Introduction

The Vehicle to Infrastructure (V2I) Deployment Guidance workshop (in Detroit on September 12, 2014) is part of a continuing effort to receive input and understanding the needs of the transportation industry. The ultimate goal is to i) provide initial advice, ii) best practices, and iii) technical support tools in 2015. This document is intended to assist transportation system owner/operators with deploying V2I technology, not only in terms of the Federal-aid Highway program requirements, but also practices to help ensure interoperability and efficient & effective planning/procurement/operations.

It is important for the State and local agencies to understand a) what the technology could mean for them, b) what they need to know in preparing for an emerging connected vehicle environment, and c) what investments could be made to leverage a nationwide fleet of equipped vehicles in support of State and local policy and operational objectives.

Although in many respects this technology resembles traditional ITS deployments, it is different in many ways:

- The technologies go beyond "connected" to be cooperative, allowing data and information from many sources to be fused in real-time;
- It thus requires a level of national interoperability and functionality not found in today's ITS deployments;
- Because of its cooperative nature, it requires attention to security and privacy beyond today's ITS deployments;
- The basic technologies that form connected vehicle systems are evolving at a dynamic pace.

As such, it is believe these technologies require a focused set of guidance and products/tools. We are seeking the following:

A. Input on the content of the guidance & products/tools;
B. What elements are missing;
C. Insight into the depth of detail and direction;
D. Gaps in the technical support tools being contemplated.

To this end, the handout provides areas being covered and documents being prepared. It also includes terminology definitions. All of which is open for comment.

Guidance areas being considered

A. The Connected Vehicle Environment
B. V2I Deployment Policy Statement
C. Planning
D. Federal-aid Eligibility of V2I Equipment and Operations
E. V2I Deployments and NEPA
F. Interoperability
G. Evaluation
H. ITS Equipment Capability and Compatibility
I. Hardware/Software Device Certification
J. Reliability
K. Use of Right of Way
L. Allowance of Private Sector Use
M. Design considerations for facilities
N. Use of existing structures and infrastructure
O. Use on public sector fleets (including incident responder vehicles)
P. Procurement Process
Q. Legacy systems/devices
R. Communication Technology
S. Dedicated Short Range Communications (DSRC) Service Licensing
T. Data Connection and Latency
U. Connected Vehicle Privacy Principles
V. Connected Vehicle Security
W. Data Access
X. Manual on Uniform Traffic Control Devices
Y. Using Public-Private Partnerships (P3s)

Products/Tools Section

The products/tools section is intended to support the guidance section with a number of best practices guides, cost analysis tools, and technology documents with an emphasis on V2I interoperability and effective planning/procurement/operations of the system. Here is a list of products/tools that is tentatively scheduled for delivery by fall 2015.

1. *System Engineering Process for Vehicle to Infrastructure*
   Augment the Systems Engineering (SE) for Intelligent Transportation Systems manual and provide guidance for professionals involved in developing systems engineering documents covering the evaluation, selection and implementation of Connected Vehicle (CV) V2I technology.

2. *V2I Benefit Cost Analysis Tool*
   Tool to assist adoption of an investment strategy that dedicates funding to the capital and ongoing operational costs for connected transportation.

3. *V2I Planning Guide*
   Provide planning staff with an increased awareness of the benefits and opportunities for deploying these technologies by State DOTs and MPOs that guidance on inclusion of the technology in long range plans and project selection process.

4. *Guide to V2I Cyber-Security*
   Provides deployers with: (1) an analysis of extensibility of security and trust system to additional points of connection, including V2I, devices, backhaul, and others; (2) an analysis of additional risks from extensibility and cyber security; and (3) an analysis of the potential impacts to the existing transportation system/network. It will also provide definitions of the organizational functions and processes for operating the security function, along with cost models for operations and maintenance.

5. *Guide to Licensing DSRC Roadside Units*
   A guide to requirements that a transportation owner/operator will use to navigate the process of licensing, be they in a position to develop or manage an outsourcing contract or understand / deal with private sector commercial deployments.

6. *Guide to V2I Communication Technology Selection*
   A description of the technology options available and why certain options may be more appropriate for some applications than others.

7. *V2I Message Lexicon*
   A list of allowable standard messages and formats for transmitted information for In-Vehicle use. Although the OEMs will control the message/warning type provided to the user, what type of information and its form the RSU sends needs to be standardized.

8. *Guide to Initial Deployments*
   A guide to transportation system owner/operators which are on a path from no V2I deployment to a build out of the various scenarios. This would include prioritization methodology, staged deployment applications, co-location with existing ITS infrastructure, legacy equipment, utility based on V2V market penetration, etc.

9. *Warrants for Deployment*
   A set of criteria which can be used to define the relative need for and appropriateness of a particular V2I application.

Definitions/Abbreviations Section

The following definitions and abbreviations are proposed for the appendix of the document.

Definitions

Term	Description
Aftermarket Safety Device (ASD)	A connected device in a vehicle that operates while the vehicle is mobile, but which is not connected to the data bus of the vehicle.
Backhaul	The closed network communication links between a Traffic Management Center (or other back offices), links between TMCs, and field installations (such as traffic signal controllers, traffic cameras, and other sensors). This could also include the link between the Security Credential Management System and roadside distribution device.
Basic Safety Message (BSM)	The core data set transmitted by the connected vehicle (vehicle size, position, speed, heading acceleration, brake system status) and transmitted approximately 10x per second. A secondary set is available depending upon events (e.g., ABS activated) and contains a variable set of data elements drawn from many optional data elements (availability by vehicle model varies). This would be transmitted less frequently. The BSM is tailored for low latency, localized broadcast required by V2V safety applications but can be used with many other types of applications.
Connected Device	Any device used to transmit to or receive messages from another device. A connected device can be sub-categorized as an OBE, ASD, VAD, or RSE. In many cases the connected device will be a DSRC device, but other types of communications can and are expected to be supported.
Connected Vehicle (CV)	A vehicle containing an OBU or ASD. Note that vehicles may alternatively include a Vehicle Awareness Device (VAD), which transmits the BSM but does not received broadcasts from other devices and cannot directly support vehicle-based applications.
Connected Vehicle Reference Implementation Architecture (CVRIA)	A set of system architecture views that describe the functions, physical and logical interfaces, enterprise/institutional relationships, and communications protocol dependencies within the connected vehicle environment. The CVRIA defines functionality and information exchanges needed to provide connected vehicle applications.
Dedicated Short Range Communications (DSRC)	DSRC is a technology for the transmission of information between multiple vehicles (V2V) and between vehicles and the transportation infrastructure (V2I) using wireless technologies.
Intelligent Transportation Systems (ITS)	Systems that apply data processing and data communications to surface transportation, to increase safety and efficiency. ITS systems will often integrate components and users from many domains, both public and private.

Term	Description
Interoperability	The ability of two or more systems or components to exchange information and to use the information that has been exchanged. The dependence of the CV Environment on successful exchange of data between independent components results in a requirement that all V2I deployments.
Latency	A measure of time delay experienced in a system, the precise definition of which depends on the system and the time being measured. For a data element in this context, latency is the time difference between the time that data value is acquired by the source and the time the message is transmitted.
NTCIP	The National Transportation Communications for Intelligent Transportation System Protocol (NTCIP) is a family of standards designed to achieve interoperability and interchangeability between computers and electronic traffic control equipment from different manufacturers.
On-Board Equipment (OBE)	This term refers to the compliment of equipment located in the vehicle for the purpose of supporting the vehicle side of the applications. It is likely to include the DSRC radios, other radio equipment, message processing, driver interface, and other applications to support the use cases described herein. It is also referred to as the Vehicle ITS Station. When referring to the DSRC radio alone, the correct term is OBU (see below).
On-Board Unit (OBU)	A vehicle mounted device used to transmit and receive a variety of message traffic to and from other connected devices (other OBUs and RSUs). Among the message types and applications supported by this device are vehicle safety messages, a primary subject of this standard, used to exchange information on each vehicle's dynamic movements for coordination and safety.
Original Equipment Manufacturer (OEM)	An original equipment manufacturer refers to the entity that originally manufactures and item that may be branded and sold by others. In the Connected Vehicle Environment, it is commonly used to refer to automobile manufacturers.
Public-Private Partnerships (P3)	Public-private partnerships (P3s) are contractual agreements formed between a public agency and a private sector entity that allow for greater private sector participation in the delivery and financing of transportation projects.
Roadside Equipment (RSE)	Term used to describe the compliment of equipment to be located at the roadside; the RSE will prepare and transmit messages to the vehicles and receive messages from the vehicles for the purpose of supporting the V2I applications. This is intended to include the DSRC radio, traffic signal controller where appropriate, interface to the backhaul communications network necessary to support the applications, and support such functions as data security, encryption, buffering, and message processing. It may also be referred to as the

Term	Description
	roadside ITS station. When speaking of the DSRC radio alone, the correct term is RSU (see below).
Roadside unit (RSU)	A connected device that is only allowed to operate from a fixed position (which may in fact be a permanent installation or from temporary equipment brought on-site for a period of time associated with an incident, road construction, or other event). Some RSEs may have connectivity to other nodes or the Internet.
Signal Phase and Timing (SPaT)	In the context of this standard, SPaT is a message type that describes the current state of a signal system and its phases and relates this to the specific lanes (and therefore to maneuvers and approaches) in the intersection.
Security **Certificate Management** System (SCMS)	A public key infrastructure approach to security involving the management of digital certificates that are used to sign and authenticate messages among legitimate but unknown vehicles and/or equipment and/or other points of connection.
Systems Engineering	An interdisciplinary practice which focuses on how to design and manage complex projects/deployments over their life cycles. It ensures that all likely aspects of a system are considered and integrated into a whole.
Vehicle	A self-propelled transport device, along with any attachments (e.g., trailers), that is a legal user of the transportation network.
V2I Reference Implementation	An interface system that supports the collection, integration, and dissemination of data between infrastructure and vehicles to enable integrated, interoperable V2I safety, mobility, and environmental applications.
V2V	Short for vehicle-to-vehicle communications: a system designed to transmit basic safety information between vehicles to facilitate warnings to drivers concerning impending crashes.
V2I	Short for vehicle-to-infrastructure communications: a system designed to transmit information between vehicles and the road infrastructure to enable a variety of safety, mobility, and environmental applications.

Symbols and Abbreviations

Term	Meaning
BSM	Basic Safety Message
CV	Connected Vehicle
DSRC	Dedicated Short Range Communications
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transportation Systems
MUTCD	Manual on Uniform Traffic Control Devices
OBE	On-Board Equipment (synonym for On-Board Unit)
OBU	On-Board Unit
PTV	Public Transport Vehicle
RF	Radio Frequency
RSE	Roadside Equipment (synonym for Roadside Unit)
RSU	Roadside Unit
SAE	Society of Automotive Engineers International
SPaT	Signal Phase and Timing
TMC	Traffic Management Center
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle