DNIT DEPARTAMENTO NACIONAL DE INFRAESTRUTURA DE TRANSPORTES

Southern African Transport Conference

IMPLEMENTATION OF WIM FOR DIRECT ENFORCEMENT IN BRAZIL

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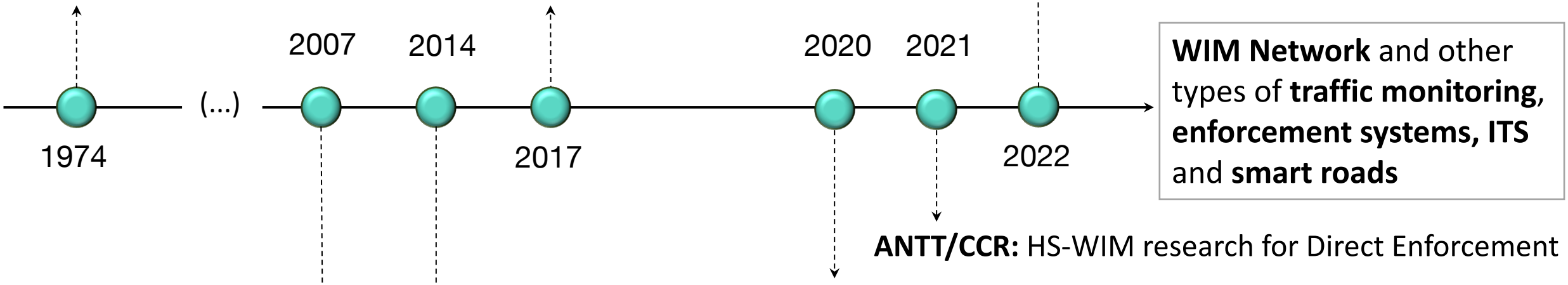
History of WIM for enforcement in Brazil



Motivations

MAIN GOALS

- Improve road safety and pavement performance on federal highways;
- Improve the performance of overload enforcement;
- Automate the pre-selection of overload enforcement;
- Optimize the activity of DNIT Traffic Agents with the help of technology;
- Allow free flow of trucks and buses without overload and reduce inspection time;
- Expand overload enforcement on the federal road network.

Brazil roads and highways in numbers

Road Network - extension in km			
	Paved	Non-Paved	Total
Federal	65.686	9.286	74.972
State, Transitional, State and Municipal Highways	149.333	1.340.814	1.490.147
Planned Road Network	-	-	157.309
Total	**215.019**	**1.350.100**	**1.722.428**

Concession Road Network - extension in km	
Federal Concessionaires	10.365
Federal Concessionaires	12.824
Municipal Concessionaires	38
Total	**23.227**

Vehicle Fleet	
Rigid truck	**29.530.222**
Tractor truck	**799.732**
Trailer	**2.002.459**
Semi-trailer	**1.160.422**
Interstate and international buses	**29.673**
Intercity buses	**57.000**
Freight bus	**23.619**
Urban buses	**107.000**
No. of Road Terminals	**173**

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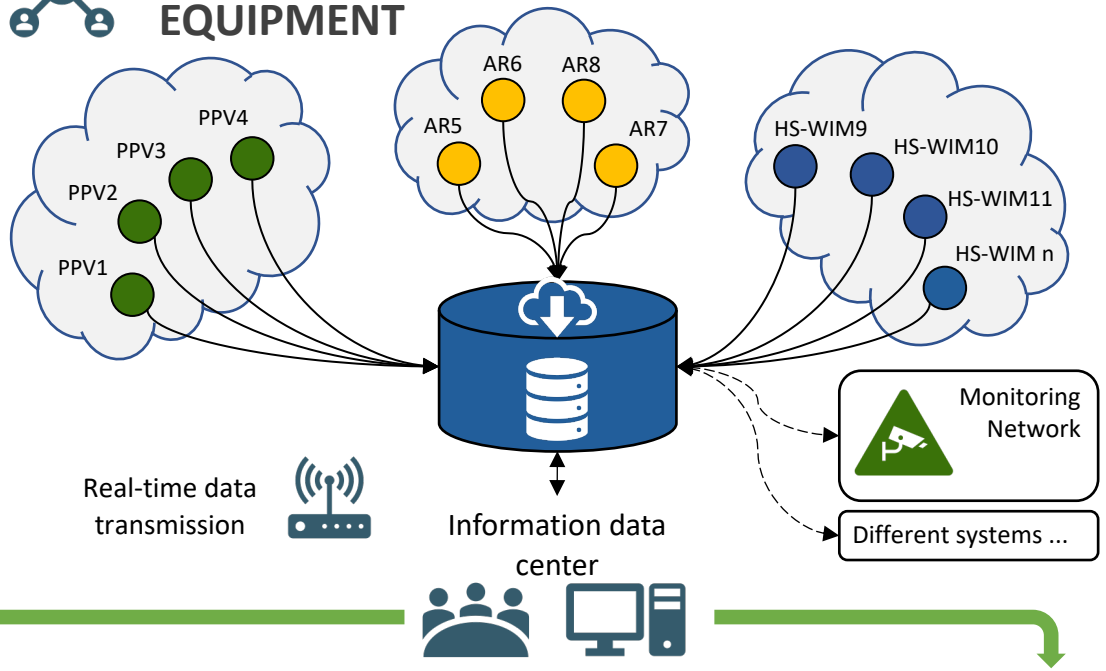
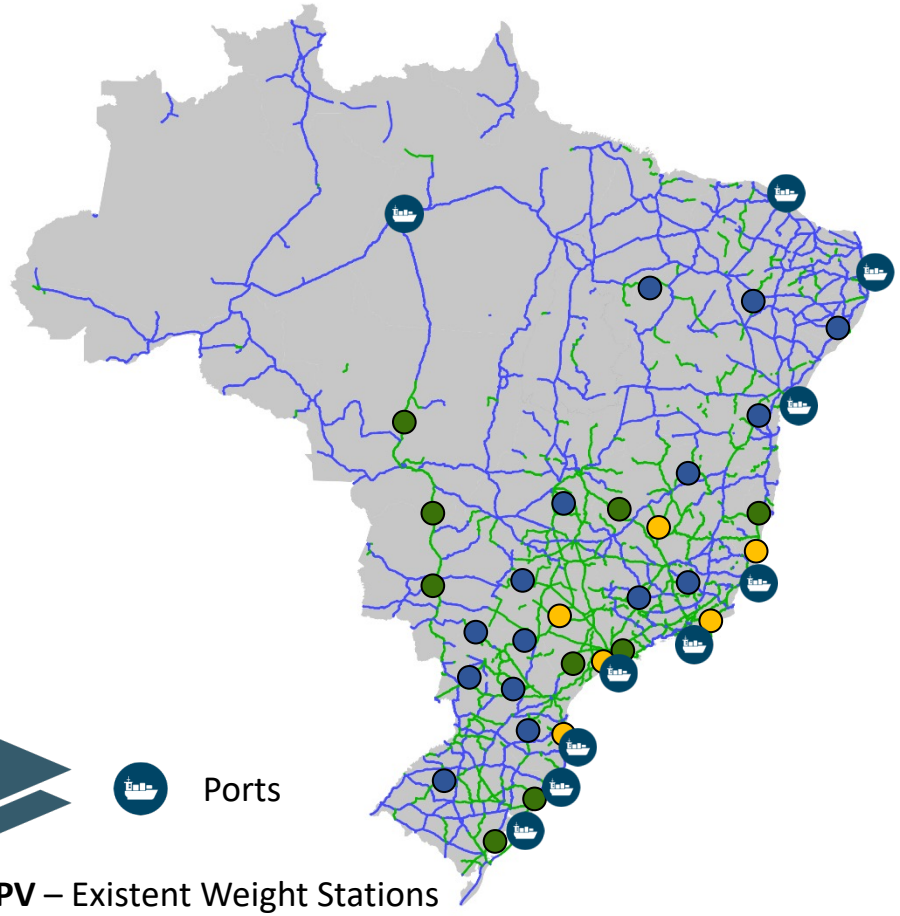
Legal support and WIM for Direct Enforcement

- **RTM do INMETRO:** Launch of Metrologic Instrument No. 019/2022, that replaces No. 375/2013:
  - ✓ 3 Classes (in service): GVW 5%, 7% e 10%.
  - ✓ 3 Classes per axle (in service): Axes/Axes groups 8%, 12%, 16%.
- **M.Infra working group:** Discussion on legal changes for enforcement with WIM.
- **Standardization ABNT/CE-016:**
  - ✓ ABNT NBR ISO 15638-20 – Framework for cooperative telematics applications for regulated commercial freight vehicles (TARV) — Part 20: Weigh-in-motion monitoring (launch in 18/11/2021).
  - ✓ ABNT NBR (under discussion) – Automatic weighing of road vehicles in motion – requirements.

Brazil plans for on-road overload enforcement

INTEGRATION BETWEEN DIFFERENT ENFORCEMENT EQUIPMENT





- Data collection of traffic and transport
- Intelligence and data from commercial transport
- Overload enforcement operation with remote agent
- Information, data, traffic statistics, weight, indicators, etc.

- Direct Enforcement for overload and transport
- Integration of data and information with different parties
- Publications of information and indicators
- Identification of new places for overweight enforcement considering the possible routes

Ports

- **PPV** – Existent Weight Stations
- **AR** – Weight Station using remote agent (and/or pre-selection with HS-WIM)
- **HS-WIM** – Weigh-in-Motion systems (stand alone)

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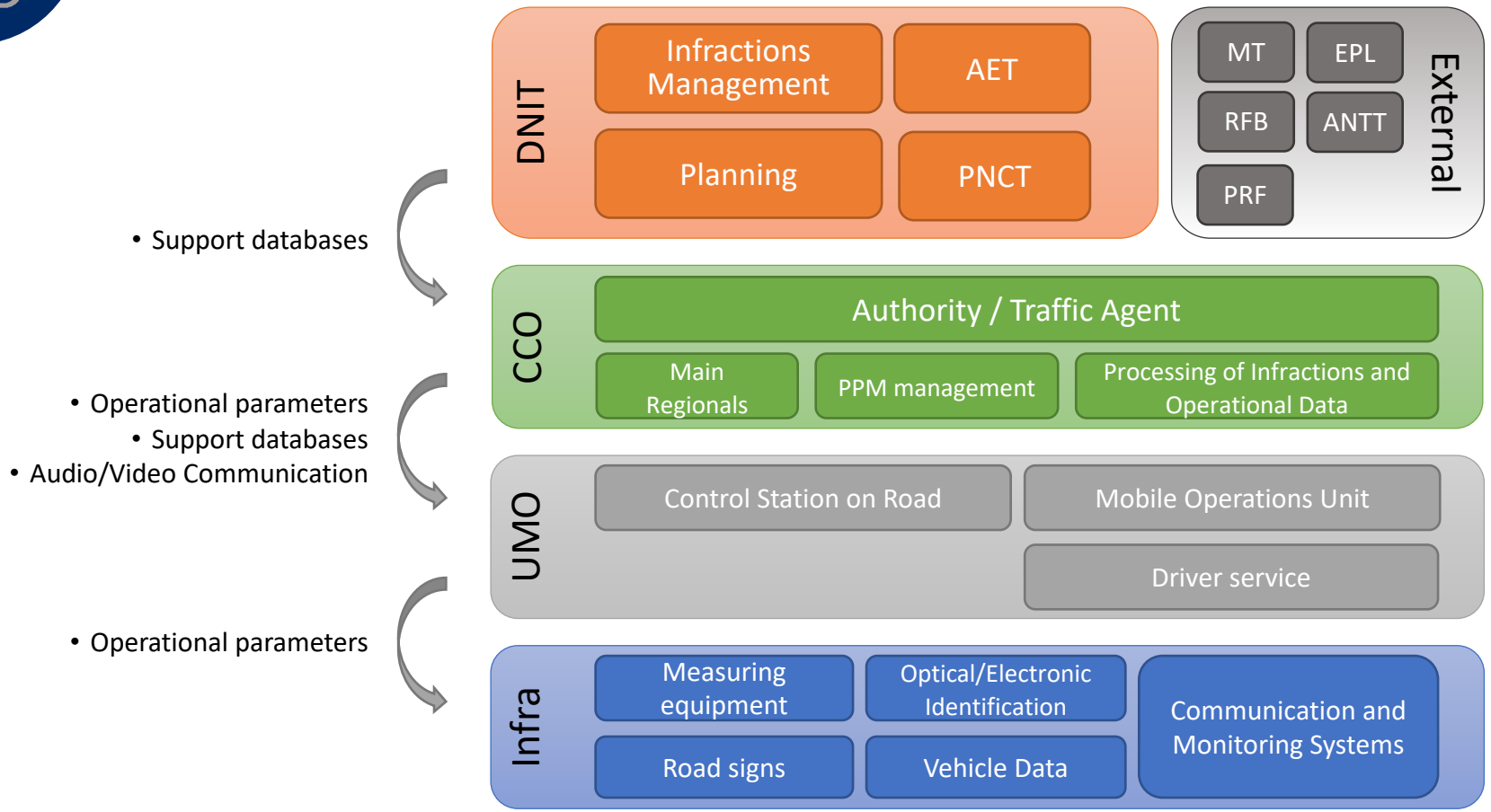
Operational architecture

BASIC DEFINITIONS

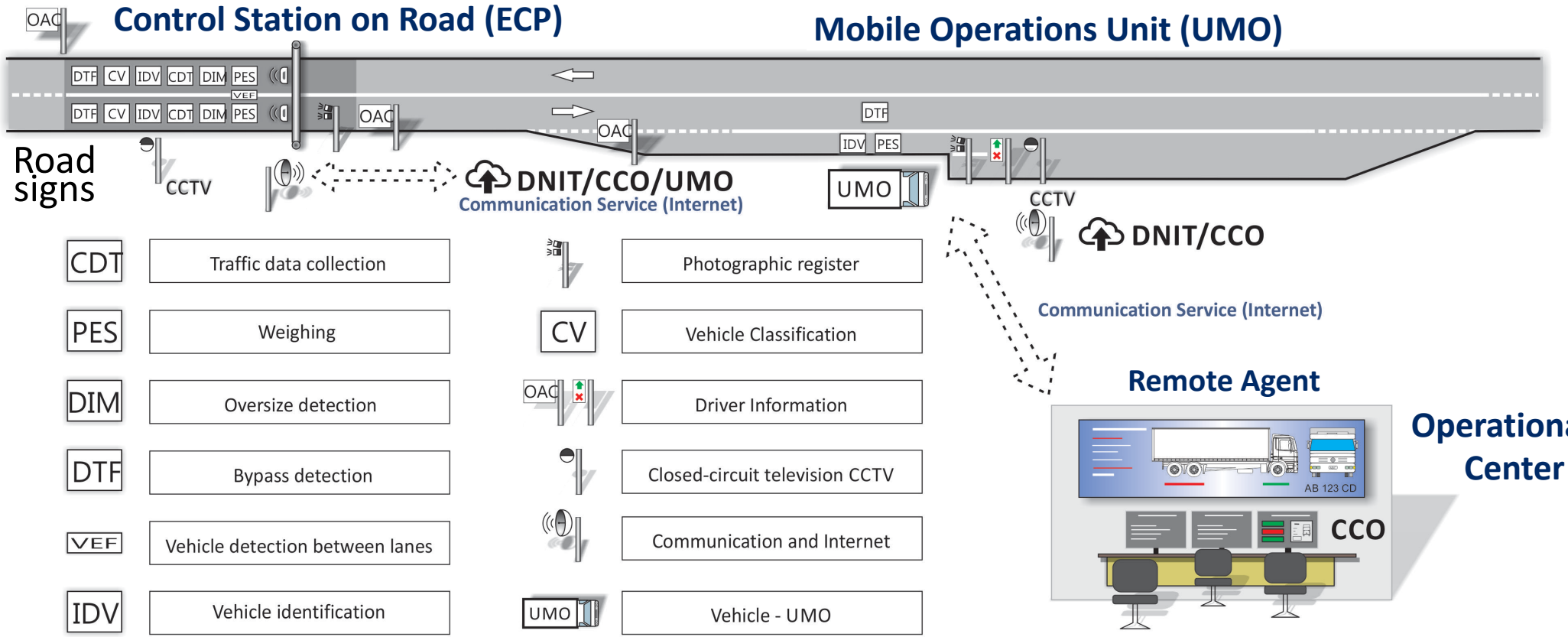
Operational Definitions



Presentation of the enforcement model

1 MODEL: HIGH-SPEED ECP, UMO E CCO

Mixed Weighing Station – PPM
(Single Lane Model)



Presentation of the enforcement model

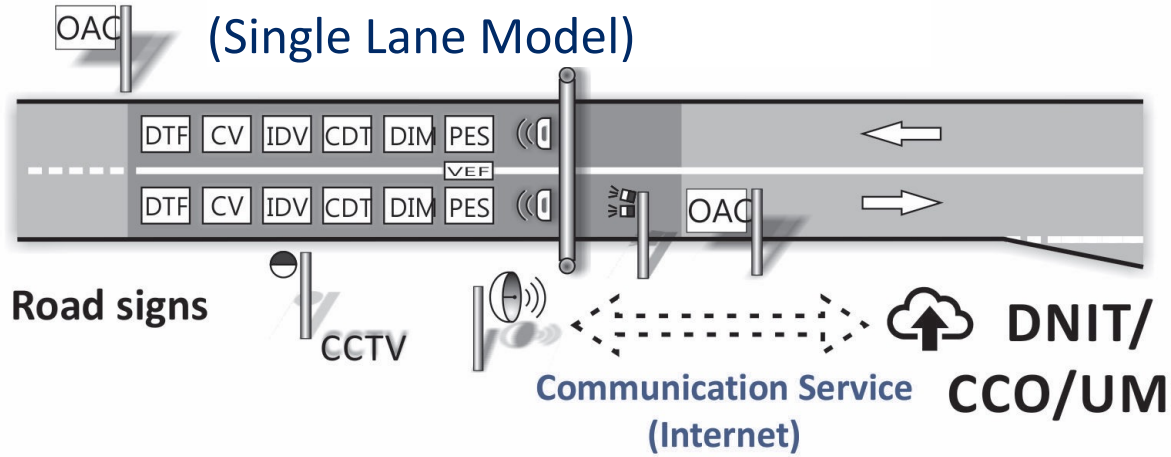
1 LOCATION FOR INSTALLATION AND OPERATION

- The choice of locations for implementing the PPM:
  - ✓ Weight Station Location Tool developed by UFSC.
  - ✓ It considers the contributions of the flow of heavy vehicles from the roads that are the main logistical corridors of the federal network.
- The result of this analysis is the indication of the sections whose inspection is necessary due to the large flow of heavy vehicles.
- Choosing the location of the ECP installation and the UMO's operation:
  - ✓ Performance of the chosen weighing systems
  - ✓ Reduction of escape routes through state and municipal roads.

Presentation of the enforcement model

2 CONTROL STATION ON ROAD - ECP

Control Station on Road
(Single Lane Model)



CDT	Traffic data collection	VEF	Vehicle detection between lanes	OAC	Driver Information
PES	Weighing	IDV	Vehicle identification		Closed-circuit television CCTV
DIM	Oversize detection		Photographic register		Communication and Internet
DTF	Bypass detection	CV	Vehicle Classification		

Presentation of the enforcement model

2 CONTROL STATION ON ROAD - ECP

- A Thick Asphalt Pavement (PCAE) solution to ensure performance and accuracy in the operation of the weigh-in-motion system.
- The pavement design considered COST-323 Class I for WIM site.
- Autonomous, uninterrupted operation and with constant communication with the CCO and UMO.
- Design solution according to:
  - ✓ International regulations, WIM performance and technologies, pavement solution performance and ease of execution, operation and maintenance.

Presentation of the enforcement model

2 ECP – INTERNATIONAL REFERENCE REGULATIONS

Adopted regulations:

- *"International Organization of Legal Metrology"* – OIML-R-134-1 (2006):
  - ✓ Adopted the Max Permissible Error (MPE) criteria for the WIM system.

- *"European Cooperation in Science and Technology"* – COST-323 (2002):
  - ✓ The Geometry and Pavement Structure criteria were adopted.

Presentation of the enforcement model

2 ECP – INTERNATIONAL REFERENCE REGULATIONS

- OIML-R-134-1 (2006):
  - ✓ It is recognized worldwide and followed by metrological institutions in countries with WIM for direct enforcement.
  - ✓ Defines Maximum Permissible Error (MPE) classes for WIM systems.
  - ✓ Defines installation conditions ANNEX B and C, regarding vertical profile.
  - ✓ It does not establish a relationship with the type of pavement and global error (WIM + Pavement).
  - ✓ The required class of error followed the proven international experiences for direct enforcement, such as: Czech Republic, Russia and Hungary.
  - ✓ Considered by INMETRO as a normative reference.

Presentation of the enforcement model

2 ECP – INTERNATIONAL REFERENCE REGULATIONS

- OIML-R-134-1 (2006): Classe 5E

Accuracy class for vehicle mass	Percentage of conventional value of the vehicle mass (6.7)	
	Initial verification	In-service inspection
0.2	±0.10 %	±0.20 %
0.5	±0.25 %	±0.50 %
1	±0.50 %	±1.00 %
2	±1.00 %	±2.00 %
5	±2.50 %	±5.00 %
10	±5.00 %	±10.00 %

Accuracy class for single-axle load and axle-group load	Percentage of the corrected mean single-axle load or corrected mean axle-group load	
	Initial verification	In-service inspection
A	±0.50 %	±1.00 %
B	±1.00 %	±2.00 %
C	±1.50 %	±3.00 %
D	±2.00 %	±4.00 %
E	±4.00 %	±8.00 %
F	±8.00 %	±16.00 %

Presentation of the enforcement model

2 ECP – INTERNATIONAL REFERENCE REGULATIONS

- COST-323 (2002):
  - ✓ Recommends Test procedure standardization, for different applications, and results comparison.
  - ✓ Establishes Performance, Accuracy and recommendations for performing performance tests – *Statistical Approach* – Does not define a Maximum Permissible Error (MPE).
  - ✓ Defines performance classes for a 95% Confidence Interval.
  - ✓ It considers pavement deformability conditions for different types of pavements (Semi-rigid, All Bitumen and Flexible) and geometry.
  - ✓ Establishes criteria and recommendations for pavement design and geometry.

Presentation of the enforcement model

2 ECP – REGULAMENTAÇÃO INTERNACIONAL DE REFERÊNCIA

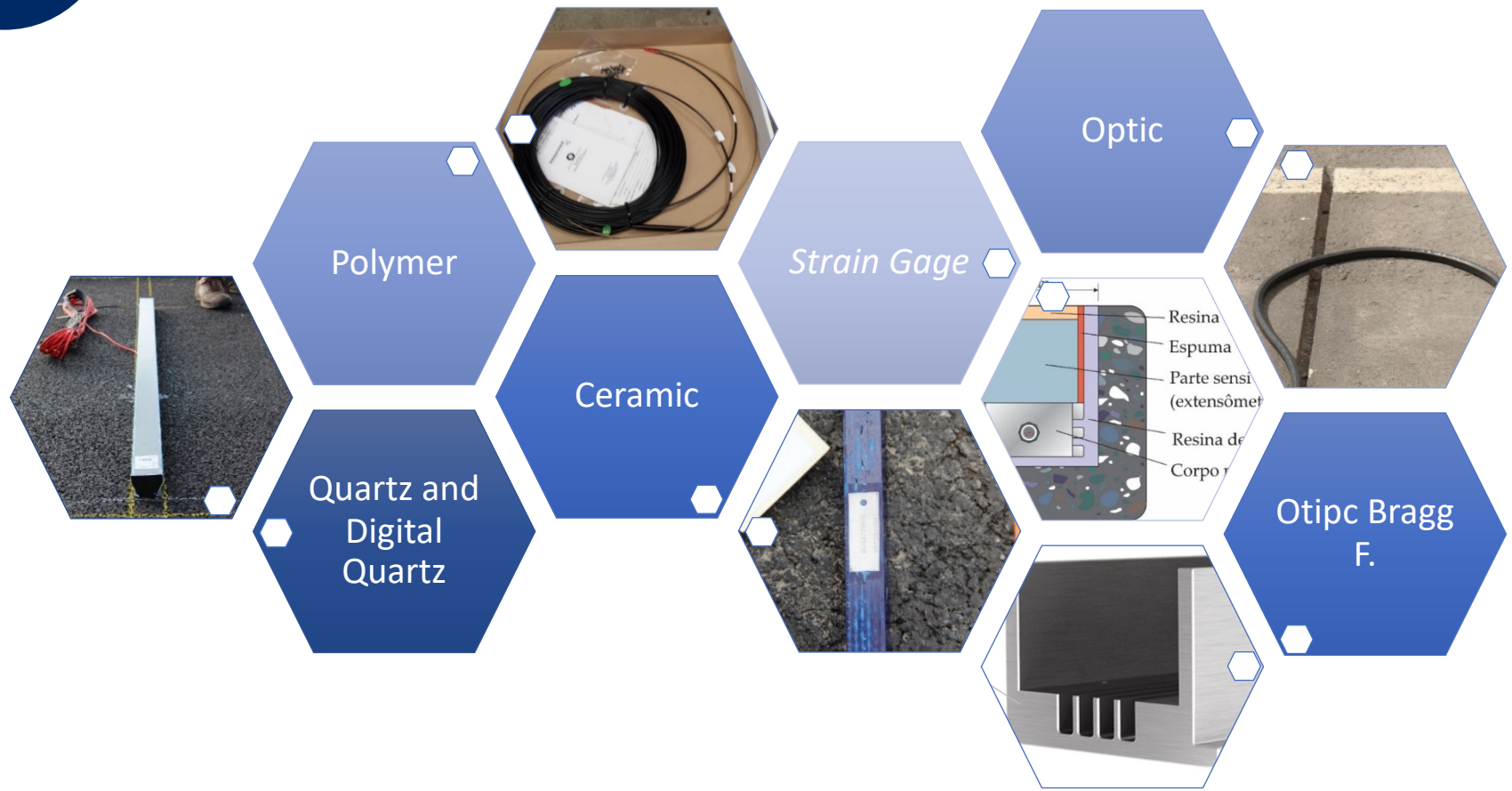
- COST-323 (2002):

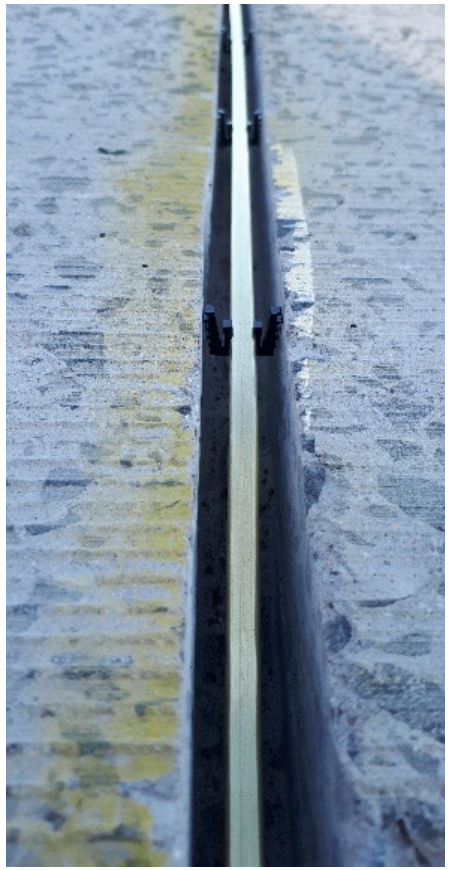
  WIM-Site conditions and pavement solution.

			WIM site classes		
			I Excellent	II Good	III Acceptable
Rutting (3 m - beam)		Rut depth max. (mm)	≤ 4	≤ 7	≤ 10
Deflection (quasi-static) (13 t - axle)	Semi-rigid Pavements	Mean deflection (10^{-2} mm) Left/Right difference (10^{-2} mm)	≤ 15 ± 3	≤ 20 ± 5	≤ 30 ± 10
	All bitumen Pavements	Mean deflection (10^{-2} mm) Left/Right difference (10^{-2} mm)	≤ 20 ± 4	≤ 35 ± 8	≤ 50 ± 12
	Flexible Pavements	Mean deflection (10^{-2} mm) Left/Right difference (10^{-2} mm)	≤ 30 ± 7	≤ 50 ± 10	≤ 75 ± 15
Deflection (dynamic) (5 t - load)	Semi-rigid Pavements	Deflection (10^{-2} mm) Left/Right difference (10^{-2} mm)	≤ 10 ± 2	≤ 15 ± 4	≤ 20 ± 7
	All bitumen Pavements	Mean deflection (10^{-2} mm) Left/Right difference (10^{-2} mm)	≤ 15 ± 3	≤ 25 ± 6	≤ 35 ± 9
	Flexible Pavements	Mean Deflection (10^{-2} mm) Left/Right difference (10^{-2} mm)	≤ 20 ± 5	≤ 35 ± 7	≤ 55 ± 10
Evenness	IRI index	Index (m/km)	0 - 1.3	1.3 - 2.6	2.6 - 4
	APL[(1)]	Rating* (SW, MW, LW)	9 - 10	7 - 8	5 - 6

Presentation of the enforcement model

2 ECP - HS-WIM TECHNOLOGY





Presentation of the enforcement model

2 ECP - TECNOLOGIAS HS-WIM

Scanner

RF-ID

Cameras ANPR/OCR

Loop Detectors

Pavement temperature gauge

Pavement strain and stress

Pavement deflection

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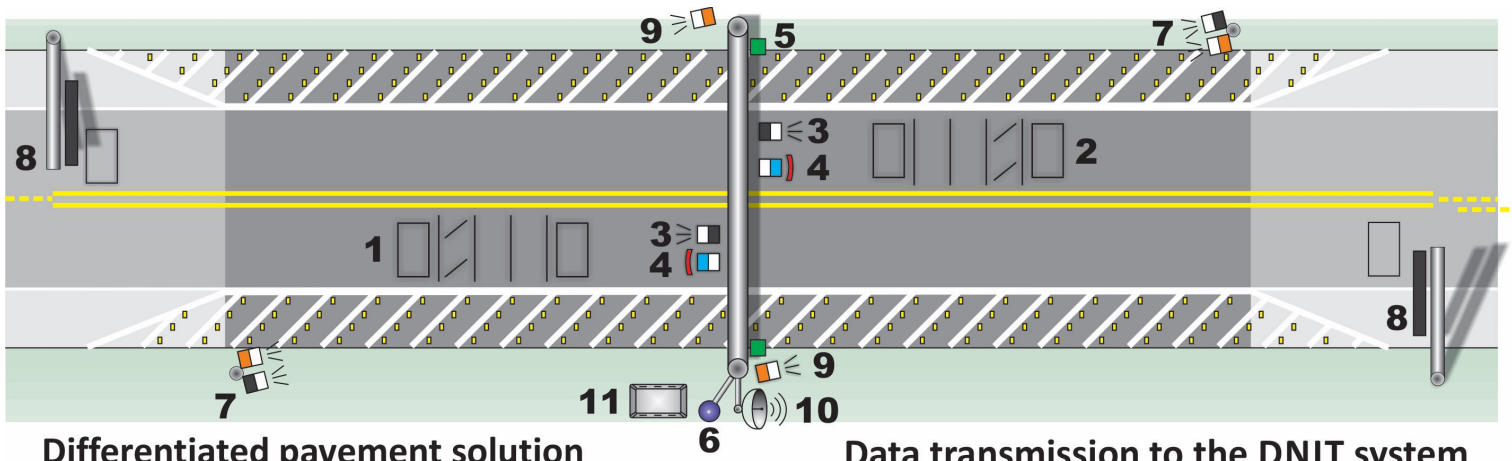
Presentation of the enforcement model

2 ECP - TECHNOLOGICAL SOLUTION

Control Station on Road
(Single Lane Model)



Differentiated pavement solution

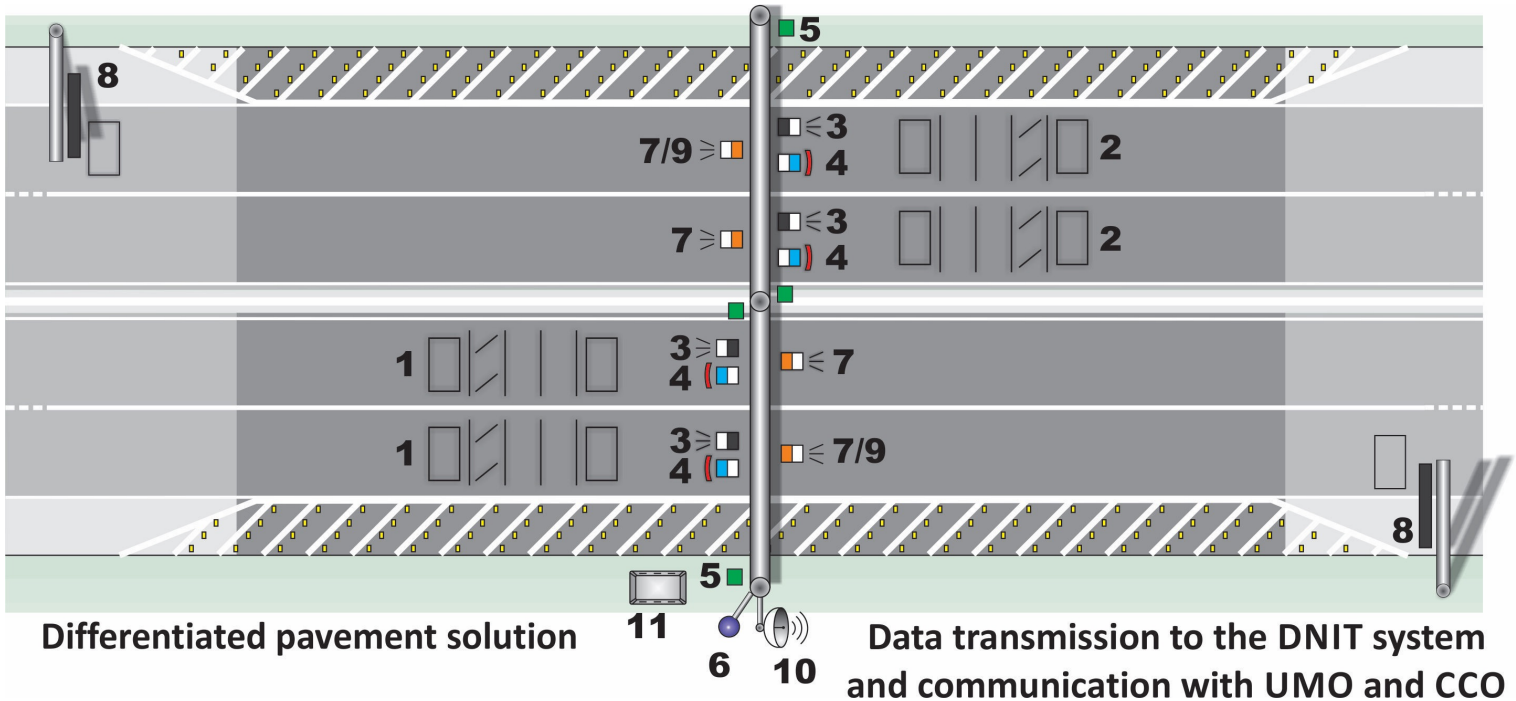
Data transmission to the DNIT system and communication with UMO and CCO

- High performance pre-selection WIM with 4 lines, WIM Quartz or Strain Gage.
- Dimension detection, laser scanner.
- Inductive loop type presence detector, triggering devices and/or speed.
- Dual wheel and side position detector, Double WIM Polymer.
- Height detection, Laser Beam.
- Driver Orientation, VMS Variable Message Sign in Half-gantry.
- Photographic record with character reading.
- Overview photographic record, Camera.
- Closed Circuit TV, PTZ camera.
- Communication and Internet, fiber, cable, radio or GPRS
- Control System and Integration of Different Technologies.

Presentation of the enforcement model

2 ECP - TECHNOLOGICAL SOLUTION

Control Station on Road
(Two Lanes Model)



Differentiated pavement solution

Data transmission to the DNIT system and communication with UMO and CCO

- High performance pre-selection WIM with 4 lines, WIM Quartz or Strain Gage.
- Dimension detection, laser scanner.
- Inductive loop type presence detector, triggering devices and/or speed.
- Dual wheel and side position detector, Double WIM Polymer.
- Height detection, Laser Beam.
- Driver Orientation, VMS Variable Message Sign in Half-gantry.
- Photographic record with character reading.
- Overview photographic record, Camera.
- Closed Circuit TV, PTZ camera.
- Communication and Internet, fiber, cable, radio or GPRS
- Control System and Integration of Different Technologies.

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Presentation of the enforcement model

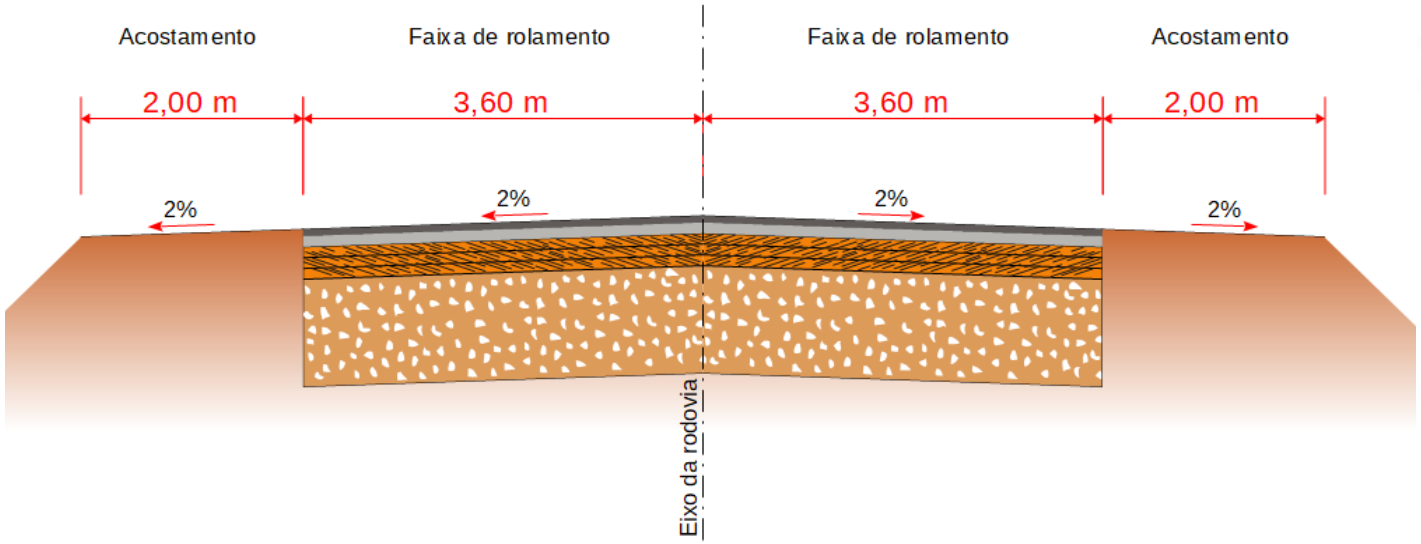
2 ECP – PAVEMENT SOLUTION

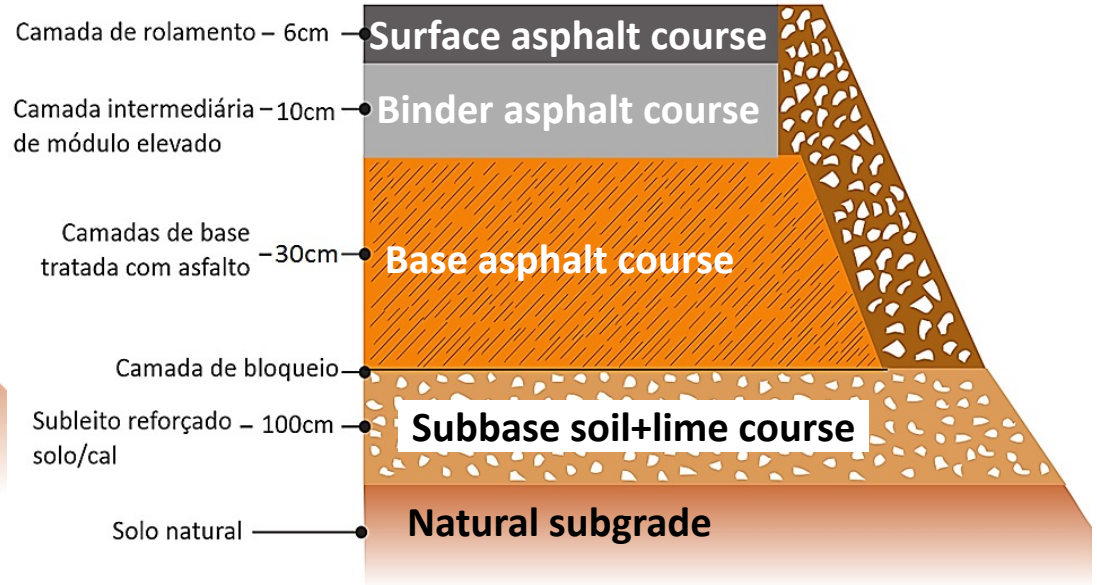
- Thick Asphalt Pavement:
  - ✓ Solution that meets the requirements of the HS-WIM technology solution (COST-323), as shown in studies carried out by CGPERT in partnership with UFSC.
  - ✓ Construction and maintenance can be perform by companies with experience in asphalt paving, which operates on the existing market.
  - ✓ DNIT road network has asphalt pavement as the main type of surface.
  - ✓ Thick asphalt pavement has low deformability and are suitable for WIM sensors installation on the surface.

Presentation of the enforcement model

2 ECP – PAVEMENT SOLUTION

Control Station on Road
(Single Lane Model)

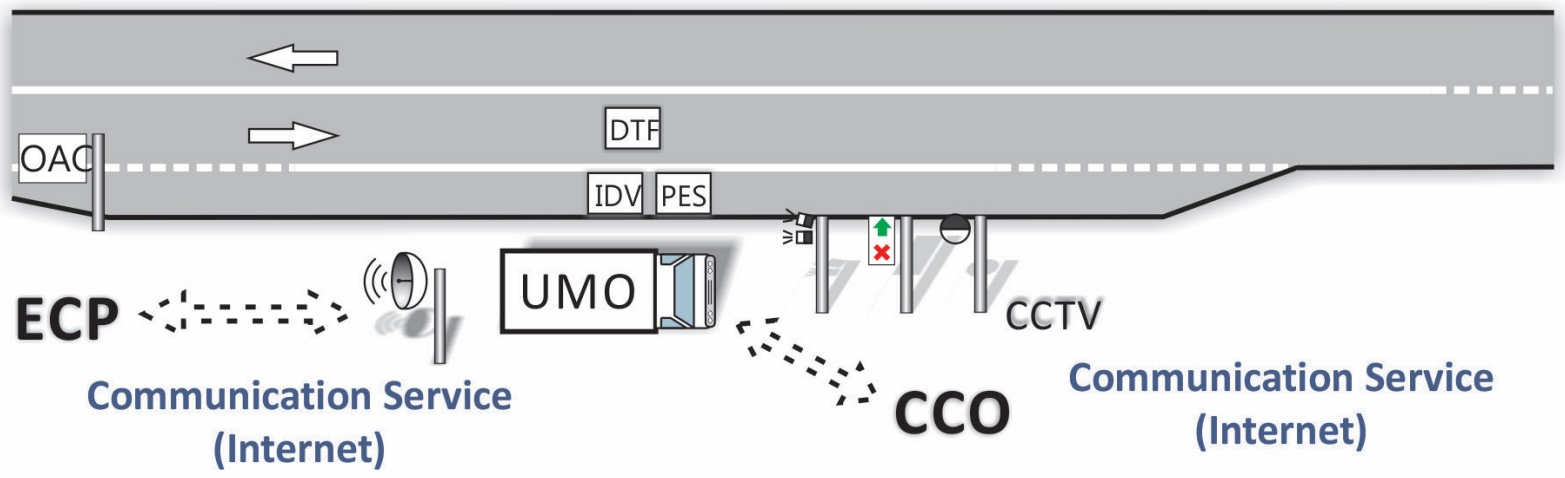




Presentation of the enforcement model

3 MOBILE OPERATIONS UNIT – UMO

Mobile Operations Unit
(Single Lane Model)



PES	Weighing
DTF	Bypass detection
IDV	Vehicle identification
	Communication and Internet
	Photographic register
OAC	Driver Information
	Closed-circuit television CCTV
UMO	Vehicle - UMO

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Presentation of the enforcement model

3 MOBILE OPERATIONS UNIT – UMO

- Each UMO will be linked to an Operation Base, from where it will depart before each operation and to which it will return, and to one or more Enforcement Locations, where it will enforce vehicles pre-selected by the ECP.
- The location of the Operation Base will be defined by the respective Regional Superintendence of DNIT (Federation units of Brazil).
- The inspection points of the UMO will be defined by the respective Regional Superintendence according to the position of their respective ECP, in places that favor the safety of the operation, taking into account the indications suggested by DNIT.

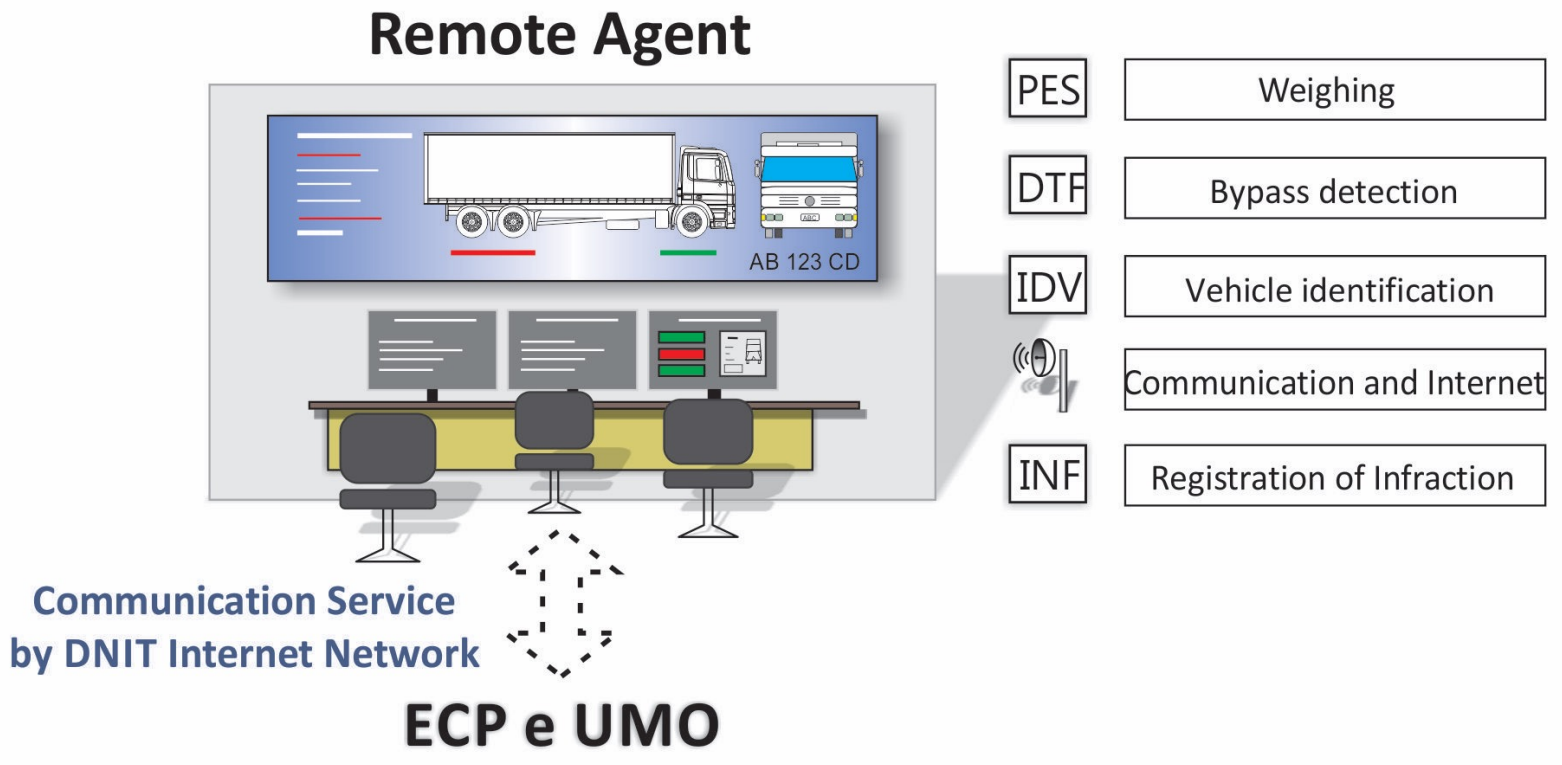
Presentation of the enforcement model

3 MOBILE OPERATIONS UNIT – UMO

- Operations Team:
  - ✓ The team was plan to operate in the 12x36 system during the day.
  - ✓ The option of night operation in the 12x36 system was also foreseen, when demanded by the regional Superintendence, on a continuous basis, based on the amounts provided for DNIT.

Presentation of the enforcement model

4 OPERATIONAL CONTROL CENTER – CCO



Presentation of the enforcement model

4 OPERATIONAL CONTROL CENTER – CCO

- The CCO will be installed at the Superintendence or at the Local Unit as indicated by DNIT.
- DNIT will provide a room for the CCO, so that the Agents can monitor the operation and inspection of the weight and size of the cargo transport vehicles in the Mobile Operating Units without any complications.

Presentation of the enforcement model

5 COMMUNICATION: CCO/UMO/ECP

- All communication will be carried out using internet connection.
- The communication system via Internet, between ECP and UMO, between ECP and SIOR DNIT/SEDE and between UMO and CCO must have a minimum bandwidth guaranteed by the provider of at least 10 Mbps for Upload, and 10 Mbps for Download.
- It must have a fixed IP address and enable the management of opening communication ports. Each of the units, ECP and UMO, must have its own independent internet link.
- It will be necessary to hire a data service provider to the location of the ECP and UMO, under the responsibility of the contractor.
- It is the contractor's responsibility to ensure continuous communication.

Implementation and operation plan

PLANS FOR IMPLEMENTATION

Progressive Implantation

1st Phase

States:

- Bahia;
- Sergipe;
- Alagoas;

Deadline:

2022/2023 – Construction of the ECP;

2022/2026 – Operation of the PPM;

Total of 4 PPM

Implementation and operation plan

PLANS FOR IMPLEMENTATION

Progressive Implantation

2nd Phase

States:

- Espírito Santo;
- Minas Gerais;
- Rio de Janeiro;
- São Paulo;
- Piauí;
- Acre;
- Amazonas;
- Amapá;
- Ceará;
- Distrito Federal;
- Goiás;
- Mato Grosso;
- Roraima;

Deadline:

2023 – Construção da ECP;

2023/2026 – Operação do PPM;

Total of 15 PPM

Implementation and operation plan

PLANS FOR IMPLEMENTATION

Progressive Implantation

EXPECTATION

- 41 PPM in 3 years;
- 19 PPM by end of 2023;
- Cover all Federal Units.


Obrigado!
Thank you!
Baie dankie!
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