Virtual Weigh-In-Motion
A "WIM-win" for transportation agencies

Championed by the WIM Lead States Team
2006-2007 Presentation
AASHTO Technology Implementation Group

- TIG accelerates adoption of life- and money-saving, high-payoff innovations for higher performing roads

- TIG chose WIM/VWIM as focus technology for non-traditional uses (enforcement)

- Lead States Team
  - North Dakota (Chair)
  - California
  - Florida
  - Indiana
  - Nevada

http://aashtotig.org
WIM Backdrop

- 25+ year track record
- Standard: 2 sensors in road, scale between
  - Sensors: vehicle speed & length
  - Scale weight: all axles, left & right wheels
  - Date/time - truck location, direction
- Evolution
  - Wireless
  - Software for info management/analysis
  - Advanced camera systems
  - Solar power & satellite communications

What’s new: Virtual WIM for weight compliance, screening & enforcement.
Virtual WIM

- Game changer for enforcement
- Non-intrusive, unmanned
- Automated data collection
- Eases traffic flow
- Selective, not random, inspections

VWI M: real-time data from a distance.
Electronic Pre-clearance

- In some States, linked to WIM
- Trucks often bypass weigh station
- Communicate via transponder for vehicle identity
  - Green for “bypass”
  - Red for “pull in”
- Credential check: State/ National databases
- Nationwide
  - 40 jurisdictions use e-screening
  - 300 sites
  - 430,000 trucks with transponders
Pre-Clearance Vendors

PrePass™, NorPass, GreenLight

- **PrePass™**
  - Adopted by about 25 States
  - PrePass™ supplies equipment; State may handle WIM integration
  - NorPass & GreenLight transponders can register for PrePass™ use
  - Cost to carrier for “bypass” when scale’s open

- **NorPass**
  - Deployed in about 12 States and Canadian Provinces
  - States pay for equipment & maintenance
  - Carrier buys own transponder

- **GreenLight**
  - Oregon only
  - State owns, operates, administers database
  - Reads any transponder registered with Oregon
  - Free transponders to qualified carriers
Over the next 20 years, truck tonnage is expected to increase at a rate more than five times that of population growth.

Texas Transportation Institute
Why VWIM, Why Now

Freight Tonnage Moved by Truck
Source: FHWA

Year

Tons (millions)


Tonnage
Pavement Damage

\[
\text{ESAL} = \left( \frac{W_{\text{Single}}}{18000\text{lb}} \right)^4 \\
\text{ESAL}_{\text{rigid}} = \left( \frac{W_{\text{Tandem}}}{29000\text{lb}} \right)^4
\]

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<th>100,000-lb</th>
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<tr>
<td>Equivalent Cars</td>
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<td>70,500</td>
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Dr. Andrew P. Nichols data/graphic
WIM Stakeholders

- Driving public
- American Trucking Associations
- State Departments of Transportation
- Departments of revenue
- U.S. Department of Transportation
- Federal Highway Administration
- American Association of State Highway and Transportation Officials
- Federal Motor Carrier Safety Administration
- State highway patrols
- Motor carriers
- Commercial Vehicle Information Systems and Networks (CVISN)
Florida’s WIM Experiences

- 41 WIMs deployed
- Ramp WIMs all Interstate sites
- 16 MCCO WIMs
- Sensor Technology: load cell, Kistler & Piezo
- 2 mainline WIM deployments
  - Escambia Bay Bridge (Hurricane Ivan)
  - Plantation Key (one way in & out)
- Virtual WIM, 3-D Scanning

FL truck volume has increased over 10% annually in the last 5 years.
Florida Virtual Weigh Station

Punta Gorda Virtual WIM ByPass System

Component Include:
- WIM
- Overview Camera
- License Plate Reader
- OCR
- PC
- RDSCS Software

BRM Software

VWBM Application

Officer can view ByPass Violators from Web Page using IE and existing wireless lan technology

MCCO Server

WEB SERVER
SQL SERVER
VWBM Web Application

MCCO WAN

License Plate Reader system

Ramp Enclosure and Equipment

SB Weigh Station

Data collection PC

BRM Software

Exit 161

License Plate Reader system

Exit 158

Ramp Enclosure and Equipment

NB Weigh Station
Bypass Monitor Virtual Weigh Station: Distances and VWS Configuration

The height of the lowest mounted camera (Overview Camera) is approximately 12 feet measured from the pavement to provide better deterrence from vandalism.

In this configuration, the Line-of-Sight Angle (Azimuth Angle) from the LPR Camera to the Field-of-View is less than 20 degrees, making plate reading more accurate.
Florida’s WIM Results

- 15 million trucks weighed in motion last year
- 24/7 on Interstates, near-95% open rate
- Pull in rates 15% - 18% Statewide
- Data for ESAL classifications 4-14
- License Plate Reader deployment
- Ahead: 3D Dimensioning, Thermal Eye
New Cargoscan Laser Software for 3-Dimensioning Scanner at Flagler

- Vehicle dimensioning system provides 3D image of vehicle with arrows identifying highest and widest points
- Provides actual L x W x H of vehicles
## 3-D WIM Record

### WIM DATA

<table>
<thead>
<tr>
<th>Class</th>
<th>Speed</th>
<th>Gross</th>
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<tr>
<td>9</td>
<td>41 mph</td>
<td>74322 lbs</td>
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**Over Height Combin Over Wt**

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<th>Height: 14'5&quot;</th>
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<td>8941</td>
<td>9573</td>
<td>7338</td>
<td>6578</td>
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<tr>
<td>LEFT</td>
<td>4396</td>
<td>8607</td>
<td>8716</td>
<td>7446</td>
<td>7514</td>
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| TOTL | 9609 | 17548 | 18289 | 14784 | 14092 |
| TNDM | 35837 | 28876 |
| InBr | 1-3 | 45446 | 2-5 | 64713 |
3D Dimensioning for Infrastructure Protection

- Cargoscan 3D measuring lasers + integration with ITS & fixed WIM facilities = heightened ability to intercept violators and protect infrastructure

Photos:
- 8-ton backhoe on top of a flatbed trailer
- Extended shovel arm of hardened refined steel
- Overpass: commercial-grade concrete, reinforced with 1 1/2 inch steel rebar spaced at 6 inch intervals in a criss-cross pattern layered at 1 foot vertical spacing
Florida’s Best Practices

• **Sites for ramp weighing facilities**
  - Straight, far from major tangent for over 1 mile
  - At least 1 mile from ramps to avoid traffic weave/merge
  - Level elevation
  - Avoid
    - Blocking private property access & egress
    - Wetlands
    - Endangered species habitats
    - Rezoning
    - Housing/commercial

• **WIM Life Expectancy**
  - Load cell, 14+ years
  - Bending plate, 15 years
  - Quartz, 3+ years
  - Piezo varies
Florida’s Challenges

License Plate Readers

Vendor: The Revenue Market Inc. (TRMI)

- Night washout/weather
- Affordable precise triggering systems
- Wide lane coverage with single cameras
- Damaged/low contrast plates
- Infrared illumination = reduced optical character recognition (OCR) performance
- Illumination to minimize motorist concerns
California’s WIM Experiences

- 110 WIM sites
- 34 PrePass™ sites
  (1 of 25 States, 259 sites)
- Virtual weigh station prototype
- Data collection for trends and patterns
  - Example: Schuyler Heim Bridge outside ports of Long Beach & Los Angeles
  - 18% of trucks overweight
  - 1000 trucks/month exceed 100,000 pounds
  - Link to early failure of bridge deck: 3rd in 12 years
California’s WIM Results

• Caltrans considering widespread VWS
• Expecting reduction in infrastructure damage
• Still planning to use fixed stations at choke points
• PrePass™ and expedited commerce
  ▪ Less time in inspections
  ▪ Fuel economy
  ▪ Reduced emissions
  ▪ Reduced congestion at fixed stations
California’s Best Practices

- Installations part of construction projects
- Concrete 150 foot approach, 50 foot following
  - Rapid set concrete
  - Developed flatness specification
  - Configuration & specification adopted by SHRP & LTPP
- Bending plate standard
  - Consistently accurate to ~5%
  - Functional in all but severe weather conditions
California’s Challenges

- Traffic volumes vs installation & maintenance
- Multiple ports of entry
  - Mexico
  - Arizona
  - Nevada
  - Oregon
- Multiple seaports of entry
  - Long Beach
  - Los Angeles
  - Oakland
  - Stockton and Sacramento
- Significant infrastructure damage from Pacific Rim traffic trucked through California
- Right-of-Way not available where most needed
- No earmarks for WIM funding
Nevada’s WIM Experiences

- Early adopter: 1979 semi-portable

- Today
  - 68 portable sites, 34 locations
    - Short term counts
  - 6 permanent WIM locations: I-15 and I-80
    - Continuous data 97% of time

- 2 uses: planning, screening for enforcement

- Data downloaded to NDOT Carson City

- General Packet Radio Service (GPRS)
  - alternative to landline and cell
Nevada DOT Bending Plate Installation
Nevada’s WIM Results

- **Portable WIM, Elko County, SR-766**
  - 78 LCVs screened for overweight
  - 74 found to be >5% over legal limit
  - 95% accuracy in identifying violators

- **Continuous Permanent WIM, Elko**
  - Pinpointed hours of most I-80 overweights
  - Detailed hourly report
  - NHP deployed resources during targeted time

- **Laptop saves labor, avoids roadblocks, promotes safety**

- **Data use: roadway design, tax allocation, air quality, hourly reports, Federal submittal**

- **Installation costs**
  - 4-lane, turnkey WIM: $200K
  - Traditional site: $1M not including ROW
Nevada’s Best Practices (Part I)

- Permanent WIM at high volume locations
  - Locations/ funding coincide with construction projects
- Portable for short term monitoring
  - Data collection/ enforcement screening on lower order roads
- Upstream site selection for permanent WIM
  - Joint screening at check site in conjunction with enforcement activity
Nevada’s Best Practices (Part II)

- **GPRS**
  - Reliable connectivity where landline’s not practical

- **Annual maintenance/calibration**
  - Verification: type “9” vehicle drives across sensors 78 times
  - Portable WIM capacitive mats: self-calibration software coefficient

- **Agency collaboration**
  - Traffic Information: acquires, installs, maintains
  - Highway Patrol: enforces size and weight laws
Nevada’s Challenges

• Cost vs functionality

• Bending plate, Kistler, Class I Piezo
  - $10K for 2 sensors/each lane, PCC only
  - $10K for 2 sensors/each lane, ACC or PCC
  - $2K for 2 sensors/each lane, ACC or PCC

• Portable
  - $8K per sensor
  - Short life expectancy, 2-4 years

• Hidden costs
  - Peripherals
  - Maintenance/calibration
  - Training

• Virtual WIM long-range deployment
  - Interagency division of responsibility
North Dakota’s WIM Experiences

- Increased mobile enforcement

- 12 Sites deployed
  - All Virtual WIM
  - Wireless Data transferred to 36 patrol units
  - $105K for single lane
  - $125K for two
  - No video capture or portable WIM

- Goals
  - Non-intrusive to improve mobility
  - Promote commerce
  - Alternative to static weigh stations

- Maintenance responsibilities
  - NDDOT: cabinets & roadway
  - NDHP: in-cruiser
Video: North Dakota WIM
North Dakota’s WIM Results

- Enforcement, screening, safety compliance
  - Target areas of known violations
  - Target worst violators by area and time of day/week
    - Historical Data
    - Real-time Data
- No ticketing directly from WIM readings
- Design of infrastructure to withstand loadings
- Legal weight trucks avoid delays

Buchanan
By Hour of Day (DOT)
North Dakota’s Best Practices

• Reasonable installation schedule
  ▪ 1 lane instrumented/day
  ▪ 1 lane/week calibration, wire hook ups, installation

• Funding: $2M for 12 sites, construction funds only

• Highway Patrol and DOT partnered in location selection

• PAT/IRD electronics, Kistler quartz piezo sensors

• Sites: no grade greater than + or -2%, tangent sections only

• Training: 8 hours for equipment 8 calibration: both HP and NDDOT personnel

• Annual calibration

• Long range VWIM deployment plan
North Dakota’s Challenges

- After the warranty
- Manpower
- Communication options
- Calibration and maintenance: to contract or not to contract
Indiana’s WIM Experiences

- Virtual WIM: 3 sites
- 50 WIM sites for data/research studies
- 12,000 miles of federal/State highways
- Pre-clearance: 2 of 10 permanent scales with mainline WIM
- Other 8: pre-clearance based on safety records (no weight check)
## Video: Overweight on Indiana’s Borman Expressway

Laptop Screen Seen by an Officer

![Image](image.jpg)

### Road Runner

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Record</th>
<th>Lane</th>
<th>Class</th>
<th>Axle Weights</th>
<th>GVW/ Limit</th>
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<td>04/11/02</td>
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<td>3</td>
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<td>Axis Weights</td>
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### Violators

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<th>Class</th>
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<table>
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<th>Lane</th>
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Overweight on Indiana’s Borman Expressway:
Laptop Screen Seen by an Officer (continued)
VWIM in Indiana

124,000-lb = 41.5 ESAL (261,000 pc)  
Actual load distribution

124,000-lb = 29.0 ESAL (182,000 pc)  
Equal load distribution

80,000-lb = 4.2 ESAL (26,000 pc)
Indiana’s WIM Results

• **Purdue Study on virtual scales**
  - 55x more efficient at citing overweights than traditional methods

• **WIM, virtual scales, 24/7 collection**
  - Plot hot spots
  - Intelligently decide where to work next

• **Enforcement moves around**
  - Advantages: covertness, unpredictability
  - Promotes weight law compliance
Eastbound WIM Class 9 Volume GVW > 80k
January 16 – March 31, 2002
Indiana’s Best Practices & Challenges

- **Strategic thinking/ planning**
  - Convene stakeholders early on
  - Determine what each expects from sensor

- **Manpower**
  - More difficult to predict in rural than metro areas
  - Partner with enforcers to make sure VWIM operates where they work & can pull over safely

- **Pavement Prep**
  - Define standards for installation
  - 2 of Indiana’s sites failed for lack thereof

- **Sensor life expectancy**
  - Sensors can outlast pavement
  - Assess how many years left in pavement & type of sensor that best matches up with volume of traffic

- **Quality control**
  - Viable, repeatable readings reinforce stakeholder confidence

- **Cameras**
  - Challenges: trucks blocked by traffic, multi-lane highways
Lead States at a Glance

- **Climate**
  - NV: arid, scorching desert, night freezes in high desert
  - FL: humid, coastal
  - IN: cold & hot, freezing & thawing
  - ND: extreme winters
  - CA: from mild coastal & salt air to desert, mountains & snow

- **Nevada**
  - Permanent WIM for high volume systems
  - Portable WIM for lower order roads

- **Florida**
  - Pioneer of License Plate Reader (LPR) systems
  - All Interstate facilities equipped with 45 mph ramp WIM lanes, 2 static scales, comfort/inspection barns, parking lots for 23-36 trucks

- **Indiana**
  - Unique working relationship among Indiana DOT, DOR/MCS, State Police & Purdue
  - Traffic Management Center, Indianapolis: INDOT & troopers

- **North Dakota**
  - Phase I and II WIM (03/04) is first large scale WIM program
  - Increased mobile enforcement

- **California**
  - Volume of sites: 1/6 of WIM sites in the country
  - Pacific Rim significant ports: freight bound for other States/ countries
Lead State Common Issues

- Enforcing legal weights
- Priority of curbing congestion
  - FHWA: by 2020, more than 25,000 miles of highway will carry over 5000 commodity-carrying trucks each day
  - 1/5 of that mileage will be congested
- Budget, efficient use of resources
- Limited Right-of-Way
- Protecting infrastructure investment
- WIM-win with VWIM

Virtual WIM can eliminate backups at scales. Credentialing helps, but future growth demands VWIM to screen for violators so non-violators can move on down the road.
VWI M Boosts
- Enforcement
- Safety
- Data collection
- Asset management
- Accuracy of design
- Commerce
- Mobility

VWI M Saves
- Pavement life
- Maintenance costs
- Operating costs
- Construction costs
- ROW costs
- Manpower
- Troopers’ time
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