CAMEA WIM

Weigh-In-Motion Conference

CAMEA – Direct Enforcement Expert

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WEIGH-IN-MOTION

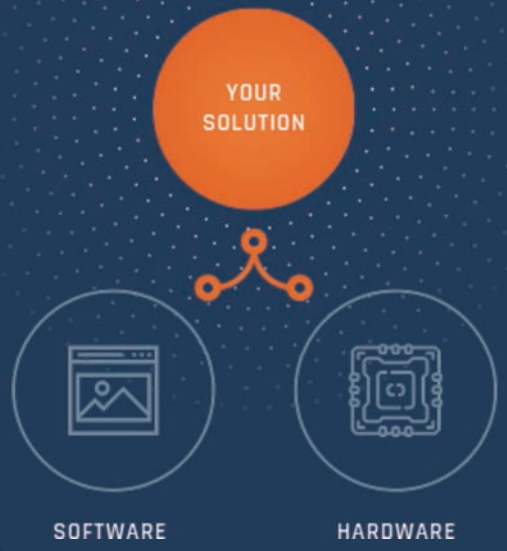
WIM DIRECT ENFORCEMENT

SPEED ENFORCEMENT

ITS WORLDWIDE

CAMEA Customer Solutions

Turn-Key



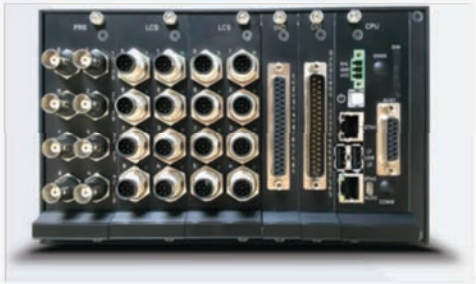
Custom Design

CAMEA OEM

CAMEA – Intelligent Transportation Systems






CAMEA WIM – Basic Features

- Bi-directional weighing, dual tire detection
- Detection and documentation of weighing avoidance
- Multiple sensor rows supported
- 3D scanning
- Weighing in whole road width

CAMEA WIM – 2019 Innovations

New measurement unit

Scalable

Unit synchronization

Various functionality

Various sensor technologies

Piezoelectric

Tensometric

Optical

Certified speed measurement

3/4D Radar

Trajectory tracing

Maneuver detection

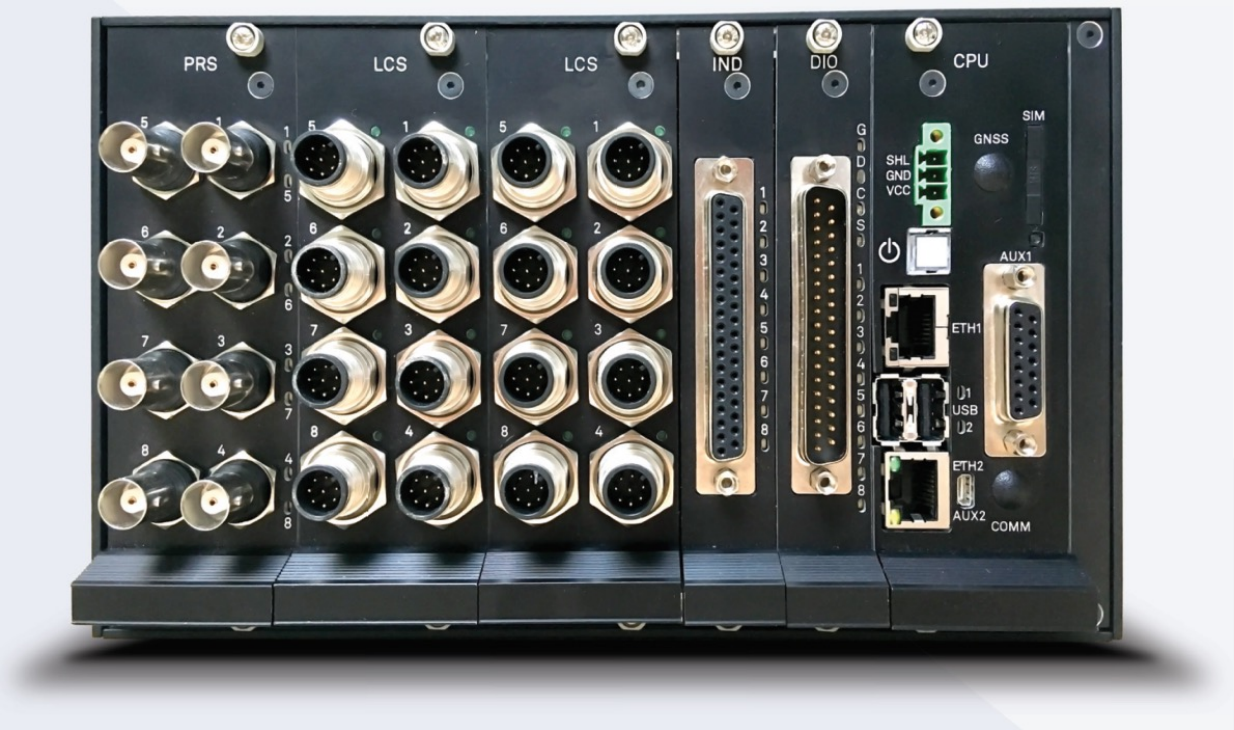
3D scanners replace loops

Better detection and classification

Free-flow

Less intrusion

CAMEA Measurement Unit



Scalability

Various functionality

Various usage classes

Enforcement Systems – Discussion Topics

- Drivers come up with new ways to avoid paying fines
  - Enforcement system operators (together with vendors) must react
  - Example – driving in shoulder lane or between lanes
- Problem of weighing at low speeds 5-20 km/h
- Advanced camera system
- Continuous monitoring of need for new calibration
- Service partners
  - 3 maintenance levels

WIM System Accuracy

Affected by various factors

Sensor parameters

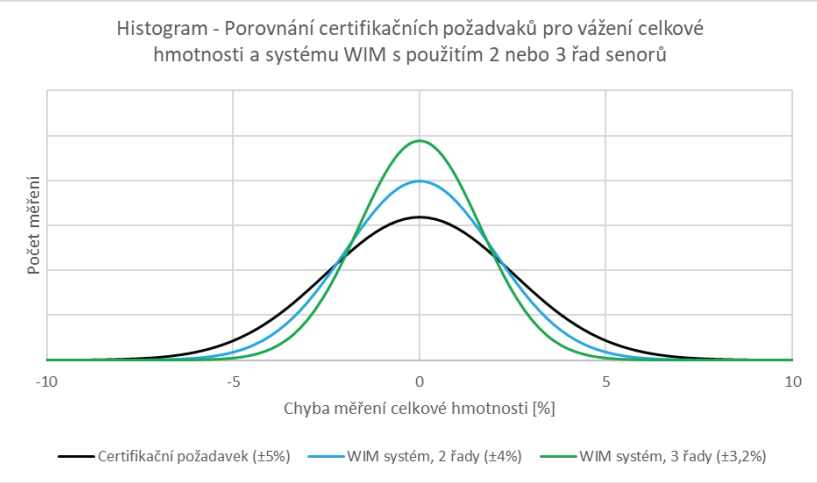
Road quality

Vehicle behavior

WIM System Accuracy – Sensors

- Accuracy is a combination of sensor and road parameters
- Typical parameters (today's standard)
  - Longitudinal sensitivity (< ±2%)
  - Linearity (< ±1 % of measurement range)
  - Hysteresis (< 2 % of measurement range)
  - Weighing accuracy (2 %) – in lab, for more see the road and vehicle influence
- Sensors must have additional parameters necessary for long-term functionality
- Longitudinal sensitivity not constant
- Sensor sensitivity not constant in time

WIM System Accuracy – Multiple Sensors



More measurements = lower uncertainty

Lower road age impact

Longer system lifespan

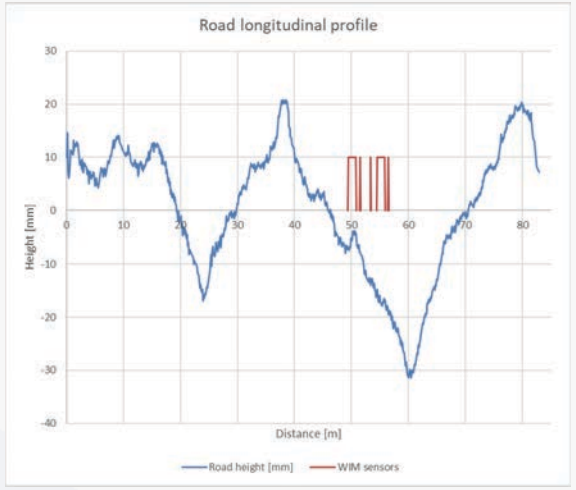
WIM System Accuracy – Road Quality

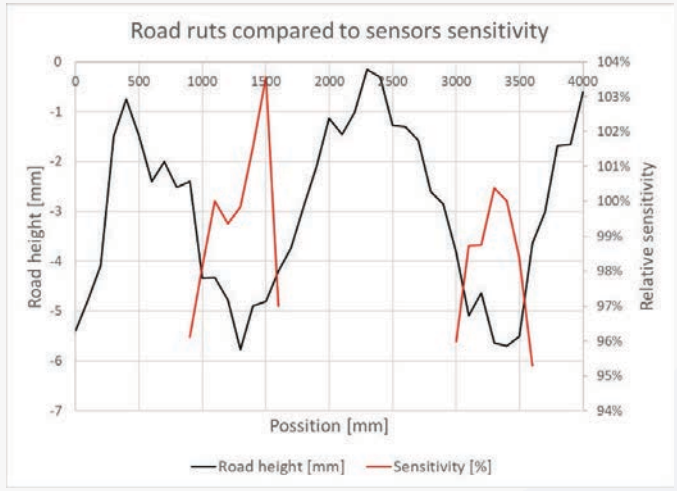
- Installation in a quality road required
  - (COST 323, Version 3.0, August 1999)
  - Low road deflection (high stiffness)
  - No or minimal rutting (≤ 4 mm)
  - Longitudinal slope < 1 %
  - Transversal slope < 3 %
  - Straight road section
- Parameters must be met during whole system operation lifetime

			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

The rutting and deflection values are given for a temperature below or equal to 20°C and suitable drainage conditions.

WIM System Accuracy – Road Quality





Longitudinal unevenness causes swaying (weight distribution shift)

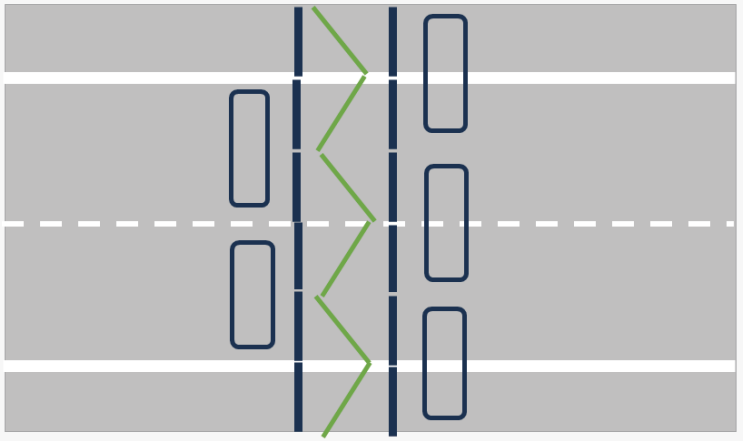
Transversal unevenness (rutting) causes different sensor sensitivity

Dynamic road instability causes deflection (higher dynamic impact)

WIM System Accuracy – Vehicle Behavior

- Drivers often try to avoid weighing
  - Not all wheels fully on sensors
  - Maneuvers (braking, acceleration, direction change etc.)
- Measurement validation to prevent higher weighing errors
  - Checking the weight measurement process
  - State which might cause a higher error marks the output as invalid

Weighing in Whole Road Width



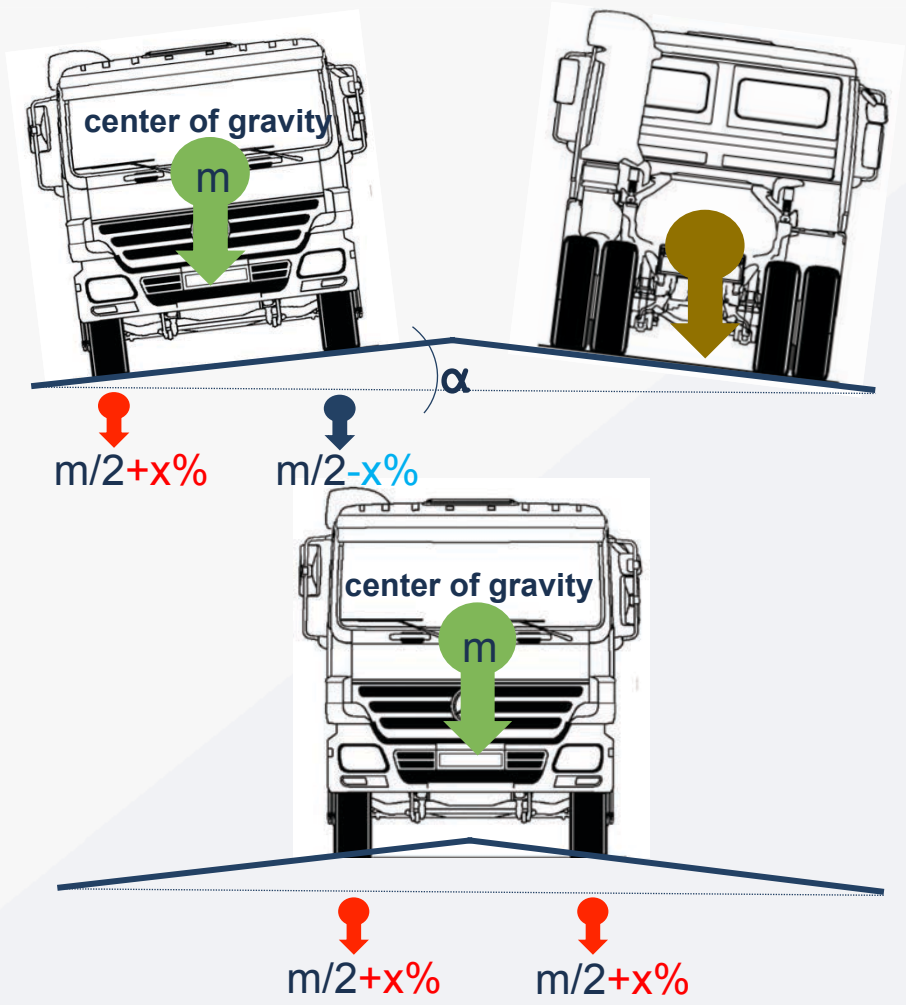
Drivers avoid weighing by driving in the middle or on shoulder

Installing crash barriers can be unsafe

Solution by using additional sensors

Weighing in Whole Road Width - Calibration

- Driving between lanes or on shoulder may be affected by an error
- Longitudinal slope causes measurement errors when wrongly calibrated



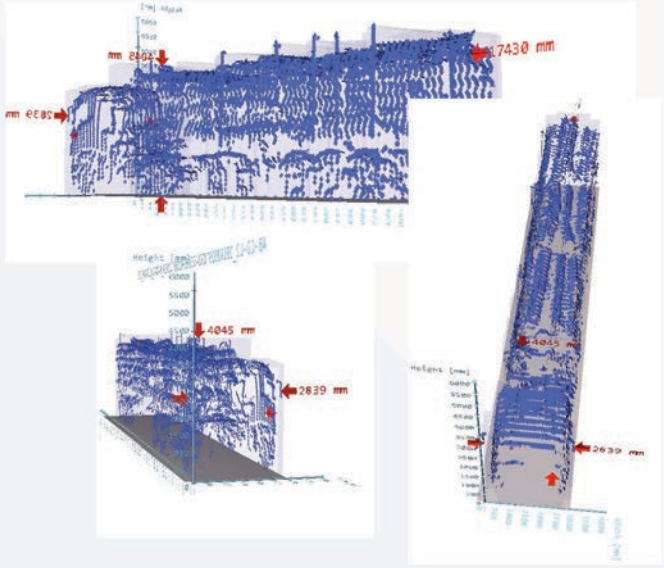
Weighing Slowly Driving Vehicles

Drivers avoid weighing by driving slowly

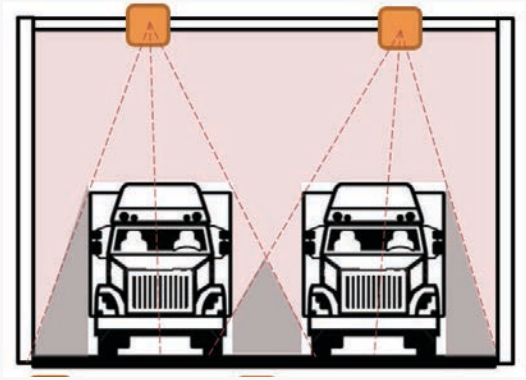
A third row of sensors can be installed

Adding low-speed weighing sensors

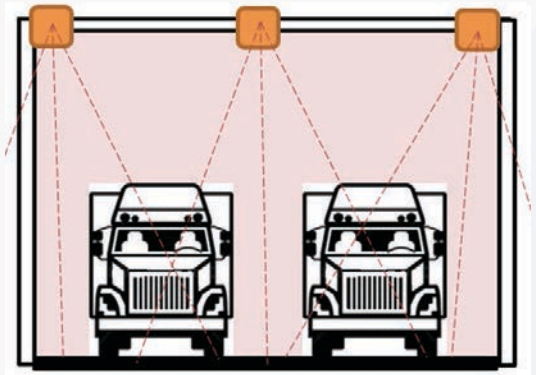
3D Scanning – Vehicle Dimension Measurement



Using laser scanners

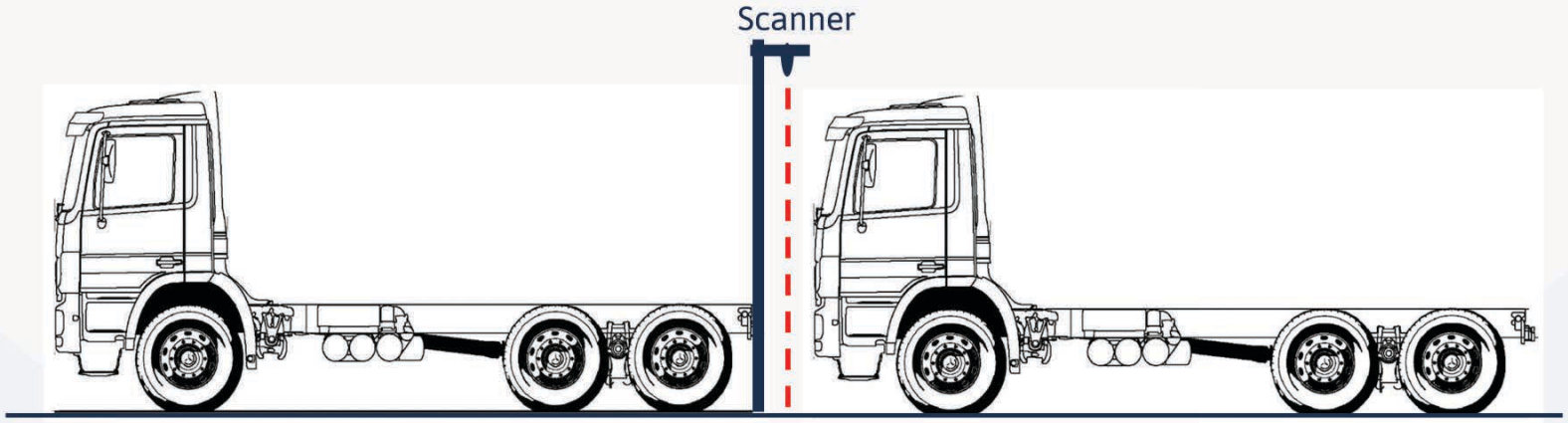


Highest possible scanning frequency for accurate measurements



Vehicle outline measurement

3D Scanning – Separating Closely Driving Vehicles

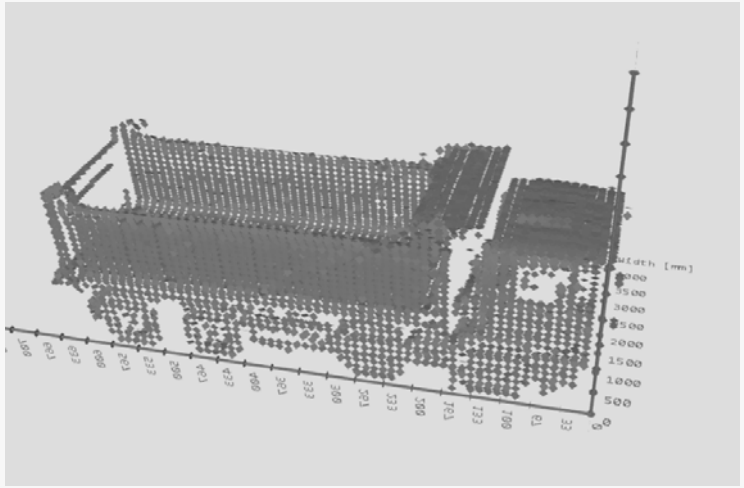


Vehicles drive too close behind one another

Difficult separation by inductive loops

Scanners to monitor separate vehicles

3D Scanning – Vehicle Classification



3D profile used to classify vehicles based on shape

Recognition of specific vehicle type

Cisterns, truck body types

CAMEA Camera System

ANPR + MMR

Driver's face

ADR table reading

Thank you!