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Products and Services for **Road Safety**

SmartCity Srl Roma ITALY

NOI SICURI

ENG Group

Product presentation

- Smartcity S.r.l.is an italian Company which collaborates with other leading partners in the sale of road safety products.

- Smartcity Srl and ENG Group present:

CELERITAS project

- Speed is a major cause of death on the streets and it is also a big social cost for every nation.

- The Project Celeritas was founded with the goal of improving the technology currently in use for the control of mean speed on the roads.

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- The result of four years of insights, labor and investment is the development of the technology of digital system CELERITAS.

- CELERITAS is internationally patented and approved by Italian Ministry of traffic

- CELERITAS is today the most innovative and effective traffic management system for the control and the automatic detection of the average speed infractions

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CELERITAS project

There are two types of speed control technologies

Instant Speed Based	Mean speed based
detect the speed of a vehicle at a given moment	calculate the average speed of a vehicle through the detection of the travel time for a specific route

- The technologies that are based on the detection of average speeds are "more right" as measure speed in the same way for everyone, not just for those who do not know where it is positioned the apparatus for assessing the precise speed and, above all, allow the possibility of a precise speed is exceeded (for example for overtaking) provided in the section considered the average speed is in accordance with the limits

- The technologies that are based on the detection of the average speed not being then interpreted by the driver as a kind of "trap", as is the case for technologies that are based on the detection of the instantaneous speed, lend themselves to be better accepted. In this way, mainly to fulfill an educational function and not persecutory.

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Benefits on use average speed technology

- On the basis of previous experience, the use of these technologies has enabled the achievement of a significant reduction of the average speed (-15%) and the peak rate (-25%) :
  - a reduction in **accidents** of 19%
  - a reduction in **mortality** equal to -51%
  - a reduction in **accidents with casualties** amounting to -27%

The use of technologies for detecting the average speed can guarantee a substantial reduction in accident rates and the risks involved.

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CELERITAS project

- Celeritas is among **the most innovative traffic management equipment** aimed at detecting the average speed of vehicles on section of routes with defined length.
- It is based on a **patented technology** in the international sphere and can be used in any context of the national and international road network.
- The operation is based on an **innovative methodology** called plate matching capable of ensuring high performance and levels of error in the detection of violations substantially lower than other similar technologies already on the market and OCR based technology.
- Celeritas has received **approval** from the Ministry of Transport in accordance with the relevant regulations (Nuovo Codice della Strada)
- **CELERITAS is the most advanced technology available on the market to control the average speed of vehicles and encourages, therefore, an educational action towards respect for the principles of the Highway Rules.**

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Reliability and the low level of complexity of the infrastructure are the main strengths of CELERITAS

RELIABILITY in the detection of offenses

- High reliability (over 99%) in the detection of transits and the identification of the offending vehicles
- High efficiency of the system even when monitoring the speed of vehicles with **foreign** number plates, **deteriorated** or **counterfeit** and **motorcycles**

EASY infrastructure

- Detection of transits only through the video captured by the cameras
- No action on the infrastructure even after the resurfacing the road
- Need only simple roadside infrastructure for the installation of the equipment

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High reliability of detection violations and easy installations compared to other certified equipment

CELERITAS

- Avant-garde technology protected by international patents (plate matching)
- High reliability (> 99%) in the detection and identification of violations, including motorcycles and foreign vehicles (patented Plate Matching technology)
- Effectiveness of the system unchanged with vehicles with foreign number plates, deteriorated or counterfeit.
- Easy infrastructure that not requires ad hoc structures neither inductive loops embedded in the asphalt
- Light data transfer that also works with normal card GPRS / UMTS

Other systems

- Outdated technology (OCR), which is unreliable and with high margin of error in the detection of transits and recognition of license plates.
- Complex structure and "heavy" for its installation that requires ad hoc portals on the section of road
- Dedicated data transfer infrastructure and require coils embedded in the asphalt or, in case of noninvasive devices involve compliance with specific and rigid constraints
- Limited effectiveness in detecting offenses committed by motorbikes
- Data management through dedicated servers resulting in higher operating costs and maintenance

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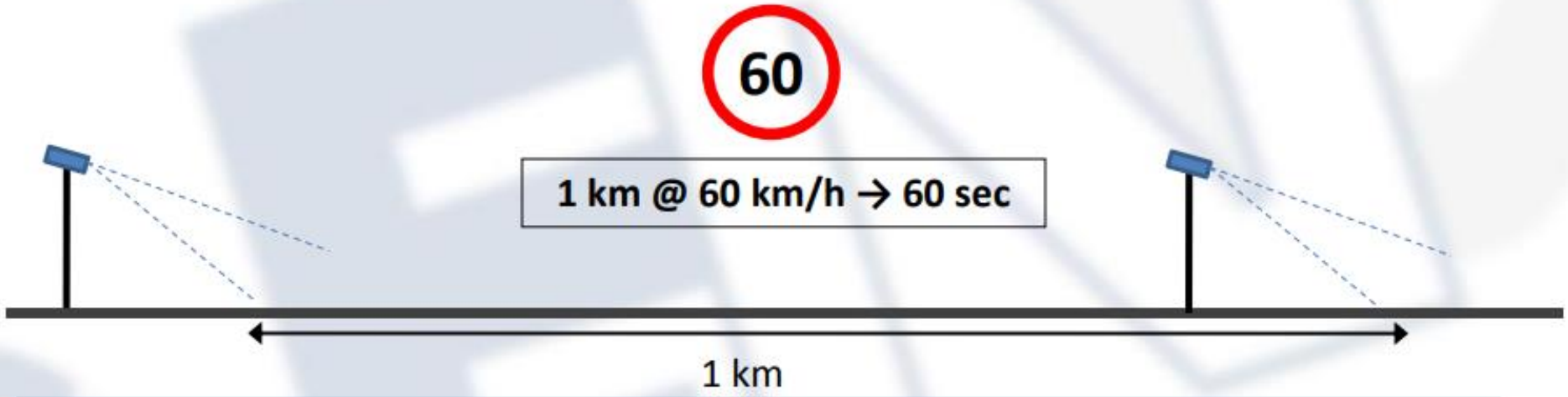
The operation process of CELERITAS

Consider for example a trait to be monitored than 1 km subject to maximum speed limit of 60 km/h



Each vehicle passes the first check point (peripheral unit) the system acquires an image (the most suitable recognition) and the time.

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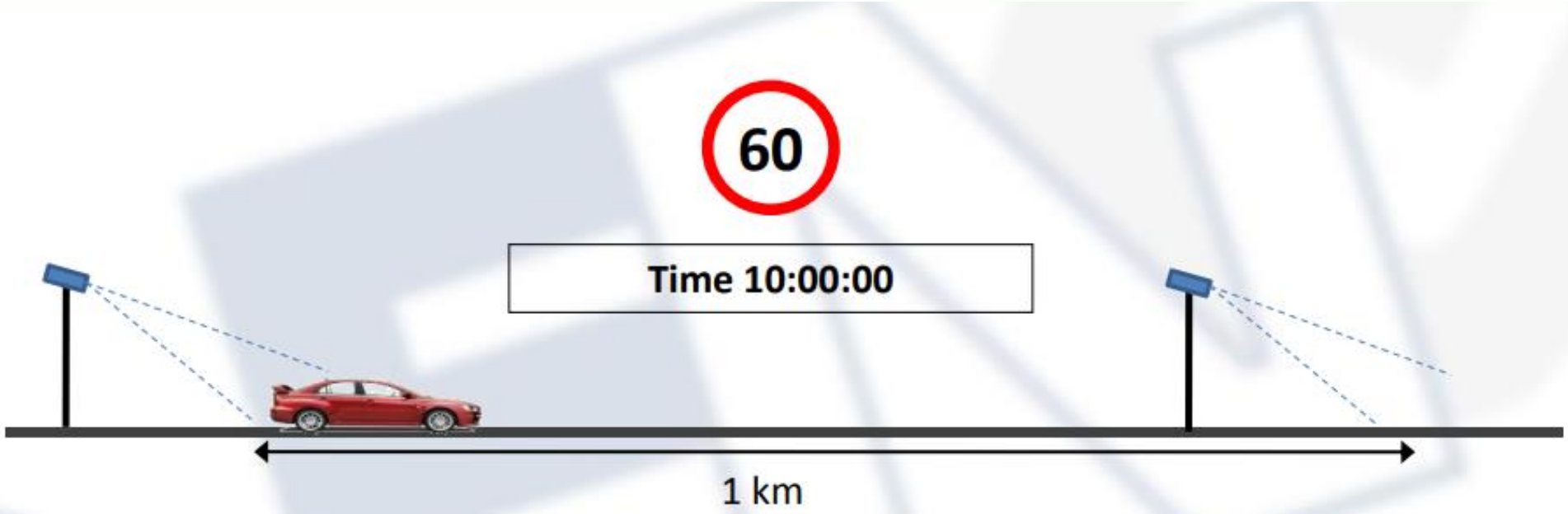
The operation process of CELERITAS



Consider that the vehicle A (red) passes under the first check point 10:00:00

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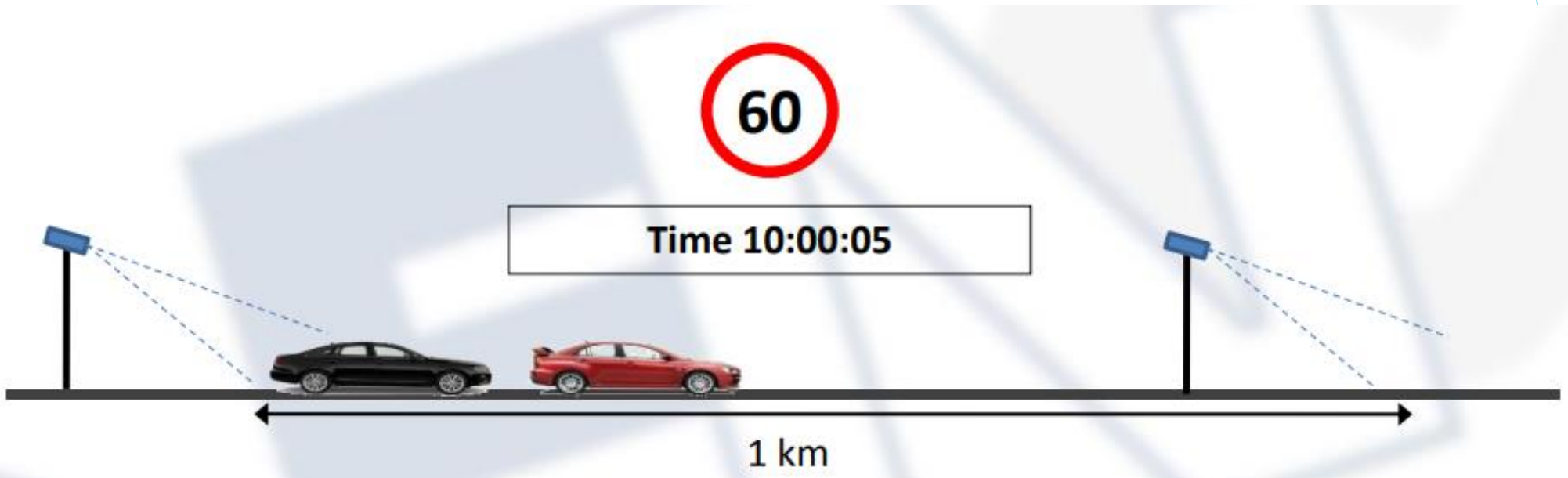
The operation process of CELERITAS



And that vehicle B (black) passes through the first checkpoint at 10:00:05

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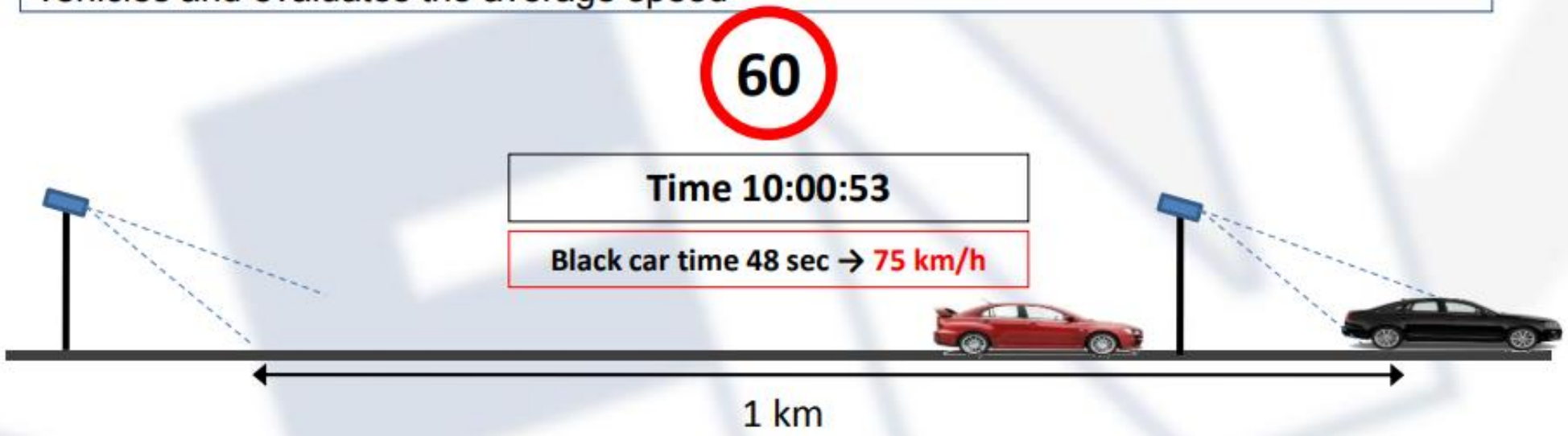
The operation process of CELERITAS

When vehicles passes the second check point the system automatically coupled vehicles and evaluates the average speed



So if the vehicle B (black) passes under the second checkpoint at 10:00:53 traveled the stretch over the limit (48 sec < limit time of 60 sec)

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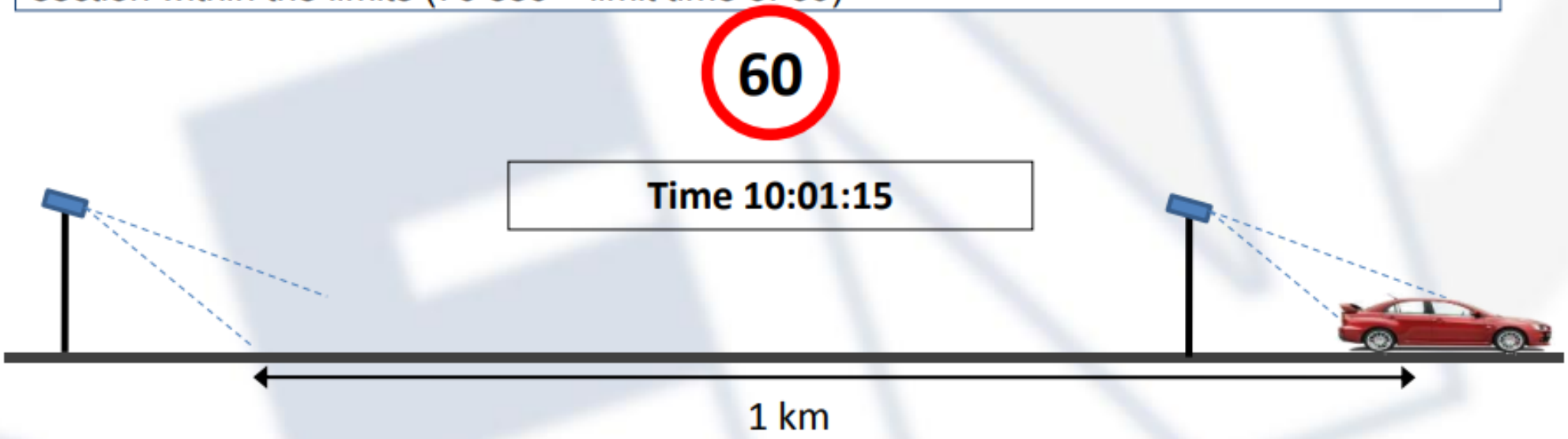
The operation process of CELERITAS

As if the vehicle A (red) passes under the second checkpoint at 10:01:15 traveled the section within the limits (70 sec > limit time of 60)



Only if the average speed measured is greater than the limit (and tolerance of law), the two images acquired by the two cameras are sent to the server.
In this example, only the images of the black vehicle are transmitted to the server and presented to the operator.

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The CELERITAS operation is divided into 5 phases

- **Celeritas allows to detect, along a stretch of road well defined between two peripheral units, the transit of vehicles with any type of license plate**

1) The peripheral units captures transit images correlated to passage of every vehicle thru the gate.
2) The peripheral units send information relative to each transit to the central processing unit using a secured encrypted network.
3) The central processing unit processes the data received and evaluates the possible violations in real time with reference to time taken to cover the distance of the monitored lanes.
4) The central unit proceeds to acquire images corresponding to each potential violation and dispatches information of each infraction to the operator for validation and control.
5) The operators proceeds for verification and confirmation of the individual violation along with all data acquired and proceeds with ticket generation.

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Speed accuracy

It is possible to evaluate the speed accuracy **%MaxErr**.

Depends from:

- Distance between the two check points or section length (L).
- Highest mean speed at which you can go to the section monitored (VMax).
- Time sync accuracy between the peripheral units.
- Depth of view of the cameras involved (PU1 and PU2)

It is usually possible to guarantee errors less than 2% t the maximum speed VMax.

When the distance L increase (5-10Km) the accuracy become less than 1%.

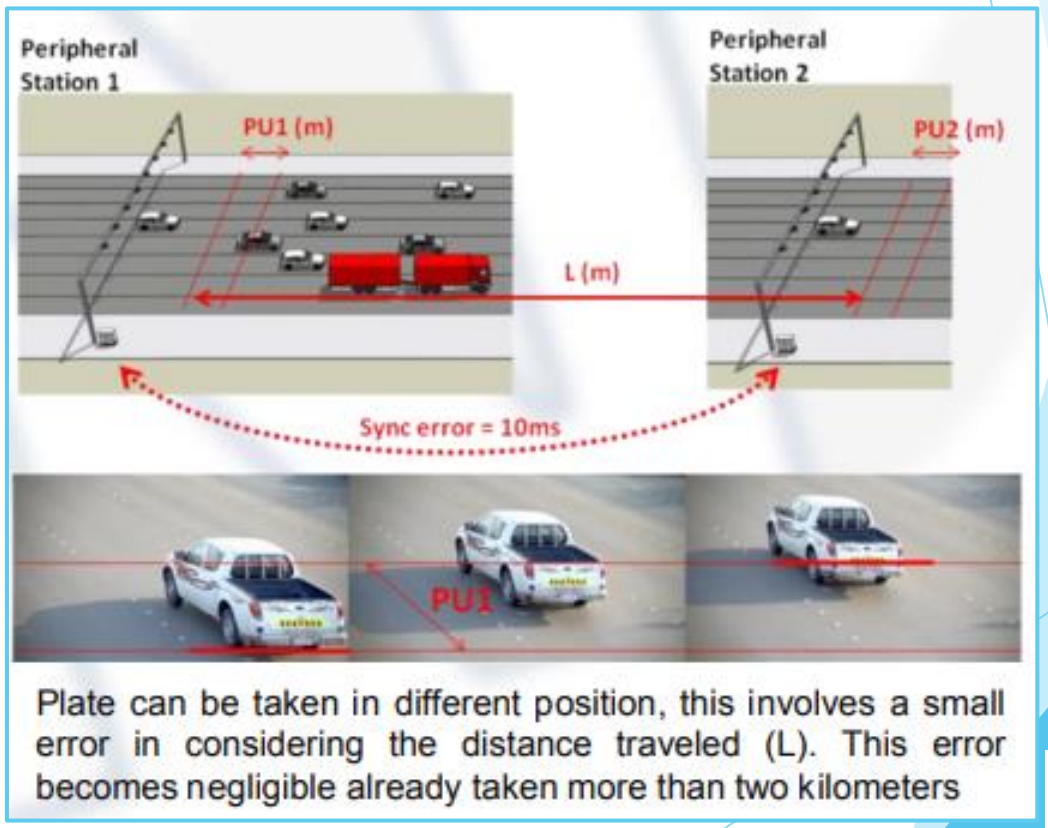

Plate can be taken in different position, this involves a small error in considering the distance traveled (L). This error becomes negligible already taken more than two kilometers

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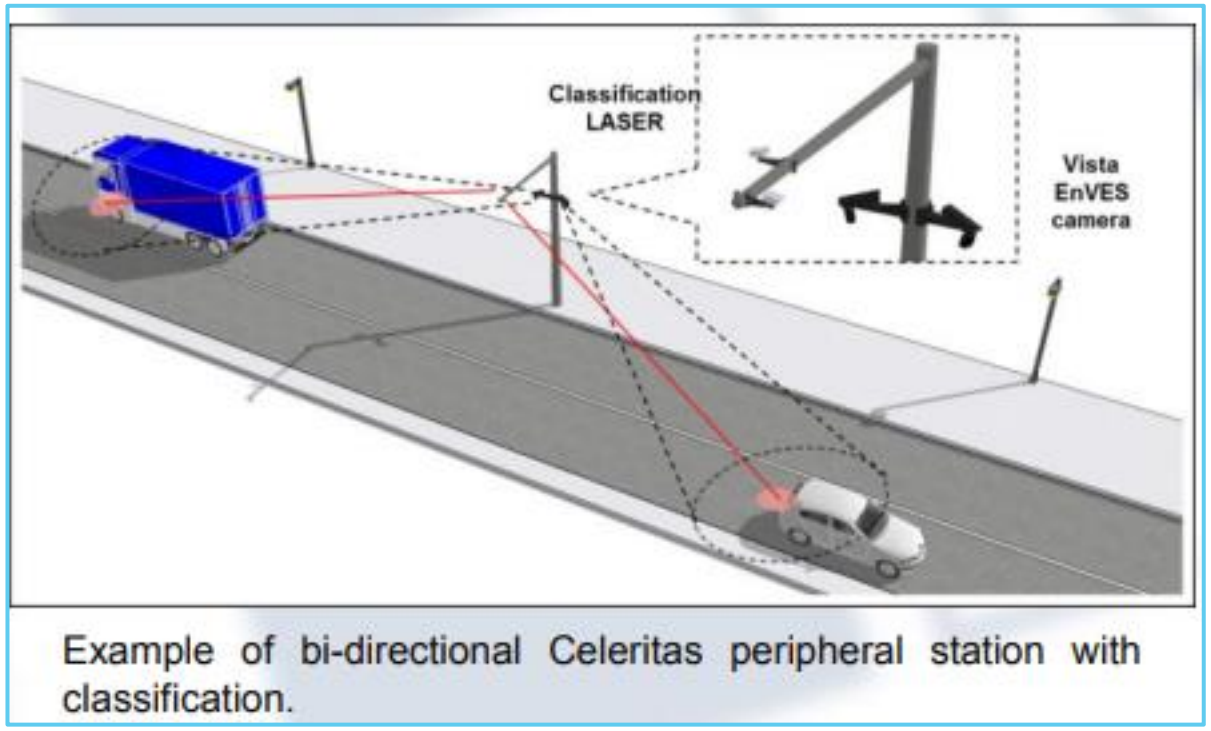
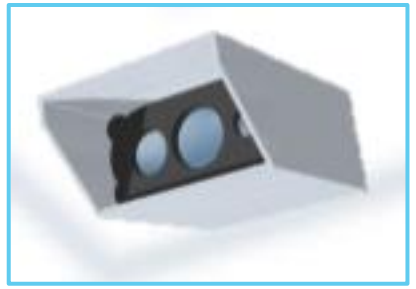
Noninvasive Vehicle Classification

- CELERITAS can automatically apply different speed limits for different classes of vehicles.
- Classification is done by a special Laser module that must be placed over the lane.
- Classification can be done also only in one of two check points (peripheral units).



Example of bi-directional Celeritas peripheral station with classification.



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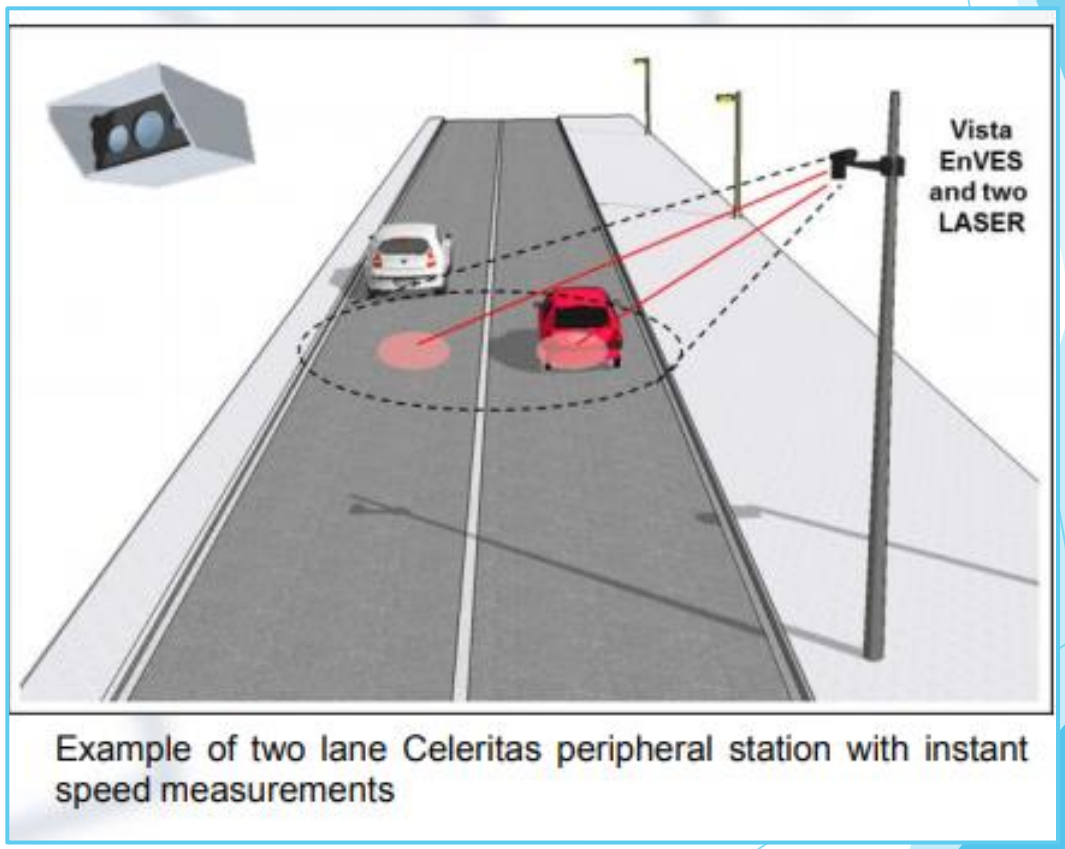
Instant speed measurement (optional)

- CELERITAS can also measure the instant speed at the checkpoint.
- Speed measurement is done by a special Laser module that can be placed on the top side of the lane.
- The system has a very high accuracy in the detection of speed. Experimental tests certified by TUV Rehinland certified that system precision is about ± 2 km/h for speeds up to 150 km/h and about ± 3 km/h for speeds between 150 km/h and 265 km/h



Example of two lane Celeritas peripheral station with instant speed measurements

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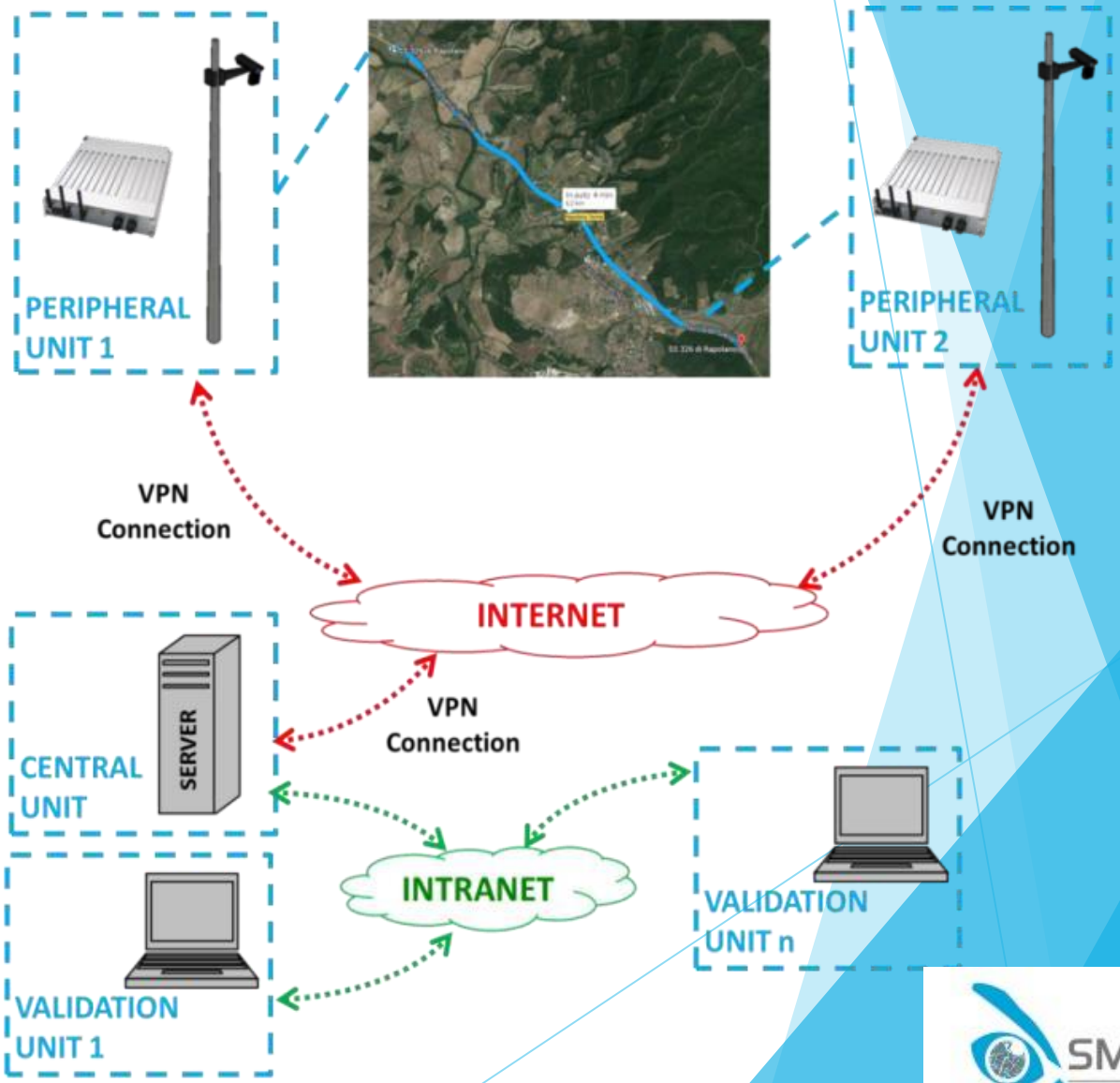
CELERITAS system architettare

CELERITAS architecture components:

- **Peripheral units** for the detection of images and data;
- **Central unit** for the management of information sent from the peripheral units;
- **Data network** (wireless or wired) for connecting peripherals with the central unit (can be INTERNET with an encrypted VPN);
- **Validation units** for the purpose of control and the validation of reports of offense;
- **Data network** for the interconnection between the central unit and the validation unit of the operators responsible for the activities of ticketing (INTRANET).



Peripheral units

Peripheral units tasks:

- detection of vehicle (directly through the processing of the video)
- acquisition of vehicle images with information like date, time, vehicle class, place.
- transmission of data (without images) ▫ receiving from the Central Unit the list of transits in violation of which shall be transmitted their images
- transmission of images required by the Central Unit relating to vehicles in violation
- deletion of images related to regular transit traffic

Where it is necessary to detect violations distinguishing different class of vehicles subject to different maximum speed, it is possible, in addition, the use of:

- LASER classificator, installed over the road or in the top side
- passive magnetic probes, installed below the road surface (to a depth of 60 cm) that do not require maintenance interventions even following operations resurfacing of the road surface.

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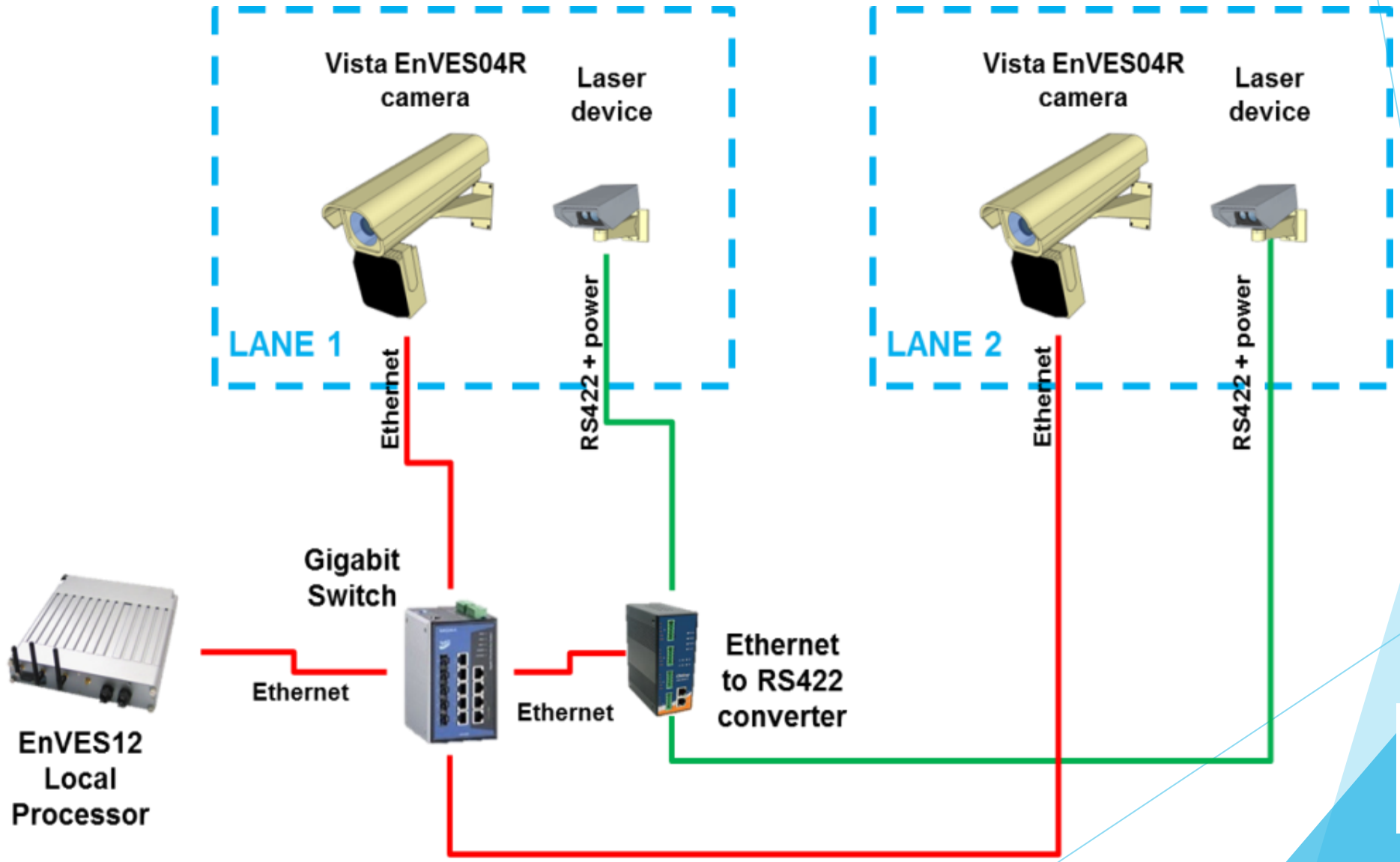
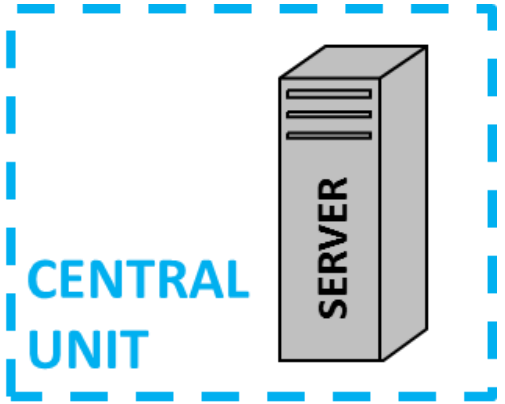
Peripheral Unit Connections



Central Unit

Central unit tasks:

- acquisition of data from the local units
- archive management on data traffic and system diagnostics
- time synchronization between the central unit and peripheral units
- the determination of the potential vehicles for speeding violation on the basis of the analysis of the data received (not images) from peripheral units
- communication with violation unit for verification and validation
- storage of data relating to offenses detected



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Validation Unit

Validation unit tasks:

- communication with the central unit for the exchange of data relating to the alleged infringements
- the management of the verification and validation on potential infringements reported by the central unit
- ability to export data violation to allow the start of the process of collection of the violation

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The operation of CELERITAS is based on an innovative methodology called **plate matching**

- **The plate matching methodology allows to overcome the limitations of existing control systems that are based on automatic number plate recognition** (ANPR with OCR). Plate matching technology providing high reliability with reference to vehicles with number plates not standard or foreign, plates with low-readable characters (broken) and plates counterfeit.

- Experimental data have made it possible to detect, in comparison procedure and coupling of transits performed through two peripheral units present on the same route, a maximum rate of errors well below 1%.

- The principal task of MEAN SPEED systems is coupling transits of same vehicles between two check points (peripheral stations).

- Traditional mean speed systems uses a “rigid” feature like the ANPR (OCR on the plate). This usual approach is less efficient because loses lot of match.

- **Plate matching is revolutionary because the information extracted from the license plate is focused to the “coupling and matching” and not the recognition**. This allows you to break free from the problems that can be on the read of some characters

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Plate matching vs traditional OCR matching

Plate matching allows to match the pair of license plates not even recognizable by the ANPR/OCR.

The license plate may not be readable for many reasons like:

- camera noise,
- reflections on the glass,
- shadows,
- occlusions of some character of the plate,
- dirt on the license plate.

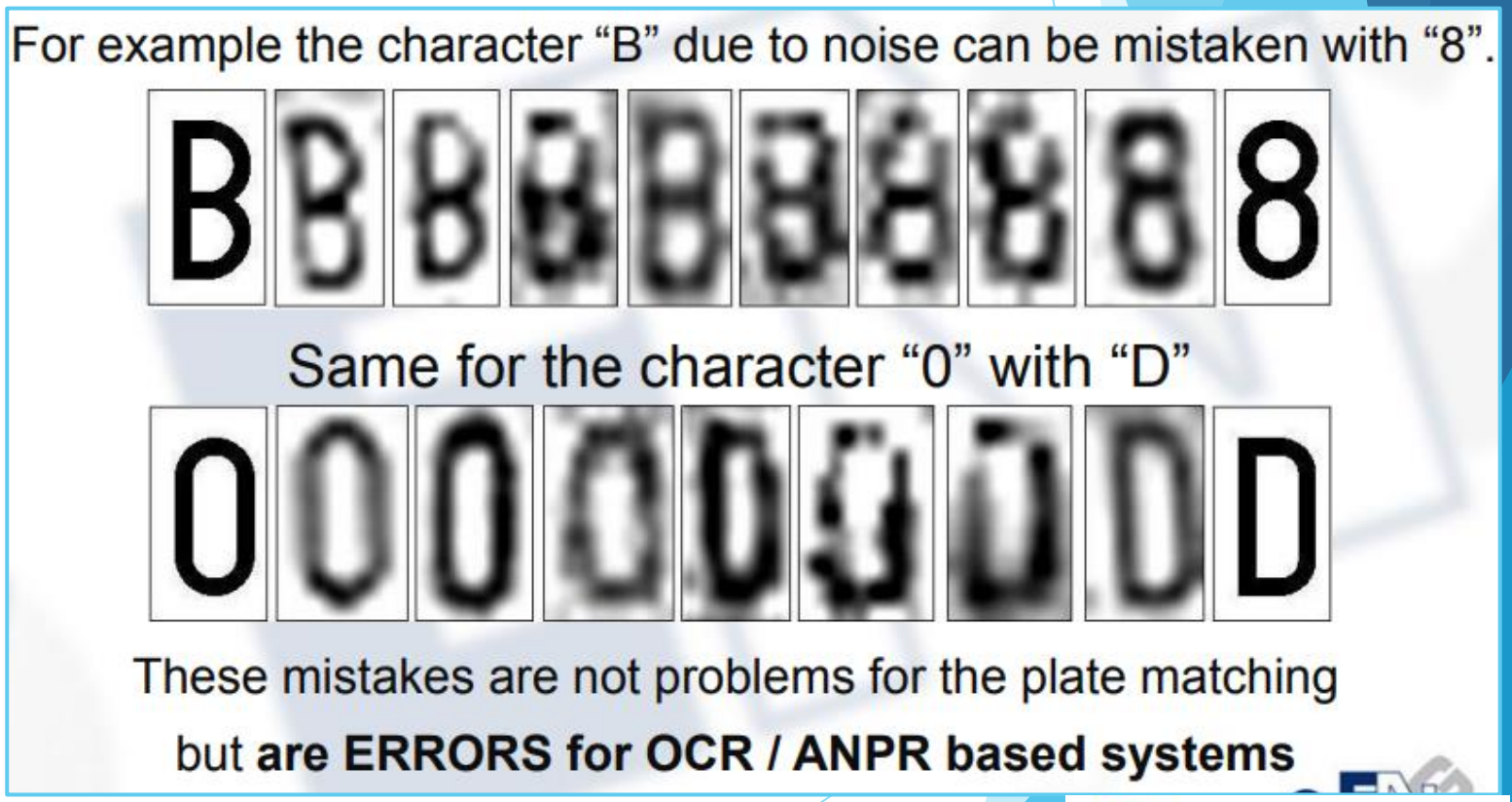

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Plate matching vs traditional OCR matching

Here some examples to show some couple of images where ANPR / OCR matching systems fails:

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Plate matching vs traditional OCR matching

Plate Matching based

- Easy infrastructure (noninvasive) for peripheral stations. Plate matching is able to extract matching information also with camera installed on the side of the road.
- Plate matching extract information from 99% of license plates, also different and unexpected countries, dirty or broken!
- Match errors are very rare, less than 1%.
- This patent allows you to control ALL VEHICLES that pass with easy and slim Infrastructure. EVERY TRANSIT IS CHECKED!

OCR / ANPR based

- Requires complex infrastructure, the camera for ANPR must be on the lane in order to achieve high ANPR accuracy
- Also with high accuracy ANPR (like 90%) the result of combination from the two stations is only around 81%.
- The ANPR accuracy can also drop markedly below 80% which implies that the system loses 1 out of 3 vehicles in violation! This system loses it credibility!

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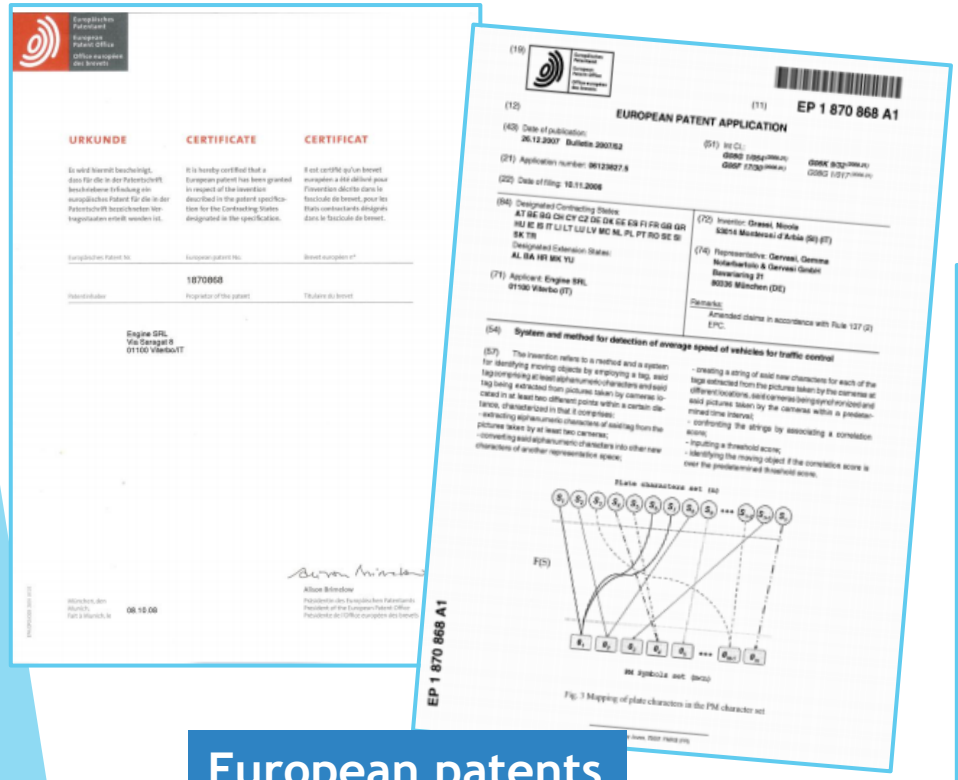
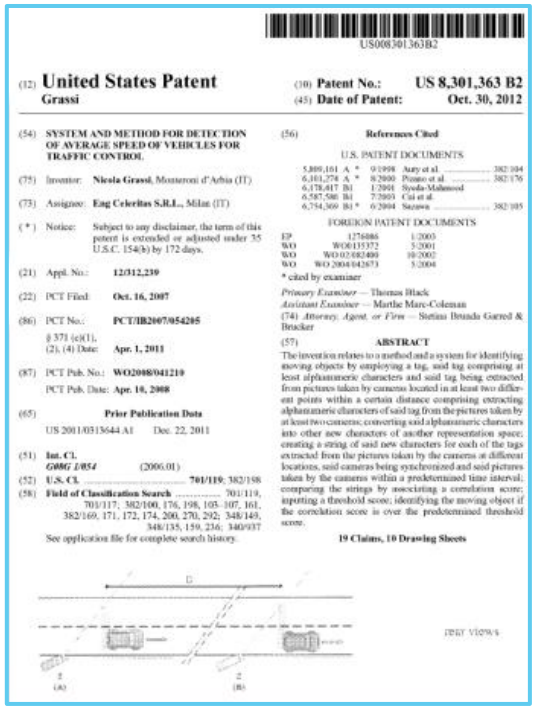
Plate Matching Patents



European patents



U.S. patent

Eurasian patents

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The four phases plate matching operation

1 DETECTION OF TRANSIT TO FIRST PERIPHERAL UNIT	✓ The license plate of each vehicle is associated with a particular string of symbols. ✓ For each transit are associated with, in addition, further information on the instant of the passage and the transit lane road.
2 DETECTION OF TRANSIT TO SECOND PERIPHERAL UNIT	✓ The license plate of each vehicle is associated with a particular string of symbols. ✓ For each transit are associated with, in addition, further information on the instant of the passage and the transit lane road.
3 IDENTIFICATION OF TRANSIT SETS WITH POTENTIAL VIOLATION	✓ The system identifies a set of transit for the first section, on the basis of the distance monitored and the maximum speed allowed on the road, can identify potential violations ✓ Within the set containing the couples of transits with potential violations time the central unit select only the couples of transits with similar or same string of symbols.
4 IDENTIFICATION OF VIOLATIONS TRANSITS	✓ Between the identified pairs is defined a score that estimates the level of confidence concerning the adequacy of the association. Couples of transits with confidence levels greater than a treshold, with high probability, are violating the speed limit.

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Some matching samples

- Following slides shows some samples of coupling detected from CELERITAS using Plate Matching technique.

- These samples show the efficiency and robustness of the technique applied to average speed enforcement in each condition of ambient conditions (day, night, sunny, rain, shadows, etc.), different type of installation (road, bridge, etc.) and different vehicles and plate country (also in cases of maliciously altered plates).

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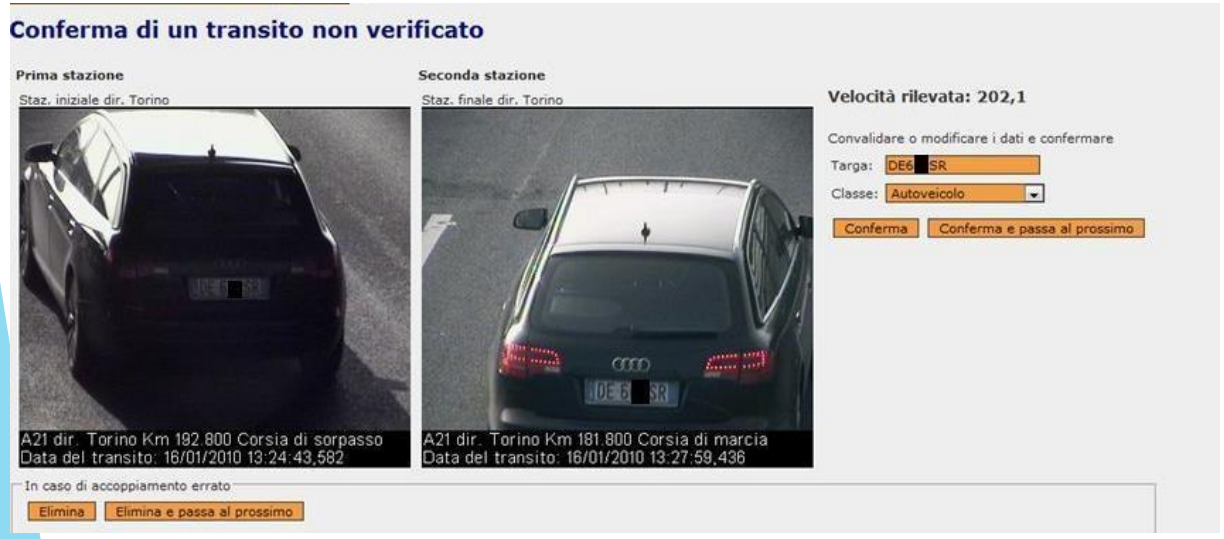
Some matching samples: cars



on shadows context

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Some matching samples: cars

with reflective glass

nighttime

nighttime with fog

rain

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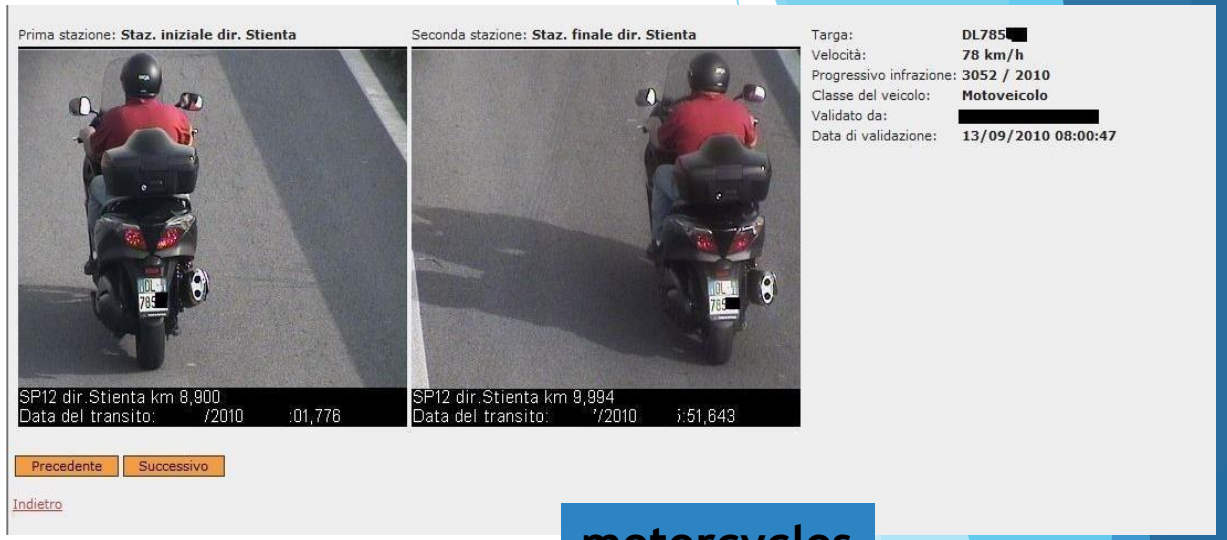
Some matching samples: other types of vehicle

trucks



motorcycles

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Matching with plates NOT readable by ANPR

Conferma di un transito non verificato

Prima stazione

Staz. iniziale dir. Brescia

Seconda stazione

Staz. finale dir. Brescia

Velocità rilevata: 85.6 km/h

Convalidare o modificare i dati e confermare

Targa: ********

Nazionalità: Italia

Classe: Autoveicolo

Conferma | Conferma e passa al prossimo

In caso di accoppiamento errato

Elimina | Elimina e passa al prossimo

Prima stazione

Staz. iniziale dir. Brescia

Seconda stazione

Staz. finale dir. Brescia

Velocità rilevata: 89.3 km/h

Convalidare o modificare i dati e confermare

Targa: ********

Nazionalità: Italia

Classe: Autoveicolo

Conferma | Conferma e passa al prossimo

Some matching samples: foreign plates

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Some installation samples

- Following slides shows some samples typical installation.
- It is possible to see how simple is the roadside infrastructure and how it is ductile: it is possible to install roadside units in a gantry, an L pole or a right pole.
- It is also possible to install roadside equipment in an above ground pole. This case is normally used for temporary installation (tipically powered by fuel cell).

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Installation example: causeway

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Installation example: right pole

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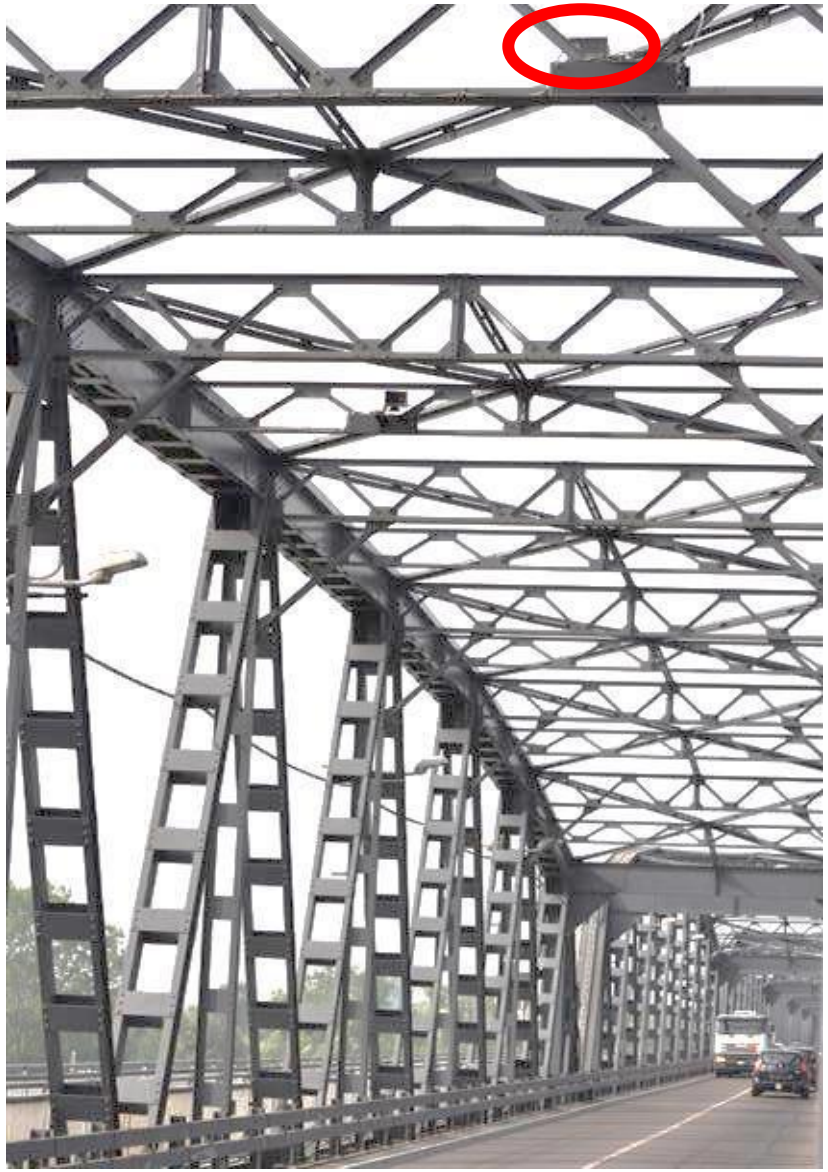
Installation example: bridge



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Installation example: L pole

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Installation example: Gantry

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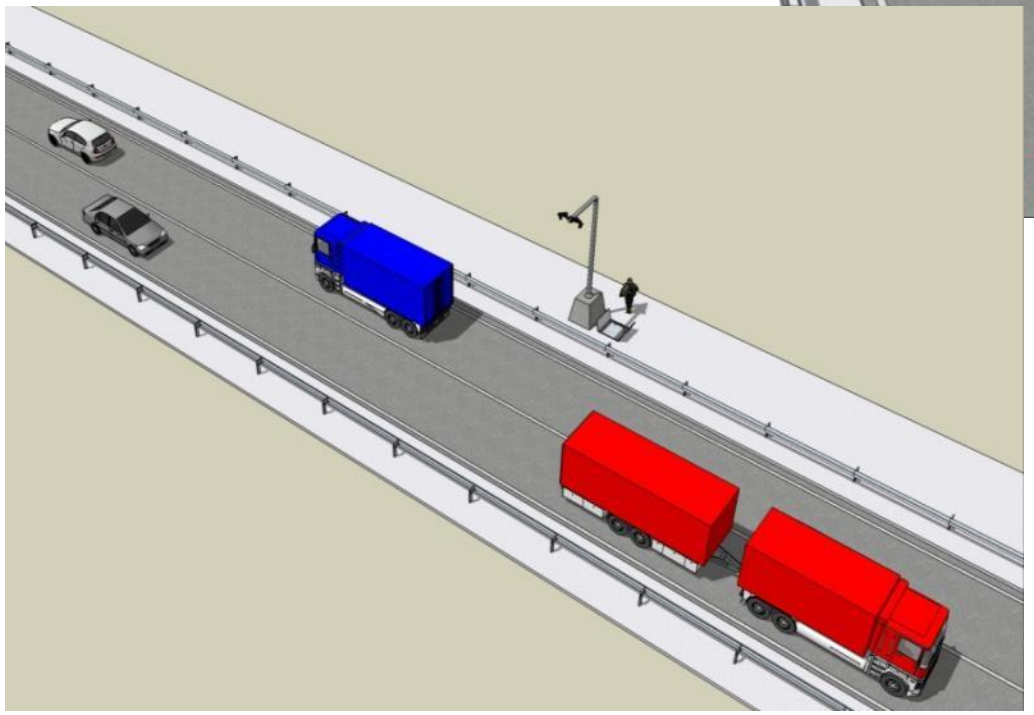
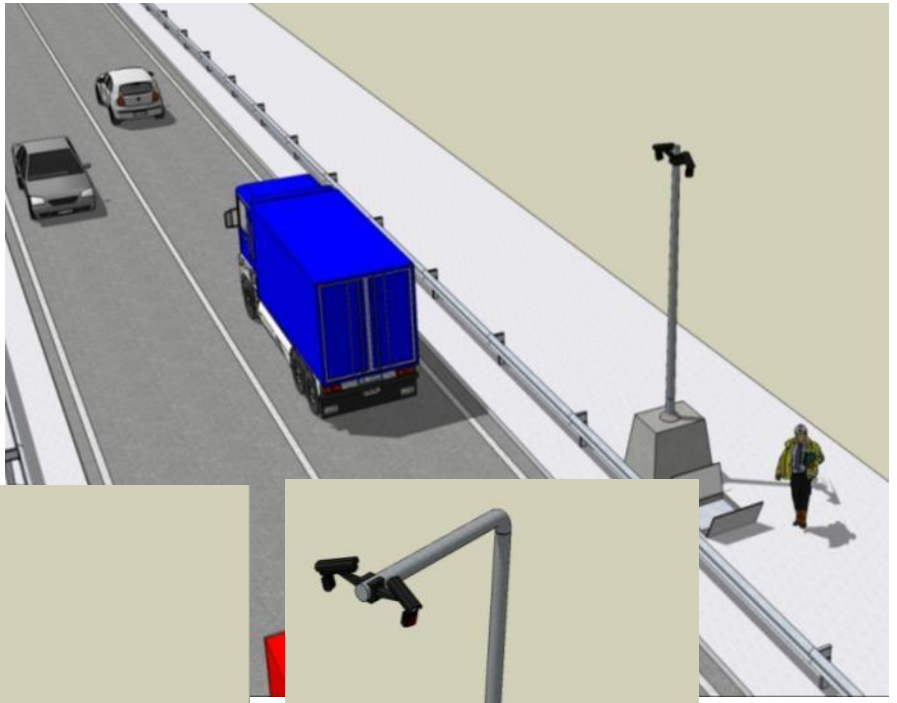
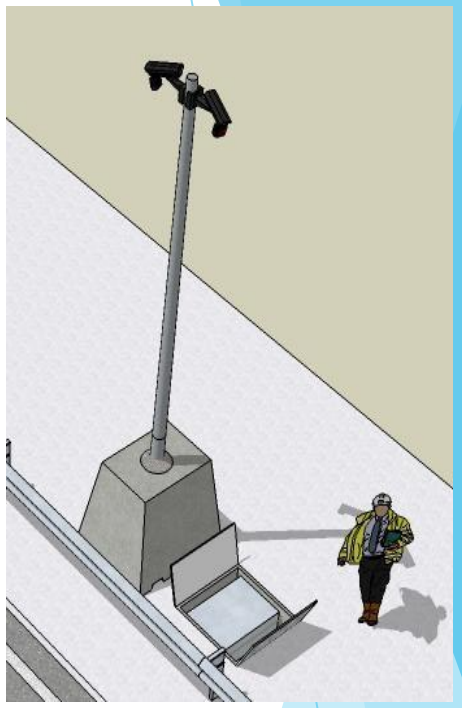
Installation example: above ground with right or L pole







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Thank You

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