



Part I.
Vehicle to
Everything Hub

Source: FHWA





Source: FHWA

Previous Sessions Review

Previous sessions:

- Introduced the “Development of Workforce Education Materials and Equipment” team.
- Developed an interactive virtual tour of Turner-Fairbank Highway Research Center.
- Introduced Connected and Automated Vehicle (CAV) Support Services Equipment Loan program.





Overview

Module Overview:

- What is V2X Hub?
- Why do we need it?
- What features does it have?
- How does it work?





Intelligent Transportation System (ITS)

Complex System

A coexistence of diverse components using different communication standards.

Messaging

Distributed messages (data/information) related to vehicles, intersections, weather sensors, roadway topologies and roadway conditions/statuses.

Middleware

The middleware message—a core component existing in the center of a complex distributed system.



What is V2X Hub?



V2X Hub is:

- A middleware component in an ITS.
- A message distribution core.
- A message translator.



Source: FHWA.

- A CAV application deployment facilitator.
- An open source software.

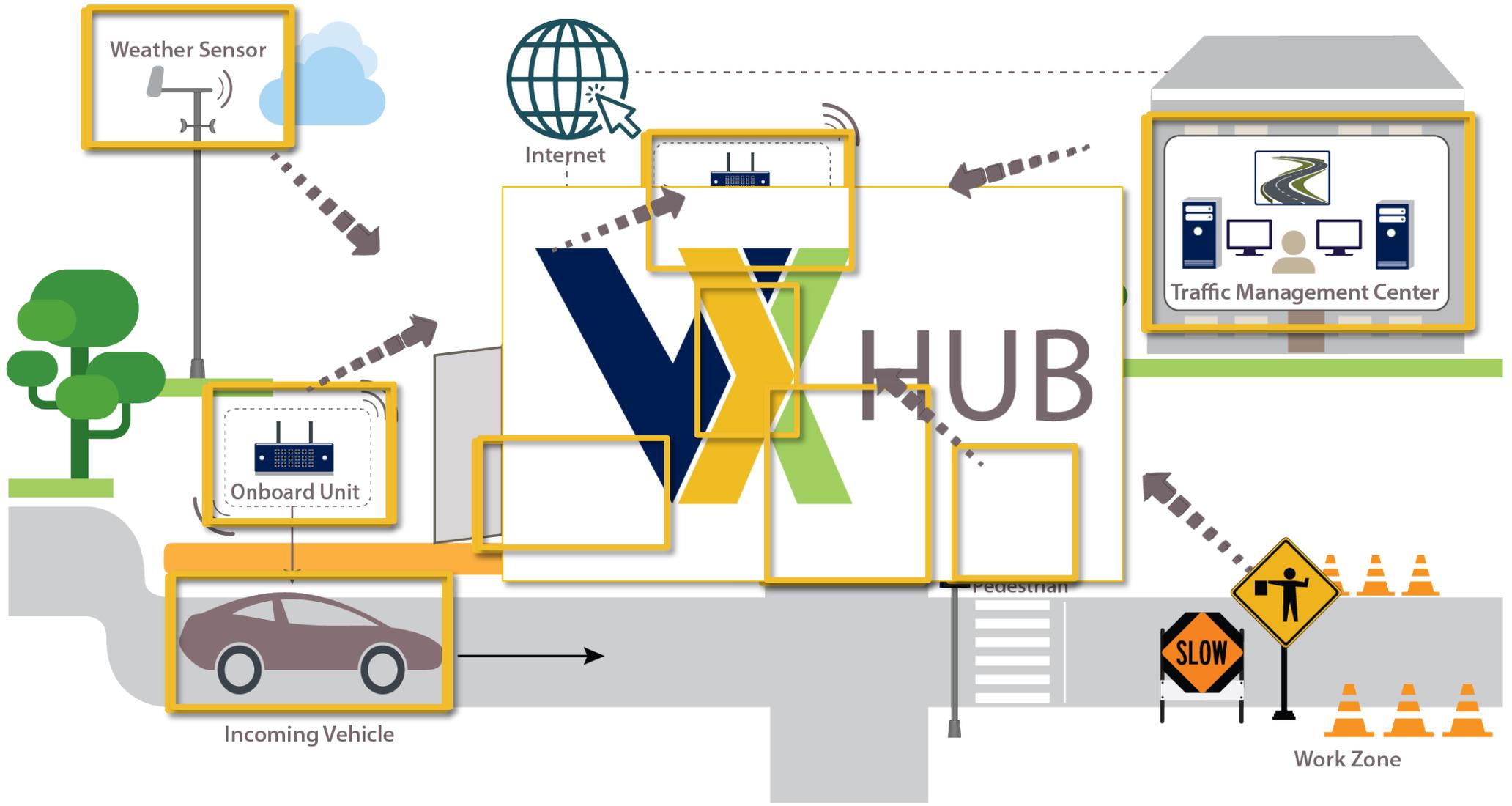




Complex System

Messaging

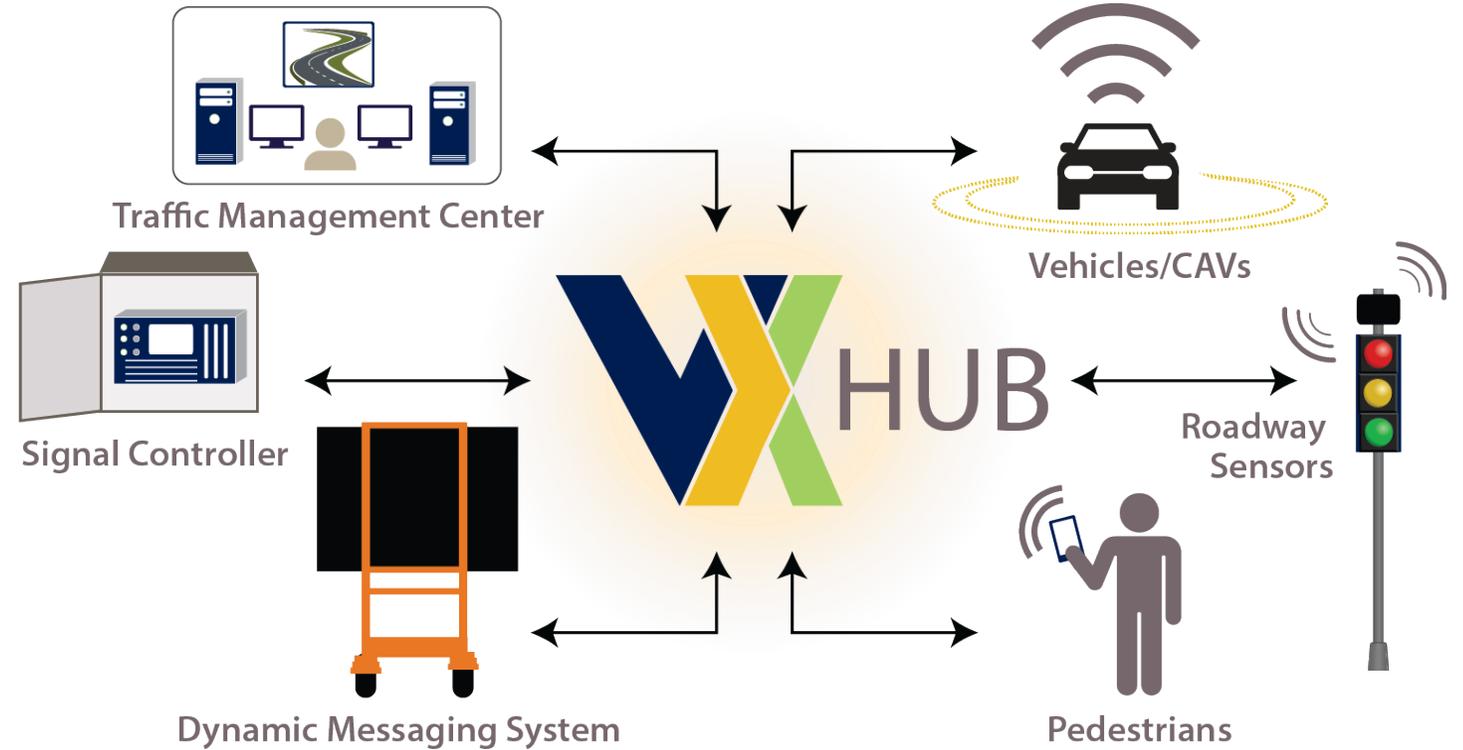
Middleware



Why V2X Hub ?

V2X Hub is important because it:

- Is a centralized hub for a distributed complex system such as an ITS.
- Allows message exchange and translation between vehicles, pedestrians, and infrastructure.
- Enables easy application deployment with performance measurement analytics.



Features of V2X Hub



V2X Hub features:

- Adhere to standards and are manufacturer agnostic.
- Provide remote access and monitoring of infrastructure components.
- Enable easy development and deployment of new CAV applications.
- Connect infrastructure at a lower cost.
- Maintain low latency and high reliability in messaging core.
- Enable message operation between different standards.



Features of V2X Hub



The different standards:

- SAE International (e.g., SAE J2735¹)
 - Encoding messages between onboard unit (OBU) and roadside unit (RSU).
- The National Transportation Communications for Intelligent Transportation System Protocol (e.g., NTCIP 1202²)
 - Messaging standard between signal controller and RSU.
- Institute of Electrical and Electronics Engineers (e.g., IEEE 802.11p³)
 - Wireless standard for dedicated short range communication (DSRC).

1. SAE, International. (R) Dedicated Short Range Communications (DSRC) Message Set Dictionary. Accessed 6/4/2020: https://www.sae.org/standards/content/j2735_200911/
2. AASHTO, ITE, NEMA. National Transportation. Communications for ITS Protocol Object Definitions for Actuated Traffic Signal Controller (ASC) Units. Accessed 6/4/2020: <https://www.ntcip.org/wp-content/uploads/2018/11/NTCIP1202v0219f.pdf>
3. IEEE. IEEE Standard for Information technology-- Local and metropolitan area networks-- Specific requirements-- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 6: Wireless Access in Vehicular Environments. Accessed 6/4/2020: https://standards.ieee.org/standard/802_11p-2010.html



V2X Hub Architecture

V2X HUB CORE:

Message Hub.
Message Circulation.
Message Translation.
Message Security.



PLUGINS:

CAV Applications.
Independent.
Real-World Interface.
Timely and Reliable.

V2X Hub Core



MESSAGE TRANSLATION



C++



MESSAGE CIRCULATION

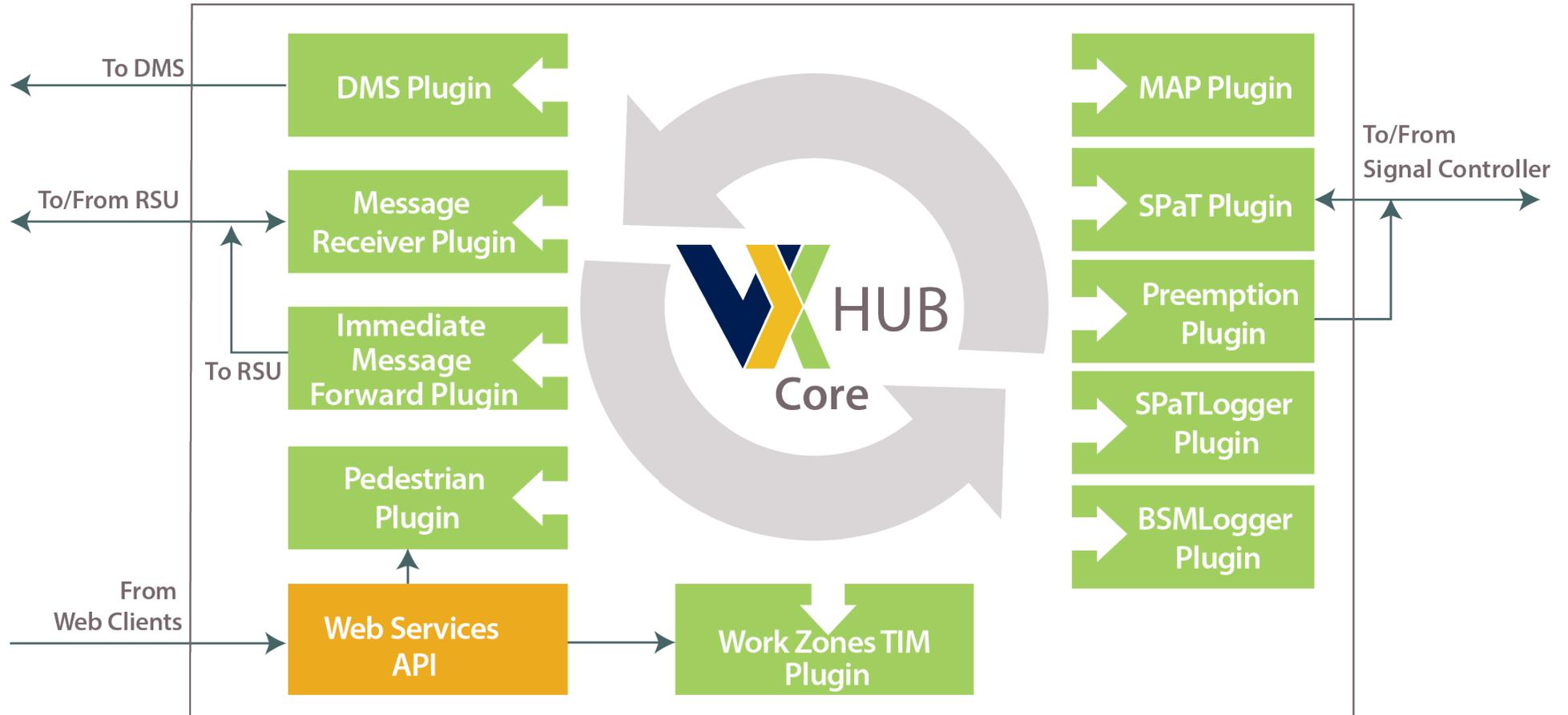


Source: FHWA.

- Translation of ASN1 encoded messages to/from XML/JSON formats.
- Object oriented C++ framework.
- Publishing to subscribers.
- Plugins interface for real world.



V2X Hub Plugins



DMS: Dynamic Message Sign
 RSU: Roadside Unit
 API: Application Programming Interface
 TIM: Traveler Information Message

BSM: Basic Safety Message
 SPaT: Signal Phase and Timing
 MAP: Map Data



V2X Hub Plugins



SPaT

Plugin features include:

- Application for connected intersection safety messages.
- SPaT information about traffic signal phase and timing information.
- SPaT message broadcast using an RSU.
- Encoder/Decoder for NTCIP 1202¹ and SAE J2735².
- Use of DSRC protocol for broadcast.

1. AASHTO, ITE, NEMA. National Transportation. Communications for ITS Protocol Object Definitions for Actuated Traffic Signal Controller (ASC) Units. Accessed 6/4/2020: <https://www.ntcip.org/wp-content/uploads/2018/11/NTCIP1202v0219f.pdf>
2. SAE, International. (R) DSRC Message Set Dictionary. Accessed 6/4/2020: https://www.sae.org/standards/content/j2735_200911/



Illustration: SPaT Plugin

- Signal controller sends NTCIP¹ frame to V2X Hub/SPaT Plugin.
- V2X Hub decodes NTCIP¹ format to SAE J2735² SPaT message in ASN1 structure.
- V2X Hub sends the ASN1 structure to RSU for broadcast.
- RSU Broadcasts the SAE J2735² SPaT messages.
- Surrounding vehicles receive the SPaT message.



1. AASHTO, ITE, NEMA. National Transportation. Communications for ITS Protocol Object Definitions for Actuated Traffic Signal Controller (ASC) Units. Accessed 6/4/2020: <https://www.ntcip.org/wp-content/uploads/2018/11/NTCIP1202v0219f.pdf>

2. SAE, International. (R) DSRC Message Set Dictionary. Accessed 6/4/2020: https://www.sae.org/standards/content/j2735_200911/

BASIC SAFETY MESSAGE (BSM) LOGGER PLUGIN

Plugin features include:

- Application for connected vehicle safety messages.
- BSM contains information about vehicle status including location, speed, trajectory and many others.
- Collection and logs of BSMs from nearby vehicles.
- Encoder/Decoder for SAE J2735¹.
- DSRC protocol for receiving BSM.

1. SAE, International. (R) DSRC Message Set Dictionary. Accessed 6/4/2020: https://www.sae.org/standards/content/j2735_200911/



Illustration: BSM Logger Plugin

- Vehicle broadcasts BSM wireless DSRC messages.
- DSRC messages are received by RSU.
- RSU forwards BSM to V2X Hub.
- BSM Logger Receives the BSM and logs locally as CSV.



CSV: comma separated values

Source: FHWA.



1. SAE, International. (R) DSRC Message Set Dictionary. Accessed 6/4/2020: https://www.sae.org/standards/content/j2735_200911/

V2X Hub Plugins



PEDESTRIAN PLUGIN

Plugin features include:

- Application for vulnerable road user safety messages using pedestrian safety message (PSM).
- PSM content of pedestrian location, trajectory, and state of roadway crossing.
- Web service support for V2X Hub.
- Encoder/Decoder for SAE J2735¹.
- DSRC protocol for broadcasting PSM.

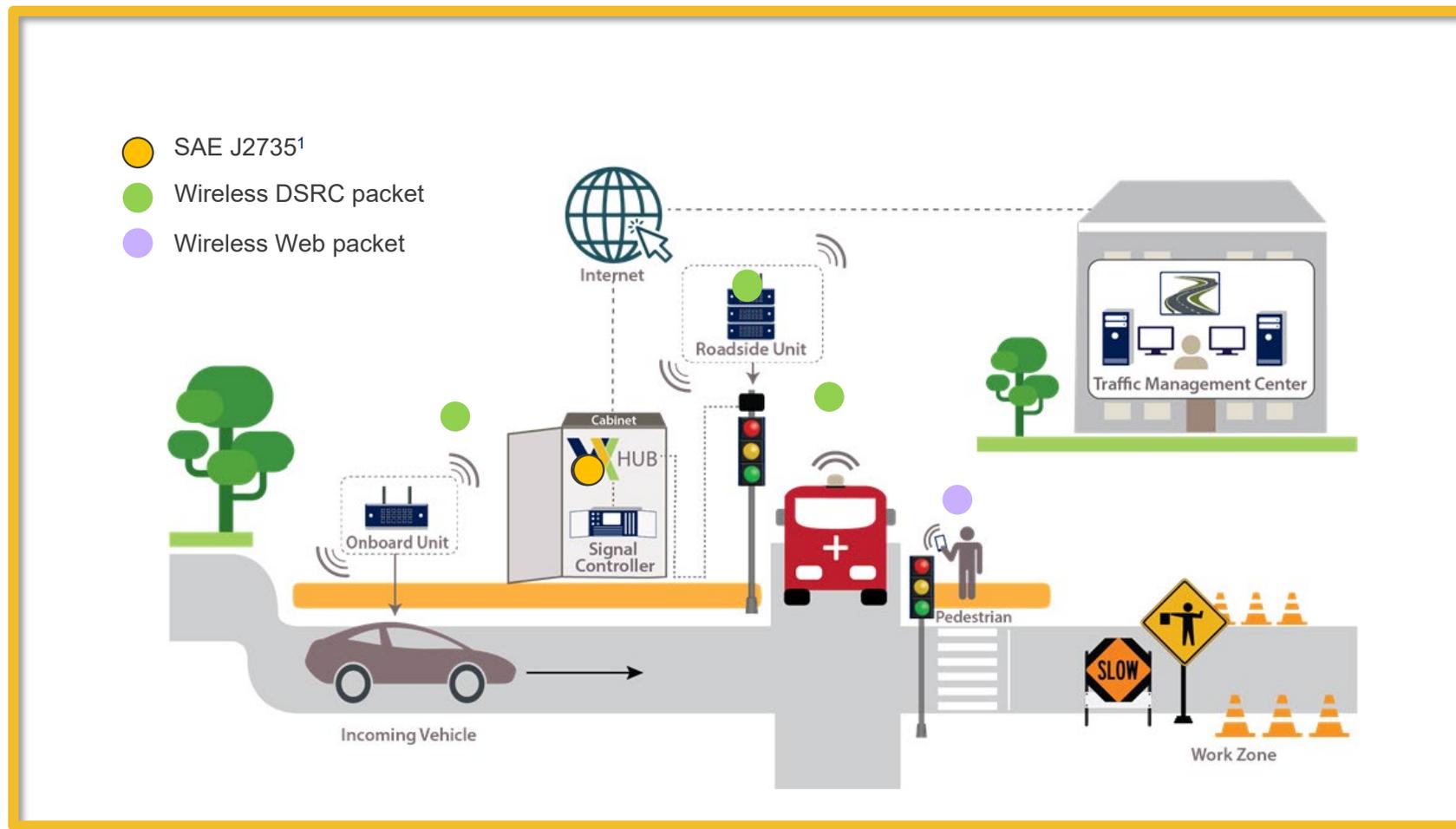
1. SAE, International. (R) DSRC Message Set Dictionary. Accessed 6/4/2020: https://www.sae.org/standards/content/j2735_200911/





Illustration: Pedestrian Plugin

- Pedestrian uses an app to send web based PSM call to V2X Hub.
- V2X Hub encodes web packet into SAE J2735¹ PSM structure.
- V2X Hub forwards PSM to RSU.
- RSU broadcasts PSM using wireless DSRC packets.
- Incoming vehicles receive PSM.



Source: FHWA.



1. SAE, International. (R) DSRC Message Set Dictionary. Accessed 6/4/2020: https://www.sae.org/standards/content/j2735_200911/



PREEMPTION Plugin

Plugin features include:

- Emergency vehicle preemption, an application for giving emergency vehicles a green light before they arrive at the intersection.
- Utilization of BSM with signal status extended fields to initiate preemption call.
- Traffic signal controller that receives the call and enables preprogrammed preemption mechanism.
- Encoder/Decoder for SAE J2735¹.
- DSRC protocol for broadcasting BSM.

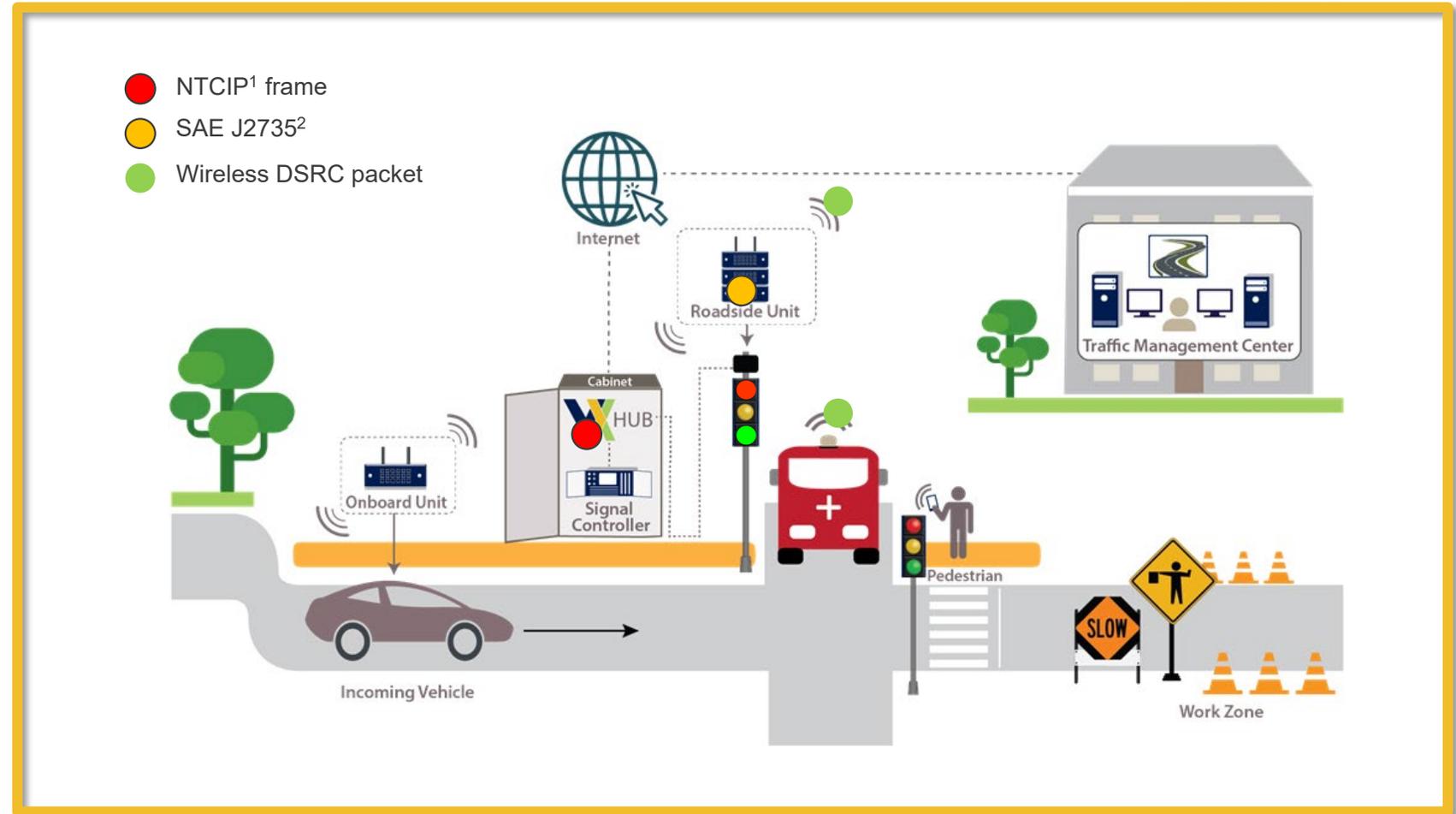


Illustration: Preemption Plugin



Source: FHWA.

- An emergency vehicle approaches an intersection broadcasting BSM.
- RSU received the BSM.
- RSU forwards the BSM to V2X Hub.
- Preemption plugin initiates a preemption call to signal controller.
- Signal controller enables preemption hence changing light to GREEN.



1. AASHTO, ITE, NEMA. National Transportation. Communications for ITS Protocol Object Definitions for ASC Units. Accessed 6/4/2020: <https://www.ntcip.org/wp-content/uploads/2018/11/NTCIP1202v0219f.pdf>

2. SAE, International. (R) DSRC Message Set Dictionary. Accessed 6/4/2020: https://www.sae.org/standards/content/j2735_200911/



***Next we will learn about an educational tool kit that
uses V2X Hub!***



Contact Us! 

CAVSupportServices@dot.gov





Questions ?





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The Federal Highway Administration (FHWA) does not endorse any entity, and the appearance of our presentation material in this template should not be interpreted as an endorsement or statement exhibiting any preference, support, etc.





Part II.
Vehicle-to-
Everything Hub

Source: FHWA





Disclaimer

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Source: FHWA

Previous Session Review

- Turner-Fairbank Highway Research Center Virtual Tour
- Vehicle-to-Everything Hub (V2X Hub) Introduction





Overview

- V2X Hub in Brief
- Accessing and Installing V2X Hub
- Using the Admin Portal



V2X Hub—A Quick Recap



V2X Hub is:

- A middleware component in an intelligent transportation system.
- A message distribution core.
- A message translator.



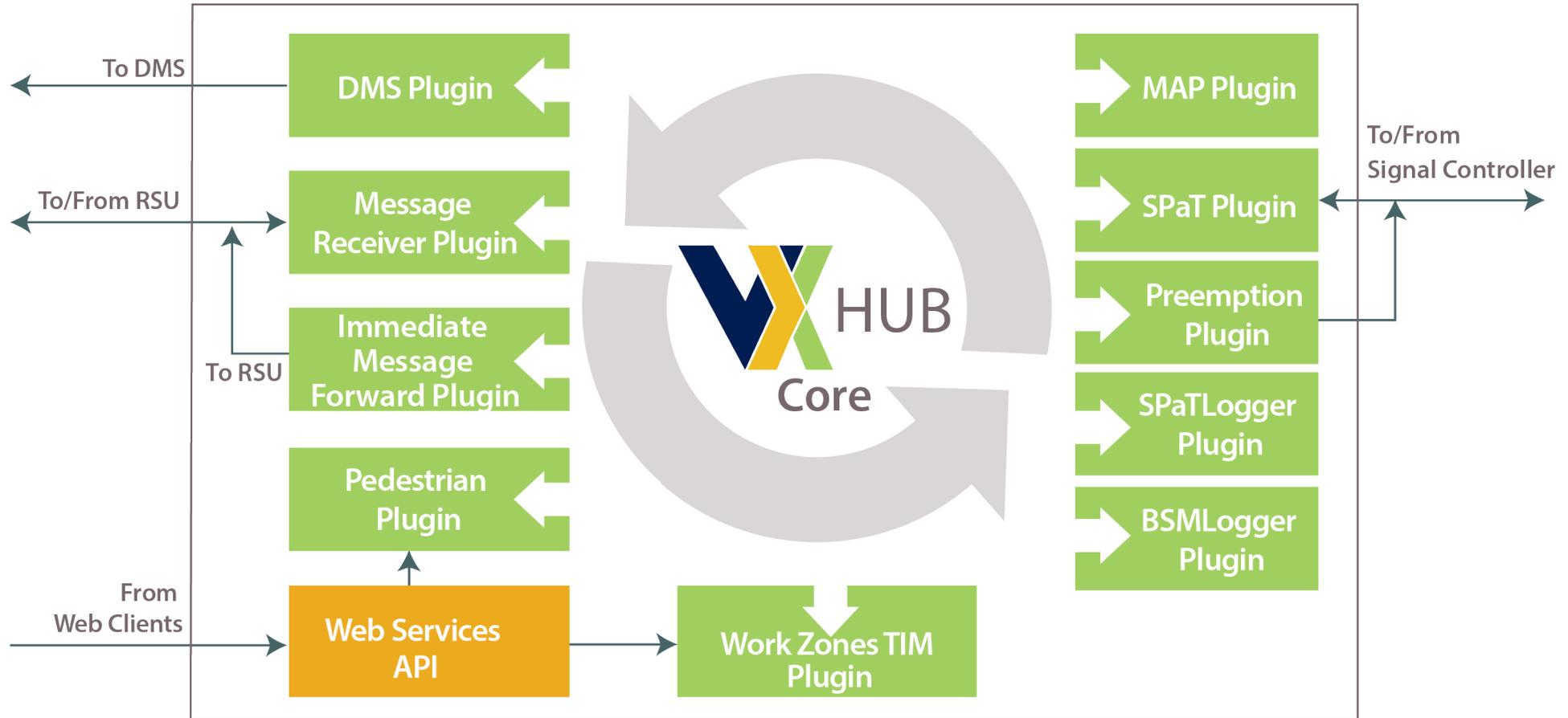
Source: FHWA.

- A CAV application deployment facilitator.
- An open source software.





V2X Hub Plugins Overview



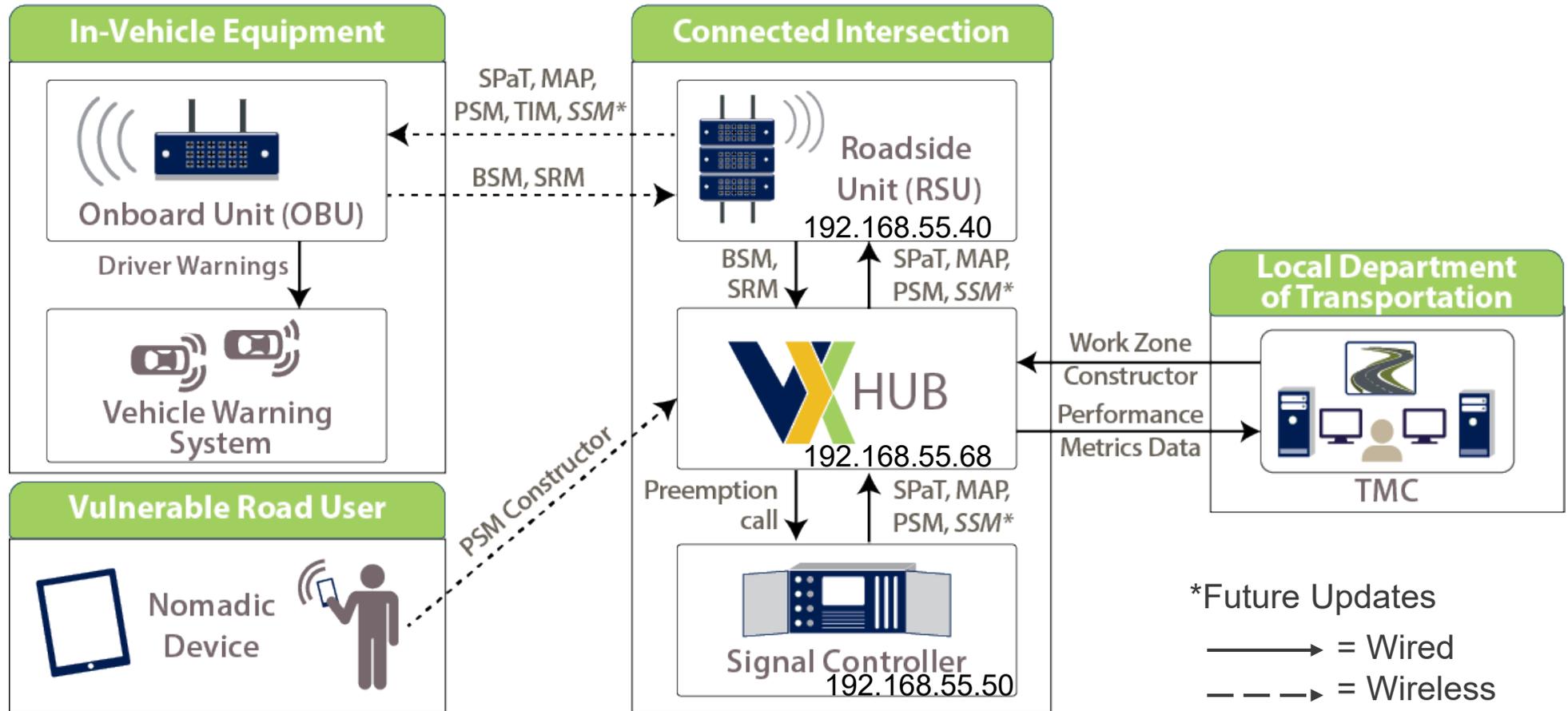
DMS: Dynamic Message Sign
RSU: Roadside Unit
API: Application Programming Interface
TIM: Traveler Information Message

BSM: Basic Safety Message
SPaT: Signal Phase and Timing
MAP: Map Data





V2X Hub in ITS





Accessing and Installing

- To access the software go to <https://github.com/usdot-fhwa-OPS/V2X-Hub>.
- To download the software: `git clone git@github.com:usdot-fhwa-OPS/V2X-Hub.git`.
- To install the software:
 - `cd V2X-Hub`.
 - `git checkout master`.
 - `cd /V2X-Hub/configuration/arm64`.
 - `chmod +x initialization.sh`.
 - `sudo ./initialization.sh`.
 - set username and password for admin portal.
 - (wait for the software to finish installation).
- To access the web admin portal:
 - <https://<v2xhub ip address>:19760>.
 - Allow certificate.
 - <http://<v2xhub ip address>>.
 - Change the IP address in text box to <v2xhub ip address>.
 - Log in with username and password set up earlier.





Configurations Using Admin Portal

- Log in to V2X Hub admin portal.
- Enable/Disable plugin.
- Messages logged.
- Events (very useful for debugging).
- User add, password reset for admin access.





Example: SPaT and MAP Plugins

- Log in to V2X Hub admin portal.
- Enable SPaT plugin.
- Enable MAP plugin.
- Enable DSRCMessageManager plugin.





Where to get more help ?

- V2X Hub repository in Git hub
 - <https://github.com/usdot-fhwa-OPS/V2X-Hub>.
 - Take a look at *V2X Hub docs* folder for relevant technical information.
- V2X Hub confluence repository
 - <https://usdot-carma.atlassian.net/wiki/spaces/CH/overview>.
 - Take a look at:
 - *V2X Hub Development Resources*.
 - *V2X Hub Project Documentation* for technical documentation.
- Technical support through *CAVSupportServices@dot.gov*.



Contact Us! 

CAVSupportServices@dot.gov





Questions ?





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