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Roads General Authority



Workshop Partner



# Strategies for Implementing Weigh-In-Motion (WIM) Systems for Direct Enforcement

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# Strategies for Implementing Weigh-In-Motion for Automated Enforcement

- IRD/Quarterhill Experience
- WIM Data Collection
- Validating Enforcement
- Setting Thresholds for Enforcement
- Implementation
- Measurement Confidence
- Regulatory Environment
- Life-cycle Management



# IRD/Quarterhill – 45 years in WIM

1980 - 1985

- Introduction of SLC-WIM scale
- First Automated Ramp Weigh Station



1986 - 1990

- Introduced the TSR line of traffic counters, classifiers and WIM Electronics
- Introduced the TCC line of traffic counters and classifiers

1991 - 1995

- IRD Bending Plate
- Offered portable WIM electronics



1998 - 1999

- First automated Mainline Sorter Weigh Station in Woodburn Oregon



2000 - 2007

- First iSINC® electronics
- Introduced Virtual Weigh Stations



2012 - 2013

- Introduced iSINC® Lite
- First Weigh Station with Auto Release



2014 - 2015

- Introduced the VectorSense tire sensor suite
- First cloud-based data solution: VI2M



2016 - 2017

- International Road Dynamics (IRD) is acquired by WiLAN
- IRD becomes part of Quarterhill

2018 - 2020

- Launched Central Data Management System (CDMS) for WIM preclearance sites
- Acquired Icoms Detections (radar detection)
- Introduced iTHEIA™ AI-based Video Traffic Counter/Classifier

2021 - 2023

- Created IRD Europe GmbH
- Acquired Sensor Line (fiber-optic sensors)
- Introduced AI-enabled CVSA decal reader for inspection stations

2024

- IRD rebrands to **Quarterhill**, subsidiaries including ETC tolling and RedFox





## IRD/Quarterhill's Experience

- Modular systems help meet Enforcement objectives
- Our strategic and structured approach helps mitigate risks, manage costs, and ensure the system meets current and future demands
- Ensures WIM systems are reliable, sustainable, and adaptable





# Managing Overloaded Vehicles at Weigh Stations

## Key Challenges...

- Limited hours of operation/staffing challenges
- Inability to build weigh stations, which often include inspection bays and parking, in desired locations
- A limited subset of vehicles is selected for compliance checks

**...Lead to a need for alternative solutions**



Sequoyah, OK Inspection Station



# Data Collection: Foundation for Implementation

Importance of comprehensive data collection:

- Understanding actual overloading trends through data
- Using data to establish enforcement baseline
- Assess enforcement program success, and justify investment

Site Summary												
Site C7L H-1 Fwy 200' West of Kaonohi St.						Class 0 to 15			Date 2021-Apr-01 to 2021-Apr-30			
Lanes E1, E2, E3, E4, E5, E6, E7, W1, W1Z, W2, W2Z, W3, W4, W5, W6, W7												
Class	Vehicle Count	Vehicle Count %	PVR Count	No Weights	Weighted	Warning Count	Warning Count %	Valid Weights	Total GWW (kips)	Average GVW (lbs)	Overweigh t %	
0	0	0.00%	0	0	0	0	0.00%	0	0	0	0.00%	
1	8,951	0.13%	8,951	2,638	6,313	809	12.81%	5,504	13,839	2,478	0.00%	
2	4,636,653	67.38%	4,636,653	751,486	3,885,167	42,220	1.09%	3,842,947	16,042,500	4,175	0.00%	
3	1,826,841	26.55%	1,826,841	186,906	1,639,935	18,507	1.13%	1,621,428	9,419,859	5,810	0.00%	
4	19,783	0.29%	19,783	0	19,783	800	3.03%	19,183	561,142	29,252	4.890	25.49%
5	170,885	2.48%	170,885	0	170,885	3,401	1.99%	167,484	1,877,857	11,212	3,021	1.80%
6	28,404	0.41%	28,404	0	28,404	327	1.15%	28,077	943,205	33,594	3,266	11.63%
7	6,918	0.10%	6,918	0	6,918	58	0.84%	6,860	479,136	66,845	5,101	74.36%
8	11,376	0.17%	11,376	0	11,376	341	3.00%	11,035	273,004	24,740	1,157	10.48%
9	35,169	0.51%	35,169	0	35,169	345	0.98%	34,824	1,767,374	50,752	5,615	16.12%
10	1,921	0.03%	1,921	0	1,921	25	1.30%	1,896	119,532	63,044	540	28.48%
11	336	0.00%	336	0	336	12	3.57%	324	18,256	56,347	163	50.31%
12	175	0.00%	175	0	175	8	4.57%	167	13,817	82,738	140	83.83%
13	506	0.01%	506	0	506	6	1.19%	500	42,768	85,536	346	69.20%
14	27,117	0.39%	27,117	25,289	1,828	703	38.46%	1,125	18,026	16,023	0	0.00%
15	105,926	1.54%	105,926	105,926	0	0	0.00%	0	0	0	0	0.00%
<b>Total</b>	<b>6,880,961</b>	<b>100.00%</b>	<b>6,880,961</b>	<b>1,072,245</b>	<b>5,808,716</b>	<b>67,362</b>	<b>1.16%</b>	<b>5,741,354</b>	<b>31,590,175</b>	<b>5,562</b>	<b>24,239</b>	<b>0.42%</b>

## WIM Report – VI2M™ Enterprise Reporting System





## Designing for the Regulatory Environment

- Addressing legal nuances in different regions
- Ensuring legal defensibility of overweight citations
- Establishing a suitable WIM standard for certification of direct enforcement systems



# Evolution of Existing Sites

- Planning enforcement architecture to **work with the existing WIM** system infrastructure
- **Build on the functionality** already in Virtual, Slow-Speed, and Preclearance systems
  - Dynamic weight measurement
  - Data collection, including e-screening
  - Variable Message Signs
  - Bypass system integration
- **Improve systems** with:
  - Software upgrades
  - Added sensors
  - AI: vehicle class and driver behaviour



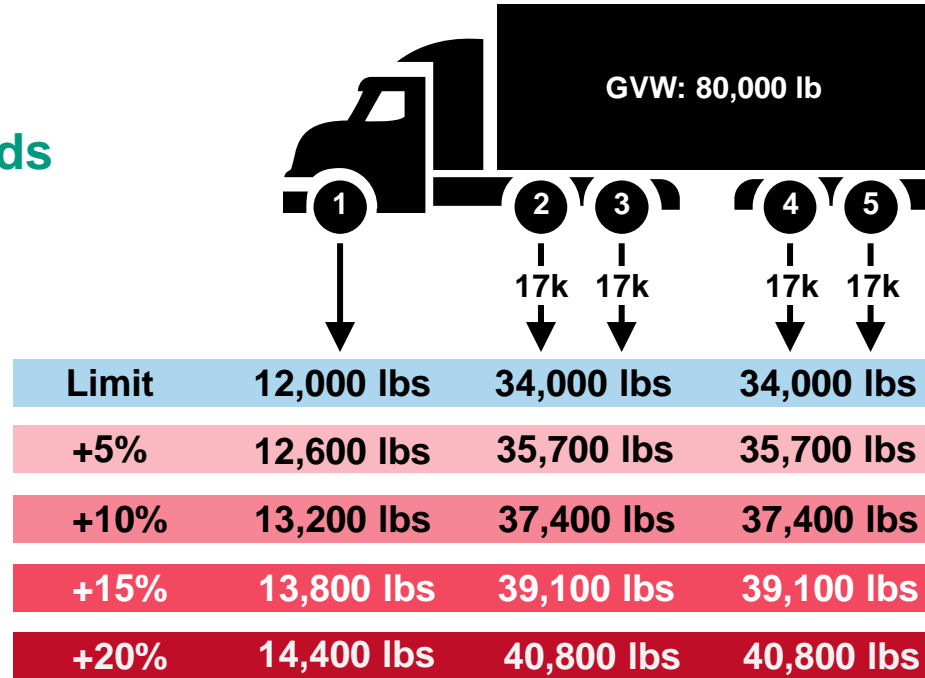
# Critical Factors for System Implementation

- Aligning enforcement thresholds to address real issues
- Avoiding arbitrary benchmarks
- Customizing WIM systems for local needs:
  - Regulations
  - Calibration complexities
  - Type of load
  - Vehicle classification
  - Tire width (wider single tires can carry more weight)



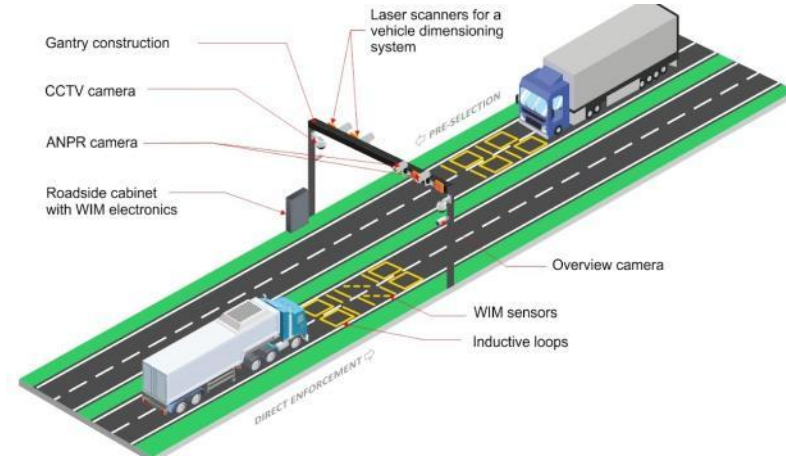
## Setting Parameters Based on Agency Needs

- **Road quality:** flatness, stability, and structural integrity
- The smoother the roadway, the less effect dynamics have on vehicles passing over the system, the better the weighing accuracy
- Road quality is critical to maintaining measurement confidence over time
- **Experienced, qualified installation team**



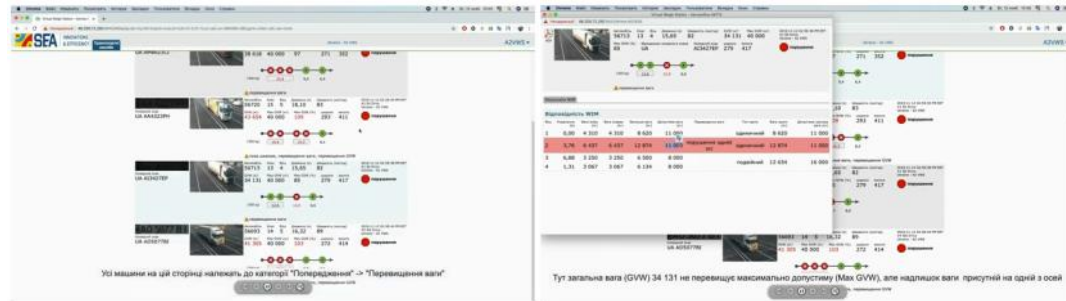
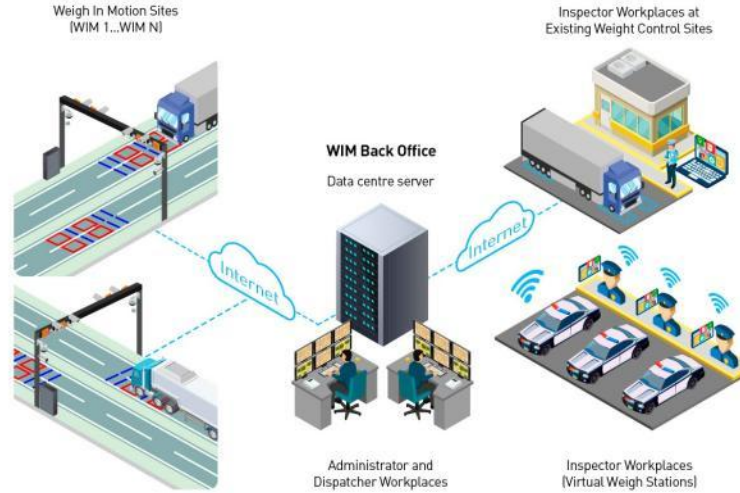
## Example: Ukrainian Direct Enforcement Sites

- HS-WIM for direct enforcement
- Gross vehicle weight:  $\pm 5\%$
- Accuracy (COST 323): Class A(5)
- Local type approval based on OIML standards
- Technology:
  - Quarterhill Virtual Weigh Station Software
  - iSINC Electronics
  - Intercomp Strip Sensors and Kistler Lineas® Quartz WIM Sensors
  - Automatic Number Plate Recognition (ANPR)



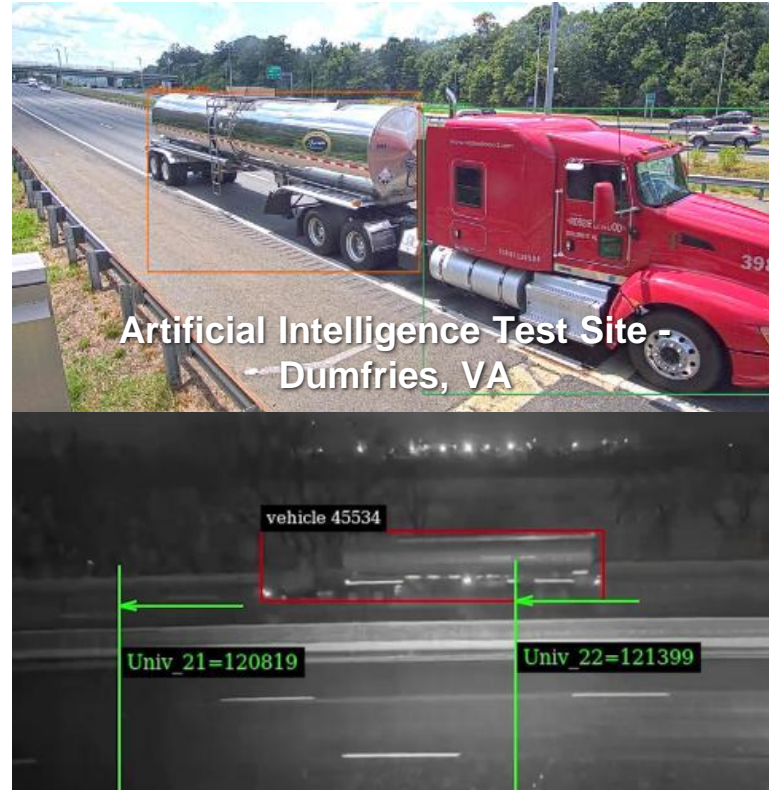
# Ukraine: Direct Enforcement Back Office

- **Connects data from multiple sites:**
  - Central Server
  - Enforcement Package
  - Enforcement Personnel Review



## Vehicle Exclusions

- Load Types
- Permitting
- Environmental conditions
- Driver behaviour
- Lane position





# Verification and Calibration

- Calibration plan
- Data monitoring
- Health monitoring

The screenshot shows a 'Services' window with a search filter for 'servicegroup\_name = Check Status File on VA IROCs'. It lists several stations with their status and last check dates:

- WARNING** since 00:03: Check Status File on IROC on VA-Troutville Station-IROC. WARNING: Missing files for the period 2025-06-09 to 2025-06-10;
- OK** since 00:26: Check Status File on IROC on VA-Carson-Station-IROC. OK: All Files are present on the IROC server for the period of 2025-06-09 to 2025-06-10;
- OK** since May 17: Check Status File on IROC on VA-Suffolk Station-IROC. OK: All Files are present on the IROC server for the period of 2025-06-09 to 2025-06-10;
- OK** since May 13: Check Status File on IROC on VA-Bland Weighstation-Scalehouse -IROC. OK: All Files are present on the IROC server for the period of 2025-06-09 to 2025-06-10;
- OK** since Apr 30: Check Status File on IROC on VA-Sandston-Scalehouse-IROC. OK: All Files are present on the IROC server for the period of 2025-06-09 to 2025-06-10;
- OK** since Apr 3: Check Status File on IROC on VA-Alberta Station-IROC. OK: All Files are present on the IROC server for the period of 2025-06-09 to 2025-06-10;
- OK** since Mar 10: Check Status File on IROC on VA-Stephens City I-81-Station-IROC. OK: All Files are present on the IROC server for the period of 2025-06-09 to 2025-06-10;
- OK** since Jan 29: Check Status File on IROC on VA-Dumfries I-95-Station-IROC. OK: All Files are present on the IROC server for the period of 2025-06-09 to 2025-06-10;

**Multi-site Monitoring: Virginia WIM**



## Post-Implementation: Measuring Effectiveness

- **Tracking trends** in overloading before/after implementation
- Assessing enforcement **impact on compliance**
- Continuous improvement through data analysis
- **Life-Cycle Management** of WIM Systems
  - Regular updates to maintain system reliability, measurement accuracy, and confidence
  - Proactive maintenance strategies
  - Planning for future scalability



# Post-Implementation: Measuring Effectiveness

## Broader AI Implementation:

- Advanced AI Vehicle Identification
  - Number Plate Reading Systems
  - Machine Visions Vehicle Fingerprinting
  - RF Signatures
- Enhance Data Accuracy and Validation
- System Reliability
  - Predictive Maintenance
  - Automated Monitoring

1 Raw image is inputted in the system.

2 Each pixel is evaluated for the probability that the pixel is a plate.

3 A SoftMax regression algorithm is applied to essentially "filter noise."

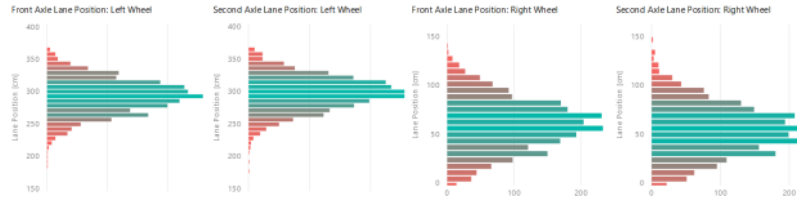
4 The final plates are extracted based on the input.





# Tire Safety Screening

- **TACS – Tire Anomaly and Classification System identifies vehicles with unsafe tires**
- The system also augments WIM with tire width and position data
- VectorSense® sensors measure lane position to within 2 cm



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## Questions?

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