-time Statistics. This is similar to the Historical Binned except the data is sent to the In-station automatically as well as being logged. The design allows for a reporting offset to avoid all the Outstations attempting to send data to the In-station at the same time.
- Real-time VBV. This is similar to the Historical Binned except that the data is sent to the In-station automatically. It also allows for a reporting offset to be set.

Data is stored internally on a 1GB SD card which can hold up to 100,000,000 vehicles depending upon the sensor array being used. The data is kept for as long as possible and is only deleted when space is required. Each file has an attribute that specifies if the file has been retrieved or not and there is a unique flag for each user. The Outstation will delete the oldest retrieved data first, and this decision is based on the master user. This allows the In-station to simply request data and the Outstation decides which files to send. Real-time data is also stored in files. Each period has a flag that indicates whether it has been successfully received by each In-station.

Sensor Technologies

Multiple sensor types supported, including:

- Inductive Loop
- Piezo electric sensor (Axle detection and Weigh-in-motion)
- Kistler WIM sensors
- Switch I/O, allowing external sensor types (such as ALPR cameras) to be interfaced
- Bluetooth Card

The Outstation is designed to operate with many different types of sensor arrays. The Outstation allows different sensor arrays to be configured for each lane, allowing the user to pick the arrays that best suit the application on a lane-by-lane basis. This can reduce the cost of installation, e.g. not fitting WIM sensors in a hard shoulder or fast lane. Arrays can be created using multiple sensor technologies to provide maximum accuracy. Signature profiling using inductive loops allows for vehicle classification without the need to axle sensors.

These sophisticated algorithms provide accurate speed and classification even on long feeders.

- Advanced straddle algorithms provides accurate count data.
- Easy to use WIM calibration system.

Algorithms

The Outstation has a number of built-in algorithms that can be independently enabled or disabled. Quite often multiple algorithms are enabled to give a clearer indication of build up of congestion. The design allows for new algorithms to be easily added, the currently available algorithms include:

- HiOCC. This algorithm is design for incident detection. When a loop detects high occupancy it assumes that an incident has occurred and sends an alert to the In-station.
- Speed Threshold. This algorithm monitors the average speed of a predefined period. If the speed changes to a different band, an alarm is sent to the In-station.
- Flow Threshold. This algorithm monitors the flow of traffic over a predefined period. If the flow changes to a different band an alarm is sent to the In-station.

The CA In-station provides enhanced algorithms. It can collect data from multiple sources and use this information to control VMS' or send data to other systems. Furthermore it provides a unique technique that allows users to create their own algorithms.

Communications Capabilities

Multiple communications devices supported, current options include:

- Ethernet 10 or 100mb network. This is provided using an RJ45 connection.
- GSM / GPRS Modem providing wireless connections to the In-station.
- RS232 interface to allow connection to legacy type equipment.
- USB connection for communications with our custom Engineer's Terminal software.

The Outstation can communicate with up to 4 In-station devices simultaneously. The data that is sent to each In-station is configurable, allowing each user to collect the data they require. This unique feature makes it possible for multiple users to share the same Outstation, making the system very cost effective. The design of the Outstation firmware makes it easy to add new device drivers.

The Outstation can communicate using a number of communications protocols which include: TCP/IP - UDP/IP – SNMP – HTTP – FTP - CA Serial Protocol

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Fault Management

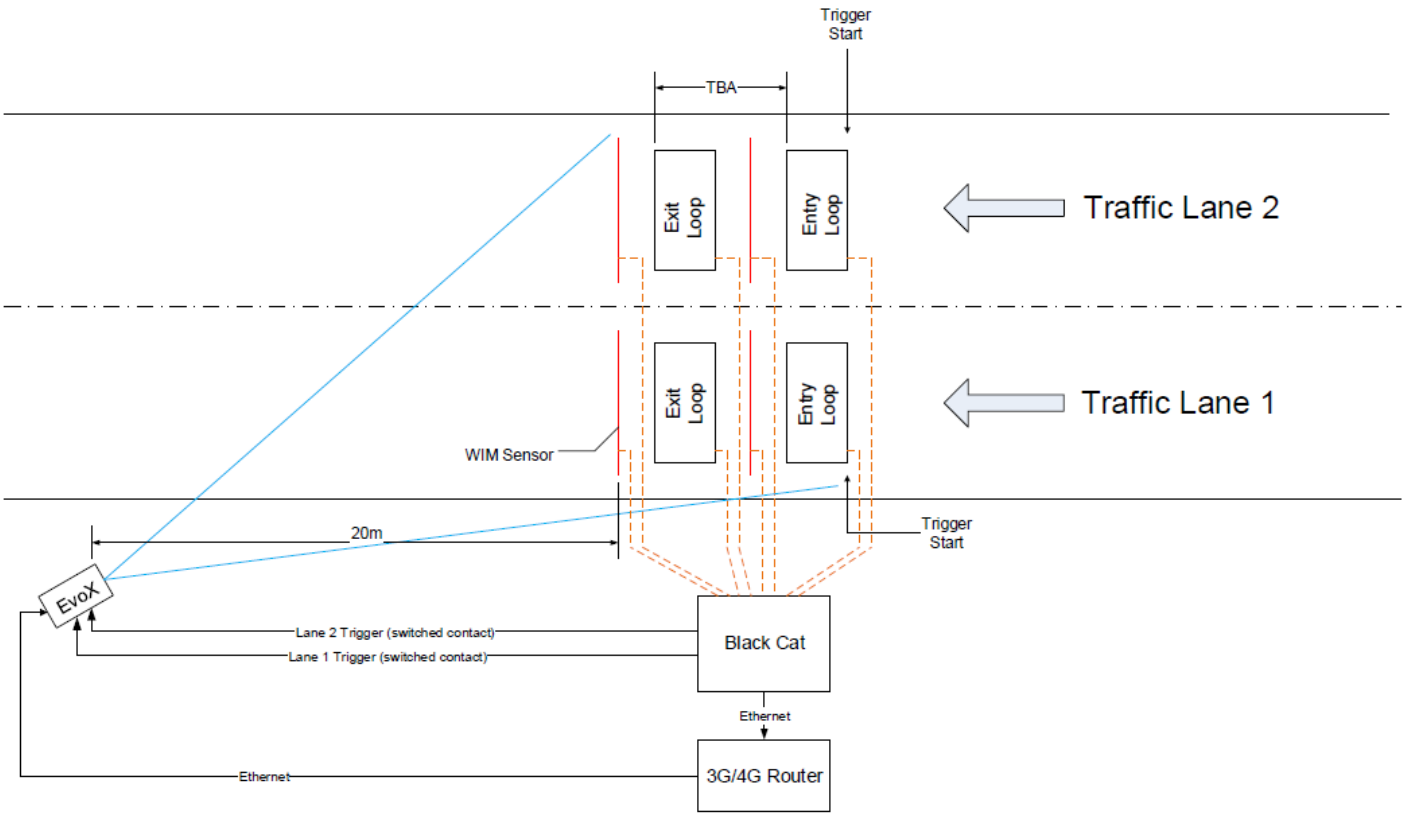
The Outstation has a wide range fault monitoring systems. When a fault is detected or cleared, it will alert the In-station. The CA In-station has an extensive fault management system to assist the user in identifying the faults in the system. This system has been developed to speed up fault detection to minimise data loss. The Outstation detects the following fault conditions:

* Sensor fault / clearance
* Charger fault / clearance
* Time faults
* Changes in the types of algorithms being run
* Mains fault / clearance
* Battery fault / clearance
* Changes in the types of data being logged
* Internal faults

Product Specification

Loop Detector Maximum Feeder	300M
Loop Detector Inductance range	40 – 500uH
Loop Detector Frequency Control	50 – 100KHz
Adjustable Threshold	Manual or automatic
Signature Class schemes (Standard)	EUR6, CA10, DOENI5
Single Loop Classification	Same functionality as two loops with reduced accuracy
Loop inputs supported	32 (MIDI and compact 24).
Axle detection	> 99%
Axle classification Schemes (Standard)	EUR13,FHWA13,FHWA15
Piezo / Kistler inputs supported	32 (MIDI and Compact 24)
Piezo / Kistler Gain Control	Settings 1 – 7.
Piezo / Kistler Sensitivity control	Manual or automatic
Total sensor inputs supported	64 (MIDI and Compact 24)
Weight error	< 5% (L2wL2w using Kistler sensors)
Bluetooth	100M range
Switch Input / Output Voltage	Input: 3 – 18V / Output: Open Collector up to 30V
Control Lines	4 X I/O and 2 Analogue
Temperature Probe	Required for Piezo WIM
Speed accuracy	+/- 3% at a 95% confidence
Length accuracy	+/- 5% at a 95% confidence
Class accuracy	Typically > 95%.
Count accuracy	Typically > 99%
Ethernet	10 or 100 BASE-T
GSM / GPRS Modem	GPRS Class
USB	Type A (PC) and Type B data storage
Serial	RS232 up to 115200 baud
IP Protocols	TCP/IP, UDP/IP, HTTP, FTP, SNMP,DNS
Time Updates	SNTP or custom protocol
Simultaneous Connections	In-station: 4 / Engineer connections: 2 local, 8 remote
Data storage	SD, 4GB, Typical 400,000,000 vehicles
Logging supported	Historical Binned & VBV, Real-time Statistics & VBV, Historical & Real-time ID, UTMC Car Park, UTMC Traffic Counter, UTMC ALPR.
Logging Resolution	Speed: 0.1 kph / Length: 1cm
Arrival time Resolution	1/1000, 1/100, 1/10 or seconds.
Algorithms supported	HiOCC, Speed & Flow Threshold. Up to 10 bands
Temperature	Formally tested to -25 – 65°C, designed to –40 +80°C.
Power supply	90 – 230vac, 47 – 63 Hz, 0.5A
High Performance	ARM7 Processor

WIM Arrangement



WIM Outstation (Dual Carriageway)

Calibration

Weigh in motion equipment must be adjusted to ensure that the weights produced by the recorder are as accurate as possible.

The weights are calculated from the outputs of the in-road sensors and these outputs will vary depending on the depth at which the sensors are installed, by the type of road material that they are installed into, the temperature of the road surface and the age of the sensors.

The technique for adjustment and checking of the weight accuracy is as below-

1. Calibration trucks, typically a mix of vehicles, are weighed on a calibrated weigh bridge to establish their axle and gross weights.

2. The calibration trucks make a number of passes over the sensors in each lane.

3. Once the trucks have passed the sensors the average weight error for each lane is calculated based on the individual axle weights.

4. A correction is made to the recorder based on the calculated weight error.

5. The calibration trucks make another number of passes over the sensors in each lane to check that the adjustment has been effective and that weights produced are now within specification.

There are no strict rules regarding calibration, other than COST323 which provides guidance regarding calibration of weigh in motion systems but make no suggestion on methodology.

If the customer is predominantly interested in accuracy of overweight trucks, then best performance will be obtained if the calibration trucks are loaded such that they are close to their maximum permitted weight.

The vehicles to be used and the number of times they must pass the sensors is not specified, however the larger the sample size and the more varied the vehicle types the more accurate the system will be.

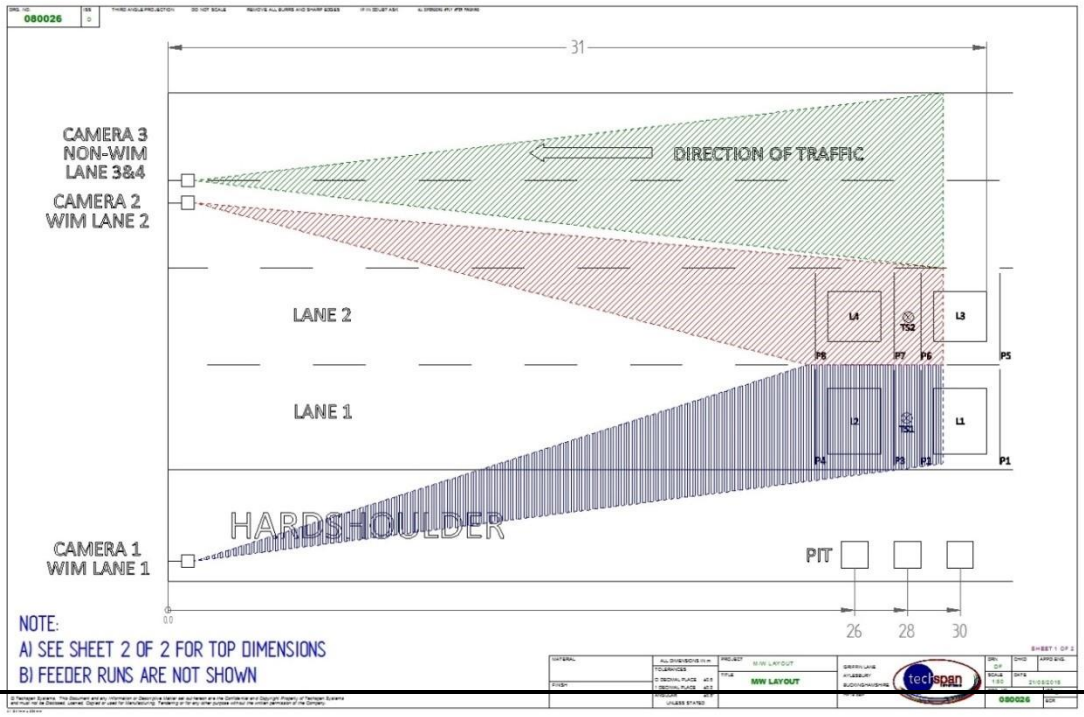
The methodology expected by the UK Department for Transport (DfT) requires that 3 trucks are used, a 2 axle rigid truck, a 3 axle rigid truck and a 5 or 6 axle articulated truck. All trucks must be loaded close to their maximum capacity and as wide a variety of axle weights as possible should be obtained.

The truck passes at point 2 above is expected to be 10 passes of each truck and the truck passes at point 5 above are expected to be 5 passes. The UK DfT expect to have their weigh in motion sites recalibrated at 6 month intervals to ensure on going accuracy.

Case Study

In 2015 CA Traffic installed a complete WIM / ANPR system on the M25 London Orbital Road at the Dartford River Crossing. The system utilised a Black CAT Rack and the EvoX cameras predecessor, the Evo8.

Lanes 1 & 2 each had WIM sensors and an individual ANPR camera, whereas as lanes 3 & 4 utilised one ANPR camera only, on the principle that large trucks mainly used the inside two lanes.



The system consisted of the following equipment:

ANPR Cameras, CA Traffic manufactured EVO8's X 3

Lane 1 and 2 cameras are configured with the Classification scheme and permitted weights by Class. The third camera covers lanes 3 and 4 and only collect plate data and colour overview.

Parapet Rail camera arms, supplied through Trafficmaster X 3

These are approved brackets for the purpose.

Weigh in Motion Class 1 sensors, manufactured by MEAS X 8

4 sensors have been installed in lanes 1 and 2 only. Four sensors have been installed to provide redundancy in the event of a sensor failure.

Black CAT WIM Classifier, manufactured by CA Traffic X 1

The Black CAT is configured with the Classification scheme and permitted weights by Class.

Adaptive Modules 8 port switch X 1

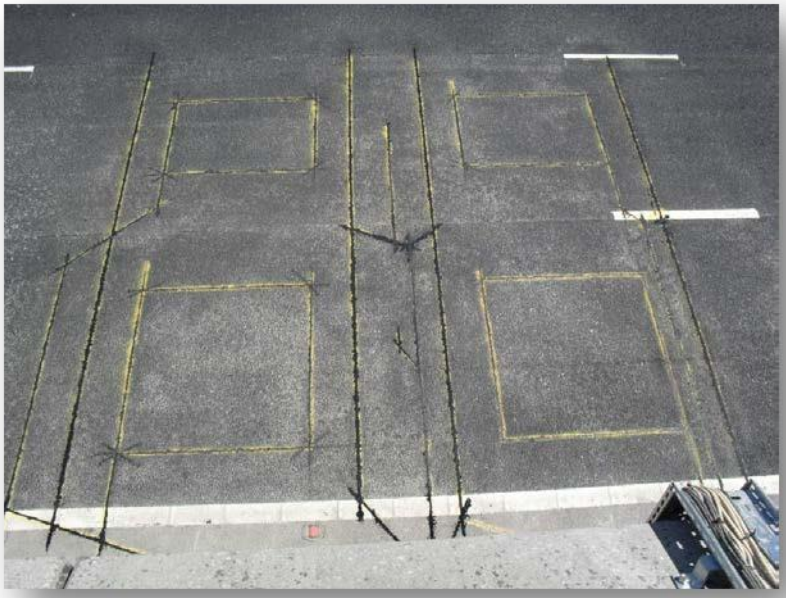
This module acts as the communication link between the Black CAT, ANPR Cameras and the Cisco Router.

Cisco 881 router X 1

This is the exit route for all data and images to the NERTS communication Network.

Adaptive Modules 4G Router X 1

This is an external interface to the CA Traffic's commissioning and support team.



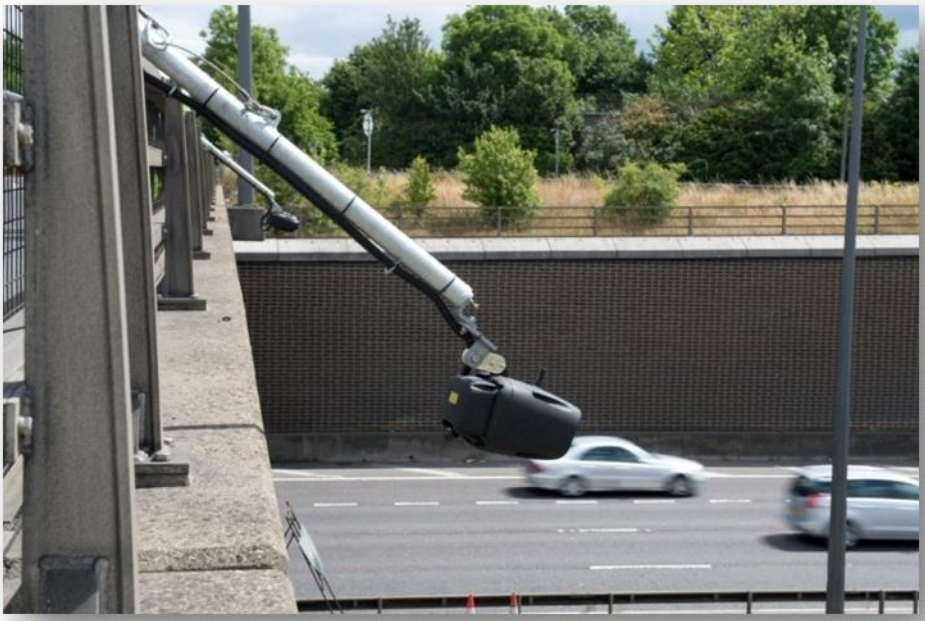
Sensor layout is Piezo-Loop-Piezo-Piezo-Loop-Piezo. There are two temperature sensors placed in the lane centres between the two middle Piezo's.

Data Path

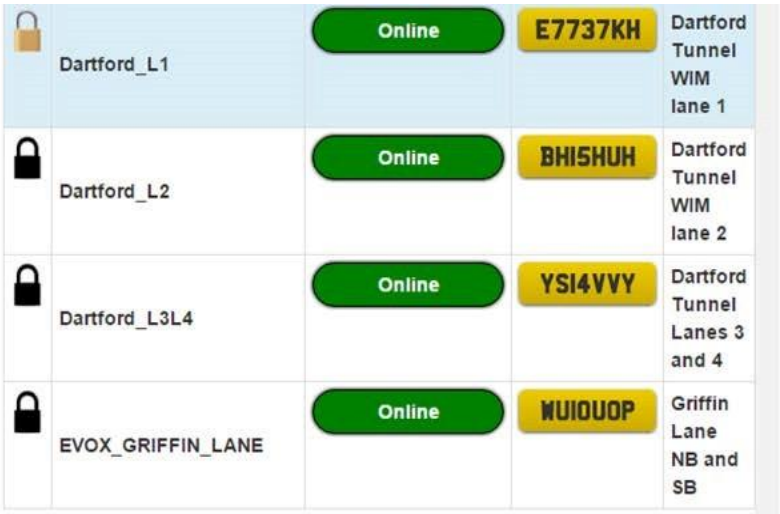
The flow of controlled data runs this way:

- Vehicle triggers leading edge of the first inductive loop. This does two start-up processes, it starts the single vehicle event data which it sends to the Black CAT Classifier and it sends a 'start' message to the EVO 8 monitoring that lane and the images are stored in the camera.
- The Black Cat processes the full individual vehicle event and sends the data to the ANPR Camera.
- When the vehicle exits the second the 'end' message is received by the ANPR Camera and the image saving is stopped.
- The ANPR Camera then constructs a complete event, vehicle data and images with ANPR Reads and embeds the 'metadata' in to the saved image. Violation events are also identified.

- The individual event data is output from the camera and sent via the 8 port switch to the Cisco router for output.



The image below is taken from our Cortex in-station. As you can see a plate patch image is displayed along with an overview image from the camera which contains customer defined metadata gathered from both the camera and the Black CAT. In this instance both a tractor weight and combined vehicle weight are gathered.



- The Black CAT is classifying vehicle to the DTP28 class scheme - standard WIM classification scheme for VOSA