The MapData (MAP) Message

Connected Intersections Program Brief

PURPOSE AND DESCRIPTION

The SAE J2735 standard includes a specification for a MAP message that includes information about intersection and road geometries for V2X systems. Specifically, the MAP message is a standardized encoding of map data designed to provide location references for other SAE J2735 messages (e.g., the Signal Phase and Timing (SPaT) message). It can provide lane information for up to 32 intersections and 32 non-intersection road segments. For the purposes of SPaT-enabled applications, it would typically contain the lane information for a single intersection.

Introduction

As connected vehicles approach connected intersections (CIs), the on-board application will receive a Signal Phase and Timing (SPaT) message describing the current signal head displays (red, green, yellow) for all approaches into the intersection. The on-board application must determine which lane the vehicle is traveling in order to understand which signal head controls the vehicle's approach. The MAP message provides the information needed for the on-board application to determine the vehicle's lane of travel. The core content of the MAP message are the latitude/longitude of centerline node points for each ingress and egress lane at the intersection. Applications compare these node points to vehicle positions to determine the lane of travel.

Accuracy Needs of MAP Messages

Because the on-board application will use the coordinates of the MAP message node points to compare to current and previous locations of the vehicle, there is a need for high levels of accuracy. According to the ITE/CI Implementation Guidelines, node positions must be accurate to within ± 0.2 meters of the actual node location.

Consistency Needs of MAP Messages

The on-board applications will use MAP message data for multiple purposes. For example, the starting node point may be used by the on-board application to determine the distance to the stop line as an aid in determining red light violation warnings to the driver. Using this example, it is important that the first node point of each ingress lane be immediately upstream of the stop line. Because of this, and other examples, consistency in MAP messages is very important for vehicles to travel through various CIs. More information about MAP message consistency can be found in the CV PFS MAP Guidance Document.

Tools for MAP Message Creation include one developed and hosted by the United States Department of Transportation (USDOT) called the ISD Message Creator, which allows a MAP creator to define the lanes and approaches of an intersection and place the nodes for ingress and egress lanes using a graphical interface and on-line map display. USDOT offers technical support for the use of this tool as well as technical questions about the creation of MAP messages, available at: CAVSupportServices@dot.gov. MAP creators may alternatiely use other supporting tools such as on-line mapping solutions (e.g., Google Maps, Bing Maps, Apple Maps), Geographic Information Systems (GIS) solutions, and proprietary MAP creation tools available from contractors and system vendors.

The MAP message, in addition to signal phase and timing (SPaT) information and position correction data, must be broadcast by an infrastructure system to vehicles for all connected intersections (CIs).

MAP Message Data Elements

- *Intersection Identification.* The intersection has a unique integer ID within a unique integer road regulator ID. The message provides for up to 65,535 road regulator IDs, each of which can have up to 65,535 intersection IDs. The MAP message uses the same intersection ID as the SPaT message and has a revision indicator like the SPaT message.

- *Lane Identification.* Each intersection can have up to 255 lane IDs. The intersection is located by a reference point. The lanes are described by node points along the center of the lane, starting with a node at the stop line and ending with a node as far back from the intersection as needed for the application to function properly. The first node is located as an X,Y offset from the reference point. Subsequent nodes are located by an X,Y offset from the previous node. (Nodes may also be identified by latitude and longitude; but more bits are required for this approach.)

- *Lane Types and Attributes.* Applications need information about vehicle lane types, crosswalk lane types, and potentially sidewalk lane types. The message describes lanes both approaching (ingress) and departing from (egress) the intersection (the first node of the lane). The message can identify the maneuvers allowed at the stop line, including left/right/through, U turns, and turns on red, which can in addition or instead be defined as part of the connection, described below. Pedestrian crosswalks are configured like other lanes.

- *Connections and Signal Groups.* The message identifies each egress lane ID that an ingress lane connects to, and can identify the maneuver required to reach that egress lane lane (left/right/through/ U turn). Lane connections in the MAP message identify to the vehicle application which signal indications are associated with the intended movement at the intersection. To provide pedestrian signal timing information for pedestrian crosswalks, the crosswalk lanes must have connections to other lanes. Crosswalks connect with each other at the corners of the intersection via sidewalk lanes.

- *Dynamic Map Information.* A revision number increments any time the contents of the MAP message have changed, allowing the vehicle system to forego processing map data that has not changed since a previous time the vehicle system received the MAP message for that intersection. The MAP message allows designating a lane as being revocable, which are not considered to be available for use unless the SPAT message identifies them as being enabled (e.g., a reversible lane or parking lane available for vehicle traffic during peak periods but reserved for parking during off peak periods.

Remaining Tasks and Challenges

- Some MAP message elements are not well understood (e.g., crosswalk and sidewalk lanes) because they have not been frequently implemented:
- Create test plan requirements and procedures to verify MAP accuracy at the next level.
- Develop approach to verify MAP messages accurately represent actual conditions and are consistent with each other.
- Understand the role of the SAE J2735 MAP message alongside the SAE J2945/Road Geometry Attributes (RGA) standard being developed.

Relevance to CV PFS MemberS

- The MAP message is an integral component for IOOs planning to deploy CIs.
- When considering a CI deployment, agency staff should familiarize themselves with MAP tools and resources to understand minimum requirements, in order to assemble and collect all required information. This may involve field visits to the intersection, a field survey, referencing intersection design documents, or using online mapping programs and tools.