STATUS OF EUROPEAN EFFORTS ON DIGITAL ENFORCEMENT, USING ITS AND FUTURE TRENDS

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SUMMARY.

One of the fundamental components of successful traffic management and control is the provision of comprehensive enforcement in a manner which is both cost- and resource-effective. 'Wet film' cameras have been used in Europe and Asia since the early 1950s, offering savings in terms of cost and manpower. However, it is the 'second generation' of vision-based enforcement systems using digital imaging technology which provide the greatest potential for improvements in enforcement on European roads. Recently, significant effort has been devoted to finding ways to automate some or all of the violation detection and prosecution process.

DIGITAL IMAGING TECHNOLOGY.

Digital imaging techniques using video camera technology offers one potential solution to address the problems raised by the detection of violations as follows:

- it can automate the 'detection' process so reducing labour (and therefore cost) requirements;
- there is no 'film' to process so reducing labour (and therefore cost) requirements;
- character recognition processes are now sufficiently advanced as to be able to uniquely identify in excess of 95% of vehicles;
- A reduction in cost and availability of video camera systems means that much greater coverage of the road networks is now possible.

This paper will provide an overview of selected testsites in Europe already in use which bear one of the above mentioned features. It is a first result of the 4th framework VERA project that will address the European development and implementation of digital enforcement and related to this will promote the necessary European legal harmonisation.

THE VERA MISSION.

VERA's overall mission is to 'examine harmonised approaches to the enforcement of traffic laws using video technology and to promote the acceptance of video records as evidence in court.'. The project will examine the use of video enforcement systems in urban, inter-urban and pricing applications, addressing any technical, institutional and legal barriers which may prevent them from fulfilling their potential. Each of these applications will be demonstrated at a number of sites around Europe. VERA will directly address the needs of authorities and organizations responsible for the enforcement of traffic regulations and those responsible for ensuring that appropriate payment (in the form of tolls, taxes or pricing charges) for use of a road is made. Therefore, VERA's primary users will be public bodies such as Ministries of Transport, road authorities and police forces as well as organizations such as private-sector road operators.

THE TESTSITES.

The Vera testsites are:

- The Dutch A-2 trajectory control.
- The Dutch Weigh in motion project.
- The Belgian Traficon testsite.
- The Highways Agency pilot.
- The Basel-Landschaft testsite.
- The German inter-urban speed control pilot near Düsseldorf on the L 52.
- The City of Valencia testsite.
- The Bologna testsite
- The bus lane testsite in Edinburgh.
- The German Wismar testsite.
- The Florence tolling testsite.

The Non-Vera testsites are:

- The Finnish Approach.
- Remote "attended" enforcement of traffic regulations by CCTV cameras.
- The buslane enforcement system in London.
- The Swiss Advice project.

All the testsites can be divided in three categories:

- Urban.
- Interurban.
- Road Pricing.

THE DUTCH A-2 TRAJECTORY CONTROL.

The system was developed and built for the Dutch Ministry of Transport and Water Management and the National Police Agency, Traffic and Transport Division.
The total system consists of equipment situated on three locations along the A-2, between the cities of Maarssen and Breukelen. The total trajectory is 3 km and two measurings are carried out; one after 800 meter and one after 2200 meter.
The cameras are located above the three northbound lanes and all nine cameras are cross referenced. For low light conditions additional lighting is installed that also works during the night. The cameras are connected to a central computer from the Ministry of Transport and data communication system is established between this computer and the office of the Dutch national police Agency in Driebergen for automatic processing.
The digital images of each camera are reduced to a limited amount of digital information, providing a fingerprint of each individual passing vehicle.
These digital fingerprints are stored temporarily. The system is continually looking for 2 matching fingerprints (yes this is object recognition) and if a match is found the system will calculate the average speed and if this is above the pre-set margin both images are stored as one object on a permanent medium.

THE DUTCH WEIGH-IN-MOTION VIDEO TESTSITE.

Selection of overloaded axles or vehicles in the traffic stream by visual identification is difficult. That's a problem in the traditional procedure of pre-selection for static weighing. It would be preferable if only vehicles with a clear identification of being overloaded are selected from the traffic for further investigation. The new system takes care of a perfect pre-selection. At the dynamic weigh location a video camera has been installed and sensors embedded in the road measure the weight while lorries pass at full speed. In a split second the axle weights are known. Not accurate enough to be enforced, but enough reason for further investigation. A picture is taken of the vehicle identified as being overloaded.
This image is sent together with weight information to the static weigh site. From there a policeman on a motorbike picks the vehicle out of the traffic. The vehicle is escorted to the static weighing site for enforcement weighing.
Even without picking out and stopping lorries WIM-VID can check and register overloaded lorries. Automatic identification of the licence plate will lead to the owner of the vehicle. With this information the State Traffic Inspectorate can execute its mission.
Companies which are known for overloading its vehicles regularly can expect to be visited by an inspector of this Inspectorate.

THE BELGIAN TRAFICON TESTSITE.

The vehicle detection is done optically. A video camera is placed above the road on a lamp post. The Traficon Video Image Processor (VIP) detects the vehicles passing the red light. The detection outputs are monitored by the red guard outstation unit. The red guard unit takes 3 video shots when a violation occurs. The red guard installation unit collects the violation from the outstation via the PSTN. The red guard outstation unit disposes of two video cameras. One wide angle camera and a zoom camera for license plate registration. On the road, there are two optical detection probes (detection zones) placed one after the other. The first video shot is taken when the vehicle enters the first detection probe. The zoom shot is taken when the vehicle has left the first detection probe. From the detection on the first probe and on the second probe, the red guard unit calculates the speed of the vehicle. The third shot is then (depending on speed) taken by the wide angle camera.

THE UK HIGHWAYS AGENCY PILOT.

The Highways Agency is proposing and currently seeking approval for the establishment of a semi-permanent trial site on the M25 within the Controlled Motorways section for the purpose of testing future enforcement systems based around electronic camera technologies.
The main objectives of this proposal are:

- To establish a motorway trial site for the demonstration and performance evaluation of video based enforcement equipment for use in variable speed control and other more general speed enforcement applications. This site will be used to complement previous 'off-road" testing which will determine the suitability of the equipment.
- To use the trial results to develop and make recommendations for the standards for electronic enforcement systems on motorways.
- Investigate the national and international institutional issues surrounding the application of stand-alone automatic electronic enforcement systems for speed control and other applications.
- Investigate the type approval, legal requirements and issues surrounding the use of electronic enforcement system on motorways.
- Demonstrate the quality of, and requirements for the video based evidence used as evidence of speed offence.
- Demonstrate suitable techniques and technologies for the secure storage and transmission of the video evidence, and the remote control of the enforcement system.
- Provide the manufacturers of this technology with an 'on-road" facility to demonstrate to approval bodies the performance of their systems with real traffic conditions.

THE BASEL-LANDSCHAFT TESTSITE.

The testsite is located on the A2 motorway at Pratteln which is a suburb on the eastern side of Basel. The installed speed check equipment is able to check both directions of traffic alternatively. On an average day about 50'000 cars are passing the site in each direction. 4 lanes are inbound with a speed limit of 100km/h, and 3 lanes are outbound with a speed limit of 120km/h. There are two poles with metal boxes on top in the central reserve. In the box of the rear pole there is the radar unit and a camera. Another camera is in the box of the front mast. Both cameras are equipped with a flash for bad light conditions. If a speeding car is triggered by the radar beam the system captures a picture from the front and the back. After half a second a third picture is taken from the rear to produce a second proof (beside the radar trigger) for the speed violation.
The whole system can be used for both directions just by transferring the equipment from the back to the front pole and vice versa. The system covers all four lanes, although it is not possible to take a front picture of vehicles using the furthest lane.

The camera unit is loaded with a film roll with a capacity of 800 pictures corresponding to 400 violations. For camera loading a police man has to cross the motorway. For safety reasons this is done at night or early morning hours. After development the film is analysed by two police staff in a manual way. The whole process for one violation takes about one minute. In the near future automatic processing of the developed film is planned. The pictures will be scanned and analysed for the license plate automatically.

THE GERMAN INTER URBAN SPEED ENFORCEMENT PILOT.

- The testsite consists of a two lane application for speed offences in Düsseldorf, Germany on an interurban highway. For both lanes separate inductive loops are installed. The loops trigger the camera to take an image. Communication will be done over ISDN-line

The camera is triggered from the inductive loop. It has to be made sure that only one trigger per vehicle is sent to the camera. The illumination of the area will be done by a flash. The vehicles will be captured from the front. The license plate of the vehicle will be read via OCR in the camera. The image is stored in the camera. At regular intervals the camera is connected to another computer via ISDN. During this connection all images are transferred to that computer. Data and images are stored in the camera until transmission. After transmission those information is deleted in the camera. The computer system receiving the images is responsible for long term storing of images and data. The control of the system is done with a software package installed on a PC running WINDOWS NT 4.0. This software consists of a camera control program giving access to the cameras all the necessary camera parameters as well as the images captured and a tool for viewing the camera files. The camera stores location, date, time, read license plate, speed and some additional information together with the image in one container file. This file format „BIF“ is a proprietary format but may be converted to public formats like JPEG.

THE CITY OF VALENCIA TESTSITE

The most important constrain of a conventional system is that it has a limited number of photographs and every week the film has to be replaced, and then the offence detection and vehicle identification has to be done manually one by one by a police operator. Currently the number of offences overflows the police centre capacity. So, the aim of this experiment is focused to the following actions:

- To reduce the number of offences and to improve the detection and localisation of those drivers involved in accidents.
- To analyse the possibility of use digital store media (digital photo or video) in spite of an analogic support (microfilms), which have the inconvenience of a short number of frames per film. Several solutions will be considered, according to the legal conditions.
- To automate the offence detection and vehicle identification processes, in order to reduce the operator time needed to produce the fine, adding a plate number recognition based on image processing techniques.
- To assure a 100 % free of error in the fine reported.
- To study the constraints in the current legal environment and to compare with other cities.

The idea is to produce a system ease to install and to move to different junctions, which allows a 24 hour operation way. The data collection and the evaluation procedures will be designed in order to enclose the following aspects:

- Reliability: analysing the percentage of offences properly detected, vehicles well identified, and final fines procedures and acceptance.
- Traffic improvement: comparing the potential reduction in the number of incidents during the experiment and previous periods.
- User acceptance: analysing the opinion of different groups of users through several surveys (citizens, drivers, operators, and authorities).

BOLOGNA TEST SITE DESCRIPTION.

Bologna as all the ancient cities has, especially in the city centre, narrow streets where it is very difficult to reserve spaces for public transport only. At this moment most of the bus lanes are not protected with physical barriers so private cars often don't respect them. The Bologna test site aims to develop and test a video enforcement system for bus lanes control using the same technologies applied from the access control system that has already been implemented to the limited traffic zone of the Bologna city centre.
The introduction of video enforcement systems will contribute to the improvement of public transport quality standards (average speed, trip duration) and will favour the modal shift from private to public transport with benefits on the global urban mobility.
The aim is to develop a bus lanes control system able to capture and transmit to a control centre, identification data of private cars that transit on the reserved lane.
The system architecture foresees.

- Terrestrial devices located near the reserved lane: device for vehicle detection, optical reader for unauthorised vehicle identification, device for data storing and transmission.
- Link to the control centre (that already manages the access control system) in order to collect and elaborate information transmitted from the controlled points.

THE EDINBURGH TESTSITE.

The City is about to introduce further public transport priority measures including all day bus lanes and stopping restrictions on certain main routes. These routes will be known as 'Greenways' and the " phase has commenced in August 1997. These will be similar to the 'Red Routes' in London. A key feature of these routes is the introduction of lengths of road where no stopping is permitted during the hours of control.
The main priority is to keep Traffic moving and avoid obstructions to public transport along the routes. With limited resources available within the Traffic Wardens and the Police, new methods of making the enforcement more affective need to be investigated. The City of Edinburgh Council is to install a network of low-resolution video cameras to automatically detect and identify vehicles stopping within the restricted areas and to alert the traffic wardens. The aim of the pilot is to explore whether or not low cost video enforcement will provide improved enforcement of the Greenways and in the long term reduce the dependency on the traffic wardens. In the long term it is hoped that the whole process can be automated and that detection and identification can be followed by an automated fixed penalty notice to the offender without the need for manual input
The objective of this test site is to develop a trial site for the detection and identification of vehicles illegally using bus lanes during hours of operation and to identify the scale of the problem and likely impact on the legal system of processing offenders.
The City of Edinburgh has at present a network of camera sites to enforce both speed and red light offences in the west side of the city. There are currently 12 speed camera locations and 14 red light camera locations**.** The system was introduced as part of a road safety initiative to reduce accidents in this area. Although there are fewer cameras than there are sites available, drivers are not able to determine which sites are 'live' at any time. In addition to this there are a number of CCTV sites around the city centre which are used to monitor traffic conditions at junctions and some are also used as part of an anti crime city watch system.
The demonstration is intended to show that video technology can be used to detect an offence and provide sufficient evidence to satisfy future legal requirements. At present, the demonstration will only be able to determine the scale of the problem. The equipment will use software developed by Napier university to detect vehicles that are stopped within the prohibited area. This will automatically trigger an alarm and send an image of the offending vehicle and details of the location to the Warden Control Centre. Supervisory staff at the Control Centre will then direct the enforcement staff to deal with the offender.

THE GERMAN WISMAR TESTSITE.

In Germany video enforcement is a method of enforcement that is under investigation now. In principle photo’s and also digital images are to be taken from the front of the car, including the driver. To ensure that developments are in line with European developments and standardisation in this area a testsite within the VERA project will be established.
It will be a testsite on the enforcement of traffic light offences, to be situated in the city of Wismar. The objective is to reduce the number of traffic lights offences and the number of accidents caused by this offence. Next to this it is to be investigated if enforcement can be executed more effectively and efficient and if video enforcement can be applied in other operational environments and enforcement areas as well.
Another important objective will be the admission of video images in a court of law. This is to be considered of vital interest for the further development and implementation of video enforcement in Germany. For the testsite two installations will be used, these will probably be installed by the end of August 1998. Video cameras will be installed at a busy junction; the cameras will be

triggered by induction loops (similar to the Spanish Valencia testsite). From each offending vehicle two pictures are taken; the pictures and other data, the measured time, are then stored on videotape while these data will be encrypted to ensure data safety.
The principle of processing is that the time will be calculated since the vehicle passed the white stop line, calculated from the beginning of each red light phase, thus ensuring that a traffic light offence has been committed (as mentioned before, in Germany a picture has to be taken of the front of the car, so this is a complicating factor).

ENFORCEMENT VIDEO CAMERA SYSTEM FOR TOLLING APPLICATION (ITALY).

All toll highway managers face the problem of recovering credits from those who, having used the service offered, have not, for whatever reason, paid for such service. Such problem is encountered independently of the various methods of payment and is consequent to a "violation" committed by the user. By a "violation" committed by the user we mean a transaction which, for whatever reason, is not completed successfully. If the method of payment is automatic (self-service or Telepass) it becomes necessary to activate a procedure allowing the automatic identification of the offending vehicle: in our case it relies upon the use of TV cameras to capture the image of the violating vehicle's licence plate.
The enforcement system is designed to take 1 picture of the rear license plate of the vehicle transiting in the lane and to transmit it back to the Lane Controller and then to the central processing centre. The design philosophy of the enforcement camera system provides concurrently with the detection of violation and vehicle position, the identification of a vehicle entering the lane, capturing of the picture of the relative rear licence plate and its temporary storage.
Subsequently, for the picture acquired, the enforcement subsystem is instructed by the Lane Controller to store such a picture until it is sent to the centre. This approach makes it possible to achieve the utmost reliability in associating each identified vehicle with its licence plate picture.
The enforcement camera system is integrated into the automatic toll collection lane architecture. The fundamental element composing such system is a video camera aimed towards the exit of the lane. The interface with the camera conforms to the CCIR standard.

THE FINNISH APPROACH.

Finland's first automatic traffic control system was introduced on a 50-kilometre test stretch on Highway E18 in the environs of the City of Salo. In 1994, camera surveillance was expanded to include the Cities of Tampere and Lahti as well as the Municipality of Juva. In 1997, the surveillance was further expanded to include the Municipality of Leppävirta. Currently, some 155 kilometres of the nation's main road network is covered by automated traffic control.

According to a decision in principle taken by the high command of the police force in 1997, the goal is to increase automatic traffic surveillance to cover approximately 1% of the national network of highways by the year 2000. At that time, the automatic traffic control system would encompass some 800 kilometres of the main road network. The intention is to expand the system to include the metropolitan city areas of Oulu, Jyväskylä, Lahti, Joensuu and possibly Vaasa. The automatic control equipment used in Finland comprises the following components: loop detectors embedded in the road, a computer unit, and a camera unit on a pole. The equipment and devices are manufactured mainly by Datainstrument - a Norwegian-based company. The equipment used in Tampere was purchased from the Dutch company Gatsometer.
The operation of the system manufactured by Datainstrument is based on piezo detectors (2 units)

which react to axle weight and are embedded in the surface of the road. These detectors relay information on vehicular speed to the control point. Based on the speed of the vehicle, a pre-programmed computer commands the camera to take one picture if the vehicle is speeding beyond a predetermined threshold speed limit. The threshold speed is at least 10% above the permitted area speed limit. The photo is taken when the vehicle reaches the so-called photo-finish line.
The camera utilises so-called traditional wet film, which means panchromatic special black-and-white film. The required information provided by the computer concerning the traffic event in question is optically stored on the picture as ASCII text.

The photograph provides details of the event, an image of the driver's face, and the license plate number. The information is used to establish the owner of the vehicle via the national motor vehicle and drivers' license registration database.
Since the piezo detectors can determine the axle weight, the camera can be programmed to recognise light-weight and heavy-weight vehicles which are required to adhere to different speed limits. In addition, the time and operation of the surveillance can be determined with the help of the software. During the entire control period, the equipment also collects statistics on the number, speed, and weight of all vehicles.
The operating principles of the Dutch Gatsometer equipment, which is used in Tampere, are on the whole similar to those of the previously mentioned systems.
The most significant difference is that the equipment is connected to the traffic lights so that running a red light can also be recorded photographically.
This equipment cannot differentiate between vehicles of different weights.

REMOTE "ATTENDED" ENFORCEMENT OF TRAFFIC REGULATIONS BY CAMERAS. (UK).

The A501 Marylebone and Euston Road corridor was considered and surveyed for potential non-compliance of box junctions and turning movements.
Three of the six existing CCTV traffic cameras were found to be located such that they were able, between them , to monitor nine of the signal controlled junctions on the corridor. All the junctions visible from the three CCTV cameras have either prohibited turning movements, yellow boxes, or both. Two junctions, Marylebone Road/Baker Street (camera 194)and Marylebone Road/Osnaburgh Street (camera 197), have a banned left or right turn movement to facilitate a signal controlled pedestrian crossing.

A vehicle undertaking the prohibited movement is potentially in direct conflict with any pedestrian being invited to cross by the pedestrian aspect on the signal head.
All cameras are mounted on 12 metre poles and have a full remotely controlled pan, tilt and zoom capability. The outstation control receiver was modified to provide a remote switch for the electronic shutter in the camera to move alternatively between the normal 1/50th of a second and 1/250th of a second. The effect of this modification is to reduce the distance over which a target vehicle has travelled during an active field.
The ambient lighting and headlights of other vehicles have compensated after sunset.
At selected monitoring sites, a secondary camera has been introduced for the specific purpose of enforcement. This has two benefits: Any extra street furniture is limited to a single pole (the controller cabinet of the primary camera being already in place) and additional costs are related only to the street equipment.

BUS LANE ENFORCEMENT, THE LONDON AREA (UK).

Buses are a vital link in London's transport system. It is frightening to think what London's roads would be like if the 3.5 million people using buses each day travelled by car instead. Congestion could be eased further if more people switched to the bus and left their cars at home. But this will only happen if people can see that taking the bus is quicker and more reliable. Priority measures such as bus lanes are designed to deliver these improvements but too often motorists misuse bus lanes, resulting in delay and congestion for bus passengers. The only way to solve the problem of bus lane infringements is to enforce bus lane rules consistently. Traditional enforcement of bus lanes, using uniformed police officers, is labour intensive and is not a high priority for use of police resources.

The Traffic Director for London was asked by the Government to develop an alternative enforcement method using unattended traffic cameras. An initial feasibility study was followed by successful trials and a pilot project where drivers breaking bus lane rules received warning letters but were not prosecuted. After reviewing these successes Government ministers asked the Traffic Director to develop a fully operational scheme in an area of North London covering approximately 60 square miles.

The Traffic Director is working in partnership with the local authorities and with bus companies MTL London and Cowie Leaside who operate in the area.

The project is being run by the Traffic Director under the authority, and in partnership with the Metropolitan Police. The bus lane cameras project takes the idea of traffic cameras one step further by installing mobile cameras on buses as well as at the roadside. Cameras fitted to buses in the scheme area record evidence against drivers whose vehicles illegally delay the bus or force it out of the bus lane. The cameras start recording automatically when the bus enters a bus lane. For bus lane cameras to be an effective deterrent; drivers need to know where they are operating.

Special Bus Lane cameras signs have been erected on key routes entering the scheme and are repeated in advance of bus lanes. The Traffic Director and the local authorities have also reviewed bus lane signs, markings and traffic orders in the area to ensure drivers are not misled. The cameras used, both make video recordings on to high quality video cassettes. Speed and red light cameras take still photographs but this approach is unsuitable for dealing with bus lane offences. For example, it would be unfair to prosecute a driver who had only entered a bus lane to avoid and accident.

While it would be difficult to tell this from a photograph, a video recording shows the sequence of events and clearly establishes whether an offence has been committed.

Each type of camera has two lenses. A wide angle lens films the bus lane and the traffic conditions in other lanes. A second lens provides a close-up of numberplates.

Pictures from the two lenses are combined and recorded on one videotape. This is done by recording alternate frames from the two lenses using a multiplexer.

Video tapes are played back using a demultiplexer so that the viewer can watch each sequence separately to identify the context of each incident and then the number plates of offending vehicles. Additional security features show that recordings have not been altered. The cameras can record in daylight and under normal street lighting so there is no flash when recording is taking place. The cameras are programmed only to record in bus lanes and then only during the times that the bus lanes are operating.

MOBILE CAMERAS.

The mobile camera system uses an automatic vehicle location (AVL) system already fitted to buses. The cameras use this information to start and stop recording as the bus enters and leaves a bus lane. Buses read their location from roadside beacons along the bus route and pass this information to the cameras.

ROADSIDE CAMERAS.

Roadside cameras are triggered by a vehicle passing sensors embedded in the bus lane. Similar sensors at the end of the bus lane will stop the recording. If more than one vehicle is detected passing the sensors, recording continues until they have all left the bus lane. If a vehicle stops in the bus lane or leaves it before passing the end sensors, recording will continue for a pre-set period. The roadside cameras are equipped with sensors which suppress recording when they detect a bus as the vehicle passing the camera.

THE SWISS ADVICE PROJECT. (ENFORCEMENT OF EFC APPLICATION , SWISS HEAVY VEHICLES TAX FEE AND ALPINE TRANSIT TOLL).

A considerable number of foreign heavy vehicles use the Swiss road network, whether it be for travelling to or from a destination in Switzerland or in transiting the country.
An enforcement system must ensure the non-discriminatory handling of foreign vehicles and Swiss vehicles.
The following points are essential as regards the enforcement of foreign vehicles:

- For cross-border prosecution foreign institutions (including toll operators) require an acceptable level of evidence to be able to give assistance, as the expensive costs of prosecution may otherwise prove prohibitive.
- Differing national laws restricting the ways in which evidence can be produced may complicate cross-border assistance.
- If foreign violators are to be tracked in their home country, there may be a need for access to central data bases for foreign institutions.

In order to enable the implementation of a distance related Heavy Vehicles Fee (HVFT) replacing the present flat fee HVFT, Switzerland will introduce an EFC system.
Additionally an Alpine Transit Toll (ATT) is planned to be introduced which uses the same components as the HVF. The Swiss government has drafted the legislation for the HVFT that includes the following definitions:

- Fee subjects: all vehicles and trailers > 3.5 tonnes
- Tolled infrastructure: entire road network of Switzerland.
- Tariff principle: the HVFT is a distance-related fee based on kilometres travelled times maximum registered vehicle weight. At a later stage it is planned that an additional fee for Alpine passes will be levied (Alpine Transit Toll).
- Classification: maximum laden weight (claimed characteristic)

The enforcement system for a distance-related area tolling such as the Swiss HVFT bears a number of particular problems because the vehicles may not pass a fixed checkpoint (i.e. toll station) for a long period or indeed even during their entire life.

Notwithstanding, the proper functioning of the OBU (distance recording, fee calculation and updating of the on-board account) must be permanently warranted.
In addition the permanent proper declaration of the class including trailer/non-trailer mode is essential. Therefore, enforcement cannot be limited to the fixed location of the toll station but must be extended in the form of mobile spot checks throughout the entire road network. This means that the enforcement function most probably cannot be assumed solely by the tolling operator but must also involve the traffic police in the entire area.

CONCLUSION.

In total, 15 testsites have been described in this document, 11 VERA en 4 Non-Vera testsites. The descriptions vary a lot, dependent on the stage the testsite, and in some cases the test site stadium has already grown into full operation (like the London Bus lane enforcement). It's interesting to see that, though similarities in applications exist, the descriptions vary in detail. What this document clearly shows is that digital image enforcement is a major subject of development in different stages of testing and implementation in Europe and that a common approach and common solutions and standards are required in the enforcement area. The following matrix gives an overview of features, commonalties and the open question marks of each testsite.

Testsites	Application	Digital image	Compressed image	Electronic fingerprint	Encrypted Datacom	Full automated chain
A-2 trajectory	Speed trajectory	Yes	Yes	No	Yes	Yes
Weigh in motion	Dynamic weighing	Yes	Yes	No	?	No
Traficon	Speed	Yes	Yes	No	?	?
Highways Agency	Variable speed limits	Yes	Yes	No	?	?
Basel-Landschaft	Speed	No	No	No	No	No
German L-52	Speed	Yes	Yes	No	Yes	Partly
City of Valencia	Red light	No	No	No	No	No
City of Bologna	Buslane	Yes	Yes	No	Yes	Partly
Edinburgh	Buslane	Yes	?	No	?	Partly
Wismar	Red light	Yes	?	No	?	?
Florence	Tolling	Yes	Yes	No	Yes	Partly
Finnland	Speed/red light	No	No	No	No	No
A 501	Banned turns/ yellow box junctions/ bus lane	Yes/no	Yes/no	No	No	No
London	Buslane	No, video	No	No	No	No
Advice	Fee collection	Yes	Yes	No	?	?

As this matrix shows, there are differences and still open questions. The VERA project will seek to come up and develop a common European approach to digital image enforcement. This paper is a synopsis of a full report on this subject, produced by the VERA project. The title of the full report is: “Deliverable 4.1. Synopsis of Video Enforcement systems and applications” and it is available on request to the VERA project manager:

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