

Radio Technical Commission for Maritime Services (RTCM) Corrections Message

Connected Intersections Program Brief

Introduction

The intent of broadcasting RTCM Corrections messages is to increase vehicle position accuracy for use in vehicle-to-infrastructure (V2I) applications such as Red Light Violation Warning (RLVW) to better interpret what lane the vehicle. RTCM Corrections messages are to be broadcast five times per second (i.e., 5 Hertz (Hz)).

RTCM Message Operation

In order for the vehicle to accurately identify the ingress lane of travel using the MAP message, it is critical that the location of the vehicle (determined by the on-board GPS) is accurate. This can be accomplished by a broadcast of Global Positioning System (GPS) correction information as standardized in messages by the RTCM Message as a method for minimizing the effects of GPS error caused by atmospheric conditions or reduced satellite access.

The general concept of the RTCM message is that a base station with a known location (the location may be known by either by surveying in the station location or operating a GPS receiver for a long continuous period of time) continuously receives satellite signals and determines a current latitude / longitude position given the current atmospheric conditions. The base station then compares the position determined with

the current atmospheric conditions to the known location and computes a correction factor that corrects the current calculated position to the known position. This correction factor is the RTCM message that can be sent out to vehicles.

Depending upon the vehicle and the GPS system on board, the vehicle may or may not be able to apply the correction factor. Creation of the RTCM message may either be done by operating a base station at the intersection, or by retrieving the RTCM from an on-line source, or by a central calculation at the TMC.

Determining which intersections should include position correction broadcasts would be a site specific decision. Vehicles approaching simple intersections where lane delineation is not required may not benefit from broadcast corrections. Vehicles approaching intersections with separated left-turn lanes (and therefore require the vehicle to process the MAP data and determine the lane of travel) would likely benefit from receiving broadcast corrections. Vehicles approaching intersections in locations with low or poor satellite visibility (e.g. urban canyons) would not benefit significantly from the broadcast corrections to overcome the poor satellite visibility.

RTCM CORRECTIONS MESSAGE RESOURCES

SAE J2735 Standard (that includes the RTCM

Corrections Message):
https://www.sae.org/standards/content/j2735_202007

Cooperative Automated Transportation (CAT) Coalition, SPaT Challenge Resources (includes SPaT V2I Infrastructure System Concept of Operations and System Requirements; SPaT Verification

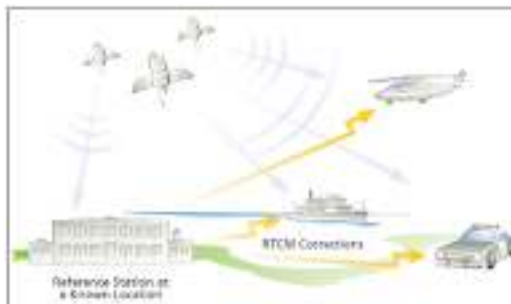
Document):
<https://transportationops.org/spatchallenge/resources>

ITE, Connected Intersections (including Functional Requirements, Concept of Operations, System Design Details, and Implementation Guide):
<https://www.ite.org/technical-resources/standards/connected-intersections>

Remaining Tasks and Challenges

In contrast with the SPaT and MAP messages that are also required for CIs, agencies generally have less experience with RTCM Corrections messages, given uncertainty about the need or benefits of providing them for various applications or locations. The CI Implementation Guide recommends that any real-time kinematic (RTK) base stations should be within 25 miles, and RTCM data may be obtained from the network via Internet Protocol (NTRIP), from a Continuously Operating Reference Station (CORS), or from other sources of positioning corrections. (Note that NTRIP and CORS are both forms of RTK differential correction that are done using a cellular modem and base station network.) However, other uncertainties and tasks remain to be addressed:

- The ITE/CI Implementation Guide recommends RTCM Standard version 3.3 (10403.3) of the RTCM message be used, which may not be available to agencies at this time.
- CORS or NTRIP may not work as well as local base stations because one of the RTCM messages to be sent is the list of satellites used, with the intent that the OBU would attempt to use the same satellites (if available to them). With CORS or NTRIP, the use of the same satellites is less likely. Some deployments have used local base stations with surveyed GPS antennas, while other agencies have used a state-based NTRIP server in lieu of deploying RTCM with a subscription at every location. Another option may be to install an NTRIP caster on roadside units (RSUs) at some locations to broadcast to other RSUs in the area. Agencies have found that accuracy decreases with increased distance from the NTRIP source.
- In general, RTCM has local variants that may prevent overall guidance from being effective. Additionally, there are varying levels of functionality of equipment.
- It is not clear what applications need RTCM Correction messages, and how important it is to provide them with other broadcast messages. However, SAE J2945/A standard will include requirements for RTCM Corrections.



(Source: ESRI, <https://www.esri.com/news/arcuser/0103/differential1of2.html>)

Relevance to CV PFS Members

- The RTCM Corrections message is a required component for IOOs planning to deploy CIs.
- When considering a CI deployment, agency staff should familiarize themselves with RTCM alternatives to understand what options are available and the associated costs.
- Agency staff should work with their signal controller manufacturer to understand the compatibility of signal controller data outputs to the data needed to create the SPaT message.

The RTCM message, in addition to signal phase and timing (SPaT) and mapping information, must be broadcast by an infrastructure system to vehicles for all connected intersections.