U.S. Department of Transportation
Federal Highway Administration

Office of Safety and Operations
Research and Development

A Web-Based and Open-Source Tool to Simplify MAP and RGA Message Development for Connected Infrastructure

■ OVERVIEW

The U.S. Department of Transportation's (USDOT) open-source MAP/road geometry attributes (RGA) Message Creator tool[1] simplifies the development of SAE International® J2735™[2] MAP and J2945/A™[3] RGA messages to support connected and automated infrastructure deployment. MAP messages[2] define intersections and segment geometry, whereas RGA messages[3] describe broader roadway attributes. The browser-based tool allows users to define lanes, approaches, and reference points over aerial imagery (figure 1), and then save, edit, and export ASN.1[4] Unaligned Packed Encoding Rules (UPER)-encoded MAP or RGA messages for deployment through roadside units or other connected vehicle systems.

■ KEY BENEFITS

Key benefits of the tool include the following:

- Allows engineers or technicians new to Vehicle-to-Everything (V2X) to create connected infrastructure messages with approximately 75 cm of positional accuracy.
- Supports SAE J2735[2] MAP and J2945/A[3] RGA message structures to ensure standards compliance and interoperability.
- Generates deployment-ready outputs in GeoJSON[5] and ASN.1[4] UPER formats.
- Enables visual verification of intersection layouts and roadway attributes.
- Can be used for direct or network V2X connected intersections or road segments.
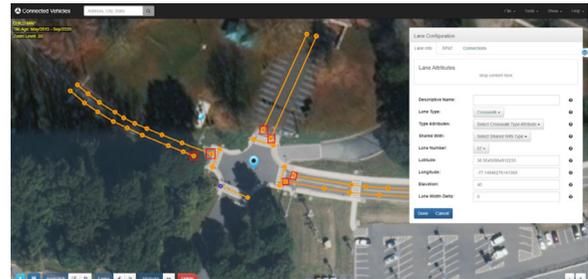
Original map: © 2014 USDOT MAP/RGA Message Creator tool. Modified by Federal Highway Administration (FHWA).

Figure 1. Screenshot. MAP/RGA Message Creator tool user interface with a simple, defined intersection.[1]

Step-by-Step Quick User Guide

The following steps show a high-level approach to creating and configuring a MAP or RGA message (https://ops.fhwa.dot.gov/publications/fhwahop17001/ch1.htm):[6]

1. Go to https://webappopen.connectedvcs.com/isd/[1] and use the search bar to locate the desired intersection.
2. Open the File menu in the top-right corner and select New Parent Map. Click OK when prompted.
3. Using the Builder menu in the bottom-left corner, place the Reference Point and Verified Point markers as needed. Update the Verified Point marker with surveyed location coordinates to calibrate it to the real world.
4. Return to the File menu and select Save. Enter a revision number and click OK.
5. In the File menu, select New Child Map, and then click OK to all prompts.
6. In the bottom-left corner, use the Approach, Lane, and Measure tools to define intersection geometry.
7. Click on the new approaches and lanes to add details (figure 2 and figure 3).
8. To enable RGA creation, toggle the RGA Enabled button, which activates the RGA editing mode and allows definition of roadway geometry attributes.
9. To save the child map, go to the File menu, select Update Child Markers and click OK on all prompts. In the file selection window, choose the parent map, then select Save.

Saved files in the MAP/RGA Message Creator tool can be reopened in the tool at any time to adjust. Files are saved in GeoJSON format and can also be viewed or edited using a standard text editor.[5] MAP files can also be uploaded and, after adding necessary details, converted to RGA.

■ CREATING AN UPER-ENCODED MAP OR RGA MESSAGE

Once users have marked and updated the intersection or roadway geometry, they can create an ASN.1[4] UPER-encoded message to use with intelligent transportation systems (ITS)[7] and connected and automated vehicle (CAV) applications.[6]

1. Open the child map to be encoded using the MAP/RGA Message Creator tool.[1]

2. Select Tools in the top-right menu and then click Encoder.

3. A JavaScript® Object Notation message[8] will be generated in the Map Data section of the encoder if there are no errors. Verify the message contents.

4. Select the desired message type at the bottom of the encoder. For most applications, choose Frame+Map or Frame+RGA, as applicable.

5. Select the desired node offsets encoding. To save transmission bandwidth, Tight is recommended for most applications. The Enable Elevation option is checked by default.

6. Click Encode to generate the message. If successful, the ASN.1[4] UPER Hex fields will populate with the encoded data.

Source: FHWA.
Figure 2. Illustration. An example of a lane and an approach definition.[1]

Source: FHWA.
Figure 3. Screenshot. Approach and lane definition buttons and icons.[1]

7. To use the encoded message, copy the ASN.1 UPER Hex and paste it into a roadside unit, load it in a network V2X platform, or use a tool such as V2X Hub[SM],[9] which facilitates communication between ITS[7] and CAV[6] applications.

Messages can be validated using the Message Validator tool[10] to ensure compliance with SAE J2735[2] today and J2945/A[3] in a potential future version. For more details, see the Help tab in the tool or visit the project's GitHub® repository: https://github.com/usdot-fhwa-stol/connectedvcs-tools.[11]

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9. FHWA. n.d. "V2X-Hub" (software and configuration files in GitHub repository). https://github.com/usdot-fhwa-OPS/V2X-Hub, last accessed October 27, 2025.

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