UNITED STATES
DEPARTMENT OF TRANSPORTATION

ITS ePrimer
Module 14: ITS in Emergencies and Disasters

ITS Professional Capacity Building Program
ITS Joint Program Office
U.S. Department of Transportation

United States Department of Transportation
Office of the Assistant Secretary for Research and Technology
Intelligent Transportation Systems Joint Program Office

INTELLIGENT TRANSPORTATION SYSTEMS
PROFESSIONAL CAPACITY BUILDING

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Module 14: ITS in Emergencies and Disasters

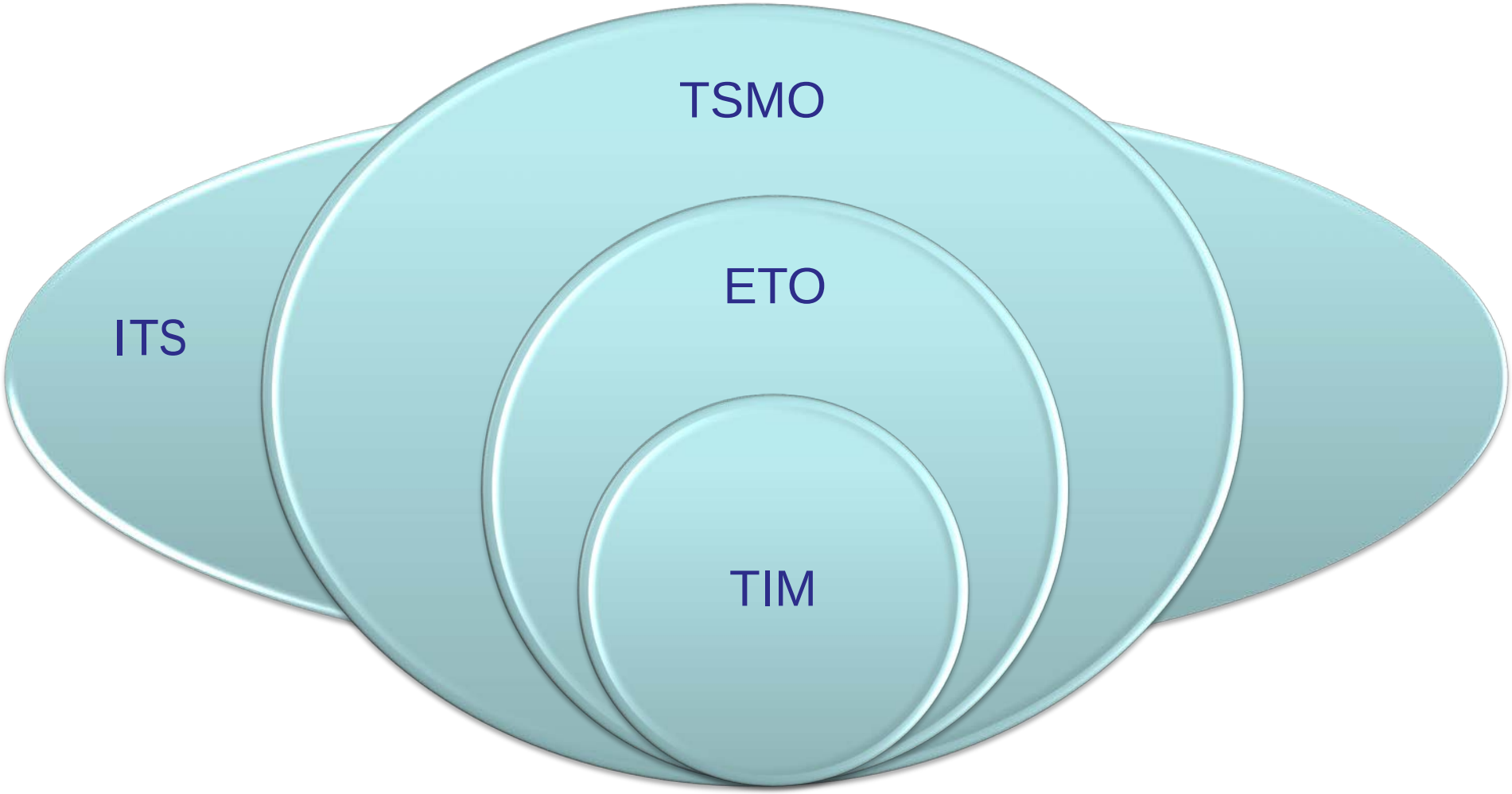
- Module 14 provides basic information on how intelligent transportation system (ITS) can support response to emergencies and disasters. By planning, operating, and training for operational resilience, emergency transportation operations (ETO), and traffic incident management (TIM), agencies will be better prepared to respond to emergencies and disasters
- The presentation identifies strategies to improve operational resilience of the ITS and the transportation system
- Module Outline
  - Background
  - Operational Resilience
  - ETO
  - TIM
  - Strategies
  - Questions

Learning Objectives

- This module examines how ITS can be used in response to emergencies and disasters through increasing operational resilience (including maintaining the resilience of ITS), implementing ETO and TIM best practices, and applying strategies to support overall system operation. The specific learning objectives of this module are the following:
  - Define operational resilience as it relates to ITS
  - Provide a basic introduction ETO and TIM practices
  - Identify how to make ITS infrastructure and related systems resilient to natural and human caused events
  - Identify how to use ITS to make the transportation system more resilient to changes in nonrecurring events (e.g., incidents, emergencies, and disasters) and use ITS to detect and respond to the impacts of these events
  - Identify how ITS can support ETO and TIM for greater system performance

BACKGROUND

Operational Resilience, ETO, TIM Relationship



Transportation Trends

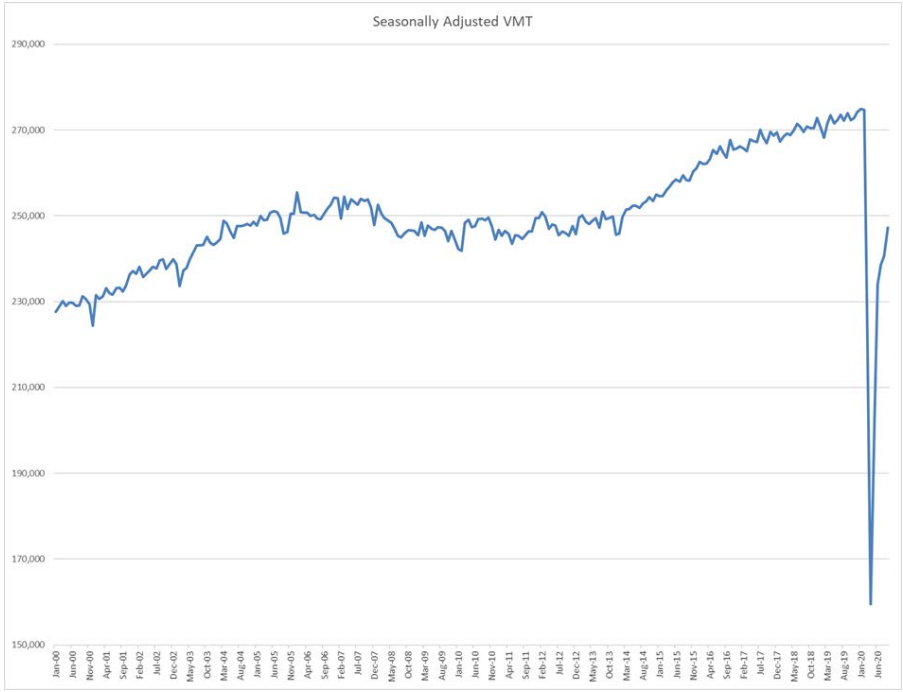
- Climate Change Impacts[1]
  - Softening and buckling of pavements
  - Buckling of rail track for heavy and light rail
  - Overheating of vehicles
  - Limitations on when construction / maintenance activities can be conducted
  - Flooding of coastal roads, tunnels, and rail lines
  - Erosion of road base and bridge supports (scouring)
  - Increase in weather-related delays and traffic disruptions
  - Increase in wildfires impacting visibility for drivers and closing roads
  - More frequent, and potentially extensive, emergency evacuations
  - Impacts to port and ferry terminals operations

Photo Courtesy of Sean Hannon acritelyphoto / Shutterstock.com

[1]Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance, FHWA-HOP-15-026, 2015 (Ref #7).

Transportation Trends (cont.)

- Travel Demand Growth
  - VMT increasing
- Technology Automation
  - All Electronic tolling
  - Automated vehicles
    - Machine-to-machine interfaces
- Alternate Transportation Technology
  - Advanced driver assistance systems
  - Mobility-on-demand
  - Mobility-as-a-service



Transportation Trends (cont.)

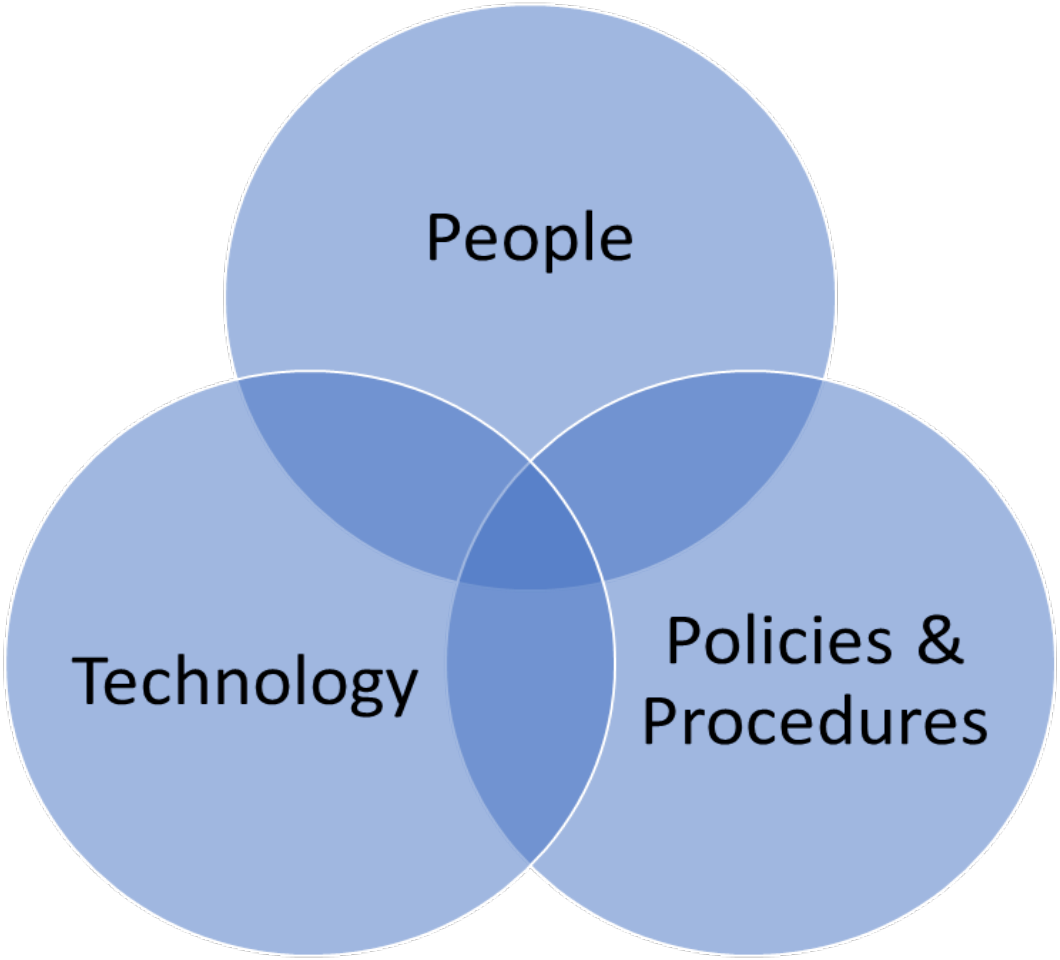
- Big Data
  - NCHRP 904 on Leveraging Big Data to Improve TIM recommends the following:
    - Adopt a deeper and broader perspective on data use
    - Collect more data, process the data, and manage the data for TIM
    - Use a common data storage environment and share data with others
    - Adopt cloud technologies for the storage and retrieval of data
    - Open and share outcomes and products to foster data user communities
- Transportation Funding
  - Last federal gas tax increase was 1991
  - Electric/hybrid vehicles reduce gas consumption
  - Constrained budgets at state and local level
  - Alternate Approaches
    - Funding programs
      - Congestion Mitigation/Air Quality, Highway Safety Improvement, National Highway Performance, Surface Transportation
    - Private Sector funding
      - State Farm and Houston Automobile Dealers Assoc.

PREPARING FOR RESPONSE TO EMERGENCIES AND DISASTERS

Operational Resilience

- Department of Homeland Security (DHS), Federal Emergency Management Administration (FEMA)
  - "A prepared and resilient Nation"
- Transportation Research Board (TRB) Operational Resilience ETO Subcommittee (ACP10-1) of the Standing Committee on Regional TSMO
  - "… the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events …"
- Key points:
  - Prepare
  - Anticipate
  - Absorb - continue to provide services during adverse conditions
  - Recover

Operational Resilience Pillars



ITS & Operational Resilience

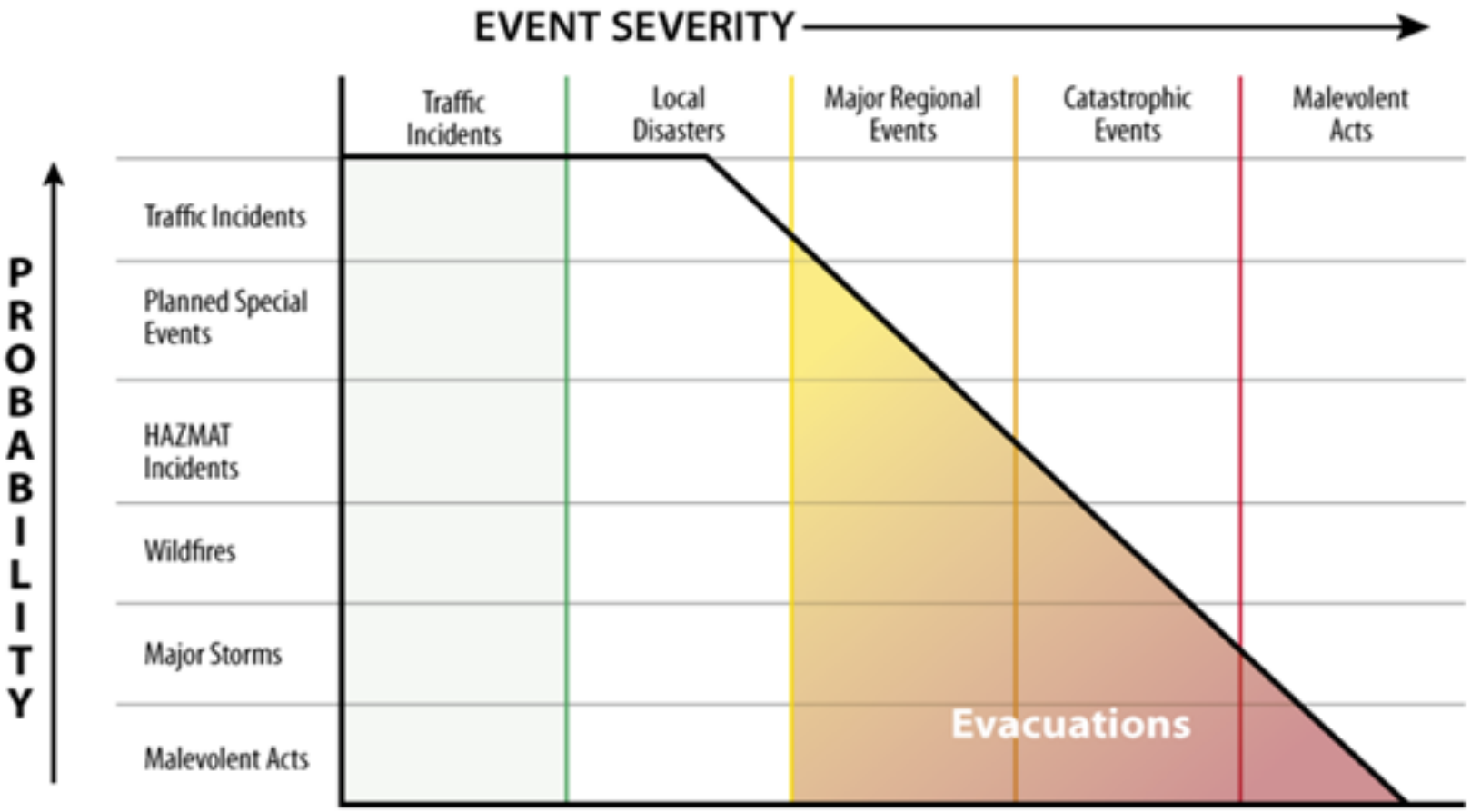
- ITS must include operational resilience in its planning, design, deployment and maintenance
  - Events impact ITS
  - Cannot lose ITS when it is needed most
- ITS can be used to improve the operational resilience of the transportation system
  - Events, small and large, need ITS to conduct ETO and TIM

EMERGENCY TRANSPORTATION OPERATIONS

Emergency Transportation Operations

- ETO events can include the following:
  - Minor Traffic incidents
  - Planned Special Events
  - HazMat Incidents
  - Wildfires
  - Major Storms
  - Malevolent Acts
- ETO, as well as most TIM response, uses the National Incident Management System (NIMS)
  - The major functions are as follows:
    - Command and Management
    - Preparedness
    - Resource Management
    - Communication and Information Management
    - Supporting Technologies
    - Ongoing Program Management & Maintenance

Event Severity and Frequency



Source: Federal Highway Administration, USDOT

ITS Support to ETO

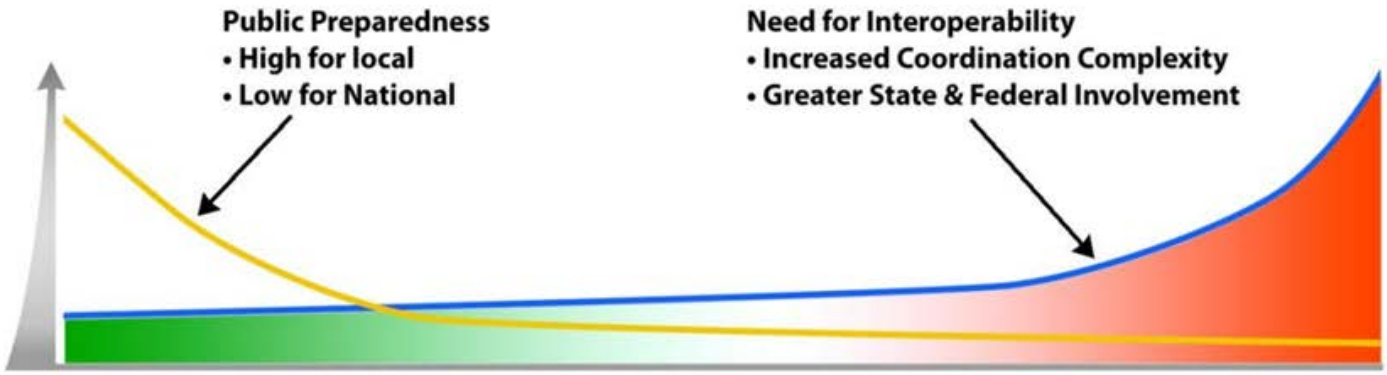
- Historically, ITS elements support ETO
  - Roadway sensors to collect traffic conditions
  - Dynamic message signs (DMS) to post traveler information
  - CCTV cameras for surveillance
- Advanced strategies
  - Road weather management (RWIS, environmental sensors, automated vehicle location for winter weather maintenance vehicles)
  - Traveler information services (511 systems, traveler information websites, media alerts)
  - Traffic control strategies (traffic signal systems, ramp metering, vehicle-to-infrastructure (V2I) and vehicle-to-everything (V2X) applications
  - Connected and automated vehicle (CAV) systems
  - Coordinated roadway strategies for construction, maintenance, and special events
  - Interoperable voice communications
  - Redundance data and communication networks to support ITS

TRAFFIC INCIDENT MANAGEMENT

Traffic Incident Management

- Incident Definition
  - Any non-recurring event that causes a reduction of roadway capacity or an abnormal increase in demand
    - Such events include traffic crashes, disabled vehicles, spilled cargo, highway maintenance and reconstruction projects, and special non-emergency events
- ITS Components
  - Detection
  - Surveillance
  - Communication
- TIM Benefits:
  - Reduces duration and impacts of incidents
  - Reduces the exposure of travelers, victims, and responders to hazardous conditions
  - Improves safety
  - Reduces secondary incidents
  - Potential to reduce congestion, fuel consumption, emissions, travel time, vehicle operating costs

Incident Scale

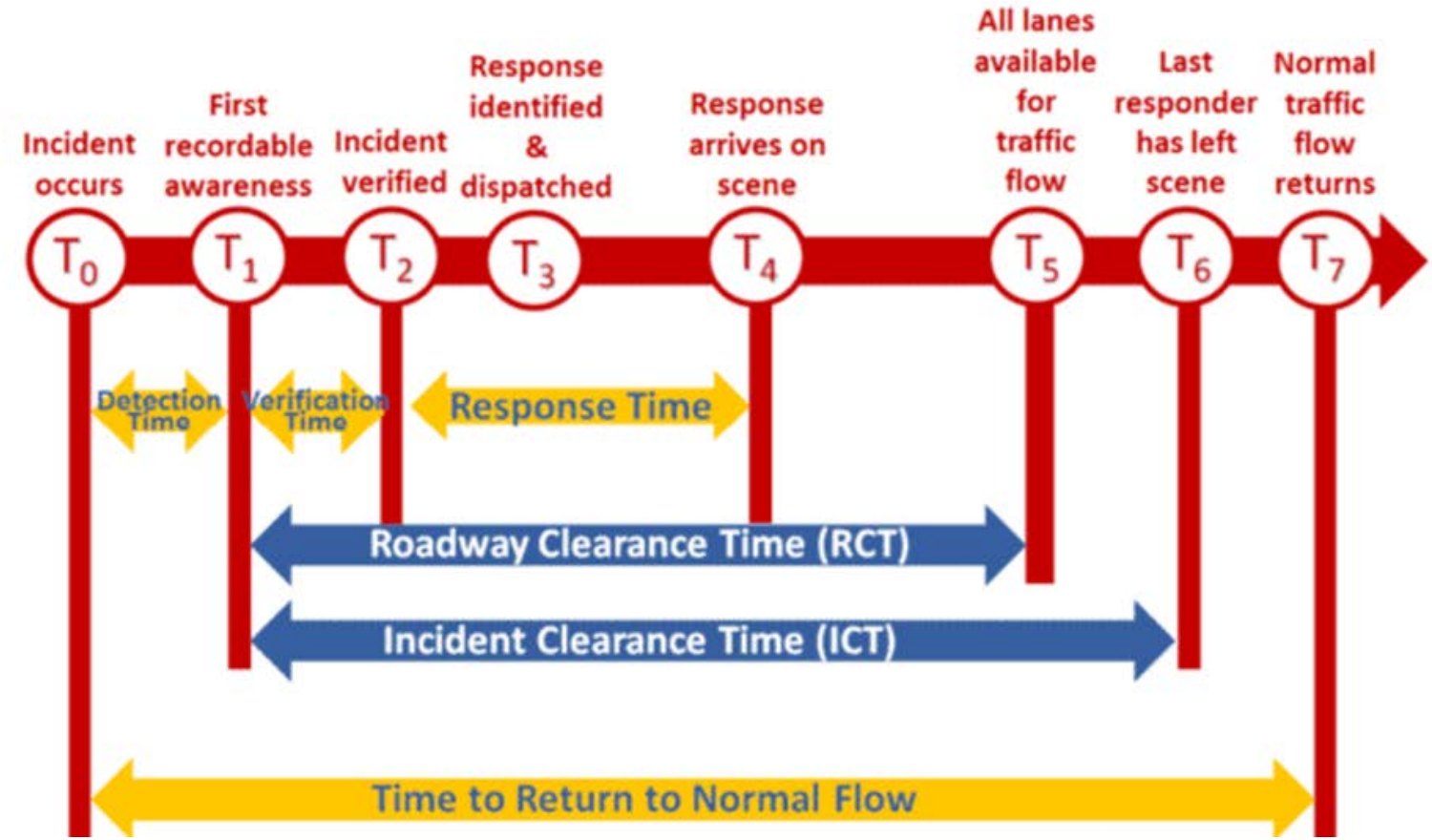


Classification	LOCAL	REGIONAL	STATE	NATIONAL
Examples	• Minor Traffic Incidents • Vehicle Fires • Minor Train/ Bus Accidents • Accidents W/ Injuries but no Fatalities	• Train Derailment • Major Bus/Rail Transit Accidents • Major Truck Accidents • Multi-vehicle Crashes • Hazmat Spills • Injuries & Fatalities	• Train Crashes • Airplain Crashes • Hazmat Incidents • Multi-vehicle Accidents • Tunnel Fires • Multiple Injuries & Fatalities • Port/Airport Incidents • Large Building Fire or Explosion • Industrial Incidents • Major Tunnel/ Bridge Closure	• Terrorist Attack/WMD • Floods, Blizzards, Tornadoes • Transportation Infrastructure Collapse • Extended Power/Water Outage • Riots • Mass Casualties
Expected Event Duration	0 - 2 HOURS	2 - 24 HOURS	DAYS	WEEKS

Systems Must Expand with the Event

Source: Johns Hopkins University Applied Physics Laboratory

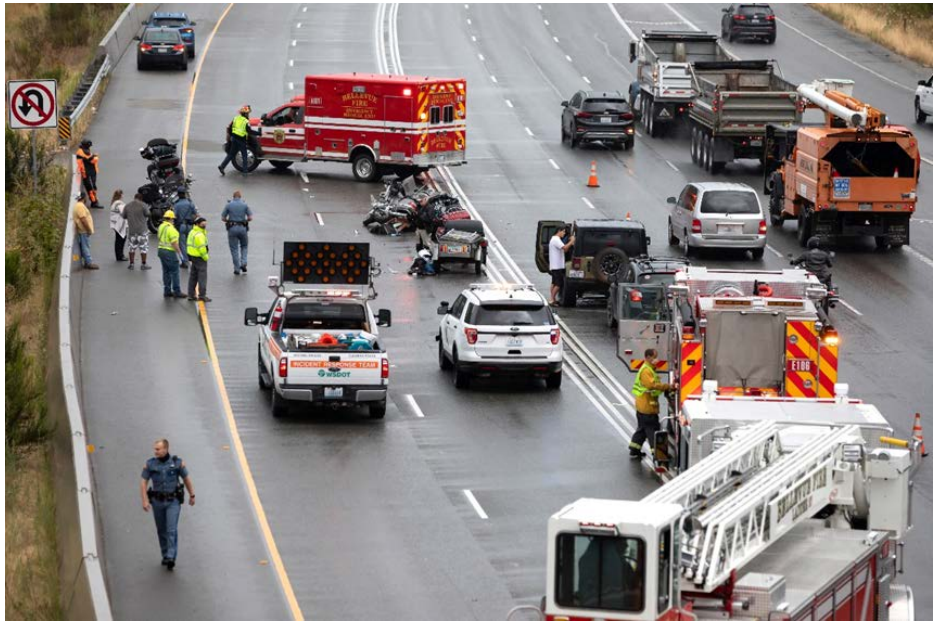
Incident Timeline



Source: Federal Highway Administration, USDOT

TIM Partners

- TIM's multi-disciplinary approach involves a number of public and private sector partners, including the following:
  - Transportation IOOs
  - Law Enforcement
  - Fire and Rescue
  - Emergency Medical Services
  - Coroners and Medical Examiners
  - Emergency Management
  - Towing and Recovery
  - Hazardous Materials Contractors
  - Public Safety Communications
  - Traffic Information Media



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TIM Strategies

- Maryland DOT
  - Maryland Coordinated Highways Action Response Team (CHART) uses TIM response and clearance data for performance measurement
  - In 2019, TIM performance data showed the following:
    - Average incident duration was 24% shorter (8 min shorter than the 34 min avg)
    - Number of severe incidents blocking 3+ lanes decreased 5%
    - Estimated number of secondary crashes was reduced by 365 crashes
- Maricopa County, Arizona
  - Arterials comprise 3/4th of region's lane miles and 2/3rd of all travel
  - Regional Emergency Action Coordination Team (REACT) provides assistance to local agencies within Maricopa county for TIM on arterials
  - Participating jurisdictions: Scottsdale, Avondale, Tolleson, Glendale, Peoria, and Surprise, Arizona.

Photo courtesy of Texas A&M Transportation Institute

TSMO Strategies to Support ETO & TIM

- Work zone management (real-time location and monitoring of work zones)
- Planned Special Event Management (advanced planning and operational strategies)
- Road weather management (environmental sensors, automate vehicle location for winter weather maintenance vehicles)
- Traveler information (511 systems, traveler information websites, media alerts)
- Traffic signal coordination (signal phase and timing for improved corridor operation)
- Ramp management (detection and metering to manage local and corridor traffic)
- Active Transportation and Demand Management (variable speed limits, dynamic lane and shoulder use, real-time alternate routing)
- Integrated corridor management (freeway, arterial, and transit strategies deployed cooperatively to maximize corridor throughput, mobility, and safety)
- Connected and automated vehicle (CAV) Deployment (vehicle-to-infrastructure (V2I) and vehicle-to-everything (V2X) applications to alert vehicles and drivers)
- Technology and data strategies to support ETO and TIM:
  - Interoperable voice communications
  - Redundance data and communication networks to support ITS
  - Remote access to data and ITS

STRATEGIES TO IMPROVE RESPONSE TO EMERGENCIES AND DISASTERS

Strategies – Climate Change

- Traffic Management Strategies to Support Climate Event Response
  - Increase in traffic incident management activities
  - Use of road and lane closures
  - Reduced speed limit or use of variable speed limits
  - Disruption of transit service
  - Use of road and transit diversions
  - Truck restrictions
  - Work zone management (to accommodate additional lane closures)
  - Adding sensors to alert operating/maintenance/response agencies when flooding is likely/imminent

Source: Transportation Research Board Special Task Force on Climate Change and Energy, Transportation Research Circular E-C152: Adapting Transportation to the Impacts of Climate Change State of the Practice 2011, June 2011.

Strategies – Climate Change

- FHWA Climate Change and Extreme Weather Vulnerability Framework:
  - Define the scope of the vulnerability assessment,
    - including key variables, program objectives, and relevant assets
  - Assess vulnerabilities through data collection, asset performance, risk assessment, and ratings/prioritization to inform the development of strategies
  - Integrate strategies into agency decision making
  - Monitor and revise process

Source: Climate Change Adaption Guide for Transportation Systems Management, Operations, and Maintenance, FHWA-HOP-15-026, Federal Highway Administration, USDOT, November 2015.

Strategies - ETO

- Emergency Operations Centers (EOCs)
  - Temporary or permanent EOCs focused on multi-agency response coordination
- Fusion Centers
  - Information sharing hubs to support terrorism response, crime prevention, and public safety response
- Mutual Aid
  - Reciprocal exchange of people and resources between two or more agencies for mutual benefit

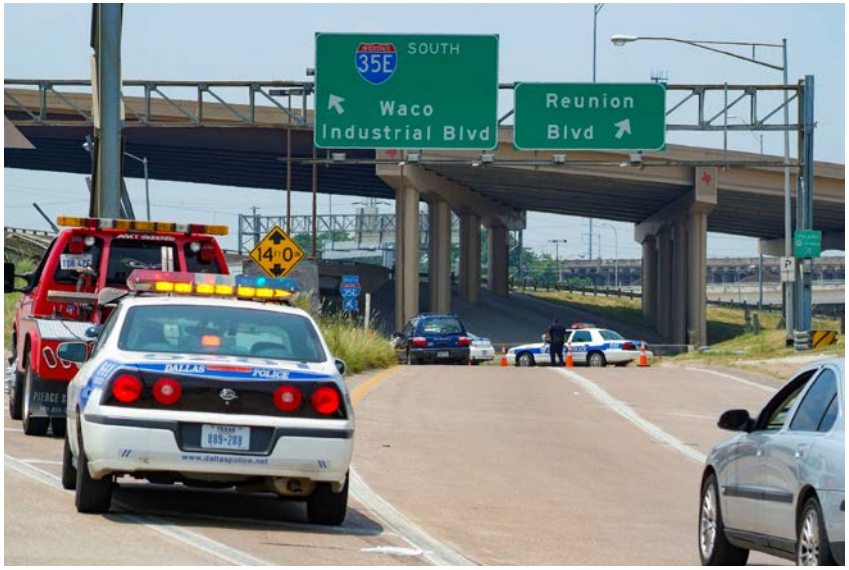

Photo Courtesy of Texas A&M Transportation Institute

Strategies – Systems in ITS

- Strategies for agencies and their contractors for IT Systems and ITS:
  - Adding redundancy (i.e., duplication of critical components or systems to ensure continuity and increase reliability) to the assets or systems (e.g., network, power, etc.)
  - Having backup (i.e., copies or spare parts to replace loss) components available at the device and system level (e.g., data, field devices, etc.)
  - Allowing for substitution of component or devices
  - Designing or redesigning to reduce or eliminate vulnerabilities of products and processes
  - Having the flexibility to improvise during incidents and events to make use of on-hand resources (human or material)
  - Allowing for priority access for responders
  - Modeling disruptions and system operation
  - Planning for back up logistics to truly be able to implement backups and substitutions when the time comes
  - Regularly run scenario tests to check equipment and system capabilities

Strategies – Technology

- Unmanned Aerial Vehicles (UAVs, commonly called drones)
  - UAVs are increasingly being used in ETO and TIM events to give greater situational awareness
- Connected and Automated Vehicles (CAVs)
  - CAVs will be introduced to the public allowing for each vehicle to be a sensor and report situation awareness to other vehicles and transportation agencies
  - CAVs also offer the potential to inform the driver and the vehicle directly of events
- Well Maintained Reference Systems
  - Graphical Information Systems (GIS) that are well maintained and shared with other agencies and users to allow for a common reference system to aid in response
- New Sensor Technologies
  - E.g., Infrared camera technology
- Artificial Intelligence (AI)
  - Florida DOT and Nevada DOT using AI with machine vision systems to recognize incidents and "likely" incidents to improve incident detection times

Photo Courtesy of Shutterstock.com

Strategies – Personnel

- Diverse knowledge, skills, abilities
  - Draw from expertise across transportation engineering, transportation planning, electrical/electronic engineering, telecommunications, computer engineering, information technology, data science, artificial intelligence, and cybersecurity
- Automate repetitive job tasks
  - Human watching monitors replaced by machine vision systems detecting anomalies and alerting operators to changes in conditions
- Wearable technology
  - Sensors on clothes for monitoring humans and situations
  - Sensors can deliver additional alerts/warnings to workers
- Intrusion alert systems
  - Alert workers of a vehicle entering construction, maintenance, incident scene
  - Alert drivers in advance when workers are present

Photo Courtesy of Texas A&M Transportation Institute

Strategies – IT Systems / Cybersecurity

- Cybersecurity considerations built into the design and operation
  - E.g., security credential management system in CAV
- Mitigating cybersecurity threats follows good information technology best practices:
  - keep software regularly updated and upgraded
  - implement user access management policies and procedures on all accounts
  - implement device and data access management policies
  - maintain a system and data recovery plan
  - actively manage systems and configurations
  - proactively detect network intrusions
  - leverage hardware security features
  - segregate critical networks and services
  - integrate threat reputation services
  - implement multi-factor authentication
- Applies to an agency, partners, users, and contractors/vendors

Summary

- Increase in events--natural and human-made--that can impact the transportation system
- Compounded by trends in increased travel demand and levels of available funding
- Transportation agencies increasingly aware of "operational resilience"
- Technologies and systems are evolving to provide greater support to ITS, ETO, and TIM

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Questions