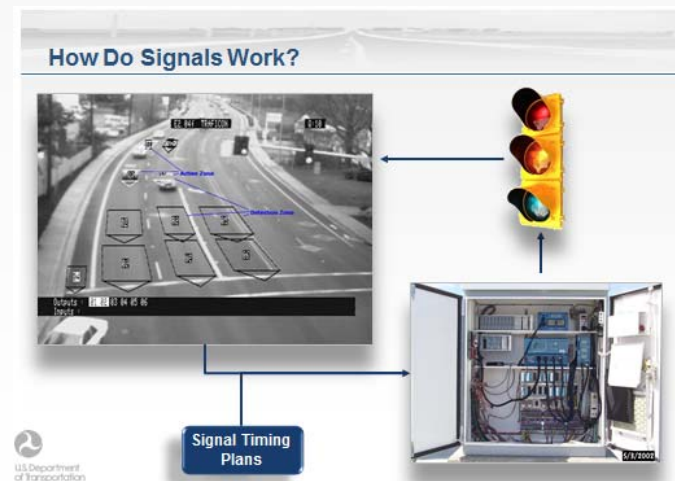# Connected Vehicles 101

ITS Professional Capacity Building Program

- Offers FREE training to develop the ITS workforce

- Talking Transportation Technology webinars, with online archive

- ITS Standards – 36 modules

- ITS Transit Standards – coming soon

- eLearning Courses from Consortium for ITS Education (CITE):

  - Telecommunications and Networking Fundamentals

  - Network Design and Deployment Considerations for ITS Managers

- Workshops at ITS America state chapter meetings

©iStockphoto.com/pagedesign

How Do Signals Work?

Signal Timing Plans

www.pcb.its.dot.gov

Image Source: ThinkStock/USDOT

Connected Vehicle Resources

- ITS PCB Archived Webinars:

  - CV Basics – April 24, 2014

  - AASHTO Connected Vehicle Infrastructure Footprint Analysis Webinar – May 22, 2014

  - Connected Vehicle Reference Implementation Architecture (CVRIA) Webinar Series – November/December 2013

- ITS ePrimer – Connected Vehicle Module

- Contact: Kevin Gay
            ITS Knowledge Transfer and Policy
             U.S. Department of Transportation
            202-493-0259
            Kevin.Gay@dot.gov

www.pcb.its.dot.gov

Course Format

Topic	Title	Duration
1	Introduction to the Connected Vehicle Environment	30 minutes
2	Connected Vehicle Applications	60 minutes
3	Research Toward Implementation	60 minutes
4	Connected Vehicle Testing and Deployment	30 minutes
5	Policy and Institutional Issues	30 minutes

Topic 1: Introduction to the Connected Vehicle Environment

Topic	Title	Duration
1	Introduction to the Connected Vehicle Environment	30 minutes
2	Connected Vehicle Applications	60 minutes
3	Research Toward Implementation	60 minutes
4	Connected Vehicle Testing and Deployment	30 minutes
5	Policy and Institutional Issues	30 minutes

Topic 1: Introduction to the Connected Vehicle Environment

After this topic, you will be able to:

- Explain the concept of connected vehicles

- Describe the technology used for connected vehicles

- List the benefits and challenges of connected vehicle technology

NBC Nightly News

http://clips.shadowtv.net/media/request/
06e5ee4197d7490fa95c5ba08bea75c0
/index.html

NBC Nightly News Video Summary

Connected vehicles have the potential to address approximately 80% of vehicle crash scenarios involving unimpaired drivers.

- Greater situational awareness:

  - Your vehicle can "see" nearby vehicles and knows roadway conditions you cannot see

  - 360-degree "visibility"

- Reduce or even eliminate crashes through:

  - Driver advisories

  - Driver warnings

  - Vehicle control

Transportation Challenges

Safety
33,561 highway deaths in 2012
5,615,000 crashes in 2012
Leading cause of death for ages 4, 11-27

Mobility
5.5 billion hours of travel delay
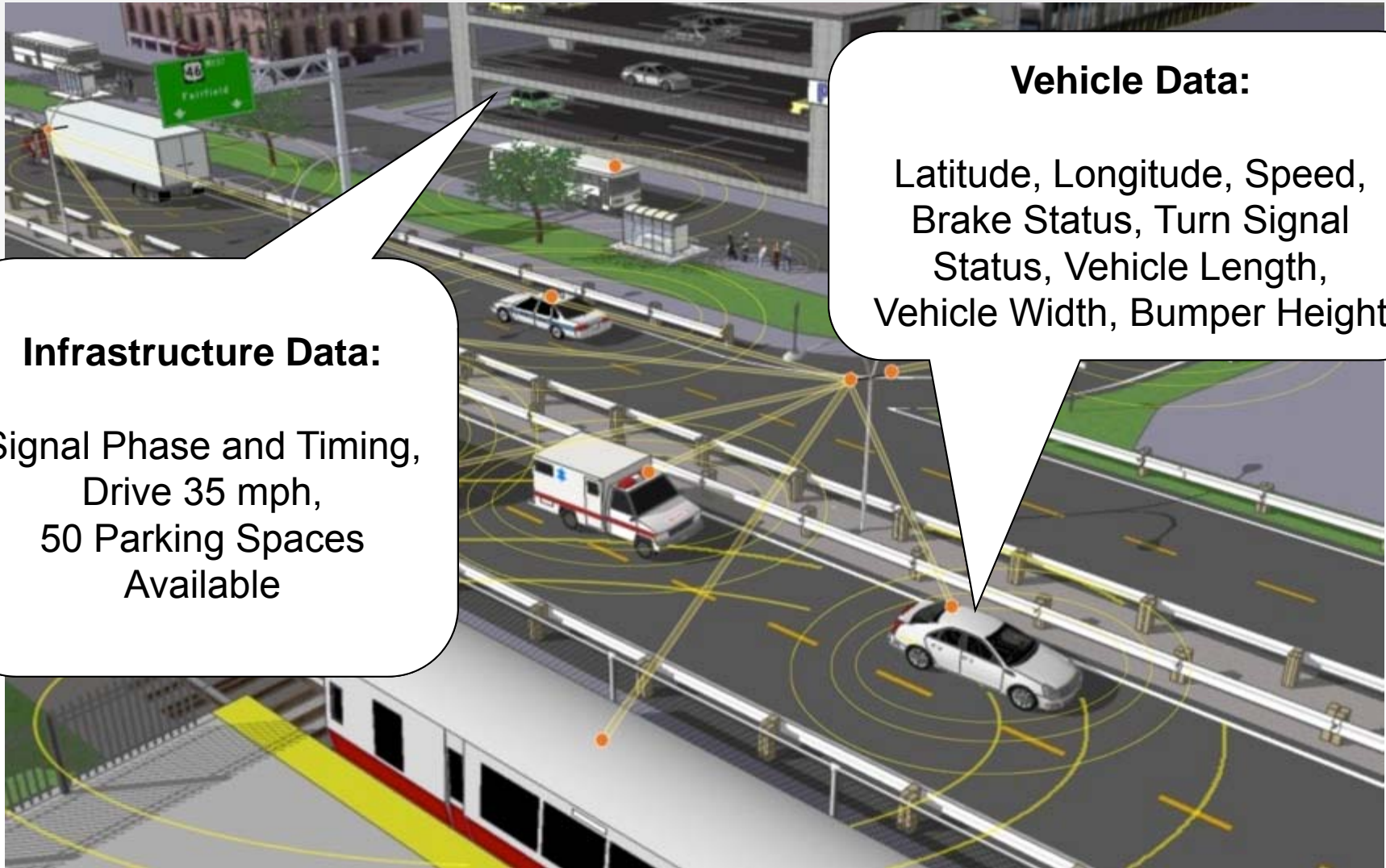$121 billion cost of urban congestion

Environment
2.9 billion gallons of wasted fuel
56 billion lbs. of additional CO_2

Fully Connected Vehicles

Vehicle Data:

Latitude, Longitude, Speed, Brake Status, Turn Signal Status, Vehicle Length, Vehicle Width, Bumper Height

Infrastructure Data:

Signal Phase and Timing, Drive 35 mph, 50 Parking Spaces Available

US DOT/NHTSA Advance Notice of Proposed Rule Making on V2V Communications Technology

- Announced August 18, 2014, to seek public input to regulation to eventually require V2V devices in new light vehicles (60 day comment period)

- Primary purpose: enable collision warnings to drivers prior to a crash

- Based on several years of research including the Safety Pilot Model Deployment – 3,000 vehicle road test in Ann Arbor, Michigan

- Report on technical feasibility, privacy and security, and preliminary estimates on costs and safety benefits concludes:

  - V2V devices in light vehicles communicated as intended using security management system during Model Deployment

  - NHTSA has legal authority to mandate V2V (DSRC) devices in new light vehicles and require installation in commercial vehicles

- Security and privacy protections built into contemplated system

- Decision on heavy vehicles planned at end of 2014

Let's Recap

- How do connected vehicles work?

Connected Vehicle Communications Technology

- 5.9 GHz DSRC

- 4G and older 3G cellular networks provide high-bandwidth data communications

- Other wireless technologies such as Wi-Fi, satellite, and HD radio may have roles to play

Source: U.S DOT

DSRC Communications Technology: How It Works

- Data is transmitted 10 times/sec (300m range)

- Privacy is built-in (vehicle location is NOT intended to be recorded or tracked)

- Wi-Fi radio adapted for vehicle environment

- Inexpensive to produce in quantity

- Original FCC spectrum allocation in 1999, revised in 2004 and 2006

Connected Vehicle Communications Technology: Benefits and Challenges

- Benefits of the DSRC communications technology:

  □ Reduced price

  □ Improved reliability → fewer false alarms

  □ Increased performance → addresses more crash scenarios

- Challenges of the DSRC communications technology:

  □ Both parties (vehicle/vehicle or vehicle/infrastructure) need to be equipped to gain benefit

  □ Requires security infrastructure

Connected Vehicle Communications Technology: Benefits and Challenges (continued)

- Benefits of 4G and 3G cellular technology:

  - Widely deployed commercial networks

  - Increasingly available in vehicles

  - Mobility and environmental applications

- Challenge of 4G and 3G cellular technology:

  - May not be suitable for safety applications that require low latency

Topic 1 Wrap-up

- What communications technologies are used for connected vehicles applications?

- What are the benefits of the DSRC connected vehicle communications technology?

- What other communications technologies can be used for mobility and environmental applications?

- What is a major challenge of the connected vehicle technology?
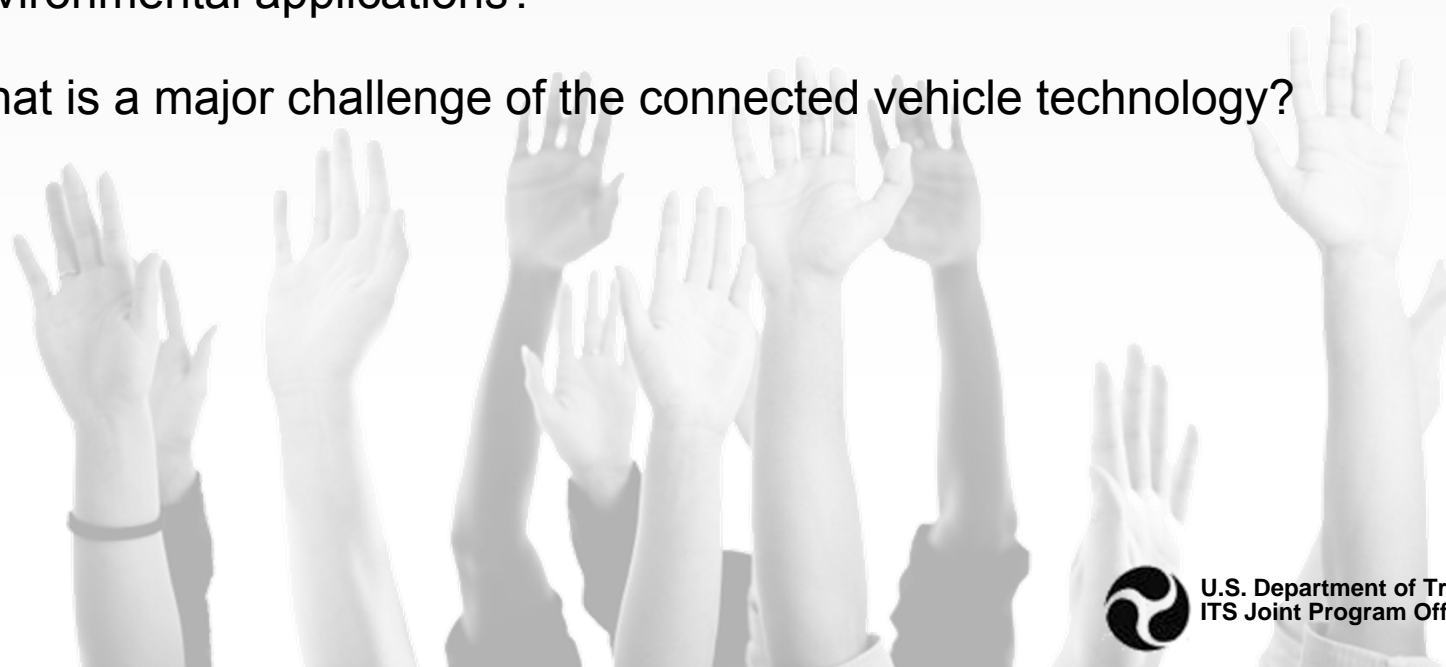
Topic 2: Connected Vehicle Applications

| Topic	Title	Duration
1	Introduction to the Connected Vehicle Environment	30 minutes
2	Connected Vehicle Applications	60 minutes
3	Research Toward Implementation	60 minutes
4	Connected Vehicle Testing and Deployment	30 minutes
5	Policy and Institutional Issues	30 minutes

Topic 2: Connected Vehicle Applications

After this topic, you will be able to:

- Describe the impact of connected vehicles on safety, mobility, and the environment

- Describe the connected vehicle applications for safety

- Describe the connected vehicle applications for mobility

- Describe the connected vehicle applications for the environment

- Identify which application would help alleviate your top transportation challenge
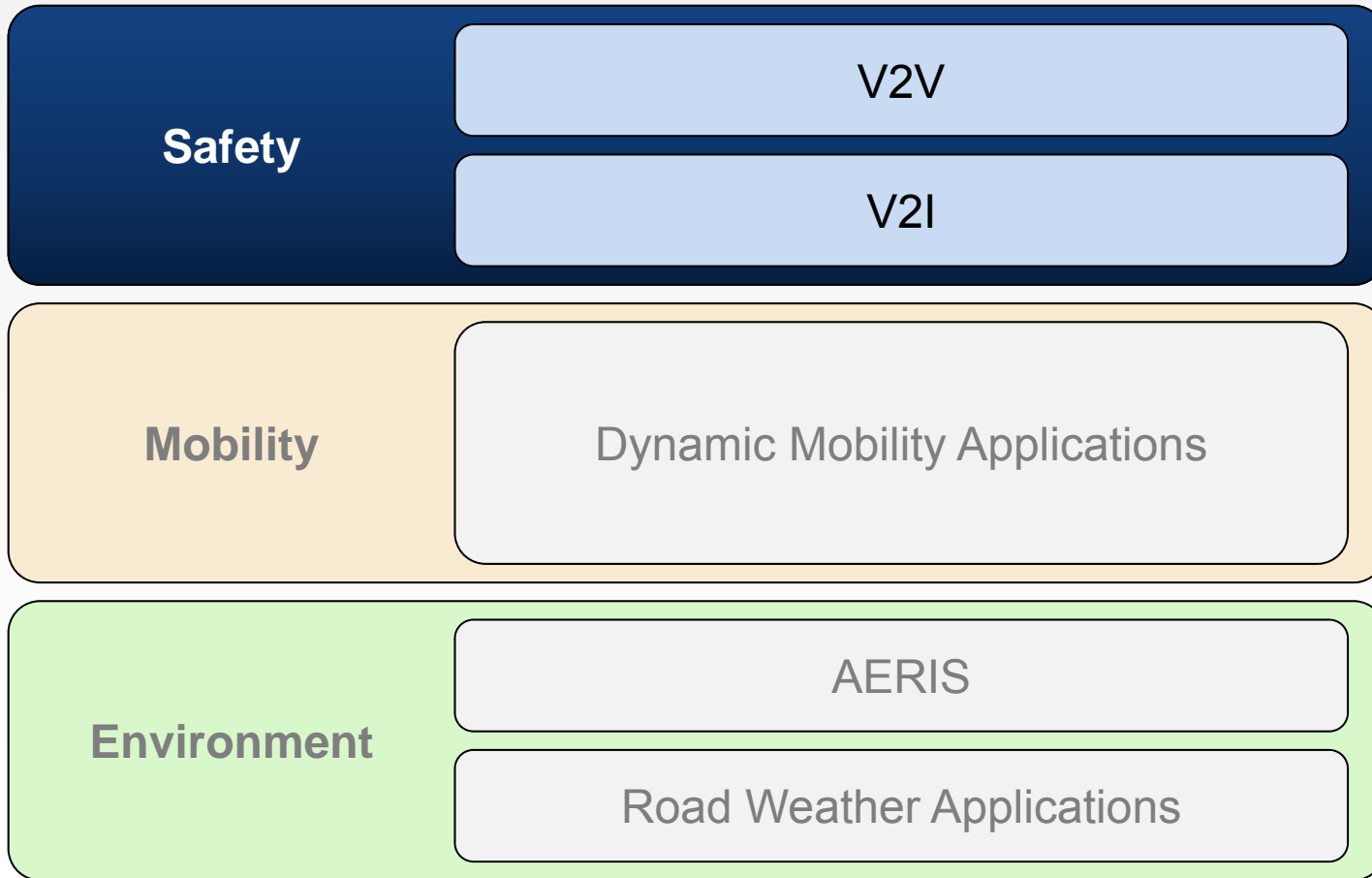
Connected Vehicle Applications

| Safety | V2V |
| | V2I |

| Mobility | Dynamic Mobility Applications |

| Environment | AERIS |
| | Road Weather Applications |
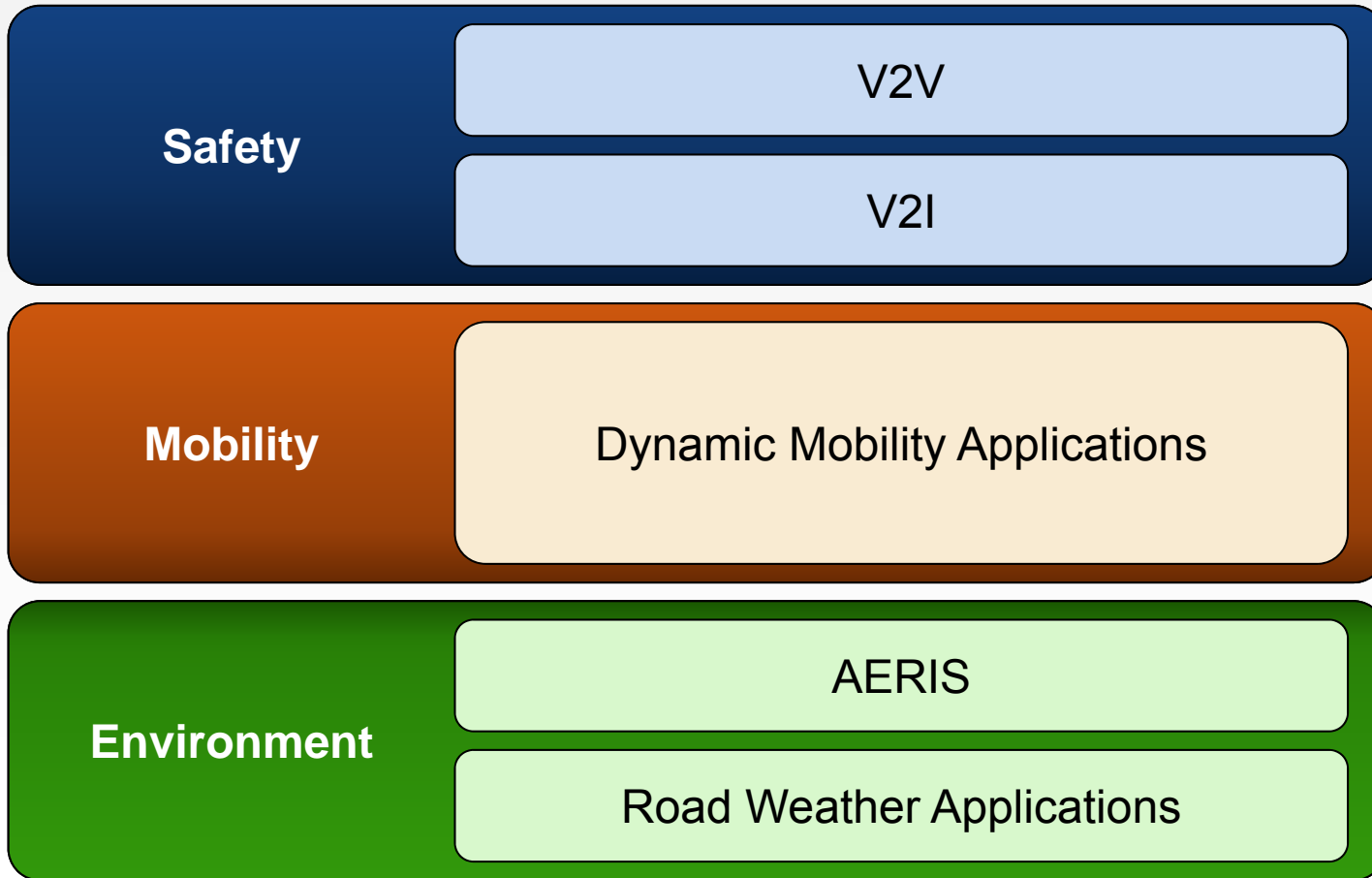
Connected Vehicle Technology Animation

Connected Vehicle Applications: Safety

| Safety | V2V |
| | V2I |

| Mobility | Dynamic Mobility Applications |

| Environment | AERIS |
| | Road Weather Applications |

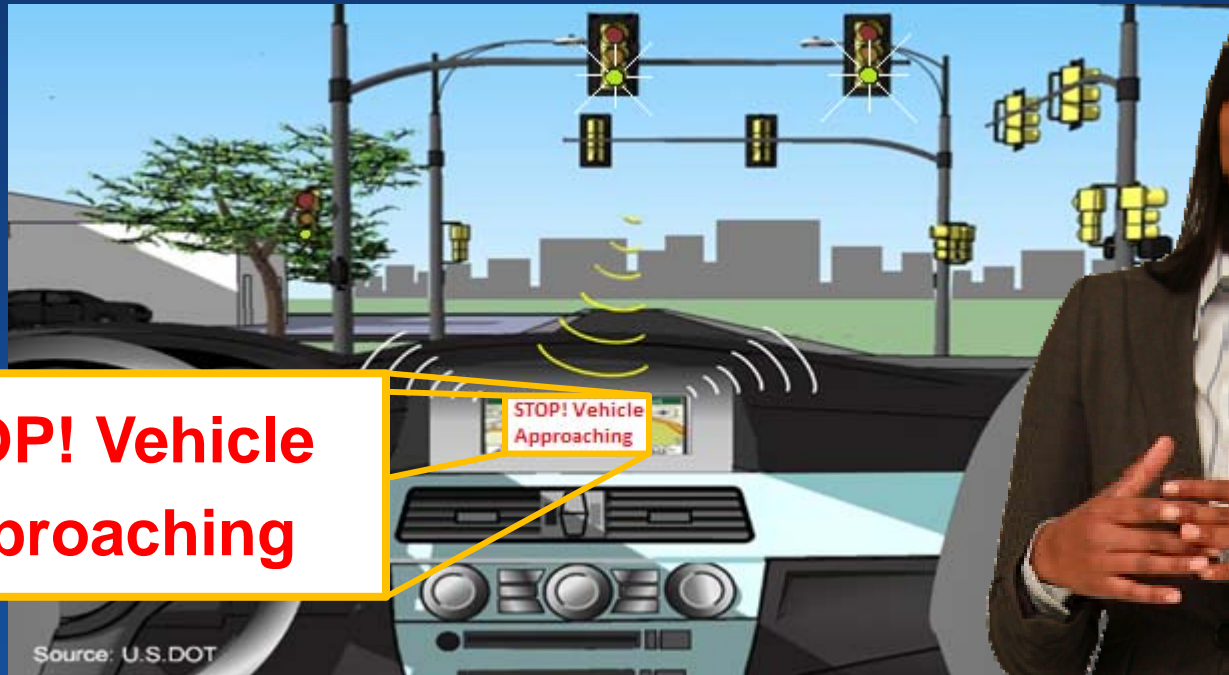# Safety Applications: V2V

V2V Safety Applications	
Forward Collision Warning	FCW
Emergency Electronic Brake Light	EEBL
Blind Spot/Lane Change Warning	BSW/LCW
Do Not Pass Warning	DNPW
Intersection Movement Assist	IMA
Left Turn Assist	LTA

Safety Applications: V2V Scenario

Lauren is driving home with her son after a day at school. She is stopped at a red light. When the light turns green, she is about to move through the intersection when she is warned of a vehicle crossing the path in front of her. She quickly brakes to avoid a T-bone crash.

STOP! Vehicle Approaching

Source: U.S.DOT

Safety Applications: V2I

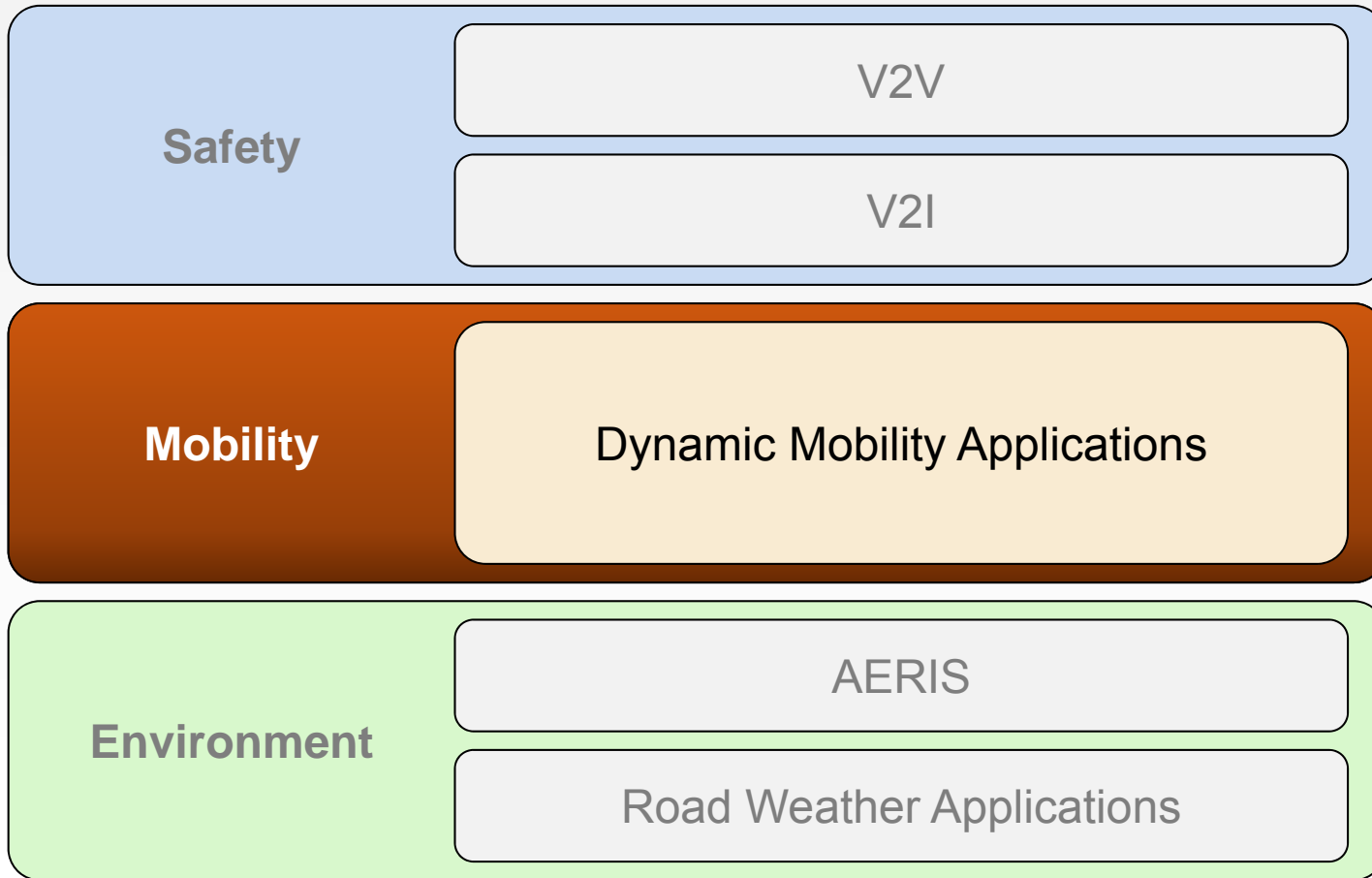| V2I Safety Applications	
Curve Speed Warning	CSW
Red Light Violation Warning	RLVW
Spot Weather Information Warning	SWIW
Reduced Speed Zone Warning	RSZW
Stop Sign Gap Assist	SSGA
Smart Roadside	SRI
Transit Pedestrian Warning	

Safety Applications: V2I Scenario

Charles is on his way to the senior center and does not notice the red light at the intersection. His car signals him to stop immediately.

Connected Vehicle Applications: Mobility

Safety	V2V
	V2I
Mobility	Dynamic Mobility Applications
Environment	AERIS
	Road Weather Applications

Dynamic Mobility Applications

Multimodal Intelligent Traffic Signal System	MMITSS
Intelligent Traffic Signal System	I-SIG
Transit Signal Priority	TSP
Mobile Accessible Pedestrian Signal System	PED-SIG
Freight Signal Priority	FSP
Emergency Vehicle Preemption	PREEMPT
Intelligent Network Flow Optimization	INFLO
Dynamic Speed Harmonization	SPD-HARM
Queue Warning	Q-WARN
Cooperative Adaptive Cruise Control	CACC

Dynamic Mobility Applications

|	
Response, Emergency Staging and Communications, Uniform Management, and Evacuation	R.E.S.C.U.M.E.
Incident Scene Pre-Arrival Staging Guidance for Emergency Responders	RESP-STG
Incident Scene Work Zone Alerts for Drivers and Workers	INC-ZONE
Emergency Communications and Evacuation	EVAC
Enable Advanced Traveler Information Systems	Enable ATIS

Dynamic Mobility Applications

|	
Integrated Dynamic Transit Operations	IDTO
Connection Protection	T-CONNECT
Dynamic Transit Operations	T-DISP
Dynamic Ridesharing	D-RIDE
Freight Advanced Traveler Information Systems	FRATIS
Dynamic Travel Planning and Performance	
Drayage Optimization	

Dynamic Mobility Applications: Scenario

Mike is on his way to work and receives a queue warning that there is an incident up ahead. How can connected vehicle mobility applications help Mike get to work on time?
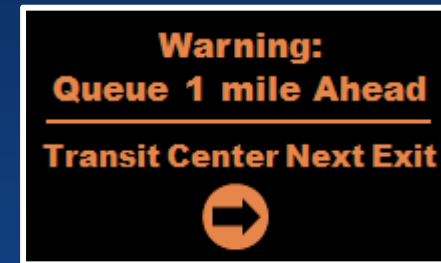
Connected Vehicle Applications: Environment

| Safety | V2V |
| | V2I |

| Mobility | Dynamic Mobility Applications |

| Environment | AERIS |
| | Road Weather Applications |
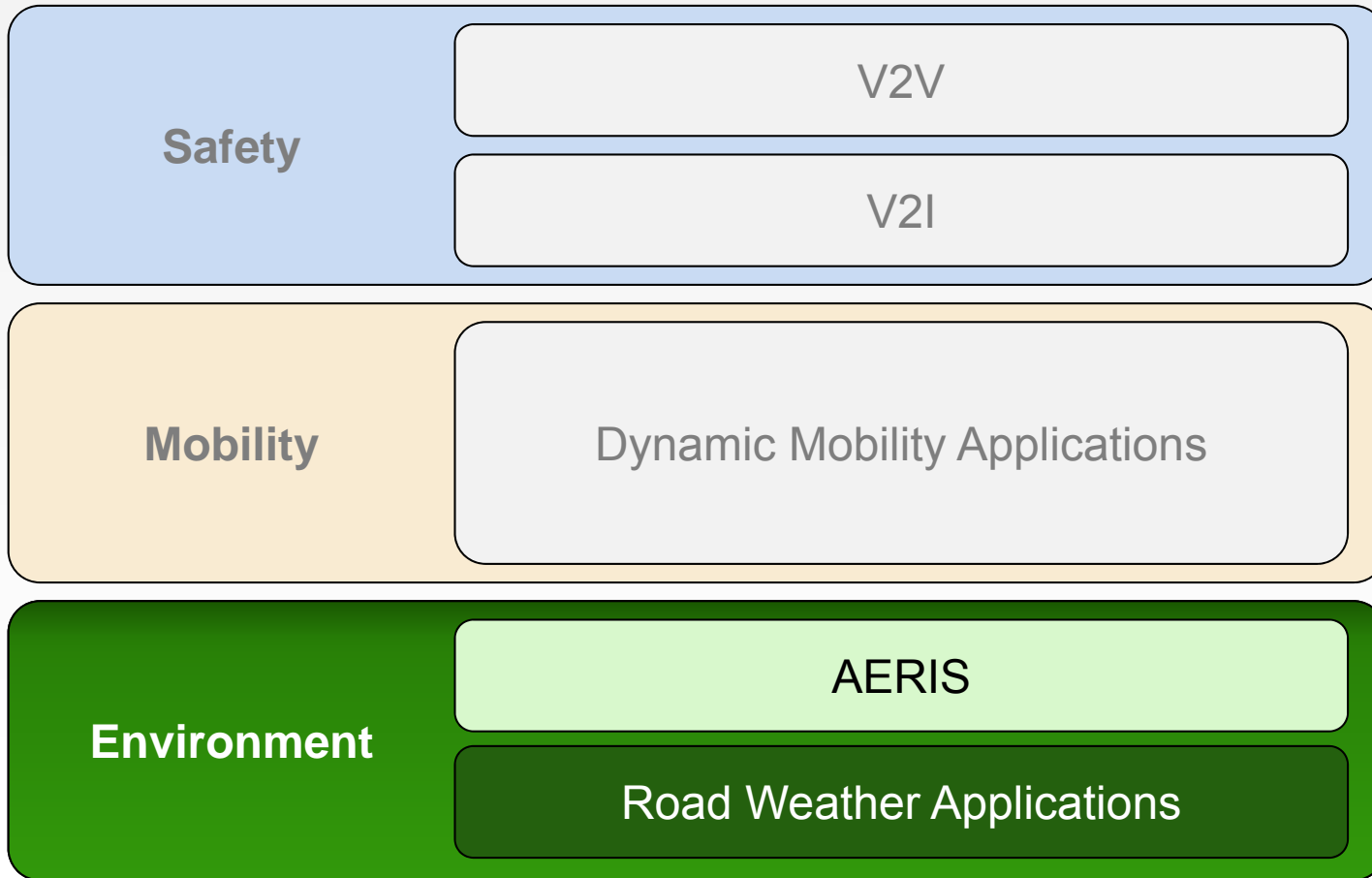
Environment Applications: AERIS

Cleaner Air Through Smarter Transportation
ECO-SIGNAL OPERATIONS
Eco-Approach and Departure at Signalized Intersections
Eco-Traffic Signal Timing
Eco-Traffic Signal Priority
Connected Eco-Driving
Wireless Inductive/Resonance Charging
ECO-LANES
Eco-Lanes Management
Eco-Speed Harmonization
Eco-Cooperative Adaptive Cruise Control
Eco-Ramp Metering
Connected Eco-Driving
Wireless Inductive/Resonance Charging
Eco-Traveler Information Applications

Environment Applications: AERIS

Cleaner Air Through Smarter Transportation
LOW EMISSIONS ZONES
Low Emissions Zone Management
Connected Eco-Driving
Eco-Traveler Information Applications
ECO-TRAVELER INFORMATION
AFV Charging/Fueling Information
Eco-Smart Parking
Dynamic Eco-Routing
Dynamic Eco-Transit Routing
Dynamic Eco-Freight Routing
Multi-Modal Traveler Information
Connected Eco-Driving

Environment Applications: AERIS

| Cleaner Air Through Smarter Transportation |
|---|
| **ECO-INTEGRATED CORRIDOR MANAGEMENT** |
| Eco-ECM Decision Support System |
| Eco-Signal Operations Applications |
| Eco-Lanes Applications |
| Low Emissions Zones Applications |
| Eco-Traveler Information Applications |
| Incident Management Applications |

Environment Applications: AERIS Scenario

Paul is driving to work and sees an advisory to adjust his speed to 35 mph. The traffic signal is telling him that if he adjusts his speed, he will arrive at the signal just as it is turning green. Using eco-approach and departure, he maximizes fuel savings, minimizes emissions, and may even get to work faster.

Connected Vehicle Applications: Environment

Safety
- V2V
- V2I

Mobility
- Dynamic Mobility Applications

Environment
- AERIS
- Road Weather Applications
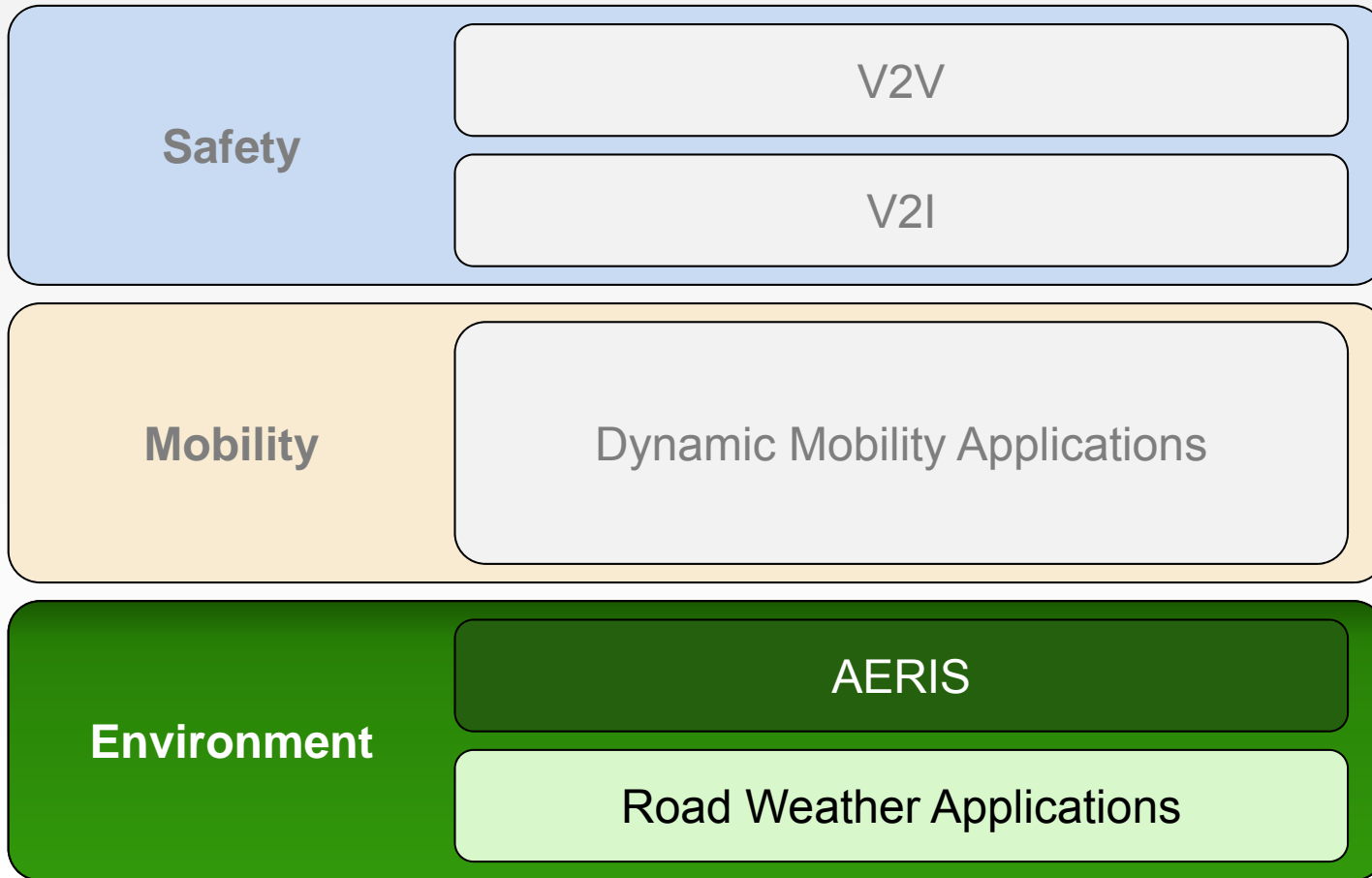
Environment Applications: Road Weather

Motorist Advisories and Warnings (MAW)
Enhanced Maintenance Decision Support System (MDSS)
Vehicle Data Translator (VDT)
Weather-Responsive Traffic Information (WxTINFO)

Environment Applications: Road Weather Scenario

Danielle sees a warning that she is approaching an icy road. A warning is transmitted from the car ahead of her, from a satellite, and from hardware on the roadside.

Data could have been collected from multiple sources in real-time. She has a lot of confidence because she knows that the data is coming from these sources in real-time.

Let's Recap

- What are three connected vehicle application categories?

- What are the connected vehicle applications for safety?

- What are the connected vehicle applications for the environment?

- What are the applications concepts for mobility?

Activity

- In which area is your top transportation challenge?

Safety

Mobility

Environment

Topic 2 Wrap-up

- Can you think of a deployment concept that can help alleviate your top transportation challenge?

- What are the applications within that deployment concept?

Topic 3: Research Toward Implementation

Topic	Title	Duration
1	Introduction to the Connected Vehicle Environment	30 minutes
2	Connected Vehicle Applications	60 minutes
3	Research Toward Implementation	60 minutes
4	Connected Vehicle Testing and Deployment	30 minutes
5	Policy and Institutional Issues	30 minutes

Topic 3: Research Toward Implementation

After this topic, you will be able to:

- Describe the three main connected vehicle research program components

- Describe the enabling technologies for the V2I reference implementation

- Describe the purpose of the connected vehicle reference implementation architecture (CVRIA)

- Describe how communication and exchange of data will occur between mobile, field, and center entities

- List questions to consider for connected vehicle infrastructure implementation

Connected Vehicle Research Components

Applications	Technology	Policy and Institutional Issues

Enabling Technologies

Equipment

Data

Standards

Role of Equipment in Connected Vehicles

Equipment
USDOT tested devices for placement on the Research Qualified Products List (RQPL). Five vendors of connected vehicle roadside equipment are currently on the list. Devices are based on RSE Specification v3.0.
Roadside Unit (RSU) Specification v4.0 is now available. It contains updates to the physical hardware, management information base (MIB), and firmware. Devices compliant with the 5.9 GHz DSRC RSU Specification v4.0 are expected to be available fall 2014.
Other connected vehicle deployments are encouraged to use equipment compliant with the RSU specification v4.0.
Results from Safety Pilot and Integrated V2I Prototype development will be used to develop a V2I reference implementation.

Data

Standards

Role of Data in Connected Vehicles

Equipment
Data
V2I Communications Support Safety, Mobility, and Environmental Applications: • Signal Phase and Timing (SPaT) data supports red light violation warning (safety), arterial speed harmonization (mobility), and eco-signal operations (environment). • The Basic Safety Message, developed for V2V safety applications, also supports the intelligent traffic signal systems mobility application. • Probe data supports transportation operations, traveler information, transportation planning, and asset management.
Common functions shared across applications: positioning, mapping, and communications.
Process for application testing (e.g., leverage Affiliated Test Beds).
The traffic management center is involved in disseminating the real-time data that enables these applications.
Standards

Role of Standards in Connected Vehicles

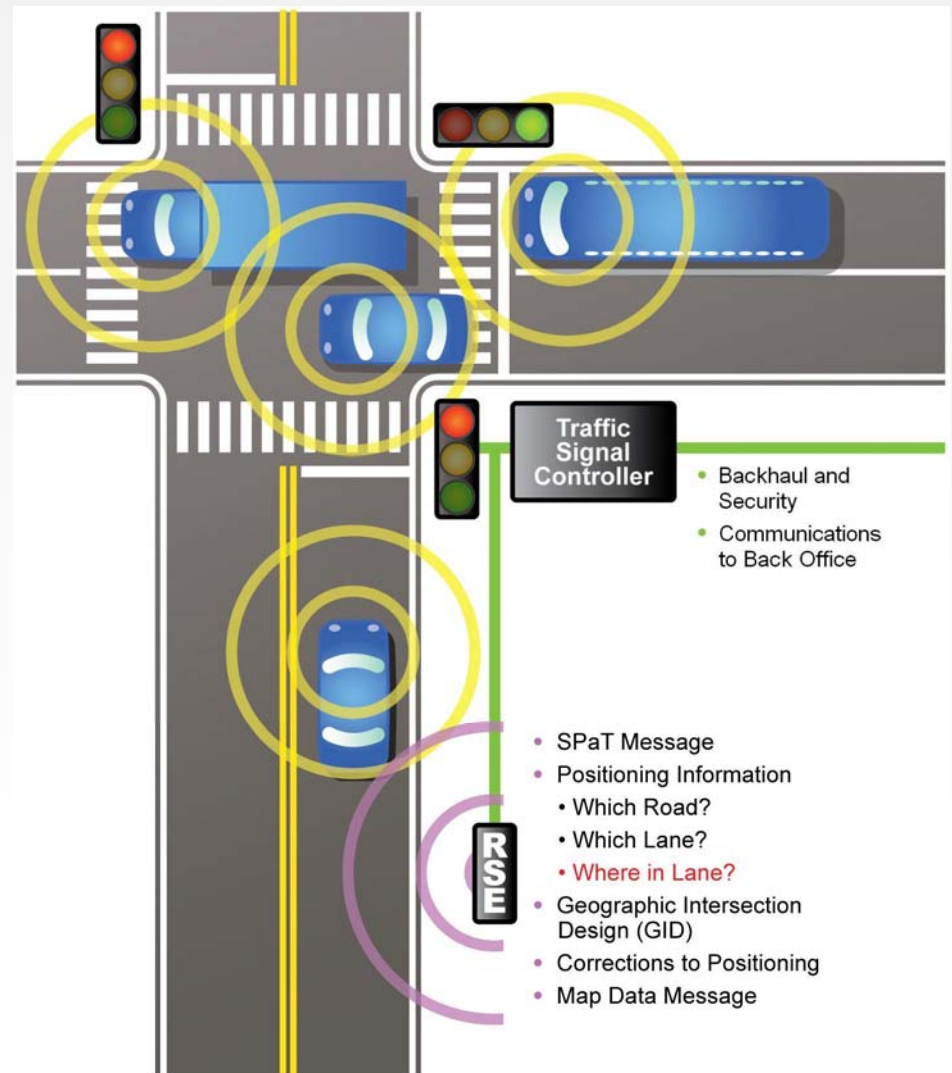| Equipment |
| --- |
| **Data** |
| **Standards** |

Interface Standards Are Essential

USDOT is working with public and private sectors to define:
- Communications standards for DSRC
- Other media, e.g., 4G LTE and/or HD radio may be used for appropriate applications
- Information exchange standards:
  - Message sets for V2X [SAE J2735]
  - Minimum performance requirements for V2X messaging [SAE J2945.x]
  - Signal controller messages
  - Certification processes will also be established to ensure off-the-shelf interoperability of devices

V2I Reference Implementation

- A system of specifications and requirements that allow the various components of V2I hardware, software, and firmware to work together

- An agency will be able to select the capabilities and applications desired at a given installation
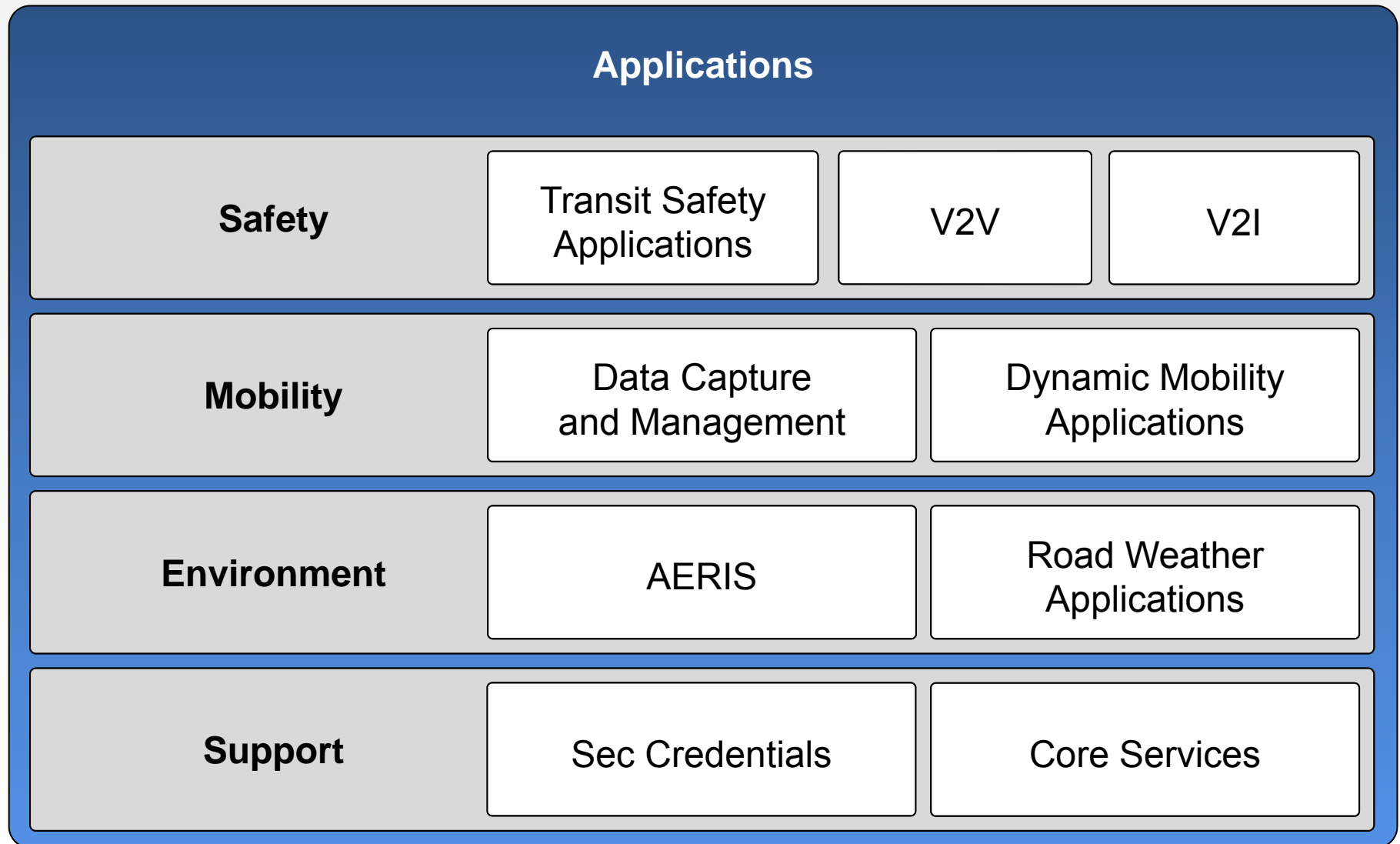

Traffic Signal Controller
- Backhaul and Security
- Communications to Back Office

- SPaT Message
- Positioning Information
  - Which Road?
  - Which Lane?
  - Where in Lane?
- Geographic Intersection Design (GID)
- Corrections to Positioning
- Map Data Message

Let's Recap

- What are the three main components needed for V2I reference implementation?

Connected Vehicle Reference Implementation Architecture (CVRIA) Background and Purpose
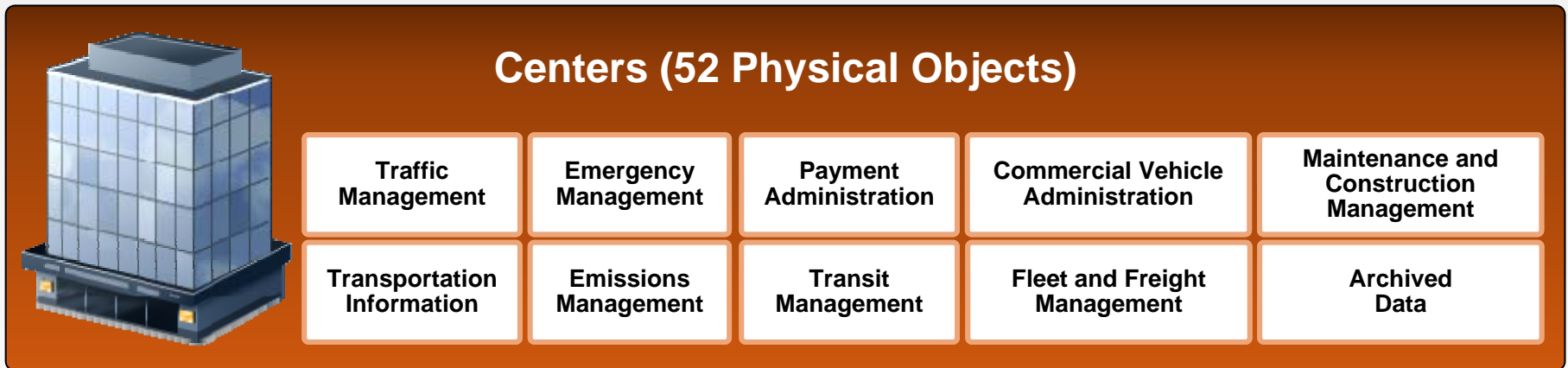
Applications

Safety	Transit Safety Applications	V2V	V2I
Mobility	Data Capture and Management	Dynamic Mobility Applications	
Environment	AERIS	Road Weather Applications	
Support	Sec Credentials	Core Services	

CVRIA Includes Multiple Views

- Enterprise

- Functional

- Physical

- Communications
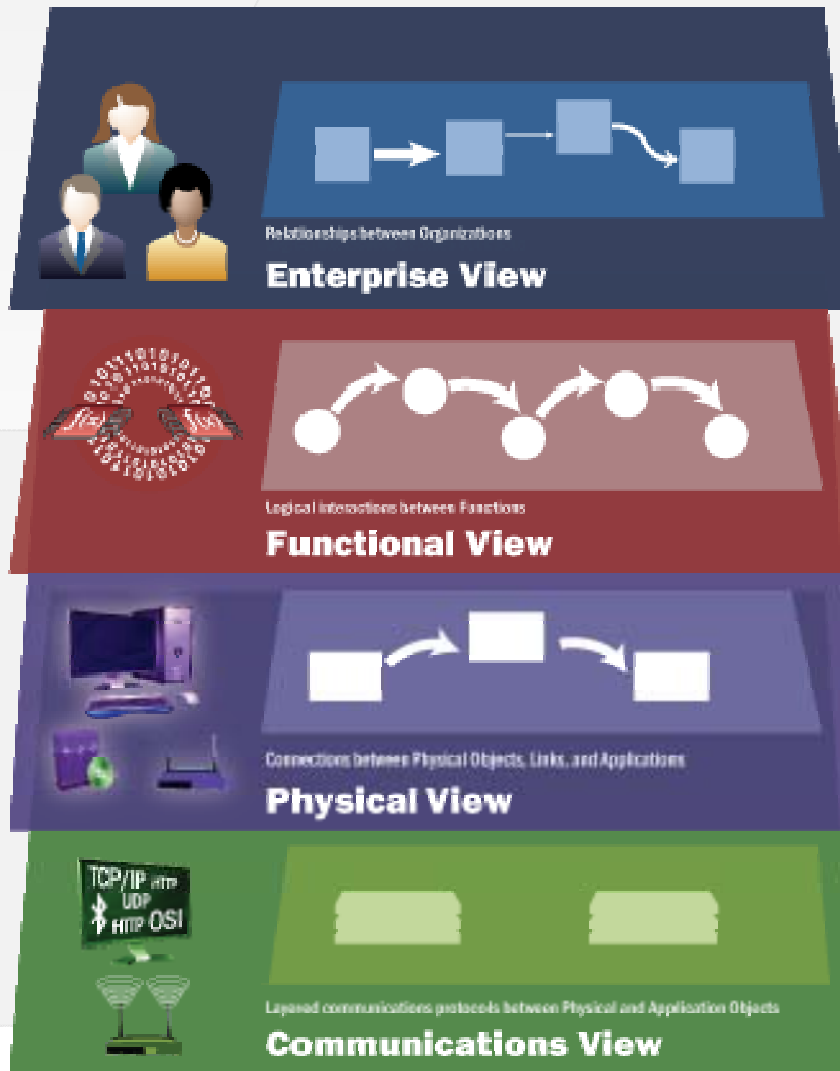
Centers / Back-office Physical Objects

Centers (52 Physical Objects)

Traffic Management	Emergency Management	Payment Administration	Commercial Vehicle Administration	Maintenance and Construction Management
Transportation Information	Emissions Management	Transit Management	Fleet and Freight Management	Archived Data

- Perform management and administration functions

- Supports connected vehicle—field and mobile devices

- Not necessarily a physical brick-and-mortar building

- Can be aggregated together or distributed across geographies or functionally

Field (13 Physical Objects)

- ITS infrastructure on or along the transportation network

- Surveillance

- Control devices
  - Signal control
  - Lane controls
  - Ramp meters

- Connected vehicle roadside equipment (RSE)

- Supply information
  - Signage

- Support payment

- Support credential/safety checks

Field

ITS Roadway Devices

CV RSEs

Roadway Payment

Parking Management

Commercial Vehicle Check
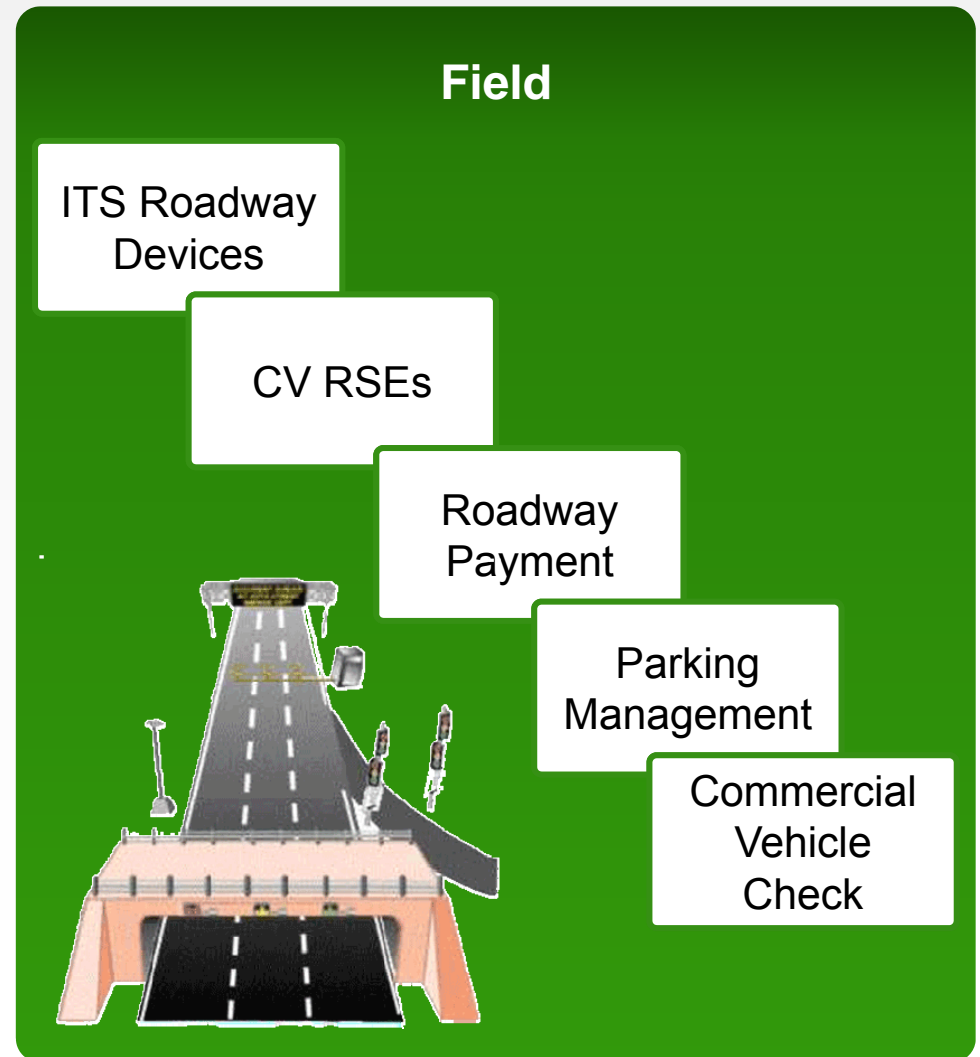
Vehicles (19 Physical Objects)
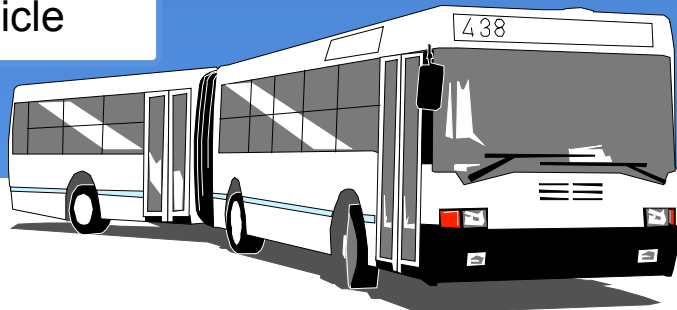
Vehicles

Vehicle On-board Equipment

Emergency Vehicle

Commercial Vehicle

Transit Vehicle

Maintenance & Construction Vehicle

- Covers the intelligent/cooperative on-board systems
  - Advanced safety systems
  - Navigation
  - Remote data collection
  - Information
- Fleet-type vehicles include special functionality:
  - Dispatch
  - Signal preemption/priority
  - Monitoring activities
  - Fleet management
  - Passenger services
  - Fare payment

Travelers (7 Physical Objects)

Travelers

Fixed Personal Information Device	Mobile Personal Information Device
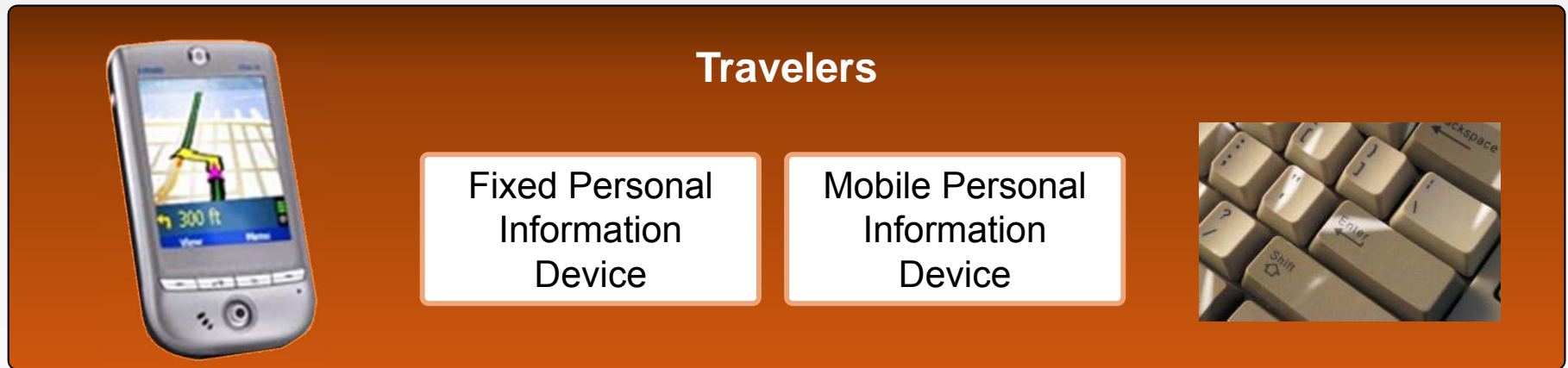
- Equipment to access transportation services

- "Personal" devices

  - Fixed personal computers

  - Personal mobile devices

Connected Vehicle Architecture

- USDOT developed the Systems Engineering Tool for Intelligent Transportation (SET-IT)

  □ Software package to support connected vehicle project architecture

  □ Connects to commercial drawing and database capabilities

  □ Alpha release now available on the CVRIA Website (http://www.iteris.com/cvria/html/resources/tools.html)

  □ Long-term plans to integrate CVRIA into existing National ITS Architecture

Connected Vehicle Supporting Services

- Definition of General Services:

  □ Data Distribution

  □ Security Credential Management

  □ Infrastructure Management

- Capabilities/Principles:

  □ Secure exchange of trusted data between users and applications without pre-existing relationship or entering into a permanent relationship

  □ Assurance of privacy between users and from third parties

 □ More efficient data collection from various sources and distribution to many users
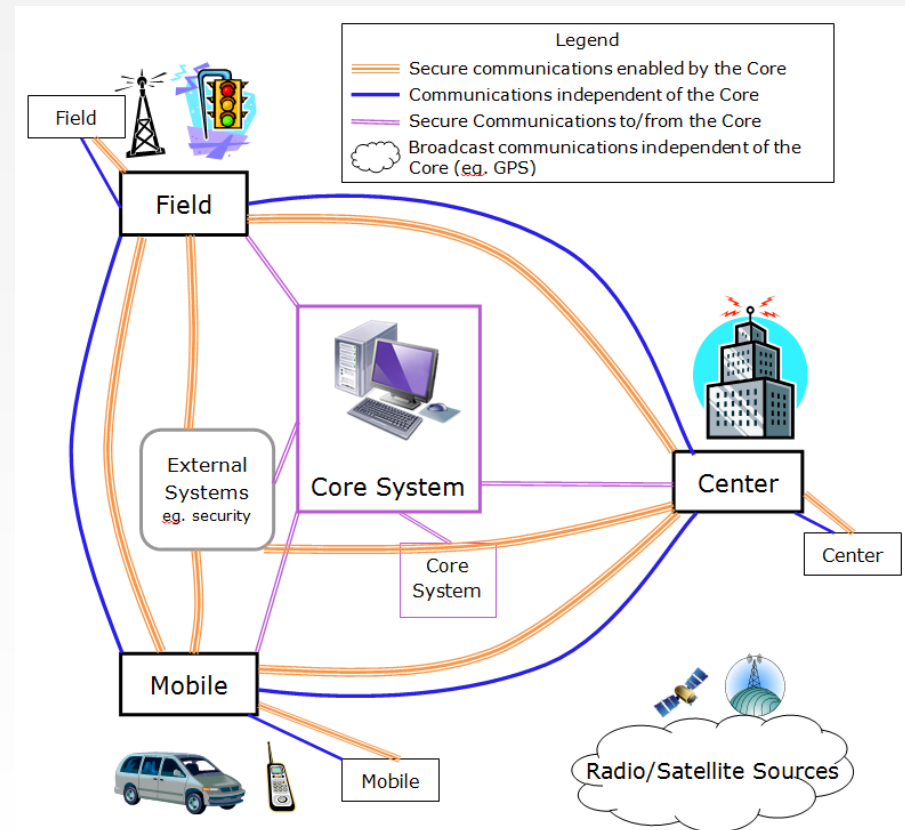
Small Group Activity

- Based on the deployment concept you worked on previously, create a list for what information you would need to gather and what physical objects and interfaces would need to be established in order to get the program up and running.
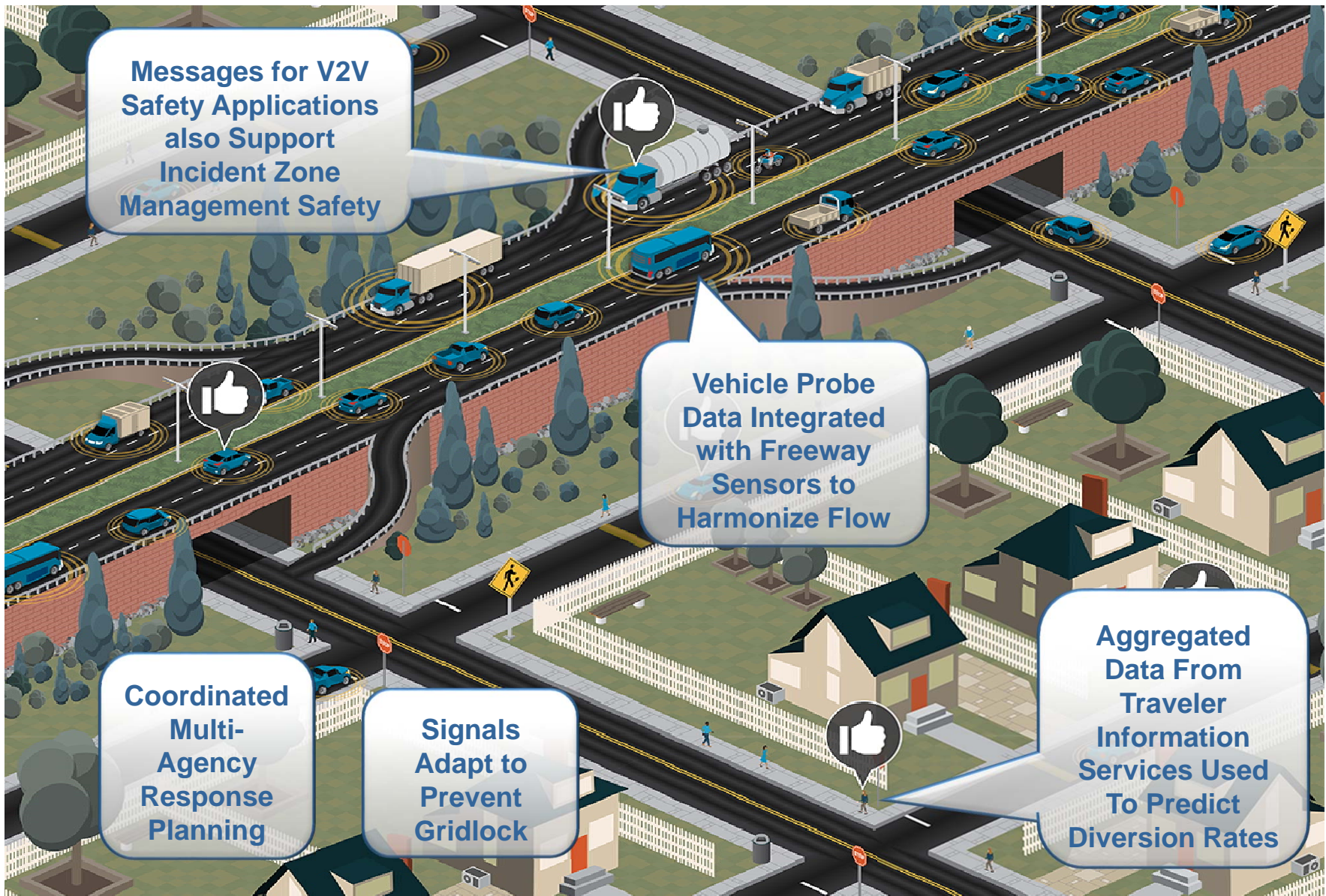
Scenario: H.W. Halleck Expressway
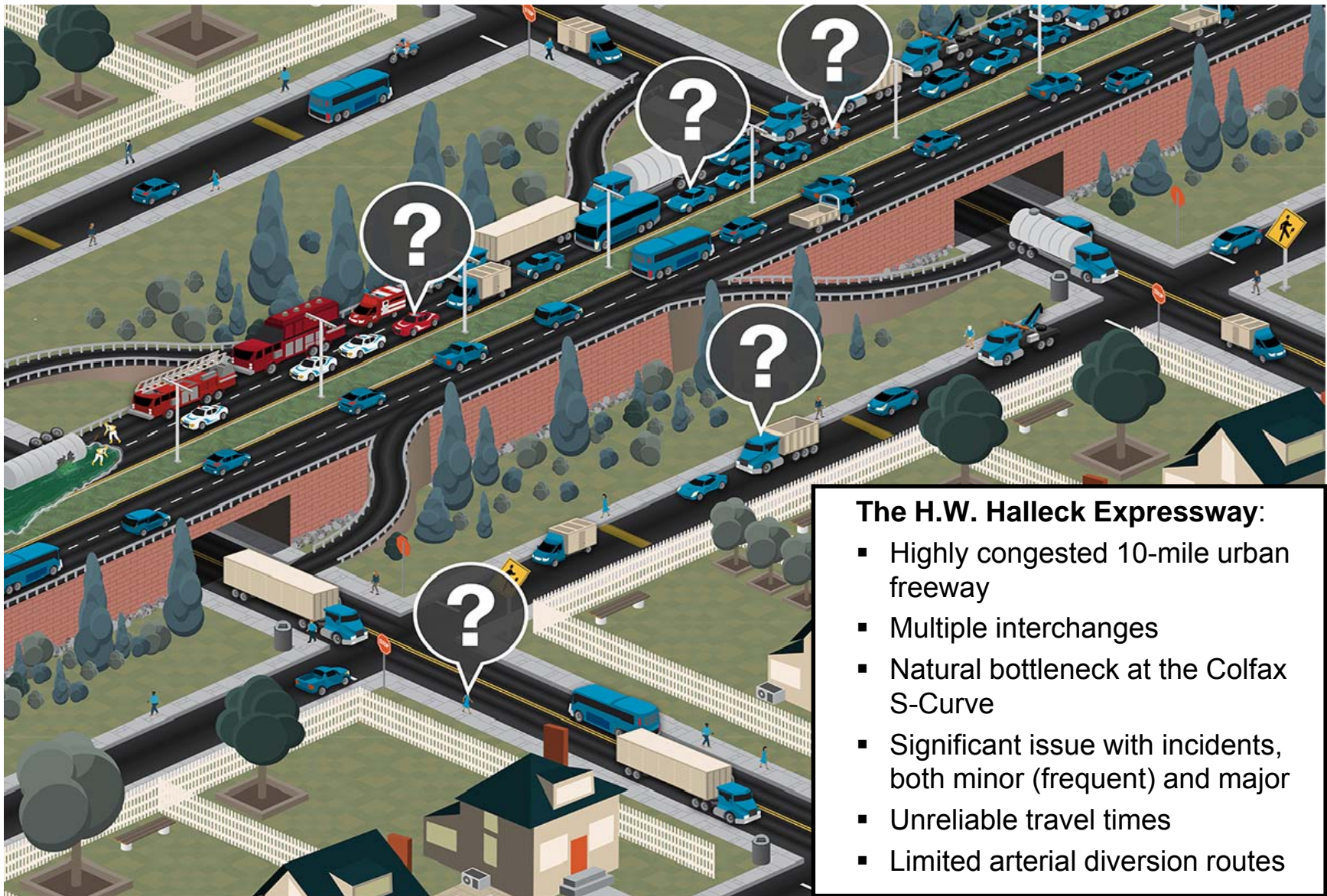

The H.W. Halleck Expressway:
- Highly congested 10-mile urban freeway
- Multiple interchanges
- Natural bottleneck at the Colfax S-Curve
- Significant issue with incidents, both minor (frequent) and major
- Unreliable travel times
- Limited arterial diversion routes

Example Integrated Concept - H. W. Halleck Express**WAY**

62

Research Data Exchange

Research Data
Exchange, Release 2
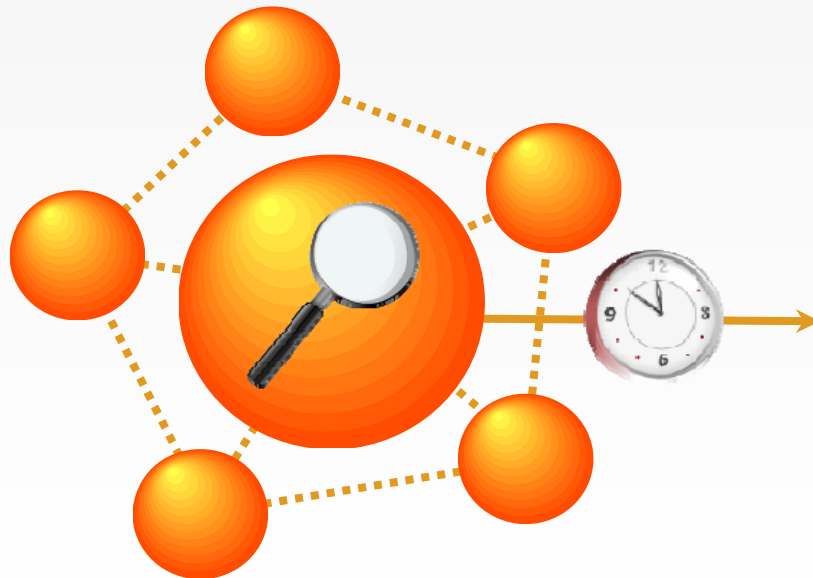
www.its-rde.net

- Promotes sharing of archived and real-time data

- Multiple data environments

- Multi-source data

- Improved search and download functions

- Exploring integrated real-time data environments

- Adding additional data environments

Open Source Application Development Portal

www.itsforge.net

- Portal for sharing documentation and source code from USDOT-sponsored application prototyping efforts

- By end of 2014, will be populated with materials describing 10+ connected vehicle applications

- Contributed code must meet documentation guidelines

- Search and download functions

- **Release 1 is now available to the public**

Topic 3 Wrap-up

- Using a scenario, describe the following roles:

  □ Describe the role of equipment in connected vehicles.

  □ Describe the role of data in connected vehicles.

  □ Describe the role of standards in connected vehicles.

  □ Describe the role of the connected vehicle reference implementation.

  □ Describe the role of the connected vehicle reference implementation architecture.

Topic 4: Connected Vehicle Testing and Deployment

Topic	Title	Duration
1	Introduction to the Connected Vehicle Environment	30 minutes
2	Connected Vehicle Applications	60 minutes
3	Research Toward Implementation	60 minutes
4	Connected Vehicle Testing and Deployment	30 minutes
5	Policy and Institutional Issues	30 minutes

Topic 4: Connected Vehicle Testing and Deployment

After this topic, you will be able to:

- Discuss opportunities with the Affiliated Connected Vehicle Test Beds

- List the steps and guidance required to deploy connected vehicles

- Describe how to become involved with the connected vehicle program

- Identify challenges to connected vehicle implementation

Connected Vehicle Test Bed Video

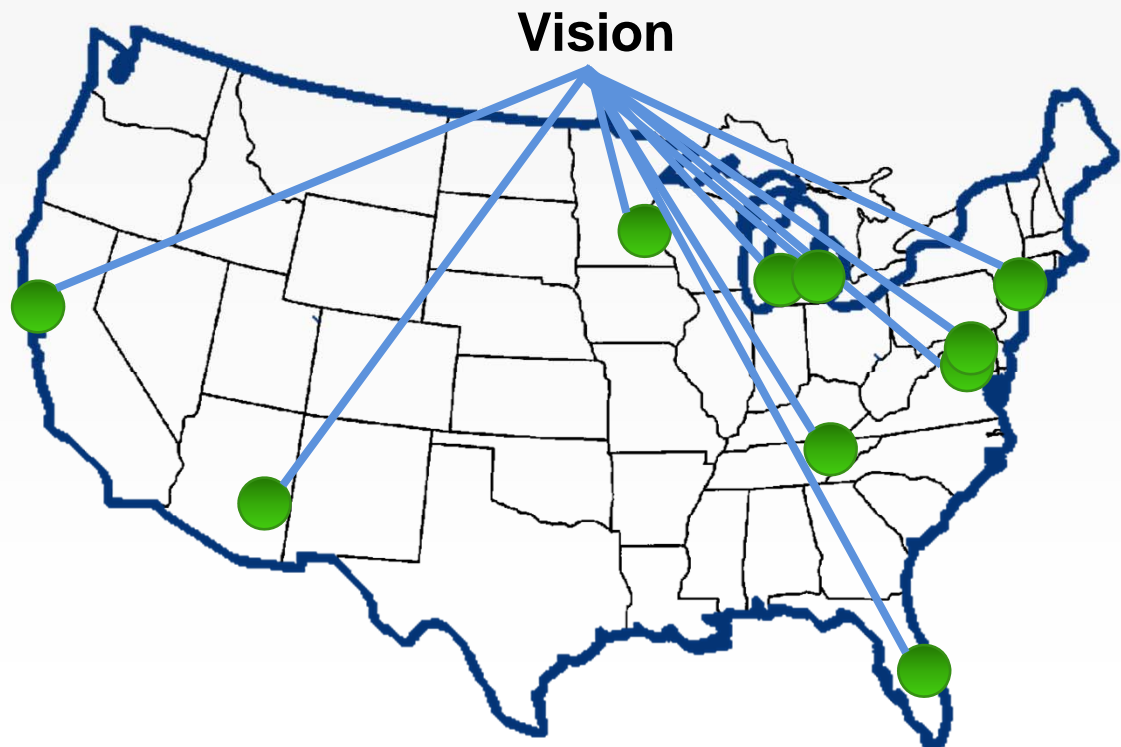http://www.its.dot.gov/library/media/8testbed.htm

Affiliated Interoperable Test Beds

- The vision is to have multiple interoperable locations as part of one connected system moving toward nation-wide deployment.

  - Common architecture

  - Common standards

  - Independent operations

  - Shared resources

Vision

Overview of USDOT Test Bed Resources

- Qualified Product List for RSE
  - Five vendors
- Qualified Product List for Onboard Equipment (OBE)
  - Vehicle Awareness Devices
  - Aftermarket Safety Devices
- Portable RSE Trailers
- Network Listeners/Sniffers

- Test Bed Operations Staff
- Signal Phase and Timing (SPaT) Resources
  - Listeners
  - Interface standards from FHWA
- Security Credential Management System (SCMS)
  - 1609.2 certificate management system

Southeast Michigan Test Bed—2014

- The Southeast Michigan 2014 Test Bed:

  - Gives users the capability to test safety, mobility, and environment applications, services and components

  - Defines the "high level" system architecture using CVRIA as a reference and foundation

  - Introduces concepts in terms of functions and information flows

  - Illustrates concepts through selected operational scenarios

- The goals of the Southeast Michigan 2014 Project are to:

  - Assure trust in data exchanged

  - Protect the confidentiality of certain data exchanged

  - Protect the anonymity and privacy of individuals while operating in a multi-application, multi-industry, multi-medium environment

USDOT Connected Vehicle PlugFests

- Upcoming Events in 2014:

  - Hackathon: Early November 2014/January 2015, Novi, MI

- Past Events:

  - Detroit Area PlugFest: August 5-7, 2014

  - Palo Alto, CA PlugFest: June 24-26, 2014

  - Detroit Area PlugFest: May 13-15, 2014

  - Detroit Area PlugFest: March 12-13, 2014

U.S. Department of Transportation

Connected Vehicle PlugFest

Benefits of Test Bed Membership

- Designation of Affiliated Test Bed

- Access to USDOT support staff and resources

- Increased access to lessons learned, documentation, and other information from peers deploying test beds

- Test beds serve as a model for future permanent deployments

- Provide opportunities for future testing

Contact:

        Walton Fehr, Systems Engineering and Test Bed Manager
        U.S. Department of Transportation
        Intelligent Transportation Systems Joint Program Office
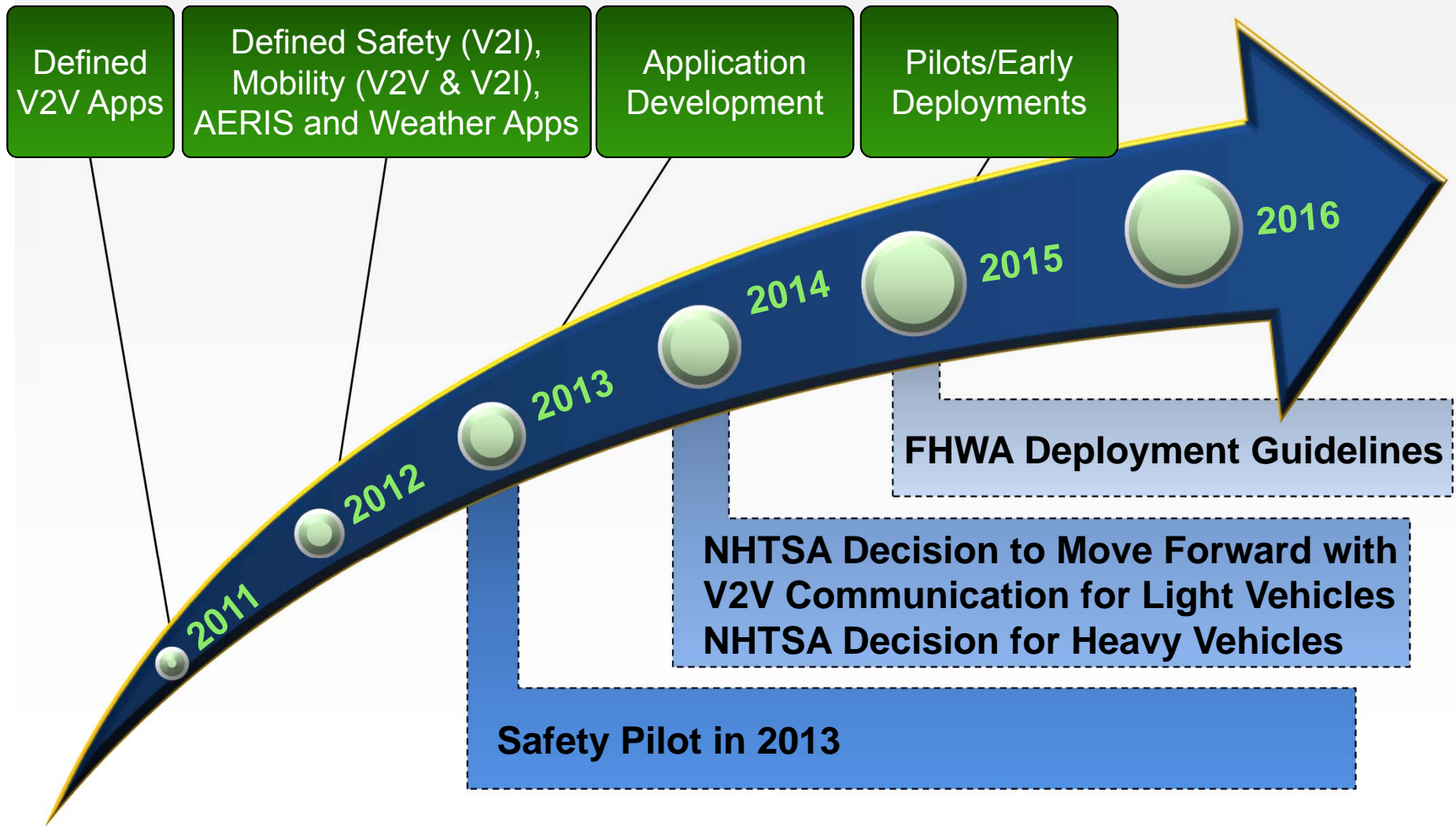   Email: walton.fehr@dot.gov

Discussion

What would be beneficial to you in using the test beds?

Path to Deployment

Defined V2V Apps

Defined Safety (V2I), Mobility (V2V & V2I), AERIS and Weather Apps

Application Development

Pilots/Early Deployments

2011
2012
2013
2014
2015
2016

FHWA Deployment Guidelines

NHTSA Decision to Move Forward with V2V Communication for Light Vehicles
NHTSA Decision for Heavy Vehicles

Safety Pilot in 2013

Infrastructure Deployment Planning

- National Connected Vehicle Field Infrastructure Footprint Analysis

- FHWA Deployment Guidance

- Standardized Interfaces

- Certification Processes for Equipment and Systems

- Nationwide Security Credential Management System (SCMS)

Source: U.S. DOT

2015 FHWA Vehicle to Infrastructure Deployment Guidance and Products

- FHWA Guidance to state and local agencies for implementing V2I to ensure interoperability and efficient and effective planning, procurement, and operations.

- Goal is to:
  - Provide initial advice
  - Best practices
  - Technical support tools

- Draft release September 2014, with planned release in 2015

- Products and Tools:

  - Systems Engineering Process for V2I

  - V2I Benefit Cost Analysis Tool

  - V2I Planning Guide

  - Guide to V2I Cyber-Security

  - Guide to Licensing DSRC Roadside Units

  - Guide to V2I Communication Technology Selection

  - V2I Message Lexicon

Connected Vehicle Pilot Deployments

- The goals of the CV Pilots Program are to:

  □ Accelerate early deployment of Connected Vehicle technology

  □ Understand and estimate benefits associated with deployment

  □ Identify and solve key technical and institutional barriers

- Pilots will serve as initial implementations of connected vehicle technology deployed in real world settings

- Request for Information (RFI) issued March 2014 to help refine the plans for one or more pilot deployments

- Procurement action anticipated for one or more pilot deployment concepts in 2015

- See Deployment Concepts at:
  http://www.its.dot.gov/pilots/cv_pilot_deployment.htm

Connected Vehicle Deployment Program - Goals

Connected Vehicle Deployment Program - Principles

- Pilots will be *pilot deployments*, that is, real-world environment deployments

  □ If successful, deployed technologies are expected to remain as permanent operational elements

- There will be *multiple* pilot sites over time

  □ Each site will have different needs, focus and applications

    ▪ That is, pilot deployments must address a critical problem

    ▪ The needs of each site must drive the application selection process

- Pilot deployments are expected to be both *large-scale and multi-modal*

  □ *Large-scale* implies pilot deployments will have measureable impact, not a specific minimum geographic or vehicle fleet size

  □ Sites will deploy *multiple applications* drawing on the products of USDOT and other connected vehicle research

Proposed Pilot Deployment Requirements

- Multiple connected vehicle applications must be deployed together

  - Cost-effectively leveraging captured CV and mobile device data

  - Address multi-modal problems

- Pilot deployments should leverage USDOT-sponsored research

  - Need not include all applications (in fact, this is unlikely to be practical)

  - May include new connected vehicle applications not considered by USDOT

  - All applications selected must work and have an impact

- Pilot deployments should include the capture of data from multiple sources

  - At a minimum, vehicles must represent one source of data used in the pilot deployment

Proposed Pilot Deployment Requirements

- Multiple forms of communications technologies are desired

    - DSRC desired as one communication technology

- Well-defined, focused, quantitative performance measures

    - Support an independent evaluation effort

- Share pilot deployment data and lessons learned

    - While protecting privacy and intellectual property

- Security and credentialing management system

- Integrated or carry-in devices for connected vehicles capable of generating an SAE J2735 Basic Safety Message (BSM)

Let's Recap

- What are the steps USDOT is taking to deploy connected vehicles?

Get Involved

- How do I get involved?

- How does the private sector participate?

- What is the governance structure to get everyone to agree on common architecture and common standards?

- What funding or resources does USDOT have to offer?

Topic 4 Wrap-up

- What is the guidance required to deploy connected vehicles?

- What opportunities do the connected vehicle test beds offer?

- When will the Connected Vehicle Pilot Deployments occur?

Topic 5: Policy and Institutional Issues

Topic	Title	Duration
1	Introduction to the Connected Vehicle Environment	30 minutes
2	Connected Vehicle Applications	60 minutes
3	Research Toward Implementation	60 minutes
4	Affiliated Connected Vehicle Testing and Deployment	30 minutes
5	Policy and Institutional Issues	30 minutes

Topic 5: Policy and Institutional Issues

After this topic, you will be able to:

- Describe key policy challenges with connected vehicles

- Describe communications security policy issues with connected vehicles

- Describe privacy policy issues with connected vehicles

- Describe the costs and benefits of connected vehicles

Connected Vehicle Policy Program

- Conducts research on critical policy and institutional issues in support of enabling successful deployment of connected vehicle technologies.

- Issues are generally cross-cutting and require collaboration among multiple stakeholder groups

- Policy research has been conducted in areas such as:
  - Communications Security
  - Privacy and Data Policy
  - Spectrum
  - Implementation
  - Standards Harmonization
  - Stakeholder Outreach

Communications Security Policy

- How do we know that the sender of a message should be 'trusted'?

  □ Need to validate messages exchanged between vehicles (V2V) and between vehicles and infrastructure (V2I)

- Requires Security Credential Management System (SCMS)

  □ Organizational entities for operating security management system

  □ Communications network for security updates

Privacy and Data Policy

- A user should not be tracked or identified (e.g. no personally identifiable information).

- Important to ensure that messages cannot be linked to personal information. Basic safety messages, certificates, and other information exchange should not link to personal identifiers.

- Data management policies.

Other Policy Challenges

- **Implementation**: FHWA V2I Deployment Guidance for Connected Vehicles
  http://www.its.dot.gov/meetings/pdf/V2I_DeploymentGuidanceDraftv9.pdf

- **Standards Harmonization:** Conducting international collaboration to harmonize technical and policy standards

- **Spectrum:** Implications of possible spectrum sharing

- **Stakeholder Outreach:** Critical to inform development of policy options and to support policy decision-making process.
  http://www.its.dot.gov/meetings/v2i_feedback.htm

Help develop the FHWA's 2015 Guidance for Connected Vehicles. Add your comment.

Challenges to Connected Vehicle Deployment

▪ What are some challenges to implementing connected vehicles?
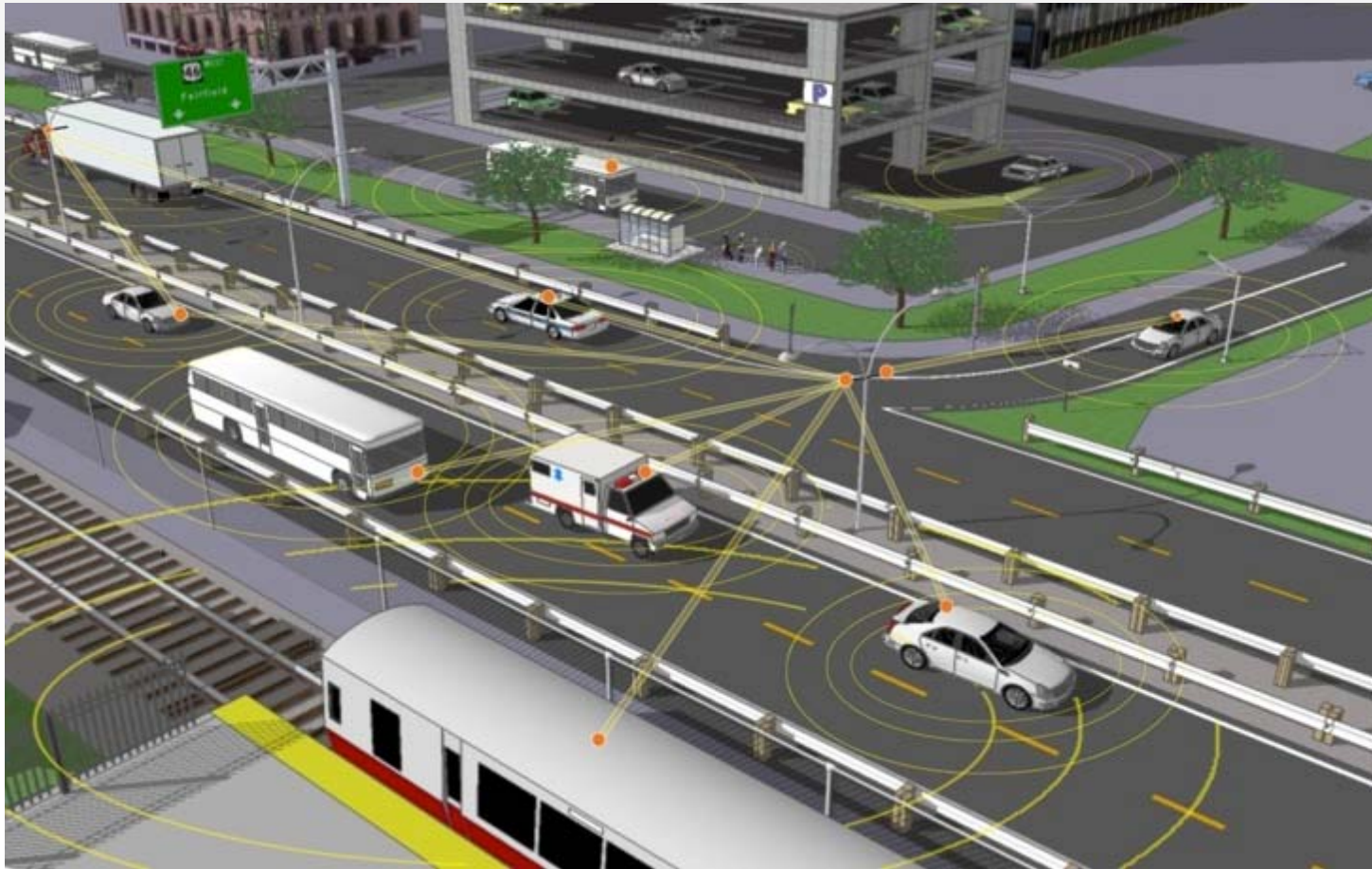
Benefits and Costs of V2V

- NHTSA Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application Report explores technical, legal, and policy issues relevant to V2V. It discusses benefits and costs, including:

  - Safety applications including IMA, FCW, and LTA, have proven effective in mitigating or preventing potential crashes, but more refinements needed. Two V2V safety applications, IMA and LTA, would potentially:

    - prevent 25,000 to 592,000 crashes, save 49 to 1,083 lives, avoid 11,000 to 270,000 MAIS 1-5 injuries, and reduce 31,000 to 728,000 property-damage-only crashes annually by the time V2V technology had spread through the entire fleet

  - NHTSA estimates V2V equipment and supporting communications would cost approx. $341 to $350 per vehicle in 2020. Could decrease to approximately $209 to $227 by 2058

  - Estimates of annual costs of the V2V system from $0.3 to $2.1 billion in 2020 depending on technology implementation scenarios and discount rates

NCHRP 03-101: Benefits of Public Sector Connected Vehicle Deployment

- Reduced need for 511 infrastructure

- Reduction of infrastructure required to monitor traffic

- Lower cost of pavement condition detection

- Adaptive lighting

- Crash response and clean-up cost reduction

- Work zone accident reduction

- DOT vehicle fleet insurance reduction

- Improved access to data for planning studies

- Potential for improved long-term planning, program management

- Faster and more cost-effective response to public issues and policy change

- Ability to measure performance of DOT operations on an accelerated schedule

- Cost savings to transit agencies by better optimizing the fleet

- Increased safety may allow reorganization of safety roles at the DOT

Exploratory Research—Vehicle Automation

- Enhanced by connectivity to other vehicles and infrastructure

- Benefits of Connectivity

  □ Increases availability, speed, and reliability of information

  □ Enables coordination of automated traffic streams

- The full potential benefits of road vehicle automation can only be achieved through a connected environment
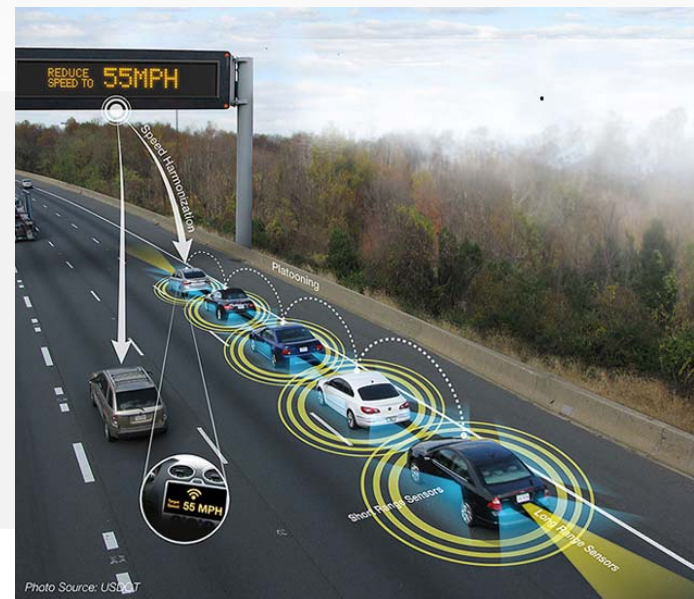
Topic 5 Wrap-Up

- What are the security challenges that the connected vehicle program faces?

- What are the data privacy challenges that the connected vehicle program faces?

- What are some cost and benefit categories related to connected vehicles?

Course Wrap-up

- What are the three main connected vehicle application categories?

- What are the three ITS research program components?

- What are the three categories of enabling technologies for the connected vehicle infrastructure?

- What are the four types of physical objects connecting to the core system?

- True or False: Test beds operate independently of each other.

- What are the goals of the Connected Vehicle Pilot Deployments?

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