Overweight screening by WIM and French initiative for using of WIM for direct weight enforcement

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IFSTTAR

Cerema

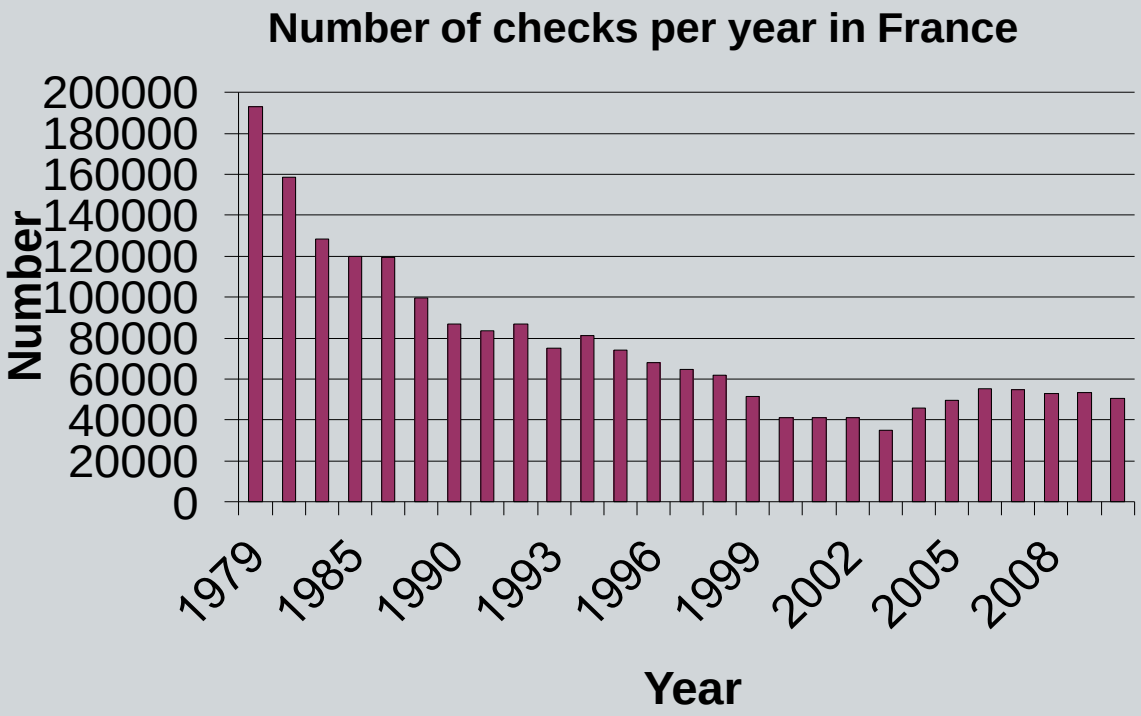
Context

- 81% freight transported by road in France (76% in the EU)
- 550,000 lorries (> 2 millions lorries in the EU)
- 300 billions ton.km/yr (1200 billions in the EU)
- 27 billions lorry.km/yr (120 billions in the EU)
- Many lorries run > 100 000 km/yr, average 50,000 km/yr
- 5-15% overloaded runs… mostly less than 10%, but up to 20%

It is necessary to check and penalize overloads to:

- Ensure a fair competition
- Improve the road and traffic safety
- Protect the infrastructure

Limitation of Static Enforcement



- Low percentage of static checks: 1 weighing/500,000 veh.km, i.e. an average per lorry of 1 weighing every 10 yrs (return period)
- Complex and costly implementation (cost, safety)
- Limited staff and devices, safety concerns

European Incentives and Objectives

- Small and limited revision of the EU Directive 96/53 on weights and dimensions:
  Member States (MS) are encouraged to take the appropriate measures to screen and control weights and dimensions, using WIM
- Road (and bridge) WIM systems and on-board systems
- Initial draft: 1 weighing per 2000 veh.km:
  i.e. 14 millions/yr in France, 60 millions in the EU,
  achievable with 10 WIM systems in France, app. 100 in the EU
- Overload screening by WIM since 2000 in many countries
- Euro Control Route and TISPOL: exchange of data, best practices, experience, REMOVE project (2005)

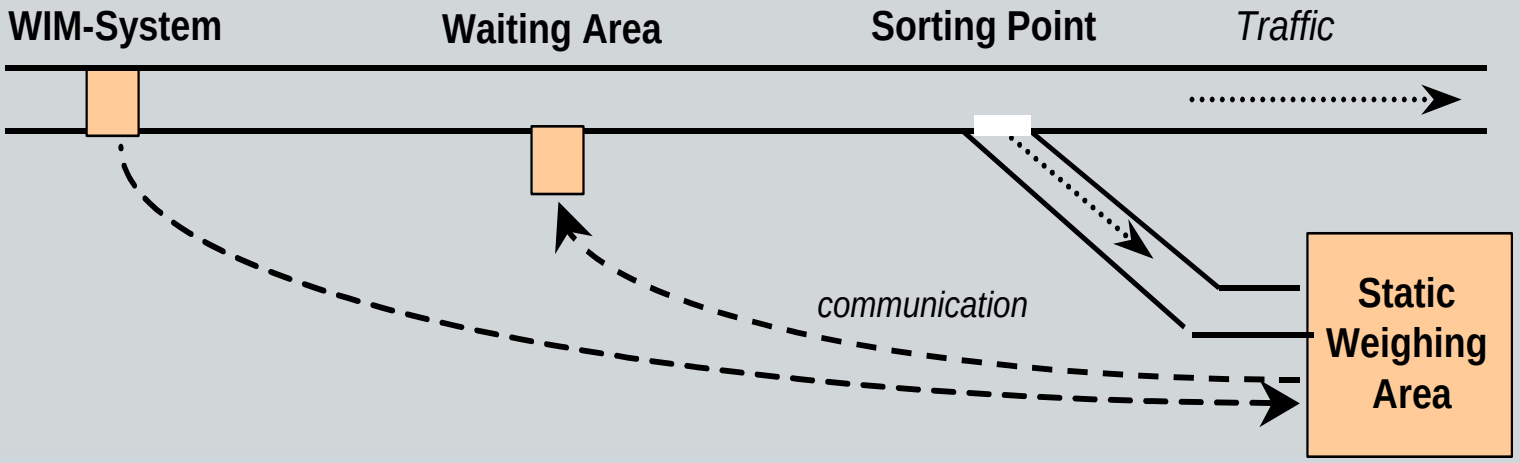
Overweight Screening by WIM

European Situation

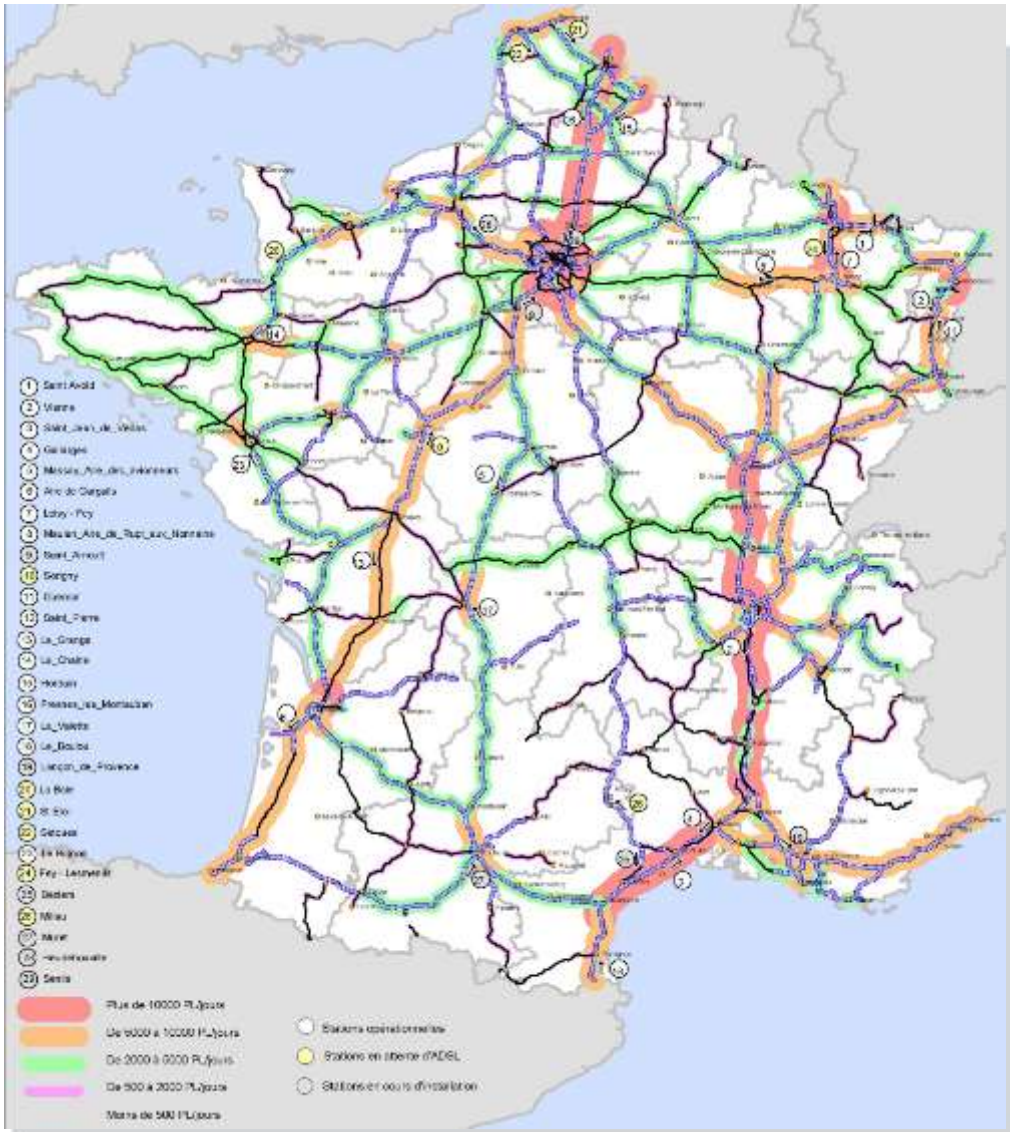
- Overload screening by WIM in several MS:
  - Video-ANPR-WIM and company profiling in NL (2000), FR (2008)
  - Screening by WIM in DE, UK, BE, HU, SE, SI, HR, PL... + CH
  - Experience of direct enforcement by WIM in CZ (2012)
- Road sensors mainly used (piezoquarz: NL, BE, DE, FR, CH; ceramic: FR, polymer: UK)
- Bridge (B-)WIM used (SI, HR, SE), tested in IE, FR, AT
- In France: 29 WIM systems (EPM network), 20 millions trucks weighed/yr
  In NL, 20 WIM systems, >10 millions trucks weighed/yr
  In UK, DfT+VOSA carried out WASP's VIPER project

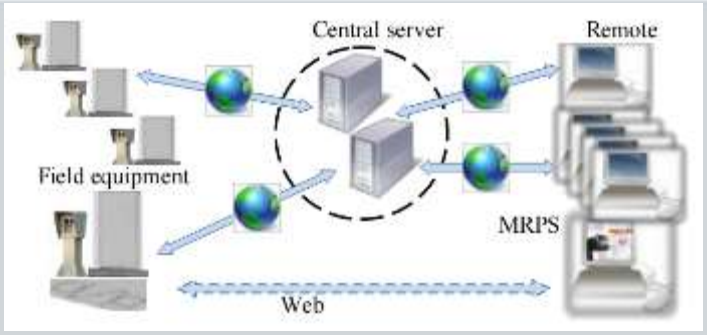
Enforcement by WIM in NL

2014: 20 WIM systems, 1 piezoquarz sensor per lane



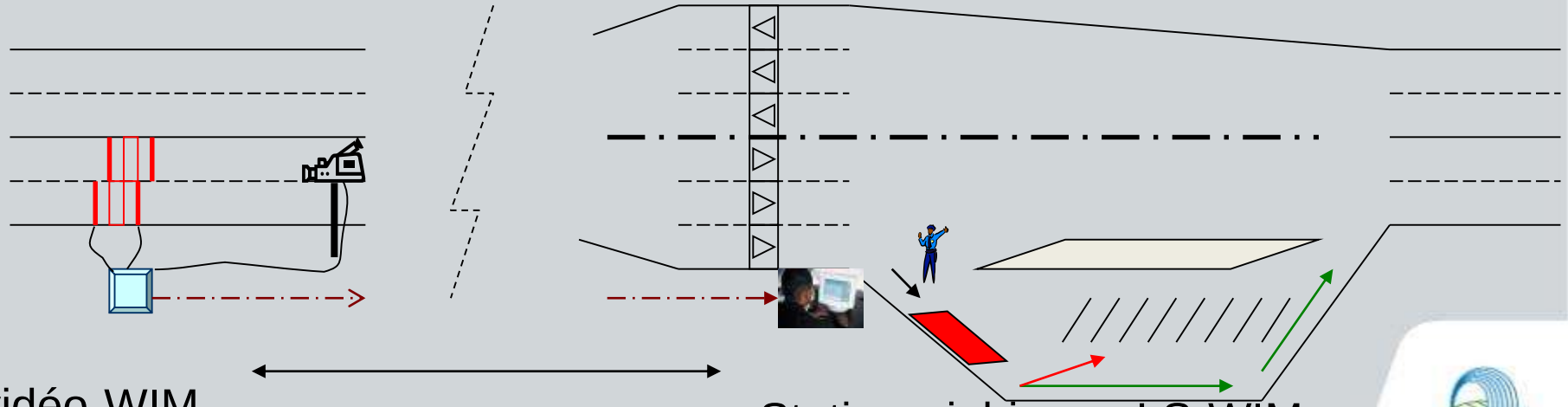
WIM Network in France (EPM)





- Decision 2004, call for tender 2007, implementation 2008-11
- Screening (24 hr) + company profiling
- 29 systems, spread on motorways + main highways (> 1500-2000 trucks/day)
- Balanced per region
- 100 k€/system
  300 k€ for a 2-lane site
  +20 k€/yr maintenance

Lay-out of a WIM Site



vidéo-WIM
Screening (24/24)

3 – 15 km

Static weighing or LS-WIM
Check, immobilisation

Weight Limits and Penalties

Limit FR (EU)

- Axle load: 12-13 t *(10 t/11.5 t)*
- Tandem: 24 t *(21 t)*
- Tridem: 27-31.5 t *(24 t)*
- GW:

2-axle: 19 t *(18 t)*
3-axle: 26 t *(25-26 t)*
4-axle: 36 t *(32-36 t)*
5-axle: 40–44 t *(40-44 t)*
log trucks:
5-axe: 48 t
≥ 6-axle: 57 t

Penalties: fines

GW: 135 €/t, axle: 135 €/0.5 t, ≥20%: up to 1500 €

GW: +17 t → 2295 € 3 axles: +6.5 t → 1755 €
total : 4050 € !

Accuracy and Efficiency

- Weighing sensors: piezoquartz + self-calibration

  among 15 sites:

  10 in B(10), 3 in C(15)

  1 in D+(20) (pavement deterioration), 1 in E(30) veh. lateral position

- Other parameters

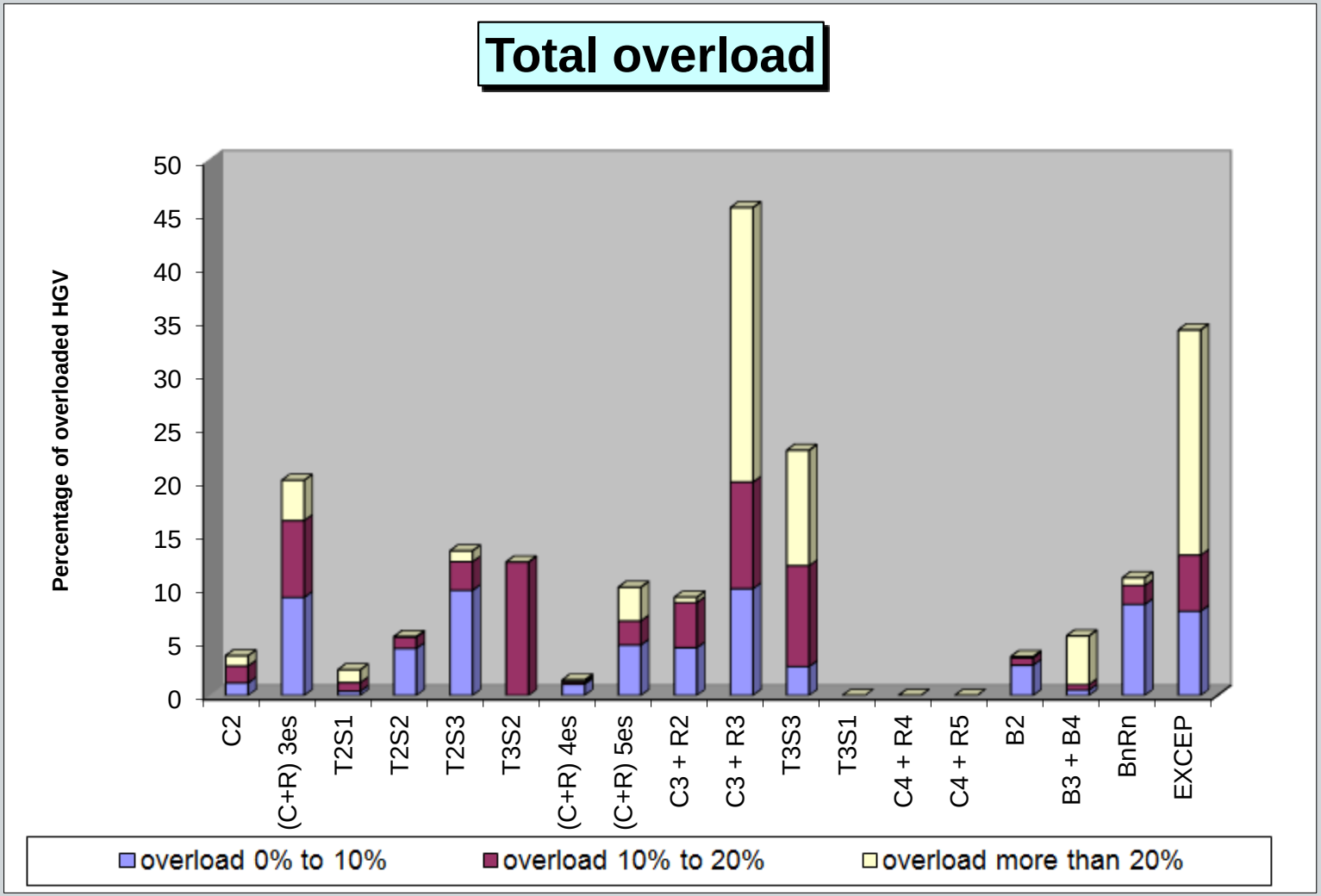
  Instantaneous speed: ±1%

  ANPR: ≈70%

- Efficiency

  - 20 millions trucks weighed / yr, ≈10% overloads
    (50,000 trucks weighed in static)
  - before WIM: 25% with WIM: 96% of stopped trucks overloaded
  - 2 weighing officers + 2 policemen/site during cheks

Overload Results (Le Muret, A64, June 2007)



Toward Direct Enforcement by WIM

Direct Enforcement by WIM in CZ

Tolerances: GVW: 5%,
axle load: 11%
i.e. 0.95 GVW and 0.89 axle load are compared to the legal limits

- Reliability of the system: 65 to 70% of the measured overloaded vehicles are validated for penalty
- Quality of the road surface, staff training, validation process and legislation finalization
- No fine at this stage

Direct Enforcement by WIM in France

- **Ministry of Transport/IFSTTAR + CEREMA**
  - Project “Automated enforcement of overloads”
  - To make checks more efficient and dissuasive
  - 4 yr project (2014-17), 145 MM + 330 k€
  - To develop the frame (type approval procedure and certification process)...
  - ...and the technical tools for an accurate and reliable WIM system
  - Same principles as for speed or spacing enforcement
  - Identification of the HCVs weighed in accuracy class 5 (OIML), for 100% of the validated weighed vehicles

Schedule

- 2 phases:
  - Phase 1 (2014-15): feasibility study for type approval of an HS-WIM system by the OIML+

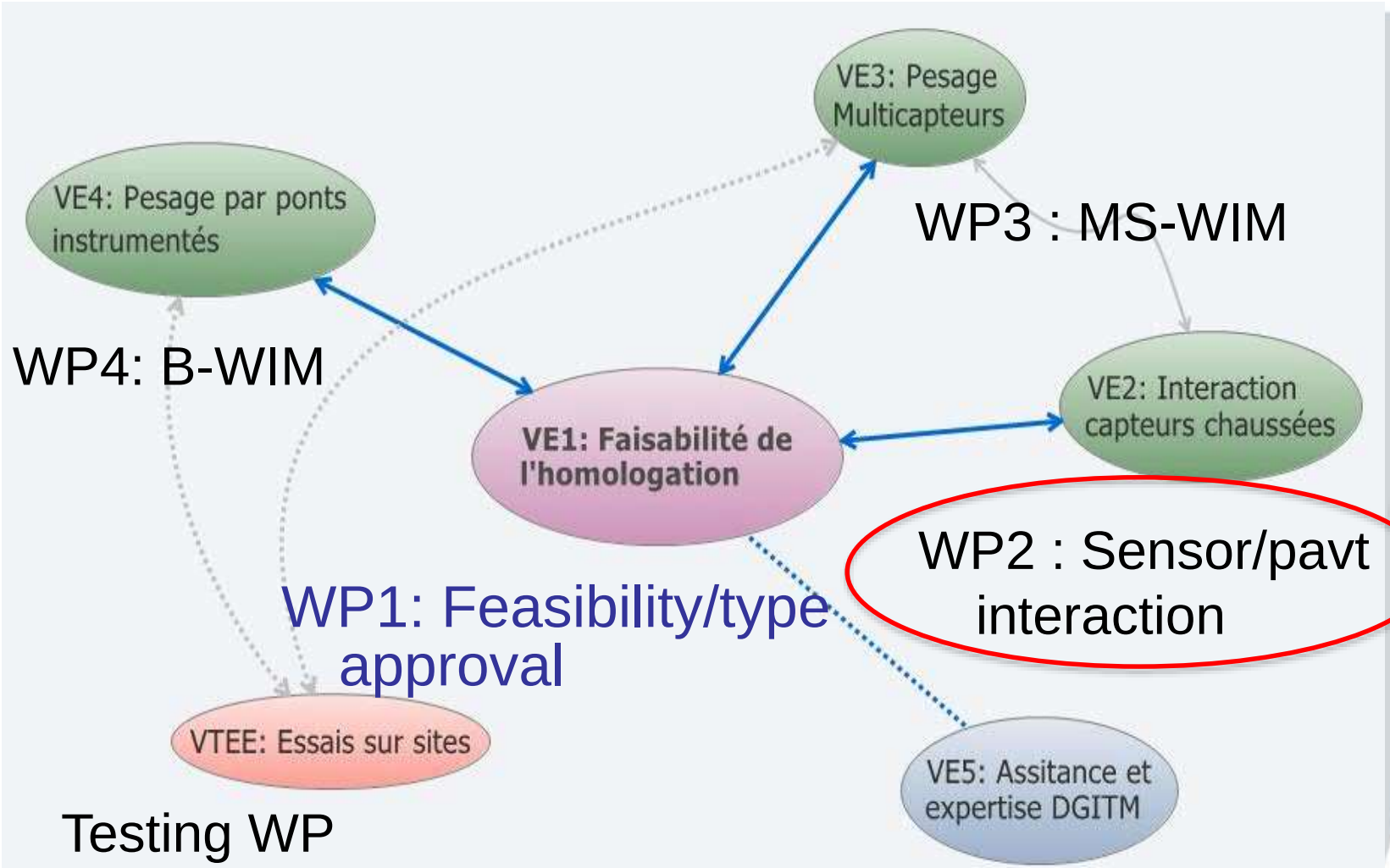
    stop/go

  - Phase 2 (2016-17): construction and test of a prototype
- Experiments with WIM vendors:
  - Lab and testing facility tests (2014)
  - On road/bridge tests (2015-16/17)

Methodology

- Very demanding challenge
  - None of the existing systems are fully reliable in class A(5)
  - Requirement of 100% of the measures above the thresholds (GVW, axles…) within the A(5) or OIML 5 tolerances
  - WIM systems do not measure static weights!
- Check and improvement of the whole chain
  - Quality of sensors, qualification
  - Sensor mounting and response, signal, signal processing, sensitivity to external factors
  - Vehicle dynamics (vertical)
  - Vehicle runs conditions (speed, acceleration, lateral position…)
  - Sorting criteria and algorithms
- Type approval procedure by the legal metrology

Project Organisation



WP1: Type Approval and Certification

- Reference to the OIML R134
- Will take into account the International experiences
- Specifications will be written by the DGITM
- (Self-)calibration procedure to be improved
- Sorting of the “good” weighings
- To identify the vehicles weighed within the tolerances of the OIML class 5: ±5% (gross weight), ±8% (axle load)
- Metrological, technical, electronic instrument and testing requirements (incl. B-WIM)

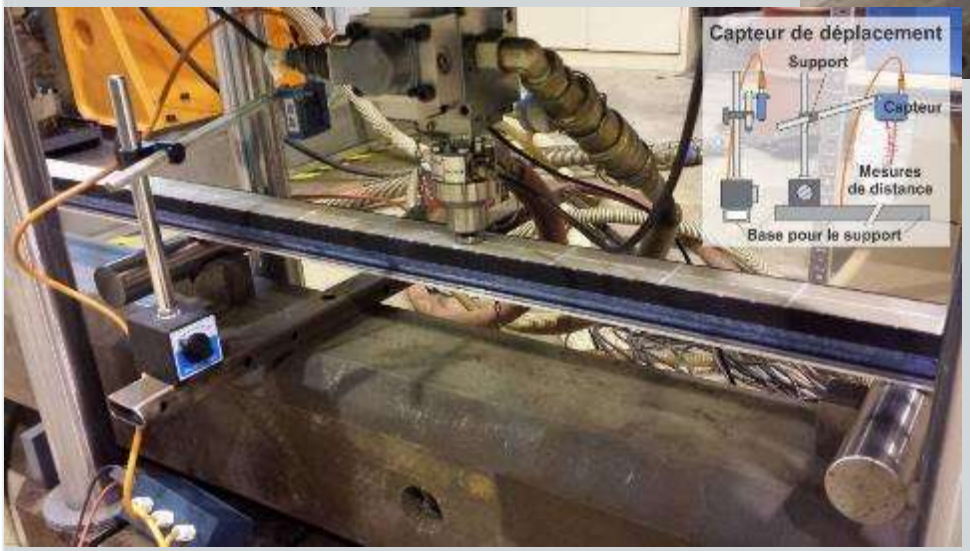
WP2.1. WIM Sensor Behaviour +VTEE

- Piezoquarz (Kistler, Lineas): Sterela
- Piezoceramic (Thermocoax): Fareco
- *Piezopolymer (MSI)*
- Other sensors incl. fiber optics

- Response to vertical (punching) force and to bending moment (lab tests: see Gustavo)
- Response under controlled wheel load in known conditions: accelerated pavement testing facility
- Check in operational condition: filed test on a motorway (VTEE), A4 St Avold by SANEF
  Sterela, TDC, *Fareco (?), Kapsch (?), Intercomp (?)*

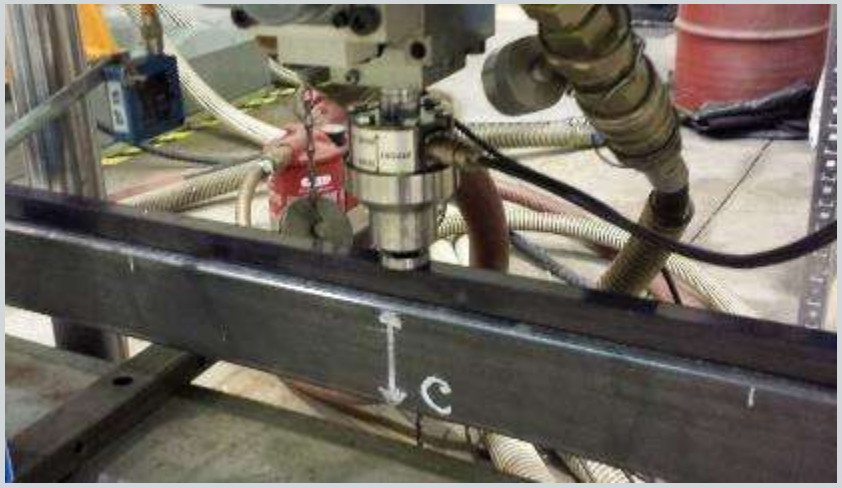
WP2.1: Lab Tests Piezoquarz (Lineas F)

- Punching test (vertical force),
- by step of 25 mm (cell spacing),
- low transverse scattering



- Bending test (3 support points)
- Flexion effect neglectible (2-4%)

WP2.1: Lab Tests Piezoceramic

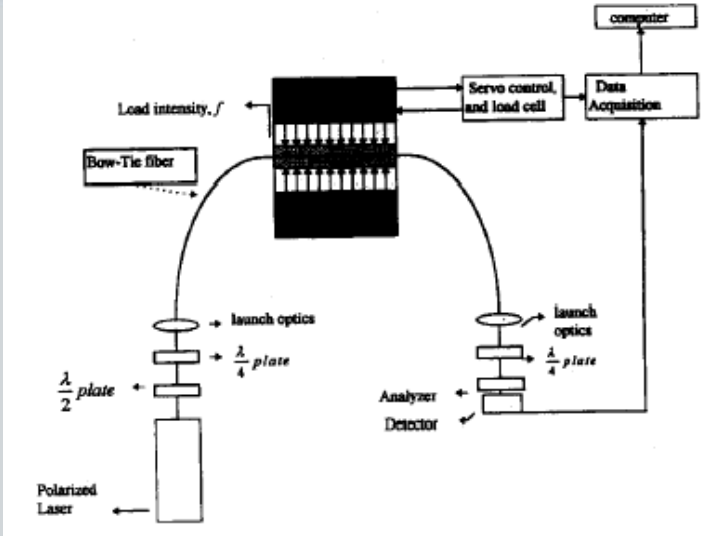


- 3 point bending test
- Sensor glued on a steel plate
- Response depends on the frequency (veh. velocity)
- Flexion and compression contribute each for ≈50% to the response
- Sensitivity to the pavement deflection/ modulus

WP2.1: Tests on the Accelerated Pavement Testing Facility Ifsttar Nantes)

WP2.2: Fiber optic sensor development

- WP2: new sensors =
  fibre optics
  higher performance and less cost than the current systems
- Technology of sensors and opto-electronics highly progressed since WAVE (1999)
- New sensor design and conditioning
- Modelling and assessment by simulation in progress
- Lab test planned in 2015, field test in 2016

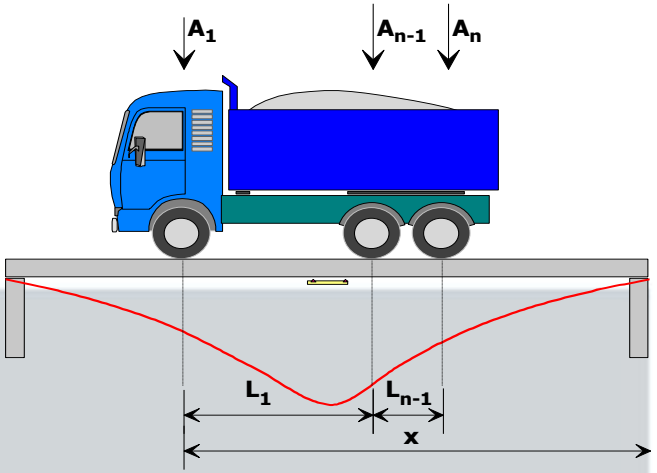


WP3: Multiple-sensor WIM

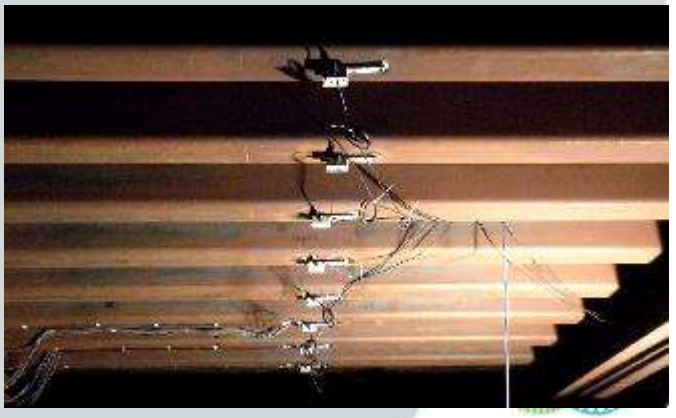
- MS-WIM: dynamic effect and external factors mitigation, sorting of the “good” measurements
- No more work on the static weight estimation algorithms (see WAVE 1999), or slight improvements
- Longitudinal acceleration monitoring and mitigation
- Vertical acceleration (dynamics) monitoring and mitigation
- Repeatability of the load measurements (by axle)

$\Rightarrow$ Sorting criteria and algorithm

WP4: Bridge WIM



- Re-assessment of the accuracy and reliability (new Si-WIM)
- Coupling with AVI, adaptation to direct enforcement
- Slab (integral) bridges and steel orthotropic decks (algorithm tbd)
- Sorting criteria and algorithms:
  - dynamic interaction veh/bridge
  - longitudinal acceleration mitigation
  - multiple presence
- Type approval procedure with reference bridges



Conclusions

- Direct enforcement by WIM = next main challenge of WIM
- Technical, legal and practical challenge
- Need an International cooperation (EU, North America...)
- May be helped by the regulation (e.g. EU directive 96/53EC), intelligent access programme (IAP)...
- Still a need to convince the authorities and governments, as well as the other stakeholders, a Win-Win/m process
- ISWIM (International Society for WIM) may help...

Contacts:

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http://www.is-wim.org

Acronyms

- WIM = weigh-in-motion
- ANPR = automatic number plate recognition
- DGITM = direction générale des infrastructures, des transports et de la mer
- ECR = Euro Control Route
- EPM = équipement de pesage en marche (WIM system)
- EU = European Union, MS = member states
- ISWIM = International society for wiegh-in-motion
- MEDDE = ministry of ecology, sustainable development and energy (in charge of transport, France)
- OIML = International organization for legal metrology
- REMOVE = Requirements for EnforceMent of Overloaded Vehicles in Europe
- TISPOL = European traffic police network
- VOSA = vehicle & operator services agency
- WASP = WIM and safety partnership