Connected Vehicle Pilot Deployment Program Phase 2

Comprehensive Installation Plan – WYDOT CV Pilot

www.its.dot.gov/index.htm
Final Report — February 16st, 2018
Publication Number: FHWA-JPO-17-471

U.S. Department of Transportation

Produced by DTFH6116H00027
U.S. Department of Transportation
Intelligent Transportation Systems (ITS) Joint Program Office

Notice

Technical Report Documentation Page

1. Report No. FHWA-JPO-17-471	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Connected Vehicle Pilot Deployment Program, Comprehensive Installation Plan – WYDOT CV Pilot		**5. Report Date** Final 2/16/2018 **6. Performing Organization Code**
7. Author(s) Shane Zumpf(Trihydro), Tony English (Trihydro), Deepak Gopalakrishna (ICF), Vince Garcia (Wyoming DOT)		**8. Performing Organization Report No.**
9. Performing Organization Name And Address Wyoming DOT, 5300 Bishop Boulevard, Cheyenne, WY 82009 ICF International, 1725 Eye St NW, Washington DC, 20006 Trihydro Corporation, 1252 Commerce Drive, Laramie, WY 82070		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.** DTFH6116H00027
12. Sponsoring Agency Name and Address ITS-Joint Program Office 1200 New Jersey Avenue, S.E., Washington, DC 20590		**13. Type of Report and Period Covered** Draft Comprehensive Installation Plan 11/1/2015 to 2/16/2018 **14. Sponsoring Agency Code** **HOIT-1**

15. Supplementary Notes
Work performed for: Kate Hartman (COR), Sarah Tarpgaard (CO)

16. Abstract

The Wyoming Department of Transportation's (WYDOT) Connected Vehicle (CV) Pilot Deployment Program is intended to develop a suite of applications that utilize vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communication technology to reduce the impact of adverse weather on truck travel in the I-80 corridor. These applications support a flexible range of services from advisories, roadside alerts, parking notifications and dynamic travel guidance. Information from these applications are made available directly to the equipped fleets or through data connections to fleet management centers (who will then communicate it to their trucks using their own systems). The pilot will be conducted in three Phases. Phase I includes the planning for the CV pilot including the concept of operations development. Phase II is the design, development, and testing phase. Phase III includes a real-world demonstration of the applications developed as part of this pilot.

This Phase II document presents the Comprehensive Installation Plan for the software, hardware and maintenance for purchases in support of the Concept of Operations document.

17. Key Words	18. Distribution Statement
Connected Vehicle Technology, I-80 Corridor, Road Weather, Truck Safety, System Architecture, Installation	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	88	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Acknowledgements

We acknowledge the timely and high-quality support offered by USDOT, and the support contractor Noblis throughout Phase 2.

Table of Contents

1 Introduction

The WYDOT Comprehensive Installation Plan (CIP) provides an overview of the proposed installation approach that includes instructions as well as a schedule for installing all equipment related to the WYDOT CV Pilot project.

1.1 Purpose of the Plan

The purpose of this plan is to document the WYDOT CV Pilot's installation plan. This will be useful to demonstrate compliance with both the policies for the State of Wyoming and the Notice of Funding Opportunities (NOFO).

1.2 Organization of the Plan

The Comprehensive Installation Plan document is organized as follows:

- Chapter 2 provides an overview of the WYDOT acquisition plan including approach, schedule and vendor selection.
- Chapter 3 provides an overview of the WYDOT installation equipment including suppliers, procurement, and inventory management.
- Chapter 4 details the installation of vehicle/in-vehicle equipment.
- Chapter 5 details the installation of roadside equipment.
- Chapter 6 details the installation of mobile devices.
- Chapter 7 details the installation of equipment for the data center.
- Chapter 8 details the installation of other equipment for the pilot.
- Chapter 9 lists the bill of materials for equipment described in this document.
- Chapter 10 lists the glossary of terms used in this document.
- Chapter 11 lists the references cited in this document.

2 Acquisition Overview

The WYDOT CV Pilot acquisition program is in compliance with the NOFO and the State of Wyoming acquisition policies. To ensure full compliance with policies and laws for the State of Wyoming, all purchasing is being done directly through the state's purchasing system. WYDOT has a procurement process that allows the acquisition and tracking of equipment and software for client contracts. The procurement and accounting processes include the following staffing resources: legal/contracts, accounts receivable, accounts payable, inventory tracking, and reporting, and the process involves a subject matter expert to provide the product specifications. WYDOT is using a procurement team that includes WYDOT staff and Trihydro. The procurement team will manage the connected vehicle equipment and software acquisitions. The Trihydro team will assist WYDOT on equipment and software acquisition. WYDOT will make the acquisitions and Trihydro will write the specifications for software and hardware. The Trihydro team has former experience with scoping out the specifications, configuring equipment and then installing the equipment on behalf of WYDOT. Vendor specific additional language is included in Appendix A for Lear, SiriusXM and WeatherCloud to cover the CV specific hardware and software needed for this project.

A detailed description of each of the components is provided in the SDD.

2.1 Acquisition Approach

The approach for acquiring equipment and services is illustrated in Figure 2-1. In summary, the first step is to define the concept of operations (ConOps) based on the identified user needs. This process leads to the system requirements (SyRS), security management operating concept (SMOC), and application development (App. Dev.) plan, all completed in Phase 1. These documents provide enough information to describe the acquisitions needed for the vehicle, roadside and the WYDOT Traffic Management Center (TMC). Based on this, vendor research will be conducted to find vendors knowledgeable in each area that equipment or services are required. The heavy seasonal Winter workload of the WYDOT fleet will drive early procurement of some equipment. In some cases, the fleet vehicles and personnel which will install and utilize the equipment are only available for installation and testing during the summer months. Consequently, vendor selection criteria will consider vendor responsiveness for all areas including: software, hardware, support and their ability to deliver on time. Procurement of the equipment will be handled by a purchasing officer within the WYDOT acquisition team. The procurement process will follow these steps:

1. Evaluation of the purchase request by the team including any sole source justifications if necessary
2. Submittal of a purchase order to the vendor based on the agreed-upon purchase price of the equipment and quantities required
3. Tracking of the order confirmation and delivery schedule provided by the vendor
4. Receipt and inventory of the delivery to compare the purchase order and equipment received

The WYDOT purchasing office will be responsible for tracking and reporting on the equipment budget to the management team.

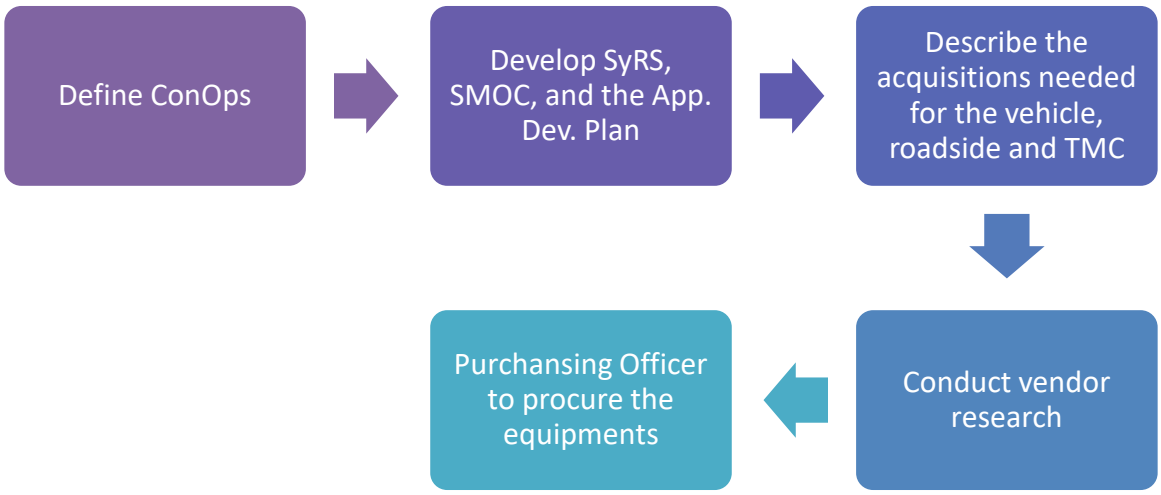

Figure 2-1. Approach for acquiring equipment and services.

2.2 Acquisition Schedule

The Wyoming Pilot will acquire one type of infrastructure RSU, three mobile types of OBUs, and one type of mobile weather sensor. This section describes the status of the type of element development, production, and schedule. A summary table of planned equipment purchases is provided in Table 2-1.

Table 2-1. Wyoming CV Pilot's Planned Equipment Purchases.

Item	Quantity	Schedule
RSUs	78	Initial set of 10 devices: December 2016. Fulfillment of devices (75 total devices): July 2017
OBU devices capable of bidirectional DSRC communications and receiving Traveler Information Messages (TIM) via satellite – no CAN Bus or environmental sensor support	28	Initial five devices: June 2017. Remaining devices: Sept 2017.
OBU devices capable of bidirectional DSRC communications and receiving TIMs via satellite – CAN Bus or environmental sensor would be supported	254	Set of devices will be purchased between December 2016 and April 2018.
OBU devices capable of DSRC bidirectional communications with no satellite capabilities – no CAN Bus or environmental sensor support	126	Initial 10 devices: December 2016. Additional 23 devices: Sept 2017. Remaining devices: April 2018.
Mobile weather sensors	53	Initial 10 devices: January 2017. Remaining devices: Sept 2017.

2.3 Vendor Outreach Plan

During Phase 1 the WYDOT team researched vendors of connected vehicle equipment, discussed with these vendors the pilot's requirements for software, hardware and services. After discussing with these vendors, the requirements and providing them the ConOps, SMOC, Application Development Plan and SyRS a proposal was requested from qualified vendors. Vendors were invited onsite for a meeting with the WYDOT CV Pilot leadership to discuss and demo equipment. Only RSU/OBUs that have passed USDOT-approved certification will be considered for acquisition. Currently, the pilot is obtaining proposals from vendors to provide turnkey solutions for certified hardware, software, installation support, and warranty support coverage for the roadside and on-board hardware and software for the pilot's duration.

3 Installation Overview

The WYDOT CV Pilot installation program is in compliance with the NOFO and the State of Wyoming installation policies. To ensure full compliance with policies and laws for the State of Wyoming, all installations involving state vehicles and infrastructure is being done directly through WYDOT staff. WYDOT has an established installation process that allows the installation and tracking of equipment and software. The installation processes include the following staffing resources: maintenance and vehicle support, inventory tracking, and the process involves a subject matter expert to provide the installation specifications. WYDOT is using an installation team that includes WYDOT staff and Trihydro. The installation team will manage the connected vehicle equipment and software installations. The Trihydro team will assist WYDOT on equipment and software installation. WYDOT will make the installations and Trihydro will write the installation guides for software and hardware. The Trihydro team has former experience with scoping out the specifications, configuring equipment and then installing the equipment on behalf of WYDOT.

3.1 Supplier Base

The WYDOT supplier base for the CV project consists of one type of infrastructure RSU, three mobile types of OBUs, and one type of mobile weather sensor. A summary table of suppliers and the equipment provided by each is provided in Table 3-1.

Table 3-1. Wyoming CV Pilot's suppliers and associated equipment.

Item	Vendor	Quantity
RSUs	Lear	78
OBU devices capable of bidirectional DSRC communications and receiving Traveler Information Messages (TIM) via satellite – no CAN Bus or environmental sensor support	Sirius XM	28
OBU devices capable of bidirectional DSRC communications and receiving TIMs via satellite – CAN Bus or environmental sensor would be supported	Lear	380
Mobile weather sensors	WeatherCloud	53

3.2 Procurement Method

During Phase 1 the WYDOT team researched vendors of connected vehicle equipment, discussed with these vendors the pilot's requirements for software, hardware and services. After discussing with these vendors, the requirements and providing them the ConOps, SMOC, Application Development Plan and SyRS a proposal was requested from qualified vendors. Vendors were invited onsite for a meeting with the WYDOT CV Pilot leadership to discuss and demo equipment. Only RSU/OBUs that have passed USDOT-approved certification will be considered for acquisition. The pilot obtained

proposals from vendors to provide turnkey solutions for certified hardware, software, installation support, and warranty support coverage for the roadside and on-board hardware and software for the pilot's duration. Based on the provided proposals vendors were evaluated and chosen.

3.3 Inventory Management

Inventory management for all CV related equipment is being handled through an Excel Spreadsheet for a detailed view of all equipment. Only equipment managers will have access to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. This will allow equipment managers to track all changes made to the Spreadsheet and ensure correctness. After receiving equipment from a Vendor all equipment is entered into the inventory spreadsheet along with the current location and responsible owner. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment. Equipment audits will be performed on a quarterly basis and the equipment manager will be responsible for reviewing the inventory spreadsheet and auditing the current in stock inventory as well as the equipment that has been checked out for testing and installation purposes. For inventory that is being distributed to private partners the inventory will be marked as checked out and the equipment manager will be responsible for contacting private partners monthly until all equipment has been installed and is in active use.

3.4 Configuration Management

Devices for this pilot will be able to be configured both manually as well as remotely. For OBU and RSU configuration the OBU/RSU management application will allow WYDOT to push new firmware out remotely to RSUs for immediate updates and provide a method to configure the RSUs/OBUs remotely through a web interface. Hardware configurations will be documented and stored on the WYDOT Confluence site. The configuration documents within the Confluence site will be considered living documents and updated as configurations are updated. The full configuration management process for RSU and OBU updates after deployments have been made will include the following.

1. Configuration updates are identified either from or with the help of Lear
2. Updates are tested in a controlled environment:
    a. On the bench top
    b. With equipped vehicles and test RSUs on a test track
    c. With equipped vehicles on a Road Test
3. If tests fail go back to step 1
4. Results are documented and handed to Vince Garcia for thumbs up/down
5. If rejected based on insufficient testing, go back to step 2
6. If rejected based on risk to equipment/project go back to step 1
7. If Approval is given, updates are scheduled for a time with low impact to CV vehicles
8. Configuration updates are rolled out to OBUs/RSUs.

If changes are made to this process then this document will be updated with the latest process.

3.5 High Level Equipment Inventory

Table 3-2 provides a high-level overview of the current total number of devices procured as well as the current number of devices that have been configured and installed within the WYDOT CV system.

Table 3-2. Equipment Inventory Summary

Equipment Type	Total # Procured	Total # Configured & Installed
RSUs	78	2
OBU devices capable of bidirectional DSRC communications and receiving Traveler Information Messages (TIM) via satellite – no CAN Bus or environmental sensor support	28	0
OBU devices capable of bidirectional DSRC communications and receiving TIMs via satellite – CAN Bus or environmental sensor would be supported	380	3
Mobile weather sensors	53	1
Dell PowerEdge R730 Server	2	2
Dell Storage Arrays	2	2
Dell Networking Switch	1	1

3.6 Installation Schedule

Table 3-3 shows a summary of the planned equipment purchases and the deployment schedule associated with each equipment type.

Table 3-3. Wyoming CV Pilot's Equipment Deployment Schedule

Item	Quantity	Schedule
RSUs	78	Initial set of 10 devices: December 2016. Fulfillment of devices (75 total devices): July 2017
OBU devices capable of bidirectional DSRC communications and receiving Traveler Information Messages (TIM) via satellite – no CAN Bus or environmental sensor support	28	Initial five devices: June 2017. Remaining devices: Sept 2017.
OBU devices capable of bidirectional DSRC communications and receiving TIMs via satellite – CAN Bus or environmental sensor would be supported	380	3 devices installed by March, 2017 120 devices installed by December 31, 2017 Remaining devices installed by April 30, 2018
Mobile weather sensors	53	December 31, 2017
Center Equipment (Servers, Storage Arrays, and Switch)	5	January 2017

3.7 Installation Plan

The Wyoming Pilot installation plan consists of plans for installing and configuring infrastructure hardware and software, Roadside Units and supporting hardware components, and Vehicle Equipment. The acquisition of all the equipment that is planned for installation is detailed in the Comprehensive Acquisition Plan. This document will reference the equipment detail in the acquisition plan and detail the installation of the equipment.

All equipment installed for the Wyoming CV Pilot project will be installed by qualified personnel with installation experience that have been approved by WYDOT or a partner for vehicle installations. All partners for the WYDOT CV project will be given detailed installation guides that detail the following information:

- Wiring, fiber optic splicing (if applicable) and interconnects
- Rack mount elevation of communications devices in the Control Center
- Electrical and power interface diagram(s) which include grounding and transient voltage surge suppression)
- Infrastructure hardware mounting details
- In-vehicle hardware mounting details
- Installation verification instructions

The installation guides will be provided to WYDOT for installation in Snow Plows as well as to Commercial Vehicle Operator partners. The guides will be written using this document as the base and then modifying it to incorporate the type of vehicle where the installation will take place. The guide will be provided to WYDOT by mid-November and distributed to Commercial Vehicle Operator partners by January 1, 2018.

4 Vehicle/In-Vehicle Equipment

The section describes equipment that will be installed within vehicles for the Wyoming CV pilot project.

4.1 Lear Locomate Roadstar Premium OBU Kit

4.1.1 Acquisition Information

The following sections describe the acquisition information related to the Lear Locomate Roadstar Premium OBU.

4.1.1.1 Technical Description/Specification

These OBUs are intended to be the primary communication link between WYDOT RSUs and vehicles. This OBU sub-system has the ability to:

- Receive TIMs via DSRC and Satellite.
- Integrate with the vehicle network via a Controller Area Network (CAN bus) connection.
- Receive BSM Parts I and II.
- Broadcast BSM Parts I and II.
- Broadcast TIMs via DSRC for Distress Notification.
- Transmit weather sensor data.

Further information on the design and requirements associated with this OBU can be found in section 3.2.1 of the Wyoming System Design Document (SDD).

4.1.1.2 Ancillary Equipment

This OBU will be purchased as part of a kit (part name: Lear Locomate Roadstar Premium). Additional components will be needed outside of the kit for a full vehicle installation. These include the following components:

- OBD2 16 pin to DB9 Serial Port Adapter

4.1.1.3 Part Numbers and Quantities

Table 4-1 shows the parts and quantities being acquired for the Wyoming CV Pilot Project.

Table 4-1. Lear Locomate Roadstar Premium Parts

Description	Part Number or Name	Quantity
OBU kit	Lear Locomate Roadstar Premium	347
OBD2 Adapter	Suntek Item# 14000219	347

HMI	Samsung SM-T580	TBD

4.1.1.4 Associated Software

All software associated with this equipment is preloaded onto the unit and is licensed with Lear. All software updates are managed over the air through Lear.

4.1.1.5 Acquisition Schedule

These devices (the OBU and the Samsung tablet) will be purchased between December 2016 and April 2018 with delivery occurring within days of the purchase.

4.1.2 Installation Information

The sections below detail the installation plan and information for the Lear Locomate Roadstar Premium OBU.

4.1.2.1 Supplier(s)

Table 4-2 lists the suppliers for the vehicle OBU.

Table 4-2. Locomate Roadstar Premium Suppliers

Description	Part Number or Name	Supplier
OBU kit	Lear Locomate Roadstar Premium	Lear
OBD2 Adapter	Suntek Item# 14000219	Suntek
HMI	Samsung SM-T580	Samsung

4.1.2.2 Inventory Control Method

All OBU's will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the spreadsheet which will be stored in a OneDrive folder with version tracking enabled. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment.

4.1.2.3 Configuration(s)

Configurations for OBU devices will need to be done prior to distribution of the OBU devices in order to work correctly with different vehicle types. Vehicle Types and their configurations are seen in Table 4-3.

Table 4-3. Lear Locomate Roadstar Premium OBU Configuration Parameters

Vehicle Type	OBU Configuration Setup
Light Trucks / Cars / Snow Plows	• Disable Telnet Configuration • Reset default admin password • Enable ipservice application • Generate an SSH public key

	• Configure the offload application
	  ○ Specify application name: weathercloud
	  ○ Psid: 35
	  ○ userRequestType: 1
	  ○ serviceChannel: 176
	  ○ wsaType: 4
	  ○ psc: offload
	  ○ host server ip: <ip address>
	  ○ host server destination directory: /tmp
	  ○ local source directory: /var/weather_cloud_files
	  ○ retrycount: 3
	• VehicleType – set to the appropriate vehicle type
	• VehicleWidth – set to the installation vehicles width
	• VehicleLength – set to the installation vehicles length

Commercial Vehicles	• Disable Telnet Configuration • Reset default admin password • Generate an SSH public key • VehicleType – set to the appropriate vehicle type • VehicleWidth – set to the installation vehicles width • VehicleLength – set to the installation vehicles length

4.1.2.4 Installation Diagram(s)

The figures below represent the detailed installation information for the Lear Locomate Roadstar Premium OBU.

Equipment Checklist		
Part No.	Item	Quantity
1	Locomate Roadstar OBU	1
2	12 Volt Adaptor plug	1
3	SiriusXM Antenna	1
4	Mounting Brackets	2
5	Anti-Vibraion Grommets	4
6	OBU Bracket Bolts	4
7	Mounting Bracket Bolts	4
8	Mounting Bracket Screws (opt)	4
9	Bluetooth Antenna	1
10	WIFI Antenna	3
11	Integrated GPS/DSRC Antenna	1

Figure 4-1. Lear Locomate Roadstar Premium OBU Parts List

Figure 4-2. OBU Base Unit Installation Diagram

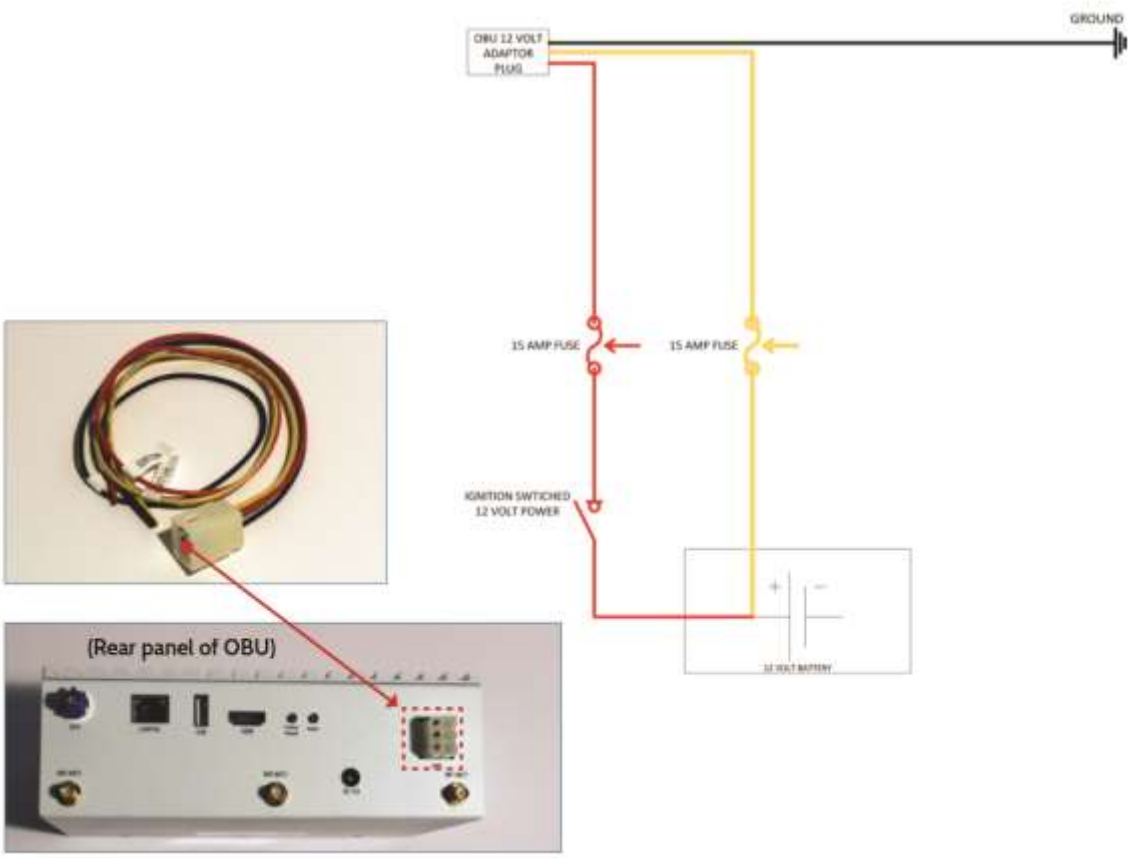

Figure 4-3. Lear Locomate Roadstar Premium Wiring Installation

Figure 4-4. Lear Locomate Roadstar Premium Antenna Placement

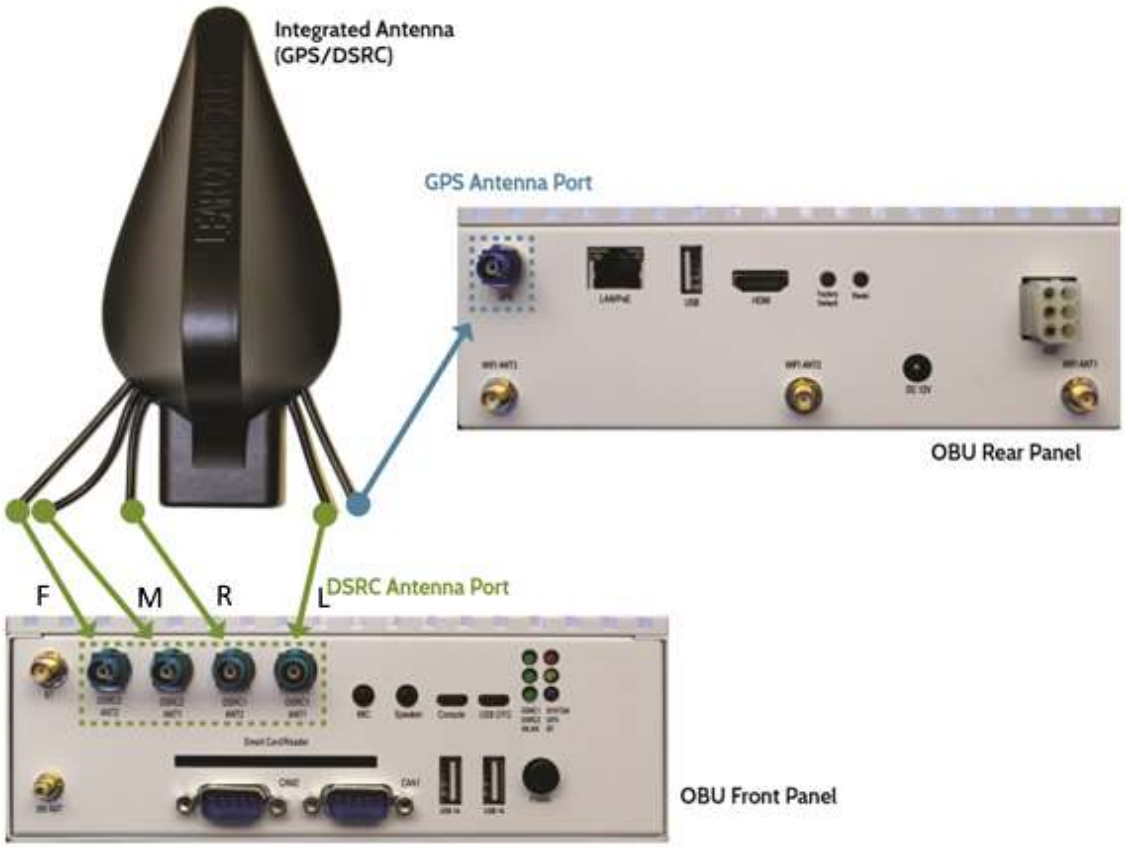

Figure 4-5. Lear Locomate Roadstar Premium Antenna Wiring

Figure 4-6. Lear Locomate Roadstar Premium CAN Bus Installation

Figure 4-7. HMI Kit

4.1.2.5 Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

4.1.2.5.1 Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the OBU package. The Table 4-4. Installation Equipment Checklist should be used to verify the equipment was delivered properly. If the package is not complete, the vendor will be contacted for the missing components.

Table 4-4. Installation Equipment Checklist

Part No.	Item	Quantity
1	Locomate Roadstar OBU	1
2	12 Volt Adaptor plug	1
3	SiriusXM Antenna	1
4	Mounting Brackets	2
5	Anti-Vibration Grommets	4
6	OBU Bracket Bolts	4
7	Mounting Bracket Bolts	4

8	Mounting Bracket Screws (opt)	4
9	Bluetooth Antenna	1
10	WIFI Antenna	3
11	Integrated GPS/DSRC Antenna	1

Additionally, all equipment in the check list should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement equipment or fixes to the existing equipment will be requested. All OBUs being installed should also be verified that the latest version of the firmware is installed on the OBU and the unit is bootstrapped with security certificates.

4.1.2.5.2 Installation Procedures

Step 1: OBU Installation (mounting) **-** Figure 4-2

1. The OBU (part no. 1) can be installed anywhere in the passenger compartment where the space allows. When choosing the location to mount the OBU remember to leave ample room for the antennas and wiring. Locate the OBU in a location to avoid damage to the WIFI and Bluetooth antennas.
2. Attach the mounting brackets (part No. 4) to the back of the OBU using the mounting bracket screws (part no. 6).
3. Attach the Bluetooth (part no. 9) and WIFI (part no. 10) antennas to the OBU by screwing the antennas to the appropriate ports.
4. Insert the anti-vibration grommets (part no. 5) into the mounting brackets.
5. Mount OBU using the mounting bracket bolts or option metal screws (part no. 7 or 8).

Step 2: OBU Installation (12 volt wiring) **-** Figure 4-3

1. Using Diagram 2 connect wires based on the constant 12 volts, switched 12 volt and ground.
2. Use 15-amp fuses on the positive charged wires to ensure surge protection to the OBU.
3. Connect the 12-volt adaptor plug to the OBU to power the unit.

Step 3: Antenna Installation **-** Figure 4-4 and Figure 4-5

1. Locate the Integrated GPS/DSRC antenna (part no. 11) on the roof of the vehicle based on Diagram 3.1.
2. Run the wires from the Integrated GPS/DSRC antenna to the OBU through a window or door.
3. Connect the antenna wires to the OBU based on Figure 4-5. Please note the wires labeled F,M,R,L are connected to the ports consistent with Figure 4-5.

Step 4: Vehicle CAN Installation (optional) **-** Figure 4-6

1. Run the OBD2 16 Pin to DB9 Serial port adaptor cable from the OBU to the vehicles OBD2 port.
2. Secure the wires to avoid damage or accidental disconnects.
3. Plug in the OBD2 to the vehicles ODB2 port
4. Plug in the DB9 Serial port into the CAN1 port on the OBU.

Step 5: Vehicle HMI Installation - Figure 4-7

1. Mount the HMI to the dash of the vehicle using an approved vehicle tablet dash mount (example mount shown in Figure 4-7).
2. Attach the tablet to the vehicle mount.
3. Use the USB cable to power the tablet.
4. Power the tablet on and connect to the OBU via Bluetooth or WiFi.
5. Launch the Lear HMI App.

4.1.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the device installed is working properly the following steps should be followed immediately after installation in the vehicle is completed.

1. No power to the device should be verified based on no led lights light up after the vehicle has been turned off and key removed from the ignition for 1 minute. The device should be able to have some residual power to the unit in order to properly shut down immediately after the vehicle has been turned off.
2. Power to the device should be verified from the LED lights on the OBU device indicating power when the vehicle is turned on.
3. With the vehicle powered on a portable RSU unit should be setup and a set of test scripts run to verify that the OBU unit is properly sending BSMs and receiving TIMs.
4. With the vehicle powered on a portable OBU unit should be setup and a set of test scripts run to verify that the newly installed OBU unit is properly receiving BSMs.
5. Verify that TIMs are displayed on the HMI.
6. Record the OBU installation in the inventory spreadsheet. Items documented in the spreadsheet include OBU firmware version, OBU Serial Number, OBU make/model, and OBU location.

4.1.2.6 Quality Assurance/Quality Control Process

In order to verify the OBUs received from Lear are functioning properly and that the device has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for each OBU. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

4.1.2.7 Installation Schedule

Table 4-5 details the delivery and installation schedule for the Lear Locomate Roadstar Premium OBU.

Table 4-5. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Initial OBU Delivery	10	December 2016
Test Vehicles (Trihydro) Installation	7	April 2017
WYDOT Snow Plow and Trihydro OBU Delivery	76	October 2017
WYDOT Snow Plow and Trihydro Installation	76	October 2017
Remaining OBU Delivery	261	April 2018
Remaining OBU Installation	261	May 2018

4.1.2.8 HW and SW Configuration Control Process

All hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be managed through a combination of the Lear HMI app (HMI) and through Over the Air updates managed by Lear. Over the Air updates will only be authorized after it has been tested in a benchtop, controlled track, and on road environment. After this

testing has passed and WYDOT has approved the update a time will be scheduled to make the Over the Air update available to OBUs so that vehicles are not impacted during times where road conditions may be hazardous. As OBUs are configured the configuration will be recorded within the inventory management spreadsheet in order to verify that the OBU has been configured prior to releasing the OBU for installation.

4.1.2.9 Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will carry 3 spare units for use in lab testing and as potential quick replacements for field units. These Units will also carry a full warranty for all hardware and software on the units for the life of the pilot project. The contingency plan for spares is to send defective units back to the Vendor for replacement units to quickly swap out OBU units.

4.2 Sirius OBU Kit

4.2.1 Acquisition Information

The following sections describe the acquisition information related to the Sirius XM OBU.

4.2.1.1 Technical Description/Specification

These OBUs are intended for trucks and other fleet vehicles that do not include integration with CAN bus data integration. This Sub-System intends to test the interaction between the systems within the WYDOT CV Pilot and external/commercial devices that are not developed as part of this pilot. In this manner, this Sub-System is intended to "simulate" a commercial-off-the-shelf (COTS) system that enables a vehicle to communicate data through DSRC to other connected devices and receive TIMs through DSRC and satellite. These devices will also receive BSM Parts I and II over DSRC. About 25 vehicles are expected in this category. This OBU sub-system has the ability to:

- Receive TIMs via DSRC and Satellite.
- Receive BSM Parts I and II.
- Broadcast BSM Parts I and II.

Further information on the design and requirements associated with this OBU can be found in section 3.2.1 of the Wyoming System Design Document (SDD).

4.2.1.2 Ancillary Equipment

This OBU will be purchased as part of a kit from Sirius XM. No additional components will be needed outside of the kit for a full vehicle installation.

4.2.1.3 Part Numbers and Quantities

Table 4-1 shows the parts and quantities being acquired for the Wyoming CV Pilot Project.

Table 4-6. Sirius XM OBU Parts

Description	Part Number or Name	Quantity
OBU kit	Sirius XM OBU	28

4.2.1.4 Associated Software

All software associated with this equipment is preloaded onto the unit and is licensed with Sirius.

4.2.1.5 Acquisition Schedule

These devices will be purchased between July 2017 and September 2017 with delivery occurring within days of the purchase.

4.2.2 Installation Information

The sections below detail the installation plan and information for the Sirius XM OBU. Please note that Sirius has provided a draft copy of their installation instructions that is attached to this document. Many of the sections below will reference the following attachment:

Auriga Installation Guide 170831c.pdf

4.2.2.1 Supplier(s)

Table 4-2 lists the suppliers for the vehicle OBU.

Table 4-7. Sirius XM OBU Suppliers

Description	Part Number or Name	Supplier
OBU kit	Sirius XM OBU	Sirius

4.2.2.2 Inventory Control Method

All OBU's will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment.

4.2.2.3 Configuration(s)

Please see the Sirius installation guide for this information.

4.2.2.4 Installation Diagram(s)

Please see the Sirius installation guide for this information.

4.2.2.5 Installation Procedures

The following sections provide details on the installations procedures for the Sirius XM OBU.

4.2.2.5.1 Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the OBU package. If the package is not complete, the vendor will be contacted for the missing components. Contact information for the vendor will be provided in the final installation guide.

4.2.2.5.2 Installation Procedures

Please see the Sirius installation guide for this information.

4.2.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the device installed is working properly the following steps should be followed immediately after installation in the vehicle is completed.

1. No power to the device should be verified based on no BSMs being sent from the vehicle and no power being drawn from the device (using a voltmeter) when the vehicle is powered off.
2. With the vehicle powered on a portable OBU unit should be setup and a set of test scripts run to verify that the OBU unit is properly sending and receiving BSMs.

Additionally, the Sirius installation guide also details post-installation procedures that will need to be followed in order to verify that the installation has been completed successfully.

4.2.2.6 Quality Assurance/Quality Control Process

In order to verify the Sirius XM OBUs are functioning properly and that the device has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for each OBU. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

4.2.2.7 Installation Schedule

Table 4-5 details the delivery and installation schedule for the Sirius XM OBU.

Table 4-8. Sirius XM OBU Installation Schedule

Vehicles	Quantity	Schedule
Initial OBU Delivery	10	December 2016
Test Vehicles (Trihydro) Installation	7	April 2017
WYDOT Snow Plow and Trihydro OBU Delivery	76	October 2017
WYDOT Snow Plow and Trihydro Installation	76	October 2017
Remaining OBU Delivery	261	April 2018
Remaining OBU Installation	261	May 2018

4.2.2.8 HW and SW Configuration Control Process

All Hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be managed through a Sirius XM user interface, details of which will need to be hashed out with Sirius XM at a later date.

4.2.2.9 Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will carry 3 spare units for use in lab testing and as potential quick replacements for field units. These Units will also carry a full warranty for all hardware and software on the units for the life of the pilot project. The contingency plan for spares is to send defective units back to the Vendor for replacement units to quickly swap out OBU units.

4.3 Weather Cloud Weather Sensors

4.3.1 Acquisition Information

The following sections describe the acquisition information related to the Weather Cloud weather sensors.

4.3.1.1 Technical Description/Specification

The Weather Cloud Environmental Sensors will collect and transmit data to the Android Tablet using the Weather Cloud GroundTruth application. The GroundTruth app is designed to be the gateway between the sensors and the HMI device. The GroundTruth app connects to the sensors using Bluetooth Low Energy (BLE) and writes the sensor data to a local file on the HMI.

4.3.1.2 Ancillary Equipment

The Weather Cloud Weather Sensors will be purchased as part of a kit. No additional components will be needed outside of the kit for a full vehicle installation.

4.3.1.3 Part Numbers and Quantities

Table 4-9 shows the parts and quantities being acquired for the Wyoming CV Pilot Project.

Table 4-9. Weather Cloud Weather Sensor Parts

Description	Part Number or Name	Quantity
Sky Environmental Sensor	Weather Cloud Sky Sensor	53[1]
Road Environmental Sensor	Weather Cloud Road Sensor	53[2]

4.3.1.4 Associated Software

All software associated with this equipment is preloaded onto the unit and is licensed with Weather Cloud. All software updates associated with the weather sensors are managed through App updates controlled by Weather Cloud.

4.3.1.5 Acquisition Method

[1] Count includes 3 spare units for use in lab testing and as potential quick replacements for field units.
[2] Count includes 3 spare units for use in lab testing and as potential quick replacements for field units.

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Vendor evaluations considered the technical maturity of the vendors' existing offerings, the vendors' willingness to update their software and hardware to the industry standards adopted by the Pilot. Our research and vendor interviews have led us to a single vendor for the Environmental Sensors.

4.3.1.6 Potential Vendors

Weather Cloud has been chosen as the vendor for this hardware. Further information on the selection process can be found in the Comprehensive Acquisition Plan.

4.3.1.7 Acquisition Schedule

These devices will be purchased between December 2016 and April 2018 with delivery occurring within days of the purchase.

4.3.2 Installation Information

The sections below detail the installation plan and information for the Weather Sensors.

4.3.2.1 Supplier(s)

Table 4-10 lists the suppliers for the vehicle weather sensors.

Table 4-10. Weather Sensor Suppliers

Description	Part Number or Name	Supplier
Sky Environmental Sensor	Weather Cloud Sky Sensor	Weather Cloud
Road Environmental Sensor	Weather Cloud Road Sensor	Weather Cloud

4.3.2.2 Inventory Control Method

All Weather Sensors will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment.

4.3.2.3 Configuration(s)

No configurations will be required for the weather sensors. They will be put on vehicles as is received from the vendor.

4.3.2.4 Installation Diagram(s)

The diagrams below show the installation and description of the Weather Cloud Weather Sensors.

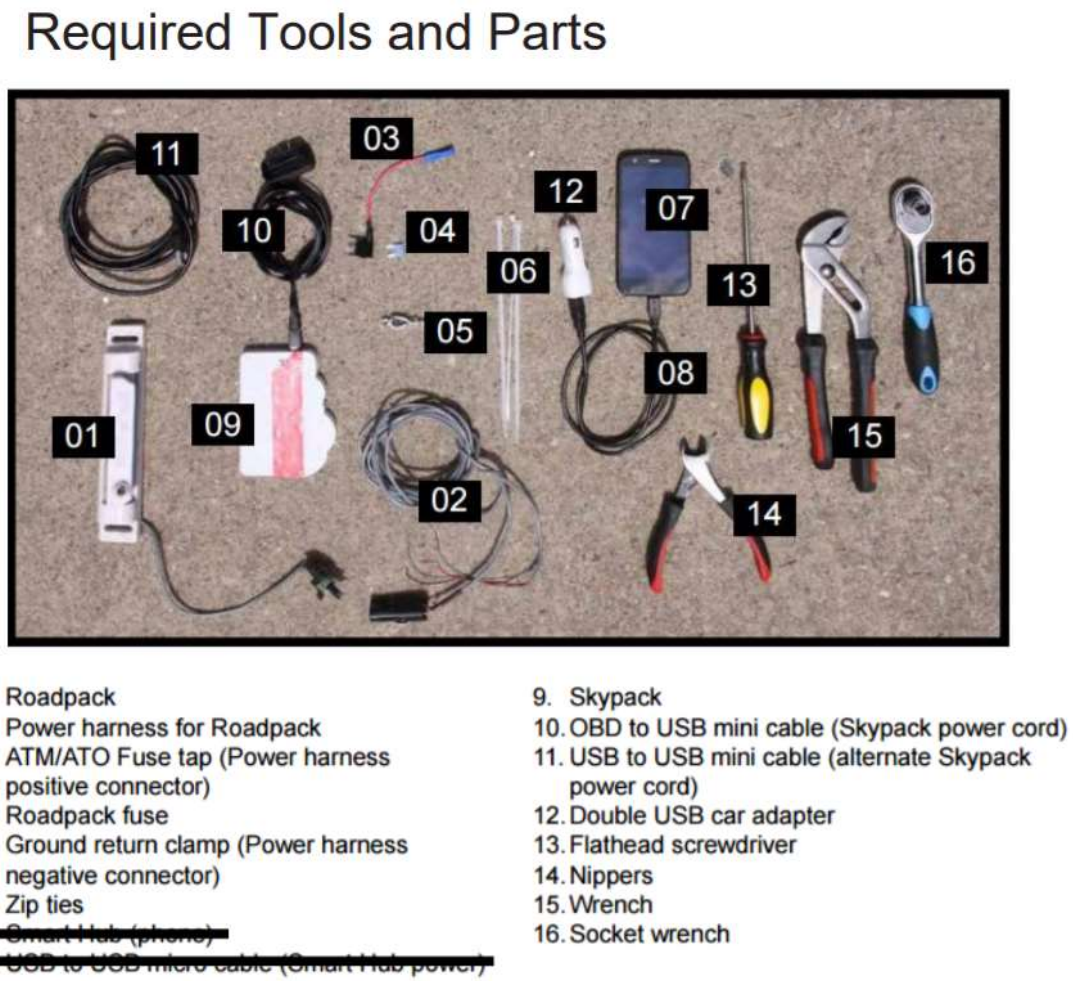

Figure 4-8. Weather Cloud Required Tool and Parts List (Source: Weather Cloud)

Figure 4-9. Attaching Ground Return Clamp to Vehicle (Source: Weather Cloud)

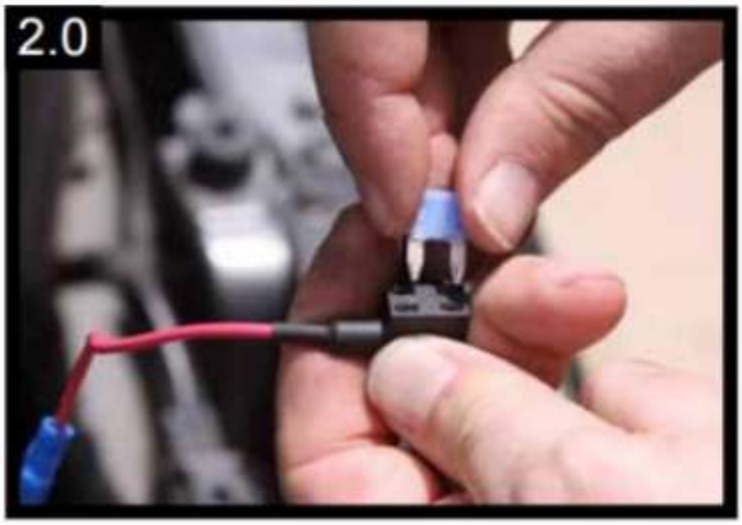

Figure 4-10. Attaching Fuse Tap to Power Harness (Source: Weather Cloud)

Figure 4-11. Attaching Fuse Tap to Power Harness (Source: Weather Cloud)

Figure 4-12. Attaching Fuse Tap to Power Harness (Source: Weather Cloud)

Figure 4-13. Replace Fuse Box Lid (Source: Weather Cloud)

Figure 4-14. Feed Power Harness through license plate. (Source: Weather Cloud)

Figure 4-15. Feed Power Harness through License Plate (Source: Weather Cloud)

Figure 4-16. Connect Roadpack to Power Harness (Source: Weather Cloud)

Figure 4-17. Attach Roadpack to License Plate Mounting Frame (Source: Weather Cloud)

Figure 4-18. Attach Roadpack to License Plate Mounting Frame (Source: Weather Cloud)

Figure 4-19. Coil and Tie Power Harness Slack (Source: Weather Cloud)

Figure 4-20. Attach Ground Return Clamp to Car (Source: Weather Cloud)

Figure 4-21. Plug in Skypack to Barrel Plug (Source: Weather Cloud)

Figure 4-22. Connect power cord to Skypack (Source: Weather Cloud)

Figure 4-23. Place Skypack on interior of windshield (Source: Weather Cloud)

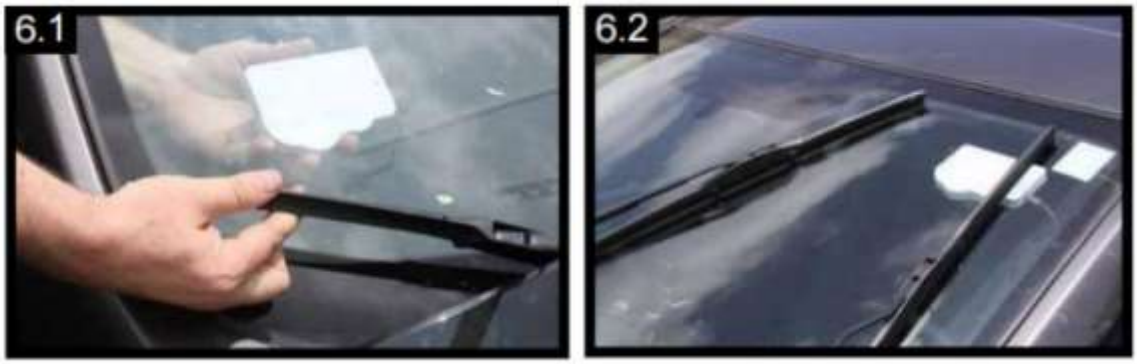

Figure 4-24. Place Skypack on interior of windshield (Source: Weather Cloud)

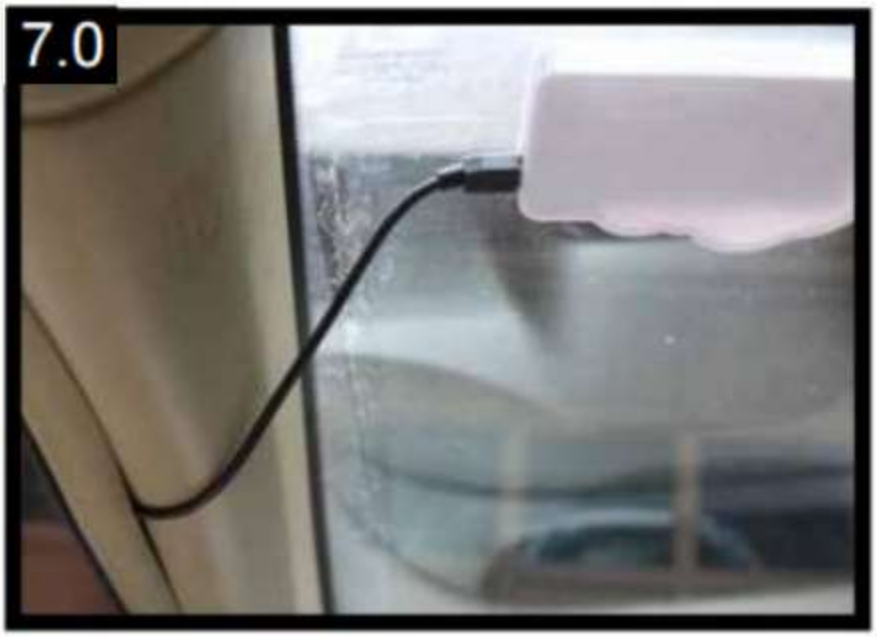

Figure 4-25. Tuck away power cord (Source: Weather Cloud)

4.3.2.5 Installation Procedures

The following sections provide details on the installation process for the Weather Cloud Weather Sensors.

4.3.2.5.1 Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the Weather Sensor package. Figure 4-8. Weather Cloud Required Tool and Parts Listshould be used to verify the equipment was delivered properly and that all necessary installation tools are available. If the package is not complete, the vendor will be contacted for the missing components.

Additionally, all equipment in the check list should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement equipment or fixes to the existing equipment will be requested.

4.3.2.5.2 Installation Procedures

Roadpack Installation

Read through all instructions before beginning installation process.

1. Attach ground return clamp to car (Figure 4-9) - Slide the bare end of the black, negative wire of Roadpack power harness into the grounding clamp. Tighten the screw with a flathead screw driver so that the bare wires are held tightly in place. Attach to grounding metal. Alternatively, a spade terminal connector can be crimped onto the end of the grounding wire, and attached to any grounding point on the vehicle.
2. Attach fuse tap to power harness (Figure 4-10) - Attach the fuse tap to the red, positive wire of power harness. Slide the bare wires of the red wire into the blue connector at the end of the fuse tap.
    a. Pinch the blue connector tightly around the bare wires with a set of plyers. Plug the entire fuse tap into an empty slot that is connected to key power in the fuse box. (Figure 4-11)

   b. Locate and remove the horn fuse (or any other safe fuse to remove that is connected to key power). (Figure 4-12)
   c. Place the fuse you just removed into the second slot of the fuse tap. (Figure 4-12)
   d. Plug the fuse tap in where the horn fuse was originally
3. Replace fuse box lid: Make sure the wires don't get pinched or pulled loose when closing the lid. (Figure 4-13)
4. Feed power harness through license plate.
   a. Feed the grey wire (black, plastic connector first), down through the hood near the radiator. (Figure 4-14)
   b. Pull the cord out through the grill or from beneath the car, where it can easily reach the license plate. (Figure 4-15)
5. Connect Roadpack to power harness (Figure 4-16)
   a. Near the front bumper, connect the male connector from the Roadpack to the female connector of the power harness.
6. Test Roadpack: If the Roadpack is powered correctly, you should see flashing lights coming out the front of plastic when vehicle power is on.
   a. Power on the provided Smart Hub. The WeatherCloud app will start automatically.
   b. Hold the Smart Hub close to the sensor pack for a quicker connection while testing.
   c. On home main screen of app Roadpack icon should turn green for a good connection.
7. Attach Roadpack to license plate mounting frame.
   a. Remove the top two screws that hold the license plate in place. Use the provided, longer screws to attach the Roadpack. (Figure 4-17)
   b. When attached correctly the road temperature barrel will be facing toward the ground. (Figure 4-18)
8. Coil and tie power harness slack
   a. Neatly coil the power harness slack and attach it to a secure and out of-the-way location under the hood with zip ties. (Figure 4-19)

Skypack Installation:

There are usually one or two fuse boxes located in the vehicles cab. They are either located on the passenger side panel under the glove box or the driver side under the steering wheel. Some larger vehicles will have both fuse boxes. Locate the preferred fuse box and start to think where to place the Skypack on the windshield for easy wire hiding. After that is decided, follow instructions for proper wiring.

1. Attach ground return clamp to car (Figure 4-20)
   a. Slide the bare end of the black, negative wire of the barrel socket (wire without writing on it and without side ribs) into the grounding clamp. Tighten the screw with a flathead screw driver so that the bare wires are held tightly in place. Attach to grounding metal. Alternatively, a spade terminal connector can be crimped onto the end of the grounding wire, and attached to any grounding point on the vehicle
2. Attach fuse tap to barrel socket
   a. Attach the fuse tap to the positive wire. Slide the bare wires into the blue connector at the end of the fuse tap.
   b. Pinch the blue connector tightly around the bare wires with a set of plyers. Plug the entire fuse tap into an empty slot that is connected to key power in the fuse box.
   c. Locate and remove the horn fuse (or any other safe fuse to remove that is connected to key power).
   d. Place the fuse you just removed into the second slot of the fuse tap.
   e. Plug the fuse tap in where the horn fuse was originally
3. Replace fuse box lid
   a. Make sure the wires don't get pinched or pulled loose when closing the lid.

4. Plug in Skypack to barrel plug (Figure 4-21)
    a. Plug dual USB charger into barrel socket. Confirm red light comes on charger.
    b. Plug 10ft USB Skypack cable into dual USB charger.
    c. Use electrical tape or zip ties to secure barrel socket, dual USB charger and cord together so they do not become unplugged due to vibration.
5. Connect power cord to Skypack (Figure 4-22)
    a. Plug the 10ft USB cable into Skypack.
6. Place Skypack on interior of Windshield (Figure 4-23 & Figure 4-24)
    a. Remove the red tape from the adhesive on the back of the Skypack. Adhere the Skypack, clouds facing down, in a place on the inside of the windshield where the wipers will pass over it fully when in motion. Make sure the Skypack does not obstruct the driver's vision.
    b. Example: Lower left corner.
    c. Example: Upper right corner. Note: The Skypack adhesive will allow the device to be removed and replaced several times if reposition is necessary or windshield has become damaged and needs to be replaced.
7. Tuck away power cord (Figure 4-25)
    a. Tuck the cord away to ensure it will not interfere with driving operations or pull loose by accident. Suggestion: Use a seam in the dashboard, weather stripping along the door frame or the underside of the dash to hide the cord completely.
8. Test Skypack
    a. Skypack will connect automatically to WeatherCloud app on Smart Hub. Connection Status will turn green.
9. Enjoy Real-Time Data!
    a. Swipe to the WeatherCloud data display screen to view real-time data generated by the Skypack and Roadpack sensors.

4.3.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the device installed is working properly the following steps should be followed immediately after installation in the vehicle is completed.

1. No power to the device should be verified based on no lights being powered on and no power being drawn from the device (using a voltmeter) when the vehicle is powered off.
2. With the vehicle powered on the weather cloud app should display incoming weather sensor data from the weather sensors installed.
3. With a handheld weather meter verify the incoming weather sensor data is accurate. Verify the incoming sky data is accurate by observing atmospheric conditions in relation to what the sensor data is outputting.

4.3.2.6 Quality Assurance/Quality Control Process

In order to verify the weather sensors are functioning properly and that the device has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for each weather sensor. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

4.3.2.7 Installation Schedule

Table 4-5 details the delivery and installation schedule for the Weather Cloud Weather sensors.

Table 4-11. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Senso Delivery	53	November 2017
Installation	50	December 2017 - January 2018

4.3.2.8 HW and SW Configuration Control Process

All Hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be managed through a combination of the Lear HMI app (HMI) and the Weather Cloud Weather sensor app. All software configuration for the Weather Cloud application will follow the steps laid out in section 3-4.

4.3.2.9 Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will carry 3 spare units for use in lab testing and as potential quick replacements for field units. These Units will also carry a full warranty for all hardware and software on the units for the life of the pilot project. The contingency plan for spares is to send defective units back to the Vendor for replacement units to quickly swap out weather sensors.

5 Roadside Equipment

The following sections describe the Road Side Unit (RSU) acquisition and installation plans for the Wyoming CV Pilot Project.

5.1 Lear LocoMate Roadstar RSU Acquisition Information

The following sections detail acquisition information related to the Lear LocoMate Roadstar RSU equipment.

5.1.1 Technical Description/Specification

This Sub-System describes the physical units for deployment as part of the system along I-80. Road Side Units (RSUs) include DSRC connectivity, application support, data storage, and other support services to enable CV applications, such as necessary certificates. WYDOT RSUs can be either fixed or portable equipment depending on the use. In general, RSUs serve as a two-way communication portal between connected vehicles that provide information through DSRC and the ODE. About 75 RSUs are planned to be deployed in the pilot.

5.1.2 Ancillary Equipment

The RSU will have the following equipment ordered as a single kit

- Dual DSRC radios
- GPS
- Bluetooth
- CPU
- Wi-Fi
- Sirius XM
- Power Adapter
- GPS Antenna
- Sirius XM Antenna
- Dual DSRC Antennas

These devices will be installed along I-80 as well as well as rest stops and WYDOT fueling areas. Locations have been selected based on availability for power, high speed back haul, and a mount at least 8 meters high. If an RSU is mounted higher than 8 meters, the EIRP must be adjusted to maintain compliance with FCC regulations.[3]

[3] https://www.law.cornell.edu/cfr/text/47/90.377

5.1.3 Part Numbers and Quantities

Table 5-1 details the number of equipment to be acquired for the RSU.

Table 5-1. Equipment for the RSU.

Description	Part Number or Name	Quantity
RSU kit	Locomate Roadstar Premium	78[4]

5.1.4 Associated Software

Lear RSU software (including all WYDOT RSU applications).

5.1.5 Acquisition Method

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Our research and vendor interviews have led us to a single vendor for the RSUs.

5.1.6 Potential Vendors

For the RSU we engaged with Cohda, Lear, Savari, and Commsignia.

We used a systematic selection process, derived from the objectives and requirements for the WYDOT CV Pilot system.

5.1.7 Acquisition Schedule

The plan is to get a few RSU kits in for proof of concept testing of the interactions with other devices in the ecosystem (OBUs, satellite messages, probe data, SNMP, etc.). Once these devices are validated, the team will purchase the remainder of the devices for the pilot based on the schedule presented in Table 5-2.

Table 5-2. Acquisition schedule for RSU (Arrival Dates).

Description	Date	Quantity
RSU kit	December 2016	10
RSU kit	September 2017	68

5.2 Lear LocoMate Roadstar RSU Installation Information

The sections below detail the installation plan and information for the Lear LocoMate Roadstar RSU.

5.2.1 Supplier(s)

Table 4-2 lists the suppliers for the RSU.

[4] Count includes 3 spare units for use in lab testing and as potential quick replacements for field units.

Table 5-3. Locomate Roadstar Premium Suppliers

Description	Part Number or Name	Supplier
RSU kit	Locomate Roadstar Premium	Lear

5.2.2 Inventory Control Method

All RSU's will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. As equipment is distributed for installation and testing the spreadsheet is updated to reflect the current status as well as the responsible party for checking out the equipment.

5.2.3 Configuration(s)

Configurations for RSU devices will be done prior to installation. **Error! Reference source not found.** d etails the configuration parameters that will be updated for each RSU prior to installation.

Table 5-4. Lear LocoMate Roadstar RSU Configuration Parameters

Equipment Type	RSU Configuration Setup
RSU	• Configure IPv6 for offloading to ODE Server • Reset default admin password • Setup TIM application for broadcasting

5.2.4 Installation Diagram(s)

The attached RSU Installation planning document that can be found in Appendix A contains the bulk of the installation diagrams that are site specific installation planning for all of the RSUs along the I80 corridor. Additional and more generic installation diagrams are found below.

Figure 5-1. RSU Installation Locations.

Figure 5-2. Lear LocoMate Roadstar RSU Unit

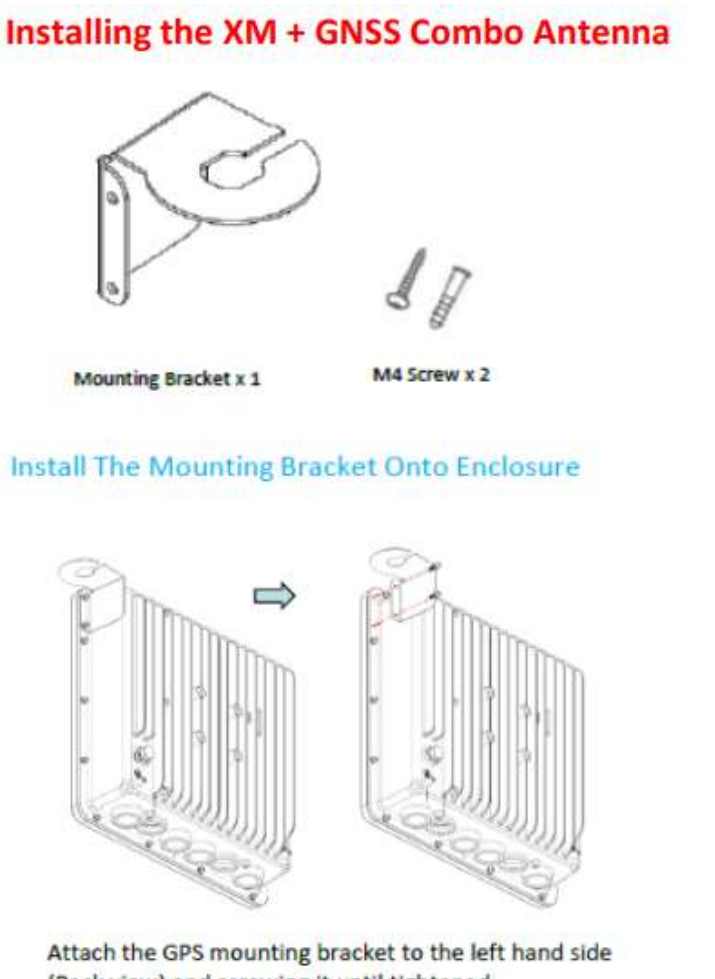

Figure 5-3. XM Antenna Mounting Bracket Installation

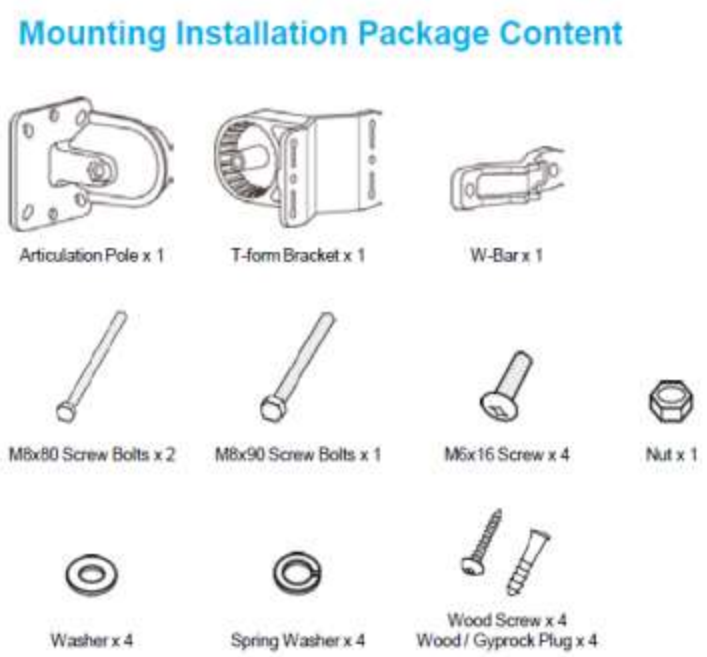

Figure 5-4. RSU Mounting Hardware (Included in Kit)

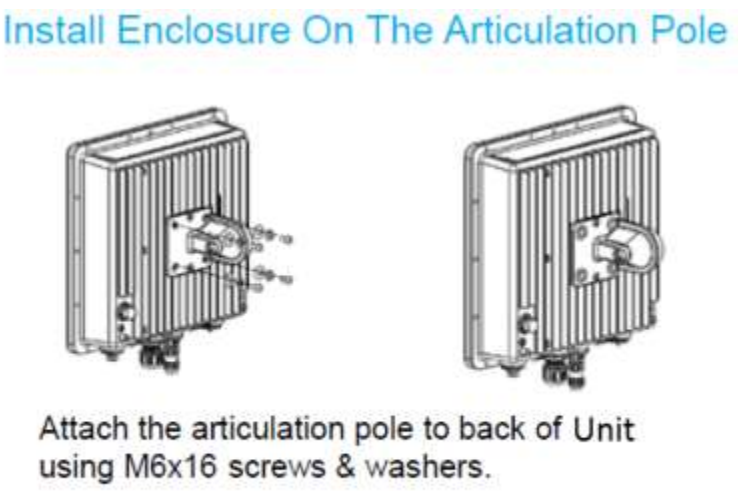

Figure 5-5. Articulation Pole Mount on RSU Unit

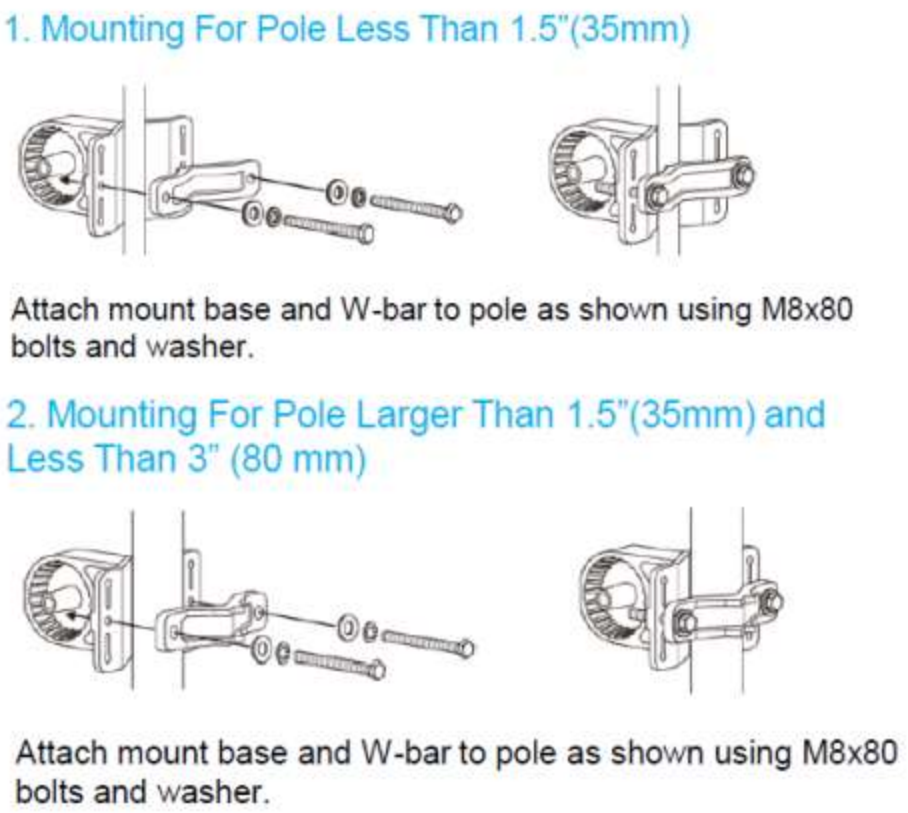

Figure 5-6. Pole Mounting

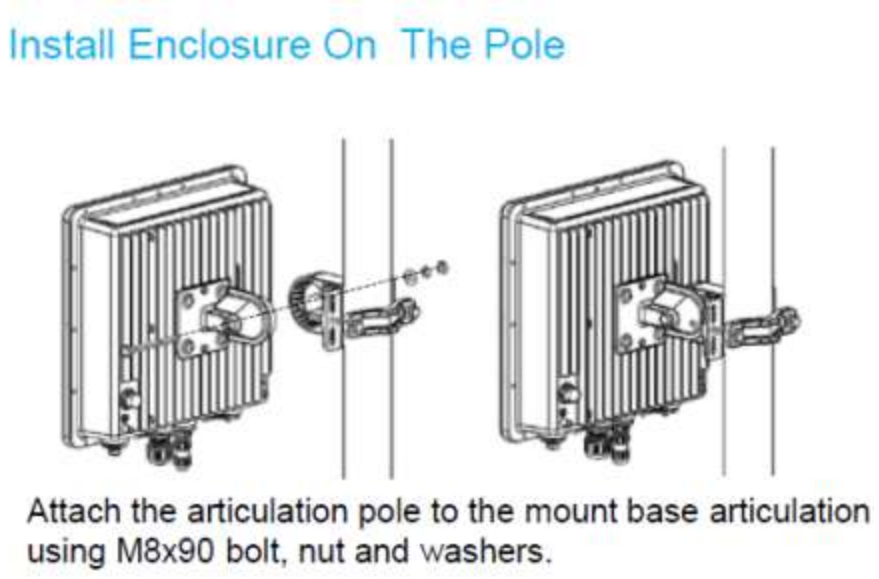

Figure 5-7. RSU Mounting to Pole

5.2.5 Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

5.2.5.1 Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the RSU package. The Table 5-5. Installation Equipment Checklist should be used to verify the equipment was delivered properly. If the package is not complete, the vendor will be contacted for the missing components.

Table 5-5. Installation Equipment Checklist

Item	Quantity
Locomate Roadstar RSU	1
12 Volt Adaptor PoE plug	1
DSRC Radio Antenna	4
WiFi Antenna	3
SiriusXM Antenna	1
Sirius XM Mounting Bracket	1
M4 Screw	2
Articulation Pole Mounting Bracket	1
T-form articulation pole Bracket	1
W-Bar	1
M8x80 Screw Bolts	2

M8x90 Screw Bolt	1
M6x16 Screw	4
Nut	1
Washer	4
Spring Washer	4
Wood Screw	4

All equipment in the check list should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement equipment or fixes to the existing equipment will be requested.
Additional pre-installation procedures are outlined in the RSU installation plan from WYDOT that can be found in Appendix A.

5.2.5.2 Installation Procedures

Detailed installations procedures can be found in the attached WYDOT RSU installation plan found in Appendix A.

5.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the device installed is working properly the following steps should be followed immediately after installation in the vehicle is completed.

1. Power to the device should be verified based on the RSU LED light turned on.
2. Users should be able to log into the RSU via SSH from a secured connection.
3. Configuration for the RSU will then be setup to properly communicate with the ODE and with OBUs.
4. Drive-by's of the RSU will then be performed to verify that TIMs and BSMs are broadcasting correctly from the RSU and received log files/BSMs from an OBU are correctly forwarded to the ODE system.

5.2.6 Quality Assurance/Quality Control Process

In order to verify the RSUs received from Lear are functioning properly and that the device has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for each RSU. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment. Additional QA/QC that will take place include continuous monitoring of installed and deployed RSUs for uptime. Any RSUs that have issues during deployment will be physically inspected for defects. If defects are found Lear will be contacted to help resolve the issues.

5.2.7 Installation Schedule

Table 4-5 details the delivery and installation schedule for the Lear LocoMate Roadstar RSU.

Table 5-6. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Initial RSU Delivery	10	December 2016

RSU Test Installations	2	April 2017
Remaining RSU Delivery	68	August 2017
Remaining RSU Installation	73	October 2017

5.2.8 HW and SW Configuration Control Process

All Hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be updated through firmware update scripts managed by WYDOT with input from Lear. Script updates will only be authorized after it has been tested in a benchtop, controlled track, and on road environment. After this testing has passed and WYDOT has approved the update a time will be scheduled to make the firmware/configuration update available to RSUs so that vehicles are not impacted during times where road conditions may be hazardous. As RSUs are configured the configuration will be recorded within the inventory management spreadsheet and in the WYDOT database in order to track RSU version and configuration information. All RSUs will be configured with the latest approved configuration script prior to installation.

5.2.9 Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will carry 3 spare units for use in lab testing and as potential quick replacements for field units. These Units will also carry a full warranty for all hardware and software on the units for the life of the pilot project. The contingency plan for spares is to send defective units back to the Vendor for replacement units to quickly swap out RSU units.

6 Mobile Devices

The WYDOT CV Pilot will not be purchasing any Mobile Devices.

7 Management Center Equipment

The following section describes the Management Center Equipment installation procedure for all CV related equipment. Please note that the Wyoming Pilot has recently found the need to acquire and install a Hardware Security Module (HSM) as part of the pilot project. Not enough information has been gathered yet on the HSM module that will be acquired or how the HSM will be installed within the TMC. Therefore, it has not been added to this Installation Plan document. A future version of this document will contain this information.

7.1 Servers

7.1.1 Server Acquisition Information

The following sections detail acquisition information related to the Server equipment.

7.1.1.1 Technical Description/Specification

The TMC will procure two servers to host the TMDD third party interface, ODE, Pikalert weather simulation and prediction software as well as management software for the RSU's. The Third Party Interface which publishes TMDD data, the Operational Data Environment and the Pikalert weather software are integral components of the WYDOT Pilot.

Both servers have redundant (RAID-1) boot devices, multi-path IO connections (iSCSI over 10GBase-T) to the Storage Array, redundant Ethernet connections for management and redundant 10GBase-T primary data links to both the public internet and to the existing WYDOT intranet.

Both servers will run Microsoft's Hyper-V 2016 Server edition and applications running on the servers will be hosted in Virtual Machines. All storage for Virtual Machines will be located on the Storage Array. Microsoft Failover Cluster Manager and Microsoft Cluster Shared Volumes will be used to enable live Virtual Machine migration between the servers and together with a regular backup plan will insure quick recovery for either a failed server or virtual machine.

Each server contains two Intel Xeon, 18 Core CPUs and 256 GB of DDR3 memory. The CPUs were selected based on price/performance per core up to the level where incremental price/performance began to diminish. The CPU and memory configurations were selected to maximize performance for virtual machine environments.

7.1.1.2 Ancillary Equipment

Each server is configured with:

- (2) Intel Xeon CPUs
- 256 GB of DDR memory
- (2) 120 GB Solid State Boot Drives

- Integrated RAID Controller, 2GB Cache
- (2) Intel 10GBASE-T, dual port Ethernet Adapters
- Broadcom 1GB, quad port, Ethernet Card
- iDRAC8 Enterprise, integrated Dell Remote Access Controller

Four years' hardware and software support

7.1.1.3 Part Numbers and Quantities

Table 7-1 details the number of equipment to be acquired for the servers.

Table 7-1. Equipment for the servers.

Description	Part Number or Name	Quantity
Dell PowerEdge R730 Server	210-ACXU	2
Intel Xeon 18 Core CPU	E5-2697 v4 2.3GHz	4
120 GB Solid State Drives, 6Gbps SATA	400-AEIB	4
32GB RDIMM, 2400MT/s, DDR	370-ACNS	16
PERC H730P Integrated RAID Controller	405-AAEH	2
Intel Ethernet X540 2-port Adapter	540-BBHZ	4
Broadcom 5720 4-port 1Gb Network	540-BBBW	2
iDRAC8 Enterprise Controller	385-BBHO	2

7.1.1.4 Associated Software

No additional software is purchased for these servers.

- The BIOS and firmware included with the servers is provided by Dell and covered under the product warranty.
- Both physical servers will run Microsoft Hyper-V Server 2016, which is a stand-alone product that contains only the Windows hypervisor, a Windows Server driver model, and virtualization components. This edition of Microsoft Server 2016 is available free of charge.

Open source Linux (Ubuntu & Debian) and existing licenses for Microsoft Windows Server will run on the virtual machines hosted by the servers.

7.1.1.5 Acquisition Method

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Our research and vendor interviews have led to us to use a single vendor for the servers, storage and switch for the Management Center Equipment.

7.1.1.6 Potential Vendors

For the servers, we engaged with Dell and Hewlett Packard (HP).

We used a systematic selection process, derived from the objectives and requirements for the WYDOT CV Pilot system.

7.1.1.7 Acquisition Schedule

The servers will be acquired based on the schedule presented in Table 7-2.

Table 7-2. Acquisition schedule for servers.

Description	Date	Quantity
Dell R730 server	12/2016	2

7.1.2 Server Installation Information

The sections below detail the installation plan and information for the WYDOT TMC Servers.

7.1.2.1 Supplier(s)

Table 7-3 lists the suppliers for the Server.

Table 7-3. Server Suppliers

Description	Part Number or Name	Supplier
Server	Dell R730 Server	Dell

7.1.2.2 Inventory Control Method

All Servers will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. This equipment will all permanently reside in the TMC Server room.

7.1.2.3 Configuration(s)

The servers came with a default BIOS configuration which can be seen in the figures below.

Figure 7-1. Default BIOS Memory Settings

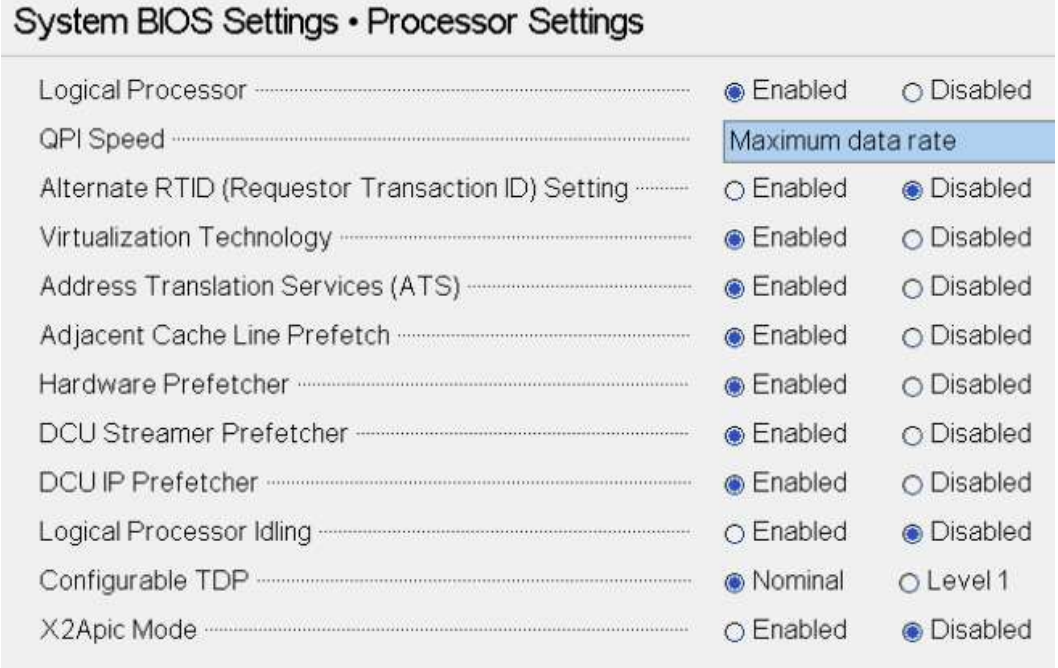

Figure 7-2. Default BIOS Processor Settings

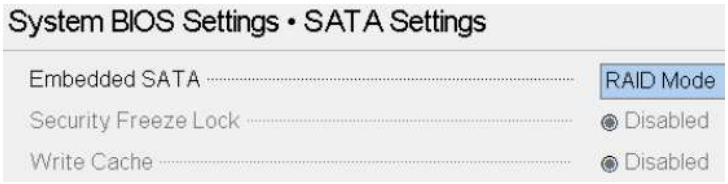

Figure 7-3. Default BIOS SATA Settings

Figure 7-4. Default BIOS Boot Settings

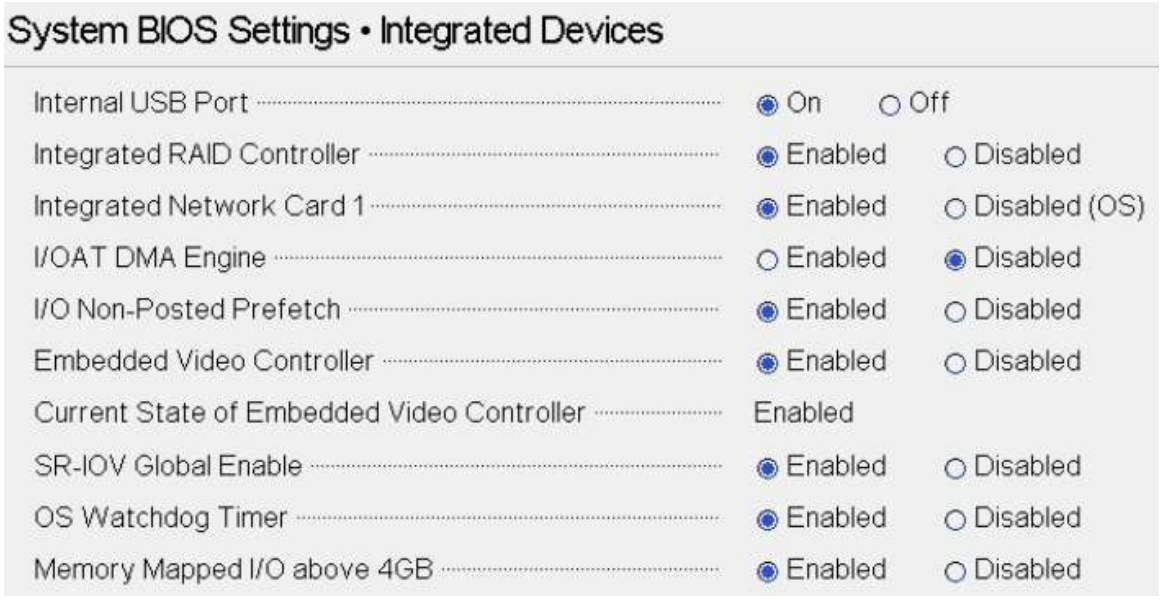

Figure 7-5. Default BIOS Integrated Devices Settings

Figure 7-6. Default BIOS Integrated Devices Settings Continued

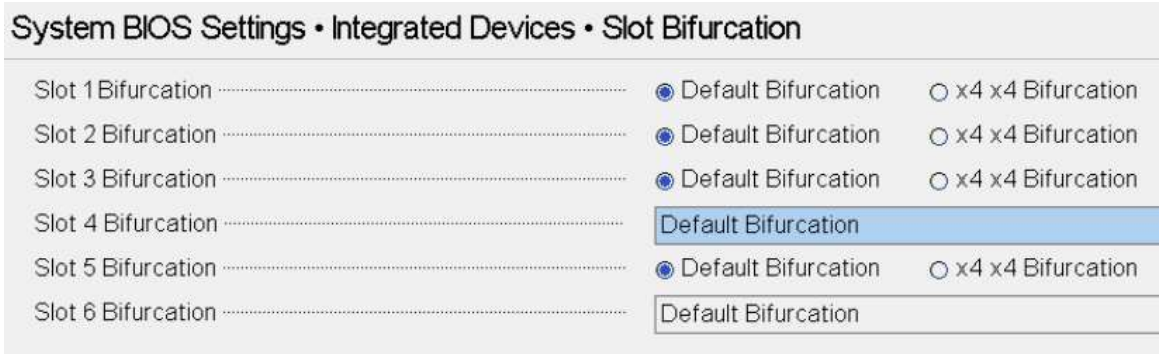

Figure 7-7. Default BIOS Integrated Devices Settings Continued

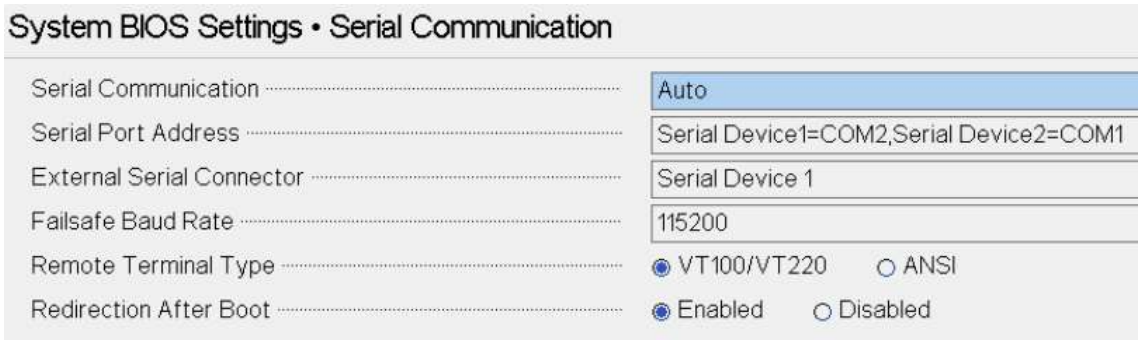

Figure 7-8. Default BIOS Serial Communication Settings

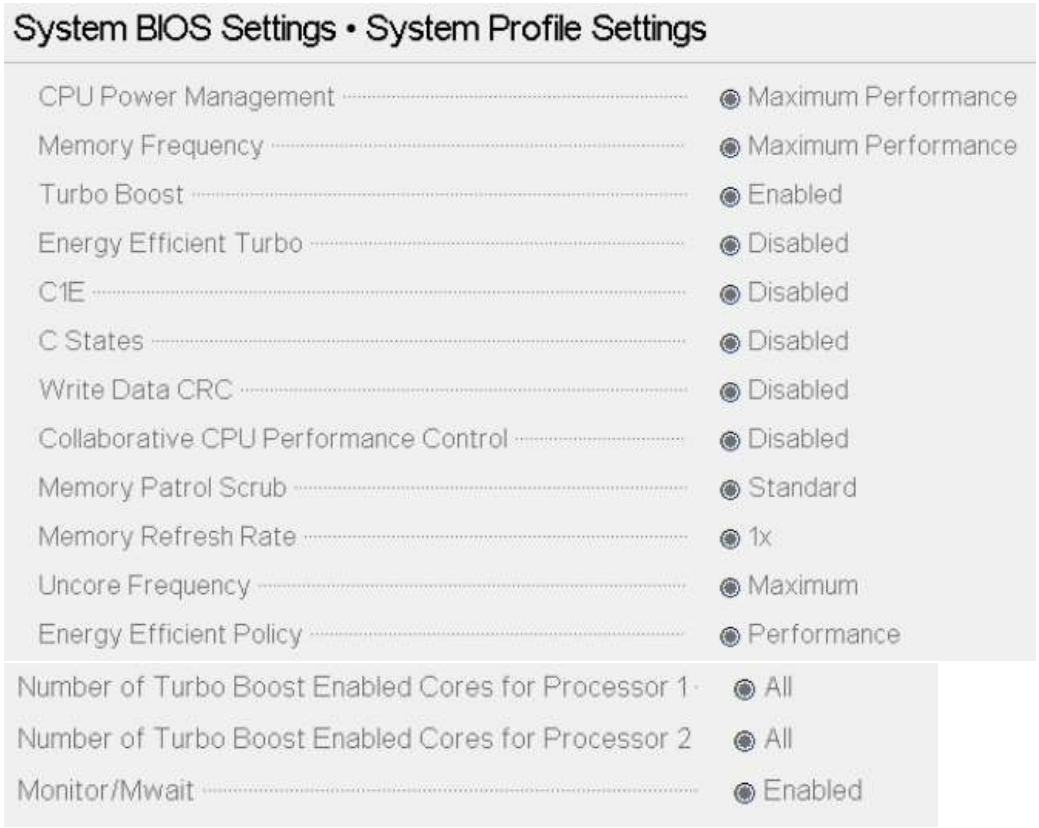

Figure 7-9. Default BIOS System Profile Settings

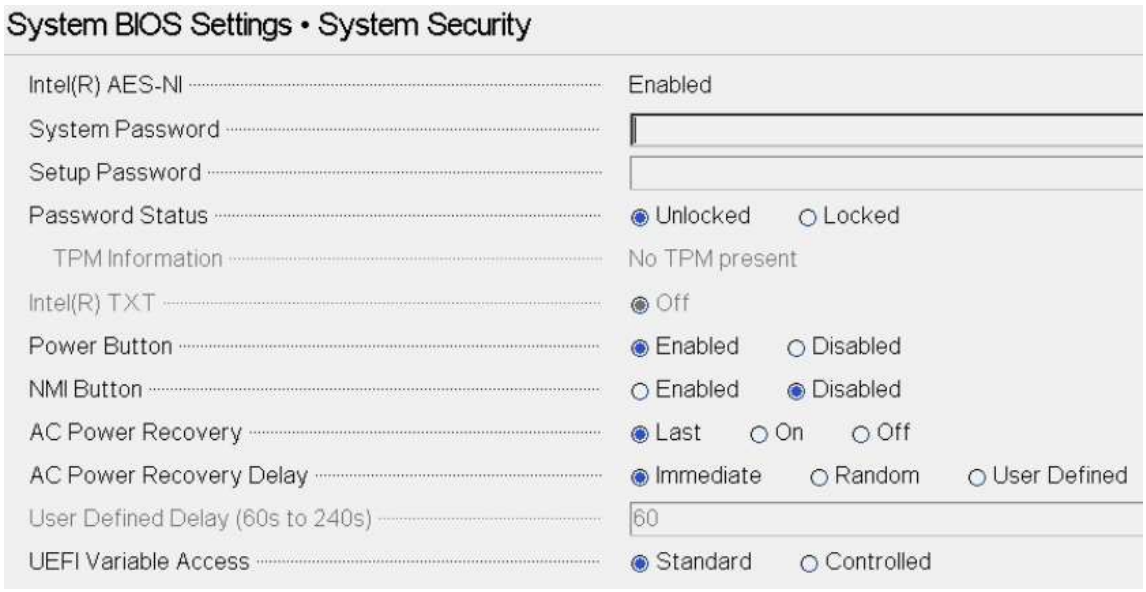

Figure 7-10. Default BIOS System Security Settings

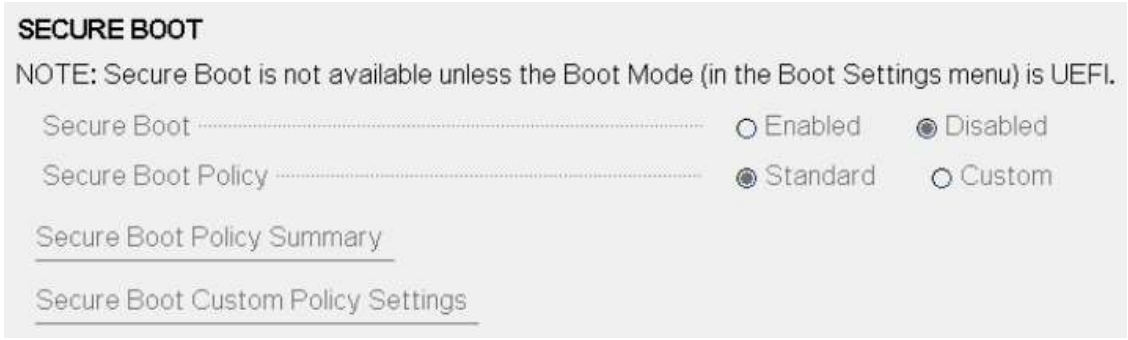

Figure 7-11. Default BIOS Secure Boot Settings

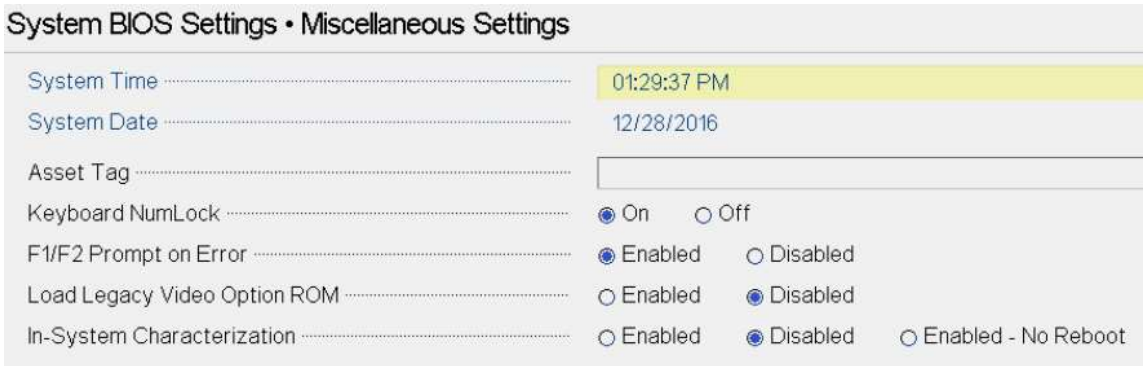

Figure 7-12. Default BIOS Miscellaneous Settings

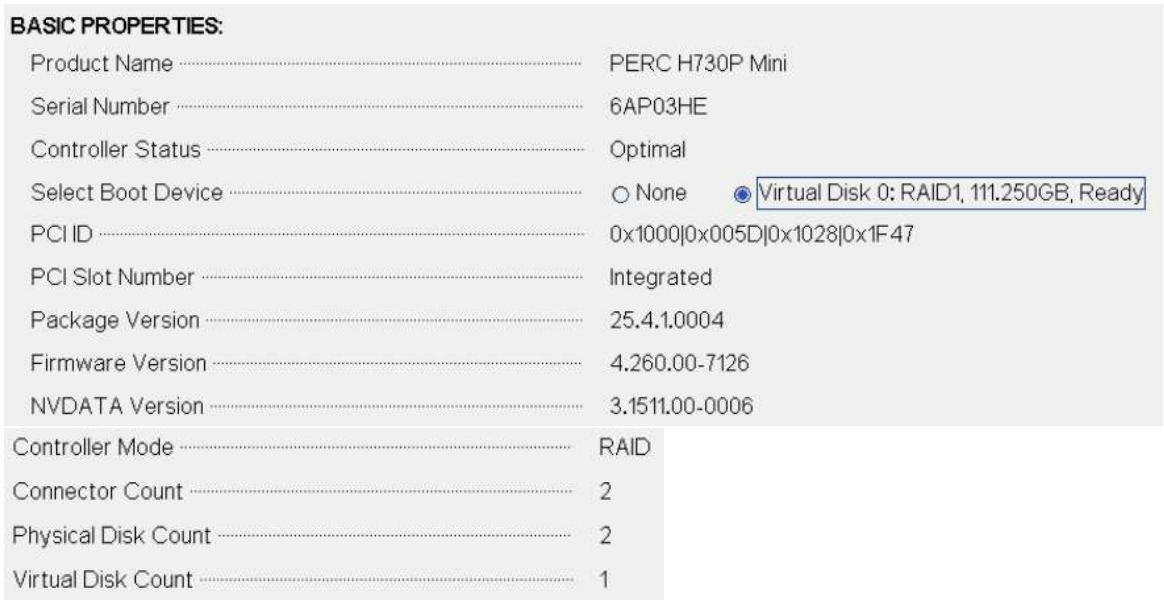

Figure 7-13. Local Boot Device Settings

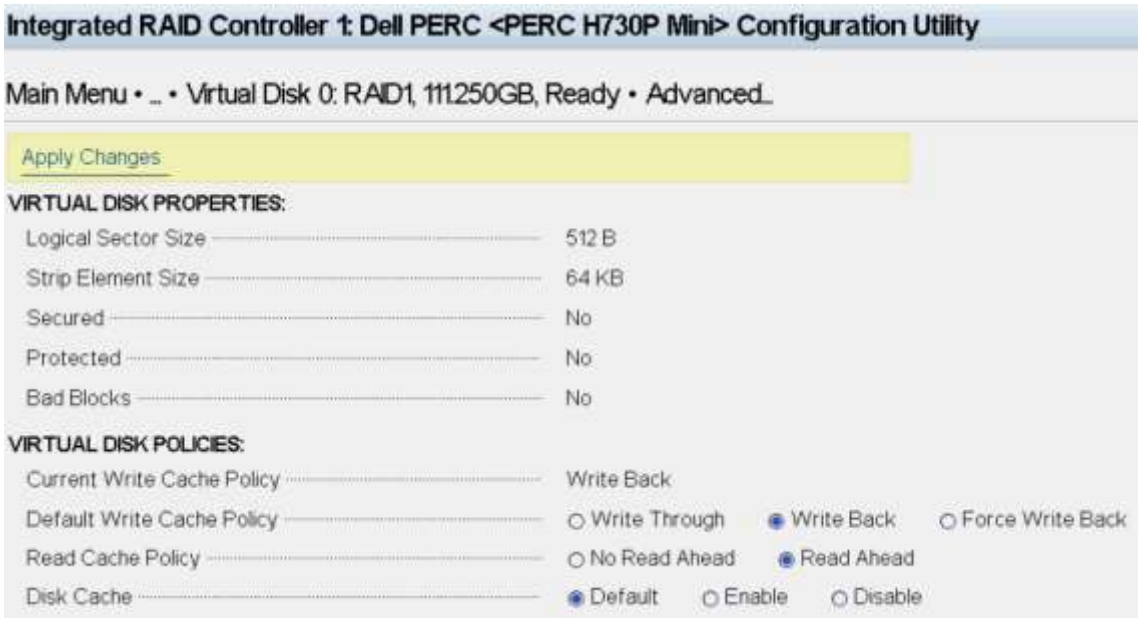

Figure 7-14. Local Boot Device Settings

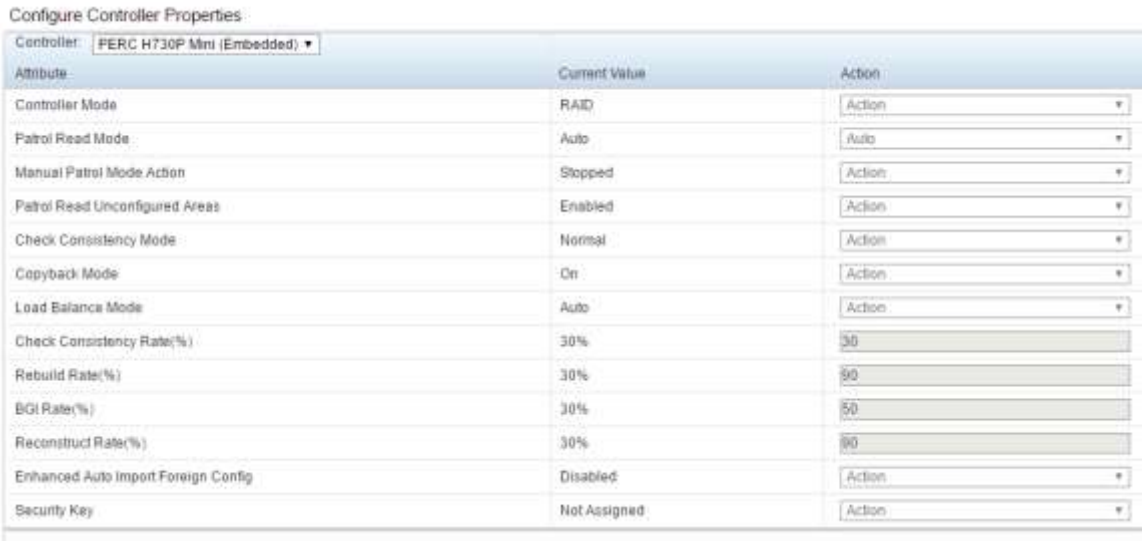

Figure 7-15. Task Rates for RAID Controller Settings

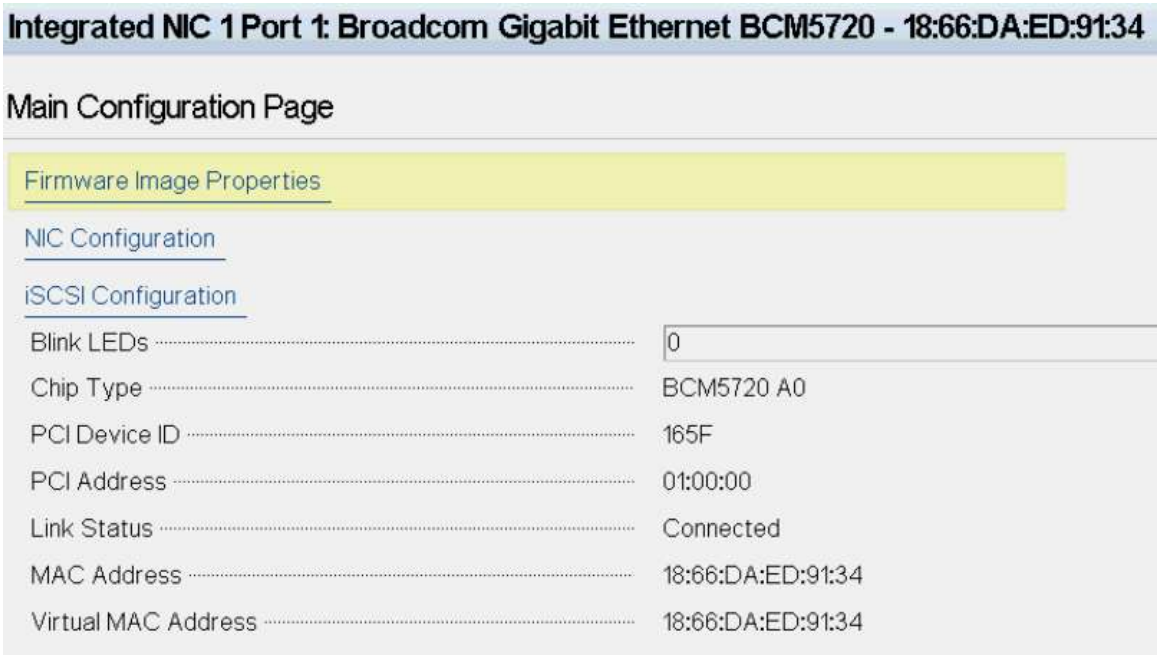

Figure 7-16. NIC Configuration Settings

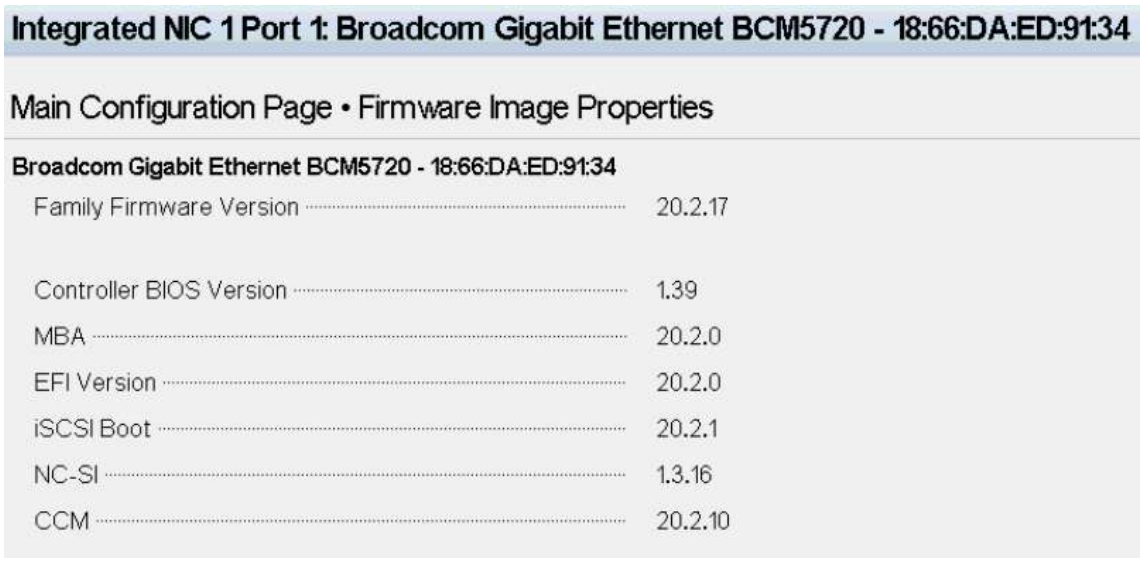

Figure 7-17. NIC Configuration Settings

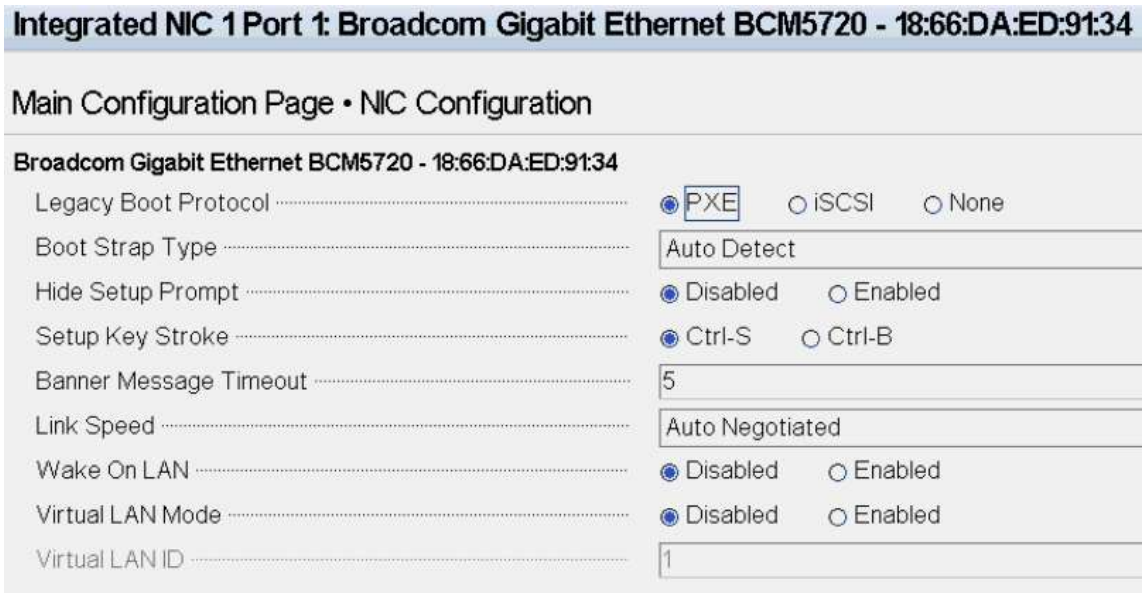

Figure 7-18. NIC Configuration Settings

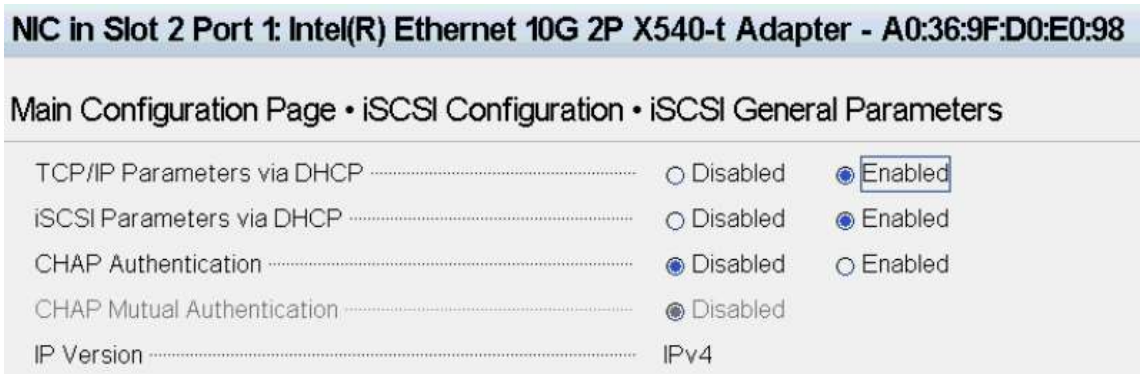

Figure 7-19. NIC Configuration Settings

Figure 7-20. NIC Configuration Settings

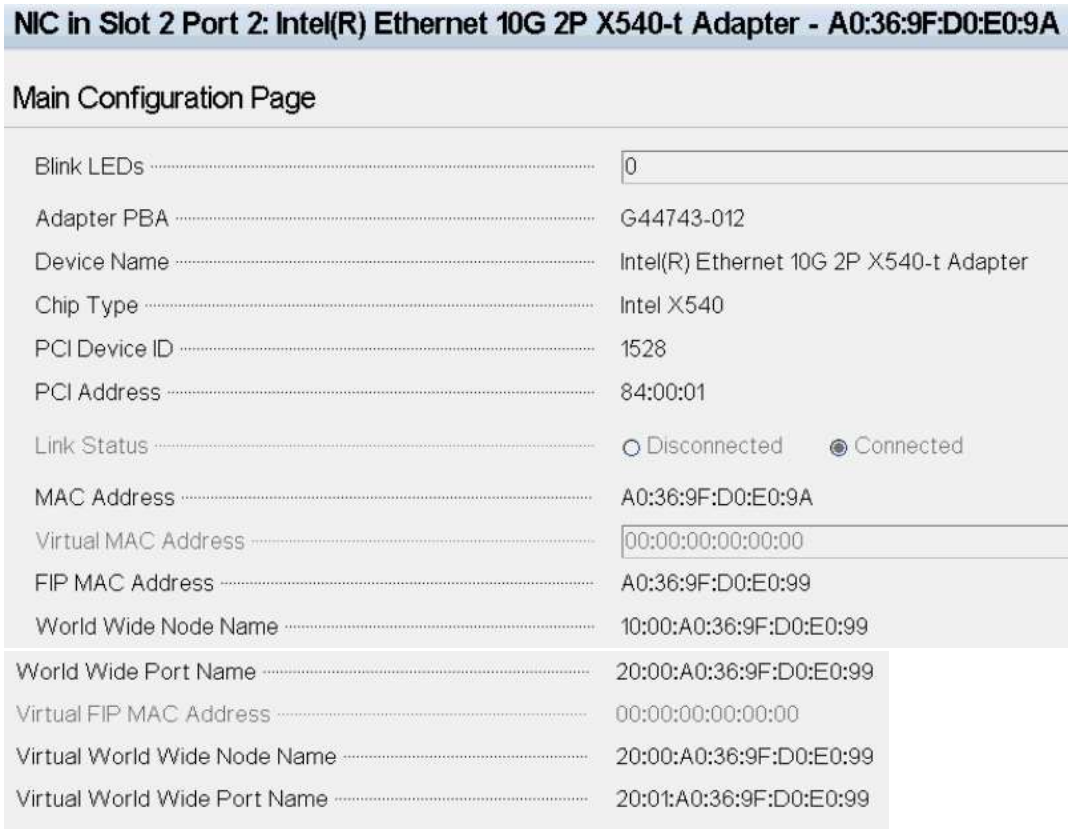

Figure 7-21. NIC Configuration Settings

7.1.2.4 Installation Diagram(s)

This section should provide the detailed installation diagram(s).

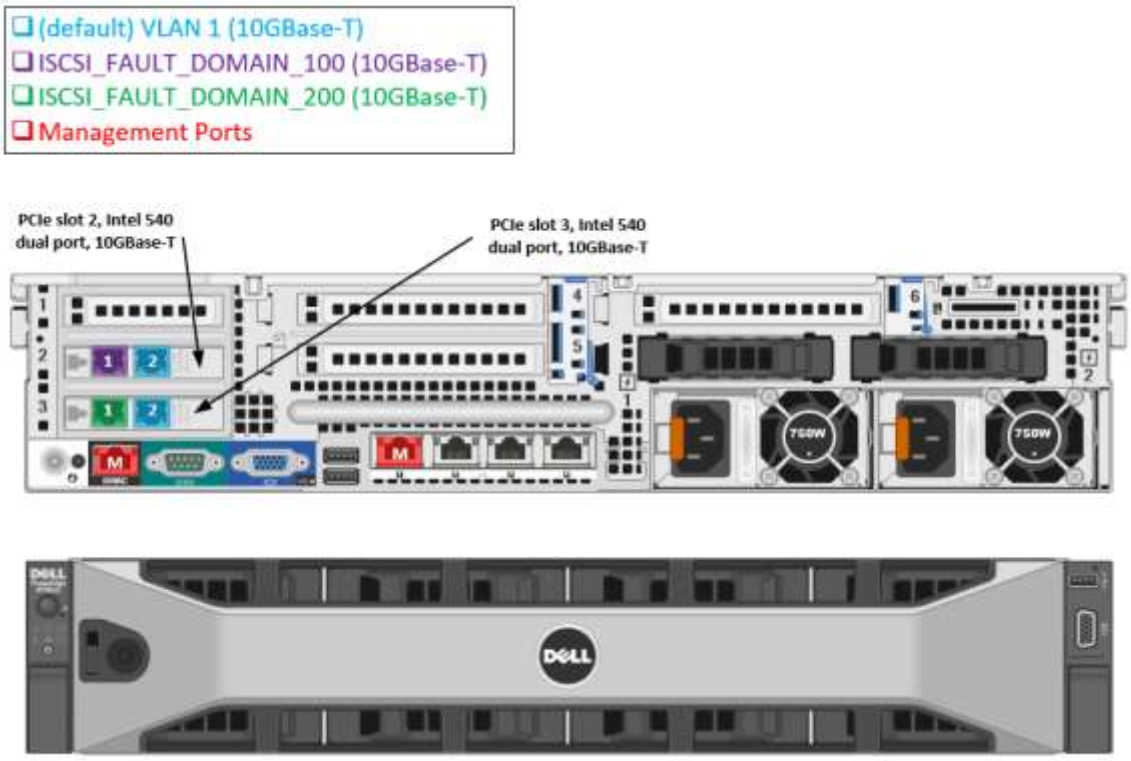

Figure 7-22. Dell R730 Server Diagram

Connected Vehicle - 10GBase-T Storage Area Network

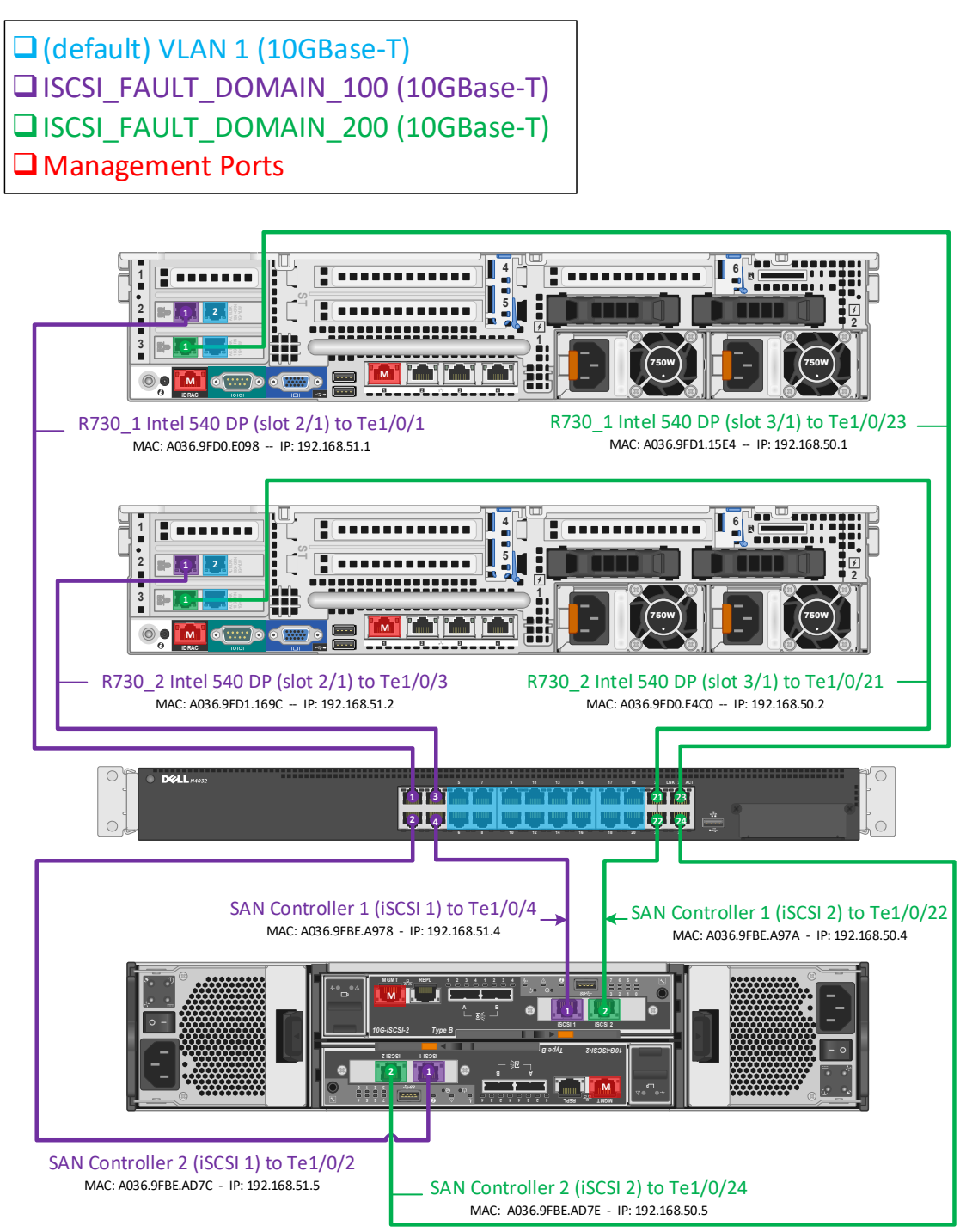

Figure 7-23. SAN Network Configuration

Connected Vehicle – 10GBase-T Data Network

- ❑ (default) VLAN 1 (10GBase-T)
- ❑ ISCSI_FAULT_DOMAIN_100 (10GBase-T)
- ❑ ISCSI_FAULT_DOMAIN_200 (10GBase-T)

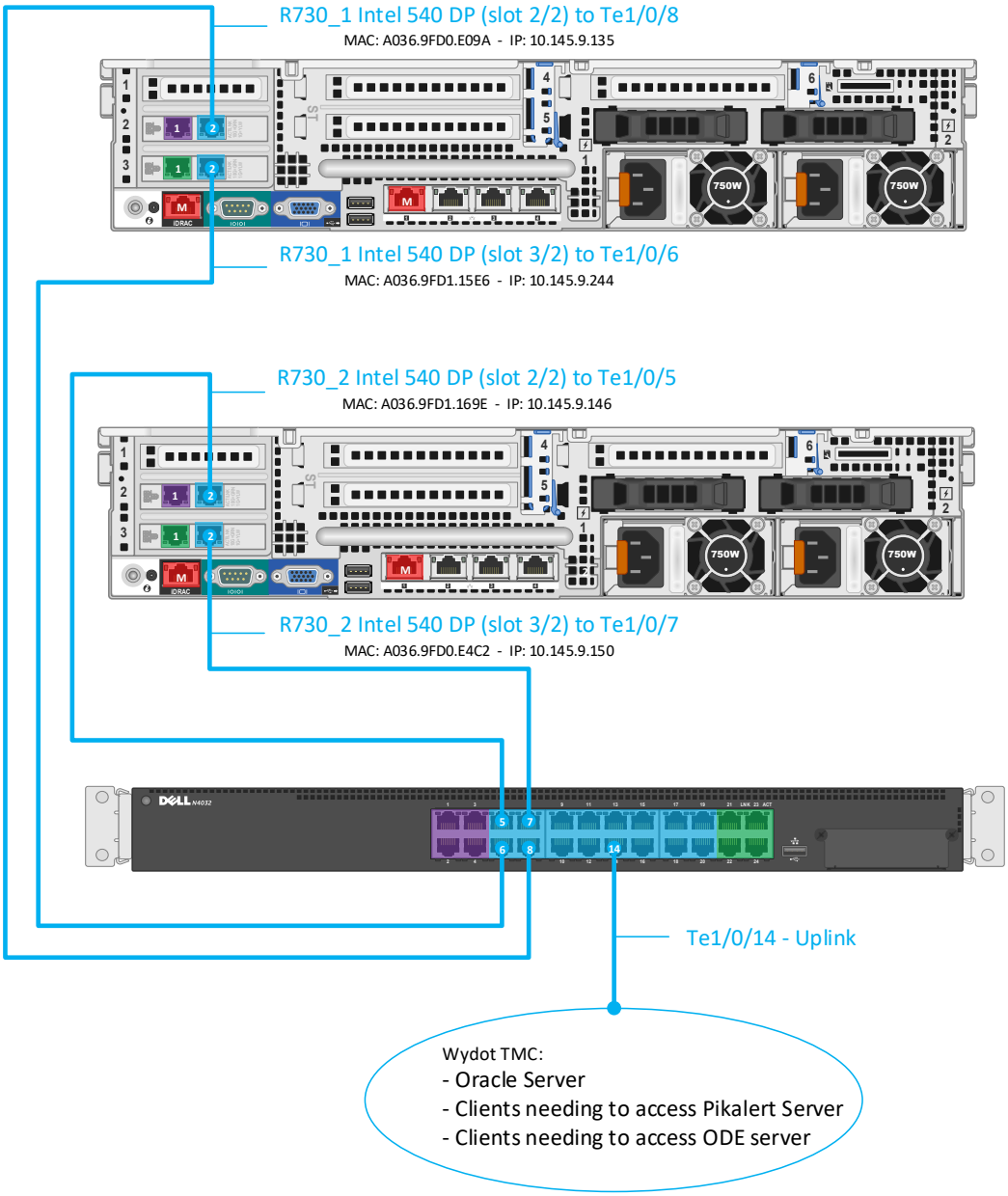

Figure 7-24. Server Network Configuration

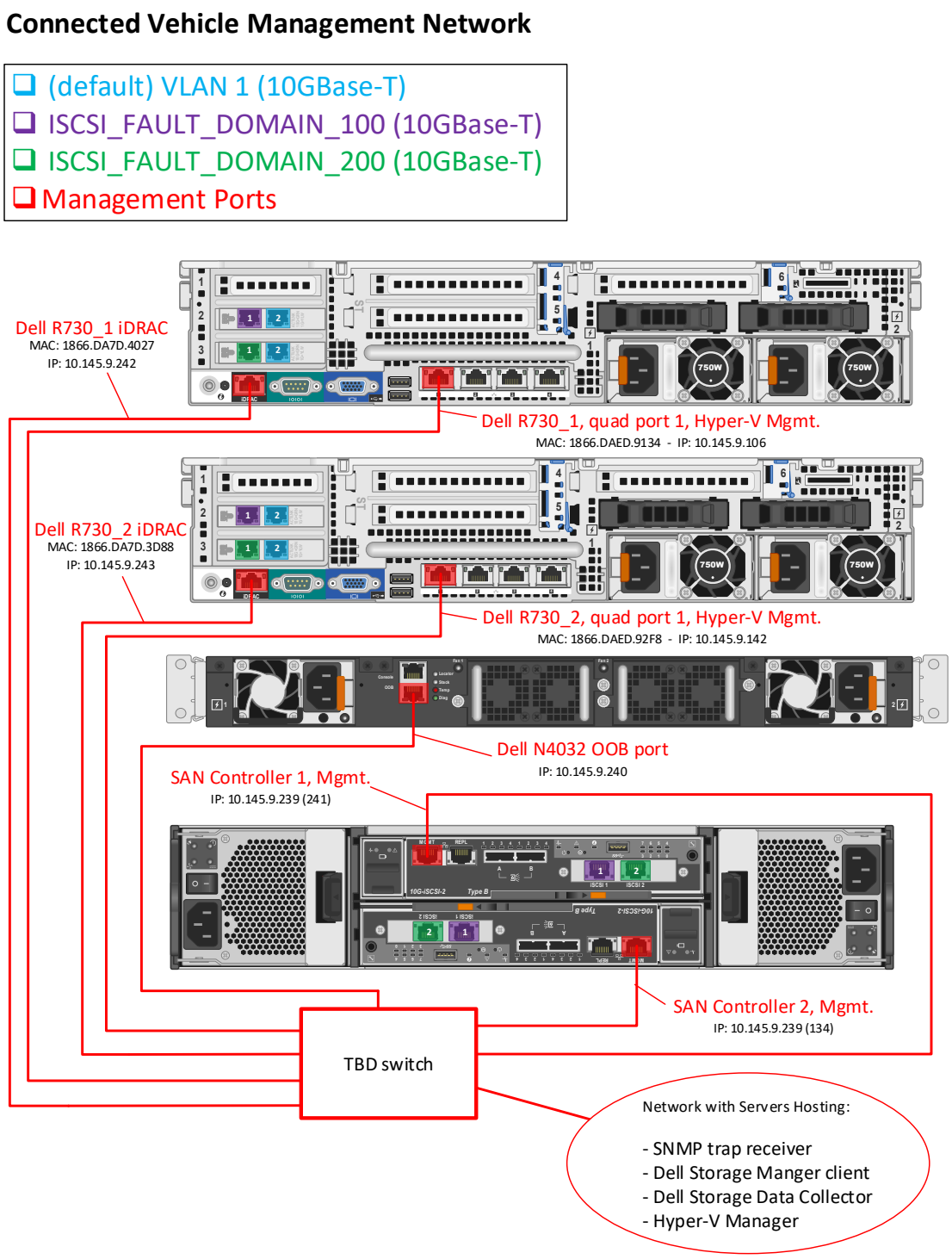

Figure 7-25. Management Network Configuration

7.1.2.5 Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

7.1.2.5.1 Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the Server package. Each server should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement server should be requested.

7.1.2.5.2 Installation Procedures

The following steps should be followed in order to properly install and configure the Servers.

1. Install the server in the Rack.
2. Updated the BIOS Configuration

   Key BIOS configuration changes were made as follows:

   1. Updated firmware for iDRAC, NIC cards, Raid controllers, backplane, power supplies, SSDs and the BIOS itself.
   2. Establish RAID configuration for dual, internal SSDs. Configured as RAID 1 for booting Hyper-V.
   3. General settings:
      a. enabled USB 3.0,
      b. enable OS Watchdog Timer
   4. Virtualization performance settings:
      a. enable SR-IOV
   5. RAID default task rates:
      a. change setting Rebuild: 30 -> 90
      b. change setting BGI (background initialization): 30 -> 50
      c. change setting Reconstruction: 30 -> 90

3. Update the Hyper-V Configuration as follows:
   a. boot source: redundant SSDs
   b. Install Windows 2016 Server Hyper-V (redundantly on SSD's)
   c. Configure Management Network
      i. Configure Lan on Motherboard, quad port, NIC #1 for static IP & default WYDOT settings.
   d. Install Microsoft Updates
   e. Microsoft Updates:
      i. Disable automatic Updates
      ii. Disable automatic Download of Updates
   f. Remote Management:
      i. Enable remote desktop (authentication: all)
      ii. Enable remote management for Failover Cluster Manager
      iii. Enable: respond to ping
   g. set hostname
   h. Add system to Domain: gisits.local
   i. Microsoft telemetry setting: Security
   j. Set time zone to MST/7
   k. Set NTP server to WYDOT default.

l. Configure additional NICs for TMC network access
    i. Configure Intel PCIe card, dual-port, 10G NIC slot 3/2 for static IP & default WYDOT settings.
    ii. Configure Intel PCIe card, dual-port, 10G NIC slot 2/2 for static IP & default WYDOT settings.
m. Configure additional NICs for iSCSI
    i. Configure Intel PCIe card, dual-port, 10G NIC slot 2/1 for static IP & iSCSI settings.
    ii. Configure Intel PCIe card, dual-port, 10G NIC slot 3/1 for static IP & iSCSI settings.

4. Add the servers to the Domain, the servers need to be added to the WYDOT AD Domain and DNS. These servers run Windows Server 2016 Hyper-V so we will need to use the ***sconfig*** interface text menus to add these servers to the domain.
5. Add local administrator privileges for CV-731 and CV-732 to domain user or if you want to designate a new cluster manager account please provide me that information.
   Create a *Cluster Name Object* (CNO) for the new failover cluster: CV-CLUSTER-ODE. This name will be registered as the cluster computer object (aka. CNO) in AD DS. If you specify a NetBIOS name for the cluster, the CNO is created in the same location where the computer objects for the cluster nodes reside. This can be either the default Computers container or an OU.

   The cluster requires a static IP for management.
6. Create Cluster Shared Volumes in a Failover Cluster

   There are three steps to create a Cluster Shared Volume.

    a. Run Get-Disk to show LUNS mounted and online for the current server. Next run "Get-ClusterAvailableDisk" to see which disks are visible to all servers in the cluster and via the same LUN. Only such disk are available to be added to Cluster.

```
PS C:\Users\tenglish> get-disk

Number Friendly Name Serial Number                  HealthStatus         OperationalStatus      Total Size Partition
                                                                                                           Style
------ ------------- -------------                  ------------         -----------------      ---------- ----------
0      DELL PERC ... 00eda5f90f34b5ce1f00aab582a06d86 Healthy             Online                  111.25 GB MBR
1      COMPELNT C... 0003601e-00000006               Healthy              Offline                    9.5 TB GPT
2      COMPELNT C... 0003601e-00000005               Healthy              Offline                    9.5 TB GPT


PS C:\Users\tenglish> Get-ClusterAvailableDisk


Cluster    : CV-CLUSTER-ODE
Id         : ab8188da-c278-4587-a0f9-36528575b4ed
Name       : Cluster Disk 1
Number     : 1
Size       : 10445360463872
Partitions : {}

Cluster    : CV-CLUSTER-ODE
Id         : f544d7cc-877d-46c0-897a-0853bb488eaa
Name       : Cluster Disk 2
Number     : 2
Size       : 10445360463872
Partitions : {}
```

    b. Now add the available disks to the cluster:

```
PS C:\Users\tenglish> Get-ClusterAvailableDisk | Add-ClusterDisk

Name           State  OwnerGroup        ResourceType
----           -----  ----------        ------------
Cluster Disk 1 Online Available Storage Physical Disk
Cluster Disk 2 Online Available Storage Physical Disk


PS C:\Users\tenglish> Get-ClusterAvailableDisk
PS C:\Users\tenglish> _
```

Run *Get-ClusterResource* to see the new disk resources along with other Cluster resources:

```
PS C:\> Get-ClusterResource

Name                      State  OwnerGroup        ResourceType
----                      -----  ----------        ------------
Cluster Disk 1            Online Available Storage Physical Disk
Cluster Disk 2            Online Available Storage Physical Disk
Cluster IP Address        Online Cluster Group     IP Address
Cluster Name              Online Cluster Group     Network Name
Virtual Machine Cluster WMI Online Cluster Group     Virtual Machine Cluster WMI
```

c. Now the Cluster has "Available Storage". The next step is to convert Cluster Disks into full blown CSV's:

Convert Available Storage resource into CSV

PS C:\Users\tenglish> Add-ClusterSharedVolume –Name "Cluster Disk 2"

7. Mount the CSVs on both servers
8. Create Ubuntu Virtual Machines on the CSVs

7.1.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the servers installed are working properly the following steps should be followed immediately after the installation is completed.

1. Power the server on and verify the server appears on the network and users are able to login successfully on the server from a valid domain account.
2. Verify the Server is pingable on the network.
3. Verify the server has access to all required resources (network, database, etc.)
4. Verify the server firewall is correctly setup by checking access restrictions.

7.1.2.6 Quality Assurance/Quality Control Process

In order to verify the Servers received from Dell are functioning properly and that they has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for

each Server. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

7.1.2.7 Installation Schedule

Table 7-4 details the delivery and installation schedule for the Servers.

Table 7-4. Dell Server Installation Schedule

Vehicles	Quantity	Schedule
Initial Server Delivery	2	December 2016
Server Installation	2	December 2016

7.1.2.8 HW and SW Configuration Control Process

All Hardware configuration will be managed through the installation procedures and instructions detailed above. Software configurations will be managed through a Confluence page setup specifically for documenting the OS and BIOS configuration. As configurations change the Confluence page is updated to reflect the changes.

7.1.2.9 Sparing Strategy, Warranty and Contingency Plan

The Wyoming CV Pilot will not carry any spare units but will instead have a strategy of failover from one of the two servers to the other server. If both servers fail the CV system will still be operable by bypassing the ODE servers and going directly to the ODE from other servers in the WYDOT Traffic Management Center. These Server will also carry a full warranty for all and software on the units for the life of the pilot project.

7.2 Storage Array

7.2.1 Storage Array Acquisition Information

The following sections detail acquisition information related to the Storage Array equipment.

7.2.1.1 Technical Description/Specification

The storage array contains (24) 1.2TB SAS HDDs and has a formatted capacity of 19TB. The storage array uses RAID configuration, hot spare disks and dual redundant controllers to insure data integrity and fault tolerance. The storage array is connected to both servers using multi-path iSCSI over 10GB Ethernet.

The storage array will host Virtual Machine images for servers hosting the TMDD third party interface, ODE, Pikalert weather simulation and prediction software as well as management software for the RSU's according to the system requirements.

7.2.1.2 Ancillary Equipment

The storage array is configured with:

- (24) Dell 1.2TB, SAS 12Gb, 10K, 2.5", HDD

- Four years' hardware and software support

7.2.1.3 Part Numbers and Quantities

Table 7-5 details the number of equipment to be acquired for storage.

Table 7-5. Equipment for storage.

Description	Part Number or Name	Quantity
Dell SCv2020 ISCSI	210-ADRU	1
Dell 1.2TB, SAS 12Gb, 10K, 2.5", HDD	400-AHEB	24

7.2.1.4 Associated Software

No additional software is purchased for the storage array.

7.2.1.5 Acquisition Method

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Our research and vendor interviews have led to us to use a single vendor for the servers, storage and switch for the Management Center Equipment.

7.2.1.6 Potential Vendors

For the storage array, we engaged with Dell and HP.

We used a systematic selection process, derived from the objectives and requirements for the WYDOT CV Pilot system.

7.2.1.7 Acquisition Schedule

The storage array will be acquired based on the schedule presented in Table 7-6.

Table 7-6. Acquisition schedule for servers.

Description	Date	Quantity
Dell SCv2020 storage array	12/2016	1

7.2.2 Storage Array Installation Information

Each item that is being installed, and its' associated components required for full installation and operation, should have its' own section with the following sub-sections.

7.2.2.1 Supplier(s)

Table 7-7 lists the suppliers for the Server.

Table 7-7. Server Suppliers

Description	Part Number or Name	Supplier
Storage Array	Dell SCv2020 storage array	Dell

7.2.2.2 Inventory Control Method

The Storage Array will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. This equipment will all permanently reside in the TMC Server room.

7.2.2.3 Configuration(s)

No configuration updates were needed for the Storage Array.

7.2.2.4 Installation Diagram(s)

The following figures represent the installation diagrams related to the Storage Array.

Connected Vehicle - 10GBase-T Storage Area Network

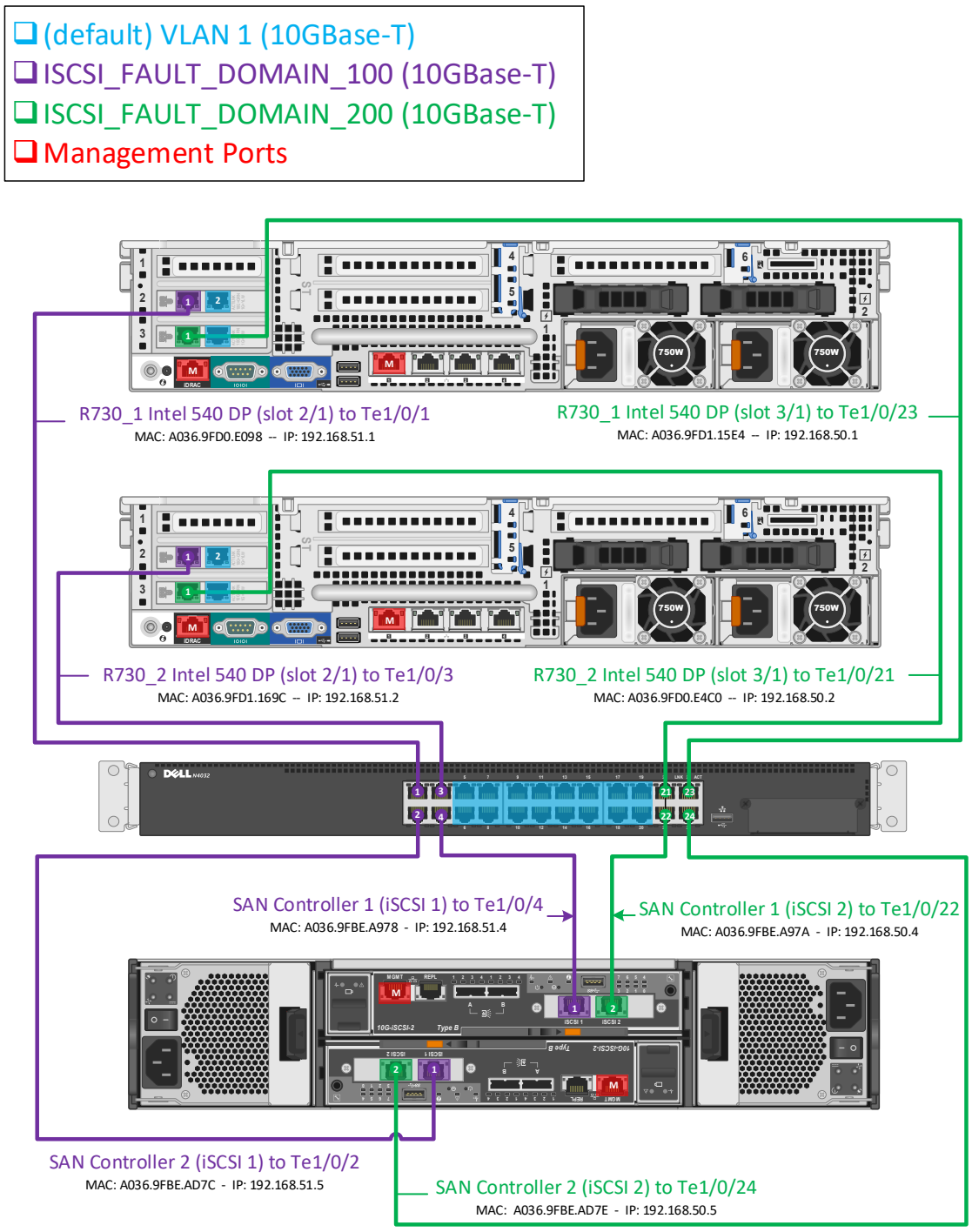

Figure 7-26. Storage Array Network Wiring

7.2.2.5 Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

7.2.2.5.1 Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the Storage Array package. The Storage Array should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement storage array should be requested. The Storage Array should also be plugged n and hooked up to a computer to verify it is operating correctly and the Storage Array is working properly.

7.2.2.5.2 Installation Procedures

The following steps should be followed in order to properly install and configure the Storage Array.

1. Install the storage array in the Rack.
2. Hook up the wiring according to Figure 7-26.

7.2.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the storage array has been installed and is working properly the following steps should be followed immediately after the installation is completed.

1. Power the storage array on and mount the storage array from a computer.
2. Verify the Storage Array is on the network and accessible.
3. Verify files can be added, removed, and accessed from the Storage Array.

7.2.2.6 Quality Assurance/Quality Control Process

In order to verify the Storage Array received from Dell is functioning properly and that it has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for the Storage Array. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

7.2.2.7 Installation Schedule

Table 7-10 details the delivery and installation schedule for the Storage Array.

Table 7-8. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Initial Storage Array Delivery	1	December 2016
Storage Array Installation	1	December 2016

7.2.2.8 HW and SW Configuration Control Process

The Storage Array requires no configuration.

7.2.2.9 Sparing Strategy, Warranty and Contingency Plan

The Storage Array will have a warranty for the life of the pilot project.

7.3 Switch

7.3.1 Switch Acquisition Information

The following sections detail acquisition information related to the network switch.

7.3.1.1 Technical Description/Specification

The switch has (24) 10GBase-T copper Ethernet ports, redundant power supplies and supports layer-2 and layer-3 capabilities.

The switch serves as the interconnect fabric for the servers and storage array. The switch also connects to the existing WYDOT intranet.

7.3.1.2 Ancillary Equipment

The following additional items were purchased for the switch:

- Cat6 Ethernet cables
- Four years' hardware and software support

7.3.1.3 Part Numbers and Quantities

Table 7-9 details the number of equipment to be acquired for the switch.

Table 7-9. Equipment for switch.

Description	Part Number or Name	Quantity
Dell Networking N4032, 24x 10GBaset-T switch	210-ABVS	1
C2G 2t Cat6 Unshielded Ethernet cables	A7523371	21

7.3.1.4 Associated Software

No additional software is purchased for the switch.

7.3.1.5 Acquisition Method

This equipment will be ordered by the Wyoming Acquisition team via a sole source purchase order. Our research and vendor interviews have led to us to use a single vendor for the servers, storage and switch for the Management Center Equipment.

7.3.1.6 Potential Vendors

For the switch, we engaged with Dell, Cisco and HP.

We used a systematic selection process, derived from the objectives and requirements for the WYDOT CV Pilot system.

7.3.1.7 Acquisition Schedule

The switch will be acquired based on the schedule presented in Table 7-10.

Table 7-10. Acquisition schedule for servers.

Description	Date	Quantity
Dell Networking N4032, 24x 10GBase-T switch	12/2016	1

7.3.2 Switch Installation Information

The sections below detail the installation plan and information for the WYDOT TMC Servers.

7.3.2.1 Supplier(s)

Table 7-7 lists the suppliers for the Server.

Table 7-11. Server Suppliers

Description	Part Number or Name	Supplier
Switch	Dell Networking N4032, 24x 10GBaset-T switch (210-ABVS)	Dell
Ethernet Cables	C2G 2t Cat6 Unshielded Ethernet cables (A7523371)	Dell

7.3.2.2 Inventory Control Method

The Switch will be inventoried in a spreadsheet upon arrival. Equipment Managers will enter in all received equipment serial numbers to the Spreadsheet which will be stored in a OneDrive folder with version tracking enabled. This equipment will all permanently reside in the TMC Server room.

7.3.2.3 Configuration(s)

No configuration updates were needed for the Switch.

7.3.2.4 Installation Diagram(s)

The following figures represent the installation diagrams related to the Switch.

Connected Vehicle - 10GBase-T Storage Area Network

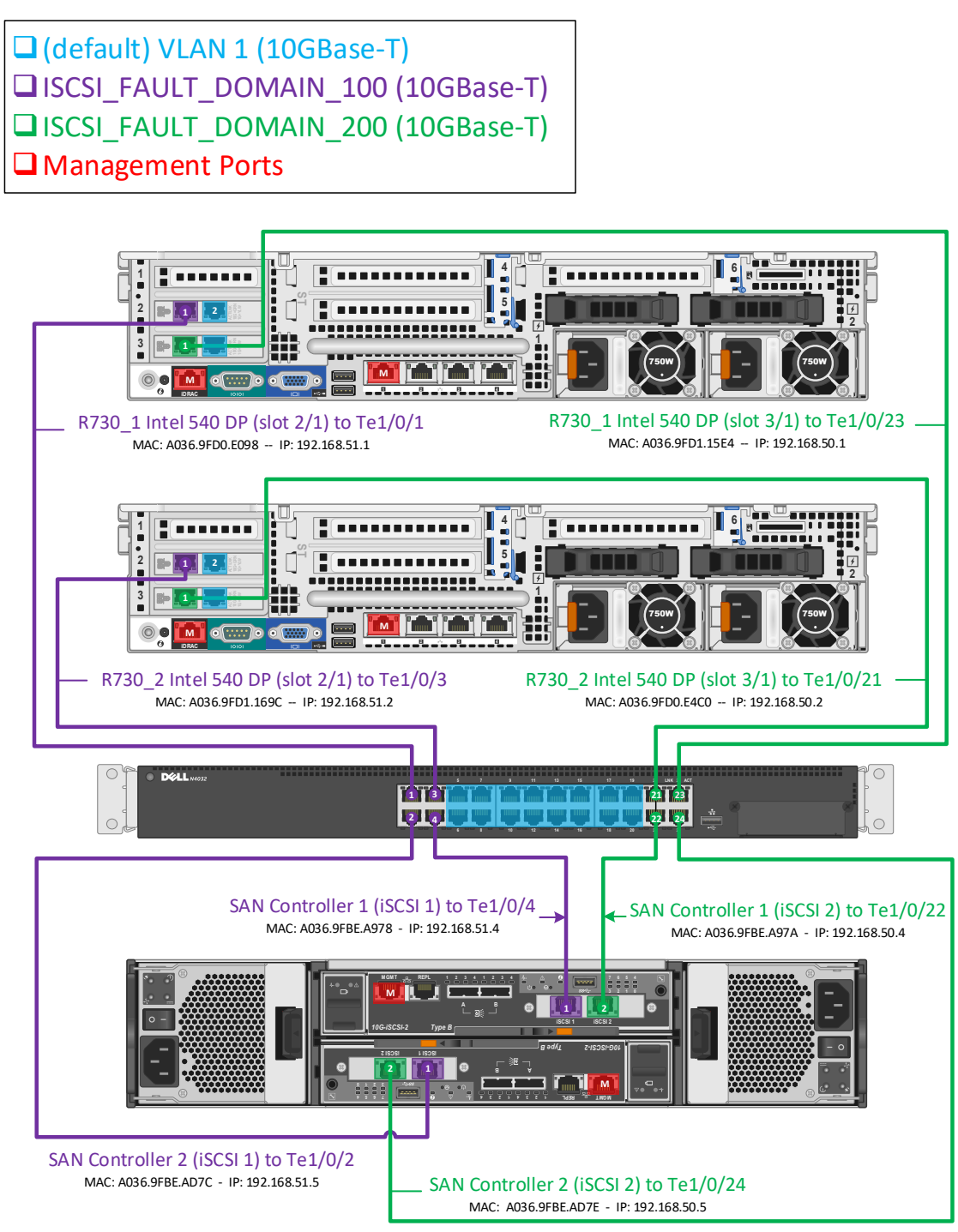

Figure 7-27. Switch Network Wiring

7.3.2.5 Installation Procedures

The following sub-sections include all of the procedures/checklists that ensure the device is ready for installation, is completely installed and was installed correctly and is operating as intended.

7.3.2.5.1 Pre-Installation Procedures/Checklist

Pre-installation procedures will require the installer to verify the contents of the Switch package. The Switch should be inspected for visual defects or visible signs of damage. All damage will be reported back to the Vendor and replacement switch should be requested. The Switch should also be plugged in and hooked up to a computer to verify it is operating correctly.

7.3.2.5.2 Installation Procedures

The following steps should be followed in order to properly install and configure the Switch.

1. Install the Switch in the Rack.
2. Hook up the wiring according to Figure 7-27.

7.3.2.5.3 Post-Installation Procedures/Checklist

In order to verify that the installation succeeded and that the Switch has been installed and is working properly the following steps should be followed immediately after the installation is completed.

1. Power the switch on.
2. Verify the Switch is accessible and correctly routing network traffic.

7.3.2.6 Quality Assurance/Quality Control Process

In order to verify the Switch received from Dell is functioning properly and that it has been installed correctly all pre-installation and post installation steps need to be followed. Pre-installation steps verify the unit integrity and allow WYDOT to verify that the configuration is setup correctly for the Switch. Post-installation steps verify that the unit is installed and functioning correctly within the WYDOT environment.

7.3.2.7 Installation Schedule

Table 7-12 details the delivery and installation schedule for the Switch.

Table 7-12. Lear Locomate Roadstar Premium Installation Schedule

Vehicles	Quantity	Schedule
Initial Switch Delivery	1	December 2016
Switch Installation	1	December 2016

7.3.2.8 HW and SW Configuration Control Process

The Switch requires no configuration.

7.3.2.9 Sparing Strategy, Warranty and Contingency Plan

The Switch will have a warranty for the life of the pilot project.

8 Other Equipment

The WYDOT CV Pilot will not be purchasing any other equipment.

9 Bill of Materials

The attached document is the estimated bill of materials for all of the items detailed in this document.

Equipment List.xlsx

10 Glossary

This section provides a glossary of terms and acronyms used in this document.

Table 10-1. Glossary of Terms.

Term	Definition
Basic Safety Message	Connected V2V safety applications are built around the capability to transmit BSMs, following the Society of Automotive Engineers (SAE) J2735 standard. The BSM is transmitted over DSRC over a range of approximately 300 meters. In general, BSMs are broadcast frequently to provide connected vehicles with data content necessary for the different safety-oriented applications. The BSM is divided into two parts: • Part I, transmitted approximately 10 times per second, contains the core data elements: Message Count, Temporary ID, Time (through a Second Mark), Latitude, Longitude, Elevation, Positional Accuracy, Transmission State, Speed, Heading, Steering Wheel Angle, Acceleration, Brake System Status, and Vehicle Size. • Part II, transmitted less frequently, is added to Part I depending on events (e.g., Anti-lock Braking System (ABS) activated) and contains a variable set of data elements drawn from many optional data elements (availability by vehicle model varies)
Broadcast	Sharing data with no specific destination. All broadcast data is sent unencrypted but is signed with a certificate (based on the Institute of Electrical and Electronics Engineers (IEEE) standard 1609.2).
Data	Data is raw (unorganized and unprocessed) digital messages sent between components. From SAE J2735: Representations of static or dynamic entities in a formalized manner suitable for communication, interpretation, or processing by humans or by machines.
Information	Processed data that is organized, structured or presented in a given context to make it useful
Message	A well-structured set of data elements and data frames that can be sent as a unit between devices to convey some semantic meaning in the context of the applications (adapted from SAE J2735).
On-Board Unit	This represents the package of DSRC radios, computing, sensors and HMI that will be installed on a vehicle. This is similar to the Retrofit Safety Device used in the Safety Pilot Program.
Requirements	Set of information necessary to accomplish one action.
Roadside Units	This represents the package of DSRC radios, computing, communications that will be installed on the roadside on I-80
Transmit	Sharing data directed to a specific receiver. In the case of transmission between Systems, all transmitted data is signed and encrypted, where required, based on SAE J2945/1.
Transportation Management Center	Center that collects information and informs the public about changing travel conditions.
WGS-84	Latest revision of the standard for use in cartography, geodesy, and navigation including by global positioning systems (GPS).

Table 10-2. Acronym List.

Acronym/ Abbreviation	Definition
ABS	Anti-lock Braking System
App. Dev.	Application Development
BSM	Basic Safety Message
CAN bus	Controller Area Network bus
CAP	Comprehensive Acquisition Plan
ConOps	Concept of Operations
CV	Connected Vehicle
DMS	Dynamic Message Signs
DN	Distress Notification
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
FCW	Forward Collision Warning
FHWA	Federal Highway Administration
GB	Giga byte
GPS	Global Positioning System
HMI	Human-Machine Interface
I2V	Infrastructure-to-vehicle
I-80	Interstate 80
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transportation System
NOFO	Notice of Funding Opportunities
NWS	National Weather Service
OBU	On-Board Unit
ODE	Operational Data Environment
RSU	Roadside Units
SAE	Society of Automotive Engineers
SMOC	Security Management Operating Concept
SCMS	Security Credential Management System
SWIW	Spot Weather Impact Warning
SyRS	System Requirements Specification
TBD	To be Determined
TIM	Traveler Information Message
TMC	Transportation Management Center
TMDD	Traffic Management Data Dictionary
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
VSL	Variable Speed Limit
WYDOT	Wyoming Department of Transportation
WZW	Work Zone Warning

11 References

The following table lists the documents, sources and tools used and referenced to develop the concepts in this document.

Table 11-1. References.

#	Documents, Sources Referenced
1.	Gopalakrishna, et al. (2016). *Connected Vehicle Pilot Deployment Program Phase 1, Concept of Operations (version 2), ICF/Wyoming (FHWA-JPO-16-287)*. U.S. Department of Transportation.
2.	Gopalakrishna, et al. (2016). *Connected Vehicle Pilot Deployment Program Phase 1, System Requirements Specification (version 2) – ICF/Wyoming (FHWA-JPO-16-291).* U.S. Department of Transportation.
3.	Gopalakrishna, et al. (2016). *Connected Vehicle Pilot Deployment Program Phase 1, Security Management Operating Concept (version 2), ICF/Wyoming (FHWA-JPO-16-288).* U.S. Department of Transportation.
4.	Gopalakrishna, et al. (2016). *Connected Vehicle Pilot Deployment Program Phase 1, Comprehensive Deployment Plan (version 2), ICF/Wyoming (FHWA-JPO-16-297).* U.S. Department of Transportation.
5.	Wyoming Department of Transportation (WYDOT), System Design Document (SDD) – Wyoming CV Pilot, Version 4, September 1, 2017
6.	Wyoming Department of Transportation (WYDOT), Interface Control Document (ICD) – Wyoming CV Pilot, Version 2, June 17, 2017
7.	Wyoming Department of Transportation (WYDOT), Comprehensive Acquisition Plan (CAP) – Wyoming CV Pilot, Version 2, May 2017

Appendix A – WYDOT RSU Installation Plans

Attached is the detailed CV RSU Installation plan for RSUs along the I-80 corridor.

CV RSU Install Plan Final.pdf

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

FHWA-JPO-17-471

U.S. Department of Transportation