CONNECTED AND AUTONOMOUS VEHICLE (CAV) MESSAGE DELIVERY BEST PRACTICES

Project 14.2: Apply Wyoming DOT Connected Vehicle Pilot Project Results

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Prepared for:

North/West Passage Transportation Pooled Fund Study

1 BACKGROUND AND NEED

Connected and autonomous vehicles (CAVs) are poised to transform our streets, communities, and personal lives. As part of this transformation, the USDOT supported the advancement of connected vehicle technology with a pilot deployment program. In 2015, WYDOT, along with Tampa and New York City, were chosen to deploy a real-world pilot project for CV technology. A large portion of this pilot program was dedicated to WYDOT and the I-80 corridor. Trihydro was the technical and application development lead for the WYDOT CV pilot project and worked to develop and deploy various applications to create and deliver Traveler Information Messages (TIMs) depicting events ranging from road conditions, to parking availability, and variable speed limits.

As a primary part of the WYDOT Connected Vehicle Pilot Project the Situation Data Exchange was developed to help with the delivery of CAV messages in a rural environment. The SDX acts as a third-party data sharing platform where CAV messages are housed. Using the SDX Sirius XM pulls TIM data and broadcasts this to all Connected Vehicles with Satellite reception. This delivery method does come with a higher latency cost though of approximately 5 minutes, thus is not intended to solve issues that are near real time.

2 DOCUMENT PURPOSE

This document will attempt to document the scenarios in which the Situation Data Exchange will work well for message distribution vs scenarios where message delivery is more time critical. The document will use an average delivery of a message of 5 minutes to a CV equipped with satellite reception vs 5 second latency for RSU delivery. Please note that the 5 second delivery of a TIM to an RSU is assuming that the RSU is within range of a given Connected Vehicle and that there is a fiber connection to the RSU from the TMC.

3 MESSAGE SCENARIOS

The following scenarios have been identified to be evaluated for the best delivery methodology and best practices.

- Road Construction
- Road Conditions
- Incidents (Near Real-Time information on crashes, landslides, floods, etc.)
- Road Closures
- Wrong-Way Driver Notifications
- Vehicle presence (snowplow or emergency vehicle) notifications

3.1 ROAD CONSTRUCTION

This scenario involves road work along a section of roadway that is either previously planned or unplanned work. Typical road construction scenarios may involve lane closures as well as workers

present along the roadway. Making drivers aware reduced speeds, workers present, and lane closures is critical for the safety of drivers and construction workers in the area.

3.1.1 Message Timeliness

Work Zones are (for the most part) planned activities that are known well in advance. Since this is the case, vehicles traveling in an area for the most part don't need the ability to get information within a matter of seconds to mitigate safety considerations for safety of life.

3.1.2 Distribution Method

Since the Messages generated are not sub second time critical an RSU is not necessarily needed to distribute CAV messages to vehicles on the road for Road Construction activities. It is therefore recommended that DOTs use the SDX for this message distribution. **Final Recommendation: SDX**

3.2 Road Conditions

This scenario involves communicating road conditions to drivers so that they know what upcoming road conditions may look like. Typical road condition notifications involve snowy roads, slick spots, fog, and heavy rain areas but also may involve uncommon scenarios such as high wind areas or even dust storms. Making drivers aware of upcoming road conditions is critical for the safety of drivers in the area.

3.2.1 Message Timeliness

Road Conditions updates to drivers typically don't have split second changes that need to be communicated in near-real time. For example, when road conditions change from dry to snowy or icy conditions that typically happens over the course of a few hours to at the quickest a few minutes. Most of the time these conditions are predictable as well allowing the DOT to send warning notifications for potential changes to road conditions so that drivers are aware. Drivers who receive road conditions information in a matter of minutes from originating from the Traffic Management Center should receive the message and be prepared for the new road conditions in plenty of time.

3.2.2 Distribution Method

Since the Messages generated are not sub second time critical an RSU is not necessarily needed to distribute CAV messages to vehicles on the road for Road Condition information. It is therefore recommended that DOTs use the SDX for this message distribution. **Final Recommendation: SDX**

3.3 Incidents

This scenario involves incidents which may be time critical to communicate with drivers on the road of upcoming impacts. Examples of some of these scenarios may include flash flood, tsunami, vehicle crashes, forest fires, landslides, and other scenarios where travel is suddenly impacted.

3.3.1 Message Timeliness

Due to the sudden nature of the example incidents listed above message timeliness is critical to communicate incidents on roads that may allow drivers to avoid the incident impact area. In this case messages delivered to drivers within seconds of a given incident may help avoid further loss of life. Given the scenario of a tsunami or flash flood area minutes may be critical to safety of life for drivers approaching a given danger area.

3.3.2 Distribution Method

Since the Messages generated are time critical in this scenario it is recommended that high incident areas be outfitted with RSUs to distribute CAV messages to vehicles on the road for incident information. For vehicles not immediately in the area of the incident but that will be approaching the incident It is recommended that DOTs use the SDX for this message distribution as in this scenario message timeliness may not be safety of life critical and will still be able to cover a wide area of vehicles not in the range of RSUs. **Final Recommendation: RSU & SDX**

3.4 Road Closures

This scenario involves communicating road closures to drivers so that they are aware of closures and can plan alternative routes or plans to find a location to wait until the closure is lifted. Typical road closures are related to poor road conditions and sometime large accidents or incidents. Making drivers aware of upcoming road closures is critical for the safety of drivers, commerce of goods, and local communities that may need to accommodate a large influx of travelers during closures.

3.4.1 Message Timeliness

Road Closure updates to drivers typically don't have split second changes that need to be communicated in near-real time. For example, when road closures typically happen with plenty of warning when associated with poor weather conditions. In instances where a road closure is associated with an incident such as a forest fire or a landslide getting information out to drivers may be a little more urgent but typically if a driver receives the closure notice within minutes that is sufficient to avoid any safety of life issues.

3.4.2 Distribution Method

Since the Messages generated are not sub second time critical an RSU is not necessarily needed to distribute CAV messages to vehicles on the road for Road Closure information. It is therefore recommended that DOTs use the SDX for this message distribution. **Final Recommendation: SDX**

3.5 Wrong Way Driver Notifications

This scenario involves notifying upstream drivers of an oncoming wrong way driver that has been detected on the roadway. Wrong way detection is typically on a divided highway or interstate and is a safety of life critical application.

3.5.1 Message Timeliness

Wrong way driver notifications are extremely time sensitive as in most cases of wrong way drivers the impact to other drivers on the roadway is extremely time-sensitive as well as safety of life critical. Based on the time sensitivity for most drivers sub second notifications are recommended for addressing this scenario/

3.5.2 Distribution Method

Since the Messages generated are sub second time critical an RSU is recommended to distribute CAV messages to vehicles on the road for wrong way driver notifications. It is therefore recommended that

DOTs use RSUs for this message distribution. The SDX may be able to supplement for some of the message distribution if RSUs are not available in a given area. **Final Recommendation: RSU & SDX**

3.6 Snowplow or Emergency Vehicle Notifications

This scenario involves notifying drivers on the roadway of the presence of snowplows or emergency vehicles in a given area.

3.6.1 Message Timeliness

There is a specific application in the Connected Vehicle realm that applies to Connected Vehicles on the road to notify other CVs of the presence of Emergency Vehicles (https://local.iteris.com/cvria/html/applications/app29.html#tab-3). This application requires the emergency vehicle to be outfitted with an On Board Unit (OBU) that can broadcast to other vehicles an emergency vehicle alert (EVA) message to notify them of the presence of the emergency vehicle or snowplow.

3.6.2 Distribution Method

Since the Messages for the EVA need to be generated for vehicle-to-vehicle (V2V) communication, sub second time critical messages are critical to communicate with vehicles on the road for Emergency Vehicle Alert notifications. It is therefore recommended that DOTs use the V2V messaging for this application. **Final Recommendation: Outfit Emergency Vehicle with OBU for V2V Communications**