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ITS WORLD CONGRESS 2017
Montréal | OCTOBER 29 - NOVEMBER 2
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Weigh in Motion Accuracy Improvements for Direct Weight Enforcement

Session SIS52 – Oct. 31, 2017

Implementation of Weigh-In-Motion Systems for Direct WIM Enforcement

Outline

- WIM Accuracy Error Contributors
- Options to Improve WIM Accuracy
- GVW Accuracy Return on Investment
- Summary

WIM Accuracy Error Contributors

- Sensor Measurement Variability
  - Sensitivity shift over sensor length: ±2 to 4%
  - Non linearity across measurement range: ±1 to 2% of FSO (Full Scale Output)
  - Temperature Effect (Sensitivity): -.02 to .03% / deg C; temperature coefficient is not necessarily linear – net impact up to -2%
- Vehicle Dynamics
  - Condition of mechanical systems, suspension, tires, etc.
- Electronics
  - With best available algorithms and electronic design, generally contributes less than 1% error
- Quality of Installation and Site Specific Factors
  - Cross slope out of specification
  - Road condition – level approaches, maintenance, road deterioration

Options to Improve WIM Accuracy

- Quality of Installation and Site Specific Errors
  - Good site selection practice
  - Pavement smoothness and characteristics to meet or exceed standard requirements (ASTM, COST, OIML, etc.)
  - Certified field installers
- Electronics
  - Industrial Grade designed for extreme environments
  - Experienced suppliers with certified systems

Options to Improve WIM Accuracy

- Vehicle Dynamics
  - High quality installation – but does not address statistical variances in measurements
  - Multiple Sensor Thresholds – reduces error by using multiple measurements
  - Staggered Sensor Arrays – additional error reductions in gross vehicle weight errors with measurement spreading
  - Calibration – adjustment factors that consider most common vehicles at each site; can also reduce impact of site condition variances

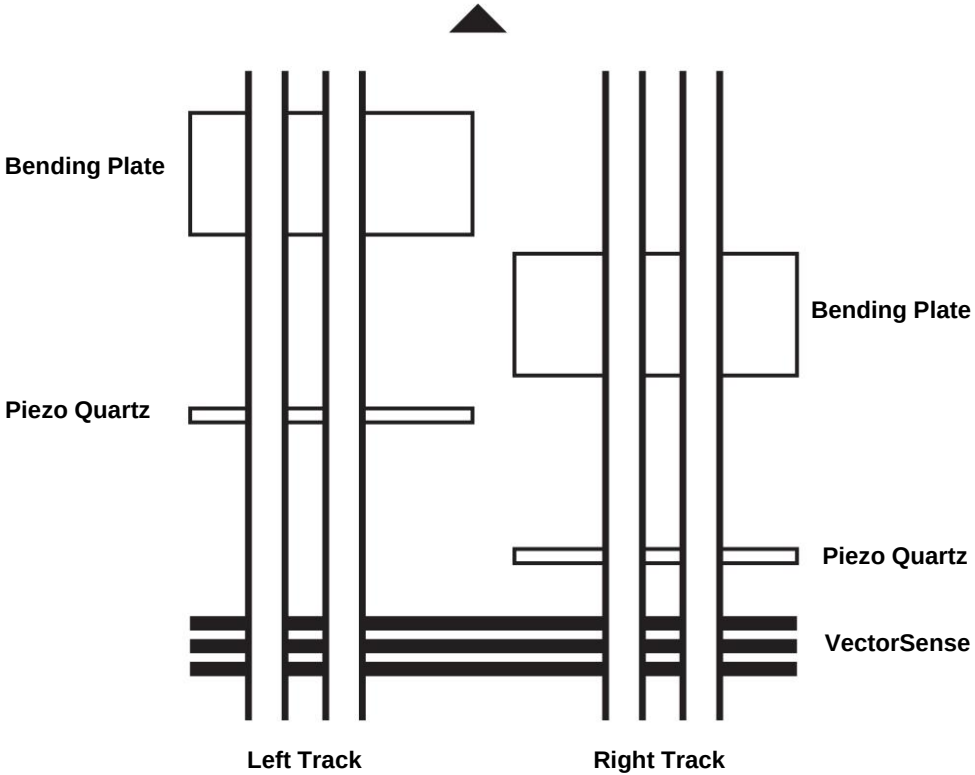
Options to Improve WIM Accuracy

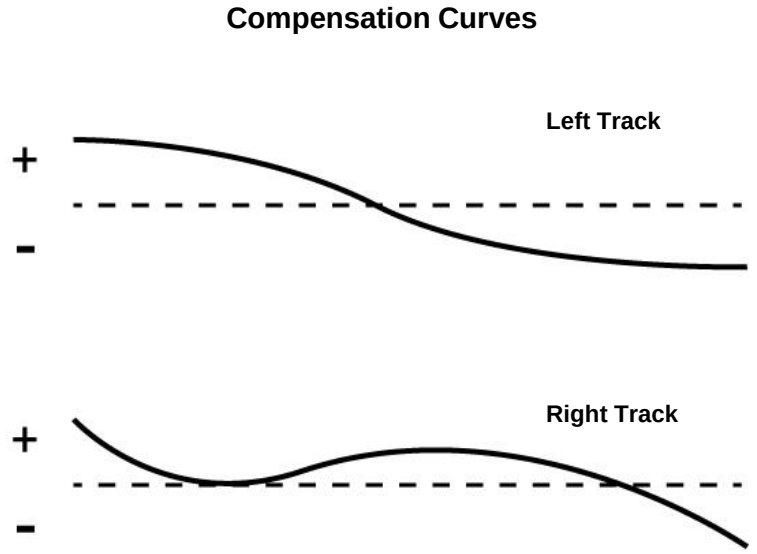
- Sensor Measurement Variability
  - Use more than one sensor type – combination of scales and sensors which when combined reduce overall variances
  - Temperature calibration curves partially offset each other
  - Measure and adjust for vehicle / tire location on each sensor / scale

Options to Improve WIM Accuracy

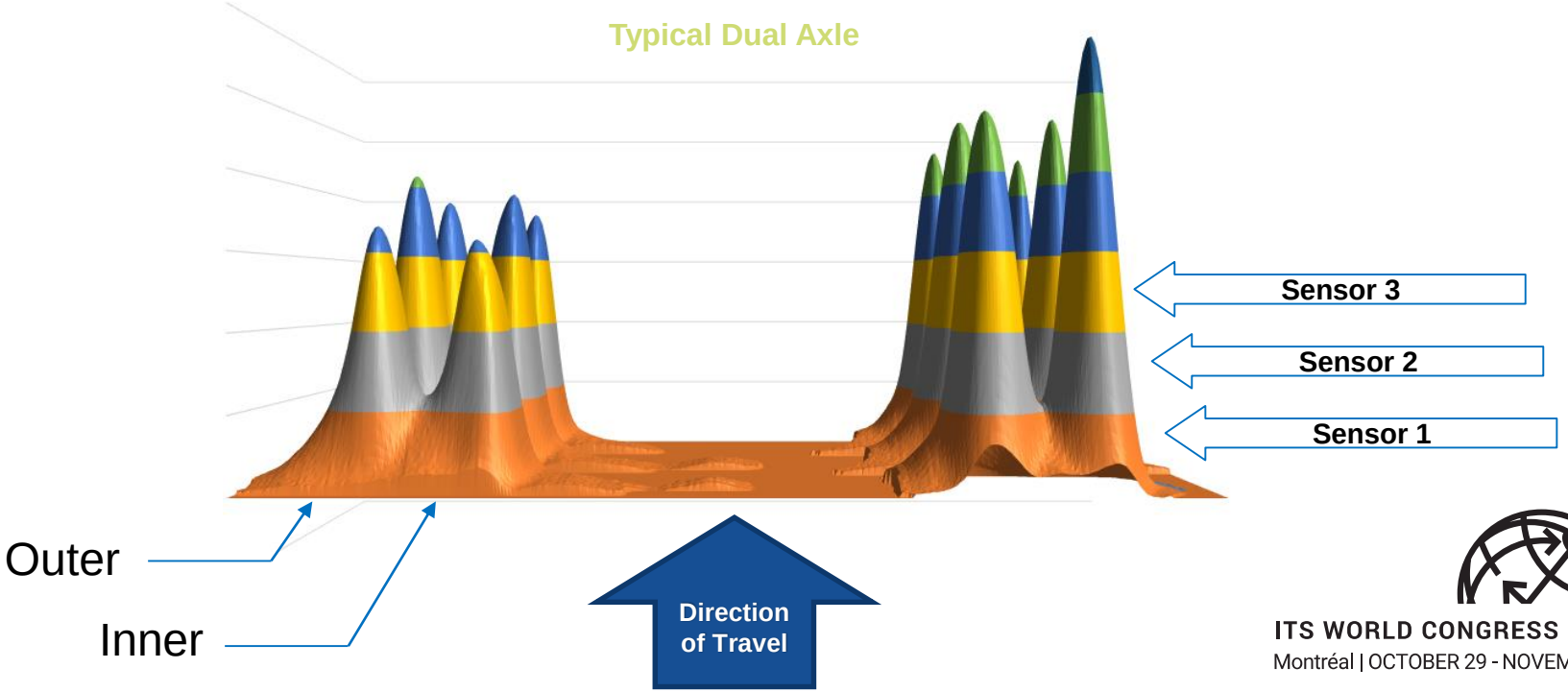
- New approaches
  - Measure vehicle / tire location on each sensor / scale and adjust WIM measurements to reduce sensitivity errors
  - Requires calibration of each sensor array along the sensor length after installation to include compensation for installation and road variability
  - Identify underinflated / missing / mismatched tires that impact measurement accuracy
  - Adjust WIM measurement due to higher loading at specific points on each sensor array

Options to Improve WIM Accuracy



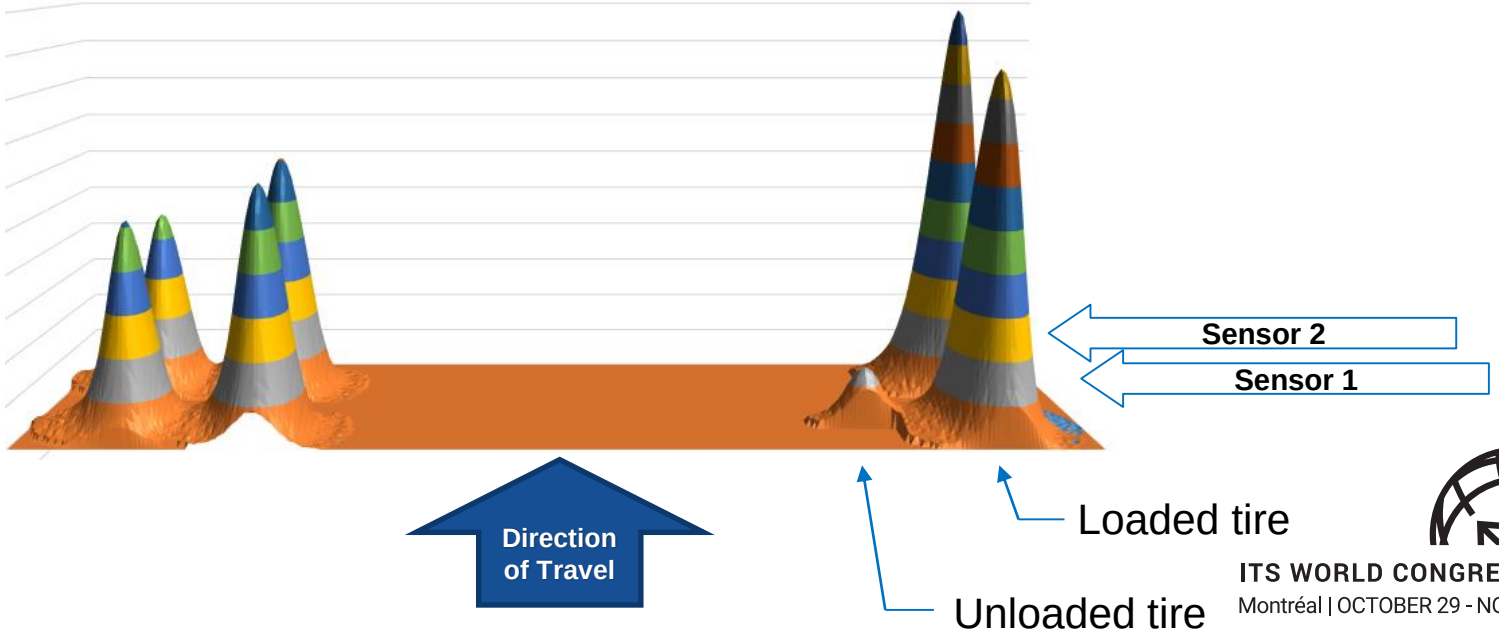


Axle with Normal Dual Tires

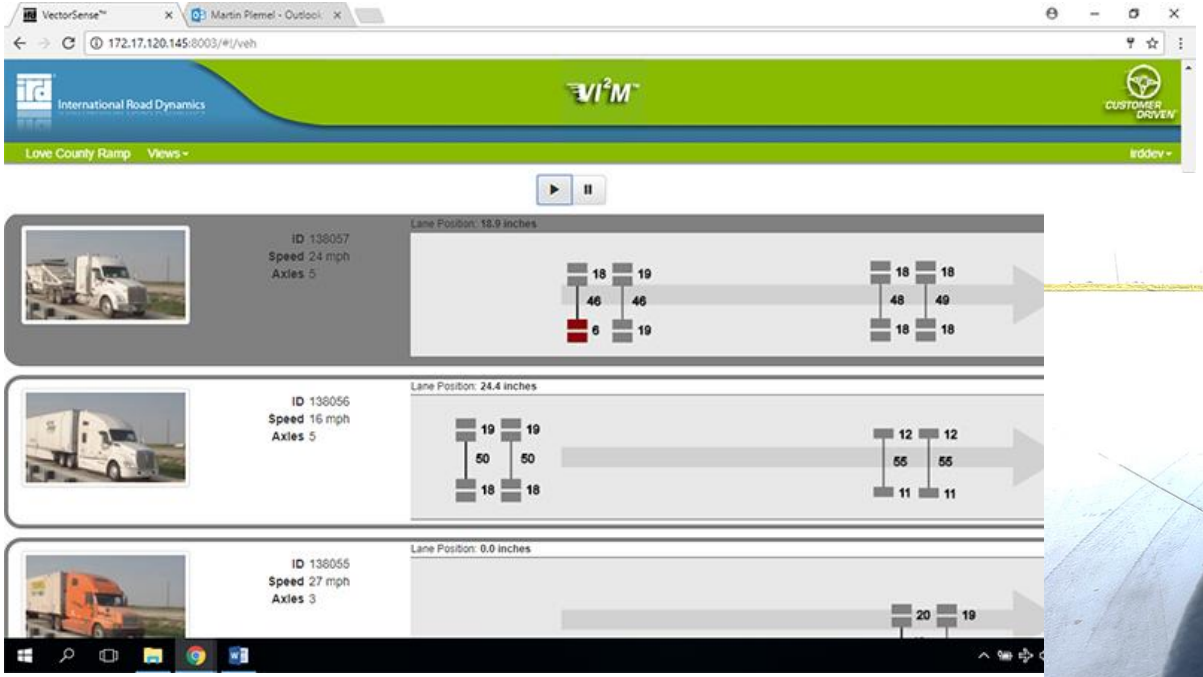


Mismatched Tires

- Significant increase in road damage due to tire level overloading

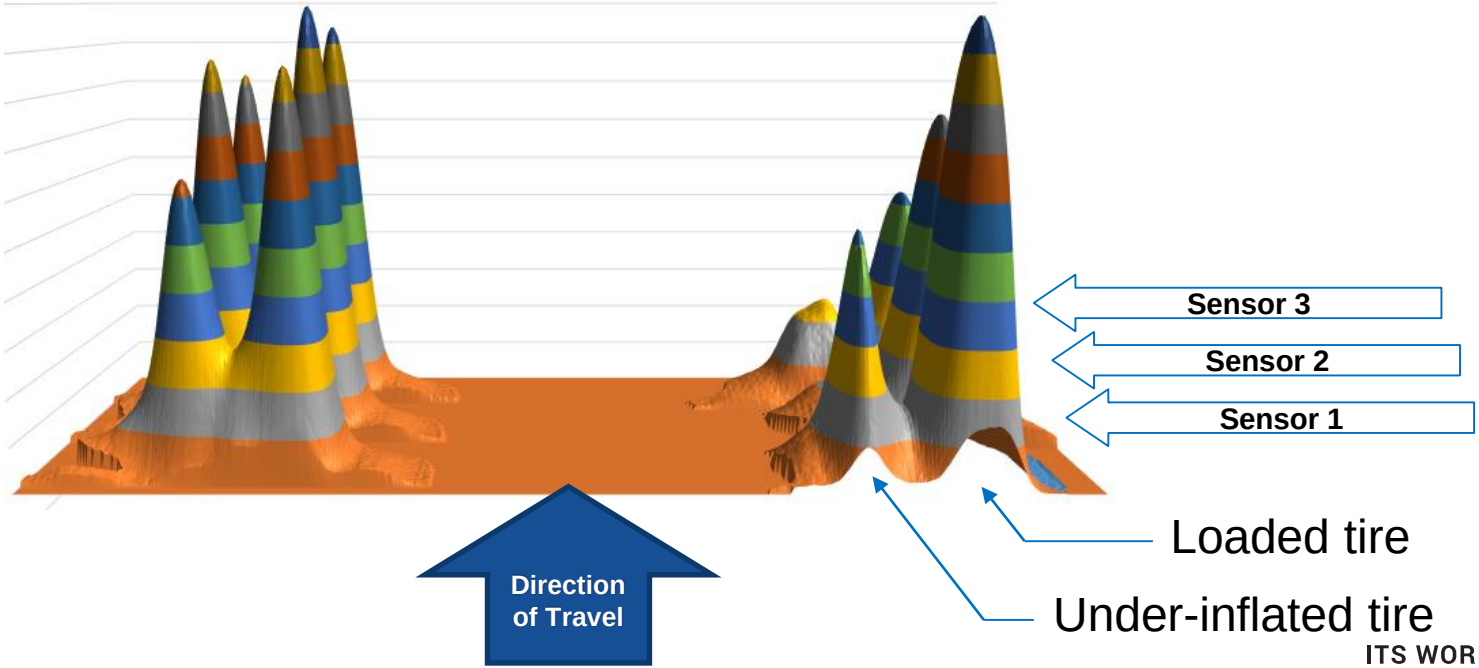


Mismatched Tires



Mismatched Tires

Low Pressure Tire – approx 20 psi



GVW Accuracy Return on Investment

- Current practice
  - Single threshold sensors (strip) — GVW ± 7% for $35K - $55K/lane
  - Single threshold sensors (scales) — GVW ± 6% for $40K - $75K/lane
  - Double threshold sensors (strip) — GVW ± 5% for $55K - $75K/lane
  - Double threshold sensors (scales) — GVW ± 4.5% for $65K - $100K/lane

- New approach with lane position information
  - Single threshold sensors (strip) — GVW ± 5% for $45K - $65K/lane
  - Single threshold sensors (scales) — GVW ± 4.5% for $50K - $85K/lane
  - Double threshold sensors (strip) — GVW ± 4% for $65K - $85K/lane
  - Double threshold sensors (scales) — GVW ± 3.5% for $75K - $110K/lane

- Note: above estimates exclude any road work to meet smoothness / slope requirements

Summary

- Most important issue in the use of WIM for enforcement is to ensure pavement thickness, condition and smoothness meet WIM installation specifications / requirements
- Second most important is to use certified installation experts
- Finally, the use of advanced technologies including lane position information improves WIM accuracy and provides a better return on investment for enforcement activities; results in > 25% reduction in false positives

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THANK YOU

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