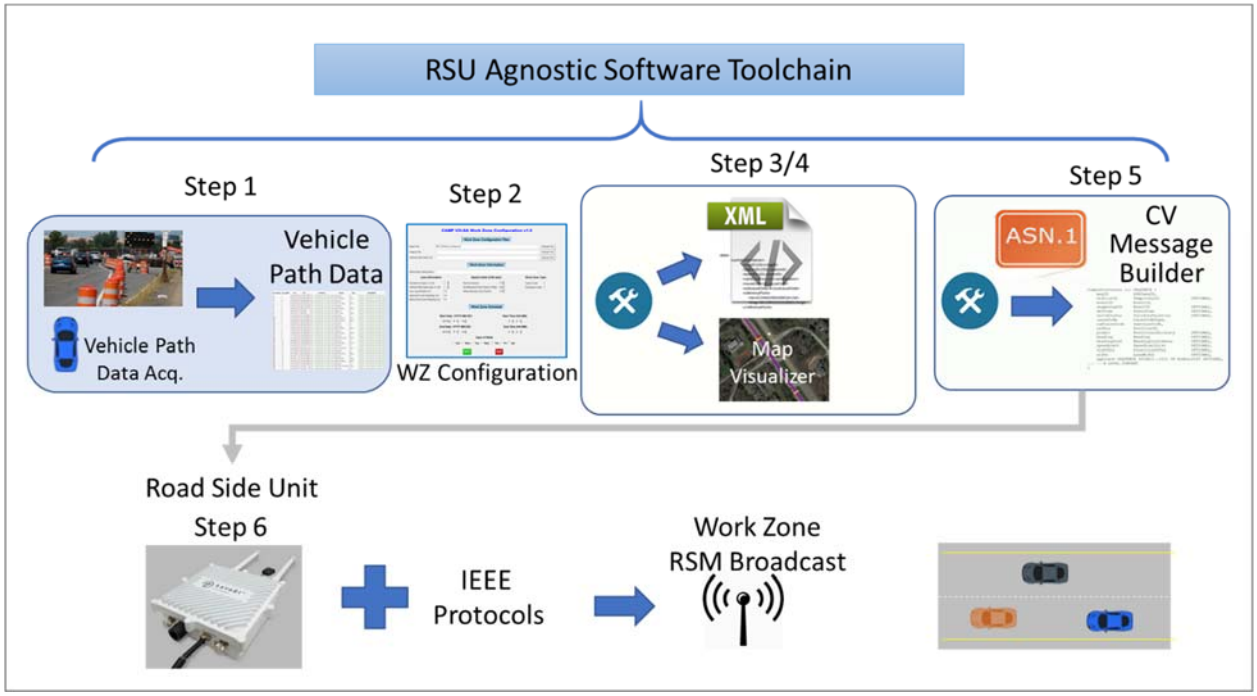
Software Toolchain for Connected Work Zone (v1.0)

The software toolchain for the Connected Work Zone (CWZ) Safety Application was developed under the Vehicle-to-Infrastructure (V2I) Safety Applications (SA) Project by Crash Avoidance Metrics Partners LLC (CAMP).

The toolchain was developed to enable mapping of a work zone in near real-time for the Reduced Speed Zone/Lane Closure Warning (RSZW/LC) application to provide Infrastructure Owners and Operators (IOOs) the ability to easily generate and validate accurate and efficient lane-level digital maps in standard format that represent both stable as well as dynamically changing road environments at lane level for over-the-air transmission. The toolchain provides a mechanism for developing a work zone map in a consistent manner.

The toolchain contains several modules (tools) to acquire vehicle path data, to build a map that describes work zone geometry, to visualize and verify the built map and to build Road Safety Message (RSM) for RSZW/LC application for over-the-air transmission. The RSM is built as per the specifications defined in Abstract Syntax Notation one (ASN.1) schema and the Society of Automotive Engineers (SAE) J2735 (March 2016) data dictionary which is being developed as SAE J2945/4 document. The generated message for transmission is encoded as Unaligned Packed Encoding Rules (UPER). Steps to generate the RSM for connected work zone using the toolchain is shown in Figure 1.



Source: Map images from Google. Used with permission. Data from CAMP – V2I Consortium

Figure 1: Connected Work Zone Map and Message Building Software Toolchain

The CWZ software toolchain contains the following tools for performing following actions:

- Vehicle Path Data Acquisition: Collect vehicle path data of an instrumented vehicle equipped with a high-resolution GPS receiver
- Work Zone Configuration: Configure work zone parameters such as number of lanes, average lane width, posted speed limits and work zone schedule
- Work Zone Map Builder: Build work zone map geometry using collected vehicle path data that describes waypoints (node points) for each lane in work zone including lane closures and workers presence zones. The generated map is represented in extended XML encoding rules (EXER).
- Work Zone Map Visualizer: Visualize the generated map waypoints (node points) on google map satellite view for verification
- Connected Vehicle Message Builder (CVMB): Build UPER encoded message as per the RSM defined specification for over the air transmission

SYSTEM REQUIREMENTS

Different tools in the toolchain are developed using different programming languages to gain portability, to provide inherent programming language efficiency and to provide the capability for rapid prototyping and ease of deployment. Required software packages / application software and hardware are listed in Table 1 for the target machine running the Windows operating system.

Table 1: System Requirements for Software Toolchain

Software Package / Application S/W	Version	Function / Application
Microsoft Windows PC	Version 7 or later	• Target platform to run software toolchain
Python for Windows	Version 3.6.4 or later	• Vehicle path data acquisition • Works zone map builder o Create work zone map in XML format o Create data elements and data arrays for JavaScript for map visualizer
pySerial	Version 3.3 or later	RS-232 Serial communication for GPS receiver
Web Browser - IE, Chrome, Firefox	Latest version	Work zone map visualizer
Java Runtime Environment (JRE)	Version 7 or later	Building UPER encoded Road Safety Message (RSM) for mapped work zone
U-blox EVK-M8N GNSS Receiver	U-center version 8.25	Vehicle Path Data Acquisition

The toolchain download package includes the user's guide that provides detail about each tool in and a step-by-step process for generating a work zone map.