



Feature Document (FD)

Augmented Reality (AR)

(F003774)

Document Type	Feature Document (FD)	
Template Version	6.1a	
Document ID	AR feature Document	
Document Location	https://www.vsemweb.ford.com/tc/launchapp?-attach=true&-s=226TCSession&-o=yZa5vIx\$x3NrTD&servername=Production_Server	
Document Owner	Mabdelh1; Iflore70; aalsamar	
Document Revision	2.1	
Document Status	Released	
Date Issued	2021/03/12	
Date Revised	2021/07/14	
Document Classification	GIS1 Item Number: 27.60/35	
	GIS2 Classification: Confidential	

Document Approval			
Person	Role	Email Confirmation	Date

This document contains Ford Motor Company Confidential information. Disclosure of the information contained in any portion of this document is not permitted without the expressed, written consent of a duly authorized representative of Ford Motor Company, Dearborn, Michigan, U.S.A.

Copyright © 2016 - 2019, Ford Motor Company

Printed Copies Are Uncontrolled



Important Note

You need to use the RE specification macros provided by the “RE_SpecificationMacroTemplate.dotm” (refer to “Utilities” on [page “Specification Templates” in the RE Wiki](#)) to allow seamless VSEM import of the specification content. **Use only these RE specification macros to create requirements** in this specification. Refer to [“How to use the Specification Templates”](#) on how to enable and use the macros and the requirements templates in this specification.



CONTENTS

Contents	3
1 Introduction	5
1.1 Document Purpose.....	5
1.2 Document Scope.....	5
1.3 Document Audience	5
1.3.1 Stakeholder List.....	5
1.4 Document Organization.....	7
1.4.1 Document Context.....	7
1.4.2 Document Structure.....	8
1.5 Document Conventions.....	8
1.5.1 Requirements Templates	8
1.6 References	9
1.6.1 Ford Documents	9
1.6.2 External Documents and Publications.....	9
1.7 Glossary	9
1.7.1 Definitions.....	9
1.7.2 Abbreviations.....	9
1.7.3 Parameters / Values	10
2 Feature Overview.....	11
2.1 Purpose and Description of Feature	11
2.2 Feature Variants.....	12
2.2.1 Regions & Markets	13
2.3 Input Requirements/Documents.....	14
2.4 Lessons Learned.....	14
2.5 Assumptions	14
3 Feature Context	15
3.1 Feature Context Diagram	15
3.2 List of Influences	15
4 Feature Modeling.....	17
4.1 Operation Modes and States	17
4.2 Use Cases.....	18
4.2.1 Use Case Diagram	18
4.2.2 Actors	18
4.2.3 Use Case Descriptions	19
4.3 Driving and Operation Scenarios	29
4.4 Decision Tables.....	30
5 Feature Requirements	31
5.1 Functional Requirements	31
5.2 Non-Functional Requirements	51
5.2.1 Safety	51
5.2.2 Security.....	51
5.2.3 Reliability	51
5.3 HMI Requirements	51
5.4 Other Requirements.....	55
5.4.1 Design Requirements.....	55
5.4.2 Manufacturing Requirements	56
5.4.3 Service Requirements	56
5.4.4 After Sales Requirements	72
5.4.5 Process requirements	72
6 Functional Safety	73
6.1 System Behaviors for HARA	73
6.2 Safety Assumptions.....	74
6.3 Safety Goals.....	74
6.4 Functional Safety Requirements	74
6.4.1 <Goal 1 Name>	74
6.4.2 <Goal n Name>	74
6.4.3 Derivation of Functional Safety Requirements on Assumptions	75
6.4.4 ASIL Decomposition of Functional Safety Requirements	75



Feature Document Augmented Reality (AR)

7	CyberSecurity	76
7.1	Security Goals	76
7.2	Cybersecurity Requirements	80
8	Architecture	81
8.1	Functional Architecture	81
8.1.1	Logical Functions	82
8.2	Logical Architecture	83
8.2.1	Logical Elements	83
8.2.2	Logical Interfaces	84
9	Open Concerns	85
10	Revision History	87
11	Appendix	88
11.1	Definitions	88
11.2	Abbreviations	88

List of Figures

Figure 1: Context Diagram	15
Figure 2: Feature Operation Modes and States	17
Figure 3: Use Case Diagram (Note-see description in Table 7: Feature Variants section about offering assumption use cases)	18
Figure 4: Functional Boundary Diagram	82
Figure 5: Logical Boundary Diagram	83

List of Tables

Table 1: Features described in this FD	5
Table 2: Ford internal Documents	9
Table 3: External documents and publications	9
Table 4: Definitions used in this document	9
Table 5: Abbreviations	10
Table 6: Parameters / Values used in this document	10
Table 7: Feature Variants	13
Table 8: Regions & Markets	13
Table 9: Input Requirements/Documents	14
Table 10: List of Influences	16
Table 11: Operation Modes and States	17
Table 12: Transitions between Operational Modes and States	18
Figure 3: Use Case Diagram (Note-see description in Table 7: Feature Variants section about offering assumption use cases)	18
Table 13: List of Actors	18
Table 14: System Behaviors for HARA	73
Table 15: Functional Safety Assumptions	74
Table 16: Cybersecurity Goals	80
Table 17: List of Functions	82
Table 18: Logical Elements	84
Table 19: Logical Interfaces	84
Table 20: Open Concerns	86
Table 21: Definitions used in this document	88
Table 22: Abbreviations used in this document	88



1 INTRODUCTION

1.1 Document Purpose

A Feature Document (FD) document specifies **what** the feature shall do and how it shall behave from customer perspective. It should also provide reasoning and background **why** we have the feature in the vehicle.

The FD also serves as an Item Definition as defined by ISO26262 for those features, which follow the Ford Functional Safety process.

To get more information about the concept of feature, function and component level abstraction refer to the [Ford RE Wiki](#). For details on the Ford Functional Safety (ISO26262) process refer to the [Ford Functional Safety Sharepoint](#).

1.2 Document Scope

This Feature Document (FD) specifies the following features:

Feature ID	Feature Name	Owner	Reference
F003774	Augmented Reality	Mahmoud Abdelhamid	https://www.vsemweb.ford.com/tc/launchapp?-attach=true&-s=226TCSession&-o=yZa5vIx\$3NrTDAAAAAAAAAAAAAA&servername=Production_Server

Table 1: Features described in this FD

1.3 Document Audience

The FD is written by the feature owner of Augmented Reality / Occupant Engagement Features. All Stakeholders, i.e., all people who have a valid interest in the feature should read and, if possible, review the FD. It needs to be guaranteed, that all stakeholders have access to the currently valid version of the FD.

1.3.1 Stakeholder List

For the latest list of stakeholder of the feature and their influence refer to [<Put VSEM Link here>](#).

List of Stakeholders

Name	CDSID /phone	Stake	Contact date	Elicitation response	Review worksheet	Review meeting
Bentley, Sonya (S.D.)	sbentle5	Systems Engineering Manager	11/23/2019	Accepted	Yes	Yes
Yousif, Meisam (M.L.)	myousif	Feature Owner Supervisor	11/23/2019	Accepted	Yes	Yes
Abdelhamid, Mahmoud (M.)	mabdelh1	Feature Owner Lead	11/23/2019	Accepted	Yes	Yes
Alsamarai, Ahmed (A.)	aalsamar	Feature Owner (co-lead)	8/17/2020	Accepted	Yes	Yes
Flores, Luis (L.A.)	lflore70	Feature Owner (co-lead)	8/17/2020	Accepted	Yes	Yes
Ahmed, Fahd	fahmed2	AR Feature Champion / AR Planning Lead	2/10/2021	Accepted	Yes	Yes
Kessler, Chris	ckessle8	Global AR Marketing Lead for Ford and Lincoln	01/25/2021	Accepted	Yes	Yes
King, Anthony (A.G.)	aking6	AR module Product owner Supervisor	8/17/2020	Accepted	Yes	Yes
Langkamp, Ulf (U.K.)	ulangkam	AR module Product owner Engineer	7/31/2020	Accepted	Yes	Yes



Feature Document Augmented Reality (AR)

List of Stakeholders

Name	CDSID /phone	Stake	Contact date	Elicitation response	Review worksheet	Review meeting
Nachtegall, Debbie (D.E.)	dnachte1	AR ECU D&R - Hardware	8/07/2020	Accepted	Yes	Yes
Keerthivasan, Venkataraman	vkeerth5	AR ECU D&R – Hardware	6/24/2021	Accepted	Yes	Yes
Vootkuri, ChandraSekhar (C.R.)	cvootkur	AR ECU D&R - Software	8/04/2020	Accepted	Yes	Yes
Lazalde, Eric (E.)	elazald1	HMI lead for the core interaction on the panoramic displays- HHDD	2/4/2021	Accepted	Yes	Yes
To, Curtis (C.S.)	cto3	HMI Supervisor, Customer Experience	8/26/2020	Accepted	Yes	Yes
Khanafer, Dima (D.)	dkhanafe	HMI Engineer, Customer Experience	8/26/2020	Accepted	Yes	Yes
Von hausen, Christian (C.)	cvonhaus	HMI Engineer, Customer Experience	8/26/2020	Accepted	Yes	Yes
Van Moen, Lidia	Ivanmoen	Core Hardware Engineer / ADAS FWC Camera	9/01/2020	Accepted	Yes	Yes
Zaragoza, Claudia	czarago1	Core Hardware Engineer / FIR Camera	10/29/2020	Accepted	Yes	Yes
Saini, Akriti (A.)	asaini10	Core Hardware Engineer / AR Camera	01/19, 2021	Accepted	Yes	Yes
Rahtz, Timothy (T.A.)	trahtz	AR Nav product owner	12/03/2020	Accepted	Yes	Yes
Check, Laura	lburek	IVI/Phoenix Product Owner	8/18/2020	Accepted	Yes	Yes
White, Melissa	mwhite35	Manufacturing point of contact	9/16/2020	Accepted	Yes	Yes
Civiero, Christian	ccivier1	ASO SME for AR	8/17/2020	Accepted	Yes	Yes
Gehrke, Mark	mgehrke2	GTDS #22423 Lead for FIR Camera Project	10/26/2020	Accepted	Yes	Yes
Hiskens, David	dhiskens	GTDS #22423 Co-Lead for FIR Camera Packaging	9/01/2020	Accepted	Yes	Yes
Diedrich, Jonathan (J.)	jdiedris	GTDS #22423 Co-Lead for FIR Camera Calibration	11/16/2020	Accepted	Yes	Yes
Cauvet, Colleen	ccaauvet	GTDS #30199 Lead for (Thermally Enhanced Night vision Features)	8/28/2020	Accepted	Yes	Yes
Dutta, Arun	adutta2	GTDS #30199 Engineer for (Thermally Enhanced Night vision Features)	9/10/2020	Accepted	Yes	Yes
Hurley, Collin	churle15	GTDS #30199 Engineer for (Thermally Enhanced Night vision Features)	9/11/2020	Accepted	Yes	Yes
Farrell, David (D.E.)	dfarre13	Functional Safety SE Lead	9/28/2020	Accepted	Yes	Yes
Dean, Shawn (S.)	sdean44	Functional Safety SE Engineer	9/28/2020	Accepted	Yes	Yes
Balachandran, Vignesh	vbalach4	Functional safety EESE Lead	1/14/2021	Accepted	Yes	Yes
Foresto, Marco (M.P.)	mforesto	Functional architecture	1/14/2021	Accepted	Yes	Yes
Perkins, Steve (S.)	sperki50	Functional architecture	10/21/2020	Accepted	Yes	Yes
Becerra, Alejandro (JABS.)	jbecer16	Feature MBSE Modeler	8/20/2020	Accepted	Yes	Yes



Feature Document Augmented Reality (AR)

List of Stakeholders

Name	CDSID /phone	Stake	Contact date	Elicitation response	Review worksheet	Review meeting
Ortiz Anguiano, Alejandro	aortizan	Feature MBSE Supervisor	8/17/2020	Accepted	Yes	Yes
Mahmood, Hamid	hmahmoo3	Pre-PS IVI – CoOps Supervisor	10/12/2020	Accepted	Yes	Yes
Rahman, Moshir	mrahma29	Pre-PS IVI – CoOps Engineer	8/20/2020	Accepted	Yes	Yes
Caballero, Fernando (F.)	fcabal11	FMA Coach Engineer	10/09/2020	Accepted	Yes	Yes
Buchanan, Alan (A.D.)	abuchan1	FMA Coach Lead	1/14/2021	Accepted	Yes	Yes
Fayad, Omar (O.)	ofayad	AR Cybersecurity Requirements	9/11/2020	Accepted	Yes	Yes
Raparthi, Satya (S)	srapart1	AR Cybersecurity Requirements	1/22/2021	Accepted	Yes	Yes
Childers, Chad (C.B)	cchilde1	AR Cybersecurity TARA modeling	9/21/2020	Accepted	Yes	Yes
Kalash, Mohammad (M.)	mkalash	ADAS customer experience	10/28/2020	Accepted	Yes	Yes
Aaron Mills	amills2	AR/DAT point of contact	11/04/2020	Accepted	Yes	Yes
Nath, Nitendra (N.)	nnath	AR/DAT point of contact	8/21/2020	Accepted	Yes	Yes
Sripinyo, Peter (P.P.)	psripiny	Power Mode - Software	2/26/2021	Accepted	Yes	Yes
Affeldt, Matthew (M.D.)	maffeldt	VSEM DAT point of contact	11/05/2020	Accepted	Yes	Yes
Cheng, Gail (L.G.)	gcheng	VSEM IVI point of contact	11/18/2020	Accepted	Yes	Yes
Sun, Jayla	Jsun55	IVI FVSS development engineer	1/17/2021	Accepted	Yes	Yes
Obeidat, Omar (O.A.)	oobeida2	AR GPS (GNSS) Location	10/20/2020	Accepted	Yes	Yes
Schein, Jamey (J.)	jschein2	AR Navigation point of contact	11/17/2020	Accepted	Yes	Yes
Medl, Chris (C.)	cmedl	AR Navigation point of contact	1/19/2021	Accepted	Yes	Yes
Olzewski, Chet	colzewsk	SIM Engineer	6/24/2021	Accepted	Yes	Yes

1.4 Document Organization

1.4.1 Document Context

Refer to the [Specification Structure page](#) in the [Ford RE Wiki](#) to understand how the FD relates to other Ford Requirements Documents and Specifications.



1.4.2 Document Structure

The structure of this document is explained below:

Introduction	– Explains how to use this document including responsibilities and requisite documents. Explains the terminology. Gives a clarification of the definitions, concepts and abbreviations used in the document.
Feature Overview	– States briefly the background and the purpose of the feature, feature variants and corresponding regions and markets. Also includes input requirements, assumptions and constraints.
Feature Context	– describes all external entities, which have an influence on the feature.
Feature Modeling	– Contains Use Case, Driving Scenarios, State Charts to describe the functional behavior of the feature.
Feature Requirements	– Lists functional and non-functional requirements of the feature.
Functional Safety Cybersecurity	<ul style="list-style-type: none">– Lists System Behaviors, Safety Goals and Safety Requirements of the feature.– Lists Security Goals and Security Requirements of the feature.
Architecture	– Shows the coarse architecture, which the feature requirements are deployed to. Describes the elements and the boundary of the feature as well as the decomposition and distribution of associated functions.
Open Concerns	– List of Open Concerns
Revision History	– Document Change History including a list of new or modified requirements. The requirements in this document are tagged, and this section contains different types of tables listing all, new, or changed requirements by their title and page no.
Appendix	– Appendix

1.5 Document Conventions

1.5.1 Requirements Templates

Refer to [“How to use the Specification Templates”](#) on how to use the specification templates and the VBA macros to create/edit the requirements in the specifications.

The VBA macro enable the import of the specification to VSEM (refer to ["How to import specifications into VSEM as separate requirements"](#)).

1.5.1.1 Identification of requirements

The unique requirement ID given in the headline of any requirement follows the requirement throughout the development process. The requirement ID format follows a well-defined syntax.

All identifiers in a FD shall be composed of 4 parts:

- A leading prefix, which indicates the type of requirement (R=Requirement, UC=Use Case, SC=Scenario, ...)
- A prefix, which indicates the abstraction level (F=Feature, FNC=Function, CMP = component).
- Followed by a name, indicating the scope, which the requirement belongs to (e.g. feature or function name)
- Ending with the actual requirement number

Example:

R_F_AutoLamps_00004

This is the fourth requirement on feature level for the feature Autolamps.



Feature Document Augmented Reality (AR)

1.5.1.2 Requirements Attributes

The templates provided by *Specification_Macros.dotm* define a list of attributes for each requirement. This helps to classify the requirement. The attributes are explained at [RE Wiki - Requirements Attributes](#).

1.6 References

1.6.1 Ford Documents

List here all Ford internal documents, which are directly related to the feature.

Reference	Title	Doc. ID	Document Location	Revision
N/A				

Table 2: Ford internal Documents

1.6.2 External Documents and Publications

The list of external documents could include books, reports and online sources.

Reference	Document / Publication	Document Location
N/A		

Table 3: External documents and publications

1.7 Glossary

1.7.1 Definitions

Definition	Description
Blending Capability	It is the ability of the system to combine the thermal (FIR-Cam) or night vision image with the standard video image from the augmented reality camera (visible) by highlighting the person or objects you cannot regularly see in dark or low light environments using the visible camera to provide a better driver experience.
Driver	Entity being presumed to drive the vehicle; target of this feature is to provide guidance/situational awareness

Table 4: Definitions used in this document

1.7.2 Abbreviations

Abbr.	Stands for	Description
ADAS	Advanced Driver Assistant System	
APIM PHOENIX	Accessory Protocol Interface Module (Phoenix Domain Controller)	Phoenix
AR feature	Augmented Reality feature – Scope of this document	
AG	Augmented Guide sub feature for Turn-by-turn, Street Names, House Numbers, Point Of Interest (POI), and Destination.	
AL	Augmented Lines (AL) sub feature for Blind Spot Information System (BLIS), Lane Low Visibility, Lane Level Navigation, and Lane Biasing.	
AR-CAM, ARC	Augmented Reality Camera (visible)	



Feature Document Augmented Reality (AR)

Abbr.	Stands for	Description
AR-ECU	Augmented Reality Electronic Control Unit (New Hardware)	
BCM	Body Control Module	
CAM	Camera	
LLG	Lane Level Guidance	
TBT	Turn-by-Turn	
ECG	Enhanced Central Gateway	
FIR-CAM	Far Infrared Camera	
FNV3	Fully Networked Vehicle-3; Allows different vehicle domains with a standard interface to allow them to work together.	
FOV	Field Of View	
GNSS	Global Navigation Satellite System	
GPS	Global Positioning System (the US GNSS system)	
HHDD	High Head Down Display (Panoramic Display), External display for AR content	
HMI	Human-Machine Interface	
MVP	Minimum Viable Product	
OEM	Original Equipment Manufacturer	
OTA	Over the Air updates	
PDB	Power Distribution Box	
PHOENIX APIM	Phoenix Domain Controller - Accessory Protocol Interface Module	
POC	Proof of Concept	
POI	Point of Interest	
TCU	Telematics Control Unit	
VR	Voice Recognition	

Table 5: Abbreviations

1.7.3 Parameters / Values

Name	Description	Range / Resolution
Augmented_Reality_Cfg	Configuration to denote feature enabled/disabled on the vehicle	0 x 0 == OFF 0 x 1 == ON; No FIR Camera (vehicle not equipped) 0 x 2 = ON; with FIR Camera (vehicle is equipped)

Table 6: Parameters / Values used in this document

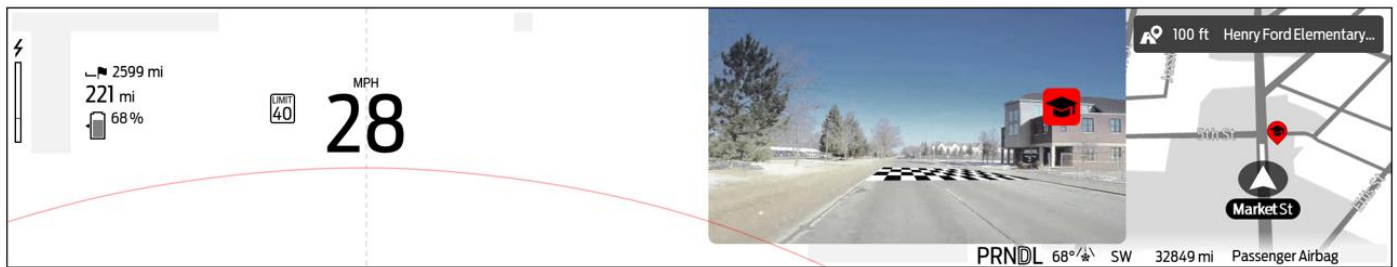


2 FEATURE OVERVIEW

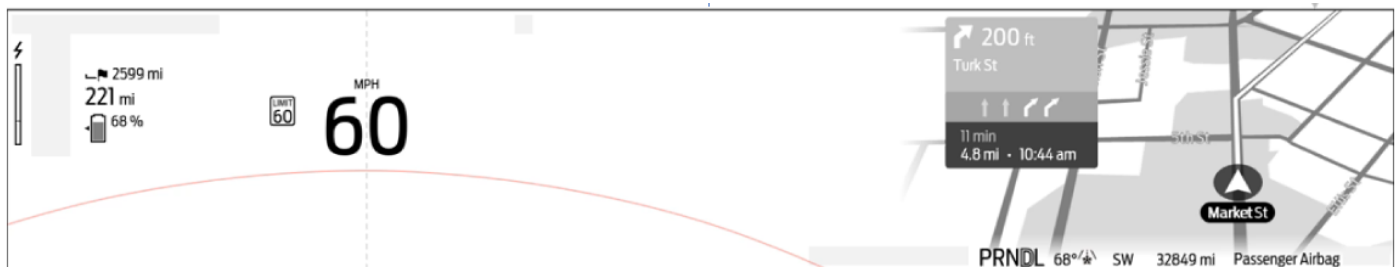
2.1 Purpose and Description of Feature

Augmented Reality (AR) feature displays virtual augmented information (Guide, Situational awareness, night vision capability) to the driver. It aligns with natural human performance to reduce cognitive workload, enhance the information perception and reaction times for the driver. This is a new feature to Ford but implemented in competitive vehicles.

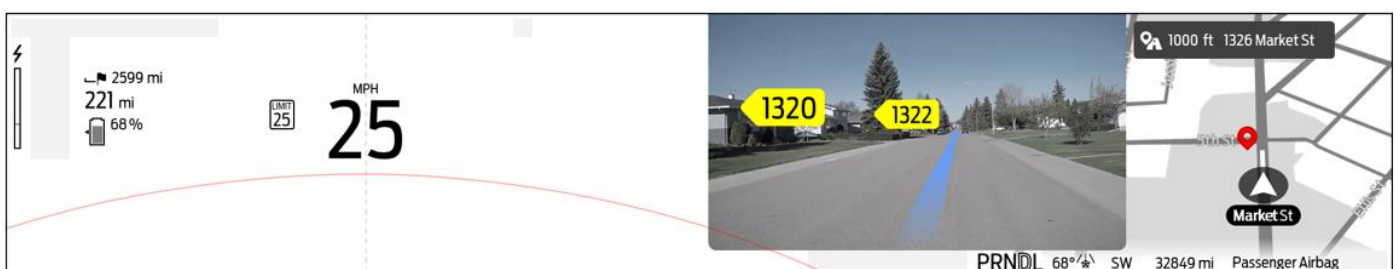
Other than, in the often-stressful act of following screen 2D directions, the AR technology renders virtual objects near relevant objects in the real environment. AR technology should visualize the driver information not only in real time but also correctly aligned (even in focal depth), meaning in a tight connection to the physical space.



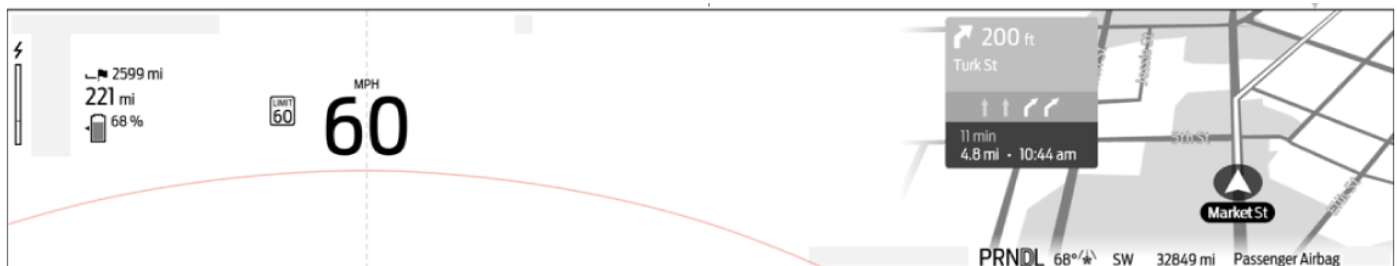
AR is contextually triggered to optimize value and mitigate potential driver distraction, just the right content at the right moment.



2D map guidance (Far Nav)



AR pinpoint exact turn location (Near Nav)



2D map guidance resumes once turn is being executed



2.2 Feature Variants

Variant Name	Variant Description	Remarks
AR MVP <J1> – base “This variant” “Part of this document”	<p>MVP- Feature Baseline: Provide navigation and situational awareness contents with high vision capability w/o blending. Include the following -</p> <ul style="list-style-type: none">• Turn by Turn- MVP variant• Street Name- *See below comment• House Number; *See below comment• Point of Interest (POI); *See below comment• Destination; - MVP variant• Blind Spot; - MVP variant• Night Vision Content: All above feature with Night Vision w/o Blending Capability between AR and FIR camera – if vehicle equipped with FIR camera - - MVP variant <p>* TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier</p>	<p>Support MY24 Programs GE2 CDX746/747; U718; target for implementation is <J1> GE2.</p> <p>Night vision has GTDS 30199 & #22423</p>
AR MVP + variant <J1+90> “Part of this document”	<p>Enhance feature content by adding:</p> <ul style="list-style-type: none">• Lane Low Visibility- MVP+ variant ** See comments• Lane Level Navigation – MVP+ variant *** See comments• Lane Biasing- MVP+ variant ** See comments• Highway assist - Far variant **** - See comment• Lane change assist - Far variant **** - See comment <p>** MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1>)</p> <p>*** Lane level navigation MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1> ; currently not available from Google – pending discussion with alternative map supplier and getting data from ADAS</p> <p>**** Far variant (ongoing discussion with CIED team if it can be moved to MVP or MVP+ or post <J1>)</p>	<p>Target for implementation is <J1+90></p>
AR Near (Post J1- OTA) “NOT part of this document”	<p>Enhance feature content by including:</p> <ul style="list-style-type: none">• Object (Pedestrian/Large Animals) detection• Night vision with Blending capability between AR and FIR cameras	<p>Target for implementation is post <J1> OTA; GTDS projects are: GTDS #30199 / GTDS #30242</p>



Feature Document Augmented Reality (AR)

Table 7: Feature Variants

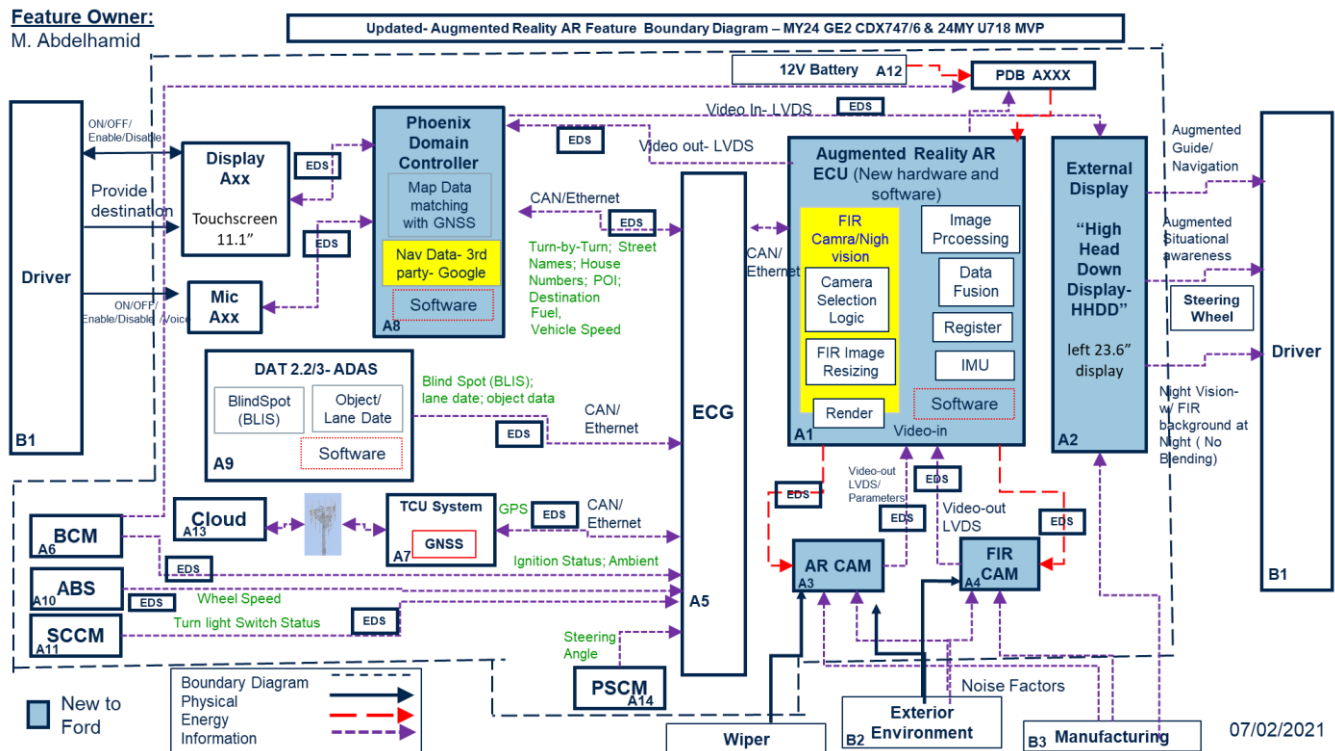


Figure- AR Feature Boundary Diagram

2.2.1 Regions & Markets

Market / Region	North America	South America	Europe	IMG	China
Variant Name					
AR CDX746 (MFAL code #HKCAT) Enhanced Navigation System	Yes	TBD	Yes	TBD	TBD
AR CDX747 (MFAL code #HKCAT) Enhanced Navigation System (MFAL code # J3QAE) Camera Front Night Vision	Yes	TBD	TBD	TBD	Yes
AR U718 Enhanced Navigation System (MFAL code #HKCAT) (MFAL code # J3QAE) Camera Front Night Vision	Yes	TBD	TBD	TBD	Yes

Table 8: Regions & Markets



2.3 Input Requirements/Documents

Reference (Reference as listed in ch. "References")	Section/Requirement	Description	Derived Requirement (optional – reference to requirement in ch. "Feature Requirements")
Attribute Requirements			
N/A			
Ford Engineering Standards			
N/A			
Legal Regulations			
	FMVSS101		The Feature shall comply with FMVSS101.
Industry Standards			
	ISO 26262		The system should be developed according to Ford's implementation of Functional Safety.
Other Sources			
	None		

Table 9: Input Requirements/Documents

2.4 Lessons Learned

N/A first implementation;

2.5 Assumptions

- FNV3 architecture and above
- Vehicle equipped with new hardware and software for AR ECU module
- Vehicle equipped with Phoenix Domain Controller and above
- Vehicle equipped with display for augmented reality (HHDD)
- Vehicle equipped with AR camera
- For night vision capability, vehicle equipped with FIR camera
- Vehicle equipped with navigation system, map data, POI available
- Vehicle equipped with DAT 2.2 and above
- Connectivity/active modem subscription to support notification
- The AR camera and FIR camera is packaged in the right distance for blending capability and sufficient FOV.
- AR camera is only offered with the 100 degree in same bracket as FWC ADAS camera (FWC offered with 100 degree).
- Vehicle equipped with ADAS feature (BLIS, Blue Cruise; Lane Biasing, and Lane Change Assist) to offer Augmented version of these features. Currently, DAT Bundle #10 include all required ADAS features and DAT Bundle #6 only has BLIS.

3 FEATURE CONTEXT

3.1 Feature Context Diagram

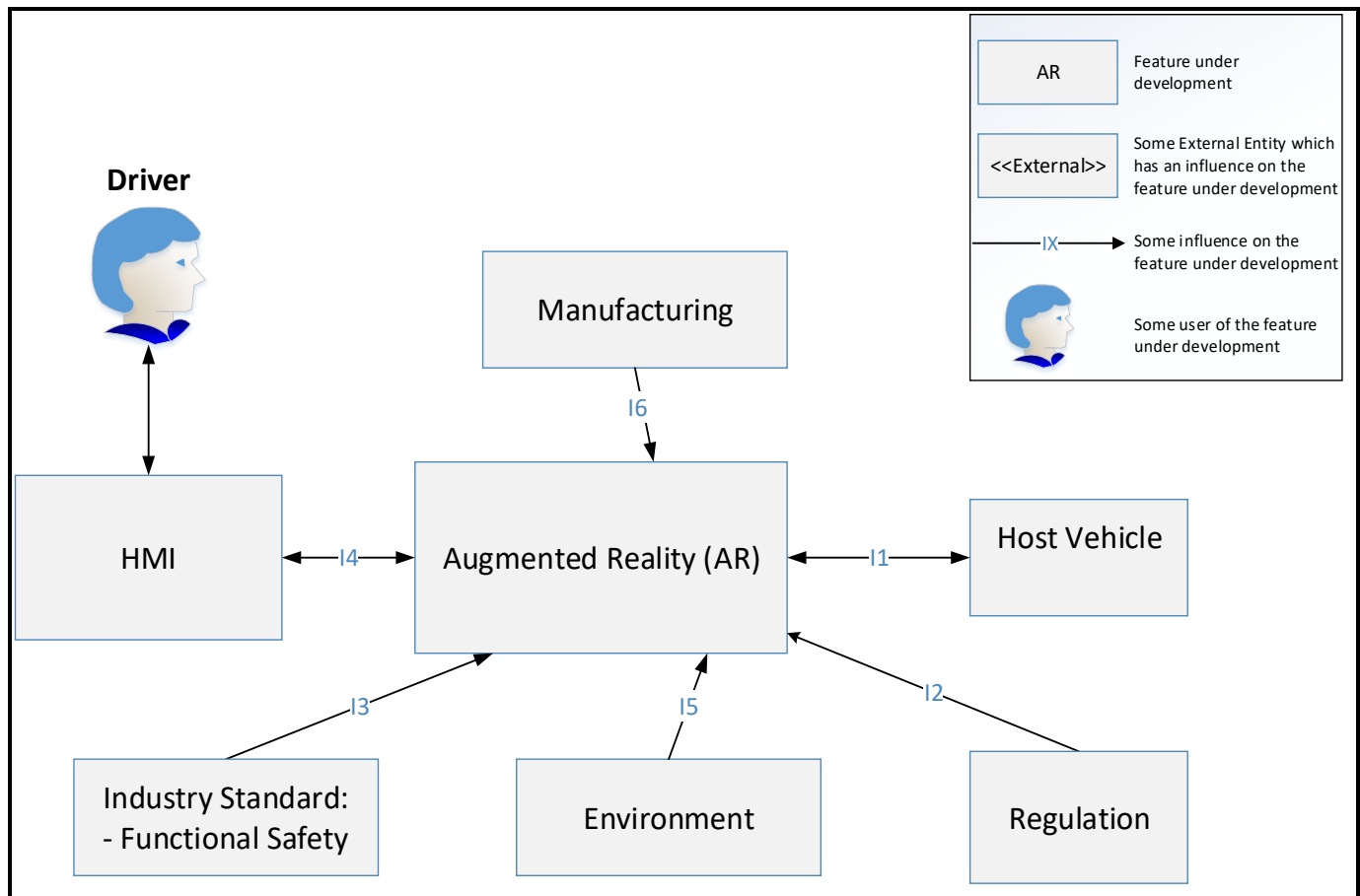


Figure 1: Context Diagram

3.2 List of Influences

ID	External Entity	Influence Description
I1	Host vehicle	Host vehicle should have: <ul style="list-style-type: none"> AR ECU module software and hardware Phoenix Domain Controller and above AR camera For night vision capability, vehicle equipped with FIR camera navigation system, map data, POI available DAT 2.2 or above FNV3 electrical architecture or above Vehicle equipped with display for augmented reality (HHDD) Connectivity/active modem subscription to support notification Turn signal indicator Light sensor
I2	Regulation	Meet the requirements called out in section 2.3



Feature Document Augmented Reality (AR)

I3	Industry Standard	Meet any Functional Safety specific requirements/measures called out in section 6 and 7.
I4	HMI	HMI contains two ways of driver interaction with the augmented reality feature: i) through HMI Phoenix Domain Controller - customer can select feature On/OFF and customize settings ii) Augmented reality output is display through HHDD
I5	Environment	Other vehicles, surrounding, day/night, road condition, weather condition
I6	Manufacturing	Configuration and Calibration of AR-ECU, AR Camera, FIR Camera

Table 10: List of Influences



4 FEATURE MODELING

4.1 Operation Modes and States

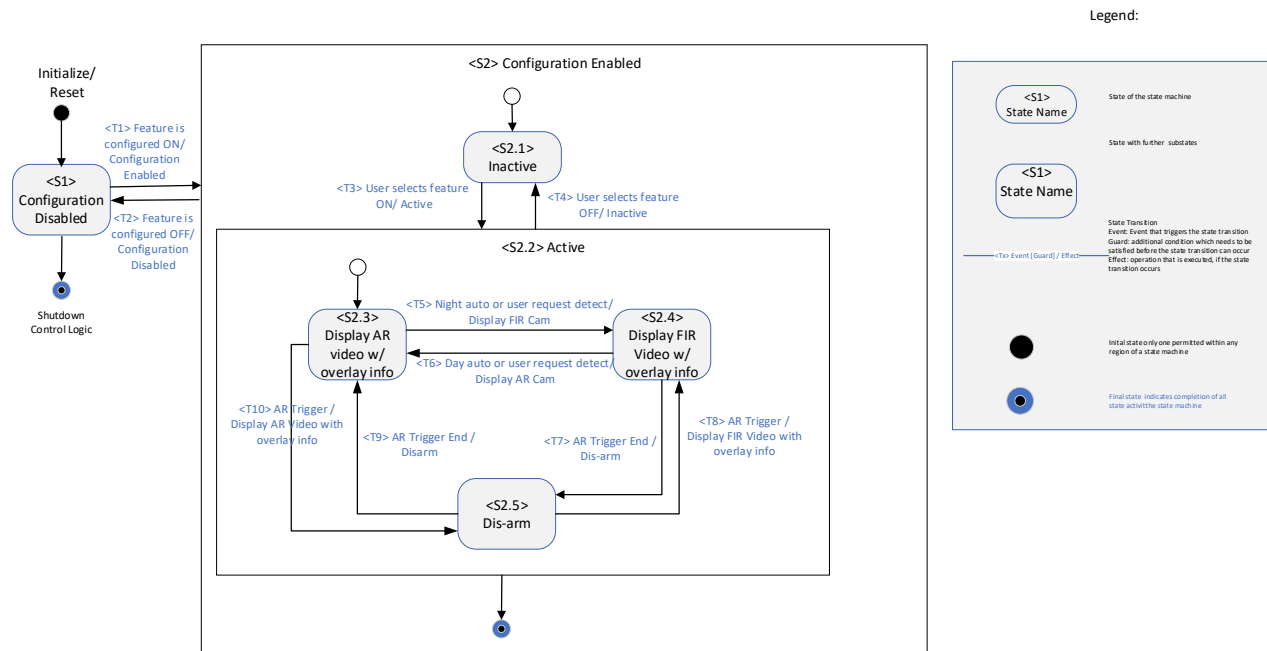


Figure 2: Feature Operation Modes and States

State	Description	Requirements Reference (optional)
S1	Configuration Disabled: Feature configuration Disabled by EOL/manufacture	
S2	Configuration Enabled: Feature configuration Enabled by EOL/manufacture	
S2.1	Inactive: User selects feature OFF	
S2.2	Active: User selects feature ON	
S2.3	Display Augmented reality AR video with overlay info	
S2.4	Display Augmented reality FIR video with overlay info	
S2.5	Disarm – stop display augmented reality once the event trigger completed	

Table 11: Operation Modes and States

Transition ID	Description	Requirements Reference (optional)
T1	Feature is configured ON/Configuration Enabled	
T2	Feature is configured OFF/Configuration Disabled	
T3	User selects feature ON	
T4	User selects feature OFF	
T5	Night auto or user request detect	
T6	Day auto or user request detect	
T7	AR Trigger End / Dis-arm	
T8	AR Trigger / Display FIR Video with overlay info	
T9	AR Trigger End / Disarm	
T10	AR Trigger / Display AR Video with overlay info	



Feature Document Augmented Reality (AR)

Table 12: Transitions between Operational Modes and States

4.2 Use Cases

4.2.1 Use Case Diagram

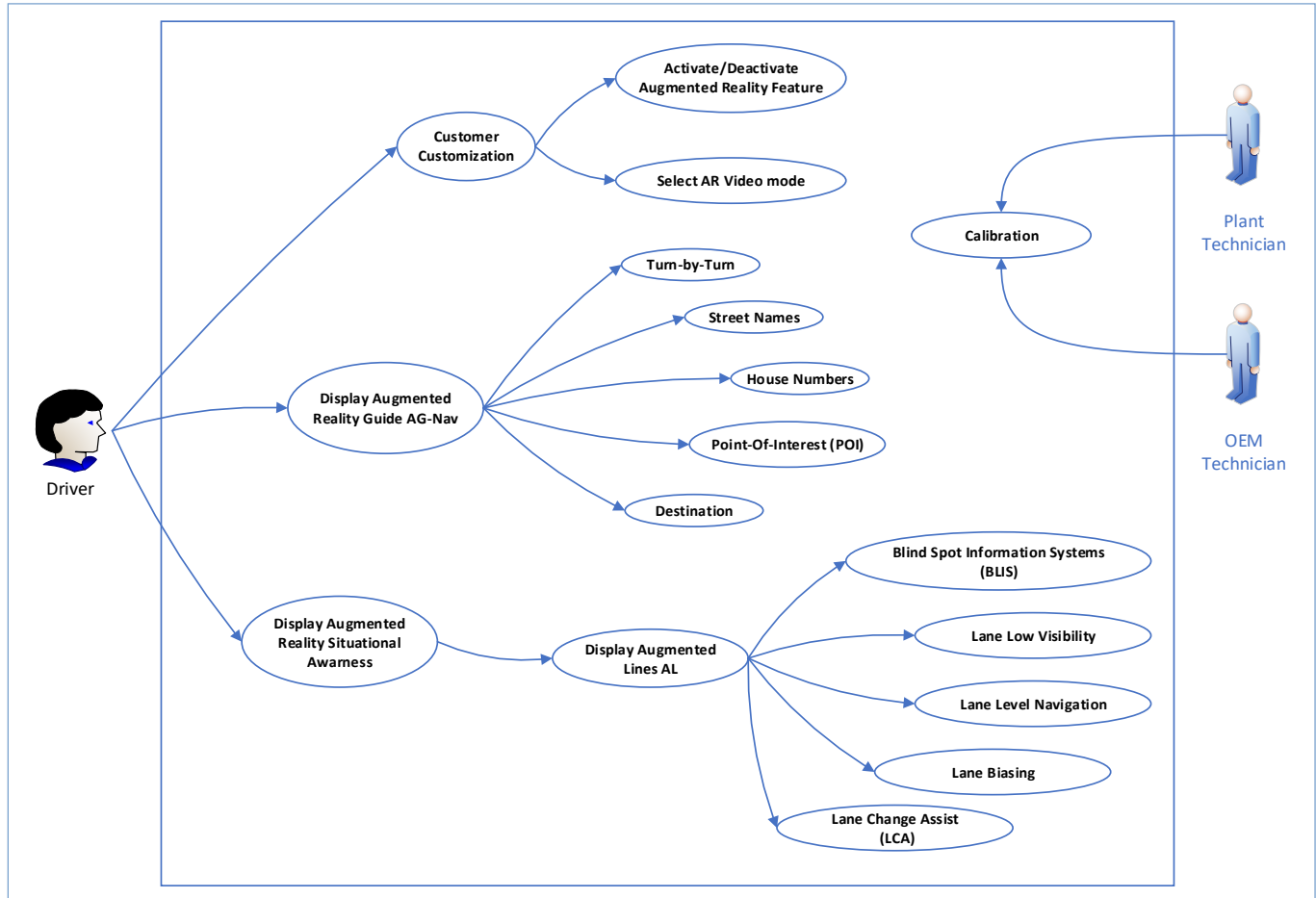


Figure 3: Use Case Diagram (Note-see description in Table 13: Feature Variants section about offering assumption use cases)

4.2.2 Actors

Actor	Description
Driver	The customer interfaces with the AR-System over the displays (HHDD) in the vehicle where navigation guidance, Points-of-Interests, driver assistant information and other information is provided. The customer shall be able to personalize the AR functionality, as well as activate/deactivate the visualization. Details will be provided through the UX specifications.
Plant Technician	The Ford Plant interacts with the system during vehicle assembly and sensor calibration. The sensors used by the AR-System require calibration in the Plant.
OEM Technician	Ford Service interacts with the system for fault diagnostics and re-calibration in case of a repair that led to a misalignment of the sensors. The sensors used by the AR-System require calibration in Service.

Table 14: List of Actors



Feature Document Augmented Reality (AR)

4.2.3 Use Case Descriptions

###UC_F_Augmented Reality_00001### AR On(default) / Off

Purpose		Provide the driver an HMI option, both physical and through spoken Voice Recognition Commands, to turn On(default) or Off the AR feature.
Actors		Driver.
Precondition		AR is On(default) / Off.
Main Flow	M1	Driver selects the physical HMI option or the Voice Recognition Command HMI option to speak out the voice command to turn Off the AR feature.
Alternate Flow	AF1	Driver selects the physical HMI option or the Voice Recognition Command HMI option to speak out the voice command to turn On(default) the AR feature.
Post-condition	PC1	AR feature is Off; no augmented reality (AR) view will be presented to the Driver at any time during vehicle operation on the AR display.
	PC2	AR feature is On(default); augmented reality (AR) view will be presented to the Driver contextually during vehicle operation on the AR display.

###UC_F_Augmented Reality_00002### Select AR Video mode Enable(default) / Disable

Purpose		Provide the driver an HMI option to select AR video mode, both physical and through spoken Voice Recognition Commands, to Disable selection and use AR-Camera (visible) only or Enable(default) selection to allow camera switches from AR-Camera to FIR camera when "low" levels of light are detected and return to AR-Camera (visible) when exterior light levels rise above "low" level thresholds (if vehicle equipped with FIR camera).
Actors		Driver.
Precondition		AR is On. AR video mode is Enable(default) / Disable
Main Flow	M1	Driver selects the physical HMI option or Voice Recognition Command HMI option to speak out the voice command to Disable the AR video mode.
Alternate Flow	AF1	Driver selects the physical HMI option or Voice Recognition Command HMI option to speak out the voice command to Enable(default) the AR video mode.
Post-condition	PC1	AR video mode Disable; the Driver can see the use of AR-Camera (visible) only on the AR display no matter the exterior light level.
	PC2	AR video mode is Enable(default); the Driver can see camera switches from AR-Camera (visible) to FIR camera when "low" levels of light are detected, return to AR-Camera (visible) when exterior light levels rise above "low" level thresholds (if vehicle equipped with FIR camera) on the AR display.



Feature Document Augmented Reality (AR)

###UC_F_Augmented Reality_00003### Display Augmented Reality Guide AG-Nav Turn-by-Turn

Purpose		Display the augmented reality Turn-by-Turn with a path/arrow on the road, with distance to maneuver , animation, and color change according to the speed of the vehicle approaching the turn point, to follow rather than abstract instructions to the driver
Actors		Driver
Precondition		AR is ON Navigation is ON Navigation with active route to destination. Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display.
Main Flow	M1	Driver is driving to his/her destination actively using the Navigation system
	M2	Display is showing Navigation 2D map guidance (Far Nav) with route to follow
	M3	Vehicle approaches to the point of maneuver
	M4	AR pinpoints exact turn location (Near Nav)
	M5	The display switches to show an AR real image as background, AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection, based on driver's AR Video Mode selection with overlay of the path/arrow to follow on the road, with distance to maneuver , animation, and color change according to the speed of the vehicle approaching to the point of maneuver.
	M6	Driver performs the maneuver following the guide on the AR display.
Post-condition		<p>If the next maneuver is not within turn by turn distance of the current maneuver and turn is completed (trigger from NAV) and AR view closes 2 seconds after completing the maneuver per the specified exit animation treatment.</p> <p>Consecutive Maneuvers: If there is a consecutive maneuver immediately after the upcoming maneuver and this consecutive maneuver is within the FoV of the AR camera view, then the consecutive maneuver is represented by a white path that extends from the upcoming turn path arrow.</p> <p><i>Object Occlusion:</i> If the path arrow appears to be overlaying an object (e.g., other vehicles on the road) in the environment, the portion of the fill of the path arrow that is overlaying the object becomes transparent. The stroke of the path arrow is not affected.</p> <p>Display shows the Navigation 2D map guidance resumes, once the turn has been executed.</p>

###UC_F_Augmented Reality_00004### Display Augmented Reality Guide AG-Nav Street Names [TBD-Not part of MVP]- TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

Purpose		Display the augmented reality Street Names by making real world elements pop by highlighting them in different sizes or colors. Street name is a subset of Turn by Turn, only showed when there is a trigger from NAV and when relative to route to destination.
Actors		Driver
Precondition		AR is ON Navigation is ON



Feature Document Augmented Reality (AR)

		Navigation with active route to destination. Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display.
Main Flow	M1	Driver is driving to his/her destination actively using the Navigation system.
	M2	Display is showing Navigation 2D map guidance (Far Nav) with route to follow
	M3	Vehicle approaches to the point of maneuver.
	M4	AR pinpoints exact turn location (Near Nav) and AR view is triggered by distance and speed relative to maneuver.
	M5	The display switches to show an AR real image as background, AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection, based on driver's AR Video Mode selection with augmented reality Street Names by making real world elements pop by highlighting them in different sizes or colors.
	M6	Driver performs the maneuver following the guide on the AR display
Post-condition		Display shows the Navigation 2D map guidance resumes, once the turn has been executed.

###UC_F_Augmented Reality_00005### Display Augmented Reality Guide AG-Nav House Number - TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

Purpose		AR system augments and overlays the numbers of the houses or building/landmark names by making real world elements pop by overlaying them on top of the objects and make them more visible and draw driver's attention to them.
Actors		Driver
Precondition		AR is ON Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display.
Main Flow	M1	Driver sets up a destination address (house number) on the Navigation, Navigation is turned On.
	M2	Driver is driving to his/her destination address actively using the Navigation
	M3	Display is showing Navigation 2D map guidance (Far Nav) with route to follow
	M4	Vehicle approaches to target address
	M5	AR view is triggered by distance (Near Nav) and speed relative to destination.
	M6	The display switches to show an AR real image as background, AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection, based on driver's AR Video Mode selection with augmented overlay of House Numbers on top of the objects and making them more visible to draw driver's attention to them.
	M7	AR overlays the house number on the drive when approaching the target house. Final house number is treated like "Destination POI" and only 1 house number appears when approaching.
Alternate Flow 1	AF1	Driver is driving to his/her destination with Navigation without a set route, or Navigation is turned Off (Driver driving without a route)
	AF2	Driver speaks out Voice Command request (e.g. "Show me house numbers") to Navigation system or Via navigation predicted route (through adaptive vehicle workstream) and at current vehicle speed.
	AF3	If vehicle speed is below 25 mph or below current residential speed limit, then the AR view is triggered (Near Nav).



Feature Document Augmented Reality (AR)

	AF4	The display switches to show an AR real image as background, AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection, based on driver's AR Video Mode selection with augmented overlay of House Numbers on top of the objects and making them more visible to draw driver's attention to them.
	AF5	AR overlays 4 house numbers on the drive of the vehicle at a time.
	AF6	AR highlights frequent destination points for the driver via "predicted route" from Navigation system.
	AF7	With navigation routing disabled, a series of 4 house numbers (matching the side of the specific destination house) appear on the drive when approaching target house at dTBT (NAV ON by setting house as destination or predicting the target house by getting the signal from Google)
Post-condition	PC1	AR identifies in plain sight the house number that is relevant to the driver at the address of destination.
	PC2	<ul style="list-style-type: none"> ▪ AR identifies in plain sight the house numbers that are relevant to the driver on his driving. AR view closes 4 seconds after last house number has been passed regardless of whether the maximum number of house numbers has been shown in series. ▪ AR view closes 4 seconds after no house number is displayed

###UC_F_Augmented Reality_00006### Display Augmented Reality Guide AG-Nav Points Of Interest (POI) – TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

Purpose		AR system augments and overlays by highlighting those POIs that best align with driver's preference and identifies in plain sight the POIs that are relevant and preferred, driver can activate this functionality by both physical HMI or Voice Recognition Commands controls.
Actors		Driver
Precondition		AR is ON Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display.
Main Flow	M1	Driver selects the physical HMI option on the Navigation System to select the nearby POI or using Voice Recognition Command HMI option to speak out the POI voice command (e.g. "show me nearby restaurants")
	M2	Driver selects one POI from the list offered by the Navigation System ((Driver driving with active route)
	M3	Display shows AR view (Near Nav).
	M4	The display switches to show an AR real image as background, AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection, based on driver's AR Video Mode selection.
	M5	AR can respond to the needs of the driver's current situation by identifying in plain sight the POIs that are relevant and preferred or history POIs, by utilizing augmented reality items/symbols overlaid on the real AR image on the display
Alternative Flow	AF1	Driver driving to his/her destination without active route
	AF2	Driver use Voice Recognition Command HMI option to speak out the (e.g. "show me nearby restaurants") or POI info categories that are required for the "smart selection" or personalization of POIs.
	AF3	Display shows AR view (Near Nav).



Feature Document Augmented Reality (AR)

	AF4	The display switches to show an AR real image as background, AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection, based on driver's AR Video Mode selection.
	AF5	AR can respond to the needs of the driver's current situation by identifying in plain sight the POIs that are relevant and preferred, by utilizing augmented reality items/symbols overlaid on the real AR image on the display
Post-condition		<ul style="list-style-type: none"> AR highlights those POIs that are highly rated and represent the Driver's familiarity and preferences. Every POI fades out after showing statically when it's outside the FOV. No cropping of the POI (it sticks and then fade away – at less than 50% of POI showing within the location of the POI) Starts appearing back when more than 50% of the actual POI showing fade-in

###UC_F_Augmented Reality_00007### Display Augmented Reality Guide AG-Nav Destination

Purpose		Display the augmented reality Destination to the driver by adding an overlay symbol to the AR image that starts appearing on the target destination by highlighting the building to help driver locate the specific location of the place
Actors		Driver
Precondition		AR is ON Navigation is ON Navigation with active route to destination. Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display.
Main Flow	M1	Driver is driving to his/her destination actively using the Navigation system.
	M2	Display is showing Navigation 2D map guidance (Far Nav) with route to follow
	M3	Vehicle approaches to target address
	M4	AR view is triggered by distance (Near Nav) and speed relative to destination.
	M5	The display switches to show an AR real image as background, AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection, based on driver's AR Video Mode selection with augmented overlay symbol that start appearing on the target destination and making them more visible to draw driver's attention to them.
	M6	A checkered pattern is applied on the roadway adjacent to the destination location.
Post-condition		AR identifies destination by highlighting destination address or Building/landmark name inputted by user (final or/and waypoint). AR view closes 4 seconds after reaching the destination. If the set destination is approached and/or reached the destination icon fades away after sticking to the edge of the FoV when physical destination is outside the FoV



Feature Document Augmented Reality (AR)

###UC_F_Augmented Reality_00008### Display Augmented Lines AL- Blind Spot Information System (BLIS)

Purpose		Display the augmented reality AL- Blind Spot Information System (BLIS) to the driver as an Amber carpet with an overlay BLIS symbol on top of it on the AR HMI display when the driver has an object on the blind spot of his/her vehicle and has activated the turn signal indicator towards that direction.
Actors		Driver
Precondition		AR is ON Blind Spot Indicator System (BLIS) is ON. Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display.
Main Flow	M1	Driver is driving
	M2	Driver wants to make a left (/right) turn or road line change.
	M3	Driver has an object on the left (/right) blind spot of the vehicle.
	M4	Driver activates the left (/right) turn signal indicator.
	M5	BLIS systems triggers the AR system to display an augmented reality image of the left (/right) lane with an Amber Carpet. The background is AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection based on driver's AR Video Mode selection.
	M6	Driver waits for the Amber Carpet to disappear so he/she can safely make the turn.
Alternative Flow	AF1	Driver is driving.
	AF2	Driver wants to make a left (/right) turn or road line change.
	AF3	Driver does not have a vehicle on the left/right blind spot of the vehicle.
	AF4	Driver activates the left (/right) turn indicator signal.
	AF5	Driver does not see any change on the AR display while he/she makes the turn or road line change. The background is AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection based on driver's AR Video Mode selection. No screen change is shown when user can make a turn when turn indicators are ON.
Post-condition	PC1	The augmented reality image clears out the Amber Carpet, and the driver can make the turn. AR view closes when signal indicator is deactivated or when blind spot is clear of objects for more than 2 seconds.
	PC2	There is no augmented reality image displayed on the AR HMI display, and driver can make the turn.

###UC_F_Augmented Reality_00009### Display Augmented Lines AL- Lane Low Visibility- MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1>)

Purpose		Display augmented reality AL- Lane Low Visibility to the driver as a visual image to show the most likely path for the driver overlay on the road within the road boundaries at the request of the driver by physically activating a readily available control on the steering wheel and/or by Voice Recognition Command control.
Actors		Driver
Precondition		AR is ON Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display.



Feature Document Augmented Reality (AR)

Main Flow	M1	Driver is driving
	M2	Driver does not see the road lines clearly due to rain, fog, bad weather, mud, or debris covering the actual lane markings on the road
	M3	Driver activates Augmented Reality feature Lane Low Visibility: <ul style="list-style-type: none"> 1- By physically activating a readily available control on the steering wheel, vigilance control (i.e., dead man's switch) 2- By Voice Recognition Command control (e.g. "Help me see") 3- By "Virtual switch" suggestion on HHDD (with virtual switches for steering wheel): <ul style="list-style-type: none"> a. ADAS system lane detection confidence (check if this value is exposed) b. Time of the day / daylight c. Rain sensor / wiper rate d. Temperature (ice might cover markings) e. Compass direction and time (driving against sun) f. Weather forecast g. Wet or slippery drive mode are selected h. Fog Lights / high beams i. Defrost windshield j. Detect if driver sun visor is down?
	M4	AR view is triggered
Post-condition		AR AL Lane Low Visibility shows on the AR display a visual image with the most likely path/arrow in Amber color for the driver overlay on the road within the road boundaries. Lane Low Visibility deactivates 30 seconds after triggers no longer meet thresholds for activation (or) driver pushes the steering wheel control.

###UC_F_Augmented Reality_00010### Display Augmented Lines AL- Lane Level Guidance - MVP+ Variant (ongoing discussion with CIED team if it can be moved to MVP or post <J1>)

Purpose		Display the augmented reality AL-Lane Level Guidance with a path/arrow to follow rather than abstract instructions to the driver
Actors		Driver
Precondition		AR is ON Navigation is ON Navigation with active route to destination. Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display.
Main Flow	M1	Driver is driving to his/her destination actively using the Navigation system
	M2	Display is showing Navigation 2D map guidance (Far Nav) with route to follow
	M3	Vehicle approaches to a point of maneuver
	M4	AR pinpoints exact turn location (Near Nav), It is shown to setup an upcoming maneuver (i.e., turn-by-turn) or a maneuver to evade an environmental object.
	M5	The display switches to show an AR real image as background, AR-Camera (visible) only or AR-Camera/FIR-Camera with light level detection, based on driver's AR Video Mode selection with overlay of the Blue path/arrow to follow on the road, with distance to maneuver, animation, and color change according to the speed of the vehicle approaching to the point of maneuver.
	M6	Driver performs the maneuver following the guide on the AR display.



Feature Document Augmented Reality (AR)

Alternative Flow 1	AF1	Driver is driving to his/her destination actively using the Navigation
	AF2	Display is showing Navigation 2D map guidance (Far Nav) with route to follow
	AF3	The display shows an AR real image as background with overlay of Timely Situational Guidance: Guide away from obstacle or hazards
	AF4	Driver performs the maneuver following the guide on the AR display
Post-condition		If the next maneuver is not within lane level guidance distance of the current maneuver and turn is completed (trigger from NAV) and AR view closes 2 seconds after completing the maneuver per the specified exit animation treatment.
		<i>Consecutive Maneuvers:</i> If there is a consecutive maneuver immediately after the upcoming maneuver and this consecutive maneuver is within the FoV of the AR camera view, then the consecutive maneuver is represented by a white path that extends from the upcoming turn path arrow.
		<i>Object Occlusion:</i> If the path arrow appears to be overlaying an object (e.g., other vehicles on the road) in the environment, the portion of the fill of the path arrow that is overlaying the object becomes transparent. The stroke of the path arrow is not affected.
		Display shows the Navigation 2D map guidance resumes, once the maneuver has been executed.

####UC_F_Augmented Reality_00011#### Display Augmented Lines AL- Lane Biasing- MVP+ Variant (ongoing discussion with CIED team if it can be moved to MVP or post <J1>)

Purpose		Display the augmented reality AL-Lane Biasing with a highlight of the object and correlate that object to the slight change in path to the left (/right) side of the road when the car is biasing to the left (/right) side of the lane because of an oncoming object on the right (/left) side of the vehicle.
Actors		Driver
Precondition		AR is ON Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display. Active Drive Assist System (ADAS) feature that allows driver for Hands-Off / Eyes-On Driving in Blue Zones is ON, i.e. when in ADA (Active Drive Assist = Highway Assist) or limited mode (ACC+Lane Centering)
Main Flow	M1	Driver is driving actively using the Active Drive Assist (ADAS) feature that allows driver for Hands-Off / Eyes-On Driving in Blue Zones
	M2	Another object is approaching the car through the right (/left) side of the vehicle
	M3	Lane Biasing signal triggers the AR display represents or highlights the object and correlate that object to the slight change in path to the left (/right) side of the road to communicate the driver why the vehicle is deviating from the center of the lane.
	M4	The car biases to the left (/right) side of the lane to give more space to the encroaching object in the adjacent lane.
Post-condition		After the vehicle has completed the bias maneuver on trajectory the AR image disappears from the AR display.



Feature Document Augmented Reality (AR)

###UC_F_Augmented Reality_00012### Highway Assist or called Active Drive Assist system or Blue Cruise - Far Variant (ongoing discussion with CIED team if it can be moved to MVP/MVP+ or post <J1> - need to be tied to Lane Biasing use Case)

Purpose		Display the augmented reality Highway Assist with a highlighted representation of the path of the Blue Zones on the highway. The metaphor is persistent until the Blue Zone comes to an end.
Actors		Driver
Precondition		AR is ON Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display. ADA (Highway Assist) feature is On
Main Flow	M1	Driver is on the Highway with his/her vehicle.
	M2	Driver activates the Highway Assist feature
	M3	AR screen is triggered when Highway Assist (ADA) is active. AR display shows the highway lane marked to communicate the driver. The guidance metaphor is the representation of the path of the Blue Zones on the highway.
Post-condition		The AR metaphor is persistent until the Blue Zone comes to an end. AR metaphor is ended

###UC_F_Augmented Reality_00013### Assisted Lane Change or called Active Drive Assist system or Blue Cruise - Far Variant (ongoing discussion with CIED team if it can be moved to MVP/MVP+ or post <J1>- need to be tied to Lane Biasing use Case)

Purpose		Display the augmented reality Lane Change Assist with a highlighted representation of the proposed path for a lane change to be performed by the vehicle. The AR metaphor is persistent until the Lane Change Assists comes to an end.
Actors		Driver
Precondition		AR is ON Driver selected AR Video Mode Enable(default) / Disable for the AR HMI display. Vehicle is in a Blue Zone highway Highway Assist feature (ADAS) is active or limited mode (ACC plus Lane Centering)
Main Flow	M1	Driver is on the Highway with his/her vehicle.
	M2	Driver has activated the Highway Assist feature or limited mode (ACC plus Lane Centering)
	M3	The vehicle reaches to a front vehicle driving at a slower speed
	M4	The Assisted Lane Change from ADAS signals the driver that an Assisted Lane Change might be helpful to continue the trip at the previous speed
	M5	AR screen changes the position of the path that was showing him the lane he was in. Lane Guidance maneuver with metaphor to differentiate between suggestion versus action (i.e. color)
	M6	Driver accepts the prompt for Lane Change Assisted by activating the turn signal switch
	M7	Vehicle performs maneuver when the lane is available
Post-condition		The AR metaphor is persistent until the Lane Change Assists comes to an end. AR metaphor is ended



Feature Document Augmented Reality (AR)

###UC_F_Augmented Reality_00014### Calibration of Augmented Reality feature

Purpose		Allow the calibration of the Augmented Reality (AR) feature
Actors		Technician
Precondition		AR feature not calibrated Vehicle engine is ON
Main Flow	M1	Technician prepare the vehicle to follow calibration procedure
	M2	Technician follows calibration procedure for the vehicle
	M3	Technician verifies that calibration procedure has been successful
Post-condition		Vehicle AR feature is calibrated according to specifications and performs as indicated on the user's manual.

###UC_F_Augmented Reality_00015### Street Name – In-active route- WIP/Not defined yet, TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

Purpose		Street Name (Under Investigation for Route Inactive), triggered by voice command
Actors		
Precondition		
Main Flow		
Post-condition		

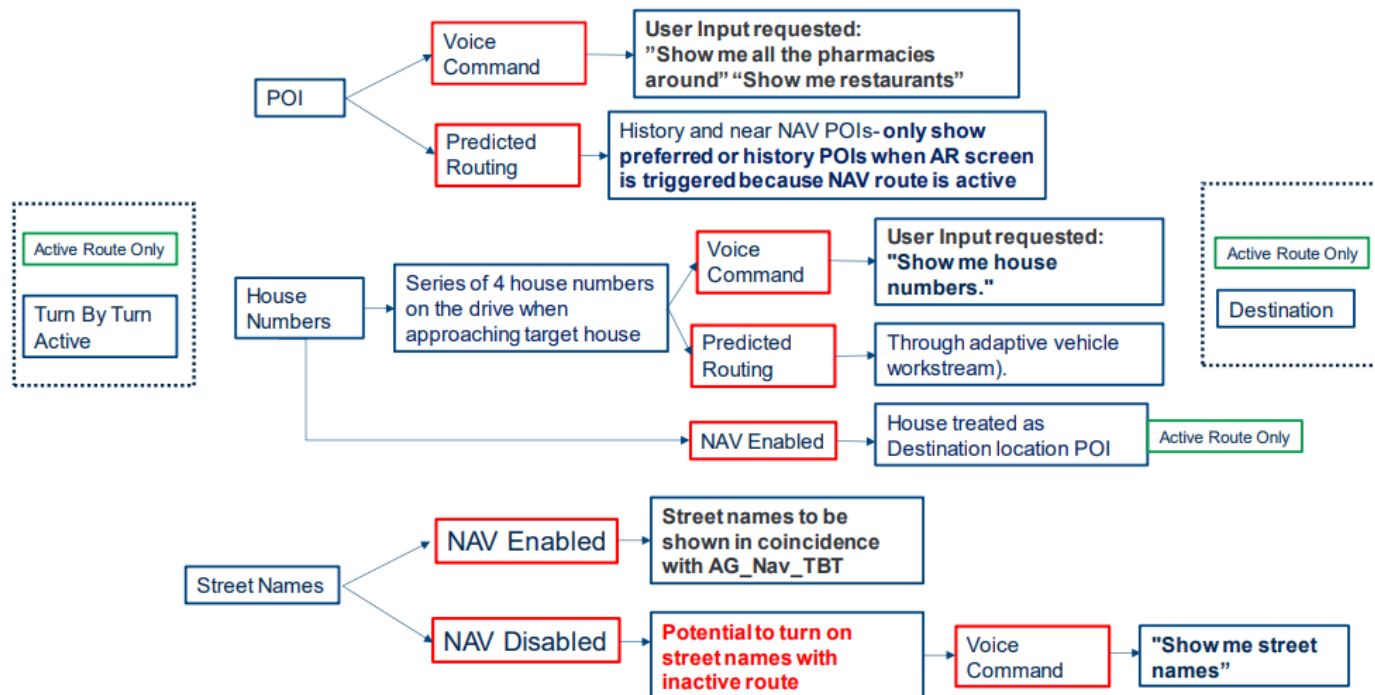


4.3 Driving and Operation Scenarios

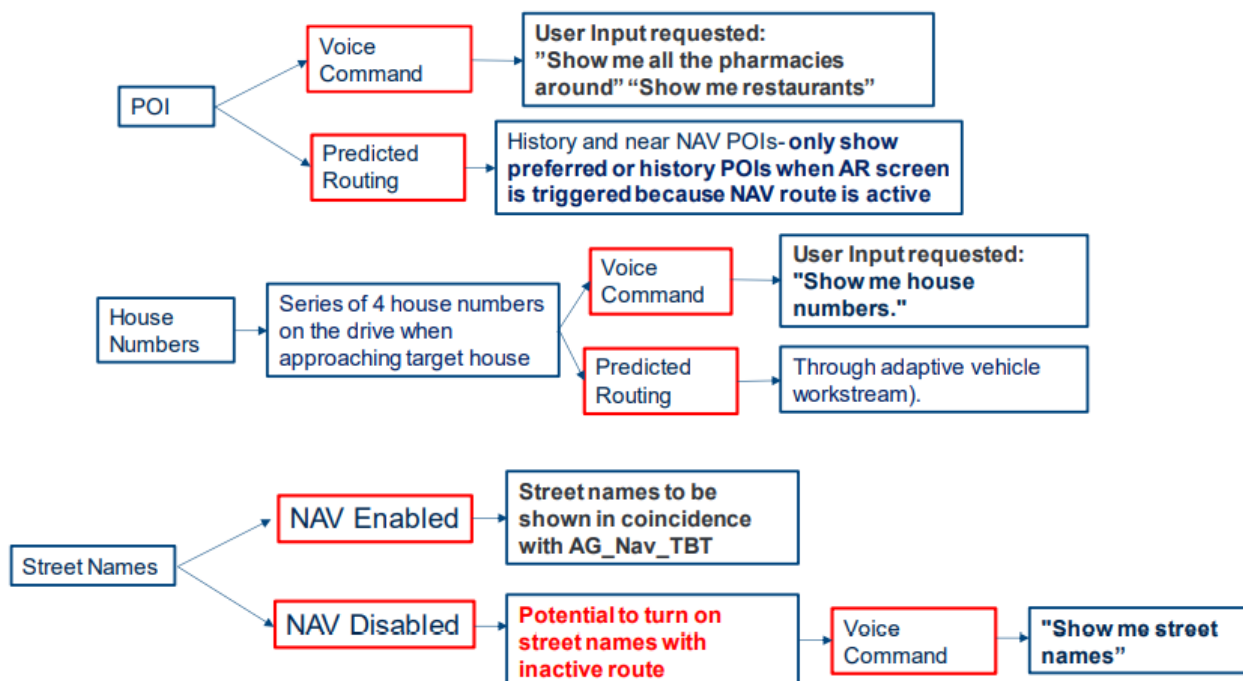
The Use cases related to navigation are displayed below with and without active route.

Note- currently only active route turn by turn and destination use cases are available from Google and within the scope of MVP. The rest of use cases availability pending ongoing discussions for alternative map supplier – TBD for MVP.

AR – with Active Route) – NAV ONLY Use Cases



AR Inactive – NAV ONLY Use Cases





4.4 Decision Tables

None.



5 FEATURE REQUIREMENTS

5.1 Functional Requirements

###R_F_Augmented Reality_00001### Augmented Reality feature to work on Run ignition status-

The Augmented Reality (AR) feature shall be able to operate while the ignition is on Run status-

Note- This requirement is replaced by new requirement "R_F_Augmented Reality_00146### AR feature to be powered only on Normal and Factory KOL modes"

End of Requirement

###R_F_Augmented Reality_00002### Augmented Reality HMI settings availability in Delay Accessory and Run ignition status

The Augmented Reality (AR) feature shall allow the driver to select the AR settings, while the ignition status is on run or delay accessory mode.

End of Requirement

###R_F_Augmented Reality_00003### Turn AR On / Off by physical control

The Augmented Reality (AR) feature shall provide the driver an HMI physical control to turn feature On/OFF

End of Requirement

###R_F_Augmented Reality_00004### Turn AR On / Off by voice command control - TBD for MVP variant, currently voice commands NOT supported by Google – Pending Technical Solution

The Augmented Reality (AR) feature shall provide the driver an HMI Voice Recognition Command control to turn feature On/OFF, i.e. "Turn ON AR"

End of Requirement

###R_F_Augmented Reality_00005### AR default state is On

The augmented reality feature shall have the default state of being turned On.

End of Requirement

###R_F_Augmented Reality_00006### AR Video selection by physical control

The augmented reality feature shall provide the driver an HMI physical control to select AR Video mode.

1. Enable: The AR feature switches automatically between the AR vs FIR camera based on the AR Outside Light Level Adaptation.
2. Disable: The AR feature uses AR visible camera only

End of Requirement



###R_F_Augmented Reality_00007### AR Video selection by voice command control - TBD for MVP variant, currently voice commands NOT supported by Google – Pending Technical Solution

The augmented reality feature shall provide the driver an HMI Voice Recognition Command control to select AR Video mode - AR Outside Light Level Adaptation

1. “Turn ON night vision”=Enable – The AR feature switches automatically between the AR vs FIR camera based on the AR Outside Light Level Adaptation.
2. “Turn OFF night vision”=Disable: The AR feature uses AR visible camera only

End of Requirement

###R_F_Augmented Reality_00008### AR Video mode default selection is Enable

The augmented reality feature shall provide the driver with the AR video mode default selection of Enable.

End of Requirement

###R_F_Augmented Reality_00009### AR selection memory

The following customer selection AR settings shall stay as individual driver preference for the upcoming ignition key cycles unless the driver overwrites it on the HMI settings:

- AR status ON/OFF
- AR video mode selection Enable/Disable

End of Requirement

###R_F_Augmented Reality_00010### AR detection of Navigation status

The AR feature shall detect the navigation status Active/Inactive route

End of Requirement

###R_F_Augmented Reality_00011### AR receiver of Navigation information –

Note: Currently only active route turn by turn and destination use cases are available from Google and within the scope of MVP. The rest of use cases availability pending ongoing discussions for alternative map supplier – TBD for MVP.

The AR feature shall be able to receive from navigation the destination, street names, Points of interest (POI), turn by turn directions, house numbers, coming turn and distance to maneuver, building vs house vs landmark.

End of Requirement



Feature Document Augmented Reality (AR)

###R_F_Augmented Reality_00012### AR triggered by Navigation

The augmented reality AR feature shall be activated only when it receives a trigger from the navigation system.

End of Requirement

###R_F_Augmented Reality_00013### Augmented Reality Display

The Augmented Reality (AR) feature shall provide an adequate display to show the driver AR events once they are triggered by the Navigation or DAT system.

End of Requirement

###R_F_Augmented Reality_00014### Augmented Reality adjustment of FOV on Display

The Augmented Reality (AR) feature shall provide adjustment of FOV on the AR display depending of AR/FIR Camera selection for background image.

End of Requirement

###R_F_Augmented Reality_00015### AR view duration

Note: Refer to Comments in Table -7 Feature Variants

The Augmented Reality (AR) feature shall stop displaying the AR view/content after the AR event ends and the screen goes back to normal state per the following guidelines:

- Guide – Turn-by-Turn:
 - If the next maneuver is not within turn by turn distance (dTBT) of the current maneuver and turn is completed (trigger from NAV), the AR view closes 2 seconds after completing the maneuver per the specified exit animation treatment.
- Guide – House Numbers:
 - AR view closes 4 seconds after no house number has been displayed regardless of whether the maximum number of house numbers has been shown in series.
 - If the set or predicted destination house is approached and/or reached, add checkered pattern near the house when reaching the destination, and the AR view closes after 4 seconds.
- Guide – Points of Interest:
 - No cropping of the POI icon.
 - As the POI leaves the FoV, the full POI icon will stay at the border of the FoV without any portion of the icon cropped as long as greater than 50% of the POI icon can be represented in the FoV at the POI icon's scaled size and geolocation.
 - The POI icon slowly fades out (but is not cropped by the edge of the FoV) if less than 50% of the POI icon can be represented in the FoV at the POI icon's scaled size and geolocation.
 - The POI icon quickly fades back in if more than 50% of the POI icon can be represented in the FoV at the POI icon's scaled size and geolocation.
- Guide – Destination:
 - AR view closes 4 seconds after reaching the destination.
- Blind Spot:
 - AR view closes when signal indicator is deactivated or when blind spot is clear of objects for more than 2 seconds.
- Lane Level Guidance:



Feature Document Augmented Reality (AR)

- If the next maneuver is not within dLLG of the current maneuver and maneuver is completed (trigger from NAV), the AR view closes 2 seconds after completing the maneuver per the specified exit animation treatment.
- Guide – Lane Low Visibility:
 - Feature deactivates:
 - 30 seconds after triggers no longer meet thresholds for activation
 - (or) driver pushes the steering wheel control.

End of Requirement

###R_F_Augmented Reality_00016### Overlay AG-Nav Turn-by-Turn

The Augmented Reality feature shall overlay rendered augmented Turn-by-Turn advise with overlay of the path/arrow to follow on the road when the Navigation system triggers the next maneuver for the driver to reach its destination.

End of Requirement

###R_F_Augmented Reality_00017### Guidance Path with Pointed Arrow

The augmented reality AR feature shall provide a guidance path with pointed arrow to communicate an upcoming maneuver to the driver.

End of Requirement

###R_F_Augmented Reality_00018### Pointed Arrow laid down on the road

The augmented reality AR feature shall provide a pointed arrow laid down on the road/street **that grows from the bottom of the camera view or fade into view** to guide the path of maneuver for the driver.

End of Requirement

###R_F_Augmented Reality_00019### Center the pointed arrow on the road/street without obstructing other objects

The augmented reality AR feature shall center the pointed arrow on the **center of the vehicle** avoiding the obstruction of objects like cars, pedestrians, bikes, motorcycles, etc. in front of driver by **becoming transparent** onto them.

End of Requirement

###R_F_Augmented Reality_00020### Remove AR image from AR display after maneuver

The augmented reality AR feature shall remove the AR image from AR display once the maneuver action is completed.

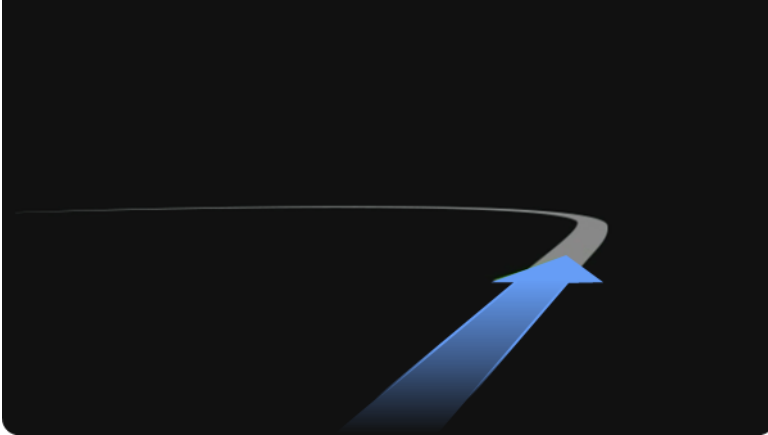
End of Requirement



Feature Document Augmented Reality (AR)

###R_F_Augmented Reality_00147### Consecutive Maneuvers in Turn-by-turn

When there is a consecutive maneuver immediately after the upcoming maneuver which is within the FoV of the AR/FIR camera view, then the Augmented Reality (AR) feature shall represent the consecutive maneuver by a white path that extends from the upcoming turn path arrow.



End of Requirement

###R_F_Augmented Reality_00148### Object Occlusion of laid down arrow on road

When the path arrow appears to be overlaying an object (e.g., other vehicles on the road) in the environment, the Augmented Reality (AR) feature shall fill the portion of the path arrow that is overlaying the object in a transparent way just keeping the outline of the arrow. The stroke of the path arrow is not affected.



End of Requirement

###R_F_Augmented Reality_00021### Transition to show street name on AR display - TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display the street name on the top of the screen when the driver is at the following distances from the maneuver point:

City: $d_{LLG} = 0.25$ mi, $d_{TBT} = 0.1$ mi

Highway: $d_{LLG} = 1$ mi, $d_{TBT} = 0.2$ mi



Feature Document Augmented Reality (AR)

Where:

LLG = lane change path arrow + 2D static Info (2D street name + distance to maneuver + turn icon)

TBT = turn path arrow + 2D Static Info (2D street name + distance to maneuver + turn icon)

End of Requirement

###R_F_Augmented Reality_00022### Activate AR Display at following distances from maneuver point – Note: Lane Change Guide (LLG) TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier or availability in DAT signals

The augmented reality AR feature shall display AR image on the AR display starting from the following distances when it receives a trigger from Navigation system:

City: $d_{LLG} = 0.25$ mi, $d_{TBT} = 0.1$ mi

Highway: $d_{LLG} = 1$ mi, $d_{TBT} = 0.2$ mi

Where:

LLG = lane change path arrow + 2D static Info (2D street name + distance to maneuver + turn icon)

TBT = turn path arrow + 2D Static Info (2D street name + distance to maneuver + turn icon)

End of Requirement

###R_F_Augmented Reality_00023### Pointed Arrow color change if speed approaching the maneuver point is higher than speed limit

The augmented reality AR feature shall monitor the vehicle speed during the turn sequence for the pointed arrow to change color property to **Amber** in order to warn the driver to slow down when the approaching speed is higher than the speed limit.

End of Requirement

###R_F_Augmented Reality_00024### Pointed Arrow animation along with the Street Name

The augmented reality AR feature shall show the pointed arrow attributes **along with Street name** pointing towards the direction of turn through some animation of Turn to visible enhance lane marking biased towards the turn to show which lane to be at.

End of Requirement

###R_F_Augmented Reality_00025### Pointed Arrow angled/biased toward the line to be at

The augmented reality AR feature shall visibly enhance lane marking on the road/street by make it biased/angled towards the turn to show which lane to be at.

End of Requirement



Feature Document Augmented Reality (AR)

###R_F_Augmented Reality_00026### Representation of Round About

The augmented reality AR feature shall be able to show the driver 3D Objects representing round about along with the suggested pointed arrow on the road/street.

End of Requirement

###R_F_Augmented Reality_00027### U-turn display and guidance

The augmented reality AR feature shall show the pointed arrow with the desired angle of turn for safe distance from curb when approaching to a U turn signal triggered by Navigation

End of Requirement

###R_F_Augmented Reality_00028### Lane change requirement and display

The augmented reality AR feature shall show the pointed arrow pointing towards the desired lane using angled guided path if there is a lane change required by the road/street (i.e. entry/exit to/from highway).

End of Requirement

###R_F_Augmented Reality_00029### Acceptance of Audio/Visual prompts from Navigation

The augmented reality AR feature shall allow visual/audio alerts to the driver by prompts from NAV when turn point of maneuver is approaching

End of Requirement

###R_F_Augmented Reality_00030### Overlay AG-Nav Street Names - Note: Street name TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier, Street name to be in 2D and not augmented

The Augmented Reality feature shall overlay rendered augmented Street Names on the HMI display when the Navigation system has an active destination route that triggers the next maneuver for the driver.

End of Requirement

###R_F_Augmented Reality_00031### Street Name highlighting for driver awareness- Note: Street name TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier, Street name to be in 2D and not augmented

The augmented reality AR feature shall highlight the street name to the driver by providing a flying flag or rectangular shape with the street name on the AR display when AR feature receives a trigger from the Navigation system.

End of Requirement

###R_F_Augmented Reality_00032### Positioning of Street Name - Note: Street name TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier, Street name to be in 2D and not augmented



Feature Document Augmented Reality (AR)

The augmented reality AR feature shall provide a colored flying rectangular flag on the top center part of the AR display to communicate an upcoming street to the driver.

End of Requirement

###R_F_Augmented Reality_00033### Transition 3D property of Street Name flying flag - Note: Street name TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier, Street name to be in 2D and not augmented

The augmented reality AR feature shall provide a flying rectangular flag having a 3D transition property to meet such alignment upon the street on the drive route.

End of Requirement

###R_F_Augmented Reality_00034### Show Street Names as a subset of Turn by Turn - Note: Street name TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier, Street name to be in 2D and not augmented

The augmented reality AR feature shall show Street name as a subset of Turn by Turn showed only when there is a trigger from Navigation relative to route.

End of Requirement

###R_F_Augmented Reality_00035### Display House Numbers like a POI when there is route on NAV system

The augmented reality AR feature shall display House Numbers like a destination location point of interest (POI) when triggered by Navigation route as with any other destination.

End of Requirement

###R_F_Augmented Reality_00036### Display House Numbers with highlighted icons- Note: House Number TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display the House Numbers more visible with highlighted icons in Yellow color to draw driver's attention.

End of Requirement

###R_F_Augmented Reality_00037### Activate Navigation via predicted route to display 4 House Numbers when approaching target house- Note: House Number TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display on AR view a series of 4 House Numbers, matching the side of the specific destination house, on the drive triggered via a navigation predicted route (through adaptive vehicle workstream), if it is available, when approaching target house with navigation routing disabled.

End of Requirement



Feature Document Augmented Reality (AR)

###R_F_Augmented Reality_00038### Prioritize the name of the building/business- Note: House Number TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall prioritize the display of the name of building/business (i.e. mall, restaurant...), if this is available, instead of the house number on address.

End of Requirement

###R_F_Augmented Reality_00039### Display Navigation directory name if available- Note: House Number TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display available data from Navigation directory for defined addresses instead of house numbers like: "friend's house", if this is available.

End of Requirement

###R_F_Augmented Reality_00040### Activate Navigation via voice command to display 4 House Numbers - Note: House Number TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display on AR view a series of 4 House Numbers on the drive triggered by the driver via a voice command like "Show me house numbers".

End of Requirement

###R_F_Augmented Reality_00041### Vehicle speed restriction to show House Numbers - Note: House Number TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall trigger the AR view of House Numbers only when the vehicle speed is to be below 25 MPH or below current residential speed limit.

End of Requirement

###R_F_Augmented Reality_00042### Display of House Numbers within the proximity of the vehicle - Note: House Number TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display to the driver the House Numbers that are within the proximity of the vehicle location.

End of Requirement

###R_F_Augmented Reality_00043### Show POIs as received from Navigation system - Note: POI TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display the AR view of any POIs active in the navigation system.



Feature Document Augmented Reality (AR)

End of Requirement

###R_F_Augmented Reality_00044### AR view to Driver's voice commands for POI - Note: POI TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display the AR view of any POIs active in the navigation system triggered by a voice command (e.g., show me gas station).

End of Requirement

###R_F_Augmented Reality_00045### AR view of driver personalization setting for POIs - Note: POI TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display on the AR view the POIs based on the available user personalized preferences/activities.

End of Requirement

###R_F_Augmented Reality_00046### POIs Icons shown accordingly to the category selected - Note: POI TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display on the AR view the POI Icons based on their category on the navigation system list.

End of Requirement

###R_F_Augmented Reality_00047### Distance from the ground level to show the POI Icons on the AR display - Note: POI TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display on the AR view the POI Icons placed vertically centered with the horizon as positioned in the camera FoV, as vehicle approaches the POI, the vertical position of the POI icon translates relative to the camera FoV perspective.

End of Requirement

###R_F_Augmented Reality_00048### POI location/placement on the AR view - Note: POI TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall display on the AR view the POI location pointing at the exact location or drivable path of the POIs existence.

End of Requirement



Feature Document Augmented Reality (AR)

###R_F_Augmented Reality_00049### AR view capability to show destination POI inputted by user

The augmented reality AR feature shall display on the AR view the destination POI on any location (final and/or waypoint) inputted by the user in the NAV system.

End of Requirement

###R_F_Augmented Reality_00149### AR to show only the closest POI text label to driver - Note: POI TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

When showing a POI text label, the Augmented Reality (AR) feature shall use the following strategy:

- One text label will be shown
- If multiple POI icons are on screen, the POI closest to the driver should be labeled
- Once the closest POI icon leaves the FoV, the next closest POI icon will be labeled with text

End of Requirement

###R_F_Augmented Reality_00150### POI icon labeled with specific company name - Note: POI TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

When the POI icon has scaled to a size equal to or greater than the specified minimum, the Augmented Reality (AR) feature shall add a text label with the specific company name if this is available.

End of Requirement

###R_F_Augmented Reality_00050### Overlay AG-Nav Destination – Note- This is valid for POI as destination or house number as destination or any destination inputted by the driver

The Augmented Reality feature shall overlay rendered augmented Destination icons/symbols on the AR image that start appearing on the target destination by highlighting the destination to help driver locate the specific location of the place upon reaching the target destination.

End of Requirement

###R_F_Augmented Reality_00051### Display address upon reaching Destination - Note: TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The Augmented Reality feature shall overlay rendered augmented street address with destination icon on HMI display upon reaching Destination.

End of Requirement



Feature Document Augmented Reality (AR)

###R_F_Augmented Reality_00052### Highlighting of destination buildings on AR view - Note: TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall highlight on the AR view the destination buildings (final and/or waypoint) that were inputted by the user on the Navigation system.

End of Requirement

###R_F_Augmented Reality_00053### Highlight/Mark of destination

The augmented reality AR feature shall highlight/mark the destination by showing a checkered pattern (250 ms fade-in) applied on the roadway adjacent to the destination location.

End of Requirement

###R_F_Augmented Reality_00054### Allow Navigation audio prompts at destination arrival

The augmented reality AR feature shall allow any audio prompts if they are produced by the Navigation system when destination is approaching. The Augmented reality feature shall not produce any audio prompt.

End of Requirement

###R_F_Augmented Reality_00055### Provide Destination address and Icon at point of arrival [TBD-Not in MVP] - Note: TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier

The augmented reality AR feature shall provide an AR view of the destination street address with Destination POI icon displayed upon reaching the destination.

End of Requirement

###R_F_Augmented Reality_00056### Show pointed arrow as Lane guidance to destination house entry or driveway [TBD-Not in MVP]

The augmented reality AR feature shall show a pointed arrow (or carpet) as Lane guidance starting to merge (e.g. reduced arrow size) with the house entry or driveway as House or Destination is starting to show on the AR view.

End of Requirement

###R_F_Augmented Reality_00057### Display a Destination Icon POI at house location or main door

The augmented reality AR feature shall display a Destination icon POI in Red color upon the house location or main door. When a destination falls outside FoV, the AR view is still triggered. The destination icon is accompanied by a pointer that directs the driver to the destination that is just outside the FoV.



Feature Document Augmented Reality (AR)

End of Requirement

####R_F_Augmented Reality_00058#### Stop showing House Number/ POI when reaching point of Destination - **Note: TBD for MVP variant, currently not available due to Google signal availability, pending ongoing discussions for alternative map supplier**

The augmented reality AR feature shall stop showing the House number POI to allow the AR display to go back to normal state when the destination has been reached as follows:

- AR view closes 4 seconds after no house number has been displayed regardless of whether the maximum number of house numbers has been shown in series.
- If the set or predicted destination house is approached and/or reached, add checkered pattern near the house when reaching the destination, and the AR view closes after 4 seconds.

End of Requirement

####R_F_Augmented Reality_00059#### AR Triggered by BLIS and Turn signals

The augmented reality AR feature shall display **Amber** "carpet" warning when blind spot detection is activated with the turn signals indicator blinking in the same direction as activated BLIS. **The carpet shall have the following characteristics:**

- a) The carpet should project out as far as possible and accommodate any curvature in the roadway.
- b) The carpet has a gradient that reduces in fill opacity with lateral and longitudinal distance from driver.
- c) The carpet quickly fades out when traffic leaves the blind spot.
- d) **Object Occlusion:** If the blind spot carpet appears to be overlaying an object (e.g., other vehicles on the road) in the environment, the portion of the fill of the carpet that is overlaying the object becomes transparent

End of Requirement

####R_F_Augmented Reality_00060#### No activation of AR view with no activation of BLIS signal.

The augmented reality AR feature shall show no change on AR view when the driver can make the turn without the activation of the BLIS signal.

End of Requirement

####R_F_Augmented Reality_00061#### Display of BLIS Symbol/icon on top of Amber carpet [TBD-Not in MVP]

~~The augmented reality AR feature shall display on the AR view a BLIS icon/symbol over the Amber "carpet" when it is shown on the AR display.~~

End of Requirement

####R_F_Augmented Reality_00062#### Stop displaying the **Amber** carpet ~~and BLIS symbol/icon~~ when clear to maneuver

The augmented reality AR feature shall stop displaying the **Amber** "carpet" ~~with the BLIS symbol/icon on top of it~~ on the AR view when driver can make the turn or lane change with no object in its blind spot or if the turn signal indicator is deactivated:

- AR view closes when signal indicator is deactivated or when blind spot is clear of objects for more than 2 seconds.

End of Requirement



###R_F_Augmented Reality_00063### Show driver path to follow on the road using push button- Lane Low Visibility - MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1>)

The augmented reality AR feature shall provide the driver on the AR view a visual image of the most likely path to follow on the road/street by showing an Amber colored pointed arrow (carpet) laid down on the road/street to guide the path of maneuver when the driver presses a button on the steering wheel (Vigilance control switch, i.e. dead man's switch) to activate Lane Low Visibility.

End of Requirement

###R_F_Augmented Reality_00064### Show driver path to follow on the road using voice command - Lane Low Visibility - MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1>)

The augmented reality AR feature shall provide the driver on the AR view a visual image of the most likely path to follow on the road/street by showing an Amber colored pointed arrow (carpet) laid down on the road/street to guide the path of maneuver when the driver uses the voice command (e.g. "Help me see") to activate Low Lane Visibility.

End of Requirement

###R_F_Augmented Reality_00065### Show driver path to follow on the road using "Virtual Switch"- MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1>)

The augmented reality AR feature shall provide the driver on the AR view a visual image of the most likely path to follow on the road/street by showing an Amber colored pointed arrow (carpet) lay down on the road/street to guide the path of maneuver when the driver confirms a "Virtual switch" suggestion on HHDD (with virtual switches for steering wheel, location offered to be active via the label-less steering wheel) with the following triggers for HHDD Button visibility:

- a) ADAS system lane detection confidence (check if this value is exposed)
- b) Time of the day / daylight
- c) Rain sensor / wiper rate
- d) Temperature (ice might cover markings)
- e) Compass direction and time (driving against sun)
- f) Weather forecast
- g) Wet or slippery drive mode are selected
- h) Fog Lights / high beams
- i) Defrost windshield
- j) Detect if driver sun visor is down

End of Requirement

###R_F_Augmented Reality_00151### Lane Low Visibility Lead Vehicle Marker - MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1>)

When the driver activates de Lane Low Visibility function, the Augmented Reality (AR) feature shall identify lead objects (i.e. vehicles, bicycles, motorcycles, etc.) with an amber bracket metaphor.



Feature Document Augmented Reality (AR)



End of Requirement

####R_F_Augmented Reality_00066#### Display Augmented Lines AL- Lane Level Guidance [This is part of MVP+] - MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1> ; currently not available from Google – pending discussion with alternative map supplier and getting data from ADAS

The Augmented Reality feature shall display rendered augmented Lane Level Guidance with a blue path/arrow to follow rather than abstract instructions to the driver for situational awareness of the driver to show the preferred lane (entry, exit, machine learning...), guide away from obstacle or hazards that will determine if it is clear and do the lateral motion to move into the desired lane.

End of Requirement

####R_F_Augmented Reality_00067#### Lane Level Guidance - evade an environmental object - MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1> ; currently not available from Google – pending discussion with alternative map supplier and getting data from ADAS

The augmented reality AR feature shall provide the driver on the AR view a visual image of the preferred line to follow on the road/street by showing a blue pointed arrow (carpet) lay down on the road/street to guide the path when an upcoming maneuver (i.e. turn by turn) is set up to evade an environmental object.

End of Requirement

####R_F_Augmented Reality_00068#### Lane Level Guidance - same attributes as Guide - Turn by turn - MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1> ; currently not available from Google – pending discussion with alternative map supplier and getting data from ADAS

The augmented reality AR feature shall provide the driver with the same AR attributes for Lane Level Guidance as for Guide - Turn by Turn.

End of Requirement

####R_F_Augmented Reality_00152#### Lane Level Guidance distance threshold triggers - MVP+ variant - (ongoing discussion with CIED team if it can be moved to MVP or post <J1> ; currently not available from Google – pending discussion with alternative map supplier and getting data from ADAS

When maneuver is within FoV, the Augmented Reality (AR) feature shall show the augmented camera view at d_{LLG} distance at the specified entry animation treatment.

- a) City near nav distance threshold: d_{LLG} = 0.25 mi



Feature Document Augmented Reality (AR)

b) Highway near nav distance threshold: $d_{LLG} = 1$ mi

Exact values are subject to change in accordance with embedded navigation triggers.
If turn is not within the FoV, the AR camera view is not shown

End of Requirement

###R_F_Augmented Reality_00069### Overlay Augmented Lines AL- Lane Biasing [This is part of MVP+]- (ongoing discussion with CIED team if it can be moved to MVP or post <J1>, need to be tied to lane change assist and highway assist)

The Augmented Reality feature shall display visualized rendered augmented Lane Biasing with a highlight of the object and correlate that object to the slight change in path to the right (/left) side of the road when the car is biasing to the right (/left) side of the lane because of an oncoming object on the left (/right) side of the vehicle.

End of Requirement

###R_F_Augmented Reality_00070### Lane Biasing of path to follow - This is part of MVP+]- (ongoing discussion with CIED team if it can be moved to MVP or post <J1>, need to be tied to lane change assist and highway assist)

The augmented reality AR feature shall provide on the AR view a visual image of the guidance path the vehicle will follow on the road/street by showing a pointed arrow (carpet) lay down on the road/street biased to the left (/right) of the lane due to an incoming object on the right (/left) prior to the vehicle performing the maneuver within the road/street lane when the vehicle is in a Blue zone and driving using the ADAS system.

End of Requirement

###R_F_Augmented Reality_00071### Lane Biasing show on AR view with same requirements as Turn by Turn - This is part of MVP+]- (ongoing discussion with CIED team if it can be moved to MVP or post <J1>, need to be tied to lane change assist and highway assist)

The augmented reality AR feature shall provide the driver with a Lane Biasing visual treatment with the same requirements as Guide - Turn by Turn.

End of Requirement

###R_F_Augmented Reality_00072### Lane Biasing to be perform when vehicle is operating with ADAS system - This is part of MVP+]- (ongoing discussion with CIED team if it can be moved to MVP or post <J1>, need to be tied to lane change assist and highway assist)

The augmented reality AR feature shall perform the Lane Biasing when the vehicle is operating with the Active Drive Assist System (ADAS).

End of Requirement

###R_F_Augmented Reality_00073### Lane Biasing to be shown on AR view until the end of the maneuver - This is part of MVP+]- (ongoing discussion with CIED team if it can be moved to MVP or post <J1>, need to be tied to lane change assist and highway assist)

The augmented reality AR feature shall maintain the AR view of the Lane Biasing event until the maneuver is completed.



Feature Document Augmented Reality (AR)

End of Requirement

###R_F_Augmented Reality_00074### Lane Biasing to be triggered coincidentally with ADAS event - This is part of MVP+]- (ongoing discussion with CIED team if it can be moved to MVP or post <J1>, need to be tied to lane change assist and highway assist)

The augmented reality AR feature shall trigger the AR view of the Lane Biasing event coincidentally to the original lane biasing signal from ADAS system.

End of Requirement

###R_F_Augmented Reality_00075### Highway Assist/ Active Drive Assist - This is part of MVP+]- (ongoing discussion with CIED team if it can be moved to MVP or post <J1>, need to be tied to lane change assist and highway assist)

The augmented reality AR feature shall display the augmented reality Highway Assist with a highlighted representation of the path of the Blue Zones on the highway until the Blue Zone comes to an end.

End of Requirement

###R_F_Augmented Reality_00076### Perform calibration of the Augmented Reality (AR) feature

The augmented reality AR feature shall allow a qualified Technician to perform a Calibration procedure/process to verify/adjust the AR vehicle parameters and Augmented Reality Cameras (AR and FIR) for the AR feature to perform to manufacturer's specifications.

End of Requirement

###R_F_Augmented Reality_00077### AR night driving capability – if Vehicle is equipped with FIR

The Augmented Reality (AR) feature shall be able to display the AR content during night/dark environment when an AR event is triggered switching the AR display from 2D navigation HMI to real-time AR view with the night image capturing device as the background image presented to the driver.

End of Requirement

###R_F_Augmented Reality_00078### AR night/dark environment during AR Event - if Vehicle is equipped with FIR

The Augmented Reality (AR) feature shall be able to display the AR content during night/dark environment when the AR event is triggered with the night image capturing device as the background image with the proper AR overlays for the AR events.

End of Requirement

###R_F_Augmented Reality_00079### Provide driver with the same user experience with FIR camera as with AR visible camera

The augmented reality AR feature shall provide the driver with the same user experience using the AR night vision (FIR) camera as with the AR visible camera for the AR Events.



Feature Document Augmented Reality (AR)

End of Requirement

####R_F_Augmented Reality_00080#### Environmental objects geometry without Blending using AR night vision camera as background

The augmented reality AR feature shall use the AR night vision camera for image processing (without Blending) to determine the geometry of environmental objects, which will be mapped/highlighted in Amber color on the background image from the night vision camera.

End of Requirement

####R_F_Augmented Reality_00081#### AR/FIR Camera Feed Auto Select– if vehicle is equipped with FIR Camera

The augmented reality AR feature shall select the camera to use, either visible AR Camera or night vision FIR camera, according to the AR camera parameters / vehicle light sensor to activate either of them automatically, unless this selection is overwritten by the driver (see HMI section).

End of Requirement

####R_F_Augmented Reality_00082#### Triggering AR event – if Vehicle Not equipped with FIR Camera

The Augmented Reality (AR) feature shall be able to display the visible real-time AR view as the background image with the proper AR overlays when an AR view triggering event switches the AR display from 2D navigation HMI to real-time AR view for the dark/night environments events and the vehicle is Not equipped with FIR camera.

End of Requirement

####R_F_Augmented Reality_00083#### Night image FIR capturing device not available on triggering AR event – if Vehicle is equipped with FIR Camera

The Augmented Reality (AR) feature shall be able to display the visible real-time AR view as the background image with the proper AR overlays when an AR view triggering event switches the AR display from 2D navigation HMI to real-time AR view for dark/night environment and the night image FIR capturing device is not available.

End of Requirement

####R_F_Augmented Reality_00084#### Detect and report FIR camera not available/operational

The augmented reality feature shall be able to detect and report to the driver on the HMI display that the night image FIR capturing device is not available/not-operational.

End of Requirement

####R_F_Augmented Reality_00085#### Visible image capturing device not available on triggering AR event

The Augmented Reality (AR) feature shall be able to display the night image real-time AR view as the background image (if vehicle is equipped with FIR camera) with the proper AR overlays when an AR view triggering event



Feature Document Augmented Reality (AR)

switches the AR display from 2D navigation HMI to real-time AR view and the visible image capturing device is not available.

End of Requirement

###R_F_Augmented Reality_00086### Detect and report AR camera not available/operational

The augmented reality feature shall be able to detect and report to the driver on the HMI display that the visible image capturing device is not available/not-operational.

End of Requirement

###R_F_Augmented Reality_00087### AR Camera video feed

The Augmented Reality (AR) feature shall be able to receive a video feed from AR camera with corresponding FOV once the augmented reality trigger is active.

End of Requirement

###R_F_Augmented Reality_00088### FIR Camera video feed – If Vehicle is equipped

The Augmented Reality (AR) feature shall be able to receive a video feed from FIR camera with corresponding FOV once the augmented reality trigger is active (if the vehicle is equipped with FIR camera)

End of Requirement

###R_F_Augmented Reality_00089### OTA capability

The Augmented Reality (AR) feature shall be able to receive fast over the air (OTA) software updates.

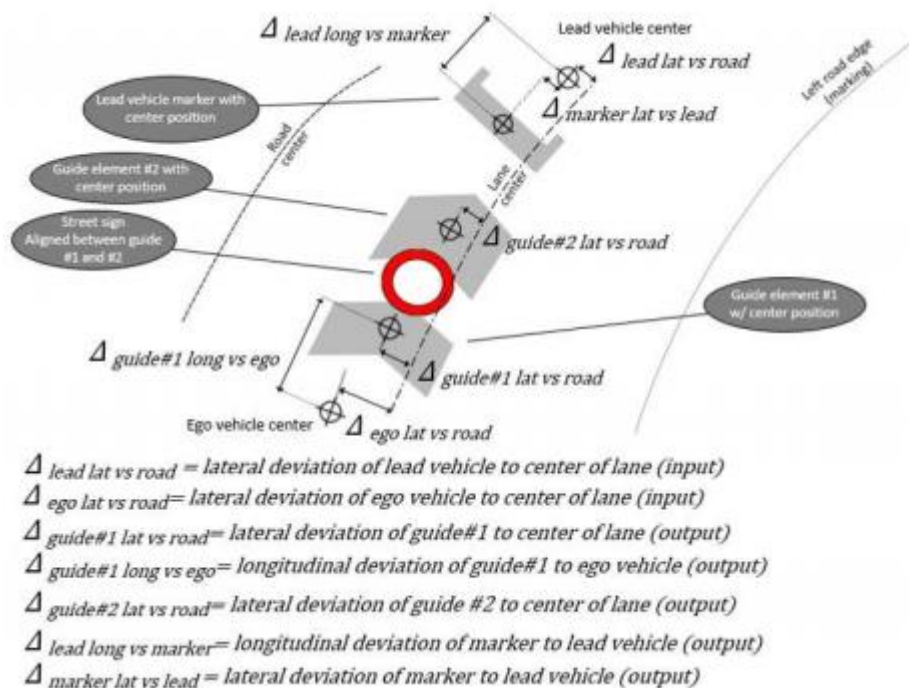
End of Requirement

###R_F_Augmented Reality_00090### Overlay Accuracy

The Augmented Reality (AR) feature shall be able to provide overlay data to the driver by below accuracy:



Feature Document Augmented Reality (AR)



The accuracy with below limits forward up to 50m:

- Δ guide#1 lat vs road < 200mm
- Δ guide#1 long vs ego < 500mm
- Δ guide#2 lat vs road < 300mm
- Δ lead long vs marker < 500mm
- Δ marker lat vs lead < 300mm

End of Requirement

###R_F_Augmented Reality_00091### Glass-to-Glass Latency

The Augmented Reality (AR) feature shall be able to provide the data to the driver at a maximum glass-to-glass latency of 100 ms.

End of Requirement

###R_F_Augmented Reality_00092### Rendering priority control

The Augmented Reality (AR) feature shall be able to provide rendering priority control in order to display the feature content based on the table below:

Feature	HMI Priority
Night Vision (Background)	1
Lane Low Visibility	2
BLIS	3
Highway Assist	4



Feature Document Augmented Reality (AR)

Lane Biasing	4
Assisted Lane Change	4
Lane Level Guidance	4
Turn by Turn	5
Destination	5
House Number	6
POI	6
Street Name	7

The concurrent display of AR features (i.e., show turn-by-turn maneuver with blind spot) is allowed and integral to the system communication to the driver.

The augmented camera view will be hidden by all Global Alert popup message (in the LINE OF SIGHT location of the display) and Warning popup messages (in the PERIPHERAL location of the display).

User actions that result in information being presented in the area of the augmented camera view (e.g., accommodations menu) will hide the augmented camera view.

End of Requirement

5.2 Non-Functional Requirements

5.2.1 Safety

None.

5.2.2 Security

None.

5.2.3 Reliability

The feature shall comply with the expected life of the vehicle of 15 years or 150,000 miles, whichever occurs first.

5.3 HMI Requirements

###R_F_Augmented Reality_00093### HMI option to turn AR On/Off though a physical control

The Augmented Reality (AR) feature shall provide an HMI option to turn AR feature ON or OFF though a physical control.

End of Requirement



Feature Document Augmented Reality (AR)

####R_F_Augmented Reality_00094#### HMI option to turn AR On/Off though a voice command control – TBD for MVP- voice commands NOT supported by Google- pending discussion

The Augmented Reality (AR) feature shall provide an HMI option to turn AR feature ON or OFF through HMI voice command control, i.e. "Turn ON AR"

End of Requirement

####R_F_Augmented Reality_00095#### Default status for AR feature is On

The augmented reality feature shall have the default status of ON.

End of Requirement

####R_F_Augmented Reality_00096#### HMI information icon "i"

The Augmented Reality (AR) feature shall provide an HMI info icon "i" to educate the driver about what this feature selections and options to choose from on the menu:

- AR Off - no augmented camera view will be presented to the driver at any time during vehicle operation.
- AR On (default) - augmented camera view will be presented to the driver contextually during vehicle operation.
- Enables / Disables - the augmented camera view that automatically pops up when you are nearing a maneuver with the built-in navigation system active or in other situations where enhanced environmental awareness would be helpful.

End of Requirement

####R_F_Augmented Reality_00097#### HMI physical control to select AR Video Mode Enable/Disable – If vehicle is equipped with FIR Camera

The augmented reality feature shall provide an HMI option to select AR video background mode by a physical control to Select AR Video mode with AR Outside Light Level Adaptation

- Disable – the AR feature shall use AR visible camera only
- Enable (default) – The AR feature shall switch automatically between the AR and FIR camera based on the level of environmental lights.

End of Requirement

####R_F_Augmented Reality_00098#### HMI voice command control to select AR Video Mode Enable/Disable – If vehicle is equipped with FIR Camera - TBD for MVP- voice commands NOT supported by Google- pending discussion

The augmented reality feature shall provide an HMI voice command control to select AR video background mode to Select AR Video mode with AR Outside Light Level Adaptation

- "Turn OFF night vision"= Disable – the AR feature shall use AR visible camera only
- "Turn ON night vision"= Enable (default) – The AR feature shall switch automatically between the AR and FIR camera based on the level of environmental lights.

End of Requirement

####R_F_Augmented Reality_00099#### HMI selection of AR Video through key ignition start cycles – If vehicle is equipped with FIR Camera



Feature Document Augmented Reality (AR)

The customer HMI selection of AR video mode shall stay as **individual** driver preference for the coming ignition key start cycles unless the driver overwrites this HMI setting.

End of Requirement

####R_F_Augmented Reality_00100#### Default selection of AR Video Mode as Enable – If vehicle is equipped with FIR Camera

The augmented reality feature shall provide an HMI default option for selection of AR video background mode as Enable:

- The AR feature shall switch automatically between the AR and FIR camera based on the level of environmental lights.

End of Requirement

####R_F_Augmented Reality_00101#### Augmented Reality Display

The Augmented Reality (AR) feature shall provide an adequate display for the driver to see the AR video once it is triggered by AR events. The display of augmented reality feature shall:

- a) show no wiper motion to the driver (in case the wiper is working and within AR camera FOV)
- b) be located with minimal interface with steering wheel location

End of Requirement

####R_F_Augmented Reality_00102#### Augmented Reality Display adjustment of FOV

The AR display shall provide different corresponding FOV in the display depending on AR/FIR/Auto camera capabilities.

End of Requirement

####R_F_Augmented Reality_00103#### Augmented Reality camera video feed remains until AR event has finished

The Augmented Reality (AR) feature shall provide a driver experience where the camera video feed is kept until the AR event being shown has finished, prohibiting the change of camera video feed during AR events.

End of Requirement

####R_F_Augmented Reality_00104#### AR contextually triggering by Event

The Augmented Reality (AR) feature shall provide a contextually triggered environment on the AR display between 2D map guidance (Far Nav) to AR exact turn location (Near Nav) and back to 2D map guidance once the maneuver has been executed by the driver to optimize value and mitigate potential driver distractions.

End of Requirement

####R_F_Augmented Reality_00105#### Select- Lane Low Visibility HMI options

The Augmented Reality (AR) feature shall provide an HMI option to trigger Lane Low Visibility through:

1. Vigilance control (i.e., dead man's switch) on steering wheel.
2. Driver voice command (e.g. "Help me see drive lines").



Feature Document Augmented Reality (AR)

3. "Virtual switch" suggestion on HHDD (with virtual switches for steering wheel, location offered to be active via the label-less steering wheel) with triggers for HHDD Button visibility:

- a) ADAS system lane detection confidence (check if this value is exposed)
- b) Time of the day / daylight
- c) Rain sensor / wiper rate
- d) Temperature (ice might cover markings)
- e) Compass direction and time (driving against sun)
- f) Weather forecast
- g) Wet or slippery drive mode are selected
- h) Fog Lights / high beams
- i) Defrost windshield
- j) Detect if driver sun visor is down

End of Requirement

###R_F_Augmented Reality_00106### FIR Camera Fault Message – If Vehicle is equipped with FIR Camera

The Augmented Reality (AR) feature shall display a FIR Camera fault text message (TBD) on the HMI display when there is a fault or lack of normal operation of the night vision FIR Camera.

End of Requirement

###R_F_Augmented Reality_00107### AR Camera Fault Message – If Vehicle is equipped with FIR Camera

The Augmented Reality (AR) feature shall display an AR Camera fault text message (TBD) on the HMI display when there is a fault or lack of normal operation of the visible AR Camera

End of Requirement

###R_F_Augmented Reality_00108### AR Camera Fault Message – If Vehicle is NOT equipped with FIR Camera

The Augmented Reality (AR) feature shall display an AR Camera fault text message with feature Not available text (TBD) on the HMI display when there is a fault or lack of normal operation of the visible AR Camera and the vehicle is not equipped with night vision FIR Camera.

End of Requirement

###R_F_Augmented Reality_00109### AR HMI positioning

The Augmented Reality (AR) feature shall provide an AR HMI to play the augmented reality images positioned in such a way that avoids impairment of the windshield or the driver line of sight to avoid any driver distraction and vehicle controllability issues.

End of Requirement

###R_F_Augmented Reality_00145### No AR operation on Transportation and Low Battery modes

The Augmented Reality (AR) feature shall stay not operational during the following modes of the vehicle:

- a) Transportation Life Cycle mode



Feature Document Augmented Reality (AR)

b) Low Battery mode

End of Requirement

###R_F_Augmented Reality_00146### AR feature to be powered only on Normal and Factory KOL modes

The Augmented Reality feature shall NOT be powered unless the last known Key OFF Load (KOL) modes value of the vehicle is "Normal" or "Factory", followed table below.

3.4.5 Determine KOL Mode

KOL_Mode is a simple combination of Ignition_Status, LifeCycMde_D_Actl and Sleep_Mode.

<u>Rqm't Num.</u>	<u>Ignition_Status</u>	<u>LifeCycMde_D_Actl</u>	<u>Sleep_Mode</u>	<u>KOL_Mode</u>
R: 3.4.2-1	RUN START ACC	Don't care	Don't care	NORMAL
R: 3.4.2-2	OFF	FACTORY	Don't care	FACTORY
R: 3.4.2-3	OFF	TRANSPORT	Don't care	TRANSPORT
R: 3.4.2-4	OFF	NORMAL	NORMAL	NORMAL
R: 3.4.2-5	OFF	NORMAL	HIBERNATE	HIBERNATE
R: 3.4.2-6	OFF	NORMAL	CRITICAL_BATT	CRITICAL_BATT

End of Requirement

5.4 Other Requirements

5.4.1 Design Requirements

###R_F_Augmented Reality_00110### AR vs FIR Camera packaging

The FIR Camera (if vehicle is equipped) shall be packaged within the following packaging distance/position compared to AR Camera with enough FOV:

- 6" in X and Y, and 2" in depth maximum separation for full blending.
- If AR and FIR Camera packaging not within full blending, the FIR camera shall package TBD distance to allow for partial/selective blending.

End of Requirement

###R_F_Augmented Reality_00111### AR Camera Packaging



Feature Document Augmented Reality (AR)

The AR Camera shall be packaged within a 6-inch distance and within a 5% FOV to the DAT (FWC) camera.

End of Requirement

5.4.2 Manufacturing Requirements

###R_F_Augmented Reality_00112### AR feature EOL Configuration/Calibration

The Augmented Reality feature shall:

- a) be configurable at the End Of Line (EOL) test at the manufacturing plant as below values.

Name	Description	Range / Resolution
Augmented_Reality_Cfg	Configuration to denote feature enabled/disabled on the vehicle	0 x 0 == OFF 0 x 1 == ON; No FIR Camera (vehicle not equipped) 0 x 2 = ON; with FIR Camera (vehicle is equipped)

- b) be able to perform EOL calibration to the AR and FIR camera

End of Requirement

5.4.3 Service Requirements

###R_F_Augmented Reality_00113### Service Calibration for AR camera

The Augmented Reality feature shall be able to perform service calibration to the AR Camera.

	The Augmented Reality feature shall be able to perform service calibration to the AR Camera
--	---------------------------------------------------------------------------------------------

End of Requirement

###R_F_Augmented Reality_00114### Service Calibration for FIR camera (if vehicle is equipped)

The Augmented Reality feature shall be able to perform service calibration to the FIR Camera.

	The Augmented Reality feature shall be able to perform service calibration to the FIR Camera.
--	-----------------------------------------------------------------------------------------------

End of Requirement



5.4.3.1 Cloud Connectivity Data Analytics Requirements

####R_F_Augmented Reality_00115#### AR data analytics to turn feature On/Off though physical interface

When the driver turns the AR feature On/Off on the physical HMI the AR feature shall provide the data analytics of this action through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the driver turn On/Off the feature using the physical interface?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00116#### AR data analytics to turn feature On/Off though voice command interface

When the driver turns the AR feature On/Off using the voice command HMI the AR feature shall provide the data analytics of this action through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the driver turn On/Off the feature using the voice command interface?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00117#### AR data analytics to turn feature mode Enable/Disable though physical interface

When the driver turns the AR feature mode Enable/Disable on the physical HMI the AR feature shall provide the data analytics of this action through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the driver turn Enable/Disable the feature mode using the physical interface?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00118#### AR data analytics to turn feature mode Enable/Disable though voice command interface

When the driver turns the AR feature mode Enable/Disable using the voice command HMI the AR feature shall provide the data analytics of this action through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the driver turn Enable/Disable the feature mode using the voice command interface?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement



####R_F_Augmented Reality_00119#### AR data analytics to turn Low Lane Visibility On/Off though push button on steering wheel

When the driver turns the AR Lane Low Visibility On/Off using the push button HMI on the steering wheel the AR feature shall provide the data analytics of this action through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the driver turn AR Lane Low Visibility On/Off using the push button on the steering wheel?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00120#### AR data analytics to turn Low Lane Visibility On/Off though voice command interface

When the driver turns the AR Lane Low Visibility On/Off using the voice command HMI the AR feature shall provide the data analytics of this action through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the driver turn AR Lane Low Visibility On/Off using the voice command interface?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00121#### AR data analytics to turn Low Lane Visibility On/Off though contextually triggered menu

When the driver turns the AR Lane Low Visibility On/Off using the contextually triggered menu on the dashboard HMI the AR feature shall provide the data analytics of this action through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the driver turn AR Lane Low Visibility On/Off responding to the contextually triggered option offered on the cluster?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00122#### AR data analytics for output to HHDD when triggered by Navigation system

When the driver has the AR feature On using the Navigation system the AR feature shall provide the data analytics of the maneuver prompts and record the number of AR feature outputs to the HHDD through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the AR feature responded to the commands/prompts from the Navigation System?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00123#### AR data analytics for output to HHDD when triggered by Lane Biasing

When the driver has the AR feature On using the ADAS system the AR feature shall provide the data analytics of the Lane Biasing prompts and record the number of AR feature outputs to the HHDD through the connected vehicle services to have data analysis throughout the following timelines:



Feature Document Augmented Reality (AR)

- How often does the AR feature was On while the vehicle system had prompts from the ADAS system for Lane Biasing?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00124#### AR data analytics for output to HHDD when triggered by Highway Assist

When the driver has the AR feature On using the ADAS system the AR feature shall provide the data analytics of the Highway Assist prompts and record the number of AR feature outputs to the HHDD through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the AR feature was On while the vehicle system had prompts from the ADAS system for Highway Assist?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00125#### AR data analytics for output to HHDD when triggered by Blind Spot

When the driver has the AR feature On using the Blind Spot system (BLIS) the AR feature shall provide the data analytics of the Blind Spot with Left/Right turn signal prompts and record the number of AR feature outputs to the HHDD through the connected vehicle services to have data analysis throughout the following timelines:

- How often does the AR feature triggered the Amber Carpet with the BLIS symbol on the HHDD while the vehicle system had prompts from the ADAS system for Blind Spot Detection with an actual object on the line the driver intended to turn/change to when actuating the turn signal indicator?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

####R_F_Augmented Reality_00126#### AR Off through physical HMI option and AR stays On failure mode

When the driver selects to turn the AR feature Off through the physical HMI option the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature stays On.

End of Requirement

####R_F_Augmented Reality_00127#### AR On through physical HMI option and AR stays Off failure mode

When the driver selects to turn the AR feature On through the physical HMI option the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature stays Off.

End of Requirement

####R_F_Augmented Reality_00128#### AR On/Off through physical HMI option and no visual feedback failure mode

When the driver selects to turn the AR feature On/Off through the physical HMI option the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature feedback to the driver stays in the same state without clear indication of the change.



Feature Document Augmented Reality (AR)

End of Requirement

###R_F_Augmented Reality_00129### AR Turn by Turn failure mode

When the driver selects to turn the AR feature On with a Destination or route set in the Navigation System the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to present to the driver the correct Turn-by-Turn directions to follow on the AR HMI according to the prompts provided by the Navigation System per the following timelines:

- How often does the AR feature was On with a Destination or route set in the Navigation System that provided prompts to the AR feature for Turn-By-Turn while the AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00130### AR Street Name failure mode [TBD- for MVP currently not available from Google]

When the driver selects to turn the AR feature On with a Destination or route set in the Navigation System the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to present to the driver the correct Street Names on the AR HMI according to the prompts provided by the Navigation System per the following timelines:

- How often does the AR feature was On with a Destination or route set in the Navigation System that provided prompts to the AR feature to display Street Name while the AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00131### AR House Number failure mode - [TBD- for MVP currently not available from Google]

When the driver selects to turn the AR feature On with a Destination or route set in the Navigation System the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to present to the driver the correct House Number on the AR HMI according to the prompts provided by the Navigation System per the following timelines:

- How often does the AR feature was On with a Destination or route set in the Navigation System that provided prompts to the AR feature to display House Number while the AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00132### AR House Numbers voice command failure mode - [TBD- for MVP currently not available from Google]

When the driver speaks the voice command to show house numbers (i.e. "Show me House Numbers") the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to present to the driver the correct House Numbers near the vehicle vicinity on the AR HMI per the following timelines:

- How often does the driver spoke the voice command to show house numbers and AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement



Feature Document Augmented Reality (AR)

###R_F_Augmented Reality_00133### AR Destination failure mode

When the driver selects to turn the AR feature On with a Destination or route set in the Navigation System the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to present to the driver the correct directions with augmented reality symbols/icons to follow to reach to his/her destination on the AR HMI according to the prompts provided by the Navigation System per the following timelines:

- How often does the AR feature was On with a Destination or route set in the Navigation System that provided prompts to the AR feature to display the correct directions with augmented reality symbols/icons to follow to reach to his/her destination while the AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00134### AR Point of Interest failure mode - [TBD- for MVP currently not available from Google]

When the driver selects a Point Of Interest (POI) through the physical or spoken HMI option the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to present to the driver the correct directions with augmented reality symbols/icons to follow to reach/show the POI on the AR HMI according to the prompts provided by the Navigation System per the following timelines:

- How often does the AR feature was On with a POI in the Navigation System that provided prompts to the AR feature to display the correct directions with augmented reality symbols/icons to follow to reach to his/her POI while the AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00135### AR Blind Spot failure mode

When the driver selects to turn the AR feature On and activates the turn signal indicator to turn towards a line where an object is in the vehicle blind spot, the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to show the augmented reality Amber carpet with an overlay blind spot icon on the AR HMI to warn the driver of the presence of the object that persist until the BLIS command finishes per the following timelines:

- How often does the ADAS BLIS signal activated with an actual object on the side the driver was trying to turn/change line to with the driver activating the turn signal indicator to turn towards and AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00136### AR Lane Low Visibility failure mode

When the driver selects to turn the AR feature for Lane Low Visibility through the physical or spoken HMI option the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to show the driver the correct road lines to follow on the AR HMI per the following timelines:

- How often does the driver activated the driver activated the AR feature for Lane Low Visibility through the physical or spoken HMI option and AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement



Feature Document Augmented Reality (AR)

###R_F_Augmented Reality_00137### AR Lane Level Navigation failure mode

When the driver selects to turn the AR feature On and the Navigation system in combination with the ADAS system provides prompts for a Lane Level Navigation the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to present to the driver the correct augmented reality arrow to follow to show to the driver the correct road line the vehicle should be going into per the following timelines:

- How often does the Navigation and ADAS system triggered the Lane Level Navigation for the vehicle to move to the correct lane to continue with its trip and AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00138### AR Lane Biasing failure mode

When the driver selects to turn the AR feature On with the ADAS system turned On in a blue zone, the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to show the Lane Biasing metaphor on the AR HMI when the ADAS system triggers any lane biasing command of the vehicle within the same road lines due to an oncoming object from behind the vehicle that persist until the ADAS command finishes per the following timelines:

- How often does the ADAS system triggered the Lane Biasing for the vehicle to bias toward one side within the same road lines and AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00139### AR Highway Assist failure mode

When the driver selects to turn the AR feature On with the ADAS system turned On, the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to show the Highway Assist metaphor on the AR HMI when the ADAS system triggers any Highway Assist command of the vehicle that persist until the ADAS command finishes per the following timelines:

- How often does the ADAS system triggered the Highway Assist for the vehicle to be driven Hands Off the wheel within a Blue Zone or requested the driver to take control of the vehicle wheel and AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00140### AR Assisted Lane Change failure mode

When the driver selects to turn the AR feature On with the ADAS system turned On, the Augmented Reality feature shall provide the necessary diagnostics for data analytics if the AR feature fails to show the Assisted Lane Change requested metaphor on the AR HMI when the ADAS system triggers any Assisted Lane Change command of the vehicle that persist until the ADAS command finishes per the following timelines:

- How often does the ADAS system triggered the Assisted Lane Change for the vehicle to perform an overpass of another vehicle in front of it with the acknowledgement of the driver with the turn signal indicator and the AR feature output to the HMI stayed without change?
- How many times per drive cycle, hours in operation, per week, month, year, etc.?

End of Requirement

###R_F_Augmented Reality_00144### Data Analytics Table



Feature Document Augmented Reality (AR)

Data Gathering/Brainstorm/Analysis Worksheet

Purpose: To gather information and Data elements for feature development in support of Data Analytics in order to understand the value and opportunities gained. In addition, this will also help prioritize the opportunities to focus on which will be investigated in more detail in the "Data Elements for FIS" worksheet.

Data Element (Variable)	Data Element Description	Purpose	Value / Opportunity	Current Data Type (If known)	Current Data Source (If known)	Priority
Data Elements for Customer Outputs						
AR Feature Status	AR Feature on/off status	<ul style="list-style-type: none"> - If many customers use this feature often, then we can make the feature standard on luxury vehicles, which increases customer satisfaction. - If customers always go into this mode, then we can make the menu selection easier to get to, or we could have as default to off, as part of reductive design - to turn the feature off before stopping the use of the Augmented Reality feature for Navigation and situational awareness, for reductive design 	<ul style="list-style-type: none"> - reductive design - customer satisfaction 	CAN signal (ARFetSta_B_Stat)	APIM, ARM	Low
AR Button Pressed	To tell if the customer is pressing the AR feature on/off button	<ul style="list-style-type: none"> - See how long the average button press is, to improve customer satisfaction and reduce warranty claims, we can tune the debounce time of the button press to the mean/median button press - Used as input to debounce button press, turn feature from on to off and viceversa 	<ul style="list-style-type: none"> - customer satisfaction - warranty 	CAN signal (ARFetSta_B_Stat)	APIM, ARM	Low
AR Voice Command	To tell if the customer is talking the voice command to turn the AR feature on/off	<ul style="list-style-type: none"> - See how long the average talking response is, to improve customer satisfaction and reduce warranty claims, we can tune the response time of the spoken command to the mean/median response time - Used as input to react to the spoken voice command, turn feature from on to off and viceversa 	<ul style="list-style-type: none"> - customer satisfaction - warranty 	CAN signal (ARFetSta_B_Stat)	APIM, ARM	Low
AR Feature Mode	AR feature Enable/Disable of automatic camera selection	<ul style="list-style-type: none"> - If many customers use Enable to keep AR-Camera always On, then we can make this the default mode, which increases customer satisfaction. - If customers always go into this mode, then we can make the menu selection easier to get to, or we could have as default to Enable (always AR-Camera), as part of reductive design 	<ul style="list-style-type: none"> - reductive design - customer satisfaction 	CAN signal (ARVidMod_B_Stat)	APIM, ARM	Low



Feature Document Augmented Reality (AR)

		- to turn the feature to Enable before starting the use of the Augmented Reality feature for Navigation and situational awareness, for reductive design				
AR Mode Button Pressed	To tell if the customer is pressing the AR mode Enable/Disable button for automatic camera selection	- See how long the average button press is, to improve customer satisfaction and reduce warranty claims, we can tune the debounce time of the button press to the mean/median button press - Used as input to debounce button press, turn feature from on to off and viceversa	- customer satisfaction - warranty	CAN signal (ARVidMod_B_Stat)	APIM, ARM	Low
AR mode Voice Command	To tell if the customer is talking the voice command to turn the AR mode Enable/Disable command for automatic camera selection	- See how long the average talking response is, to improve customer satisfaction and reduce warranty claims, we can tune the response time of the spoken command to the mean/median response time - Used as input to react to the spoken voice command, turn feature mode from Enable to Disable and viceversa	- customer satisfaction - warranty	CAN signal (ARVidMod_B_Stat)	APIM, ARM	Low
Guide - Turn by Turn	To tell if the AR feature function turn-by-turn is activated by the Navigation system prompts	- See if the AR display is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	Low
Guide - Street Name	To tell if the AR feature function Street Name is activated by the Navigation system prompts	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	Low
Overlay House Number	To tell if the AR feature function House Number is activated by the Navigation system prompts	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	Low
Overlay Destination	To tell if the AR feature function Destination is activated by the Navigation system prompts	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	Low
Overlay Point of Interest (POI)	To tell if the AR feature function POI is activated by the Navigation system prompts	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we	- customer satisfaction - warranty	CAN signal (TBD)	ARM	Low



Feature Document Augmented Reality (AR)

		can verify the correct operation of the AR feature				
Overlay Blind Spot (BLIS)	To tell if the AR feature function BLIS is activated by the ADAS system prompts and turn signals	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM, DAT, SCCM	Low
Overlay Lane Low Visibility– MVP+	To tell if the AR feature function Lane Low Visibility is activated by the AR system menu buttons	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (ARLanLowVis_B_Stat)	APIM, ARM, DAT, SCCM	Low
Overlay Lane Low Visibility– MVP+	To tell if the AR feature function Lane Low Visibility is activated through the Steering Wheel acceptance of Contextual Virtual Option on HHDD	- See if the AR feature is prompted by the contextually option for Virtual selection, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (ARLanLowVis_B_Stat)	APIM, ARM, DAT, SCCM	Low
Overlay Lane Low Visibility– MVP+	To tell if the customer is talking the voice command to turn the AR feature function Lane Low Visibility On	- See how long the average talking response is, to improve customer satisfaction and reduce warranty claims, we can tune the response time of the spoken command to the mean/median response time	- customer satisfaction - warranty	CAN signal (ARLanLowVis_B_Stat)	APIM, ARM, DAT	Low
Overlay Lane Level Navigation – MVP+	To tell if the AR feature function Lane Level Navigation is activated by the Navigation and ADAS system prompts	- See if the AR feature is activated with the prompts from ADAS and Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	APIM, ARM, DAT	Low
Overlay Lane Biasing – MVP+	To tell if the AR feature function Lane Biasing is activated by the ADAS system prompts	- See if the AR feature is activated with the prompts from ADAS System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM, DAT	Low
Overlay Highway Assist – MVP+	To tell if the AR feature function Highway Assist is activated by the ADAS system prompts	- See if the AR feature is activated with the prompts from ADAS System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM, DAT	Low



Feature Document Augmented Reality (AR)

Data Elements for Customer Inputs						
AR Menu Active	AR menu Activate/Deactivate signal	- See how often the customer goes into the AR menu, if very often, then make the menu easier to use, i.e. higher level, less button presses, etc. as part of the reductive design to improve customer satisfaction	- reductive design - customer satisfaction	CAN signal (ARFetSta_B_Rq)	APIM, ARM	High
AR Voice Command to Activate/Deactivate	AR voice command Activate/Deactivate signal	- See how often the customer uses the AR voice command menu, if not often, then we can consider the removal of it as part of the reductive design	- reductive design - material cost	CAN signal (ARFetSta_B_Rq)	APIM, ARM	High
AR Mode Menu Enable/Disable	AR menu Enable/Disable automatic camera selection signal	- See how often the customer goes into the AR menu, if very often, then make the menu easier to use, i.e. higher level, less button presses, etc. as part of the reductive design to improve customer satisfaction	- reductive design - customer satisfaction	CAN signal (ARVidMod_B_Rq)	APIM, ARM	High
AR Voice Command to Enable/Disable	AR menu Enable/Disable automatic camera selection signal	- See how often the customer uses the AR voice command menu, if not often, then we can consider the removal of it as part of the reductive design	- reductive design - material cost	CAN signal (ARVidMod_B_Rq)	APIM, ARM	High
AR Low Lane Visibility push button	Activate AR road lanes visibility by push button on steering wheel	- See how often the customer uses the AR push button on steering wheel, if not often, then we can consider the removal of it as part of the reductive design	- reductive design - material cost	CAN signal (ARLanLowVis_B_Rq)	APIM, ARM, ADAS	High
AR Low Lane Visibility voice command	Activate AR road lanes visibility by voice command, i.e. "help me see"	- See how often the customer uses the AR voice command menu, if not often, then we can consider the removal of it as part of the reductive design	- reductive design - material cost	CAN signal (ARLanLowVis_B_Rq)	APIM, ARM, ADAS	High
AR Low Lane Visibility contextually triggered	Activate AR road lanes visibility by contextually triggered menu help on dashboard according to weather conditions or wiper high speed	- See how often the customer uses the AR contextually triggered menu, if not often, then we can consider the removal of it as part of the reductive design	- reductive design - material cost	CAN signal (ARLanLowVis_B_Rq)	APIM, ARM, ADAS	High
Data Elements for Customer Level Failure Modes						
AR feature Off through push button	Unintended function - Feature is activated when setting = OFF	- Detect the failure mode of the feature being active when the setting is OFF	- Reduce Warranty	CAN signal (ARFetSta_B_Rq; ARFetSta_B_Stat)	APIM, ARM	High
AR feature On through	No function. Feature is deactivated	- Detect the failure mode of the feature being deactivated when the setting is ON	- Reduce Warranty	CAN signal (ARFetSta_B_Rq)	APIM, ARM	High



Feature Document Augmented Reality (AR)

push button	when setting = ON			ARFetSta_B_Stat)		
AR feature On/Off through push button no visual feedback	Partial function. No visual feedback (greyed out or missing)	- Detect the failure mode of the feature selection screen not providing status feedback to the customer	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	High
AR feature On through push button visual feedback shows Off	Partial function. Visual feedback shows OFF when feature is ON.	- Detect the failure mode of the feature providing incorrect status feedback to the customer as OFF when the feature is ON	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature Off through push button visual feedback shows On	Partial function. Visual feedback shows ON when feature is OFF.	- Detect the failure mode of the feature providing incorrect status feedback to the customer as ON when the feature is OFF	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature defaults to On	Unintended function. Feature defaults to OFF.	- Detect the failure mode of the feature setting as OFF by default	- Reduce Warranty	CAN signal (ARFetSta_B_Rq; ARFetSta_B_Stat)	APIM, ARM	Low
AR feature "i" button for information	Partial function. Information is not displayed when "i" is selected	- Detect the failure mode of the feature not showing the feature information to the driver when it is selected	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature On/Off through push button not responding	Partial function. Unable to reverse feature settings	- Detect the failure mode of the feature not being able to change its current status	- Reduce Warranty	CAN signal (ARFetSta_B_Rq; ARFetSta_B_Stat)	APIM, ARM	Low
AR feature Off through voice command	Unintended function - Feature is activated when voice command detected (turn the AR feature OFF)	- Detect the failure mode of the feature being active when the voice command setting is OFF	- Reduce Warranty	CAN signal (ARFetSta_B_Rq; ARFetSta_B_Stat)	APIM, ARM	Low
AR feature On through voice command	No Function. Feature is deactivated when voice command detected (turn	- Detect the failure mode of the feature being deactivated when the voice command setting is ON	- Reduce Warranty	CAN signal (ARFetSta_B_Rq; ARFetSta_B_Stat)	APIM, ARM	Low



Feature Document Augmented Reality (AR)

	the AR feature ON)					
AR feature On/Off through voice command no visual feedback	Partial function. No visual feedback (greyed out or missing)	- Detect the failure mode of the feature selection screen not providing status feedback to the customer after the voice command	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature On through voice command visual feedback shows Off	Partial function. Visual feedback shows OFF when feature is ON.	- Detect the failure mode of the feature providing incorrect status feedback to the customer as OFF when the feature is ON when using the voice command	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature Off through voice command visual feedback shows On	Partial function. Visual feedback shows ON when feature is OFF.	- Detect the failure mode of the feature providing incorrect status feedback to the customer as ON when the feature is OFF when using the voice command	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature mode Disable through push button	Unintended function - Feature mode is Enable when setting = Disable	- Detect the failure mode of the feature mode being Enable when the setting is Disable	- Reduce Warranty	CAN signal (ARVidMod_B_Rq; ARVidMod_B_Stat)	APIM, ARM	Low
AR feature mode Enable through push button	No function. Feature mode is Disable when setting = Enable	- Detect the failure mode of the feature mode being Disable when the setting is Enable	- Reduce Warranty	CAN signal (ARVidMod_B_Rq; ARVidMod_B_Stat)	APIM, ARM	Low
AR feature mode Enable/Disable through push button no visual feedback	Partial function. No visual feedback (greyed out or missing)	- Detect the failure mode of the feature mode selection screen not providing status feedback to the customer	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature mode Enable through push button	Partial function. Visual feedback shows Disable when feature mode is Enable.	- Detect the failure mode of the feature mode providing incorrect status feedback to the customer as Disable when the feature mode is Enable	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low



Feature Document Augmented Reality (AR)

visual feedback shows Disable						
AR feature mode Disable through push button visual feedback shown Enable	Partial function. Visual feedback shows Enable when feature mode is Disable.	- Detect the failure mode of the feature mode providing incorrect status feedback to the customer as Enable when the feature mode is Disable	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature mode default to Enable	Unintended function. Feature defaults to Disable.	- Detect the failure mode of the feature mode setting as Disable by default	- Reduce Warranty	CAN signal (ARVidMod_B_Rq; ARVidMod_B_Stat)	APIM, ARM	Low
AR feature mode "i" button for information	Partial function. Information is not displayed when "i" is selected	- Detect the failure mode of the feature not showing the feature mode information to the driver when it is selected	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature mode Enable/Disable through push button not responding	Partial function. Unable to reverse feature settings	- Detect the failure mode of the feature mode not being able to change its current status	- Reduce Warranty	CAN signal (ARFetSta_B_Rq; ARFetSta_B_Stat)	APIM, ARM	Low
AR feature mode Disable through voice command	Unintended function - Feature mode is Enable when setting = Disable	- Detect the failure mode of the feature mode being Enable when the voice command setting is Disable	- Reduce Warranty	CAN signal (ARVidMod_B_Rq; ARVidMod_B_Stat)	APIM, ARM	Low
AR feature mode Enable through voice command	No function. Feature mode is Disable when setting = Enable	- Detect the failure mode of the feature mode being Disable when the voice command setting is Enable	- Reduce Warranty	CAN signal (ARVidMod_B_Rq; ARVidMod_B_Stat)	APIM, ARM	Low
AR feature mode Enable/Disable through voice command no visual feedback	Partial function. No visual feedback (greyed out or missing)	- Detect the failure mode of the feature mode selection screen not providing status feedback to the customer after the voice command	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low



Feature Document Augmented Reality (AR)

AR feature mode Enable through voice command visual feedback shows Disable	Partial function. Visual feedback shows Disable when feature mode is Enable.	- Detect the failure mode of the feature mode providing incorrect status feedback to the customer as Disable when the feature mode is Enable when using the voice command	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
AR feature mode Disable through voice command visual feedback shows Enable	Partial function. Visual feedback shows Enable when feature mode is Disable.	- Detect the failure mode of the feature mode providing incorrect status feedback to the customer as Enable when the feature mode is Disable when using the voice command	- Reduce Warranty	CAN signal (TBD)	APIM, ARM	Low
Guide - Turn by Turn not responding	To tell if the AR feature function turn-by-turn is activated by the Navigation system prompts	- See if the AR display is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	High
Guide - Street Name not responding	To tell if the AR feature function Street Name is activated by the Navigation system prompts	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	High
Overlay House Number not responding	To tell if the AR feature function House Number is activated by the Navigation system prompts	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	High
Overlay Destination not responding	To tell if the AR feature function Destination is activated by the Navigation system prompts	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	High
Overlay Point of Interest (POI) not responding	To tell if the AR feature function POI is activated by the Navigation system and driver prompts	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM	High



Feature Document Augmented Reality (AR)

Overlay Blind Spot (BLIS) not responding	To tell if the AR feature function BLIS is activated by the ADAS system prompts and turn signals	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM, DAT, SCCM	High
Overlay Lane Low Visibility– not responding	To tell if the AR feature function Lane Low Visibility is activated by the AR system menu buttons	- See if the AR feature is activated with the prompts from Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (ARLanLowVis_B_Stat)	APIM, ARM, DAT, SCCM	High
Overlay Lane Low Visibility– not responding	To tell if the AR feature function Lane Low Visibility is activated through the Steering Wheel acceptance of Contextual Virtual Option on HHDD	- See if the AR feature is prompted by the contextually option for Virtual selection, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (ARLanLowVis_B_Stat)	APIM, ARM, DAT, SCCM	High
Overlay Lane Low Visibility– not responding	To tell if the customer is talking the voice command to turn the AR feature function Lane Low Visibility On	- See how long the average talking response is, to improve customer satisfaction and reduce warranty claims, we can tune the response time of the spoken command to the mean/median response time	- customer satisfaction - warranty	CAN signal (ARLanLowVis_B_Stat)	APIM, ARM, DAT	High
Overlay Lane Level Navigation – not responding	To tell if the AR feature function Lane Level Navigation is activated by the Navigation and ADAS system prompts	- See if the AR feature is activated with the prompts from ADAS and Navigation System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	APIM, ARM, DAT	High
Overlay Lane Biasing – not responding	To tell if the AR feature function Lane Biasing is activated by the ADAS system prompts	- See if the AR feature is activated with the prompts from ADAS System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM, DAT	High
Overlay Highway Assist – not responding	To tell if the AR feature function Highway Assist is activated by the ADAS system prompts	- See if the AR feature is activated with the prompts from ADAS System, to improve customer satisfaction and reduce warranty claims, we can verify the correct operation of the AR feature	- customer satisfaction - warranty	CAN signal (TBD)	ARM, DAT	High

End of Requirement



5.4.4 After Sales Requirements

None

5.4.5 Process requirements

None



6 FUNCTIONAL SAFETY

6.1 System Behaviors for HARA

System Behaviours of Augmented Reality

ID	Name	Description
System Behavior 1	Disable Augmented Reality applicable information to the driver on HHDD	Display the forward looking camera image on the AR display, to provide a background to overlay the AR data onto screen
System Behavior 2	Display Augmented Cruise (AC) information to the driver on HHDD	Display information from the navigation system on the AR display, as an overlay onto the base camera image, in the relevant part of the base image: <ul style="list-style-type: none">- Turn-by-Turn direction arrows- Address numbers- Street names- Point-of-Interest information- Destination Beacon/pointer
System Behavior 3	Display Augmented Guide (AG) information to the driver on HHDD	Display information from the Active drive assist system on the AR display, as an overlay onto the base camera image, in the relevant part of the base image: <ul style="list-style-type: none">- Lane Biasing - MVP+- Highway Assist - TBD if part of MVP+- Assisted Lane Change - TBD if part of MVP+
System Behavior 4	Display Augmented Lanes (AL) information to the driver on HHDD	Display information from the DAT/Navigation system on the AR display, as an overlay onto the base camera image, in the relevant part of the base image: <ul style="list-style-type: none">- Blind Spot Information System Notification – MVP- Lane guide (Lane Level Guidance), navigation - MVP+- Lane low visibility - MVP+
System Behavior 5:	Display Augmented Visibility (AV) information to the driver on HHDD	Display the forward-looking FIR camera image on the AR display, to provide a background at night to overlay the AR data onto <ul style="list-style-type: none">- Night vision- FIR camera will use as background to AR camera when display at night, enhance image quality

Table 15: System Behaviors for HARA



6.2 Safety Assumptions

None.

ID	Assumption	
A1.x	Name	
	Description	
	Purpose	
	Category	
	Related Requirements IDs	
A2.x	Name	
	Description	
	Purpose	
	Category	
	Related Requirements IDs	
A3.x	Name	
	Description	
	Purpose	
	Category	
	Related Requirements IDs	
A4.x	Name	
	Description	
	Purpose	
	Category	
	Related Requirements IDs	
A5.x	Name	
	Description	
	Purpose	
	Category	
	Related Requirements IDs	

Table 16: Functional Safety Assumptions

6.3 Safety Goals

Not applicable for Augmented Reality feature. Feature is QM per HARA document.

6.4 Functional Safety Requirements

Not applicable for Augmented Reality feature. Feature is QM per HARA document.

6.4.1 <Goal 1 Name>

Not applicable for Augmented Reality feature. Feature is QM per HARA document.

6.4.2 <Goal n Name>

Not applicable for Augmented Reality feature. Feature is QM per HARA document.



6.4.3 Derivation of Functional Safety Requirements on Assumptions

Not applicable for Augmented Reality feature. Feature is QM per HARA document.

6.4.4 ASIL Decomposition of Functional Safety Requirements

Not applicable for Augmented Reality feature. Feature is QM per HARA document.



7 CYBERSECURITY

7.1 Security Goals

ID	Goal	
1	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Data Repudiation by AR ECU
	Description	AR ECU may not have sufficient logging for forensic purposes after an incident occurs. May not have appropriate DTCs.
	CAL	
	Related CSR IDs	Mitigation Implemented - Planning diagnostics for lost comm and invalid data. Covered in functional requirements, NETCOM has lost comm, may need to add additional ones.
2	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Information Disclosure on ECU
	Description	CAN data may be disclosed including vehicle dynamics. XYZ of eye gaze.
	CAL	
	Related CSR IDs	Mitigation Implemented - Not storing or recording any driver behavior, messages already broadcast on CAN, normal NETCOM requirements. On die Hardware Security Module (HSM) may be included depending on spoofing above. Display adjustment.
3	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - CAN bus interruption
	Description	An external agent interrupts data flowing across a bus to AR ECU or floods the bus, not able to provide correct rendering of information.
	CAL	
	Related CSR IDs	Mitigation Implemented - Normal NETCOM requirements, lost comm DTC.
4	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - ECU elevation of privilege
	Description	Attacker may be able to change application, configuration, or calibration. Stop AR functionality or display wrong data.
	CAL	
	Related CSR IDs	Mitigation Implemented - Firmware updates following Ford standard requirements, supplier to perform TARA and rest of cyber eSOW when selected. If supplier has HSM, secure boot may help.
5	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Spoofing CAN ECU
	Description	TCU may be spoofed by an attacker and this may lead to unauthorized access to AR ECU to provide GNSS data. Used to calculate vehicle position. Attacker with physical access to CAN sends improper messages, causing unauthorized behavior.
	CAL	
	Related CSR IDs	Mitigation Implemented - GNSS data is often inaccurate, uses default assumptions and GNSS to calculate. will ignore if it decides it is wrong. TCU currently using CAN, plan to move to SOA GNSS platform when available, China TCU is different, may have different controls.
6	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Lack of Input Validation for AR ECU
	Description	GNSS data from TCU to AR ECU may be tampered with by an attacker. Data or command tampering impact is ____
	CAL	
	Related CSR IDs	Mitigation Implemented
7	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Information Disclosure on ECU
	Description	GNSS data disclosed on vehicle bus.



Feature Document Augmented Reality (AR)

	CAL	
	Related CSR IDs	Mitigation Implemented - Existing signal, see above, mTLS in future.
8	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - ECU elevation of privilege
	Description	Attacker may be able to change application, configuration, or calibration. What is the worst potential impact?
	CAL	
	Related CSR IDs	Mitigation Implemented - Will have supplier TARA, cover there.
9	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Lack of Input Validation for AR HUD
	Description	LVDS from AR ECU to AR HUD may be tampered with by an attacker. Data or command tampering impact is garbled or incorrect image.
	CAL	
	Related CSR IDs	Mitigation Implemented - Delivered on an FPD3 link with an I2C back channel. same questions for supplier as for camera. AR HUD is responsible for adjusting brightness, has its own light and rain sensor inputs over CAN.
10	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Data Repudiation by AR HUD
	Description	AR HUD may not have sufficient logging for forensic purposes after an incident occurs. Data integrity failure.
	CAL	
	Related CSR IDs	Mitigation Implemented - If this is primary display, may need lost comm strategy, same as for AR ECU and DAT. Part of functional spec.
11	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Process Crash or Stop for AR HUD
	Description	AR HUD crashes, halts, stops or runs slowly; in all cases violating an availability metric.
	CAL	
	Related CSR IDs	Mitigation Implemented - Covered in functional spec.
12	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Spoofing CAN ECU
	Description	AR ECU may be spoofed by an attacker and this may lead to unauthorized access to Phoenix or above for LVDS. Attacker with physical access to hardwired coax data cable sends improper video stream.
	CAL	
	Related CSR IDs	Mitigation Implemented - Hardwired physical connection. Attacker would need to set up data stream and connect a new device, as soon as connection is broken would not have image.
13	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Lack of Input Validation for SYNC 4.2 or above
	Description	LVDS from AR ECU to Phoenix may be tampered with by an attacker. Data or command tampering impact is wrong video displayed, wire cut.
	CAL	
	Related CSR IDs	Mitigation Implemented - A requirement is in place to determine if there is a stuck image, this requirement will be cascaded to the Phoenix controller via the feature owner.
14	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Spoofing the AR-CAM Process
	Description	AR-CAM, other thermal cam may be spoofed by an attacker and this may lead to unauthorized video signal delivered to AR ECU for LVDS or other video or I2C connection from AR-CAM to AR ECU.
	CAL	
	Related CSR IDs	Mitigation Implemented - Physical attack if this is hardwired coax connection, how camera malfunctions or other data are communicated to AR-ECU, I2C, may require additional micro on AR-CAM if it needs to be responsible for diagnostics, Debbie to investigate how it happens. Authentication not technically possible over I2C. Diagnostics to set a DTC if



Feature Document Augmented Reality (AR)

		communication is broken. AR ECU will set stuck images and gambled images.
15	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Lack of Input Validation for AR ECU
	Description	LVDS or other video from AR-CAM or other thermal cam to AR ECU may be tampered with by an attacker. AR functionality will be incorrect, corrupt, or missing.
	CAL	
	Related CSR IDs	Mitigation Implemented - A requirement is in place to determine if camera has been swapped or if there is a stuck image
16	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Data Repudiation by AR ECU
	Description	AR ECU may not have sufficient logging for forensic purposes after a failure occurs. DTC not present when required.
	CAL	
	Related CSR IDs	Mitigation Implemented - Need DTC for calibration failure, end of line test, any failures reported by camera, covered in issue 2.
17	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - CAN bus interruption
	Description	An external agent interrupts data flowing across a bus to AR ECU or cuts the wire.
	CAL	
	Related CSR IDs	Mitigation Implemented - Monitors on power, see DTCs in 2 above.
18	Goal Name	Prevent compromise of a single vehicle or vehicle system from propagating to other vehicles or fleets - Spoofing AR ECU
	Description	AR ECU may be spoofed by an attacker and this may lead to unauthorized access to AR-CAM over LVDS or other video.
	CAL	
	Related CSR IDs	Mitigation Implemented - AR ECU sends i2c commands to camera, hardwired connection. Consider follow up with Cheri Hansen on Sensing System Architecture Platform for future camera services. Hardwired controls sufficient for current vehicle program but consider for long term strategy. Diagnostics to set a DTC if communication is broken. AR ECU will set stuck images and gambled images
19	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Lack of Input Validation for AR ECU
	Description	Display control, Map, nav data from SYNC 4.2 or above to AR ECU may be tampered with by an attacker. Data or command tampering impact is
	CAL	
	Related CSR IDs	Mitigation Implemented - See above, mTLS.
20	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Spoofing CAN ECU
	Description	Phoenix may be spoofed by an attacker and this may lead to unauthorized access to AR ECU for Display control, Map, nav data. GNSS antenna may come through SYNC for older modules, if so, that data will go over CAN.
	CAL	
	Related CSR IDs	Mitigation Implemented - If GNSS, covered under GNSS data same as TCU. Phoenix ethernet authenticates using SOA, mTLS. Can signals rated are C5. If the controller does not get any response Phoenix should enter DTC
21	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Information Disclosure on ECU
	Description	Map, nav data disclosed, route, POI, street name from SYNC to AR ECU
	CAL	
	Related CSR IDs	Mitigation Implemented - mTLS over ethernet. Nav data may be stored, either get all maneuvers or send each maneuver and then display. Will



Feature Document Augmented Reality (AR)

		delete every time, have functional spec for delete command, not retain after arrived to destination. Does not store for long time and keeps refreshing.
22	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - CAN bus interruption
	Description	If no nav data cannot display directions.
	CAL	
	Related CSR IDs	Mitigation Implemented - Nav team has 2D map already whenever the signals are present then the AR navigation pops up.
23	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - ECU elevation of privilege
	Description	Attacker may be able to change application, configuration, or calibration. This would stop AR functionality or display wrong data.
	CAL	
	Related CSR IDs	Mitigation Implemented - JTAG port is locked, Software signing is integrated as part of the requirement
24	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Spoofing AR ECU
	Description	AR ECU may be spoofed by an attacker and this may lead to unauthorized access to Phoenix domain controller over Map, nav data. Attacker with physical access to CAN sends improper messages, causing unauthorized behavior.
	CAL	
	Related CSR IDs	Mitigation Implemented - AR signal ratings completed, C5, CMA not required, also have Ethernet which has SOA authentication.
25	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Spoofing the TCU Process
	Description	Cloud POI data may be spoofed by an attacker and this may lead to incorrect POI information displayed on AR ECU.
	CAL	
	Related CSR IDs	Mitigation Implemented - Points of Interest will be displayed to customer, pushed from the cloud, open item, no use cases yet defined. Very high level use cases defined from SYNC. If using standard FTCP and SYNC encryption, via Ford cloud, do not need additional investigation, if going to third party cloud or WIR IP Passthrough, cover under a new threat model.
26	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Spoofing CAN ECU
	Description	DAT 2.X may be spoofed by an attacker and this may lead to unauthorized access to AR ECU for Position, object, lane over ethernet. Attacker with physical access to CAN sends improper messages, either no function or wrong information provided.
	CAL	
	Related CSR IDs	Mitigation Implemented - DAT 2.X authenticates using SOA mTLS cert.
27	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Lack of Input Validation for AR ECU
	Description	Position, object, lane over ethernet from DAT 2.X to AR ECU may be tampered with by an attacker. Data or command tampering impact is wrong or no AR display.
	CAL	
	Related CSR IDs	Mitigation Implemented - Ethernet, mTLS Encryption in transit.
28	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Potential Data Repudiation by AR ECU
	Description	AR ECU may not have sufficient logging for forensic purposes after an incident occurs. Data integrity failure.
	CAL	
	Related CSR IDs	Mitigation Implemented - Yes requirements for Lost comm and invalid data is captured through the diag requirements DiagFaultCovAndDTCNmbrsDesignConsid_00.06.15.601-003



Feature Document Augmented Reality (AR)

		ECUs would set U-Codes - loss of communications DTCs against all the ECUs that they are expecting messages from but are unable to transmit due to loss of arbitration.
29	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - Information Disclosure on ECU
	Description	Position, object, lane data disclosed.
	CAL	
	Related CSR IDs	Mitigation Implemented - Encrypted in transit.
30	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - CAN bus interruption
	Description	An external agent interrupts data flowing across a bus to AR ECU or floods the bus, will not show anything related to DAT.
	CAL	
	Related CSR IDs	Mitigation Implemented - Need to define lost comms strategy from DAT. Within certain amount of time if the DAT is not broadcasting the message then the feature will not be displayed, CAN Message arbitration is used to prioritize CAN messages. Higher priority messages will be sent within 1 frame length even under 100% bus utilization. Message filtering on receiving ECUs will ignore unwanted message IDs
31	Goal Name	Prevent unauthorized remote access and control of the vehicle and vehicle systems - ECU elevation of privilege
	Description	Attacker may be able to change application, configuration, or calibration. What is the worst potential impact?
	CAL	
	Related CSR IDs	Mitigation Implemented

Table 17: Cybersecurity Goals

7.2 Cybersecurity Requirements

###R_F_Augmented Reality_00141### Camera Swapped

AR Feature shall be able to detect any augmented reality camera swap.

End of Requirement

###R_F_Augmented Reality_00142### Stuck Image

AR Feature shall be able to detect any stuck image coming from the feed of any of the augmented reality cameras.

End of Requirement

###R_F_Augmented Reality_00143### Unauthorized Remote Access

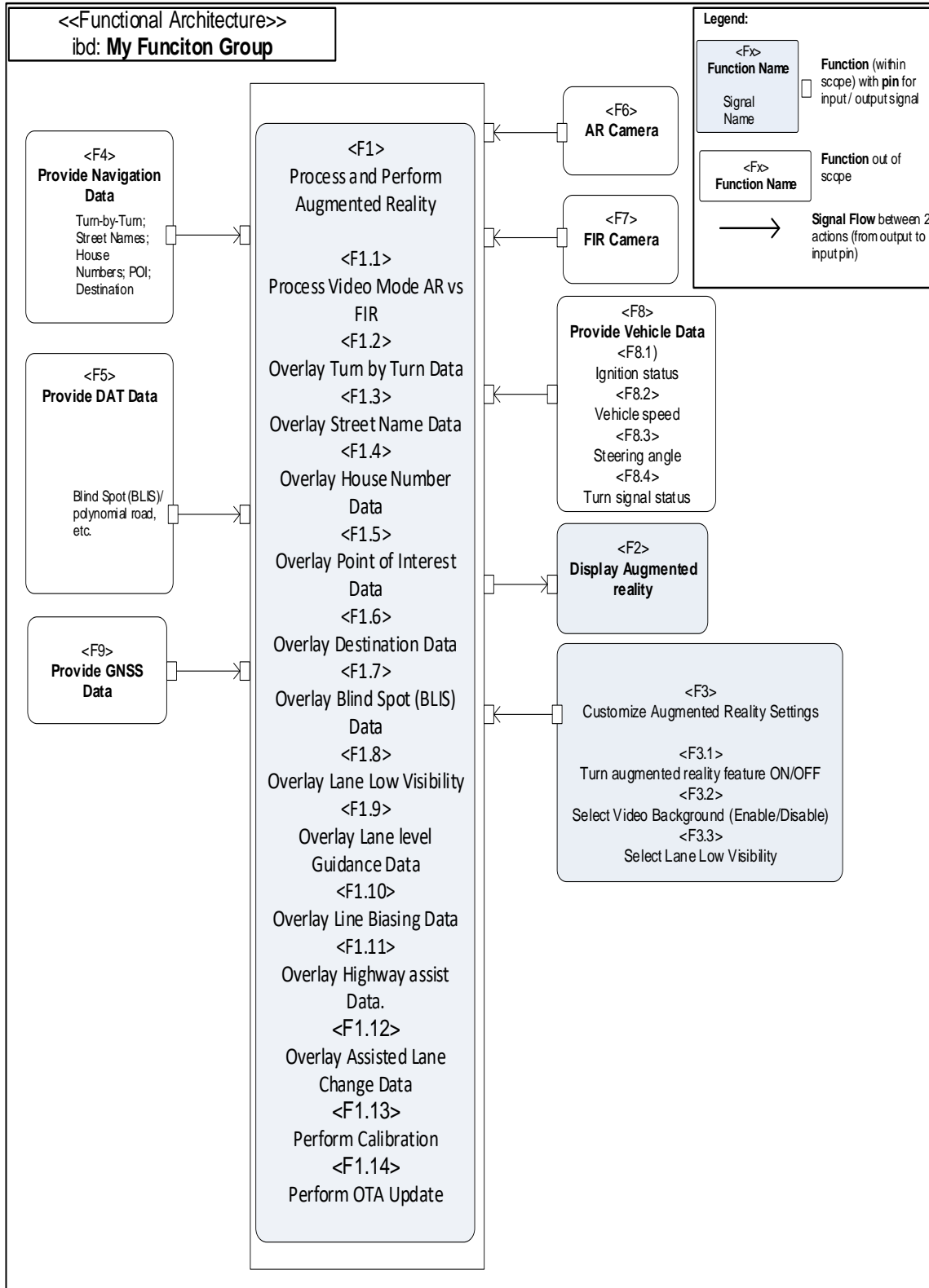
AR Feature shall be able to detect any unauthorized remote access to the augmented reality system to report it for cybersecurity concerns.

End of Requirement



8 ARCHITECTURE

8.1 Functional Architecture





Feature Document Augmented Reality (AR)

Figure 4: Functional Boundary Diagram

8.1.1 Logical Functions

Function ID	Function Name	Function Description	ASIL
F1	Process and Perform Augmented Reality	Process the received data and Perform the AR overlay functions required by the feature.	QM
F1.1	Process Video Mode	Process video mode AR camera vs FIR camera	QM
F1.2	Overlay Turn by Turn Data	Turn by turn Data received from NAV will be overlaid on the video feed from the cameras.	QM
F1.3	Overlay Street Name Data	Street names Data received from NAV will be overlaid on the video feed from the cameras.	QM
F1.4	Overlay House Number Data	House numbers Data received from NAV will be overlaid on the video feed from the cameras.	QM
F1.5	Overlay Point of Interest (POI) Data	POIs Data received will be overlaid on the video feed from the cameras.	QM
F1.6	Overlay Destination Data	Destination icons Data received from NAV will be overlaid on the video feed from the cameras.	QM
F1.7	Overlay Blind Spot Data	BLIS warning will be rendered spatially correct to the neighboring lane.	QM
F1.8	Overlay Lane Low Visibility	Lane Low Visibility Data received will be overlaid on the video feed from the cameras.	QM
F1.9	Overlay Lane level Guidance Data	Lane level Guidance Data received will be overlaid on the video feed from the cameras.	QM
F1.10	Overlay Line Biasing Data.	Line Biasing Data received will be overlaid on the video feed from the cameras.	QM
F1.11	Overlay Highway assist Data.	Highway assist Data received will be overlaid on the video feed from the cameras.	QM
F1.12	Overlay Assisted Lane Change	Assisted Lane Change Data received will be overlaid on the video feed from the cameras.	QM
F1.13	Perform Calibration	Perform calibration for AR/FIR cameras.	QM
F1.14	Perform OTA Update	Receive and perform OTA updates.	QM
F2	Display Augmented Reality	Display the AR video to the HHDD display (TBT, POI, Street Name, House Number, Destination, and Blind Spot)	QM
F3	Customize AR Settings	Provide the user the ability to customize the feature.	QM
F3.1	Select AR Feature	Turn AR feature (ON/OFF)	QM
F3.2	Select Video background	Select video background (Enable/Disable)	QM
F3.3	Select Lane Low Visibility	Turn Lane Low Visibility feature (ON/OFF)	QM
F4	Provide Navigation Data	Provide the required data from NAV to support the overlay functions.	QM
F5	Provide DAT Data	Provide the required data from DAT to support the overlay functions.	QM
F6	Provide AR Camera Data	Provide the video feed from AR camera.	QM
F7	Provide FIR Camera Data	Provide the video feed from FIR camera.	QM
F8	Provide Vehicle Data	Provide the required vehicle data from different ECUs.	QM
F8.1	Ignition Status	Get ignition status from	QM
F8.2	Vehicle Speed Status	Get vehicle speed status	QM
F8.3	Steering Angle Status	Get steering angle status	QM
F8.4	Turn Signal Status	Get turn light signal status	QM
F9	Provide GNSS Data	Get GNSS data	QM

Table 18: List of Functions

8.2 Logical Architecture

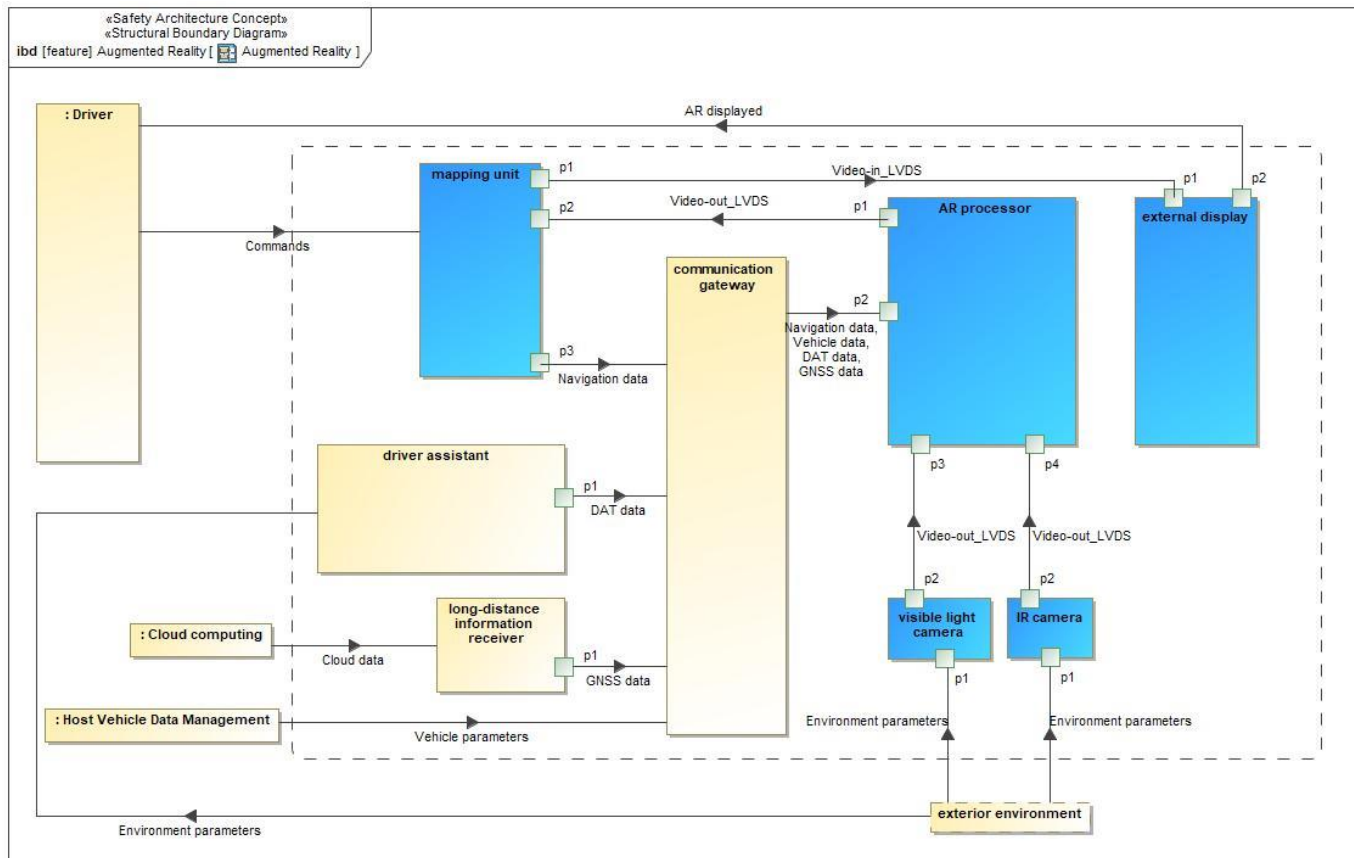


Figure 5: Logical Boundary Diagram

8.2.1 Logical Elements

Element Name	Description	Allocated Functions	Comments
A1 AR processor	The ECU module dedicated to the AR feature.	<ul style="list-style-type: none"> F1.1 Process and Perform Augmented Reality 	
A2 External display	A horizontal display HHDD.	<ul style="list-style-type: none"> F1.2 Display Augmented Reality 	
A3 Visible camera	The type of camera that sense the visible spectrum.	<ul style="list-style-type: none"> F1.6 Provide AR Camera Data 	
A4 FIR camera	A type of camera that uses the IR spectrum.	<ul style="list-style-type: none"> F1.7 Provide FIR Camera Data 	
A6 Communication gateway			
A7 Long-distance information receiver	ECU that deals with telematics	<ul style="list-style-type: none"> F1.8 Provide GNSS data 	
A8 Mapping unit	ECU that deals with navigation data.	<ul style="list-style-type: none"> F1.4 Provide Navigation Data 	
A9 Driver assistant	The ECU that deals with the Advance Driving Assistance Technologies.	<ul style="list-style-type: none"> F1.5 Provide DAT Data 	
Cloud computing	Servers that are accessed over the Internet, and the software and		



Feature Document Augmented Reality (AR)

	databases that run on those servers. It also includes telematics.		
Driver	The customer interfaces with the AR-System over the displays (AR-HUD or AR-SCREEN) in the vehicle where navigation guidance, Points-of-Interests, driver assistant information and other information is provided. The customer shall be able to personalize the AR functionality, as well as activate/deactivate the visualization. Details will be provided through the UX specifications.		
Host Vehicle Data Management	The vehicle electronic components that are outside the feature boundary but will provide signals to the feature.		
Physical environment			

Table 19: Logical Elements

8.2.2 Logical Interfaces

Interface	Direction	Description	Value Range
AR displayed	p2 To Driver		
Cloud data	Cloud computing To A7 Long-distance information receiver	Input source for TCU GNSS	
Commands	Driver To A8 Mapping unit	Commands can be sent through HMI Phoenix Domain Controller, customer can select feature On/OFF and customize settings for example. Voice commands are other type of commands the feature will be able to process.	
Vehicle parameters	Host Vehicle Data Management To A6 Communication gateway	Data from modules like BCM, ABS, SCCM, etc.	

Table 20: Logical Interfaces



9 OPEN CONCERNS

ID	Concern Description	e-Tracker / Reference	Responsible	Status	Solution
1	2.2.1 Regions & Markets other than North America are TBD			Open	
2	###UC_F_Augmented Reality_00012### Highway Assist / Active Drive Assist system [TBD-This is part of MVP+ along with lane biasing]			Open	
3	###UC_F_Augmented Reality_00013### Assisted Lane Change / Active Drive Assist system [TBD- This is part of MVP+ along with lane biasing]			Open	
4	###R_F_Augmented Reality_00080### Environmental objects geometry without Blending using AR night vision camera as background <ul style="list-style-type: none"> mapped/highlighted in color (TBD) 			Open	
5	###R_F_Augmented Reality_00106### FIR Camera Fault Message – If Vehicle is equipped with FIR Camera <ul style="list-style-type: none"> FIR Camera fault text message (TBD) on the HMI display 			Open	
6	###R_F_Augmented Reality_00107### AR Camera Fault Message – If Vehicle is equipped with FIR Camera <ul style="list-style-type: none"> AR Camera fault text message (TBD) on the HMI display 			Open	
7	###R_F_Augmented Reality_00108### AR Camera Fault Message – If Vehicle is NOT equipped with FIR Camera <ul style="list-style-type: none"> AR Camera fault text message with feature Not available text (TBD) on the HMI display 			Open	
8	###R_F_Augmented Reality_00110### AR vs FIR Camera packaging <ul style="list-style-type: none"> packaged within (TBD) 			Open	
9	###R_F_Augmented Reality_00111### AR Camera Packaging <ul style="list-style-type: none"> ... packaged within a (TBD) distance and within a (TBD) FOV to the DAT camera 			Open	
10	###R_F_Augmented Reality_00144### Data Analytics Table <ul style="list-style-type: none"> Can signals TBD 			Open	
11	6.1 System Behaviors for HARA <ul style="list-style-type: none"> System Behavior 3 <ul style="list-style-type: none"> Highway Assist - TBD if part of MVP+ Assisted Lane Change - TBD if part of MVP+ 			Open	
12	Guide- Use Cases / Navigation Signals/Voice Commands, still depends on Google confirmation			Open	



Feature Document
Augmented Reality (AR)

Table 21: Open Concerns



Feature Document Augmented Reality (AR)

10 REVISION HISTORY

Revision	Date	Description	Approved by	Responsible
1.0	10-7-20	Initial Release / <PSC>		mabdelh1
2.0	4-21-21	<p>The following changes were performed:</p> <ul style="list-style-type: none"> Updated Stakeholder list 1.3.1 1.4.2 Document Structure updated to reflect the correct section names Included additional abbreviations to 1.7.2 Updated 1.7.3 Parameters / Values Updated 2.1 Purpose and Description of Feature Updated Boundary Diagram in 2.2 Updated 2.5 Assumptions Updated 3.1 Feature Context Diagram to add Manufacturing Updated 3.2 List of Influences to add Manufacturing 4.1 Operation Modes and States, Figure 2: Feature Operation Modes and States updated by swapping T9 and T10 Updated all descriptions for Use Cases on 4.2.3 and included: <ul style="list-style-type: none"> Added Logical Boundary Diagram on 8.2 Logical Architecture Added 8.2.2 Logical interfaces Included information on section 9 Open Concerns 		mabdelh1
2.1	7-08-21	<p>The following section were updated on the document:</p> <ul style="list-style-type: none"> 1.3.1 Stakeholder List 1.7.2 Abbreviations 2.1 Feature Overview 2.2 Feature Variants – AR Feature Boundary Diagram 2.2.1 Regions & Markets 4.2.3 Use Case Descriptions: #3, #4, #5, #6, #7, #8, #9, #10, #12, #13, and #15 4.3 Driving and Operation Scenarios 5.1 Functional Requirements: <ul style="list-style-type: none"> Deleted/replaced requirement- #1, #56, #61, #145 Modified requirement: #2, #4, #7, #9, #11, #13, #15, #17, #18, #19, #21, #22, #23, #24, #26, #27, #28, #30, #31, #32, #33, #34, #36, #37, #38, #39, #40, #41, #42, #43, #44, #45, #46, #47, #48, #51, #52, #53, #55, , #57, #58, #59, #62, #63, #64, #65, #66, #67, #68, #69, #70, #71, #72, #73, #74, #75, #92, #94, #98, #99, #101, #105, #110, #111, #125, #130, #131, #132, #134, #135 New: #144, , #146, #147, #148, #149, #150, #151, #152 9 Open Concerns 10 Revision History 		mabdelh1



11 APPENDIX

11.1 Definitions

Definition	Description
AR-ECU	Augmented Reality Electronic Control Unit
AR-HHDD	Augmented Reality High Head-Down Display
AR-System	Augmented Reality System
DAT2.2	Ford ADAS ECU Version 2.2
FTTI	Fault Tolerance Time Interval
Phoenix	Ford Communication and Infotainment System – Domain Controller

Table 22: Definitions used in this document

11.2 Abbreviations

Abbr.	Stands for
ADAS	Advanced Driver Assistant System
AR	Augmented Reality feature
DAT	Driver Assistance Technologies Module
ECG	Enhanced Central Gateway
GNSS	Global Navigation Satellite System
HMI	Human-Machine Interface
OTA	Over-The-Air
TCU	Telematics Control Unit

Table 23: Abbreviations used in this document



Document ends here.