



Next Generation Integrated Mobility:

Driving Smart Cities

www.itsworldcongress2017.org



ITS WORLD CONGRESS 2017
Montréal | OCTOBER 29 - NOVEMBER 2

Produced by



In Conjunction with



Co-organized by





ITS WORLD CONGRESS 2017

Montréal | OCTOBER 29 - NOVEMBER 2

www.itsworldcongress2017.org

Randy Hanson

International Road Dynamics Inc. (IRD)

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): -0.02 to 0.03% / 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

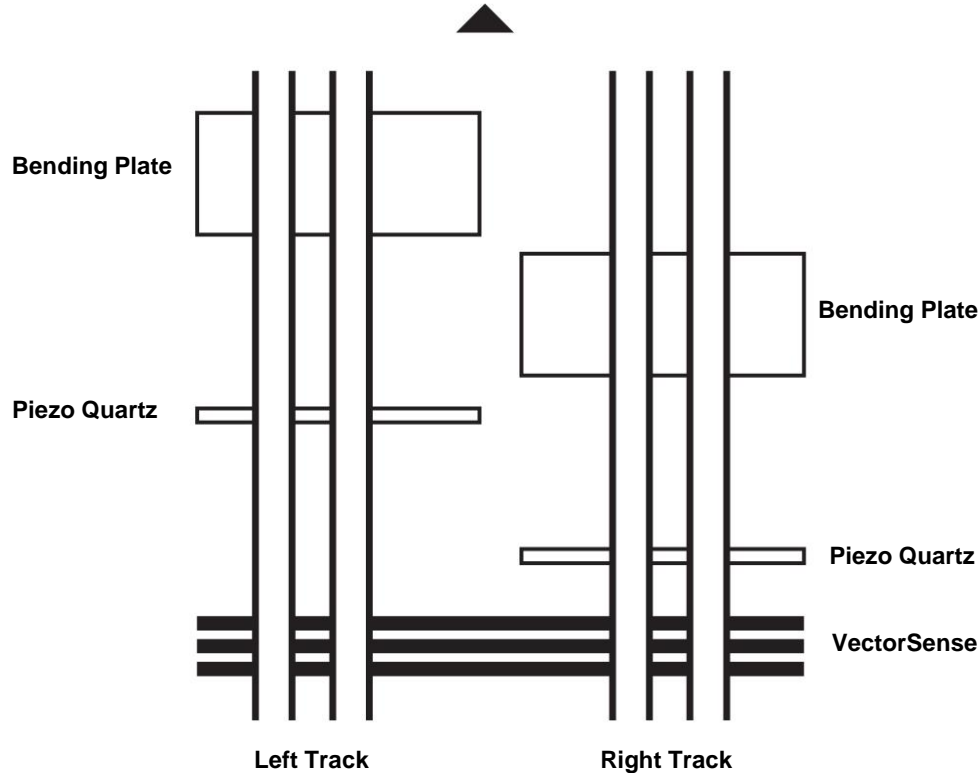


Options to Improve WIM Accuracy

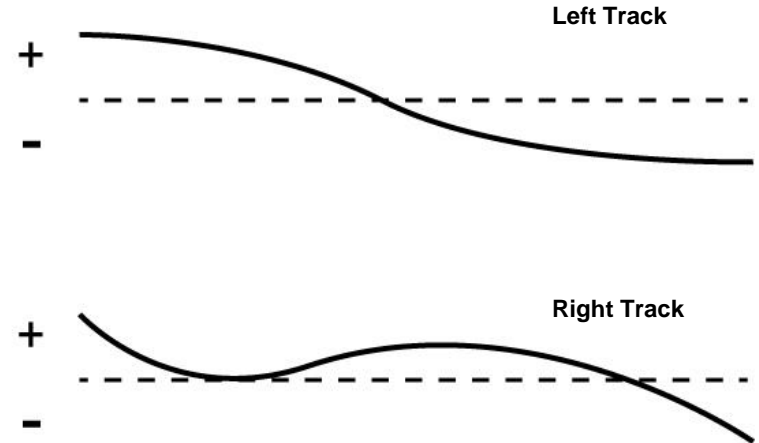
- New approaches
 - Measure vehicle / tire location on each sensor / scale and adjust WIM measurements to reduce sensitivity errors
 - Requires calibration of each sensor array along the sensor length after installation to include compensation for installation and road variability
 - Identify underinflated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



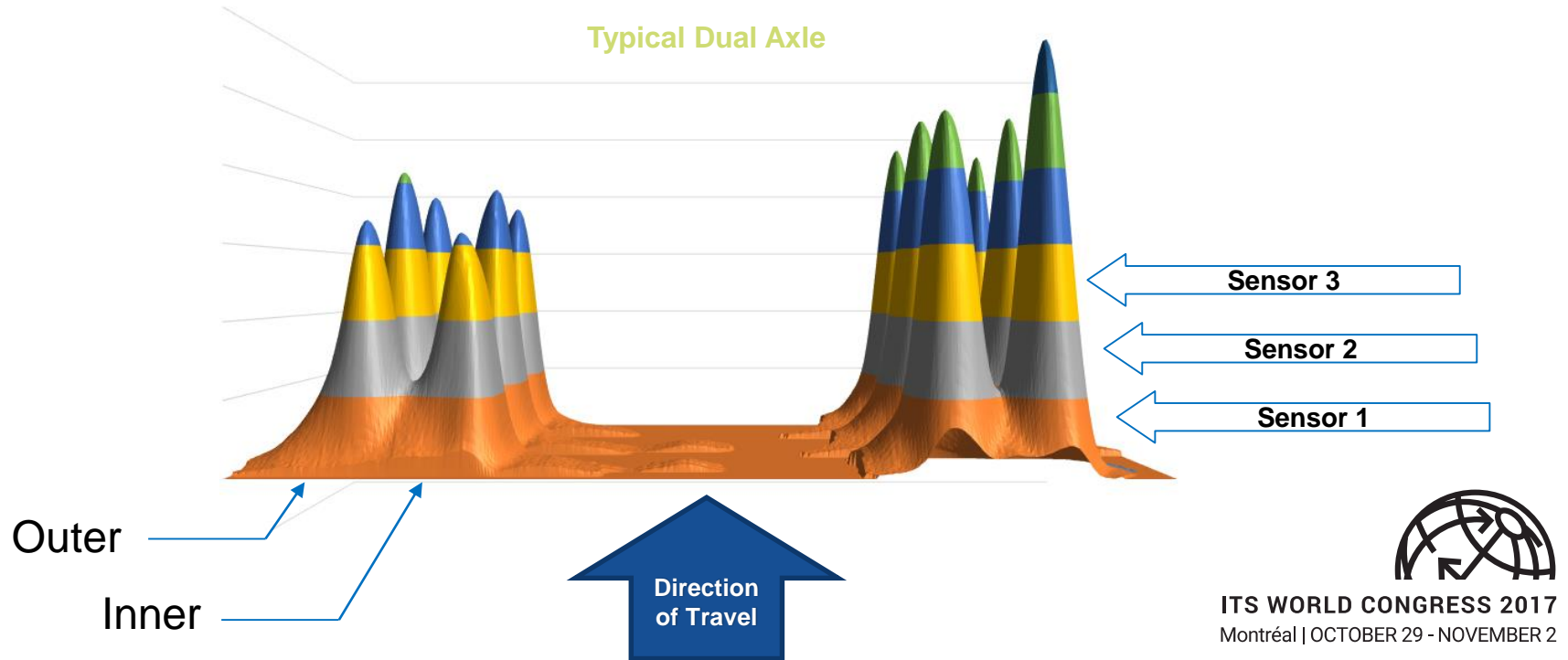
Options to Improve WIM Accuracy



Compensation Curves

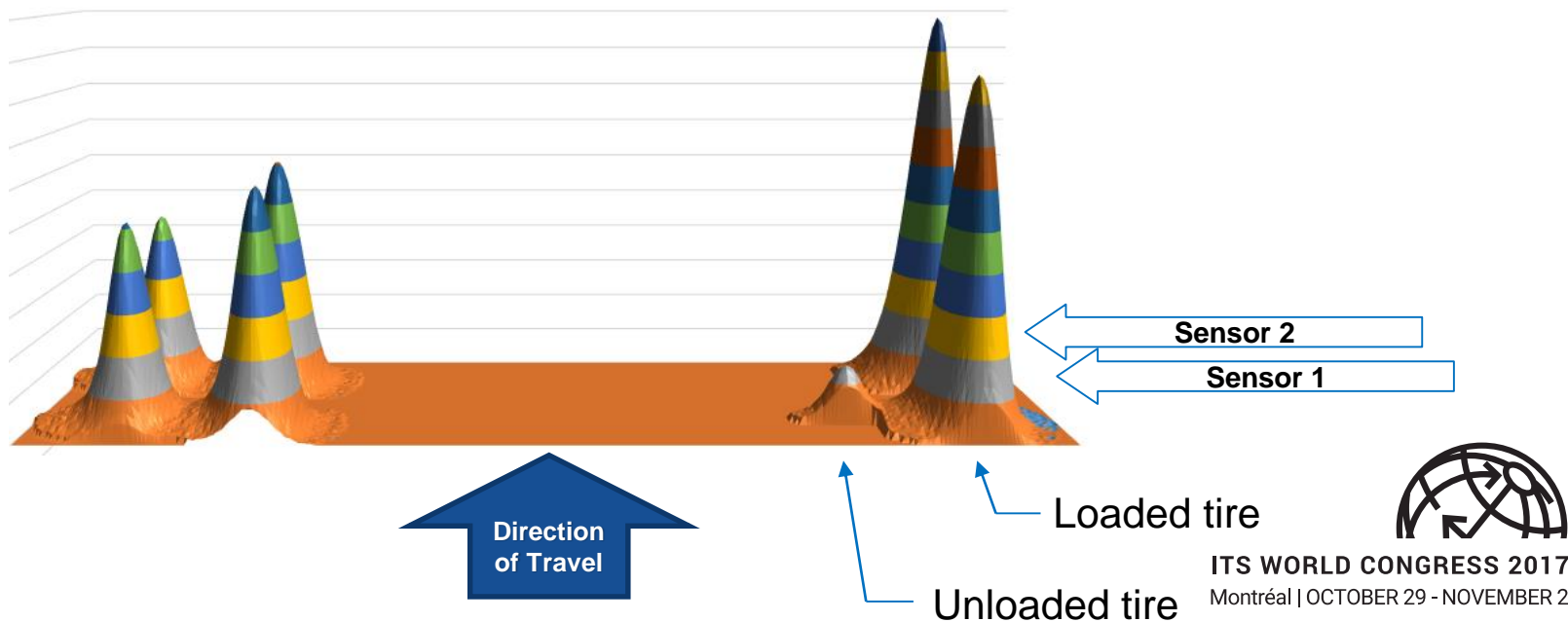


Axle with Normal Dual Tires



Mismatched Tires

- Significant increase in road damage due to tire level overloading



Mismatched Tires

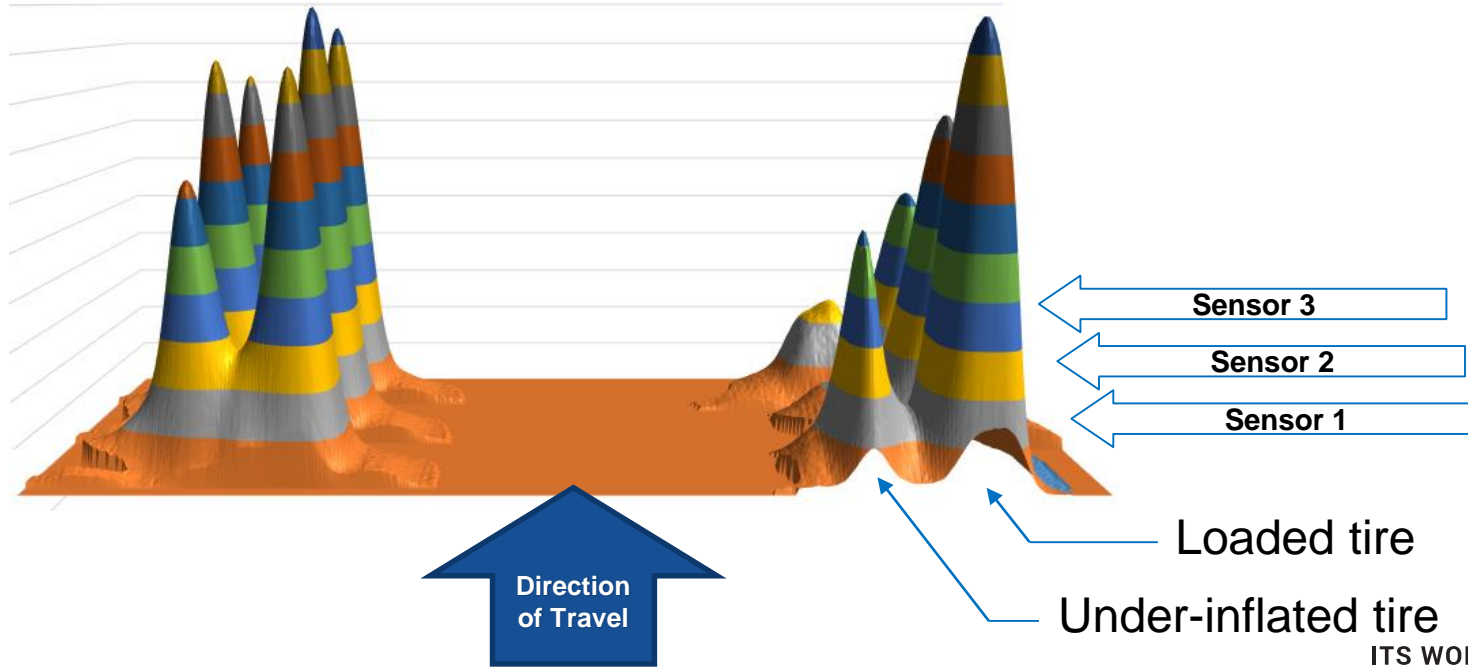


Mismatched Tires



ITS WORLD CONGRESS 2017
Montréal | OCTOBER 29 - NOVEMBER 2

Low Pressure Tire – approx 20 psi



GVW Accuracy Return on Investment

- Current practice
 - Single threshold sensors (strip) GVW \pm 7% for \$35K - \$55K/lane
 - Single threshold sensors (scales) GVW \pm 6% for \$40K - \$75K/lane
 - Double threshold sensors (strip) GVW \pm 5% for \$55K - \$75K/lane
 - Double threshold sensors (scales) GVW \pm 4.5% for \$65K - \$100K/lane
- New approach with lane position information
 - Single threshold sensors (strip) GVW \pm 5% for \$45K - \$65K/lane
 - Single threshold sensors (scales) GVW \pm 4.5% for \$50K - \$85K/lane
 - Double threshold sensors (strip) GVW \pm 4% for \$65K - \$85K/lane
 - Double threshold sensors (scales) GVW \pm 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



International Road Dynamics Inc.



THANK YOU



ITS WORLD CONGRESS 2017
Montréal | OCTOBER 29 - NOVEMBER 2