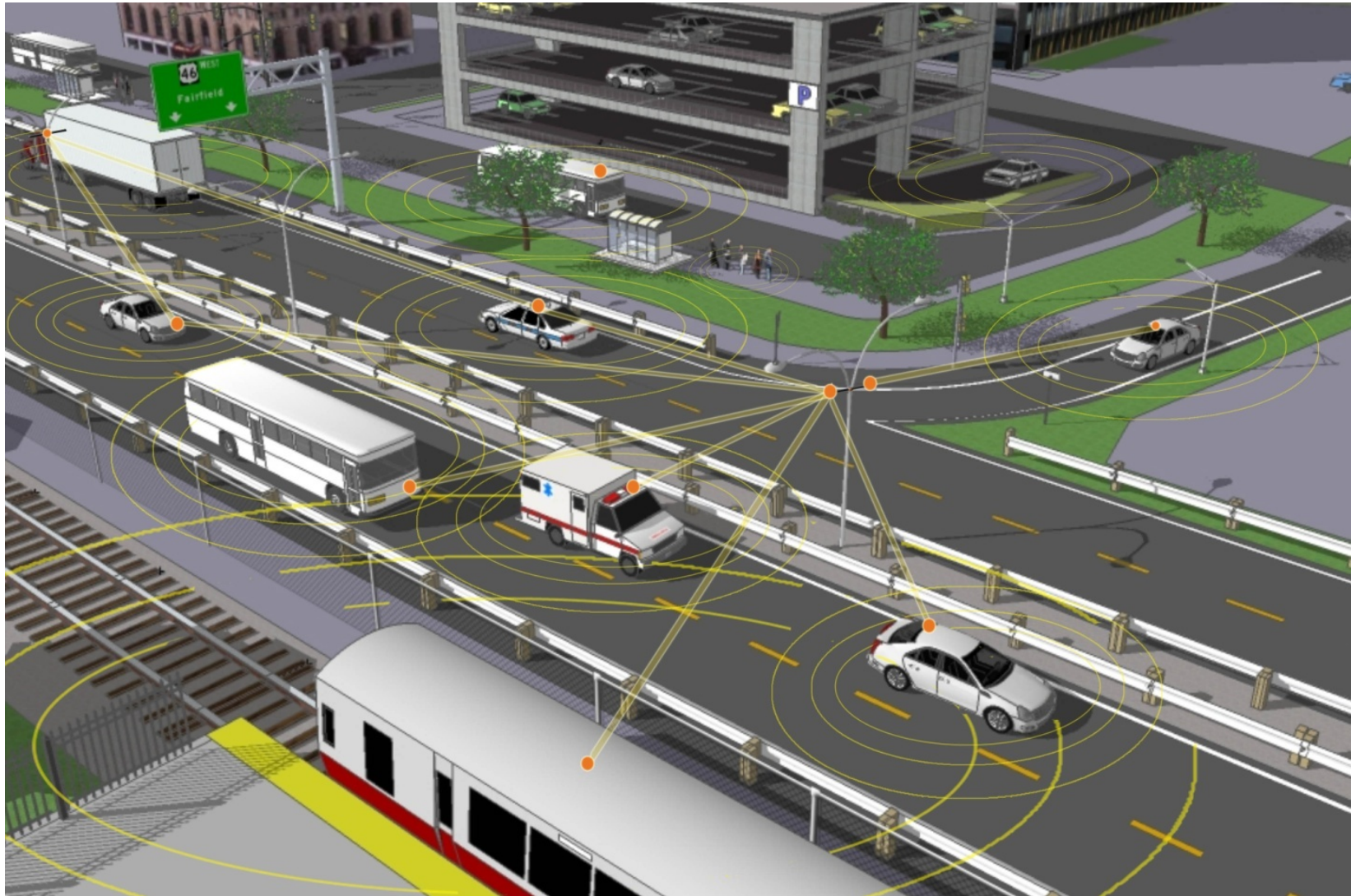# V2I for Safety

Roadmap, Accomplishments & Constraints

Carl K. Andersen, FHWA (HRDS-10)
Ben McKeever, FHWA (HRDO-30)

The Connected Vehicle

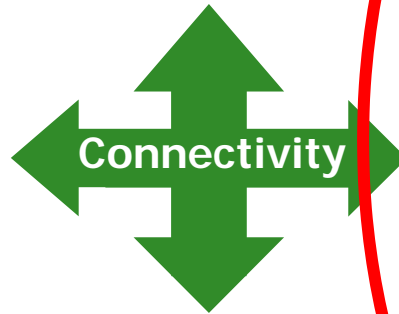# The Connected Vehicle

Drivers/Operators

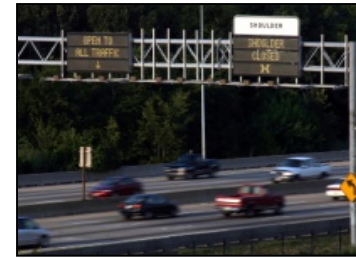**Vehicles and Fleets**

Infrastructure

Connectivity

Wireless Devices

V2I Safety Program Elements

Enabling Technology

Application Selection, Development and Evaluation

Infrastructure Planning and Policy

Implementation Guidelines

V2I Safety Program - Applications

Application Selection, Development and Evaluation

Data Analysis

- Crash Factors Analysis – Published July 2011
- Migration Study – Published August 2011
- Transit Analysis – Completed Summer 2010
- Smart Roadside Analysis – Completed August 2011
- Stakeholder Input
  - October 2010 Meeting with AASHTO

OUTCOMES: List of Potential Applications
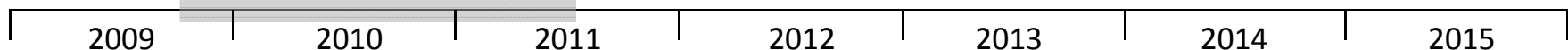
| 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |

V2I Safety Program - Applications

Application Selection, Development and Evaluation

Data Analysis → Prototyping

Evaluation

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015
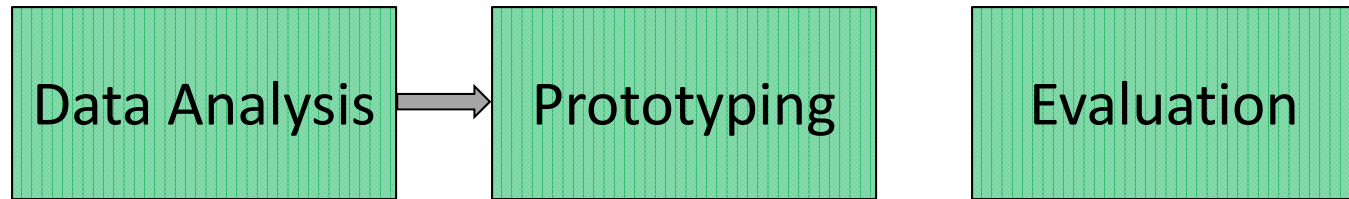
V2I Safety Program - Applications

Application Selection, Development and Evaluation

Prototyping

- Develop Concept of Operations (ConOps)
- Develop Safety Applications
- Smart Roadside Systems Requirements
- Stakeholder Input
  - Safety ConOps Review – January 2012
  - Applications Prioritization – August 2012
  - Final Applications Review – May 2013

OUTCOMES: Selection of Applications for Testing

| 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |

Transit – Pedestrian Warning Concept

- A Pedestrian Warning System will provide an in-vehicle warning to transit operators when pedestrians are in the crosswalks.

- Approximately 35% of all pedestrian-bus crashes, and 49% of fatal crashes, occur during turning maneuvers.

- 85% occur during left turns, and 15% during right turns.

Pedestrian Warning Application for Transit Vehicles

Option 2
Pedestrian Detection System

Pedestrian Detection System
Option 2

Traffic Signal Controller

RSE

SPaT Message and MapData Message

NOTE:

Option 1 – This option includes sending an alert when the crosswalk signal has been activated.

Option 2 – This option includes the use of a pedestrian detection system to detect the presence of a pedestrian in the crosswalk.

Smart Roadside Vision

1. E-Screening Site
2. E-Tolling
3. Over-Height Detector
4. Weather Monitoring Station
5. Transponder Reader (probes)
6. Weigh-in-Motion
7. Loop Detector
8. In-Vehicle Monitoring (In Motion)
9. E-Permitting Verification
10. Radiation Detection Systems

V2I Safety Program - Applications
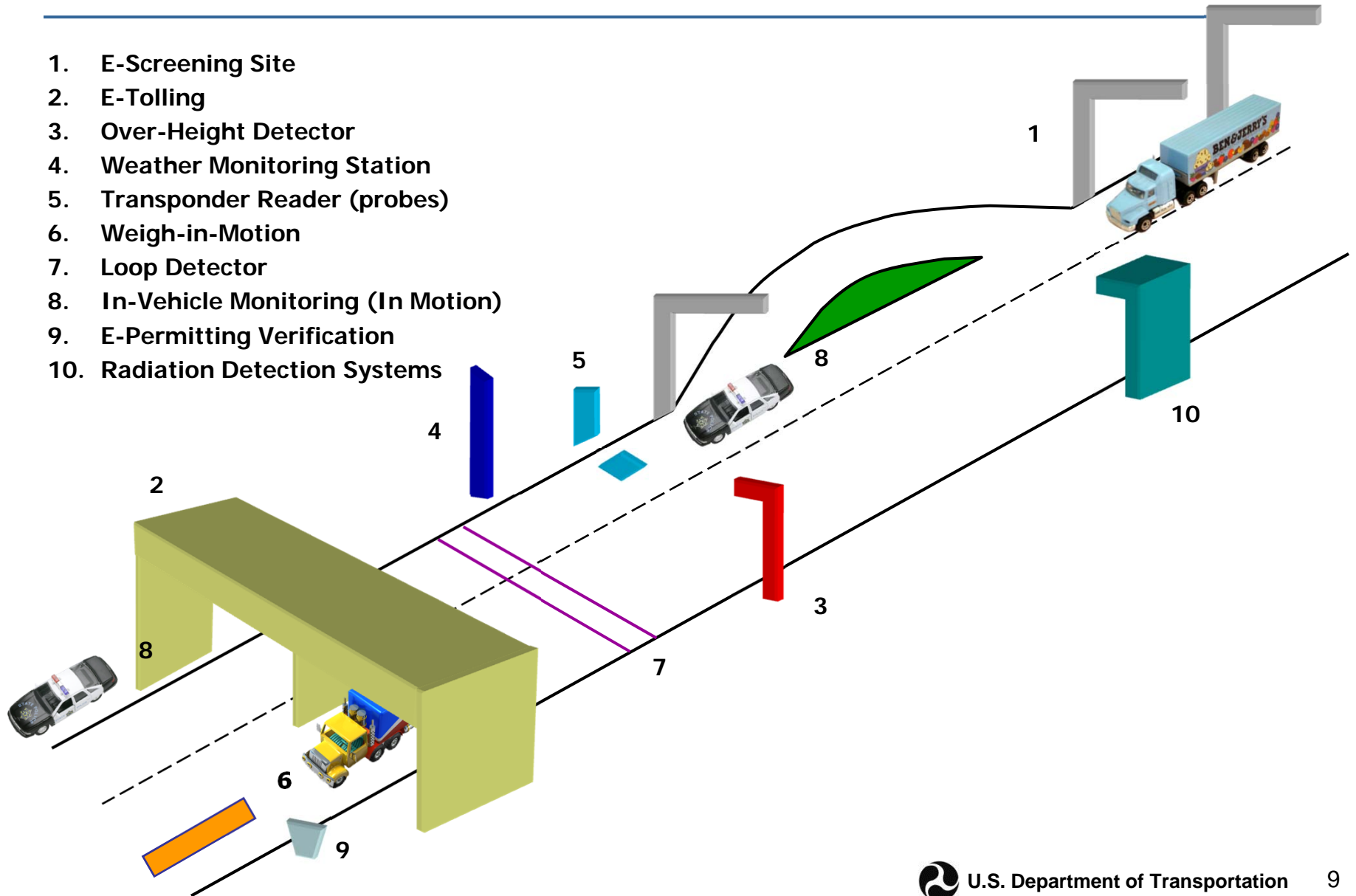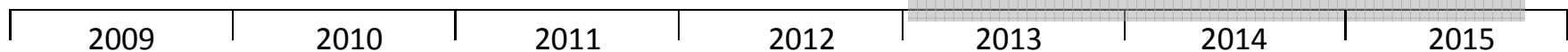
Application Selection, Development and Evaluation

Evaluation

- Evaluation Planning and Build – 2013
- Smart Roadside Prototype Design & Testing – 2012
- Multi-modal Regional Tests – 2014 thru 2015
- Stakeholder Input
  - Final Application Review – October 2013

OUTCOMES: Benefits Assessments

| 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |

V2I Safety Program - Technology

Enabling Technology

Application Selection, Development and Evaluation

Infrastructure Planning and Policy
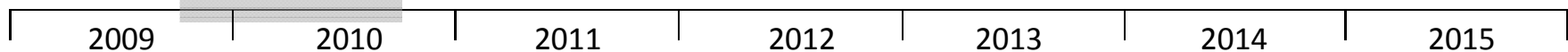
Implementation Guidelines

V2I Safety Program - Technology

Enabling Technology

Market Survey

- Roadway Geometry and Inventory Trade Study
  - Published November 2010

**OUTCOMES: State-of-Practice in Mapping Industry**

| 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |

V2I Safety Program - Technology

Enabling Technology

Technology Assessment

- Develop Signal Phase & Timing (SPaT) Prototype – 2011
- Identify Mapping, Positioning and Communications required for V2I to support Connected Vehicle – 2011
- Develop Roadside Equipment (RSE) required for V2I communications – 2011
- Stakeholder Input
  - SPaT Interface Review – December 2011

OUTCOMES: Requirements & Technological Capabilities

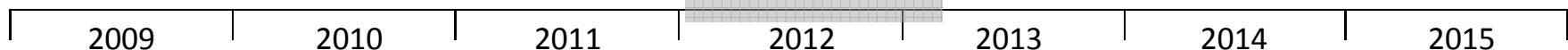| 2009	2010	2011	2012	2013	2014	2015
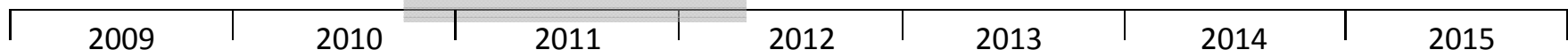
V2I Safety Program - Technology

Enabling Technology

Integrate & Test

- Develop SPaT unit for testing – 2012
- Ground-truth positioning and communications technologies at USDOT testbeds – 2011 & 2012
- Develop Integrated V2I Prototype – 2012

OUTCOMES: Integrated V2I Prototype

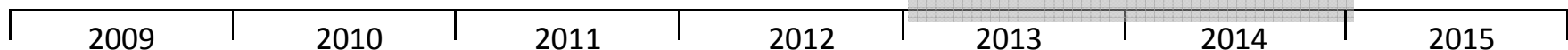| 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |

V2I Safety Program - Technology

Enabling Technology

Evaluation & Refine

- Perform Operational Testing of SPaT Interface – 2013
- Define final SPaT Interface Definition – March 2014
- Test & Refine V2I Reference Implementation – 2013 & 2014

OUTCOMES: V2I Reference Implementation

| 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |

V2I Reference Implementation – Concept

- 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
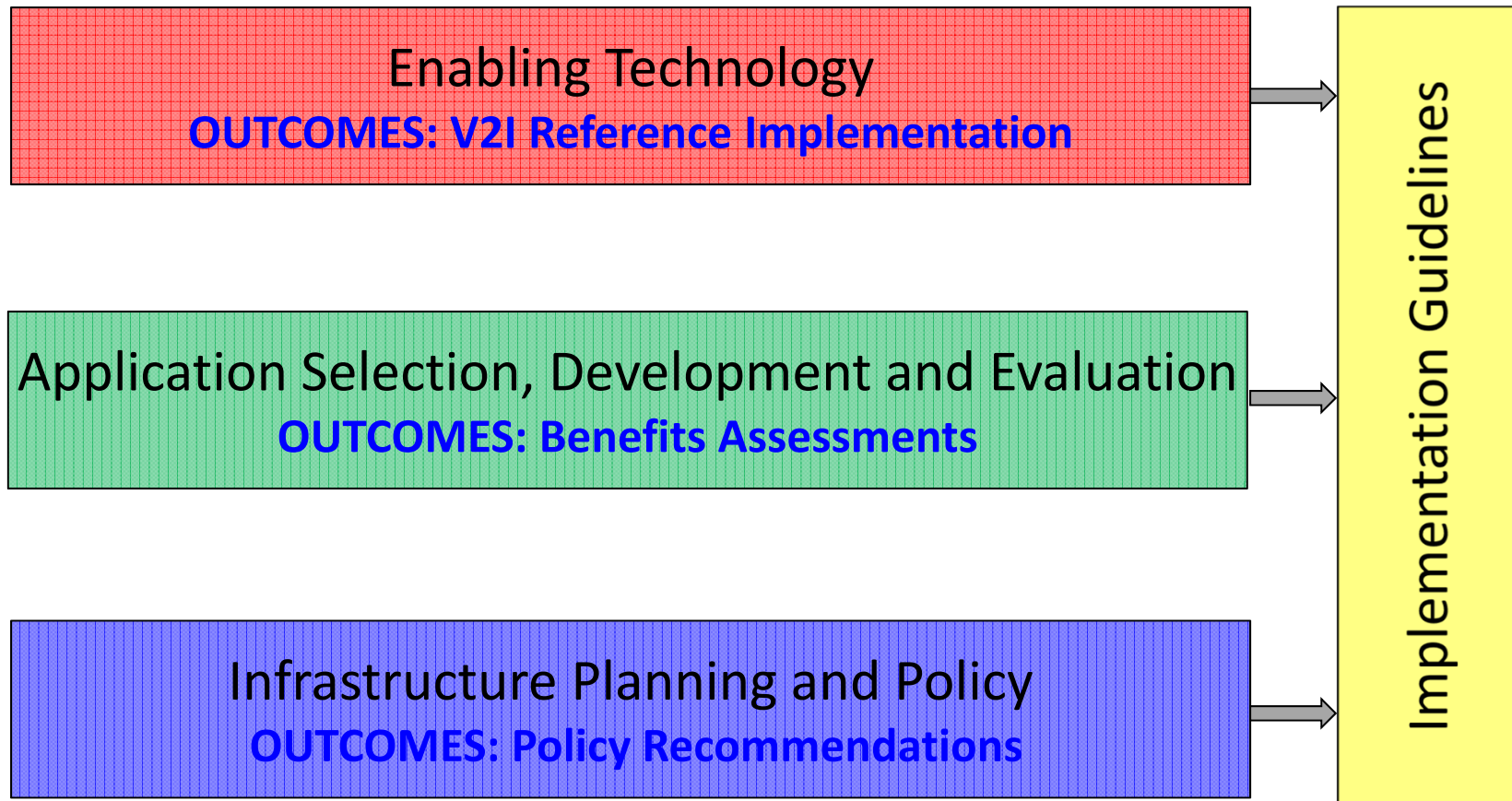- Map Data Message

RSE

V2I Safety Program – Planning & Policy

Infrastructure Planning and Policy

- Communications Security & Infrastructure
- Certification
- Spectrum Analysis
- Risk Allocation and Liability
- Governance & Deployment
- Cost-Benefit Analysis & Regulatory Support
- Stakeholder Input
  - Safety Workshop – August 3, 2011

OUTCOMES: Reports & Recommendations – July 2013

V2I Safety Program Elements

Enabling Technology
OUTCOMES: V2I Reference Implementation

Application Selection, Development and Evaluation
OUTCOMES: Benefits Assessments

Infrastructure Planning and Policy
OUTCOMES: Policy Recommendations

Implementation Guidelines

V2I Safety Program Elements

<div style="background-color: yellow;">

Implementation Guidelines

</div>

- Public Agency Guidelines and Specifications
    - Certificate Maintenance Entity
    - Governance Model
    - Final Cost-Benefit Analyses (CBA)
    - V2I Reference Implementation
    - Infrastructure Deployment & Financing

Anticipated Date: October 2015

Contact Information

Carl K. Andersen, FHWA
202-493-3366
carl.andersen@dot.gov

Ben McKeever, FHWA
202-493-3270
ben.mckeever@dot.gov

Intelligent Transportation Systems
Joint Program Office

http://www.its.dot.gov/