Research & Vehicle Technology
"Infotainment Systems Product Development"

Feature – 5G V2V (China Go Fast)

Subsystem Part Specific Specification (SPSS)

Version 1.0
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Version Date: April 29, 2022

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Revision History

Date	Version	Notes	
March 18, 2022	**0.01**	**Draft In Process**	**Chen Dandan(dchen97)**
April 29, 2022	**1.0**	**Initial Release**	**Chen Dandan(dchen97)**
May 7, 2022	**1.01**	**3.2.2** Removed "(reserved)" from "4 – BSM transmission on/off setting(reserved);" **3.2.3 & 3.2.4** Removed "(reserved)" from "v2v_bsm_tx_on_off_setting (reserved)" **3.2.4** Added "3 – not implemented" to v2v_bsm_tx_on_off_setting item **4.1.1** Added alt when v2v_bsm_tx_on_off_setting is "3 – not implemented"	**Chen Dandan(dchen97)**

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1 Overview

Many safety applications such as FCW and pedestrian collision warning are implemented using a traditional line of sight sensors such as cameras or radars. However, cameras and radars cannot detect vehicles and pedestrians in non-line of sight scenarios such as a blind intersection or obstructed traffic.

A unique feature of V2X technology is the ability to detect threats in non-line of site situations. V2X is envisioned to fill "the gap" and enhance the sensing ability of the vehicle. A traditional line-of-sight sensor (e.g., camera or radar) is estimating information such as relative position, speed, direction and infer the braking status of the targets whereas V2X is getting this information from the best possible sensors, from the remote vehicle internal bus itself.

V2X allows a vehicle to communicate with "Everything". It is a short-to-medium range low-latency communications technology used for vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and vehicle-to-pedestrian (V2P) communications for safety, driver assistance, mobility, and service applications. C-V2X is Cellular Vehicle to Everything, a specific standard to accomplish V2X communication. C-V2V communications can provide vehicles the ability to talk to each other with PC5 interface and therefore see around corners and through the obstacles over a longer distance compared to the current on-board sensors. It is estimated that V2V communications address up to 80% of the unimpaired crashes[1].

A vehicle needs an On-Board Unit (OBU) to establish the V2V communication with other vehicles also equipped with OBUs. In general, an OBU has a radio for transmission and reception, GNSS receiver, a processor, and several interfaces (e.g., CAN, Ethernet, GPS/GNSS) for obtaining the vehicle data. Essential message in V2V communication is called Basic Safety Messages (BSM). BSM is a broadcast message typically transmitted frequently up to ten times a second. Content of BSM includes vehicle information such as vehicle speed, location, and brake status.

V2V application uses the remote vehicles (RVs) data from BSM and Host Vehicle (HV) data from the OBU interfaces like CAN and GNSS to predict a potential crash warning and alert the driver. V2V messages could also potentially be fused with on-board sensors like Radar, Lidar, and Camera to improve the confidence level of vehicle detection for safety applications or even for autonomous driving to some extent. However, data fusion of V2X data and the other traditional line of sight sensors such as cameras and radars are not intended in this document.

1.1 Terms and Definitions

Abbreviation	Description
V2X	Vehicle to Everything
V2V	Vehicle to Vehicle
V2I	Vehicle to Infrastructure
V2P	Vehicle to Pedestrian
C-V2X	Cellular Vehicle to Everything Specific standard to accomplish V2X communication from 3GPP
BSM	Basic Safety Message
3GPP	The 3rd Generation Partnership Project
EEBL [2]	Electronic Emergency Brake Light
LTA [3]	Left Turn Assist
HV	Host Vehicle
RV	Remote Vehicle
SCMS	Security Credential Management System
FCW	Forward Collision Warning
PC5	PC5 interface, the direct communication between vehicles and other devices
Uu	Uu interface, the logical interface between the device and the base station

1.2 Preconditions

1. China V2V Application SW resides in the Modem 6.1C (maybe some later versions with possible SW changes) TCU equipped with C-V2X capability and GNSS chip, as well as China unique security HSM chip.
2. C-V2X system services or ITS stack have been done in C-V2X foundation SW on TCU, it means that all information China V2V Application needs could be easily fetched, such as BSM from RV, GNSS data and CAN data of HV, etc. SCMS management interface via cellular communication implementation unique for Chinese encryption algorithms (SM2, SM3, SM4) has been done in C-V2X system services.
3. The target lead vehicle program of the China V2V Application SW shall use FNV3 (maybe FNV2.1 backward or FNV4 and later architectures with some possible SW changes) platform and CAN message database (CMDB) to support Basic Safety Messages (BSM).
4. 5G V2X sharkfin antenna and V2X jewel antenna and corresponding EDS are needed.

1.3 Assumptions

1. China V2V Application SW will send collision warning to the driver, it shall not perform or automatically initiate any vehicle control function (like braking, steer, accelerate etc.).
2. Due to Chinese regulations on elevation data transmission limit, IMA won't be in current scope. Only EEBL [2] and LTA [3] are included in the initial version.
3. The document is currently only applicable to mainland China region.
4. SYNC+ phase 5 is the assumption to implement V2V China go fast HMI.

2 Architectural Design

2.1 System Boundary Diagram

2.1.1 V2V_APP-IBD-REQ-V2V_APP System Service Boundary Diagram
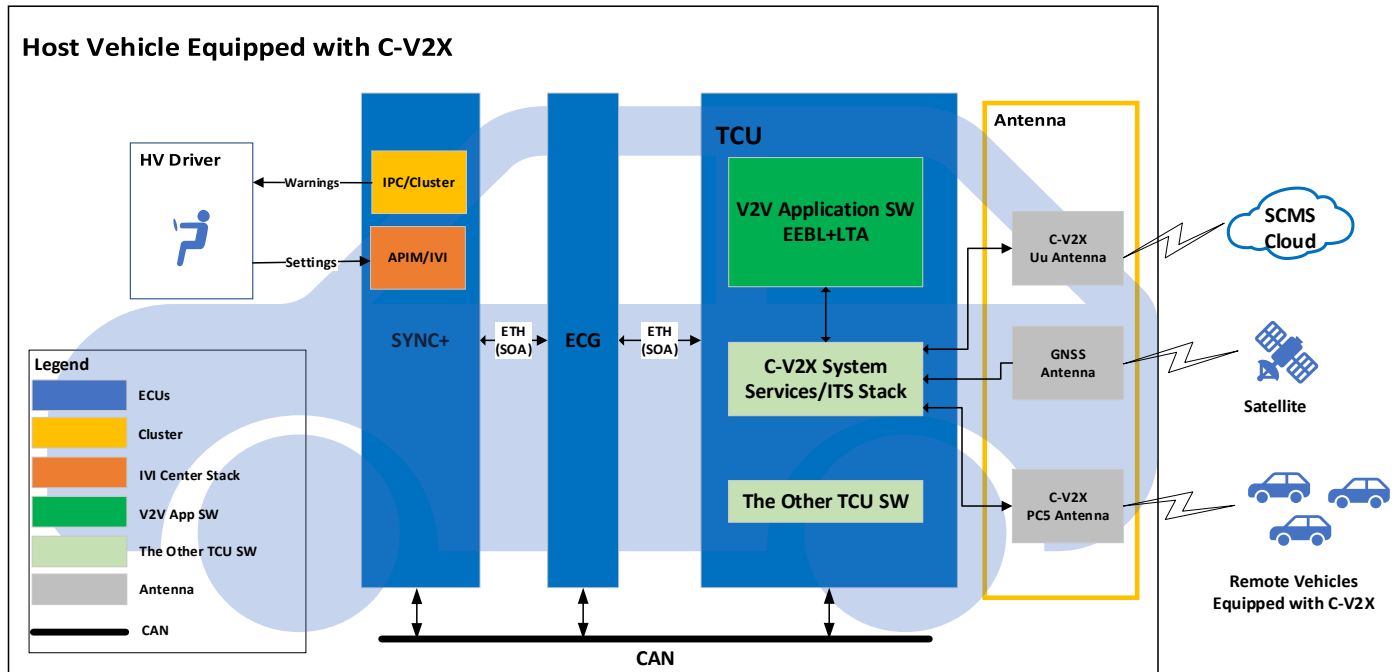
Please note that cloud data of V2V application feature will only contain some data related to security and confidential, there will be NO other data included.

2.2 System Service Diagram

2.2.1 V2V_APP-IBD-REQ-V2V_APP System Service Functions Diagram

V2V Application

Obtain HV and RV data

HV Data (GNSS, CAN, etc.)

RV BSM

Target Classification

LTA Collision Threat Assessment

EEBLA Collision Threat Assessment

Other Applications to be added

Threat Arbitration
Collision Warning Arbitration Request

C-V2X System Service Server (China Go Fast)
C-V2X Foundation SW/ ITS stack

HMI Setting/Display/Audio

V2V Feature/Warning on/off setting and Sensitivity high/normal/low setting

V2V Warning Display and Chime

V2X temporary Failure Fault Warning

V2X permanent Failure Fault Warning

Driver

3 General Requirements

3.1 V2V_APP-REQ-V2V Application

Responsibility:

The V2V Application is intended to assist the driver in driving situations that provides an imminent risk for collision. It continuously communicates with remote vehicles through PC5, obtains host vehicle' s data and remote vehicles' data, processes the data to determines collision possibility and provides the highest priority warning to the driver. It contains the following applications:

● EEBL (Electronic Emergency Brake Light Assist) [2]
● LTA (Left Turn Assist) [3].

The China V2V Application communicates with China IVI module over the FNV based ethernet to get the V2V settings update from IVI module and to send warning arbitration to it. And China IVI module will be responsible to play CHIME and popup warning on cluster. The logic view of the functionality on communication between China V2V Application and China IVI module could be found in the following figure.
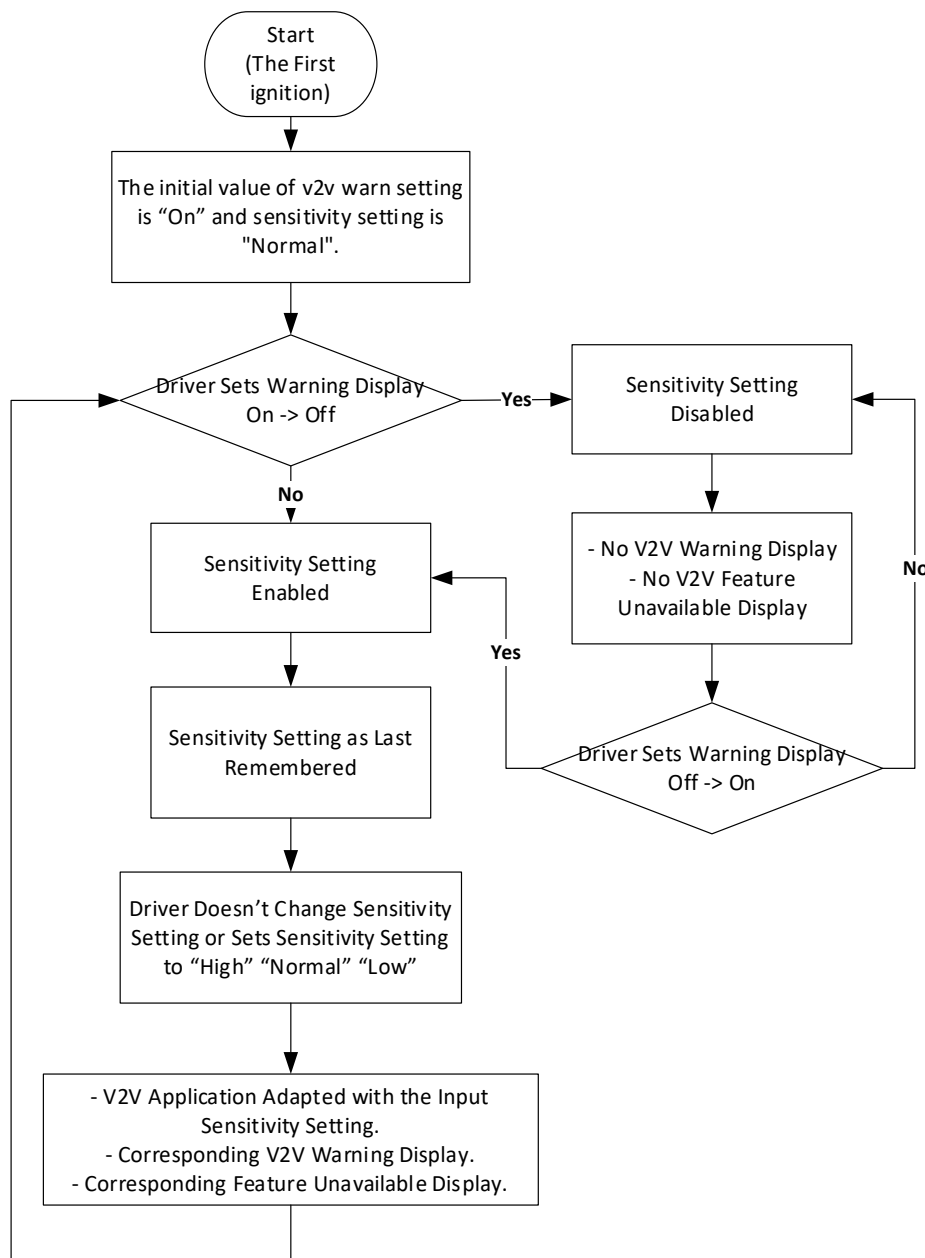
V2V settings mentioned in this chapter stand for feature/warning on/off setting and sensitivity high/normal/low setting.

Settings	Initial value
v2v_warn_on_off_setting	on
v2v_warn_sensitivity_setting	normal

3.2 V2V Application Interface

With the introduction of the FNV2.1 and later version architecture, all the communication between TCU and China IVI Module is available via SOA.

China IVI Module will be responsible for providing the following messages over SOA to V2V Application:

1. Get V2V Settings Status Request
2. Update V2V Settings Status Request

V2V Application will be responsible for providing the following messages over SOA to China IVI Module:

1. V2V Settings Status Response
2. V2V Warning Status (Periodically)

Apart from V2V Application, IVI module should also handle CV2XServiceStatusMsg from C-V2X System Service Server (China Go Fast) and display temporary V2X failure and permanent failure.

3.2.1 MD-REQ-405241/B-CV2XServiceStatusMsg[4]

This is provided by TCU C-V2X Service Server, it is used to provide the CV2X TCU module status to subscribers. The CV2X System Server publishes this data On Change with the following data structure.

Method Type	On Change				
QoS Level	Default				
Retained	Yes				
R/O	**Name**	**Type**	**Literals**	**Value**	**Description**
Request (_Rq)					
-	-	-	-	-	N/A
Response (_Rsp)					
R	msgID	uint8		0-255	
R	status	uint8		0 - 4	0=n/a 1=normal 2=Standby 3=Failure-temp 4=Failure-permanent

3.2.2 V2V_APP-REQ-IVIGetV2VSettingsReqMsg

This message is used for IVI to get V2V setting status from V2V application.

Method Type	One Shot				
QoS Level	Default				
Retained	No				
R/O	**Name**	**Type**	**Literals**	**Value**	**Description**
Request (_Rq)					
R	system_time	uint64	-	-	Vehicle system time in milliseconds

R/O	Name	Type	Literals	Value	Description
R	setting_type	uint32	-	-	0 – inactive; 1 – all; 2 – warn on/off setting; 3 – sensitivity setting; 4 – BSM transmission on/off setting; 5 – V2V sub features on/off setting(reserved)

3.2.3 V2V_APP-REQ-IVISetV2VSettingsReqMsg

This message is used for IVI to update V2V setting status stored in V2V application on change from HMI.
The full message is defined in the table below. The minimum set of data that will always be included is:
- V2V Feature/Warning on/off Setting Status Update
- V2V Sensitivity high/normal/low Setting Status Update
- V2V BSM transmission on/off Setting Status Update

Method Type	On change				
QoS Level	Default				
Retained	No				

R/O	Name	Type	Literals	Value	Description
Request (_Rq)					
R	system_time	uint64	-	-	Vehicle system time in milliseconds
R	v2v_warn_on_off_setting	uint32	-	-	0 – inactive; 1 – on; 2 - off
R	v2v_warn_sensitivity_setting	unit32	-	-	0 – inactive; 1 – low; 2 – normal; 3 - high
R	v2v_bsm_tx_on_off_setting	uint32	-	-	0 – inactive; 1 – on; 2 -off;
R	v2v_sub_features_on_off_setting (reserved)	uint32	-	-	Bit 0: reserved Bit 1: EEBL Bit 2: LTA Bit 3: IMA Bit 4 – Bit 31: reserved 0x0: off 0x1: on
R	v2v_reserved_setting (reserved)	uint32	-	-	reserved

3.2.4 V2V_APP-REQ-V2VSettingsStatusRspMsg

The full message is defined in the table below. The minimum set of data that will always be included is:
- Current Saved V2V Feature/Warning on/off Setting Status
- Current Saved V2V Sensitivity high/normal/low Setting Status

Method Type	One Shot				
QoS Level	Default				
Retained	Yes				

R/O	Name	Type	Literals	Value	Description
Request (_St)					
R	system_time	uint64	-	-	Vehicle system time in milliseconds
R	v2v_warn_on_off_setting	uint32	-	-	0 – inactive; 1 – on; 2 - off
R	v2v_warn_sensitivity_setting	unit32	-	-	0 – inactive; 1 – low; 2 – normal; 3 - high

R	v2v_bsm_tx_on_off_setting	uint32	-	-	0 – inactive; 1 – on; 2 -off; 3 – not implemented
R	v2v_sub_features_on_off_setting (reserved)	uint32	-	-	Bit 0: reserved Bit 1: EEBL Bit 2: LTA Bit 3: IMA Bit 4 – Bit 31: reserved 0x0: off 0x1: on
R	v2v_reserved_setting (reserved)	uint32	-	-	reserved

3.2.5 V2V_APP-REQ-V2VWarningStatusMsg

The full message is defined in the table below. The minimum set of data that will always be included is:
- V2V Warning Type

Method Type	Event Periodic				
QoS Level	Default				
Retained	No				
R/O	**Name**	**Type**	**Literals**	**Value**	**Description**
Request (_St)					
R	system_time	uint64	-	-	Vehicle system time in milliseconds
O	protocol_version	uint32	-	-	0 – initial version
R	v2v_warn_type	uint32	-	-	0 – No warning; 1- EEBL; 2 – LTA; 3 – IMA L (reserved); 4 – IMA R (reserved)

3.2.6 V2V_APP-REQ-V2VServiceStatusMsg (Reserved)

The full message is defined in the table below. The minimum set of data that will always be included is:
- Status

Method Type	OnChange				
QoS Level	Default				
Retained	Yes				
R/O	**Name**	**Type**	**Literals**	**Value**	**Description**
Request (_Rq)					
-	-	-	-	-	N/A
Response (_Rsp)					
R	system_time	uint64	-	-	Vehicle system time in milliseconds
R	status	uint8	-	-	0=n/a 1=normal 2=Standby 3=Failure-temp 4=Failure-permanent

4 Functional Definition

4.1 V2V_APP-FUN-REQ-SYNC+ Get V2V Settings Status

IVI/SYNC+ should query V2V settings every time after bootup and get response in 500ms and display last remembered settings. Last remembered settings are saved on TCU.
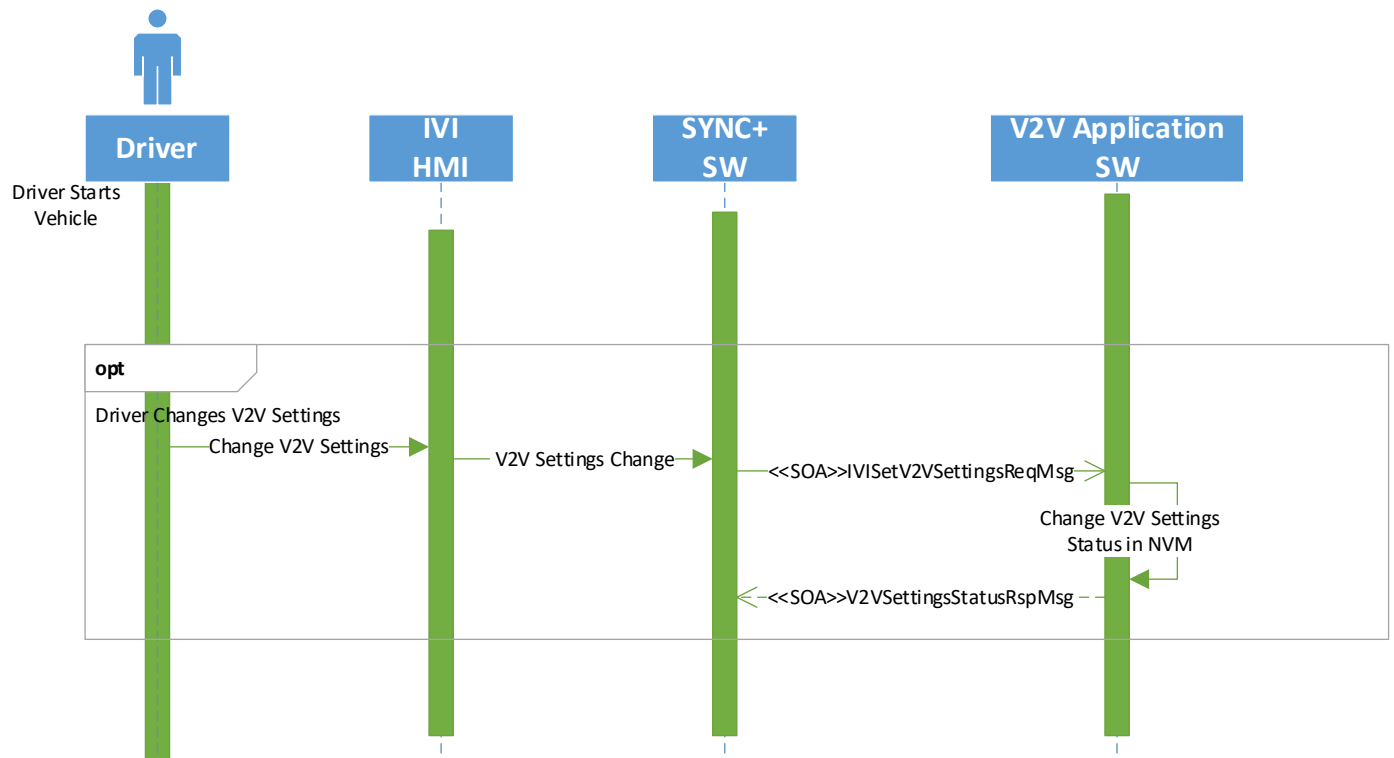
4.1.1 Sequence Diagram
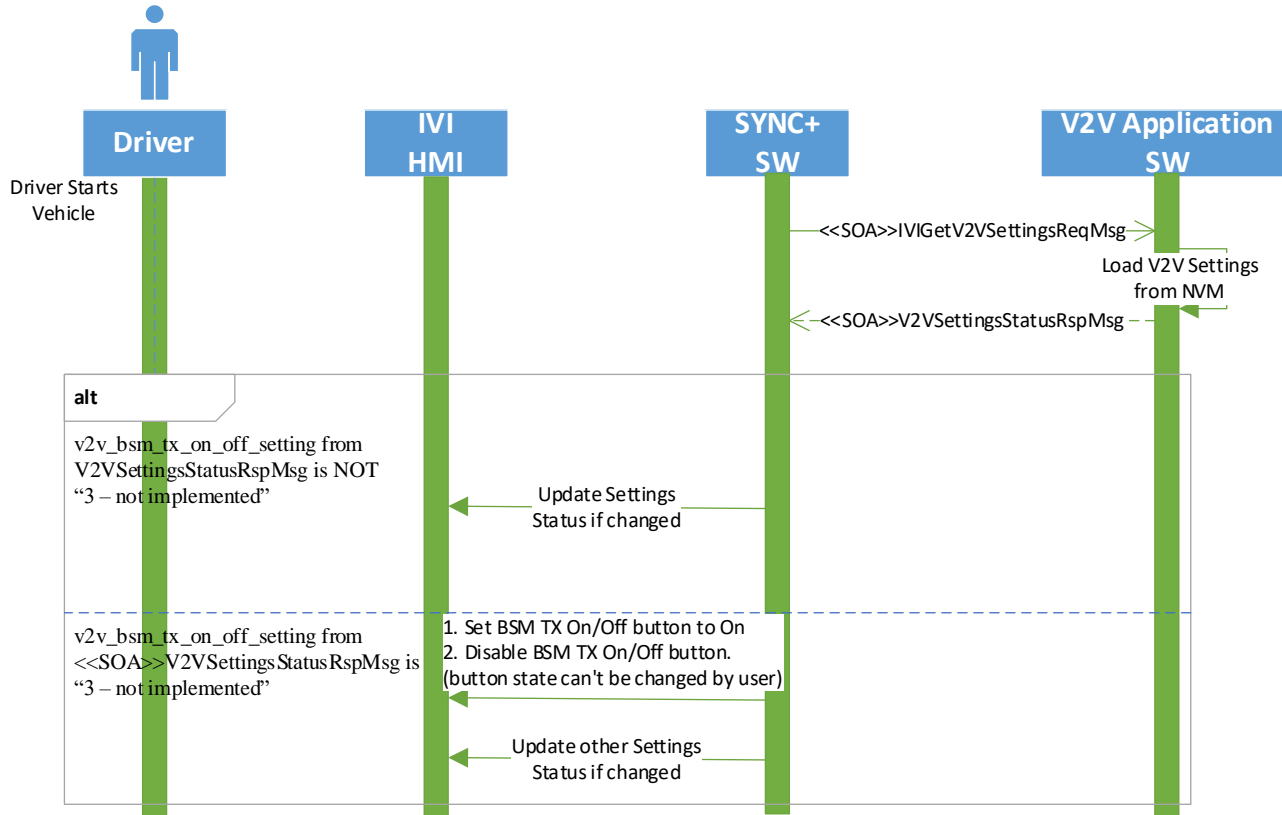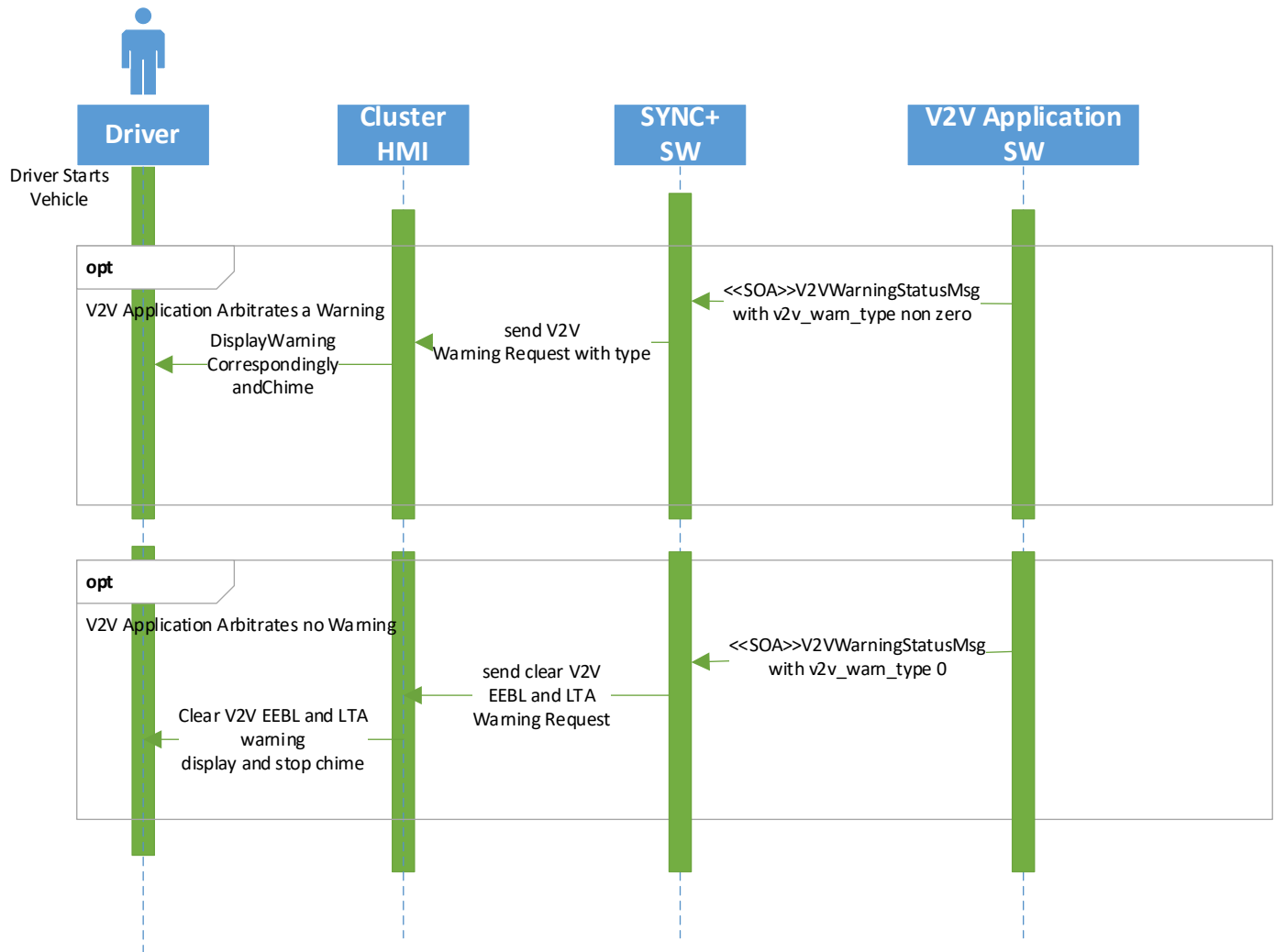

4.2 V2V_APP-FUN-REQ-SYNC+ Set V2V Settings

IVI/SYNC+ should update V2V settings to TCU every time after driver update V2V settings and receive response message from TCU in 500ms.

4.2.1 Sequence Diagram

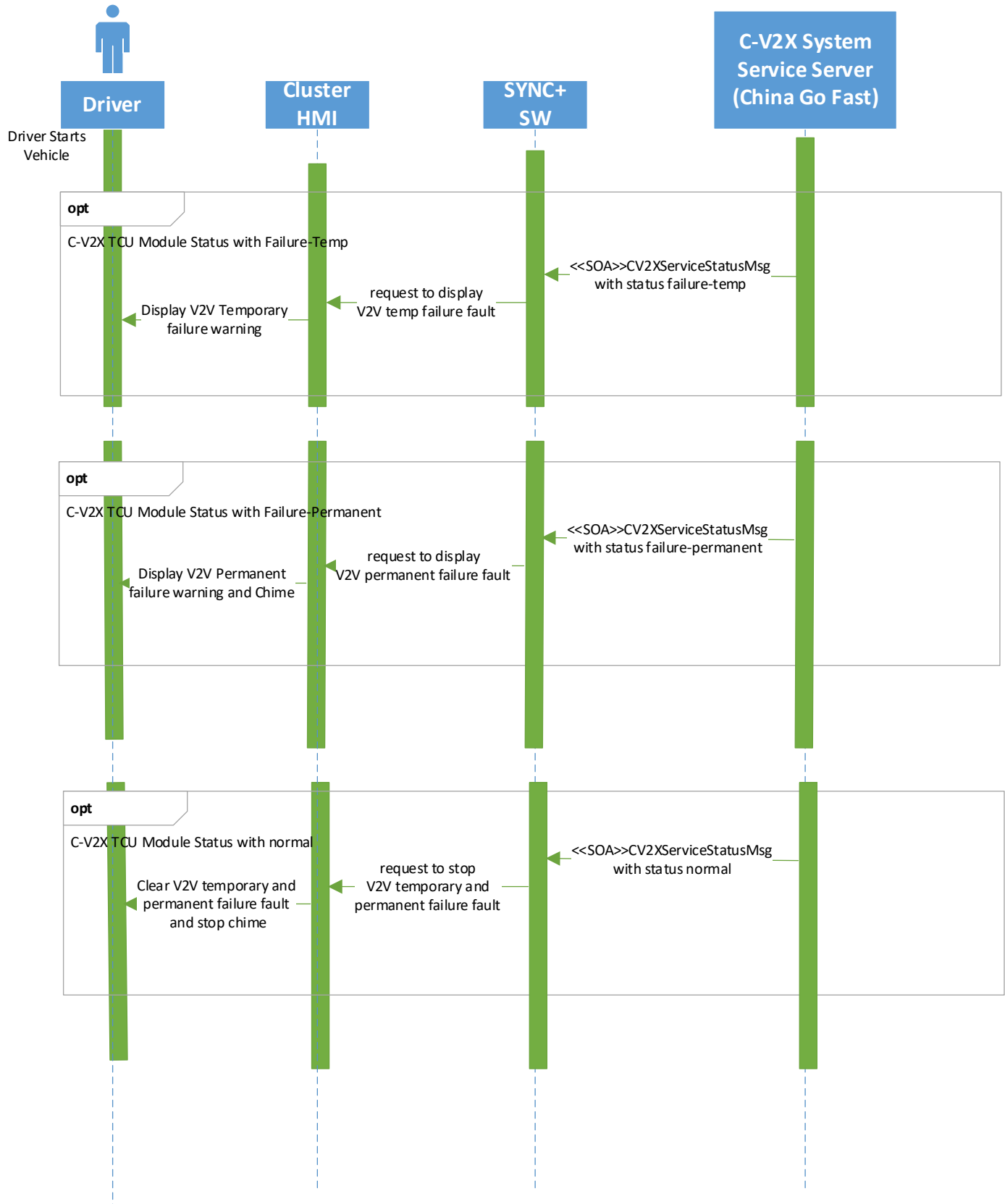## 4.3 V2V_APP-FUN-REQ-SYNC+ Display V2V Collision Warning on Cluster and Chimes
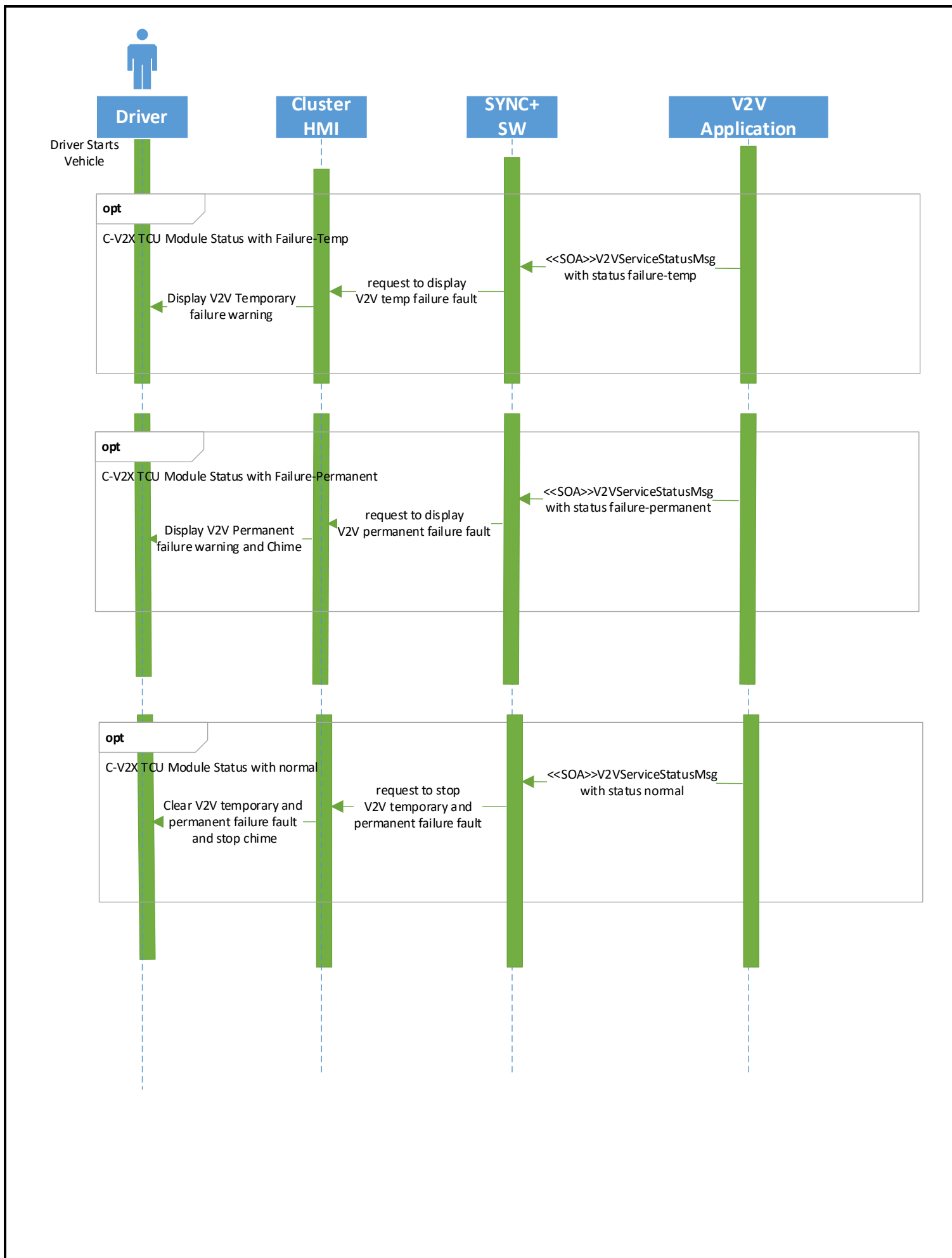
4.3.1 Sequence Diagram

4.4 V2V_APP-FUN-REQ-SYNC+ Display V2X Failure Warning on Cluster

4.4.1 Sequence Diagram

Following sequence diagram is reserved.

Driver | **Cluster HMI** | **SYNC+ SW** | **V2V Application**

Driver Starts Vehicle

opt

C-V2X TCU Module Status with Failure-Temp

<<SOA>>V2VServiceStatusMsg with status failure-temp

request to display V2V temp failure fault

Display V2V Temporary failure warning

opt

C-V2X TCU Module Status with Failure-Permanent

<<SOA>>V2VServiceStatusMsg with status failure-permanent

request to display V2V permanent failure fault

Display V2V Permanent failure warning and Chime

opt

C-V2X TCU Module Status with normal

<<SOA>>V2VServiceStatusMsg with status normal

request to stop V2V temporary and permanent failure fault

Clear V2V temporary and permanent failure fault and stop chime

5   Appendix A: Reference Documents

Reference #	Document Title
[1]	National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT), "Notice of proposed rulemaking (NPRM)," Federal Motor Vehicle Safety Standards; V2V Communications, Tech. Rep. 49 CFR Part 571, 2016.
[2]	Electronic Emergency Brake Light Assist Feature (F002493) Feature Document Specification (FD)
[3]	Left Turn Assist Feature (F002492) Feature Document Specification (FD)
[4]	Feature – C-V2X System Service Server (China Go Fast) SPSS