Integrated V2I Prototype Application Description

Tab 1: Overview

The Integrated Vehicle-to-Infrastructure (V2I) Prototype (IVP) System brings results from mapping, positioning, communications research, and Signal Phase and Timing (SPaT) and related message set development into a single operating environment that supports V2I communications-based connected vehicle applications. The IVP provides a sound platform for V2I applications to function. It is an interface system supporting the collection, integration and dissemination of data between roadside infrastructure and connected vehicles for a wide variety of vehicle-to-infrastructure (V2I) safety, mobility and environmental applications including:

* Communication with a traffic signal controller to create a J2735 Signal Phase and Timing message
* Creation of J2735 MAP messages that contain intersection and roadway geometry
* Communication with NTRIP networks to create J2735 RTCM messages for GPS position correction
* Transmission of J2735 messages out of a dedicated short range communication (DSRC) roadside unit

Tab 2: Description

The IVP system reduces time needed to create and deploy a roadside based V2I system. The IVP system contains a suite of plugins that are built to handle specific functionality. The output of these plugins will vary, but any plugin that communicates externally will produce a message from the J2735 R41 messages set. Plugins can request to receive data that is being produced by other plugins in the system. For example, a location plugin can create a location message that is then received by the MAP plugin for use it in its processing. Below are a list of plugins and the messages they produce that are included in the IVP system.

* AradaRecieverPlugin – Created for the Arada Commando RSU, this plugin will receive J2735 BSM messages and inject them back into the system for use by other plugins
* CSWPlugin – The curve speed warning plugin will monitor J2735 BSM messages at a curve, and send a message to the dynamic message sign when it detects that a vehicle is approaching a curve too fast. The CSW plugin also produces a J2735 TIM message containing the approach zones for the curve to be used by a CSW in-vehicle CV application.
* DMSPlugin – The dynamic message sign (DMS) plugin will receive messages from other plugins containing information to be display on the sign.
* MAP Plugin – Produces intersection geometry in J2735 MAP format
* SPAT Plugin – Communicates with a TSC using NTCIP 1202, and creates a J2735 SPAT Message
* DSRCImmediateForwardPlugin – Sends all J2735 traffic to the RSU for transmission out the DSRC radio
* LocationPlugin – Communicates with any GPS producing NEMA GP\* sentences and forwards location information to the IVP system
* RTCMPlugin – Communicates with a NTRIP network to create J2735 RTCM messages

The IVP is a communication, computational and processing platform for V2I applications. The IVP provides the following functions for these applications:

* Message Handling across Multiple Interfaces using J2735 Messages
  + Integrating data from multiple sources and compiling messages for delivery to vehicles and drivers and nomadic devices via multiple communication methods
  + Obtaining and aggregating data from multiple vehicles and nomadic devices and delivery to Traffic Management Entity
  + Distribution of Traffic Management Entitiy messages to local vehicles
* Local Infrastructure Based Computation and Processing:
  + e.g. Local computation of safe speeds and safe stopping distances using real time weather and road condition data for crash imminent V2I safety scenario such as Reduced Speed (Work Zone) Warning and Spot Weather Information Warning
  + e.g. Aggregation of vehicle weather data for efficient communication to Traffic Management Entity for Weather Responsive Traffic Management
  + e.g. Multi-Modal Intelligent Traffic Signal Systems (MMITSS) “Intersection level” functions including J2735 Intersection Geometry (MAP) and J2735 Signal Phase and Timing (SPAT) broadcast manager, equipped vehicle tracker, priority request server, and interface to traffic signal controller

The initial deployment of the IVP platform supports the dynamic mobility applications (DMA), although it has been designed to accommodate additional applications in the future. The table below lists all of the current and potential applications and application groups that the IVP platform supports.

|  |  |
| --- | --- |
| **Dynamic Mobility Applications**   * + INFLO Speed Harmonization (SPD-HARM)   + INFLO Queue Warning (Q-WARN)   + RESCUME Incident Zone (INC-ZONE) - Low latency comm for V2V; High latency comm for V2I   + FRATIS – High latency communications   **Multi-Modal Intelligent Traffic Signal System**   * Intelligent Traffic Signal System * Transit Signal Priority * Pedestrian Mobility * Freight Signal Priority * Emergency Vehicle Priority   **AERIS Applications**   * Eco-Signal Operations * Eco-Traffic Signal Timing * Eco-Approach and Departure at Signalized Intersections * Eco-Traffic Signal Priority * Connected Eco-Driving * Dynamic Low Emissions Zones * Dynamic Eco-Lanes | **Transit Applications**   * Pedestrian Crossing Warning (PCW)   **V2I Safety Applications**   * Red-Light Violation Warning (RLVW) * Stop Sign Gap Assist (SSGA) * Curve Speed Warning (CSW) * Stop Sign Violation Warning (SSVW) * Railroad Crossing Violation Warning (RCVW) * Spot Weather Information Warning (SWIW) * Oversize Vehicle Warning (OVW) * Reduced Speed Zone Warning (RSZW) – Speed Reduction and Lane Closure Advisories * Reduced Speed Zone Warning (RSZW) – Lane Closure Alerts & Warnings   **Road Weather Connected Vehicle Applications**   * Enhanced Maintenance Decision Support System (MDSS). * Information for Maintenance and Fleet Management Systems. * Weather-Responsive Traffic Management. * Motorist Advisories and Warnings. * Information for Freight Carriers. * Information and Routing Support for Emergency Responders. |
| Source: Battelle | |

Tab 3: Release Notes

* Version 2.3
* Uses J2735 R41 (2015) message set
* Contains API, Core, MAP Plugin, SPaT Plugin, CSW Plugin, DMS Plugin, RTCM plugin and Location Plugin

Hardware Requirements for Installation and Running IVP

* Intel Core i3 processor
* 4GB of memory
* 10 GB of HD space
* Ubuntu 14.04 LTE with packages listed below

Operational Requirements

* Traffic signal controller producing a NTCIP 1202 message over Ethernet (Econolite ASC/2100 with firmware greater than 2.58), which is used by the SPAT Plugin
* 3.0 specification RSU, which is used to transmit data over DSRC.

The IVP software application was developed using c and c++ and requires Ubuntu 14.04 LTE with the following packages installed via apt-get:

* cmake
* gcc-4.8
* g++-4.8
* libboost1.55-dev
* libboost-thread1.55-dev
* libboost-regex1.55-dev
* libboost-log1.55-dev
* libboost-program-options1.55-dev
* libboost1.55-all-dev
* libxerces-c-dev
* libcurl4-openssl-dev
* libsnmp-dev
* libmysqlclient-dev
* libjsoncpp-dev
* uuid-dev
* libusb-dev libusb-1.0.0-dev
* libftdi-dev
* swig
* liboctave-dev
* gpsd libgps-dev
* portaudio19-dev libsndfile-dev
* libglib2.0-dev libglibmm-2.4-dev
* libpcre3-dev
* libsigc++-2.0-dev
* libxml++2.6-dev
* libxml2-dev
* liblzma-dev

The following must be compiled and installed from the included source in TMX\_OAM/Externals directory.

1. Mysql-connector-c\_\_-1.1.3: Run the following from your TMX\_OAM/Externals directory:
   1. tar xzf mysql-connector-c++-1.1.3.tar.gz
      1. cd mysql-connector-c++-1.1.3
      2. cmake .
      3. make
      4. sudo make install
      5. cd ..
      6. rm -rf mysql-connector-c++-1.1.3
2. J2735r41: Run the following from your TMX-OAM/Externals directory:
   1. ./setupAsnJ2735\_r41.sh

Compilation Instructions

Each project contains its own cmake file. Downloaders will need to compile the projects in TMX/Core first. Start with the TmxUtils project, then the TmxApi, followed by the TmxCore. After those are built, you can compile any of the projects from the Plugins directory.

To compile a project:

* Change directory to the Debug or Release subfolder for the project (cd Debug)
* Run cmake (cmake ..)
* Run make (make)
  + This will compile the project
* To create a deployment package type make package

Deployment Instructions

Deployment Instructions can be found in the *IVP Deployment Guide* document.

Tab 4: Documentation

* *IVP Requirements*
  + This document defines the requirements for the IVP platform and message handlers recommended for development
* *IVP Interface Control Document*
  + This document captures the external interfaces necessary to support the Integrated Vehicle-to-Infrastructure (V2I) Prototype (IVP) Platform and related messages between the platform and a variety of infrastructure devices, including traffic signal controllers, back office systems, mobile devices, etc., organized around the V2I applications supported by the platform.
* *IVP Design*
  + This report documents the System Design Document (SDD) for an Integrated V2I Prototype (IVP) platform that is a key research activity within the DMA program.

Tab 5: Discussion

Main Discussion

Issue Tracker

Tab 6: Similar Applications

To be populated from metadata file