The Evolution of ITS Applications in Commercial Vehicle Operations & Enforcement

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2025 MASITE Annual Meeting

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Reinventing tomorrow.

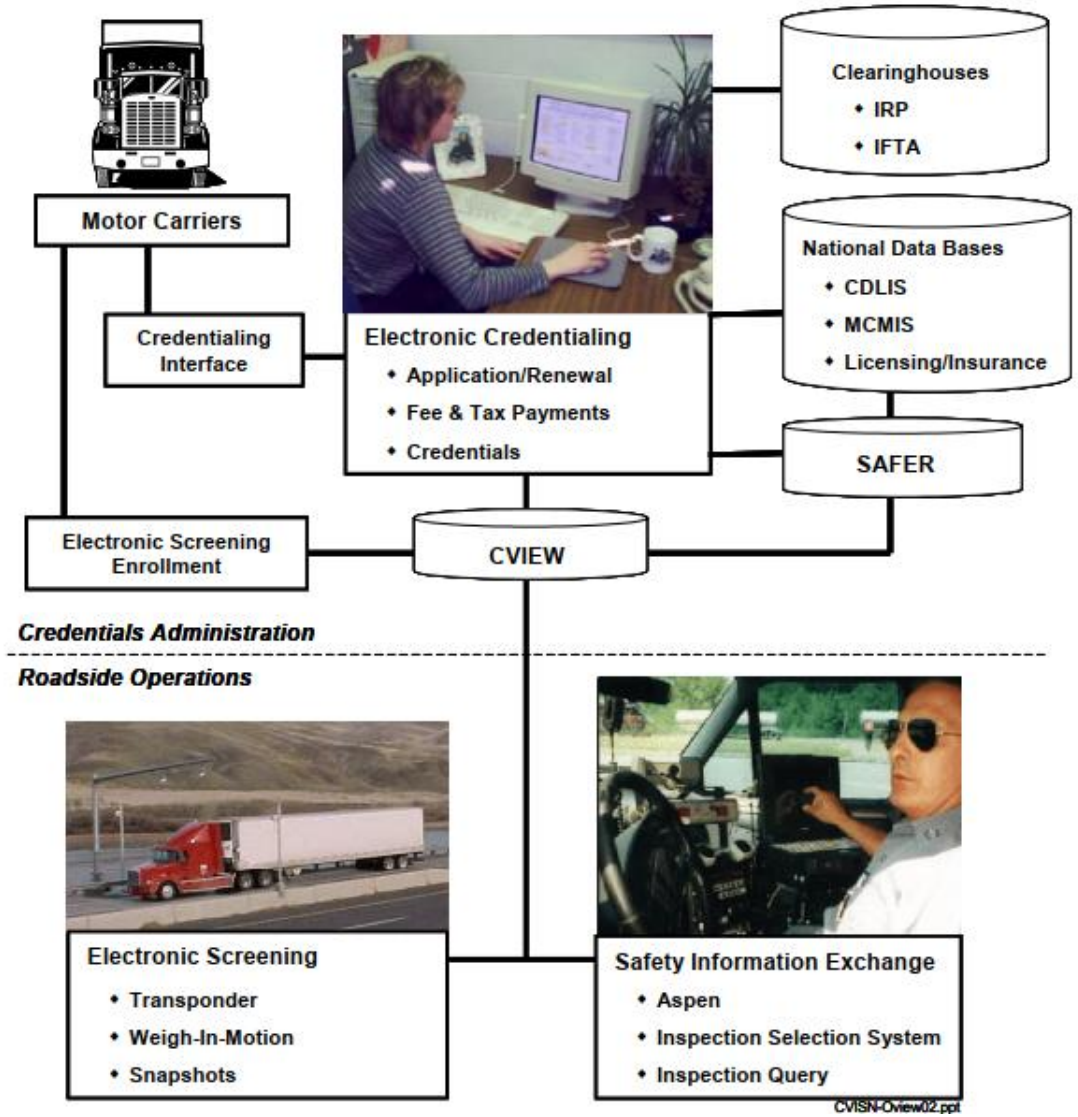
Agenda

1. **The Advent of ITS Applications in Commercial Vehicle Operations (ITS-CVO)**
2. **ITS-CVO Architecture and Applications**
3. **E-Screening Technologies**
   - Weigh-in-Motion Scales
   - Tire Anomaly Detection
   - Thermal Brake Sensor
4. **Integrated Solutions**
   - Weigh Station Bypass Systems
   - Virtual Weigh Stations
     - Automated Enforcement Systems
   - Truck Parking Information Systems

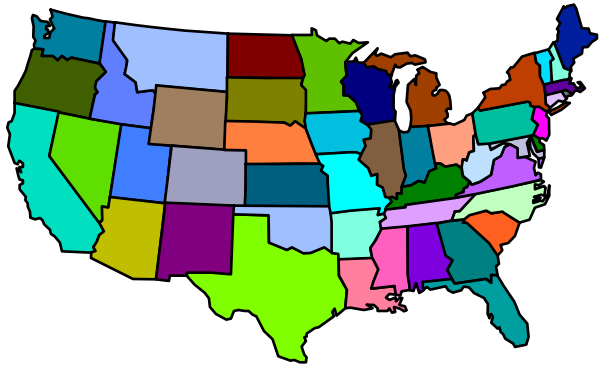
The Advent of ITS-CVO Applications

Commercial Vehicle Information Systems & Networks (CVISN) Model Deployment Initiative (MDI)

- CVISN MDI established in 1996 as part of a nationwide ITS initiative to improve safety, security, and productivity by deploying information sharing systems & technology
- MDI had two prototype states & 8 pilot states
- MDI established process for planning, development, and implementation of CVISN nationwide
- CVISN includes electronic credentialing, electronic screening, and safety information exchange
- Processes & requirements established through ITS-CVO MDI are still in use today



Why is it Important?

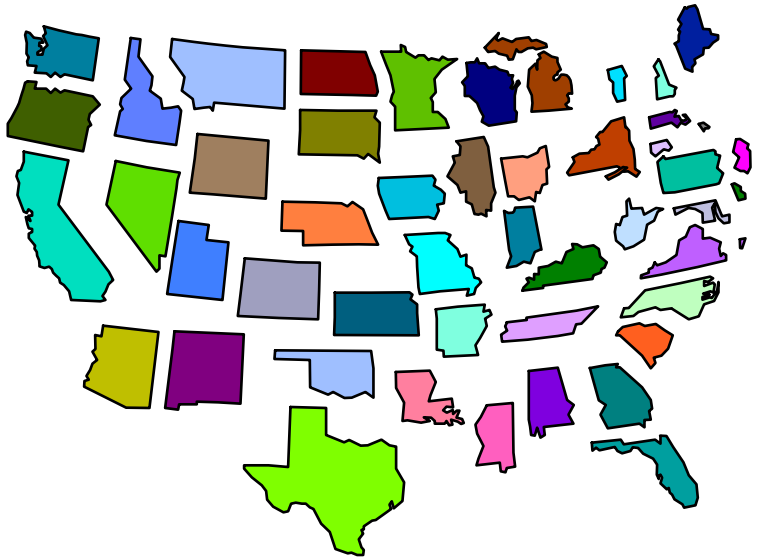


Roads were built to allow traffic flow within and between states

Chameleon carrier

Information systems were built primarily to allow information to flow within a particular state or local agency, carrier, or supplier

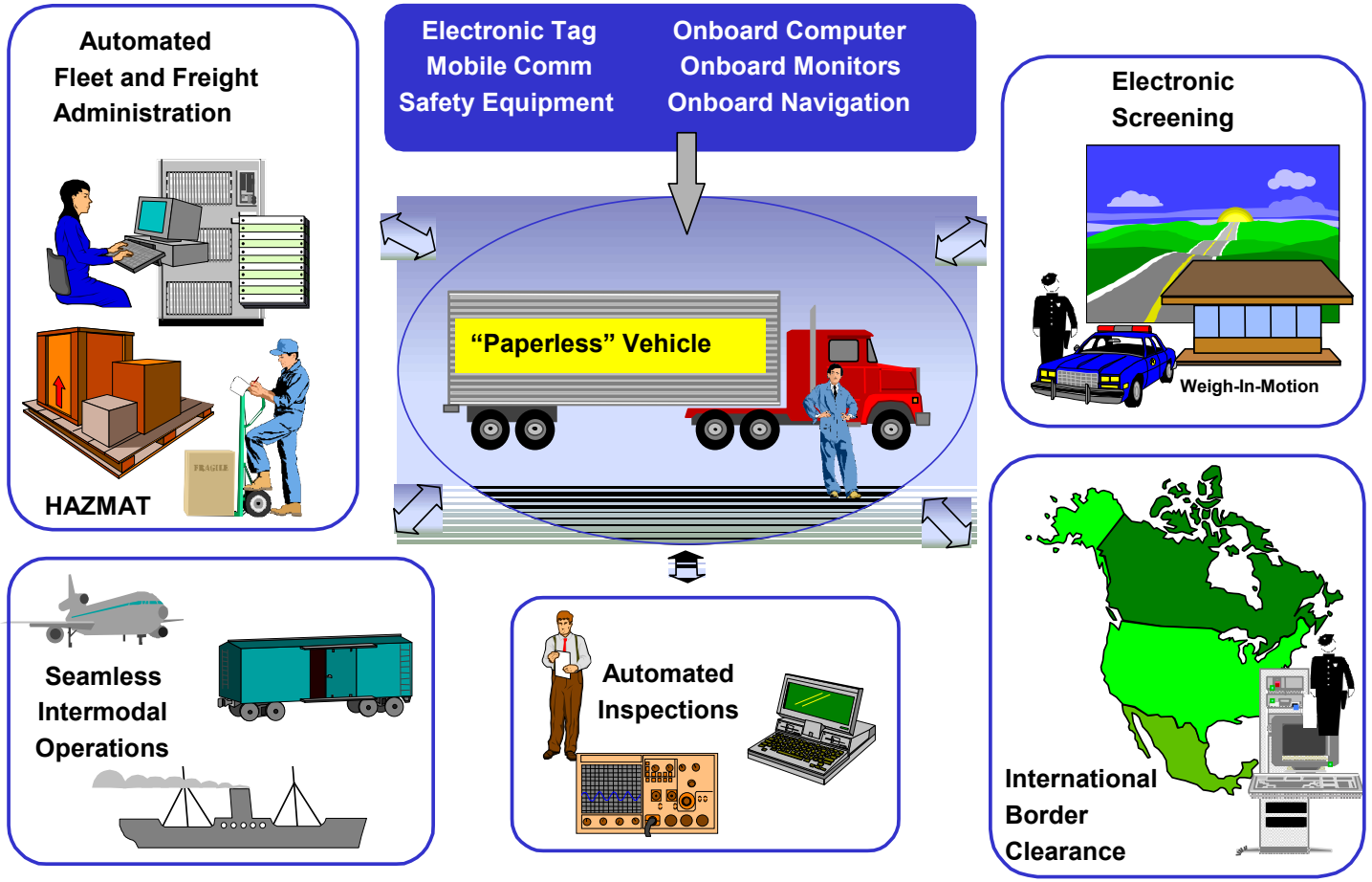
As a result, it is difficult to share information



Source: FMCSA Introduction and Overview, CVISN Workshop, 2007

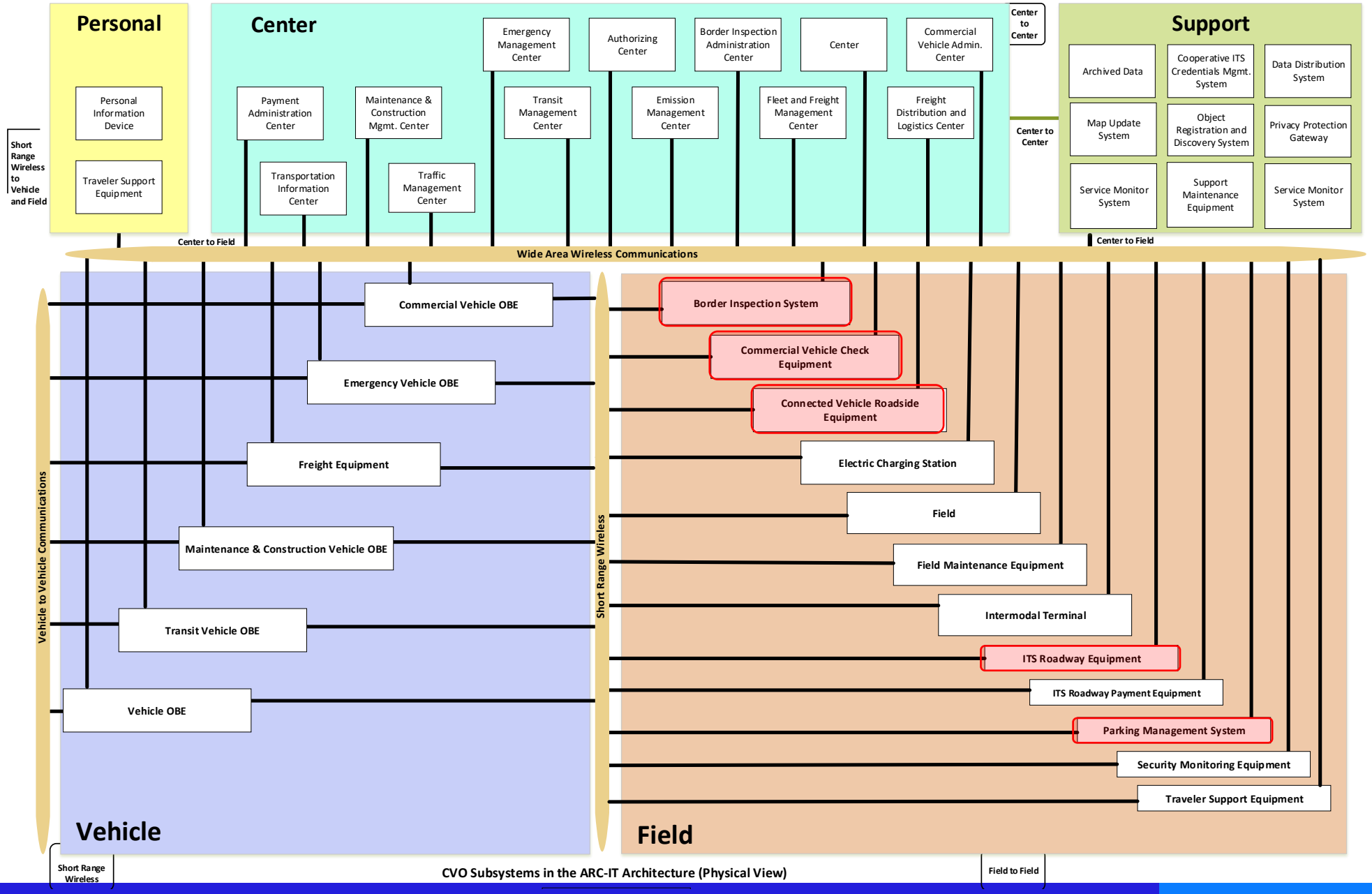
The Genesis of a New Federal Administration & Grant Program

- Motor Carrier Safety Improvement Act of 1999
- FMCSA established 01/01/2000
- $25 million in annual grant funding allocated to CVISN through SAFETEA-LU in 2005
- Program rebranded as Innovative Technology Deployment (ITD) through FAST Act of 2015
- IIJA continues the program and increased funding authority to $40 million annually



CVISN Vision circa 2002, FMCSA Workshop

CVO Subsystems in the ARC-IT Architecture



CVO Subsystems in the ARC-IT Architecture (Physical View)

Examples of ITS-CVO Applications

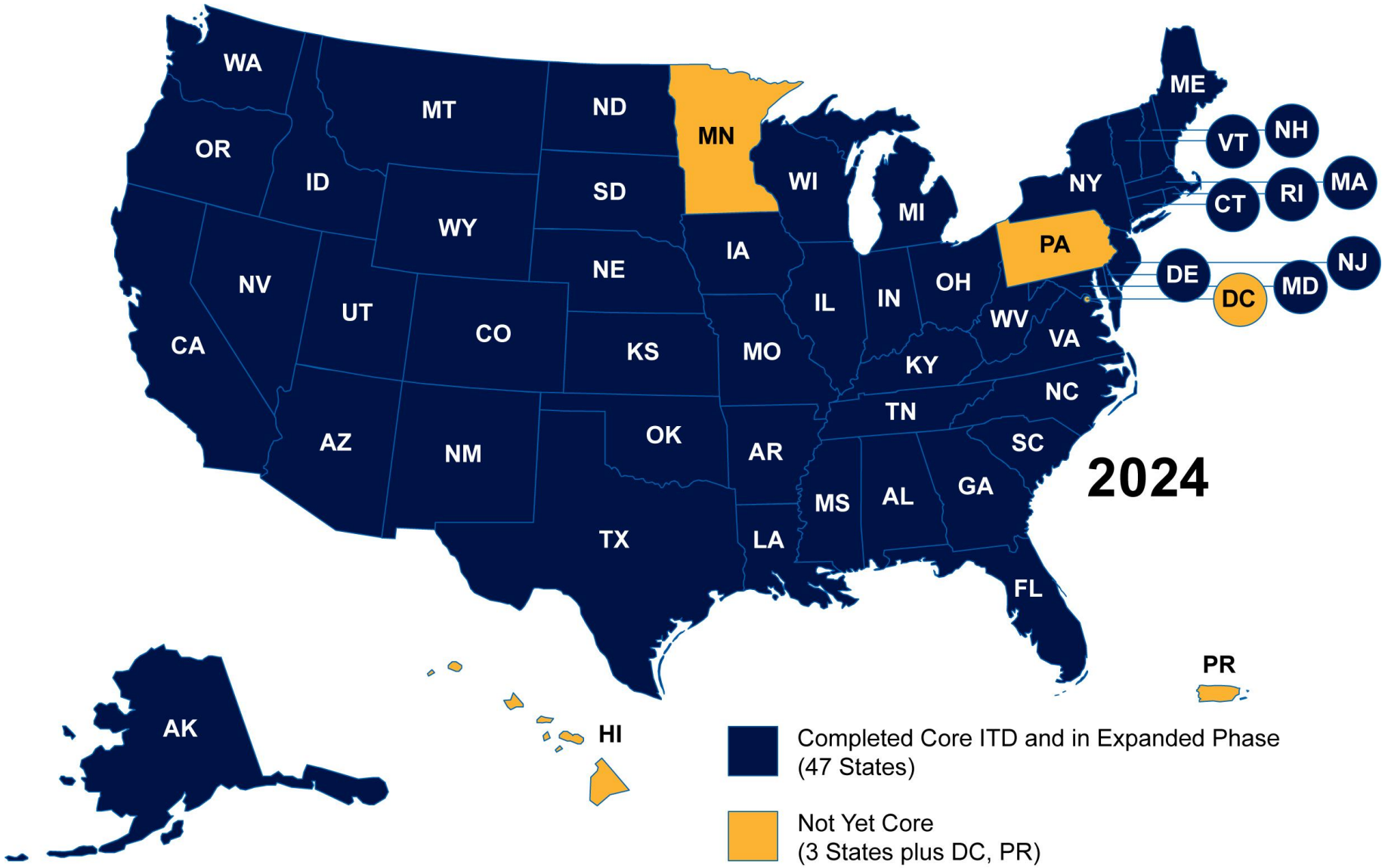
- Automated Vehicle Identification
- Automated Vehicle Classification
- Automated Toll Collection
- Automated Vehicle Location
- In-Vehicle Systems
  - Route Guidance
  - On Board Safety Monitoring
  - Real-time Safety Alerts
- **E-Screening Technology**
  - Weigh-in-Motion
  - Tire Abnormality Detection
  - Thermal Brake Sensors
- **Integrated Solutions**
  - Truck Parking Information Systems
  - Weigh Station Bypass
  - Virtual Weigh Stations
  - Automated Enforcement Systems

Federal Funding for ITS-CVO

- Federal Funding Sources
  - CVISN Grant Program, 2002-2015
  - Innovative Technology Deployment (ITD) Grant Program, 2016-present
- FMCSA Grant Match Requirements Evolve
  - 2006 through 2015 – 50% state match
  - 2016 through 2021 – 20% state match
  - 2022 through 2026 – 0% state match
  - 2026-future – ???

Fiscal Year	Number of Grants	Total Funding Value
FY 2019	19	**$19,057,095**
FY 2020	25	**$23,273,191**
FY 2021	28	**$23,937,954**
FY 2022	35	**$37,769,531**
FY 2023	34	**$37,890,576**

Current Status of ITD Program Nationwide



E-Screening Technologies

Weigh-in-Motion Scales

- ASTM E1318 – 09 Standard Specification for Highway Weigh-In-Motion (WIM) Systems defines WIM as:

  "the process of measuring the dynamic tire forces of a moving vehicle and estimating the corresponding tire loads of the static vehicle."
- Type III WIM systems needed for enforcement pre-screening
- 4 major sensor types
  - Load Cell
  - Bending Plate
  - Quartz Piezo
  - Strain Gauge

Performance Requirements for WIM Systems

Function	Tolerance for 95% Compliance		
	Type I	Type II	Type III
Wheel Load*	±25%		±20%
Axle Load	±20%	±30%	±15%
Axle-Group Load	±15%	±20%	±10%
Gross Vehicle Weight	±10%	±15%	±6%
Speed	±1 mph		
Axle-Spacing and Wheelbase	±0.5 ft		

* Includes single or dual tires

Weigh-in-Motion Scales – Strain Gauge sensor based

- How it works
  1. Applied force from vehicle **causes deformation**
  2. Compressed strain gauges **measure deformation** and converts to electrical signal
  3. Change in signal is **converted into a weight measurement**

<- Bending Plate

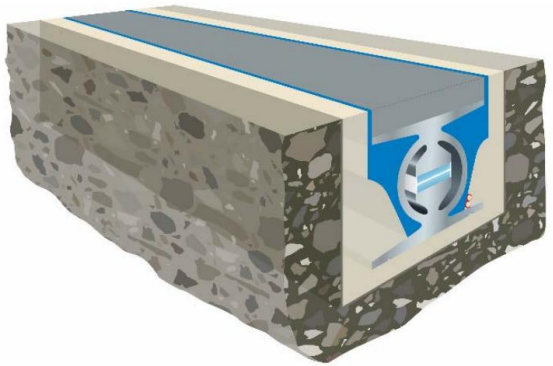
Load Cell ->

<- Strain Gauge Strip

Weigh-in-Motion Scales – Quartz Piezo

- How it works
  1. Use the **piezoelectric effect**, where certain materials (i.e. quartz) generate an electrical charge when mechanically stressed
  2. Piezo sensors measure the electrical charge output from the quartz crystal when compress by passing vehicle
  3. Charge is then converted into a weight measurement.

Quartz Piezo Sensor



Installation Depiction

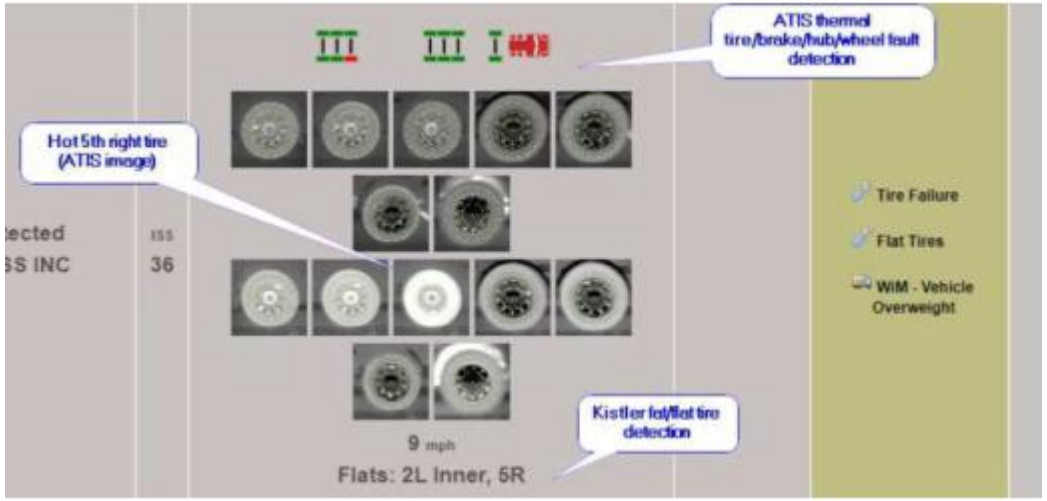
Sensor Type Comparison Table

SENSOR TYPE	ACCURACY	DURABILITY	INSTALLATION	DIMENSIONS (L/W/D)	OTHER CONSIDERATIONS
Load Cell	High (±2–5%)	Very High	Permanent, complex setup in pit	72″x38″x36″	Must be installed in concrete
Bending Plate	Moderate (±5%)	High	Permanent, in-road	70″x26″x4″	Must be installed in concrete; may be sensitive to temp
Quartz Piezo	Moderate (±5-9.8%)	Moderate-High	Embedded, minimal impact	72-90″x2.75″x2.25″	Can be installed in concrete or asphalt
Strain Gauge	Moderate (±5-10%)	Low–Moderate	Embedded, minimal impact	60-80″x3″x3″	Can be installed in concrete or asphalt

Commercial Vehicle Electronic Screening – Tire Anomaly and Classification System

- Identifies bald, flat or under-inflated tires before they cause problems on the road

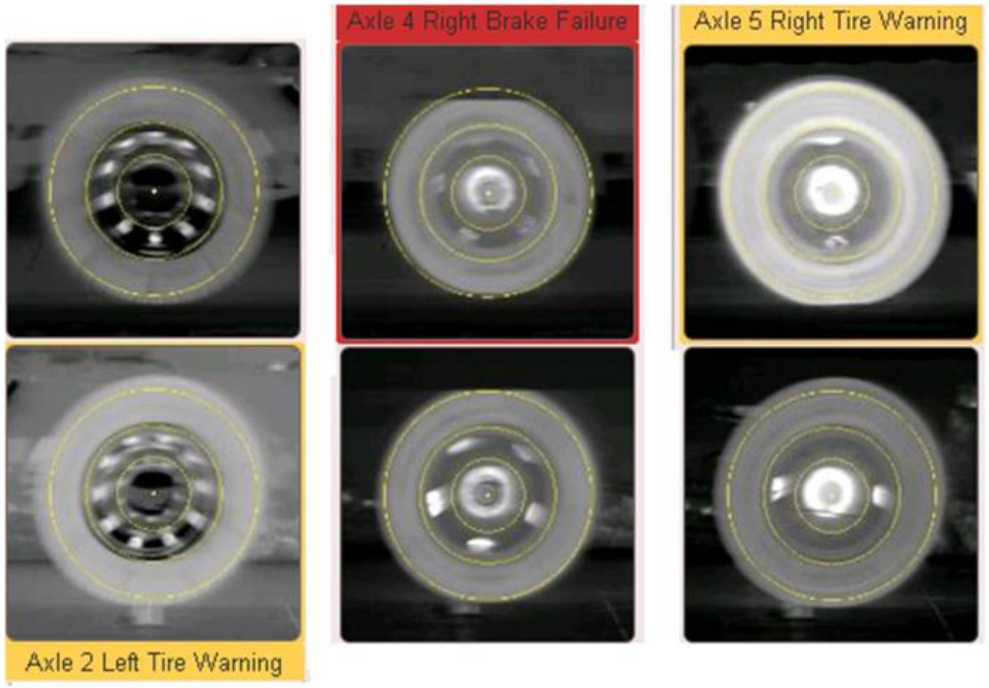
- How it works
  1. As vehicles pass over in-road sensors, the system detects the number of tires, measures the tires, determines the vehicle speed, vehicle position in the lane, axle width and the vehicle length
  2. If an anomaly is detected the system will highlight the potential tire anomalies identified by the system
  3. Information is provided to weigh station operator through dashboard



Commercial Vehicle Electronic Screening – Thermal Brake Sensor System

- Flag vehicles that have potentially faulty equipment based on the heat signature of the thermal images.

- How it works
  1. Vehicles passing inductive loops activates the system to capture thermal images
  2. Scans images for heat signatures associated with unsafe and defective equipment
  3. Images provided to weigh station operator
  4. System flags and identifies the equipment through dashboard



Integrated Solutions

Weigh Station Bypass Systems

- Subscription Systems
  - Transponder Screening
  - Geo-fence Screening
- Camera-based Systems
  - Overview Image
  - Automated License Plate Reader
  - Automated USDOT Number Reader
  - HAZMAT Placard Reader

Drivewyze By Fleetworthy

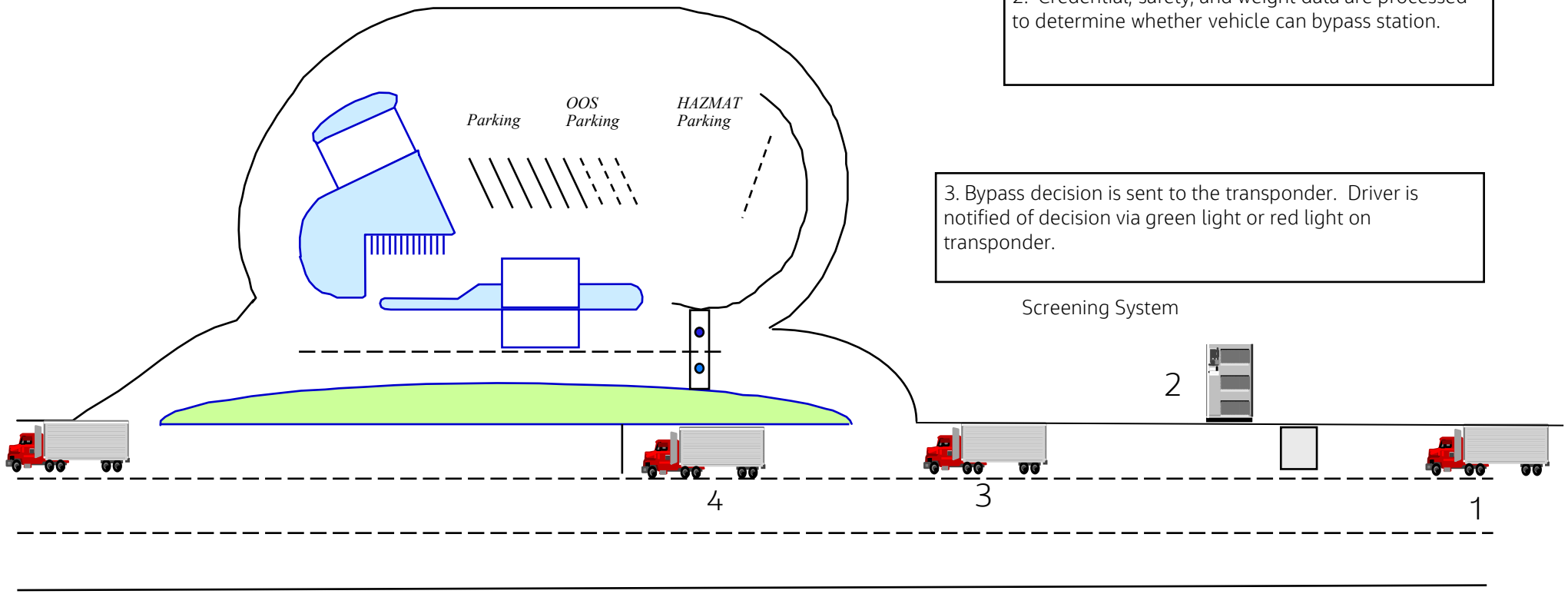
PrePass®

Weigh Station Bypass Operational Scenario – Circa 2006 (FMCSA)

1. Commercial vehicle approaches weigh station. Screening system identifies the carrier and vehicle; classifies the vehicle; and weighs the vehicle.

2. Credential, safety, and weight data are processed to determine whether vehicle can bypass station.

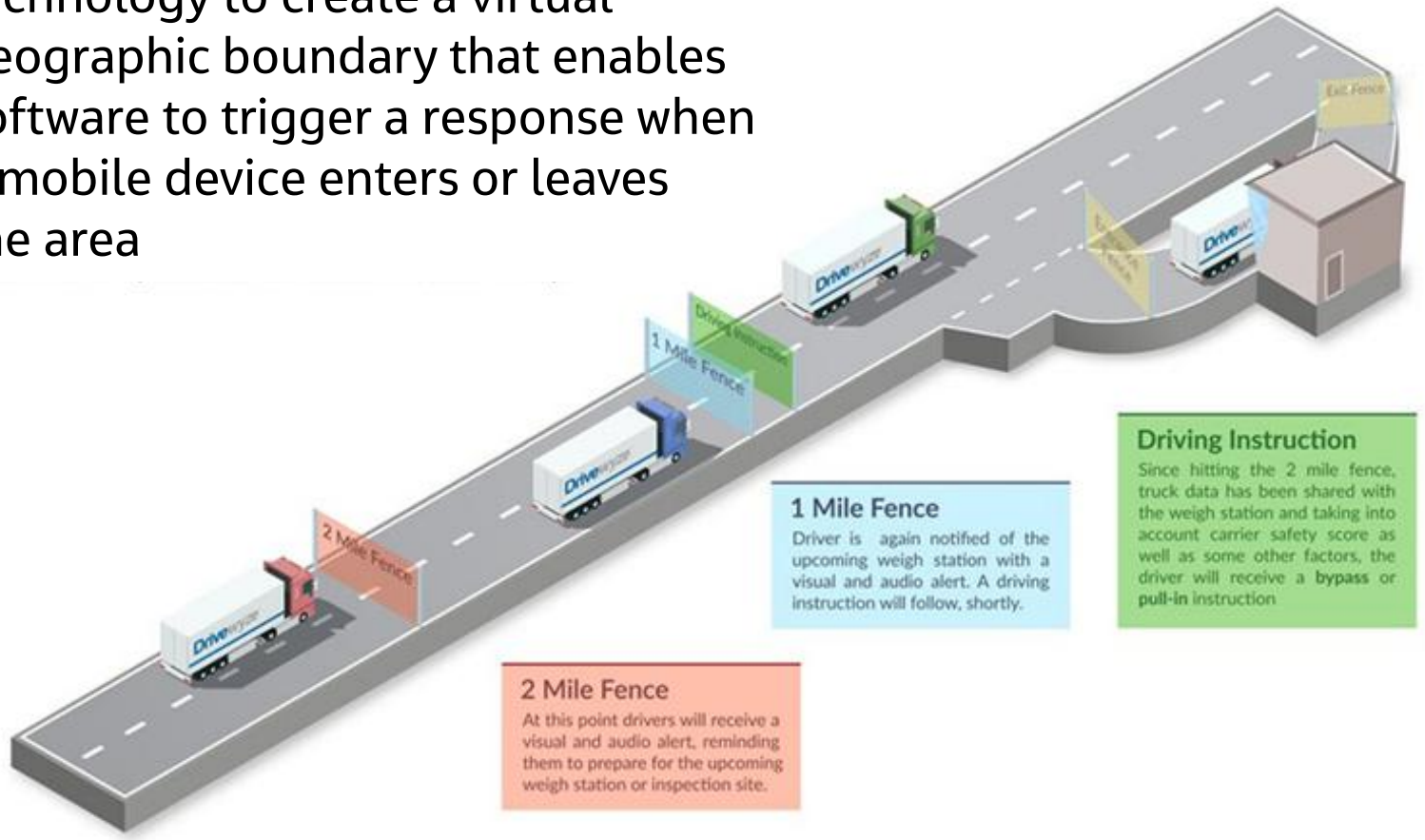
3. Bypass decision is sent to the transponder. Driver is notified of decision via green light or red light on transponder.



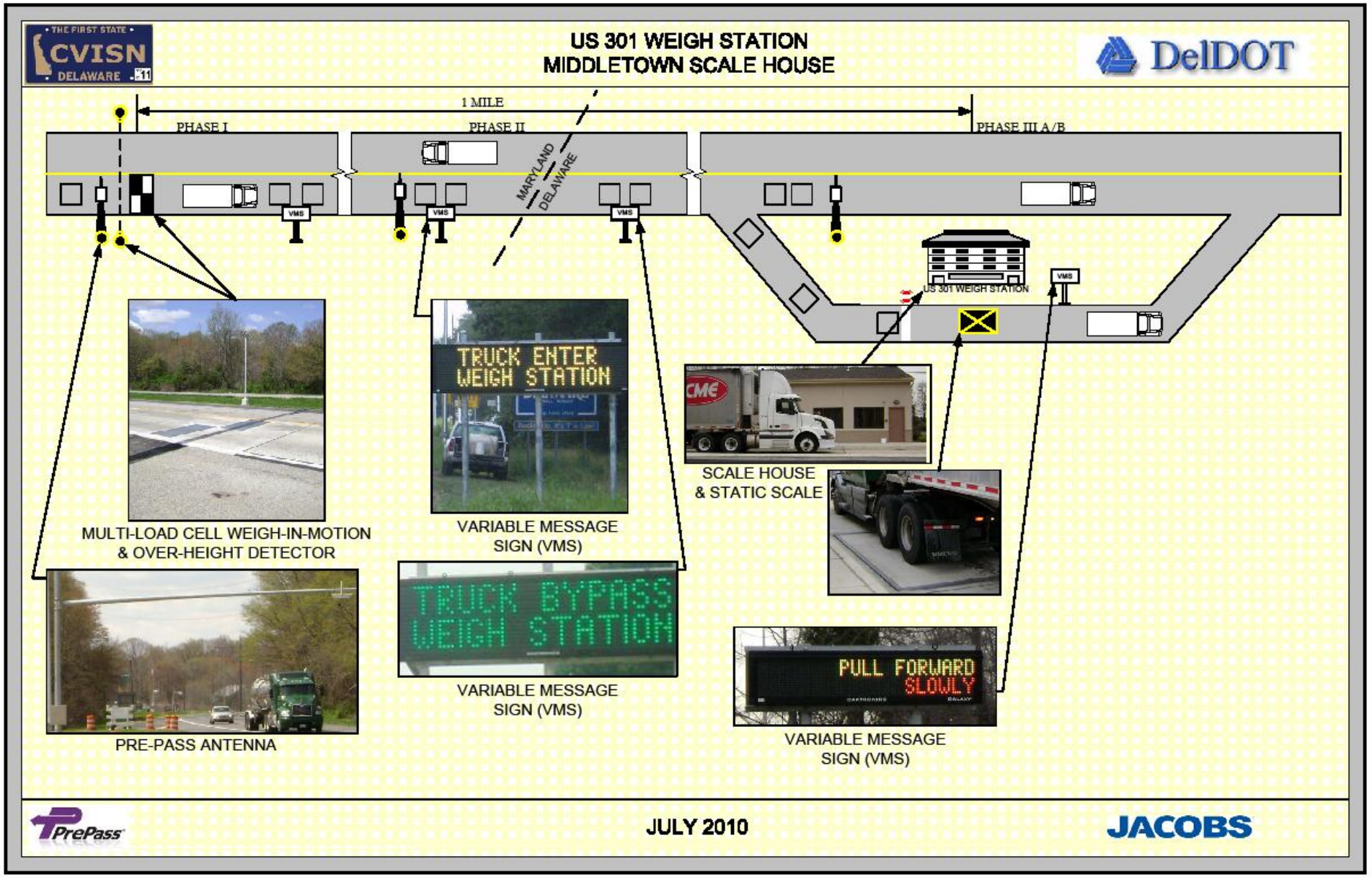
4. Compliance reader verifies that vehicle has been cleared to bypass the station

Weigh Station Bypass – Geofencing

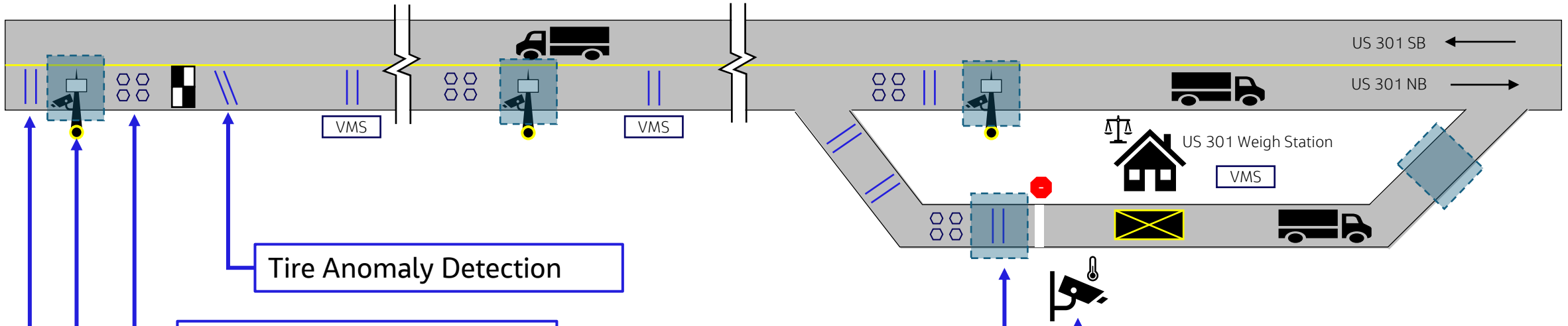
Geofencing takes advantage of GPS technology to create a virtual geographic boundary that enables software to trigger a response when a mobile device enters or leaves the area



Layout of Delaware US-301 Weigh Station, 2010



Layout of Delaware US-301 Weigh Station, 2025



Tire Anomaly Detection

Vehicle Waveform Identifier

3 Cameras
- Overview
- License Plate Reader (LPR)
- USDOT/HAZMAT Reader

Geofence
Transponder reader

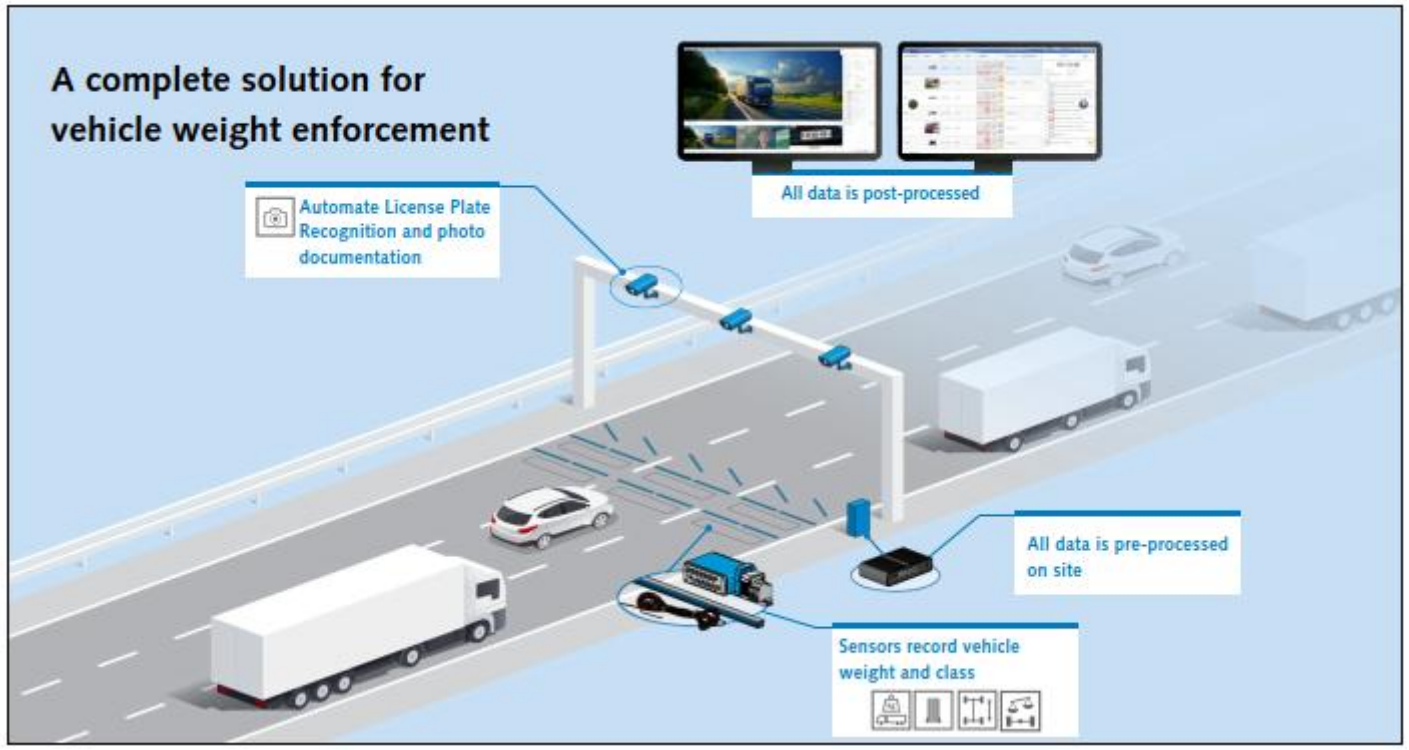
Load Cell WIMs have been replaced with Quartz Piezo WIMs

Geofence

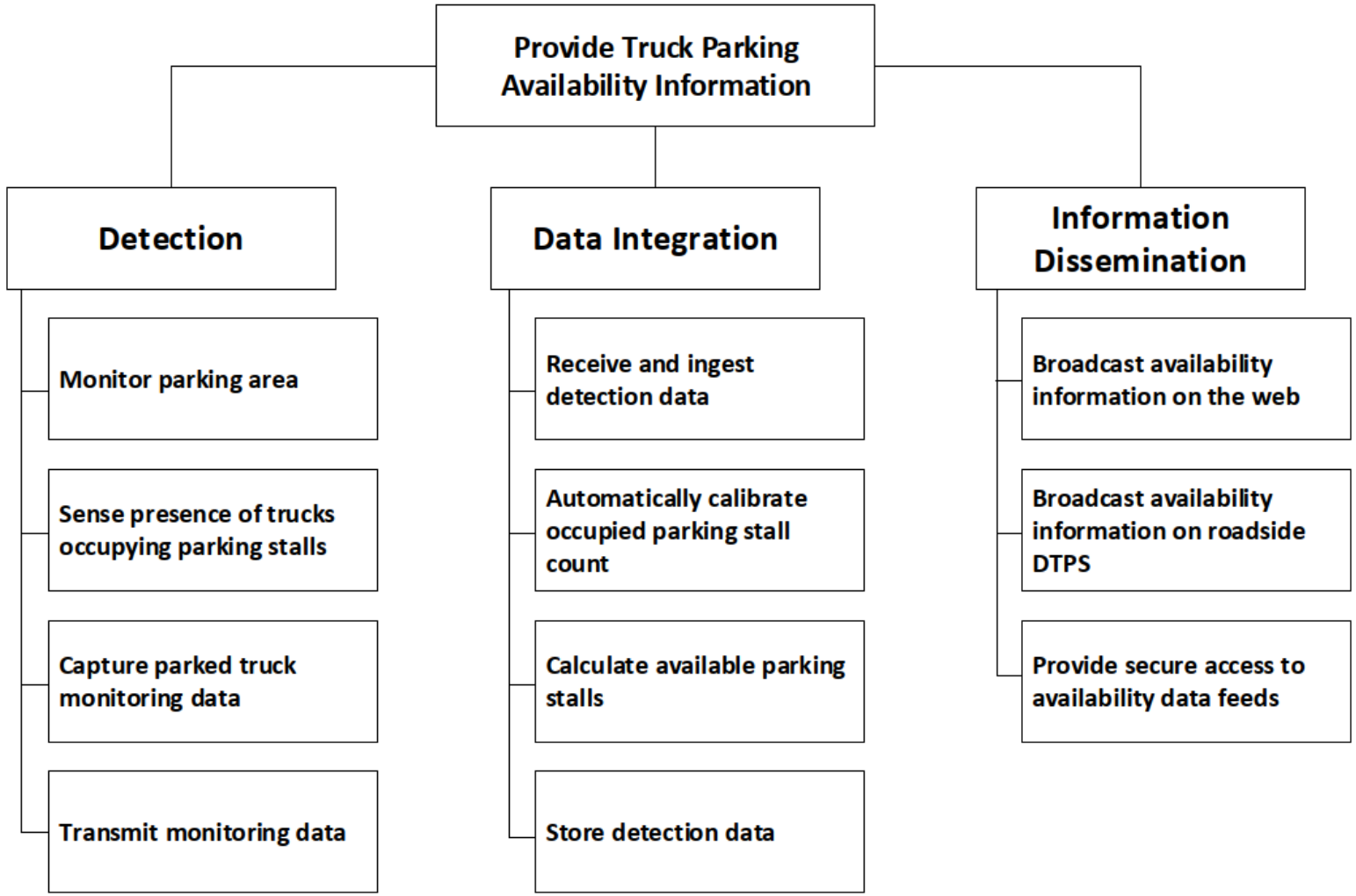
Thermal Brake Sensor

Virtual Weigh Stations (VWS) / Automated Enforcement

- VWS sites use the same technology as weigh station bypass and pre-screening systems; sites are installed in remote locations
- NYC WIM Automated Enforcement Program
  - First program of its kind in the US
  - Required enabling legislation
  - Installed on Brookly-Queens Expressway
  - Overweight citations issued by mail
  - WIM scales calibrated every six months

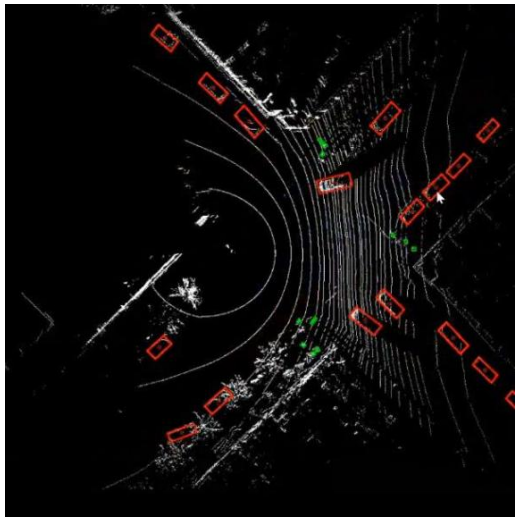


Truck Parking Information (TPIS) - System Capabilities



TPIS - Detection

- Direct
  - Detect number of spaces available by determining the occupancy of each individual space
  - Advantage: High accuracy and real-time data on individual space occupancy
  - Consider for larger, more critical truck parking areas with more activity and turnover, where detailed analytics are desired.
- Indirect
  - Infer parking availability by tracking vehicle movements into and out of the facility.
  - Advantage: Lower cost and simpler installation
  - Consider for smaller locations with limited access points and limited activity, minimizing the need for additional data, and reducing the frequency of validation



TPIS – Detection Technologies

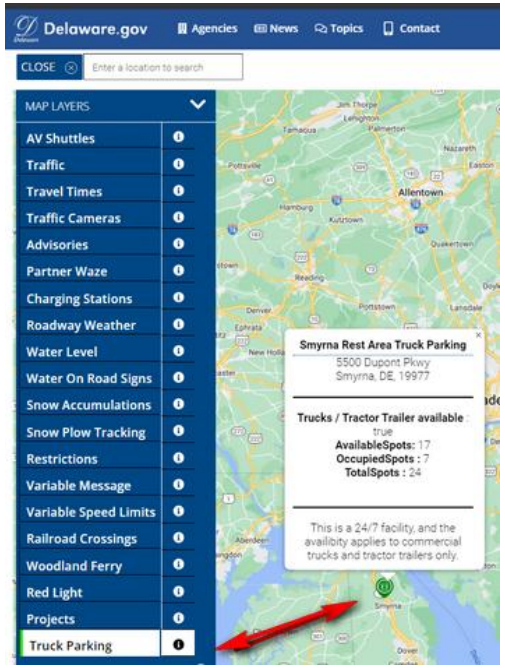
Technology	Direct / Indirect Monitoring	Description
Video Detection (visual & infrared)	Direct or Indirect	Cameras use video analytics to “count” the truck spaces occupied by visual recognition. Cameras can use either 2D or 3D models. -or- Cameras are configured to detect trucks at the entrance and exit of a parking facility, which triggers the camera to capture truck counts.
LiDAR	Direct or Indirect	LiDAR sensors are mounted on masts to monitor entrances and exits for trucks or identify vacant parking spaces. Sensors use an active light source in the form of a pulsed laser. Both 2D and 3D sensors can be used.
Magnetometers	Direct or Indirect	Magnetic sensors monitor trucks at either a parking facility's entrance and exit or individual parking spaces.
In-pavement Inductive Loops	Direct or Indirect	Inductive loops detect trucks by measuring the change in the loop’s resonant frequency as trucks either pass over or stop on the loop.
Microwave Radar	Indirect	Microwave detection devices transmit a continuous signal of low-energy microwaves at the entrance and exit of a parking facility and analyze the reflected signal for the presence of vehicles.

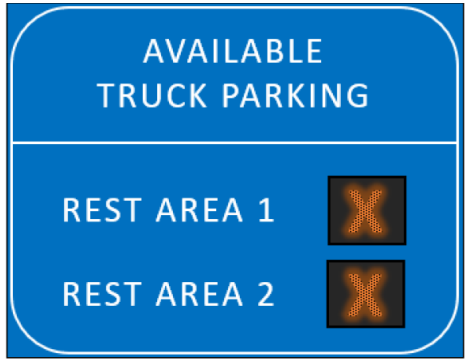
TPIS - Data Integration

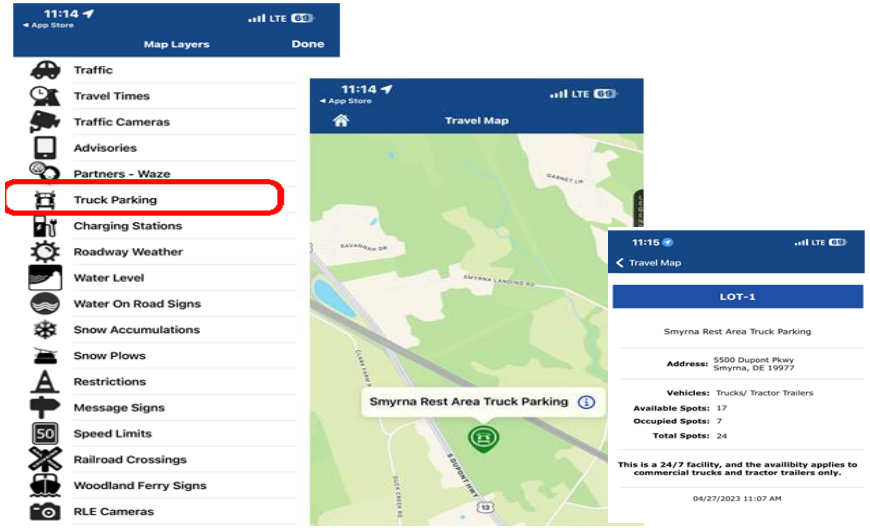
- Receive data from detection system
- Calibrate and validate data
  - Autocalibration
  - Manual calibration / validation
- Report number of available spaces
- Data repository
  - Onsite storage
  - Cloud storage
  - Multi-location data hub

TPIS - Information Dissemination

- Broadcast truck parking information using available channels
  - DelDOT Website / App
  - Application Programming Interface for 3rd parties
  - Truck Parking Message signs (Full DMS or static sign board with digital insert)

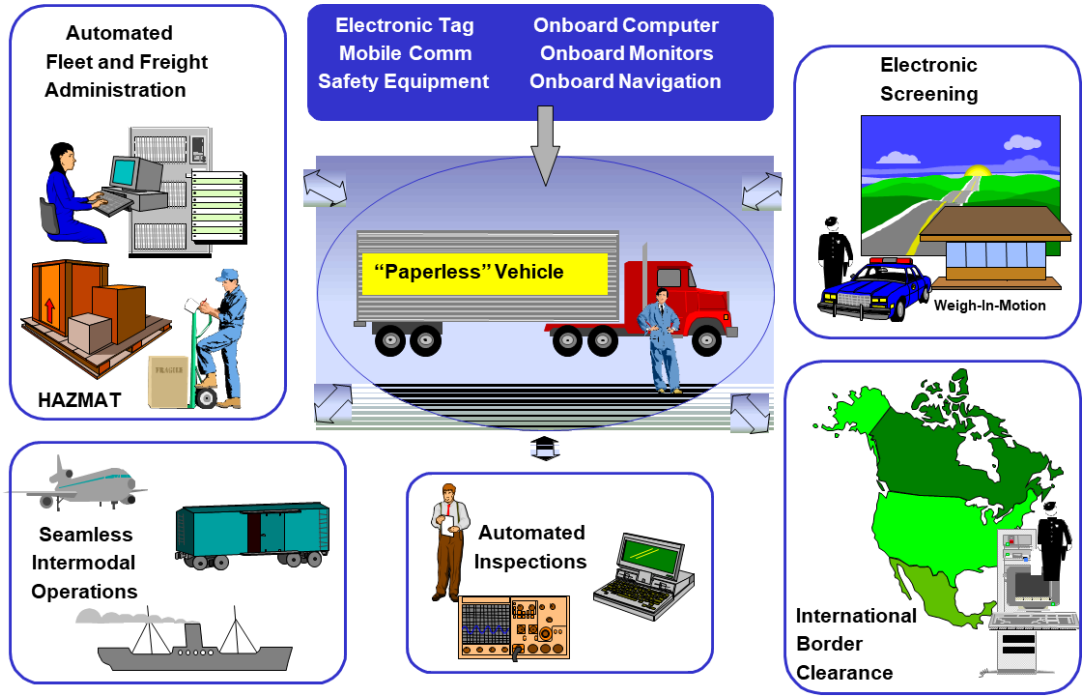






Recap

- Framework for ITS-CVO was established by the Model Deployment Initiative
- The original framework remains, while technology advancements have enabled the vision for CVISN (commercial vehicle info systems & networks) to come to life
- FMCSA provides grant funding to states to support the deployment of innovative ITS-CVO technologies through its High Priority Grants program
- There are a variety of technologies and approaches for engineers to consider when designing integrated solutions to support ITS-CVO operations & enforcement



Q&A

Thank you

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