국제표준 추진 사례 - 자율주행

ISO TC204 WG14 자율차/ADAS 시스템 중심

2019. 8. 28
서울 자율차 R&D 연계 표준화 초청 워크샵

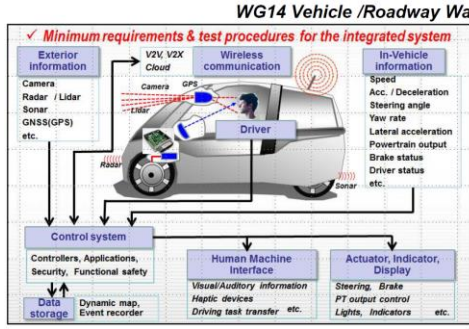
KATECH

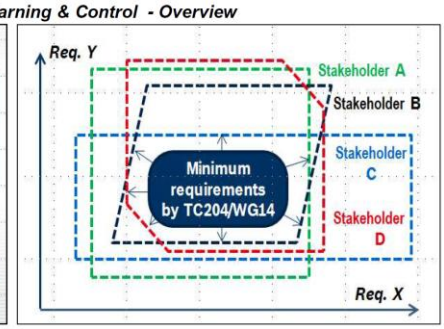
ISO TC204 WG14

Vision:

- ✓ Standardization of general system aspects of ADAS*1 and ADS*2 will increasingly be more important for the spread of sophisticated vehicle technologies. (*1 Advanced Driver Assistance Systems) (*2 Automated Driving System)
- ✓ WG14 should play the major roles in developing these international standards in conjunction with relevant WGs and SDOs.

WG14 Vehicle /Roadway Warning & Control - Overview





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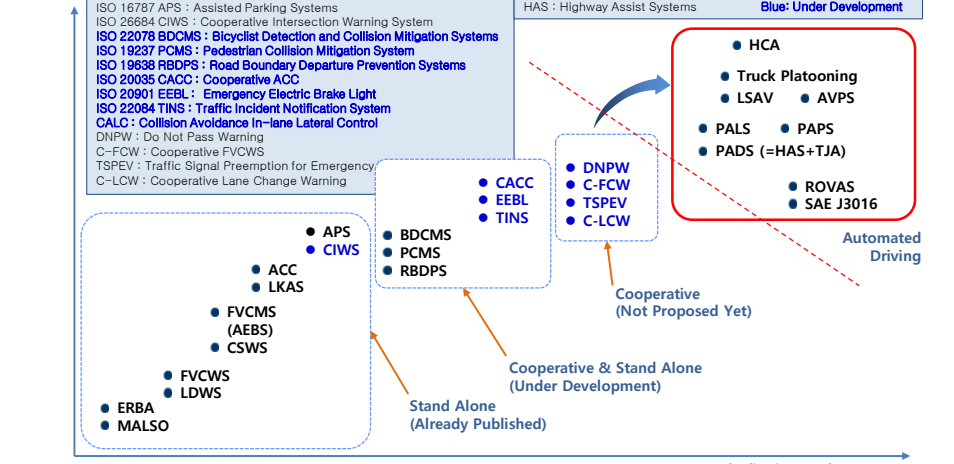
ADAS/AV Systems Standardization

ISO 22840 ERBA : Extended Range Backing Assist
ISO 17386 MALSO : Maneuvering Aid for Low Speed Operation
ISO 22839 FVCWS : Forward Vehicle Collision Warning System
ISO 17361 LDWS : Lane Departure Warning Systems
ISO 15623 FVCMS : Forward Vehicle Collision Mitigation System
ISO 11067 CSWS : Curve Speed Warning Systems
ISO 15622 ACC : Adaptive Cruise Control
ISO 11270 LKAS : Lane Keeping Assist Systems
ISO 16787 APS : Assisted Parking Systems
ISO 26684 CIWS : Cooperative Intersection Warning System
ISO 22078 BDCMS : Bicyclist Detection and Collision Mitigation Systems
ISO 19237 PCMS : Pedestrian Collision Mitigation System
ISO 19638 RBDPS : Road Boundary Departure Prevention Systems
ISO 20035 CACC : Cooperative ACC
ISO 20901 EEBL : Emergency Electric Brake Light
ISO 22084 TINS : Traffic Incident Notification System
CALC : Collision Avoidance In-lane Lateral Control
DNPW : Do Not Pass Warning
C-FCW : Cooperative FVCWS
TSPEV : Traffic Signal Preemption for Emergency
C-LCW : Cooperative Lane Change Warning

ISO 21202 PALS : Partially Automated Lane Change Systems
ISO 20900 PAPS : Partially Automated Parking Systems
ISO 21717 PADS : Partially Automated In-Lane Driving Systems
ISO 22737 LSAD : Low Speed Automated Driving Systems
ISO 23374 AVPS : Automated Valet Parking Systems
HCA : Highway Chauffeur Systems
AVFB : Automated Vehicle Fallback Systems
TJA : Traffic Jam Assist
HAS : Highway Assist Systems
Blue: Under Development



Reference : KATECH

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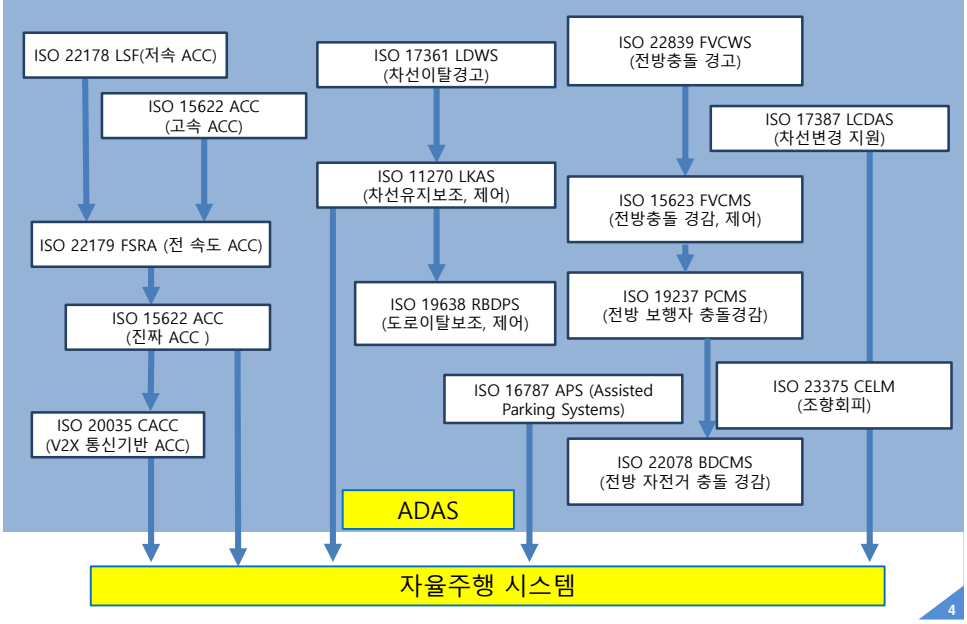
ADAS System Standards



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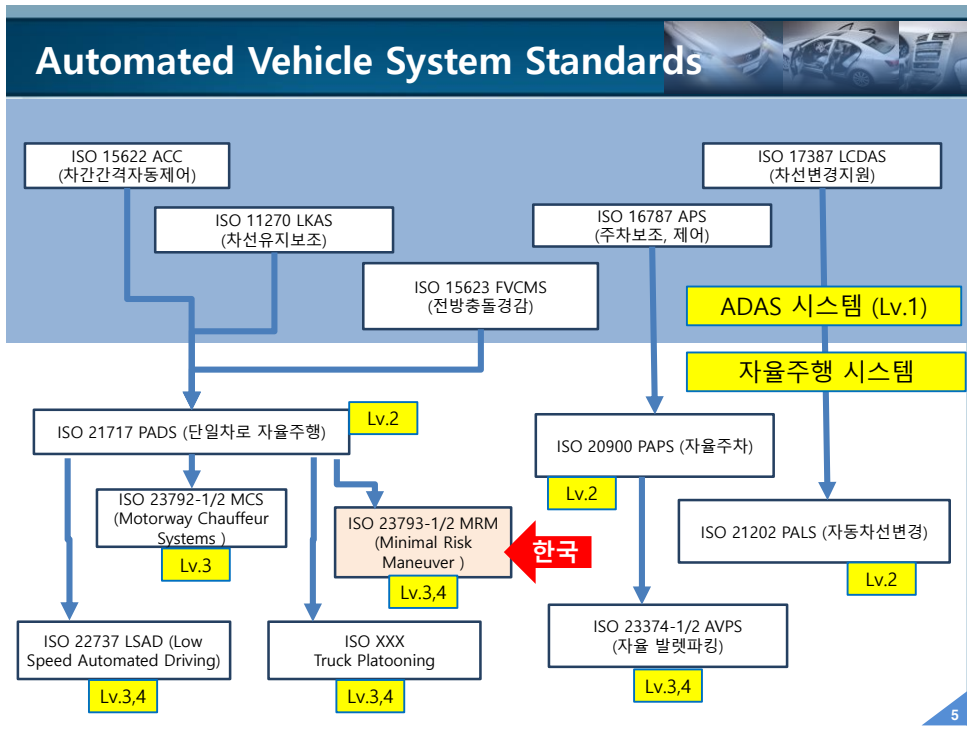
Automated Vehicle System Standards
ISO 15622 ACC
(차간간격자동제어)
ISO 11270 LKAS
(차선유지보조)
ISO 15623 FVCMS
(전방충돌경감)
ISO 17387 LCDAS
(차선변경지원)
ISO 16787 APS
(주차보조, 제어)
ADAS 시스템 (Lv.1)
자율주행 시스템
ISO 21717 PADS (단일차로 자율주행)
Lv.2
ISO 23792-1/2 MCS
(Motorway Chauffeur Systems)
Lv.3
ISO 23793-1/2 MRM
(Minimal Risk Maneuver)
Lv.3,4
한국
ISO 22737 LSAD (Low Speed Automated Driving)
Lv.3,4
ISO XXX
Truck Platooning
Lv.3,4
ISO 20900 PAPS (자율주차)
Lv.2
ISO 21202 PALS (자동차선변경)
Lv.2
ISO 23374-1/2 AVPS
(자율 발렛파킹)
Lv.3,4
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ISO TC204 WG14 – Overview; 2019.4월. Florida
2. WG14 Status – Membership 3
Number of registered committee members on the ISO Live Link
(as of Mar. 1, 2019, underline: change since Oct. 2018)
North America 9: Canada 3, USA 6
Europe 40: Belgium 2, Czech Republic 1, France 11, Germany 10, Hungary 1, Italy 2, Netherlands 2, Spain 1 , Sweden 3, Switzerland 1, UK 6,
Africa 1: South Africa 1
Asia Pacific 31: Australia 2, China 1, India 2, Iran 1, Japan 18, Korea 5, Malaysia 2
Total 81 experts from 21 Countries (85 experts at #50 WG14)
Liaison representative: 4 (SAE; 3, ISO/IEC JTC1; 1)
Document monitor: 9 (AFNOR, ASI, BSI, JISC, NEN, NSAI, SIS)
Convener/ Secretary Support Team: 5 (ANSI 1, JISC 3, Convener)
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ISO TC204 WG14 – Overview; 2019.4월. Florida

1. #51 WG14 Meeting Objectives

1. Refine and facilitate current work items *9 topics need to be discussed*

- ✓ **CD 21202** Partially Automated Lane Change Systems (**PALS**)
- ✓ **CD 22078** Bicyclist Detection & Collision Mitigation Systems (**BDCMS**)
- ✓ **AWI 22737** Low-Speed Automated Driving Systems for Limited ODD (**LSAD**)
- ✓ **NP 23375** Collision Evasive Lateral Maneuver Systems (**CELM**)
- ✓ **NP 23376** V2V Intersection Collision Risk Warning Systems (VVICW)
- ✓ **PWI 23374** Automated Valet Parking Systems (**AVPS**)
- ✓ **PWI 23792** Motorway Chauffeur Systems (**MCS**)
- ✓ **PWI 23793** Fallback Functions for Automated Driving Systems
- ✓ **ISO/SAE NP PAS 22736** Taxonomy and Definitions for Terms related to DAS

2. Propose new work items / Discuss WG14 future plan

- ✓ Substantiate /Prioritize potential work items
- ✓ Discuss WG14 actions in relations to other standard development groups

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ISO TC204 WG14 – Overview; 2019.4월. Florida

3. Development since #50 WG14 (Budapest)

WG14 workshops, expert meetings

Nov. 14-15 PWI 23374 AVPS
The 2nd workshop @ Tokyo

Dec. 5-6 NP 22737 LSAD
The 2nd workshop @ Otawa

Feb. 6-8 PWI 23374 AVPS
The 3rd workshop @ Munich, Ingolstadt


Photo. by Author

Feb. 26-28 Joint expert meeting @ Seoul

NP 22737 LSAD,
PWI 23792 MCS ,
PWI 23793 Fallback fucntions

Coordinated by experts and JSAE. Thank you for the time and efforts to facilitate standard development

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ISO TC204 WG14 – Overview; 2019.4월. Florida

3. Development since #50 WG14 (Budapest)

WP1. - WP29 event (Feb. 18)

Jan. 16 : Invitation letter distributed by TC204 secretariat

Jan. 23 : Remote consensus requested ; WG14 actions for WP29

1. Submit a WG14 position report to the UNECE WP1-WP29 event on Feb. 18 by way of the TC204 chair in order to let them be aware of our standardization activities relating to automated driving systems.

2. Coordinate for the next WP29 meeting in the future to make a timeslot for WG14 to present our deliverables and ongoing efforts on automated driving systems.

3. Ask Dr. Shladover to represent WG14 for the future WP29 meetings. This is because not only of the fact that Dr. Shladover has the longest experience and hence the deepest understanding on WG14 activities, but also of the fact that the discussion points in WP29 include the common terminology in the area of automated driving systems, which he is currently leading the development of the joint ISO/SAE document.

No negative comments. Thank you for many encouragements

Jan. 30 : A draft WG14 presentation for WP1-WP29 was sent to TC204 Chair.

Jan. 31 : It was found that the event agenda had already been finalized with no room for ISO presentation.

WG14 will seek for the next chance

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ISO TC204 WG14 - Overview

info. Draft WG14 presentation for WP1-WP29 (excerpt)

ISO /TC204 /WG14 Mission 5

✓ *Promote sophisticated system technologies:*

- *by establishing common understandings of new technologies, introduced / to be introduced, to the market, among the all stakeholders*
- *by establishing internationally consented technical bases that can be referred to by relevant stakeholders*

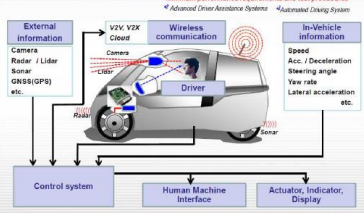
Stakeholders: Customers, Automotive Industry, Regulatory people, Public agencies,*

(* Note : WTO Agreement on Technical Barriers to Trade; Article 2.4)

2.4 Where technical regulations are required and relevant international standards exist or their completion is imminent, Members shall use them, or the relevant parts of them, as a basis for their technical regulations except when such international standards or relevant parts would be an ineffective or inappropriate means for the fulfilment of the legitimate objectives pursued, for instance because of fundamental climatic or geographical factors or fundamental technological problems

*Standardization of integrated system aspects*1 of ADAS*2 and ADS*3*

*1 Minimum performance requirements and test procedures
*2 Advanced Driver Assistance Systems *3 Automated Driving System



ISO /TC204 /WG14 ADAS Standards 9

Collision Warning / Mitigation

ISO 15623	Forward Vehicle Collision Warning Systems	FVCWS
ISO 22839	Forward Vehicle Collision Mitigation Systems	FVCMS
ISO 19237	Pedestrian Detection & Collision Mitigation Systems	PDCMS
CD 22078	Bicyclist Detection & Collision Mitigation Systems	BDCMS
PWI 23375	Collision Evasive Lateral Manoeuvre Systems	CELM

Lane Keeping /Lane Departure Warning etc.

ISO 11270	Lane Keeping Assistance Systems	LKAS

ISO /TC204 /WG14 Automated Driving Systems 11

Taxonomy / Definitions

Joint ISO PAS 22736 / SAE J3016
Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles

Nominated experts from National Standards Body

ISO /TC204 /WG14 Automated Driving Systems 12

Level 2

ISO 21717	Partially Automated In-lane Driving Systems	PADS
DIS 20900	Partially Automated Parking Systems	PAPS
CD 21202	Partially Automated Lane Change Systems	PALS

Level 3

PWI 23792	Motorway Chauffeur Systems	MCS

Level 4

NP 22737	Low Speed Automated Driving Systems for Limited Operational Design Domain	LSAD
PWI23374	Automated Valet Parking Systems	AVPS

Common

PWI 23793	Fallback Functions for Automated Driving Systems	

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MCS

ORIGINAL

Scope of Motorway Chauffer System

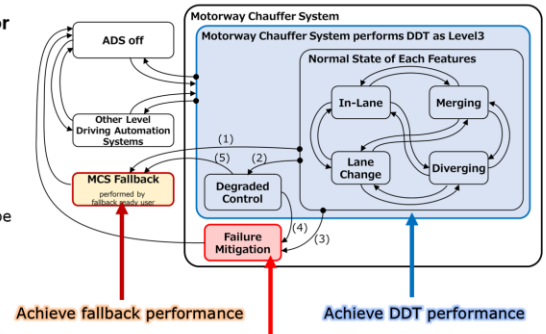
■ Lv3 ADS + additional functions for utilization

As MCS is based on Lv3 ADS, a fallback-ready user is required.
However, for practical use of MCS, we need to consider the case which the fallback-ready user cannot takeover the driving tasks.

Therefore, the scope of MCS-1 needs to be addressed as shown in the figure on the right and the formula below.

MCS = Level3 ADS + α
※α = Failure mitigation

This concept of the scope matches Chapter 8 of J3016.



Achieve fallback performance

Achieve DDT performance

Perform Failure mitigation instead of achieving minimal risk condition

MCS

PROPOPOSAL

Framework for Motorway Chauffer System

Example of relation between features and required functions (General image)

		Tactical Path Selection	Dynamic Driving Task			Request to Intervene		Failure Mitigation	
			OEDR	VMC	Handover	Driver Monitor	System Information	Safe Stop	External Warning
Motorway Chauffer System	In-Lane Driving		✓	✓	✓	✓	✓	✓	
	Lane Change		✓	✓	✓	✓	✓		
	Path Change	✓	✓	✓	✓	✓	✓	✓	✓

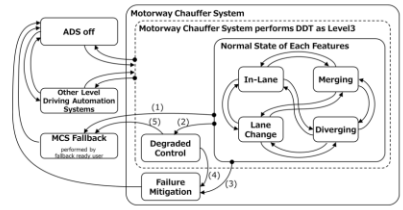
MCS

ORIGINAL

Degraded control & Failure mitigation

■ Degraded control when MCS issues RTI and its concept

When MCS issues RTI, depending on the system state right before the issuance, there are two cases, which are, "DDT performance can be maintained" and "DDT cannot be maintained".
Degraded Control is a mode to maintain the driving state for a certain period of time after RTI is issued with less performance, even when the system cannot maintain DDT performance.



MCS

ORIGINAL

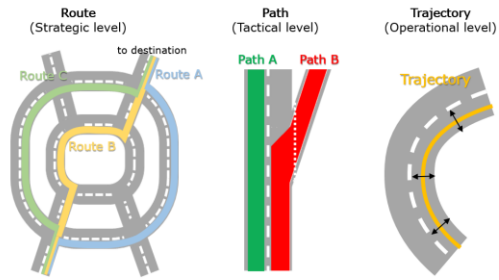
Definition of route, path, and trajectory

Destination for MCS means the final point to reach on the driving route which is planned by the vehicle equipped with MCS.
MCS performs as an automated driving level 3 system from the entrance though the exit of a motorway including junctions.

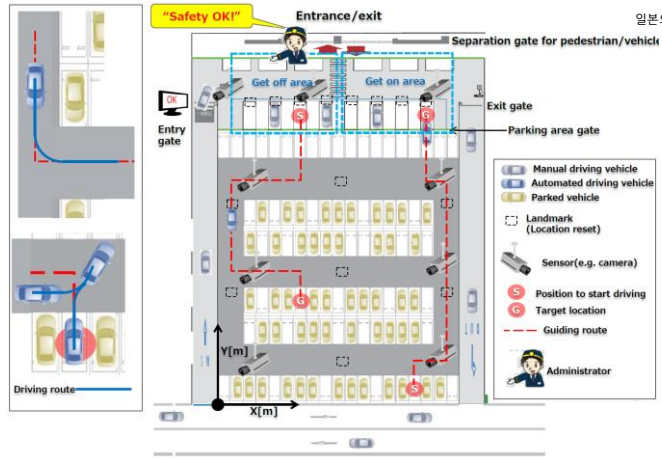
(1) **Trajectory** : It doesn't include destination. Driving line as a control target for VMC

(2) **Path** : Combination of driving lanes for route selection to the destination or lane changing

(3) **Route** : Whole pre-defined driving path leading to the destination



AVPS



일본의 자동 발렛파킹 개념

- **자동발렛파킹(AVPS): 주차장 인프라 중심 시스템과 차량탑재 시스템 중심 시스템으로 분류, 한국도 적극 참여 중임**
- **독일과 일본은 결국 1개의 표준으로 추진하는 방안으로 진행 중임**

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CALC (Collision Avoidance In-lane Lateral Control systems)

■ System Classification of functionality (Type, Class) and test definition

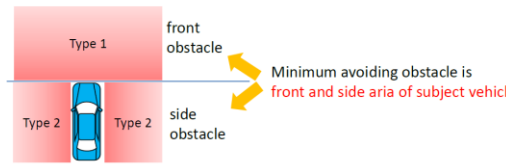
1. Avoiding collision with obstacles
   Minimum functionality
   - Avoiding collision with front obstacle (Type 1)
   - Avoiding collision with side obstacle (Type 2)

2. Operation environment
   Minimum requirements and functionality
   - Public road < XXX km/h (Class 1)
   - Highway > XXX km/h (Class 2)

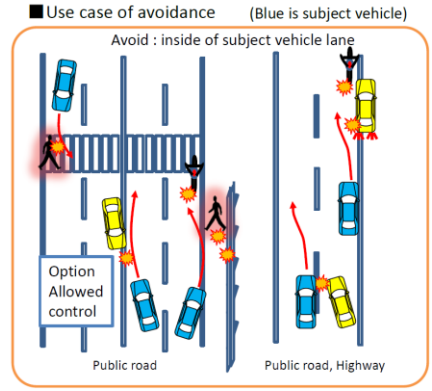
3. Maximum lateral movement for avoidance
   Minimum requirements and operational limits
   - Maximum movement = inside of subject vehicle lane + 0.XX m
     Same for the case when AEB is activated.
   - MAX lateral G < XXX G

4. Test procedure
   - Type and Class combination
     - Avoidance test : 2 type
     - Vehicle driving speed
   - Test subjects for avoidance
     - Obstacles defined by manufacturers
     - More than one from;
       vehicle, motorcycle, bicycle, pedestrian or ot.. obstacles.
   - Pass criteria
     - Under the specified test conditions,
       collision shall be avoided within operational limits.
     - Same minimum requirements apply when other AEB system is activated.

Explain : next page



■ Use case of avoidance (Blue is subject vehicle)



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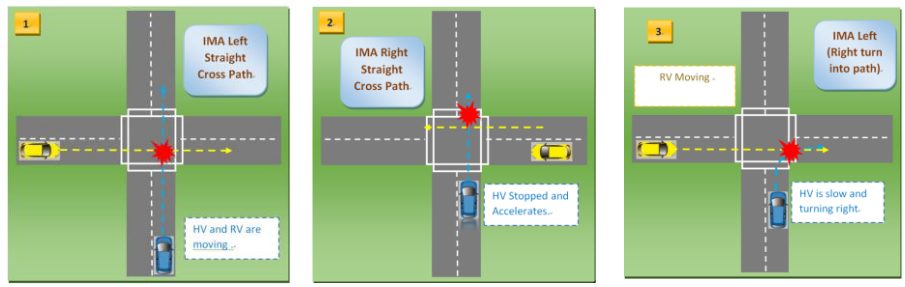
ICW; Intersection Collision Warning Sys.

» IMA (Intersection Movement Assist)

Crash Scenarios \ Safety Applications	EEBL	FCW	BSW/ LCW	IMA	LTA	CLW
Lead Vehicle Stopped		✓				
Control Loss without Prior Vehicle Action						✓
Vehicle(s) Turning at Non-Signalized Junctions				✓	✓	
Straight Crossing Paths at Non-Signalized Junctions				✓		
Lead Vehicle Decelerating	✓	✓				
Vehicle(s) Changing Lanes – Same Direction			✓			
Left Turn Across Path – Opposite Direction					✓	

» IMA Applications



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VVICW; Intersection Collision Warning Sys.

Accelerating V2V and V2I Development & Diverse Specifications

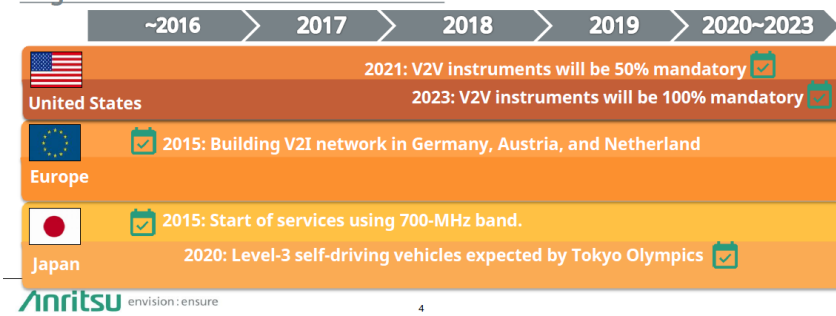
Accelerating V2V and V2I Communications Development

Fundamental research on V2V and V2I communications started in 2010 and the trend towards commercial release is especially active in the US, Europe, and Japan.

- In the US, V2X will be mandatory in 2023.
- In Europe, roadside networks were constructed in 2015 in Germany, Austria and Holland and large-scale field testing is in progress.
- In 2015, services using the 700-MHz band started in Japan where Level-3 self-driving vehicles are expected to be deployed for the 2020 Tokyo Olympics.

In line with these commercial trends, standardization measures are becoming active in the US, Europe, and Japan.

Regional Commercialization Trends



Anritsu envision:ensure

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VVICW; Intersection Collision Warning Sys.

Accelerating V2V and V2I Development & Diverse Specifications

■ Diverse V2V and V2I Communications Specifications (2/2) - Regional Standards

	United States			Europe		Japan
Specific Application	User Data		Non-safety Apps	ETSI TS101 539-1 Safety Apps RHS	Non-safety Apps	ITS Forum RC-013 V2I Message V2V Message
Common Application	IEEE1609.3 -2016 WSA	SAE J2735-2016 BSM, CSR, EVA, ICA, NMEA, PSM, PDM, PVD, RSA, RTCM, TIM, ,SPAT. MAP, SRM, SSM		ETIS EN302-637-3 DEMM ETSI EN302 637-2 CAM		ITS FORUM RC-010 Extended Layer ARIB STD-T109 Layer 7
Transport/ Network	WSM	IEEE1609.2 -2016 Dot 2 Data Electronical Certificated	UDP, TCP, etc.	ETSI EN302 636-5-1 BTP-A BTP-B	TCP/UDP ETSI TS 102 636-6 IPv6 over GN	ARIB STD-T109 IVC-RVC
				ETSI EN302 636-4-1 SHB,GUC,TSB,GBC/GAC, BEACON,LS Request/Reply, Any		
LLC	LLC		IPv6	IEEE802.2 LLC + SNAP		IEEE802.2 LLC + SNAP
MAC	IEEE802.11 MAC (only WAVE Part)			ETSI TS 102 687.724 IEEE802.11 MAC		ARIB STD-T109 ARIB MAC
PHY				ETSI EN 302 663 ITS-G5 PHY IEEE 802.11p PHY		ARIB STD-T109 ARIB PHY
Band	FCC Title 47 Part 95.150x (OBU) FCC Title 47 Part 90.37x (RSU)			ETSI EN 302 571		Japanese Radio Law
	SAE J2945/1(Over MAC Layer)					

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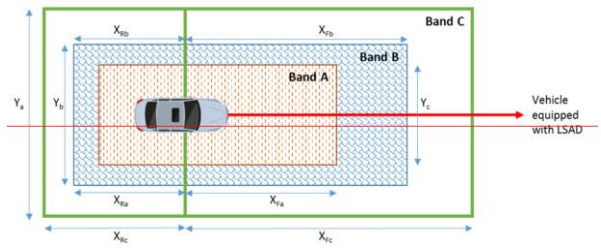
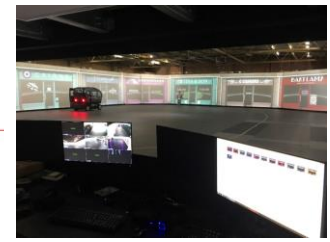
AV System Standards – LSAD (Low Speed Automated Driving Systems)





Operating Center

NAVYA

Easymile

UltraPods

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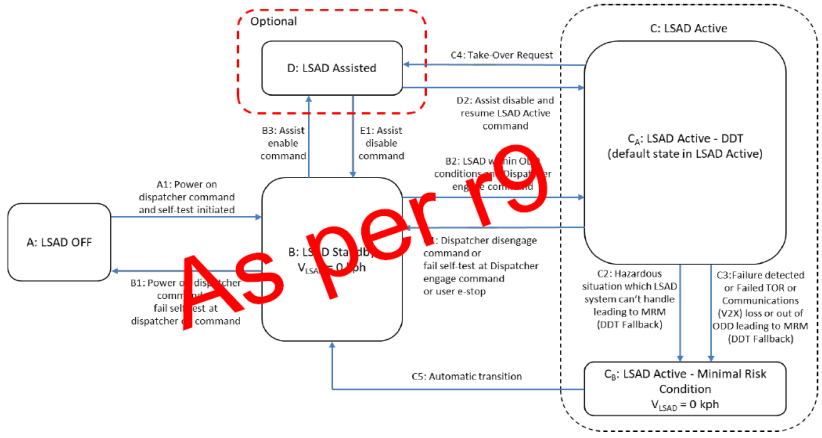
AV System Standards – LSAD (Low Speed Automated Driving Systems)

LSAD State Diagram



As per ISO

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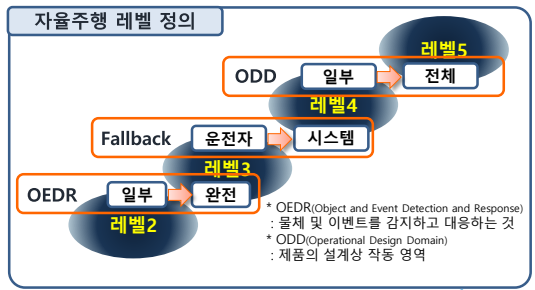
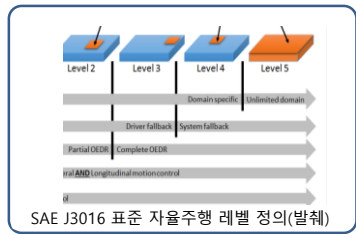
Fall Back과 MRM의 개념

MRM(Minimal Risk Maneuver)
- MRC(Minimal Risk Condition; 보다 안전한 상태)로 가는 거동
- 반드시 Stop으로 종료





SAE J3016 표준 자율주행 레벨 정의(발췌)

안전상태로 이전	본 과제 포함
운전자 운전 요청	일부 포함
주변에 알림	일부 포함
속도 제어	일부 포함
종횡방향 제어	포함 않음
타인이 제어	포함 않음

* 안전상태(Minimal Risk Condition) : 이상상태 보다 안전한 상태

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Fall Back – Failure Case

» Case that require fallback during automated driving

Actors		Fallback Cases	Condition
Driver	Driver not ready to take over	Active driver monitoring	
		Driver task failure	
Vehicle	Actuation Failure	Other Failures	Steering & Speed Control Available
		Steering Failure	Speed Control Available
		Acceleration Means Failure	Steering & Brake Control Available
		Deceleration Means Failure	Steering & Acc. Control Available
		All Actuators Failure	
	ADS Failure	Lane Detection Failure	
		Front Object Detection Failure	
		Rear Object Detection Failure	
		Side Object Detection Failure	
		ADS ECU Failure	ADS all failure, ...
		Connection Failure for Connected ADS	
ODD	Out of ODD	Road Shape	Curve, Narrow, roundabout..
		Road Type	Intersections, Speed Limit..
		Weather	Rain, Fog, Snow..
		Road Surface Condition	Pot hole, bump, Icy, Water..
		Not considered use case	Traffic density, high speed approaching vehicle during right turn, ..

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Fall Back – MRM 종류

» Minimum Risk Conditions or Lower Risk Conditions at fallback

Actors		MRC or LRC	Condition
Driver	Prompt driver	Visual prompt	
		Audible prompt	
		Haptic prompt	
		Speed reduction warning	
Vehicle	Informing to others	Switching hazard lights on	Or it can be mentioned in the Part 1
		Transmitting emergency message to traffic control center	
	Longitudinal	Speed reduction	Part 2
		Cancel driving power	
		Vehicle Standstill	
	Longitudinal-Lateral	In-lane standstill	Part 3
		Keeping lane	
		Lateral maneuvour to outside of road	
		Move to the slower lane	
		Emergency shoulder standstill	
		Keeping latest steering angle	
	Control Authority Transition	Turn off/on ADS	
		Control transition to other passenger	
		Remote Control	

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Fall Back – MRM 표준 구성 방안

- Idea 1 : Three Parts

  ISO 23793-1 Intelligent Transport Systems – Minimal Risk Maneuver for Automated Driving – Part 1 Framework

  ISO 23793-2 Intelligent Transport Systems – Minimal Risk Maneuver for Automated Driving – Part 2 In-lane stop

  ISO 23793-3 Intelligent Transport Systems – Minimal Risk Maneuver for Automated Driving – Part 3 Shoulder stop

- Idea 2 : Two Parts

  ISO 23793-1 Intelligent Transport Systems – Minimal Risk Maneuver for Automated Driving – Part 1 Framework

  ISO 23793-2 Intelligent Transport Systems – Minimal Risk Maneuver for Automated Driving – Part 2 In-lane stop and Shoulder stop

- Idea 3 : Two Parts

  ISO 23793-1 Intelligent Transport Systems – Minimal Risk Maneuver for Automated Driving – Part 1 Framework and long.

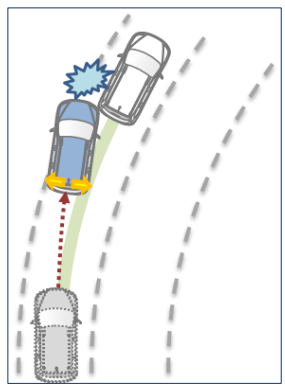
  ISO 23793-2 Intelligent Transport Systems – Minimal Risk Maneuver for Automated Driving – Part 2 with intended lane change

Together We can!

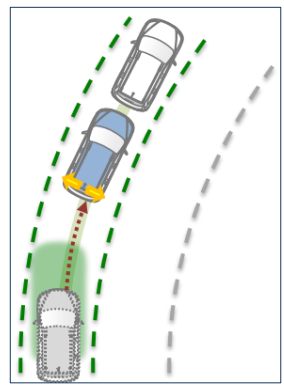
출처: MRM 표준 Part 1 리더 김윤수 책임(현대차)

HYUNDAI MOTOR GROUP

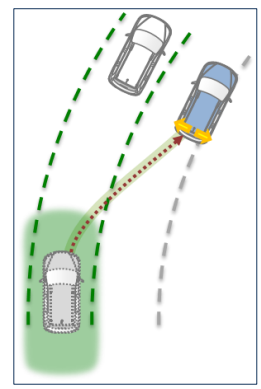
Fall Back – MRM의 Type 분류



종방향 속도 감속



차선내 정지



차선변경 후 정치

그림출처: MRM 표준 Part 1 리더 김윤수 책임(현대차)

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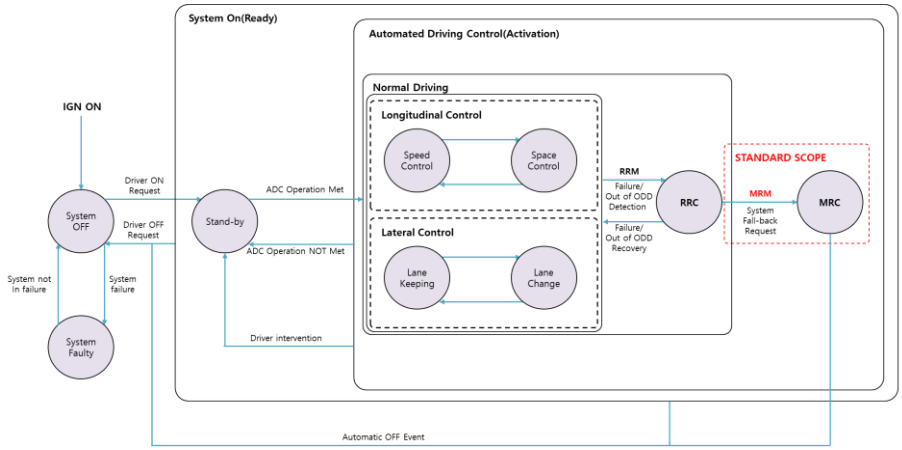
Fall Back – scope



그림출처: MRM 표준 공동작업자 송문형 연구원(자부연, 서울대)

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Fall Back – MRM Part 2 ; Emergency Shoulder Stop

» Scope

This document contains the basic control strategy, minimum functionality requirements, basic driver interface elements, ~~minimum requirements for diagnostics and reaction to failure~~, and performance test procedures for Emergency Shoulder Stop ~~Systems~~ (ESSS).

The ESSS is the second part of ISO 23793 Intelligent Transport Systems – Emergency Fallback Systems for Automated Driving standard.

ESSS automatically maneuvers the vehicle to the road shoulder and stop in order to reduce the risk of continuing the automated driving on the road ~~for the vehicle with the emergency event described in ISO 23793 Part 1. The responsibility for safe operation of the vehicle always remains with the driver.~~

The scope of this document does not include definition or identification of the emergency event requiring the emergency fallback systems ~~for automated driving which is described in ISO 23793 Part 1~~.

The document shall apply to light duty vehicles and heavy vehicles with four or more wheels. These systems are not intended for off-road use.

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Fall Back – MRM Part 2 ; Emergency Shoulder Stop

» **Basic functions**

The purpose of the ESSS is to provide better safety to the passengers of the vehicle equipped with automated driving system ~~when unexpected emergency fallback occurs~~. ~~The cause of emergency fallback is listed in section X.X of ISO 23793 Part 1.~~

Note detection of the cause of emergency fallback and decision making whether the emergency shoulder stop is necessary to be initiated are not within the scope of this document. These two process are depending upon manufacturer.

When the ESSS is initiated, the ESSS automatically maneuvers the vehicle to the road shoulder and stop the vehicle. It is optional for the vehicle to inform the emergency situation to other vehicles or related facility through wireless communication.

ESSS has following functions.

- ESSS makes a decision whether there is a road shoulder where the vehicle can stop
- ESSS makes a decision whether the longitudinal distance from the current position to the stop location is long enough to complete the ESSS maneuver
- ESSS safely controls the vehicle to reach to the road shoulder. This process can includes lane change and/or acrossing the road boundary
- ESSS stops the vehicle

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Development in KATECH : KATECH AV Platform

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Thank you