Weigh-in-Motion for Enforcement in Europe

Authors:

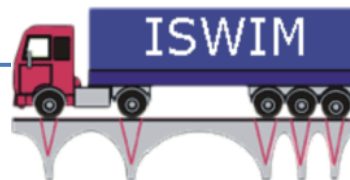Hans van Loo

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- Developments in WIM

- Applications for Enforcement

- Examples in Europe (Fr, NL, CZ)

- Future Developments

What is Weigh-In-Motion

- ## Weighing in Motion:
  - process of estimating the gross weight of a moving vehicle, and the portion of that weight that is carried by each of its wheels or axles, by measurement and analysis of dynamic vehicle tyre forces

- ## WIM-System:
  - Sensors in or under the road, or attached to a bridge
  - Different sensing principles

- ## Additional Measurements:
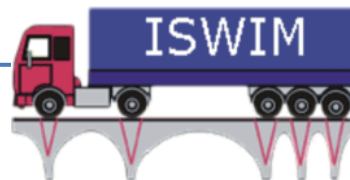 - Time, Speed, Axle Spacing, Vehicle Length, Vehicle Class

Developments in WIM <1990

- ## Focus on Sensor Development
  - ### Different sensing principles
  - ### More accurate sensors

- ## Focus on Infrastructure Applications
  - ### Pavement cracking and rutting
  - ### Effects on bridges

- ## National Projects
  - ### France, UK, Germany, Switzerland, Netherlands, …
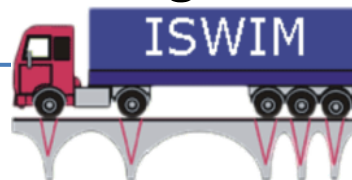
ISWIM

Developments in WIM 1990-2000

- Focus on Sensor & System Development

  - More reliable sensors

  - Accuracy test for WIM systems

  - Multiple sensor (MS-)WIM and B-WIM

- First Tests for Enforcement

  - Combination with video (VID-WIM in NL)

- First International Projects

  - COST323 (Co-operative action, COST Transport)

  - WAVE (4th Framework Program Project)

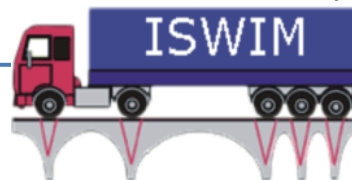# Developments in WIM >2000

- Focus on Applications
  - Pavement and bridge loading (advanced methods)
  - Enforcement of overloading

- Development of WIM Systems
  - Further analysis of MS-WIM (array design, algorithms)
  - Bridge-WIM: commercial system marketed

- International Projects
  - Top Trial, REMOVE, FiWi
  - Foundation of ISWIM

WIM in 2013, Status Quo

- ## WIM is proven Technology

  - Accurate and reliable measurements are possible

  - Good installation and maintenance are essential

  - WIM ≠ No plug and play forever

- ## Current WIM Systems

  - National WIM Networks

  - Local, individual systems

- ## Main users

  - Road maintenance, enforcement, toll roads

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- Applications to Enforcement

- Examples in Europe (Fr, NL, CZ)
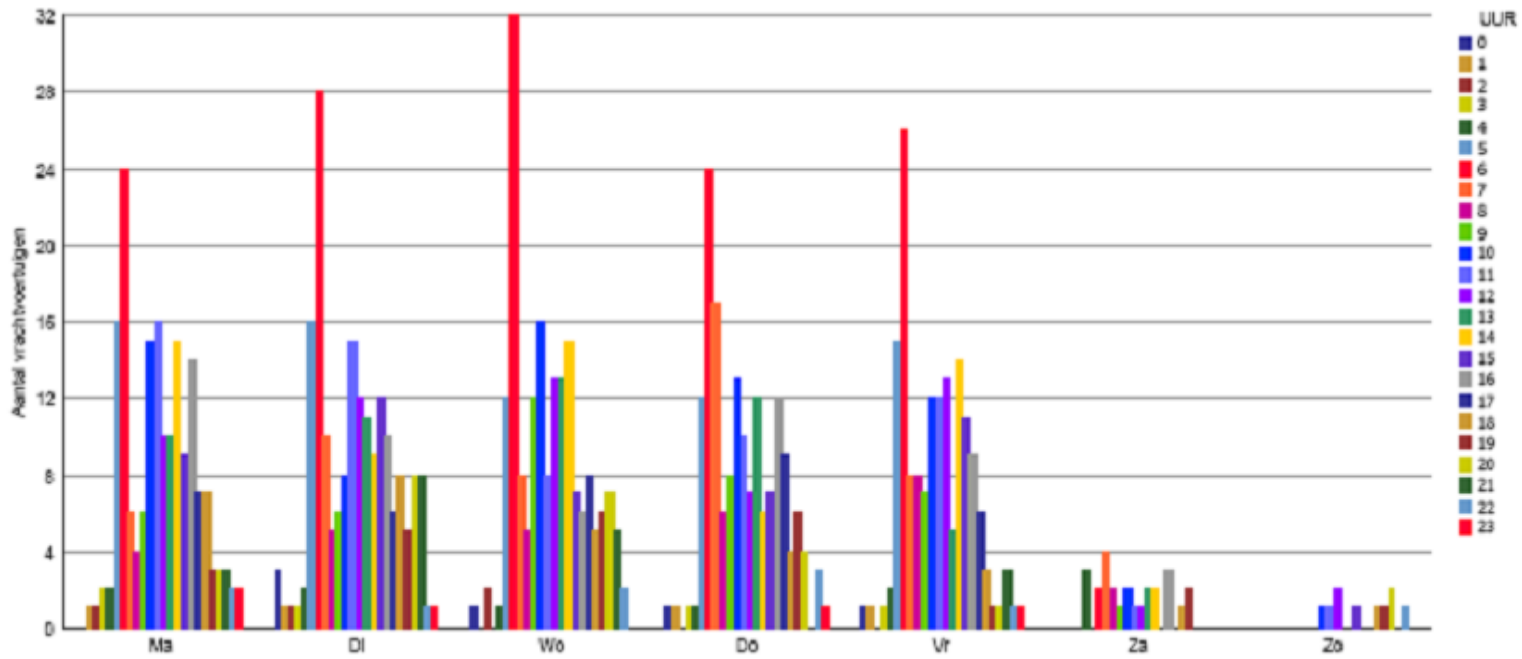
- Future Developments
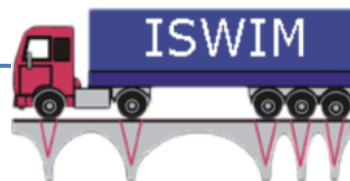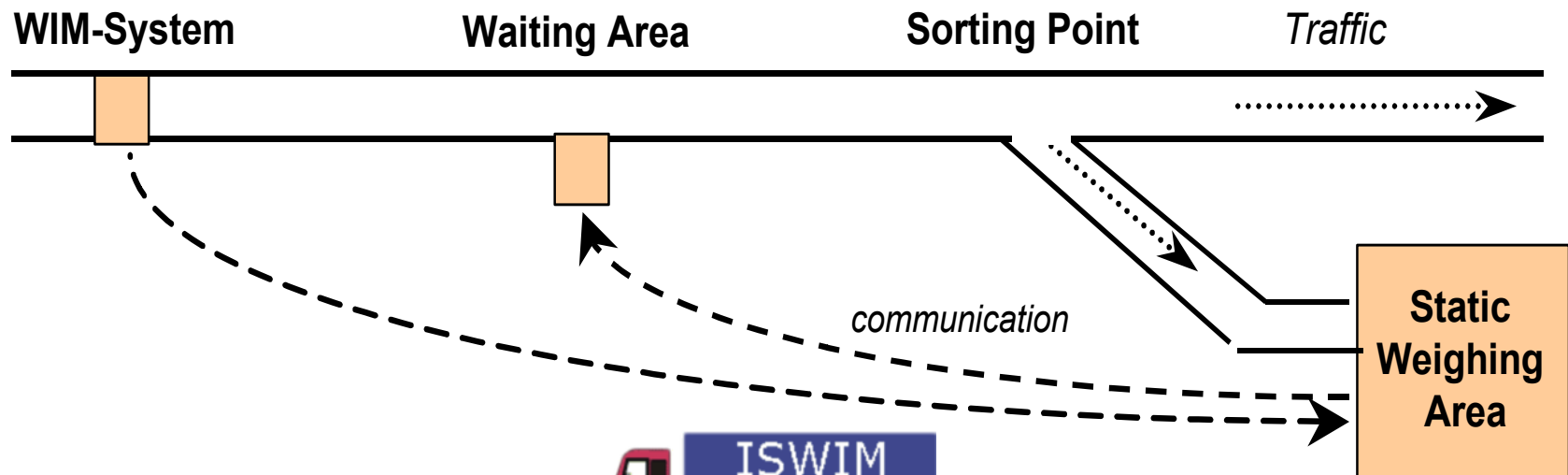
Applications for Enforcement

- "Manual" Selection

- Manual Selection

- Statistics & Planning

Applications for Enforcement

- Manual Selection
- Statistics & Planning
- Screening & Pre-selection

WIM-System   **Waiting Area**   **Sorting Point**   *Traffic*

communication

Static Weighing Area
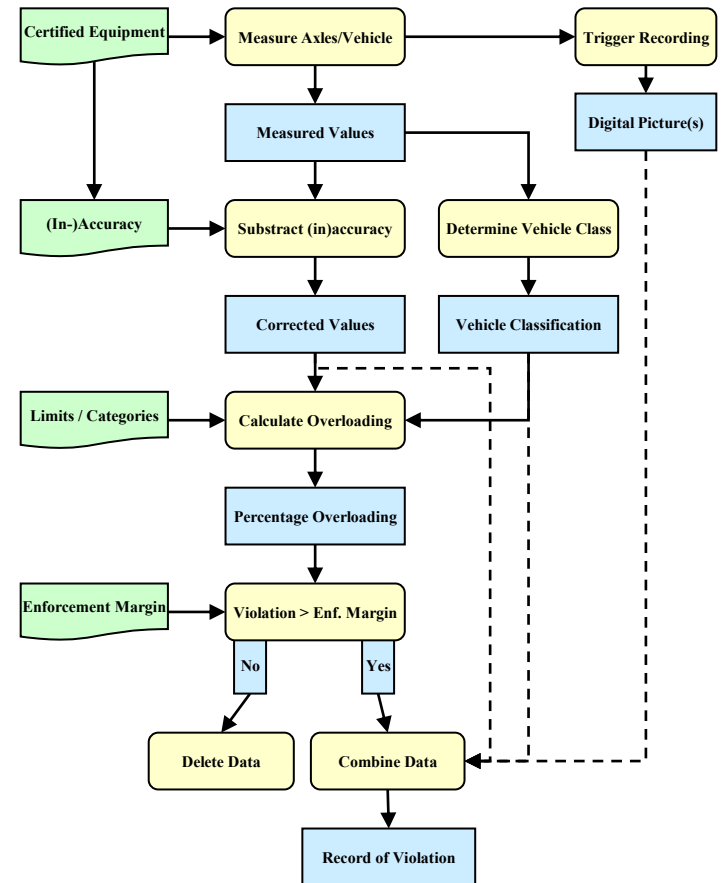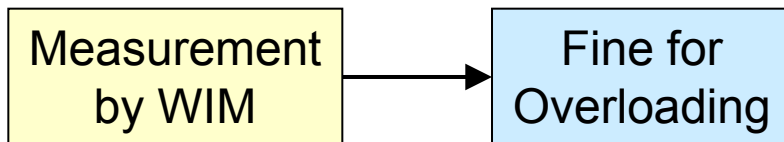
ISWIM

Applications for Enforcement

- Manual Selection

- Statistics & Planning

- Screening & Pre-selection

- Preventive Actions
  - Company profiling
  - In company checks

Applications for Enforcement

- Manual Selection
- Statistics & Planning
- Screening & Pre-selection
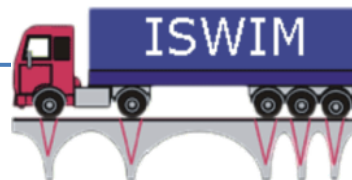- Preventive Actions
- Direct Enforcement

Applications for Enforcement

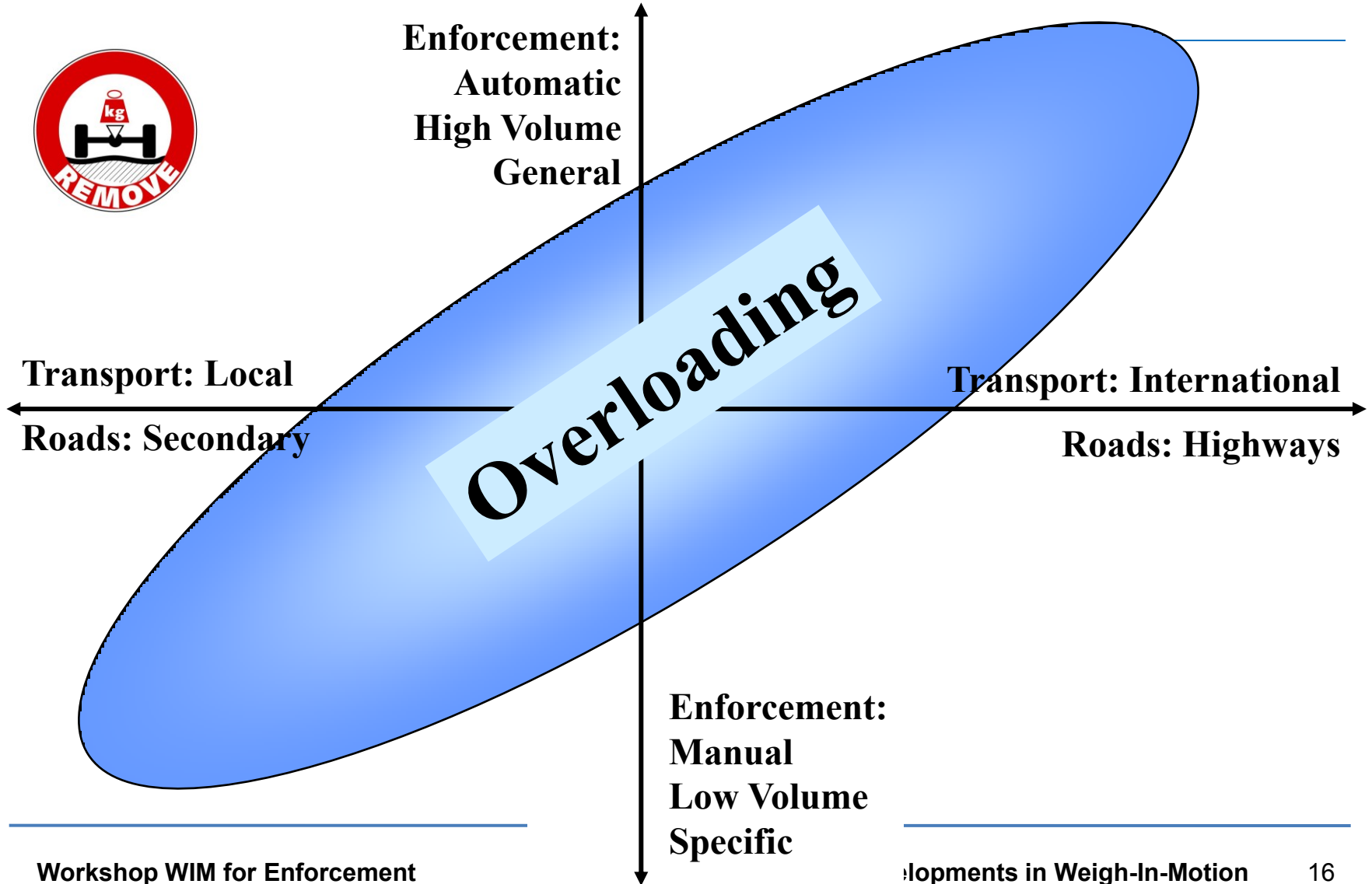| Direct Enforcement	Other Applications
⬤ Quality of each <u>individual</u> measurement - Max. permissible error - 100% of measurements (used)	⬤ Quality of <u>average</u> measurement - Mean error - Standard deviation
⬤ <u>Evidence</u> of vehicle identification	⬤ <u>Indication</u> of vehicle(s) involved
⬤ Performance certified by a notified body - Type approval + Initial verif.	⬤ Performance agreed between vendor & buyer - Acceptance test

Aspects of Overloading

- What is the overloading problem? (axle loads / gross vehicle weights)

- Which vehicles are overloaded? (Local / international / container / bulk materials / liquid tanks)

- Where does overloading occur? (highways / local roads)

- When are the peaks? (morning, evening, nights / week days or week-end)

- Who is responsible? (driver / transport company / shipper)

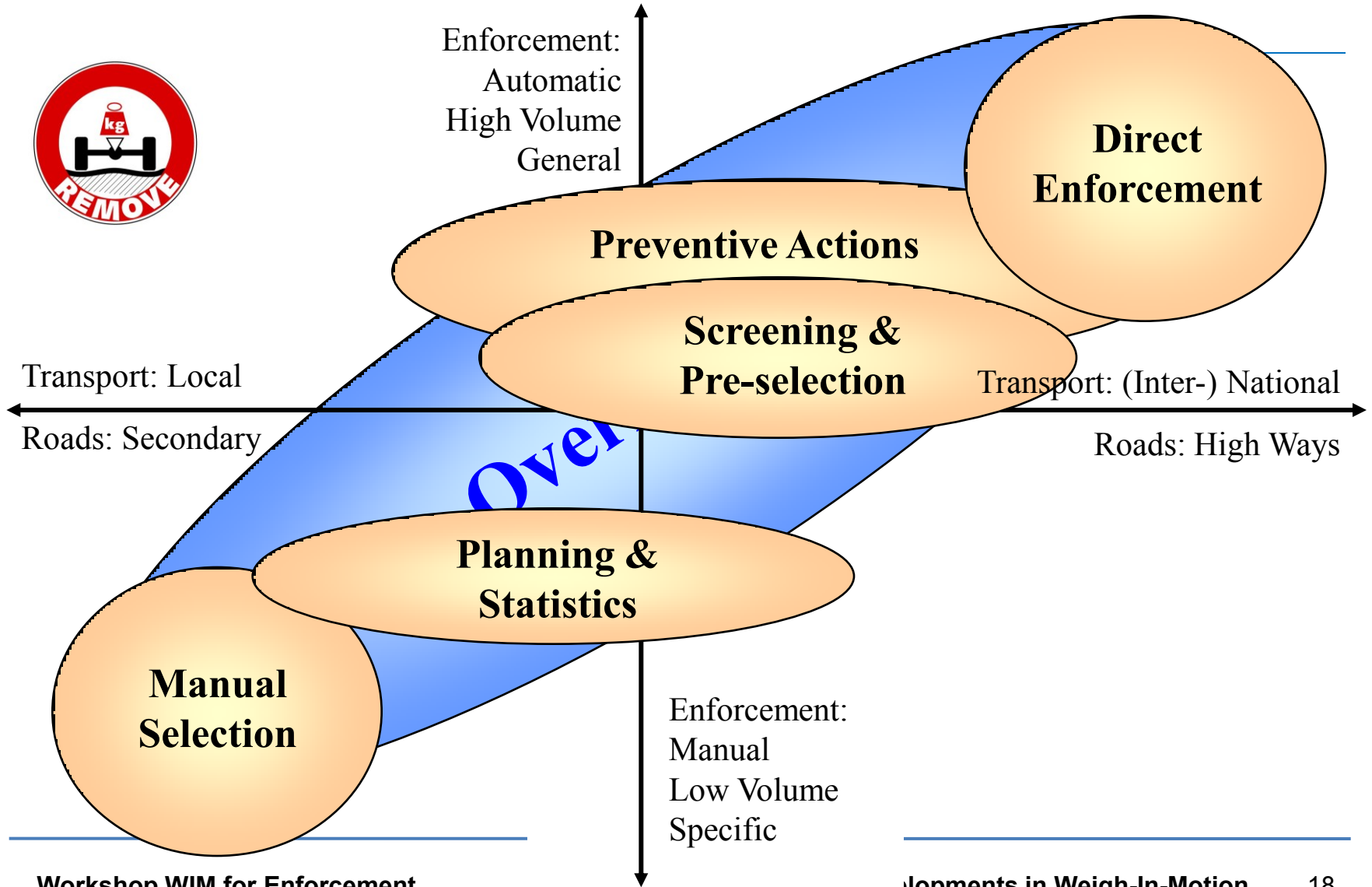- Why is a truck overloaded? (by accident / structural)

- Etc…

Enforcement Mix

Enforcement:
Automatic
High Volume
General

Transport: Local

Roads: Secondary

Overloading

Transport: International

Roads: Highways

Enforcement:
Manual
Low Volume
Specific

Applications of WIM

| Application	Pro's	Con's
Manual Selection	Flexibility for special situations	Low efficiency
Statistics & Planning	More effective controls	No identification of violators
Screening & Pre-selection	Efficient controls, Hit rate > 95%	Only local effects, Evasion possible
Preventive Actions	Focus on compliance + Cheat companies	New way of working
Direct Enforcement	Highly efficient High traffic volumes	Expensive systems, Not (yet) accepted

Enforcement Mix

Enforcement:
Automatic
High Volume
General

Transport: Local

Roads: Secondary

Transport: (Inter-) National

Roads: High Ways

Enforcement:
Manual
Low Volume
Specific

Direct Enforcement

Preventive Actions

Screening & Pre-selection

Over

Planning & Statistics

Manual Selection

LEGO Approach

- Manual Selection

- Statistics & Planning

- Pre-selection

- Problem Solving

- Direct Enforcement

| WIM |

| WIM | Camera |

| WIM | Camera | Vehicle Data Base |

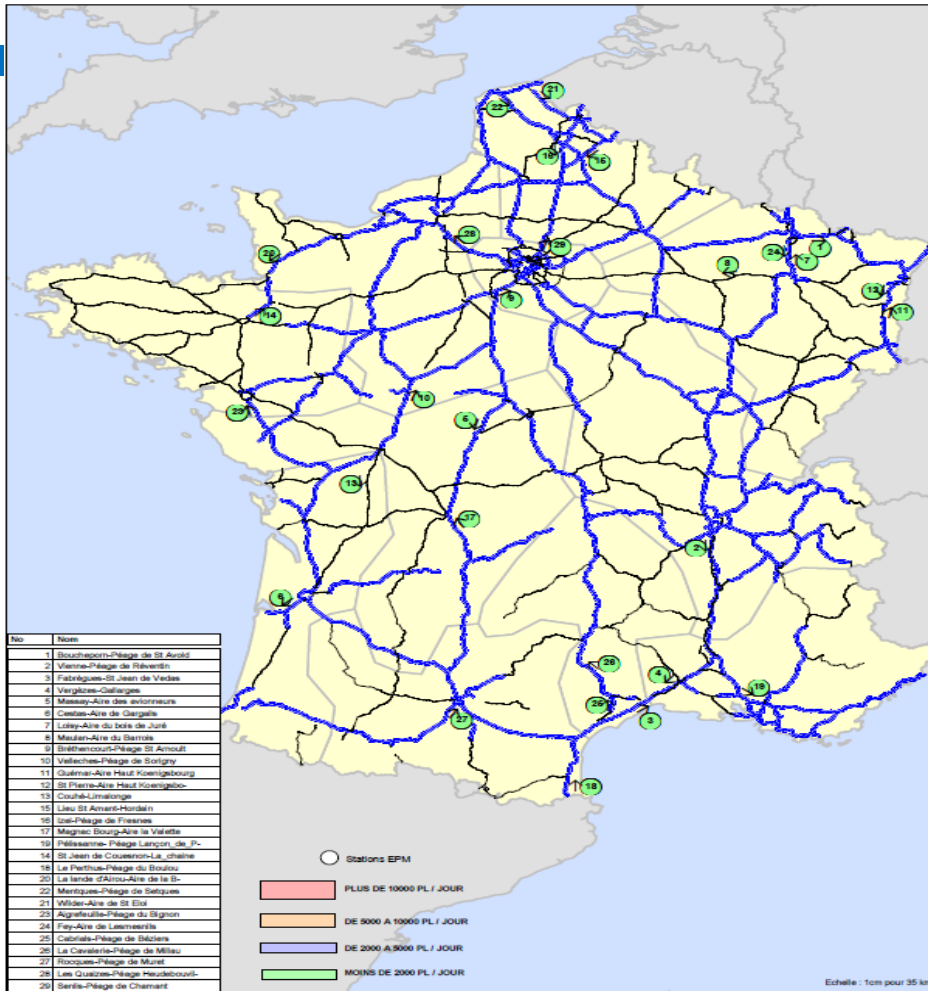| WIM+ | Camera | Vehicle Data Base |
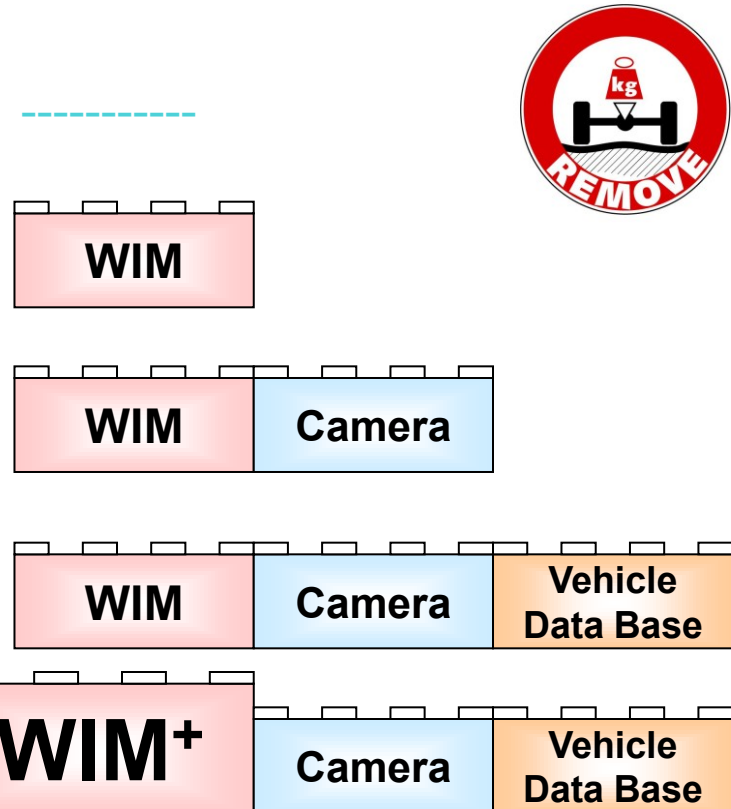
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- Enforcement Mix

- Examples in Europe (Fr, NL, CZ)

- Future Developments

WIM in France


- For pre-selection + company profiling
- **30 systems** installed
- motorways + highways
- balanced by region
- most > 2000 trucks/day
- accuracy ≥ C(15)
- 85 k€/system

WIM in France

- 22 silhouettes of trucks
- axle loads and gross weights
- Speed (if implemented: mean speed)
- Axle distances + total length
- Pictures of vehicles + license plates (presumed violators only)
- All recorded data (statistical + violators') → MoT (safe telecom network)

2 camera: whole truck + license plate

2 WIM sensors

2 ind. loops
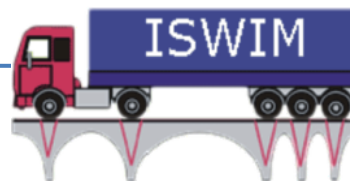
1 transverse location sensor
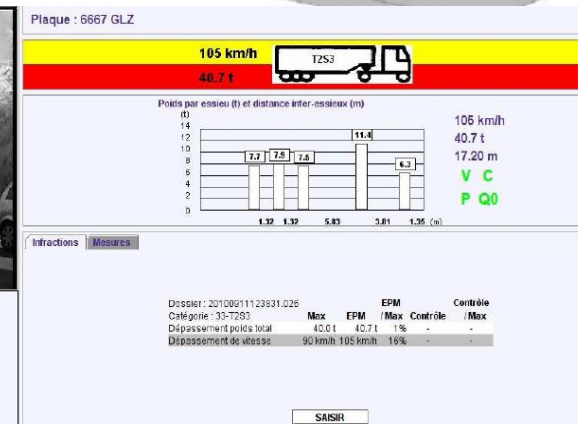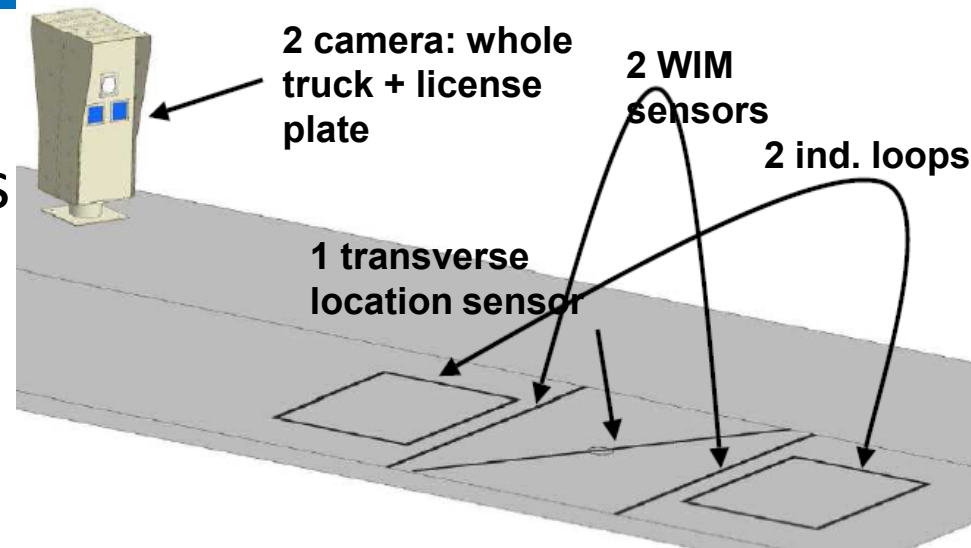
WIM in France

Main users

- Enforcement departments of DREALs

- Police, gendarmerie, customs

- Ministry of Transport: DGITM/DST/TR4

- Road and infrastructure

  - Inter-regional road directorates: DIR

  - Motorway concessionary

- Research and technical public organizations

  - IFSTTAR (ex LCPC)

  - CETE, SETRA

WIM in the Netherlands

WIM-NL Network

- 20 WIM systems
- Highways only
- National coverage
- Upgraded in 2012
- Registration of:
  - Loads + Weights
  - Vehicle Class
  - Licence Plates

WIM-NL System

Weegpunt

WIM in the Netherlands

Users	Application
Rijkswaterstaat (RWS)	Pavement Loading Design & Maintenance
Transport Inspectorate (IL&T)	Pre-Selection Company Profiling
Vehicle Authority (RDW)	Special Transports
Tax & Customs Administration	International Transports

WIM in the Czech Republic

HS-WIM for Direct Enforcement

- 2011, Tested by Czech Metrology Institute

- Specification based on OIML, COST, ASTM, FiWi;

- e.g. <u>Max.</u> errors

  - Axle (group) Loads   11%

  - Total Vehicle Mass   5%

- Tests for EMC, Physical robustness and Environmental influences

- 2012, Type Approved according to CZ-law (MoT)

WIM in the Czech Republic

System Design

- 2 rows of Kistler Lineas WIM sensors;

- 2 Induction Loops;

- 3 Accerometers;

- 2 Temperature sensors

- 1 Piezo sensor for detection of:

  - Wheel position

  - Twin Tyres

- Used for Validation of measurement

  - If validation number too low $\Rightarrow$ rejection for enforcement

- ○ Accelerometer
- ▫ Temperature sensor
- ▬ Lineas – quartz crystal sensor
- — Wheel position, twin tyre detection
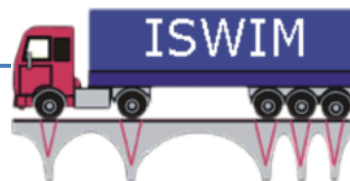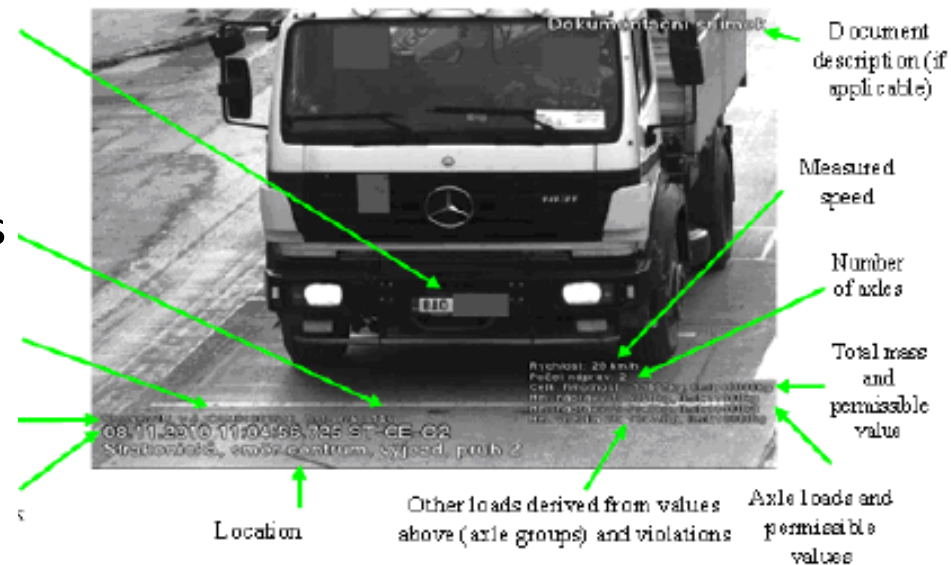- ▭ Inductive loop
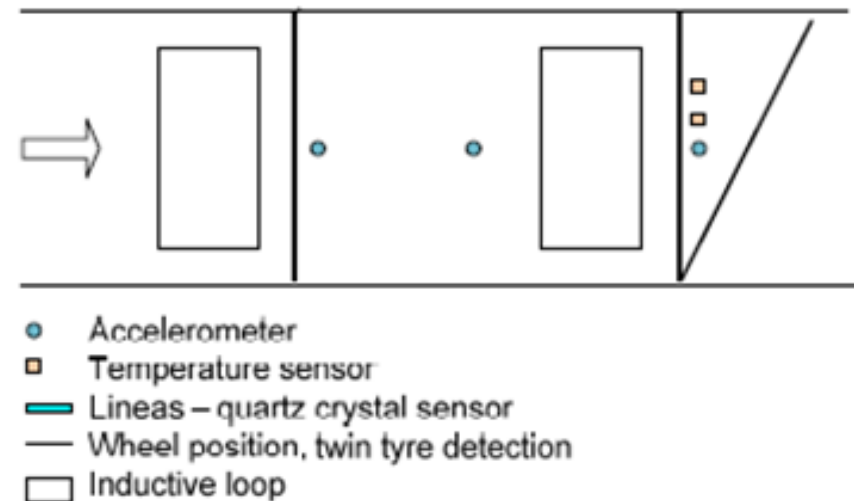
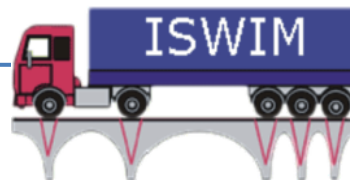# WIM in the Czech Republic

Registration of:

- Location

- Type and number of sensor

- Axle Loads, Axle Group Loads and Total Mass
  - Measured and Permitted values

- Number of Axles

- Speed

- Licence Plate

- Registration number

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Needs for the Future

- Overloading is an global issue

- Enforcement needs to be Regional/International (EU)

- Need for International data exchange (EU)

- International acceptance of WIM data

- Need for International harmonization

  - Specifications & Test procedures

  - Data format

  - Certification & Legal Acceptance

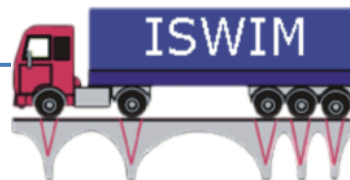- Need for direct/automated enforcement?
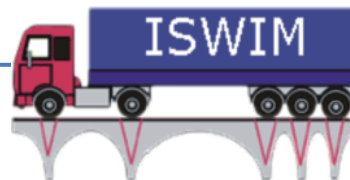
Needs for the Future

- Benefits are global

- Research is time consuming and expensive

- Resources are limited

- Need for International cooperation
  - Coordination of research
  - Data exchange
  - Exchange of experience
  - International Standard

Needs for the Future

Issue	Advantage	Challenge
Stronger, more robust Sensors	Longer life span	Sensor development
Guaranteed quality of WIM data	Allows International exchange of data	EU Standard in process
Multiple applications and users	Sharing of required investments	Cooperation between organisations
Preventive actions / Company profiling	Focus on compliance	Introduction of a new way of working
Direct enforcement	Highly efficient controls	EU Standard and procedures to be done

Needs for the Future

Issue	Challenge	Main Actors
Stronger, more robust sensors	Sensor development	WIM Industry
Guaranteed quality of WIM data	EU Standard and procedures	Certification bodies + Technical centers
Multiple applications and users	Cooperation between organisations	Users (Enforcement + road maintenance)
Preventive actions / Company profiling	Introduction of a new way of working	Governments, enforcement officers
Direct enforcement	EU Standard and procedure tbd	Certification bodies + Technical centers