Vehicle to Infrastructure: Safety, Mobility, Weather, and the Environment

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Fully Connected Vehicle
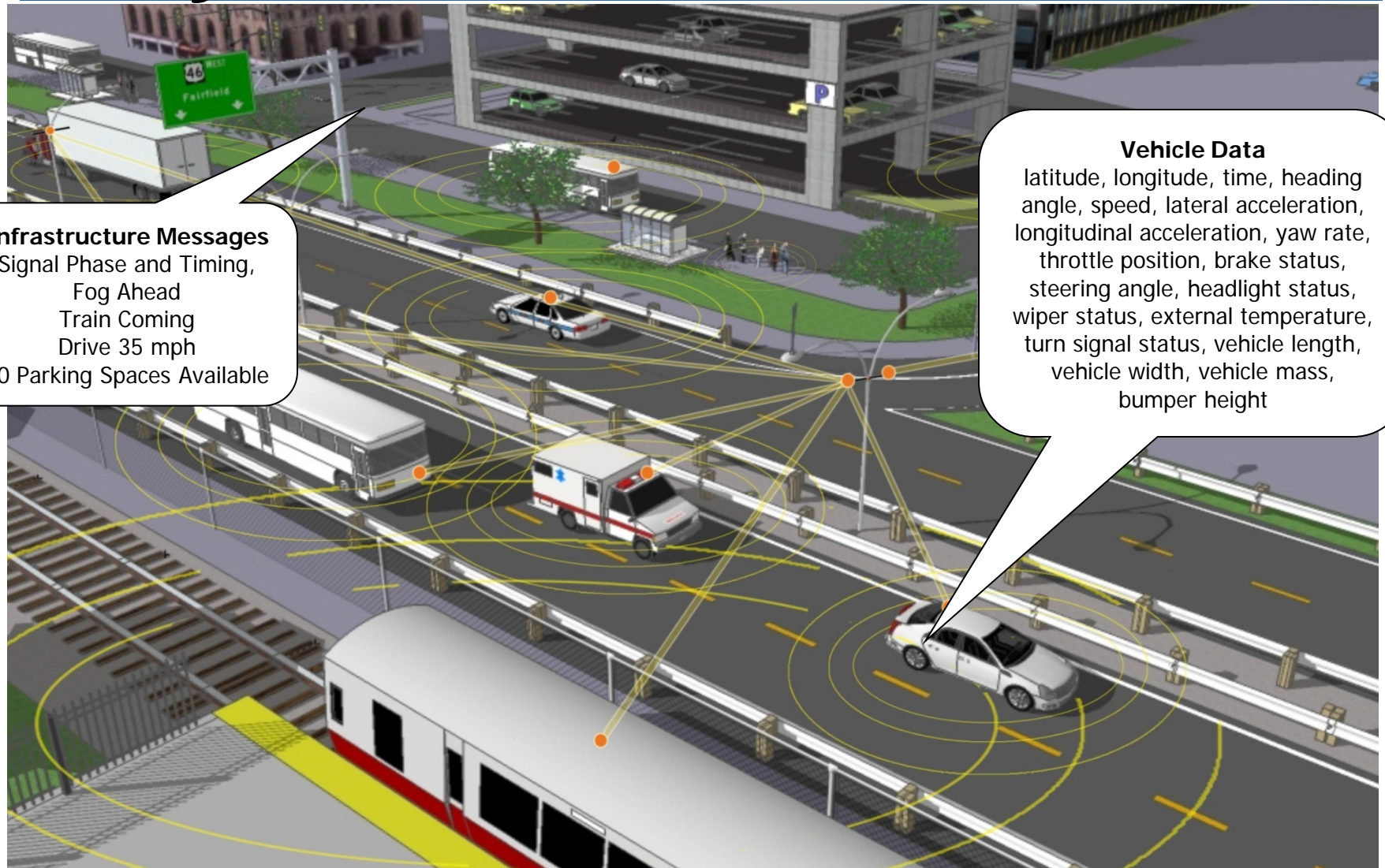
Infrastructure Messages
Signal Phase and Timing,
Fog Ahead
Train Coming
Drive 35 mph
50 Parking Spaces Available

Vehicle Data
latitude, longitude, time, heading angle, speed, lateral acceleration, longitudinal acceleration, yaw rate, throttle position, brake status, steering angle, headlight status, wiper status, external temperature, turn signal status, vehicle length, vehicle width, vehicle mass, bumper height

Why It Matters

- Safety – 32,885 highway deaths in 2010, 5,400,000 crashes/year
  - Opportunity - Intersection safety, where 7% of fatalities at signalized intersections ($19 billion annual cost) and 14% at non-signalized intersections
  - Run off Road – 40% of fatal crashes
- Mobility – 4,200,000,000 hours of travel delay, $80,000,000,000 cost of urban congestion
  - Cooperative Adaptive Cruise Control could improve freeway capacity by 50%
  - Reduce delay from signal system management by 25%
  - Improve transit connection success by 90% and reduce wait time to 10 minutes or less
  - Improve incident response by 30%
  - Improve freight delivery travel time (less wait time at terminals and faster freeway travel – 15 to 30%)
  - Weather
    - Improve safety in adverse weather conditions
    - Reduce Public Sector cost in treating facilities
  - Environment - 2,900,000,000 gallons of wasted fuel
    - Reduce Fuel Use
    - Reduce Emissions

Source for Problems, NHTSA and TTI. Initial estimates & studies for benefits.
Actual benefits are not determined at this time.

Key Assumptions and Questions

Assumption

- Vehicles have DSRC and penetration rates climb over a 20 year period
- Cellular based communications to vehicles will continue to evolve (carry-in and built-in products, with opt-in consumer pay services)
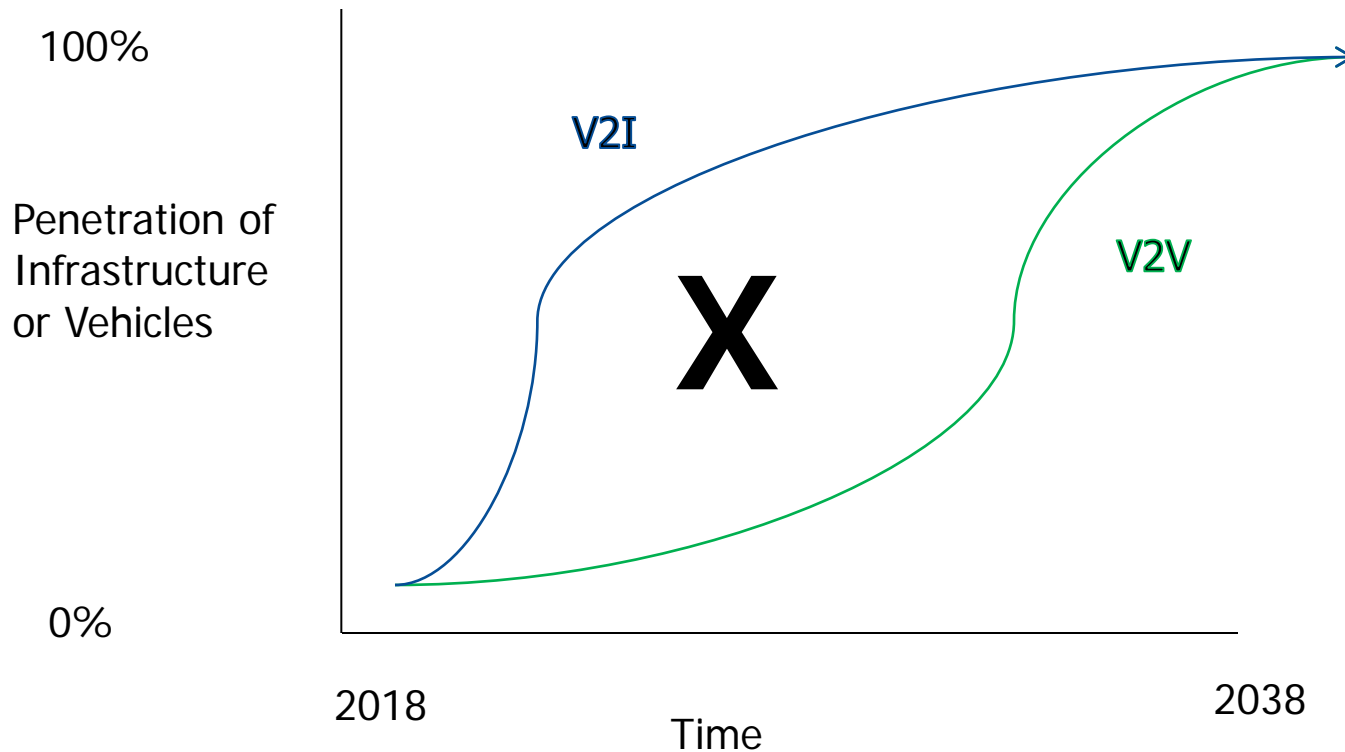- Connected Vehicle Core System Architecture Guides system evolution.

Questions

- Where is DSRC Infrastructure Communications Necessary?
- How does the benefits equation for installation of DSRC Infrastructure change as penetration rates for vehicles and infrastructure evolve?
- How would a cellular based solution occur and provide benefits to the public sector? We are already seeing some.
- What additional vehicle based data is needed to enable applications that solve problems? Over what portion of a trip is that data needed? When and where is that data needed?
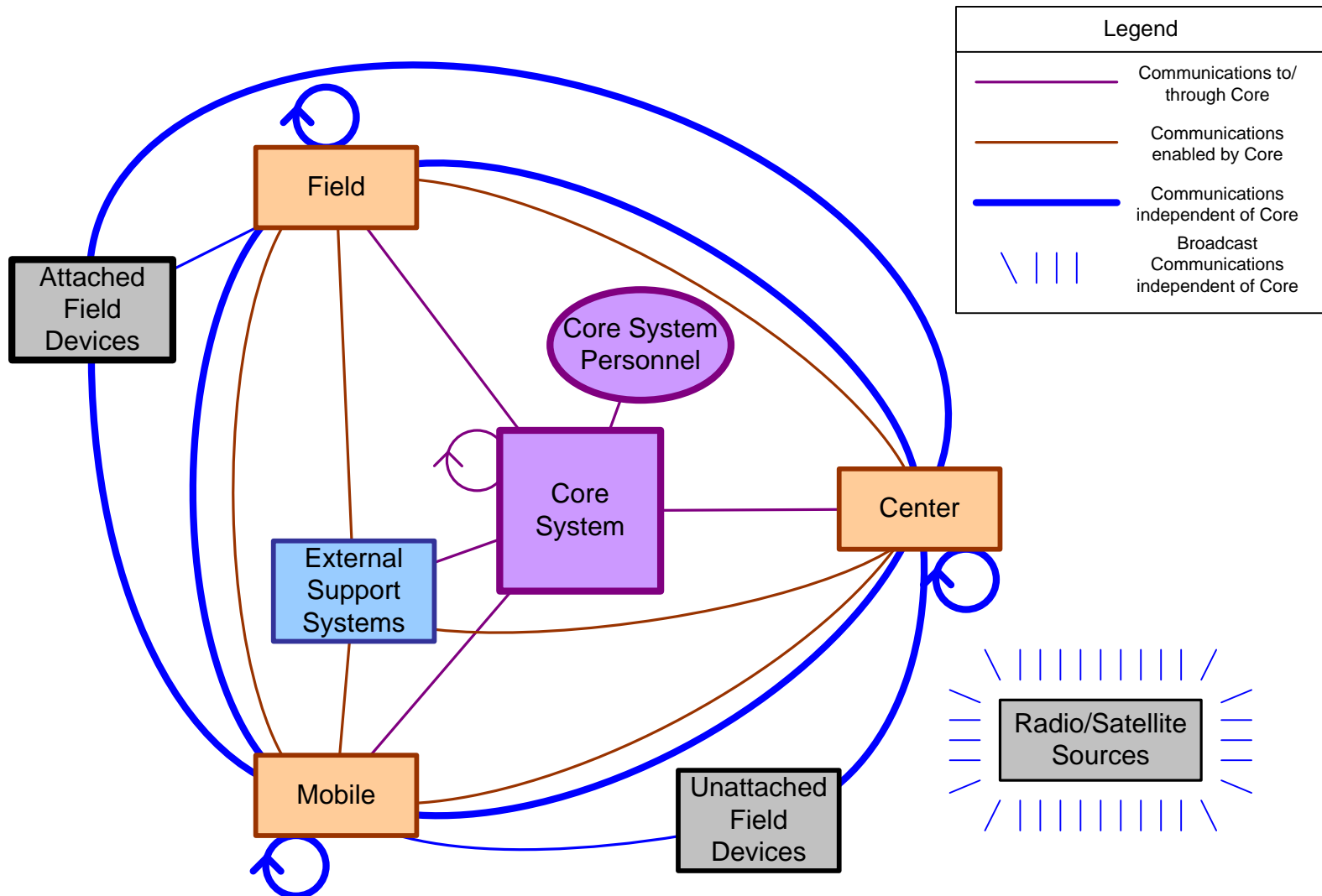- What information is necessary to send from the infrastructure to vehicles?

When/How Do Benefits Occur?

Connected Vehicle Environment
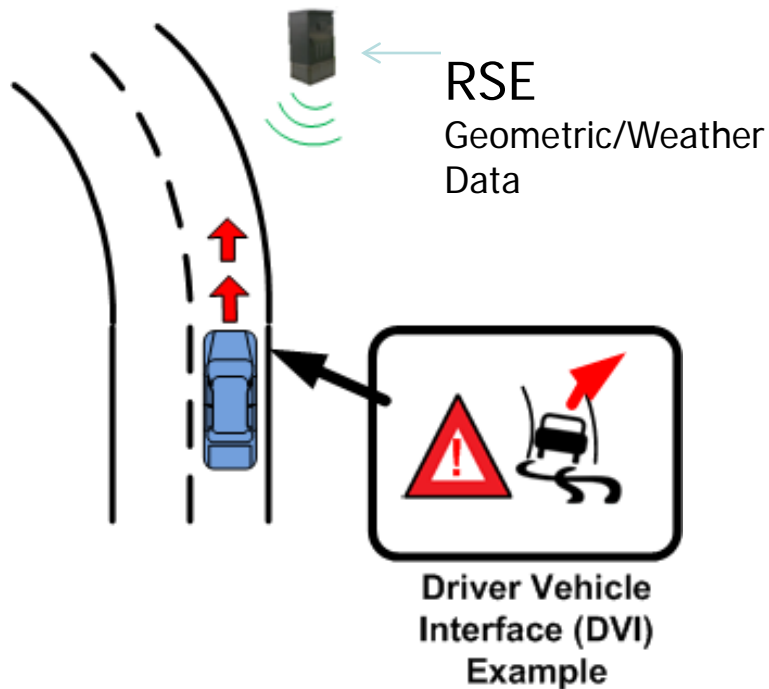## with Core System and External Support

V2I Safety

- Enable the Critical Infrastructure Technology
  - Communications
  - Positioning
  - Signal Phase and Timing Messaging
  - Developing the Prototype Roadside Equipment

- Determine Benefits through Applications Development and Testing
  - Red Light Violation Warning
  - Curve Speed Warning
  - Rural Stop Sign Assist
  - Transit Pedestrian
  - Truck - Smart Roadside

- Create Implementation Guidance
  - Standards
  - Specifications
- We are in the middle of the application definition phase and about to enter into application prototyping and testing.
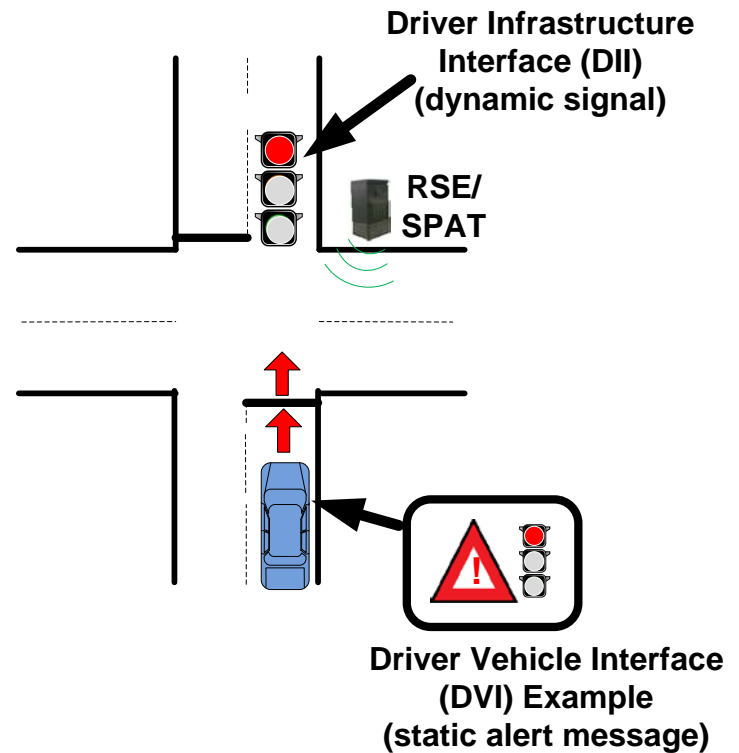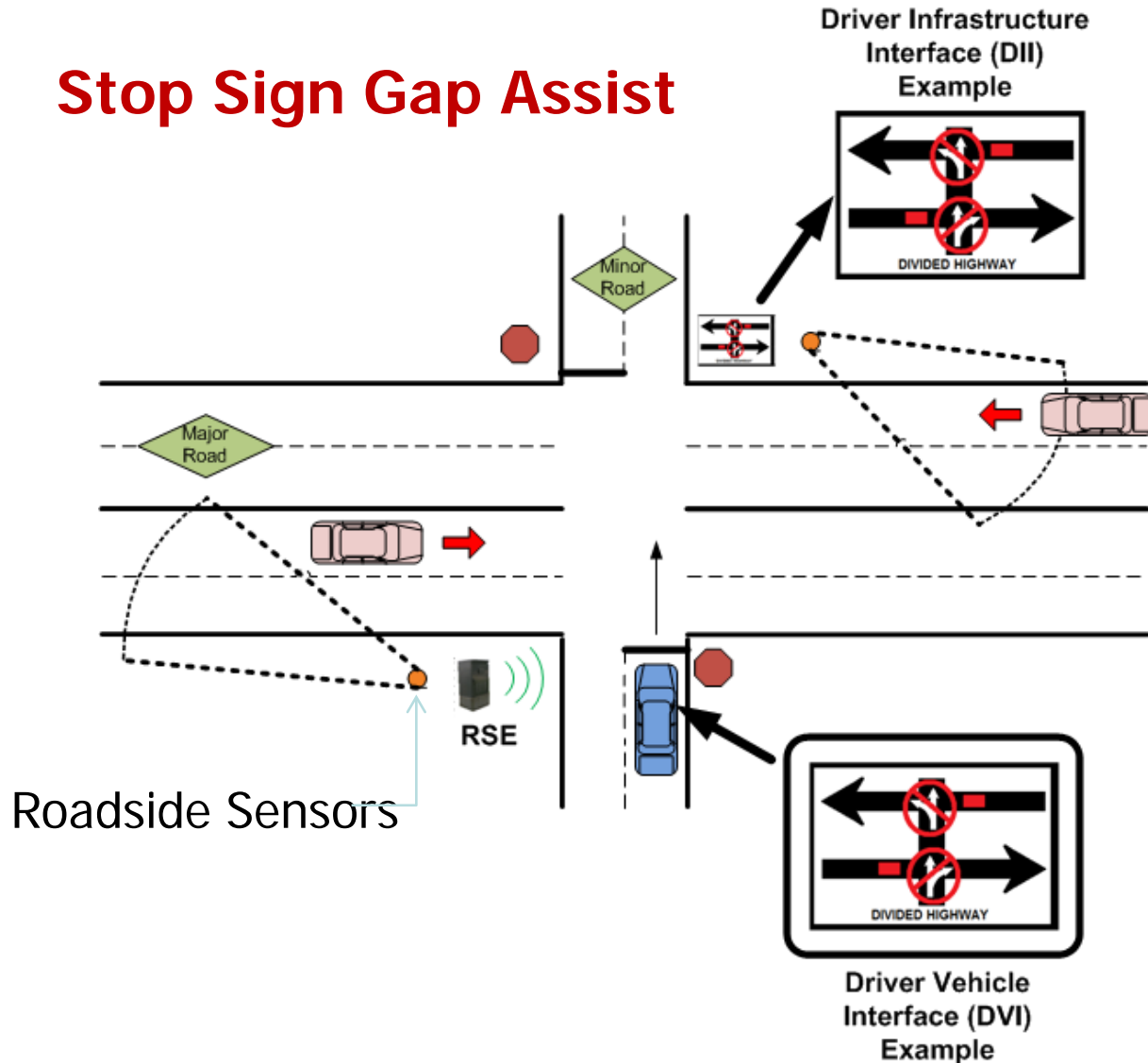
V2I Safety Applications

Curve Speed Warning

RSE
Geometric/Weather Data

Driver Vehicle Interface (DVI) Example

Red Light Violation Warning

Driver Infrastructure Interface (DII) (dynamic signal)

RSE/ SPAT

Driver Vehicle Interface (DVI) Example (static alert message)

V2I Safety Applications

Stop Sign Gap Assist

Key Questions for V2I Safety

- What **DSRC-specific apps** are most valuable? What are the **benefits**?

- How will we **cost-effectively** obtain **absolute** positioning?

- How/when might **equipment installation** occur? Signal upgrades, targeted intersections, transit enhancements, high accident curves, truck inspection stations?

- What info do you need to **invest in DSRC infrastructure**? Currently, application investment assumes existing local and federal funding sources.

Mobility Program Elements

- Determine Approaches to Capturing and Managing Multi-sourced Data
- Determine Benefits from Applications
  □ Identify and Define Applications
  □ Build and Test Prototype Applications
- Develop Implementation Guidance
  □ Policies
  □ Standards
  □ Specifications

- We are defining applications in 6 high priority bundles (freeway operations, arterials, incident management, transit, freight, and traveler information) and will move into application development soon.

- Weather Research has dedicated funding and a similar approach.
- AERIS Program (Environment) has similar approach, without funding for specific application development and testing.

Mobility Applications

Traveler
Decisions

Weather
Data

M2V
Integration

Itinerary Data
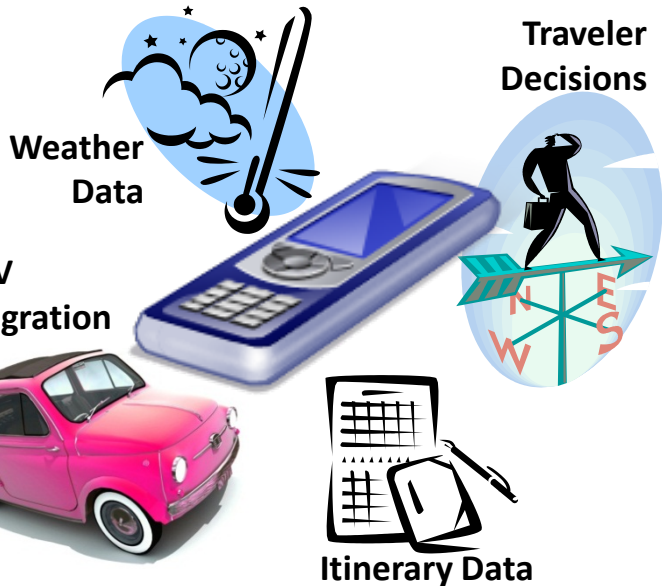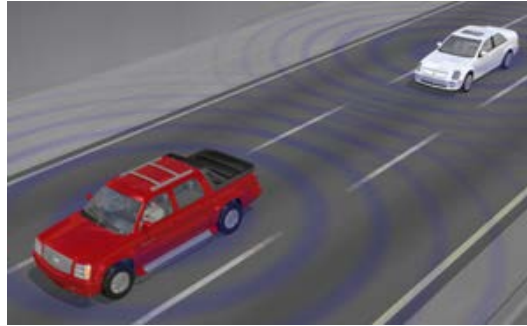
Let's Talk About Data

Existing Sources

- States purchase information based on GPS probe data collected through cellular from private entities

- Infrastructure Based Sensors providing data to management centers

V2V provides

- **Basic Safety Message Part 1**

  o Core data elements communicated 10x per second via DSRC

- **Basic Safety Message Part 2**

  o Additional data elements communicated via DSRC when an "event" happens

Mobility, Weather and AERIS Need What?

Data and Mobility

Existing Probe and Sensor

Freeway Travel Times, Traffic Volumes and Spot Speed

Data and Mobility

Basic Safety Message 1 via DSRC

Existing Probe and Sensor
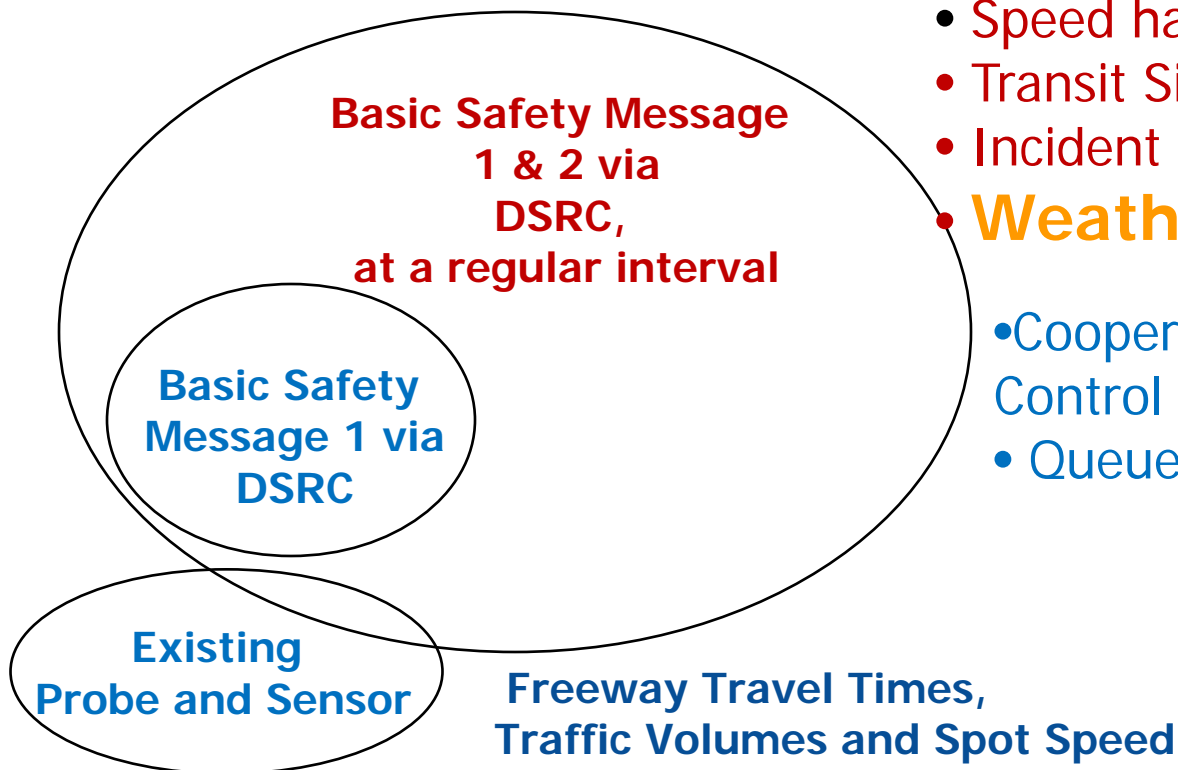
Freeway Travel Times, Traffic Volumes and Spot Speed

Mobility applications may include:
- Cooperative Adaptive Cruise Control
- Queue warning

Data and Mobility

Mobility applications may include:
- Speed harmonization
- Transit Signal priority
- Incident scene work zone alerts
- **Weather**

- Cooperative Adaptive Cruise Control
- Queue warning

Basic Safety Message 1 & 2 via DSRC, at a regular interval

Basic Safety Message 1 via DSRC

Existing Probe and Sensor

Freeway Travel Times, Traffic Volumes and Spot Speed

Data and Mobility

Even more mobility and environmental services

Basic Safety Message
1 & 2+,
at a regular interval,
via cellular

Mobility applications may include:
- Intelligent Traffic Signal Systems
- Mobile accessible ped signal systems
- Emergency comm & evacuations
- Incident scene staging guidance
- Work zone alerts for drivers & workers
- Next gen integrated corridor mgt
- Transit Connection protection
- Dynamic transit operations
- Freight traveler information
- Traveler information

Data and Mobility

Even more mobility and environmental services

Basic Safety Message 1 & 2+, at a regular interval, via cellular

Basic Safety Message 1 & 2 via DSRC, at a regular interval

More mobility and environmental services

Basic Safety Message 1 via DSRC

Mobility and environmental services

Existing Probe and Sensor

Freeway Travel Times, Traffic Volumes and Spot Speed
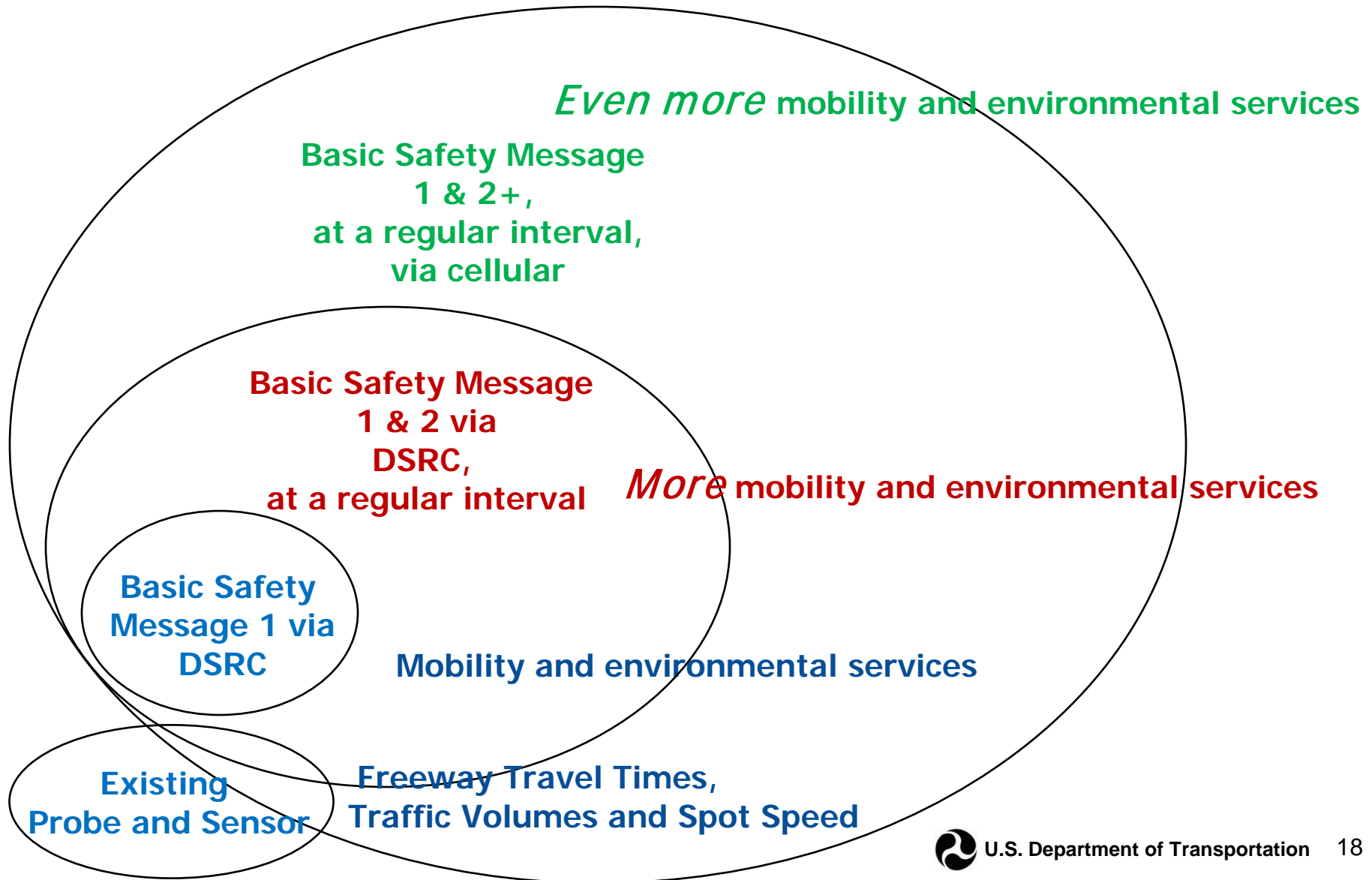
Key Questions for Mobility, Weather, Environmental Apps

- What specific **data elements** do you need?

- **How often** do you need them?

- What are the **benefits** of the applications?

- **How do you get the data**?
  - ○ Installation of equipment?
  - ○ Purchase from a data aggregator?

- What **new opportunities** are there with cellular and a world of apps?

Timing!!!!!!

| '12 | '13 | '14 | '15 | '16 | '17 | '18 | '19 | '20 | '21 | '22 | '23 | '2 |

risk assessment

V2V model deployment

DOT decision 10/13

rulemaking

Lead time

Initial Deployment 2019

Transition

V2I Safety and Mobility Applications Prototyped
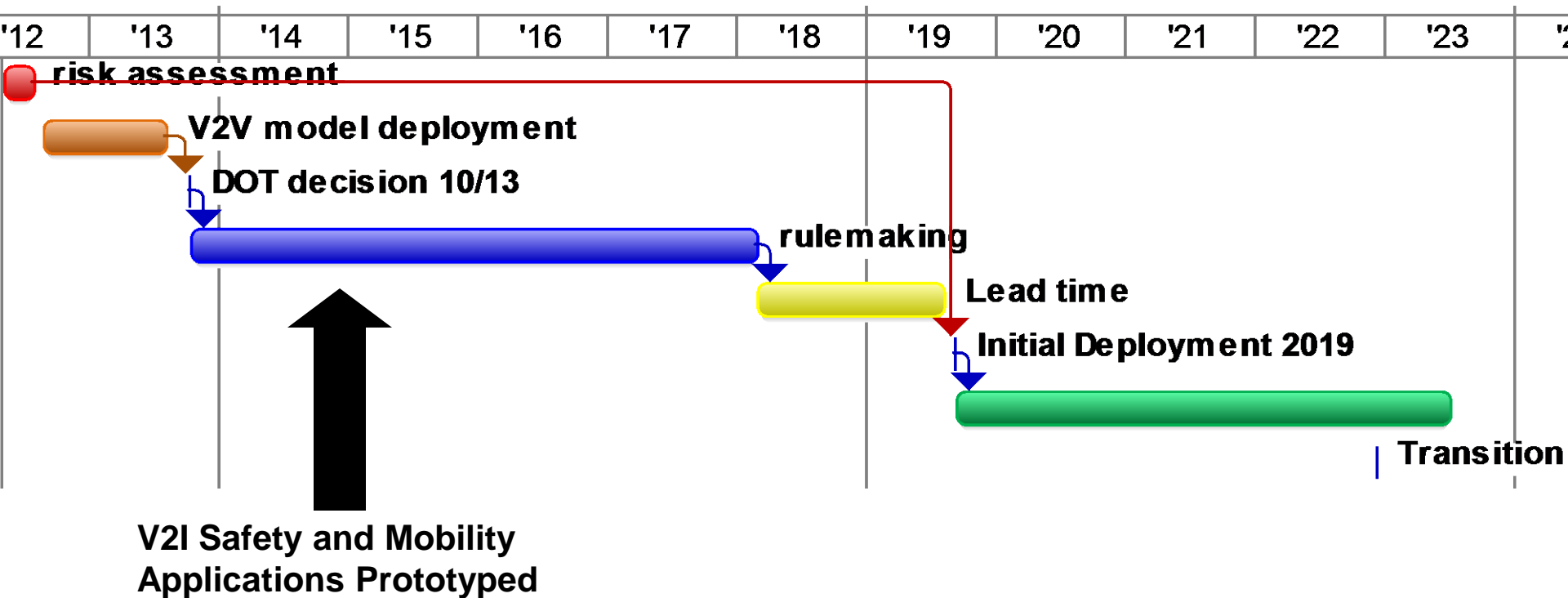
Do we conduct additional Pilots / Model Deployments?

Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) Technology Test Bed and Affiliated Interoperable Test Beds
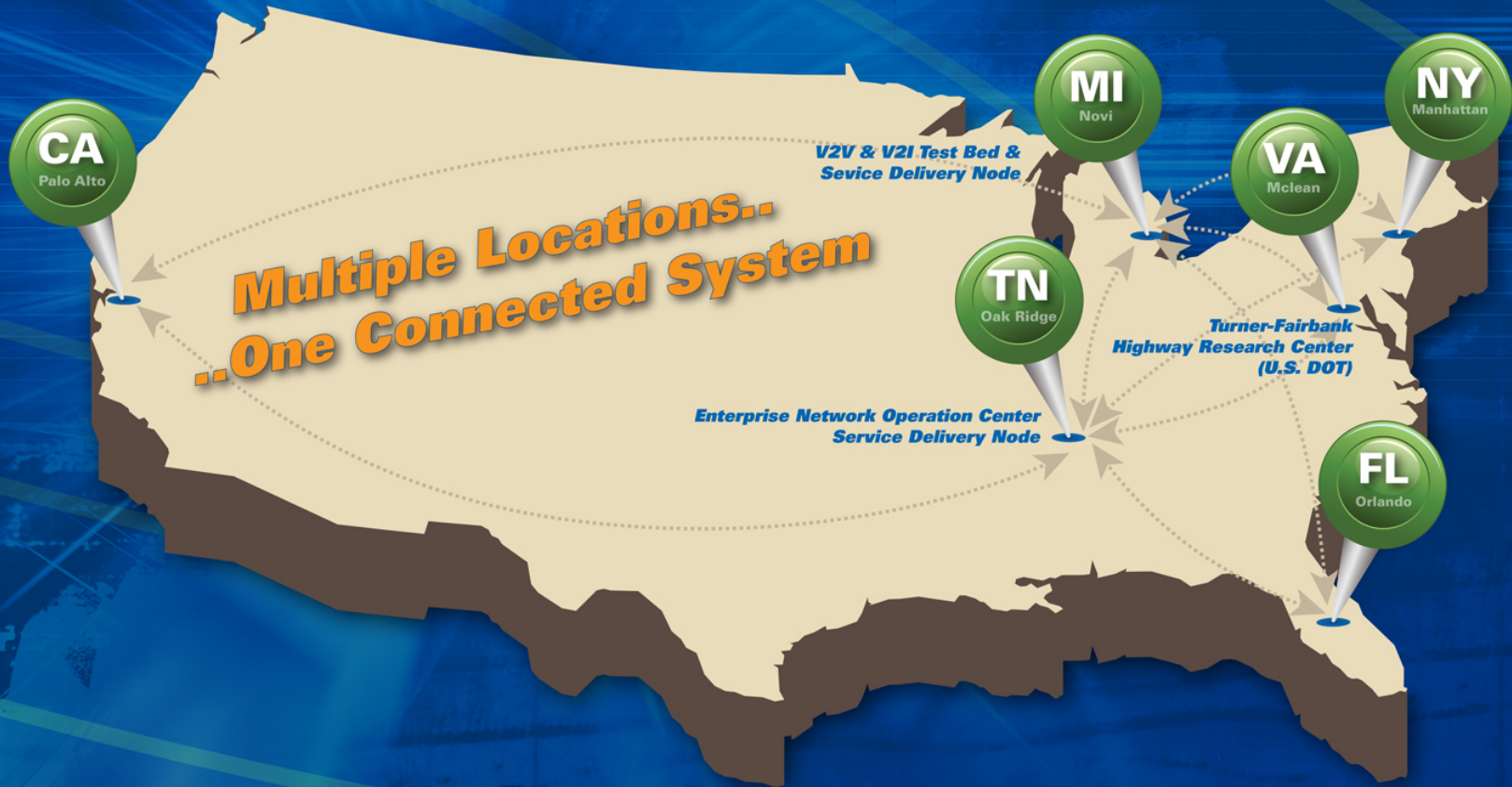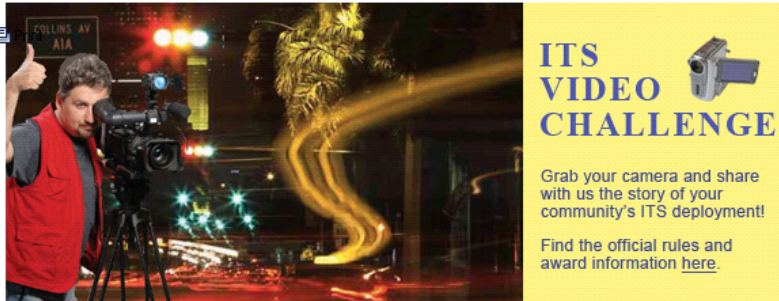
Connected Transportation

For More Information

www.its.dot.gov