RESEARCH

Utah Department of Transportation - Research Division
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Keeping Utah Moving

Report No. UT-22.11

DEVELOPMENT OF EDUCATIONAL MATERIALS FOR THE PUBLIC AND FIRST RESPONDERS ON THE LIMITATIONS OF ADVANCED DRIVING ASSISTANCE SYSTEMS

Prepared For:

Utah Department of Transportation
Traffic & Safety Division

Final Report
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DISCLAIMER

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16. Abstract

With the advancement of automated vehicle technologies, it is critical to understand the knowledge gap among drivers on the limitations and safety restrictions of existing advanced driving assistance systems (ADAS), which contributes to dangerous driving habits and misjudgments. For example, some ADAS include adaptive cruise control, but many drivers do not know that this feature may not function as expected in response to stationary objects. Lane departure warning systems do not always register lane markings or pavement edges with damage or covered with snow. This kind of misunderstanding has led to some highly publicized crashes. Currently, limited information is available related to crashes involving ADAS since there is no proper distinction for this kind of vehicle in current crash reporting. There is also a major concern to understand the cause and fault behind a crash involving this kind of vehicle. Without sufficient knowledge about the functionality of the technology, it is difficult for traffic incident management (TIM) personnel to determine whether the ADAS feature of a vehicle impacted a traffic incident. This study will help TIM personnel better understand ADAS technology by providing a database of commercially available vehicles incorporating this technology and training on terminology and limitations of ADAS. These findings can be used by the Utah Department of Transportation to educate both drivers and first responders.

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UNIT CONVERSION FACTORS

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. (Adapted from FHWA report template, Revised March 2003)

LIST OF ACRONYMS

AAA	American Automobile Association
ADAS	Advanced Driving Assistance Systems
ADS	Automated Driving System
AEB	Automated Emergency Braking
AHB	Automated High Beams
AV	Autonomous Vehicle
BSM	Blind-Spot Monitoring
CAGR	Compound Annual Growth Rate
CAS	Collison Avoidance System
CAV	Connected Autonomous Vehicle
CR	Consumer Reports
DA	Driver Attention
DOT	Department of Transportation
DUI	Driving Under the Influence
FCW	Forward Collision Warning
FHWA	Federal Highway Administration
FSD	Full Self-Driving
HLDI	Highway Loss Data Institute
IIHS	Insurance Institute of Highway Safety
LiDAR	Light Detection and Automated Ranging
LDW	Lane Departure Warning
LKA	Lane-Keeping Assistance
MPH	Miles Per Hour
NHTSA	National Highway Traffic Safety Administration
NTSB	National Traffic Safety Board
ODD	Operational Design Domain
OEM	Original Equipment Manufacturers
PA	Parking Assistance
PD	Pedestrian Detection
RC	Rearview Camera

RCTW	Rear Cross-Traffic Warning
RDM	Road Departure Management
SAE	Society of Automotive Engineers
SCE	Safety-Critical Events
TIM	Traffic Incident Management
UDOT	Utah Department of Transportation

EXECUTIVE SUMMARY

Human error is a factor in the vast majority of vehicle crashes. Advanced Driving Assistance Systems (ADAS) can play a major role in minimizing driver error and improving road safety. However, the capabilities and limitations of ADAS vary significantly from manufacturer to manufacturer and year to year. The number of vehicles equipped with ADAS are increasing each year. ADAS features that are currently available on the market are intended to assist the driver, not to take full control of the vehicle. Therefore, drivers are meant to always pay attention and be ready to take control of the vehicle at any given time.

However, while ADAS has received significant attention in the automotive and transportation industry, many consumers do not have proper understanding of ADAS capabilities and limitations. Over-reliance, confusion, misconception, mis-advertisement, etc. are major barriers to consumers' proper understanding of ADAS features. It is crucial to address this knowledge gap and raise awareness among drivers about the limitations, requirement to operate, and reactions of ADAS. Unsafe practices while using ADAS technologies are leading to dangerous driving behaviors and resulting in crashes. Acceptance of and response to these technologies by drivers are imperative for the successful adoption of ADAS (and, in the future, autonomous vehicles). This study covers common limitations and misconceptions of ADAS, resulting driver behavior/perception, and crash case studies. Recommended public messaging was developed to provide simple and clear information to drivers regarding ADAS capabilities.

At present, there is limited data available regarding ADAS-involved crashes, as there is no consistent practice across the US for reporting them. First responders and traffic incident management (TIM) personnel, similar to drivers, also need consistent education on ADAS. As part of this study, a database of the ADAS names of different manufacturers was developed to mitigate terminology and naming confusion. Additionally, a database of vehicles with ADAS features (and which features they possess) was developed, primarily for use by first responders and TIM personnel. These databases will help to identify vehicles equipped with ADAS and will help determine if ADAS was potentially involved in crashes.

Overall, this research addresses both driver and first-responder knowledge gaps regarding ADAS. By compiling various studies, reports, and media coverage, this report provides a comprehensive summary of ADAS terminology, limitations, misconceptions, education issues, and safety implications. The overall goal of this research was to provide educational resources to improve safety in Utah by (1) improving driver knowledge and behavior related to ADAS, (2) improve first responder safety related to ADAS, and (3) move towards improved reporting mechanisms for ADAS-related crashes.

1.0 INTRODUCTION

1.1 Problem Statement

With the advancement of automated vehicle technologies and the inevitable increase in their availability within the vehicle fleet, one of the primary questions left unanswered is how exactly they will impact safety (National Science and Technology Council and United States Department of Transportation, 2020), particularly in regard to vehicles that require at least some driver input and control. There is limited education for drivers on the capabilities and limitations of existing advanced driving assistance systems (ADAS), which can lead to dangerous driving habits and crashes due to driver misjudgment. For example, some ADAS include adaptive cruise control, but many drivers are unaware that this feature often cannot respond to stationary objects. This has led to some highly publicized crashes where a vehicle utilizing adaptive cruise control has crashed into first responder or construction vehicles. Additionally, consumers may encounter dozens of unique names and terminologies for the same or similar technologies.

(McDonald et al., 2016) found that 87.3% of people believe the driver is the most important element for safe driving all or most of the time, whereas 33.9% of people believe the vehicle is the most important element for safe driving. Poor understanding of system limitations may negatively affect a driver's trust, particularly if their expectations do not match the technology's actual capabilities (Jenness J., Lerner, Mazor, Osberg, & Tefft, 2008). Significant variety in system capabilities has already contributed to both lack of trust and too much trust. For example, the current Tesla ADAS can change lanes automatically by pressing a button whereas the Cadillac ADAS requires the driver to change lanes manually. A survey conducted by the American Automotive Engineering Team (AAA, 2019) of over 34 vehicle brands found that 40 different brand names were used to describe automatic emergency braking (AEB), 20 different names for adaptive cruise control (ACC), and 19 different names for lane-keeping assistance (LKA) and blind-spot monitoring (BSM). Moreover, the advertising policy and naming system is often misleading and/or confusing. This lack of communication between the consumers and manufacturers and misconception about limitations are obstacles to the successful implementation of ADAS.

A secondary area of concern is the impact that ADAS will have on traffic incident management (TIM), particularly how first responders will be able to identify potential causes and factors of crashes involving these vehicles. Currently, there is limited capability for reporting the involvement of ADAS in crashes due to lack of appropriate reporting mechanisms (i.e., no applicable field in a crash report or lack of training) and lack of clear identification of ADAS-equipped vehicles. Many vehicles with ADAS, such as adaptive cruise control or communications with signal controllers, do not look very different from vehicles without those capabilities. In fact, manufacturers often include these features as add-ons. For example, a Subaru Legacy with EyeSight, Subaru's ADAS technology package, looks nearly identical to a Subaru Legacy without EyeSight. While it may be very difficult for TIM personnel to determine if these ADAS technologies directly contributed to the crash, the knowledge that the technology was available may inform their investigation and reporting of the incident. The findings of this research will facilitate this by providing clear definitions of ADAS technology, an exploration of the capabilities and limitations of ADAS, a list of commercially available vehicles with ADAS, and developing an educational workshop for first responders.

1.2 Objectives

The primary objective of this research was to develop educational and informational materials demonstrating the capabilities and limitations of existing ADAS technologies. The overall goal of this project was to facilitate and improve public and first responder understanding of ADAS to mitigate crash risk and to identify crashes involving ADAS technologies.

1.3 Scope

While there have been several studies conducted to assess the limitations and capabilities of ADAS, these studies have been disjointed and limited in scope. Most of the existing studies are focused on the real-world benefits and technical aspects of limited iterations of ADAS. This study was designed to gather and combine information regarding ADAS from various sources, including formal research experiments, driving behavior studies, mainstream media reporting, professional discussions, etc., and package that information for dissemination to the public, first responders, and other stakeholders via educational and informational materials. An extensive literature review was conducted to summarize the capabilities and limitations of currently available ADAS technologies. A list of commercially available ADAS was developed by collecting data from different vehicle manufacturers, which will help first responders and other transportation professionals to identify vehicles equipped with ADAS technologies. As part of this project, the research team developed suggestions and a lesson plan for a workshop that could be implemented throughout Utah to educate first responders on ADAS. This research will benefit Utah by contributing to the Zero Fatalities initiative and improving quality of life through public education on this critical safety technology.

1.4 Outline of Report

This report is organized into the following chapters:

- Chapter 1.0 includes an introduction to the research, problem statement and scope of the project, project objectives, and the organization of the report.
- Chapter 2.0 provides descriptions of the major/most common ADAS technologies and a literature review of their capabilities and limitations.
- Chapter 3.0 includes a literature review regarding drivers' perspectives of, experiences with, and education about ADAS technologies.
- Chapter 4.0 summarizes different media-reported crashes involving ADAS and a discussion of how reporting reflects and impacts public perspective of ADAS.
- Chapter 5.0 provides recommended public messaging based on the findings of Chapters 2.0 through 5.0.
- Chapter 6.0 provides recommendations for first responder training based on the findings of Chapters 2.0 through 5.0.
- Chapter 7.0 summarizes the report by highlighting the major findings and outlining the challenges and limitations of this study.

2.0 TECHNOLOGICAL CAPABILITIES AND LIMITATIONS OF ADAS

2.1 Overview

This chapter covers an extensive literature review on the capabilities and limitations of different ADAS technologies. There is a significant gap in communication and collaboration among policymakers, manufacturers, transportation professionals, and the public regarding these technologies. Lack of understanding and misconception about the capabilities of ADAS is common among most users. This review provides commonly accepted definitions related to ADAS and discusses the findings from previous studies of the technology itself. Discussions and findings about driver interactions with and perceptions of ADAS will be covered in Chapter 3.0.

ADAS stands for Advanced Driving Assistance System. It is an umbrella term covering different technological features designed to improve safety and/or driving experience. It is considered to be a precursor to fully automated vehicles (AVs). ADAS tasks involve monitoring, warning, and completing driving tasks. ADAS functionality relies on different kinds of sensors, which vary based on the range from the vehicle, type of ADAS using the sensor, and vehicle manufacturer/model. The sensors gather continuous information about the vehicle's surroundings and process it to provide feedback to the system. Currently, four categories of sensors (LiDAR, camera, ultrasonic, and radar) are primarily used in ADAS. Figure 2-1 demonstrates an example of sensing technologies typically used in ADAS. The continued development of ADAS (and AVs) has significantly increased demand for these sensing technologies.

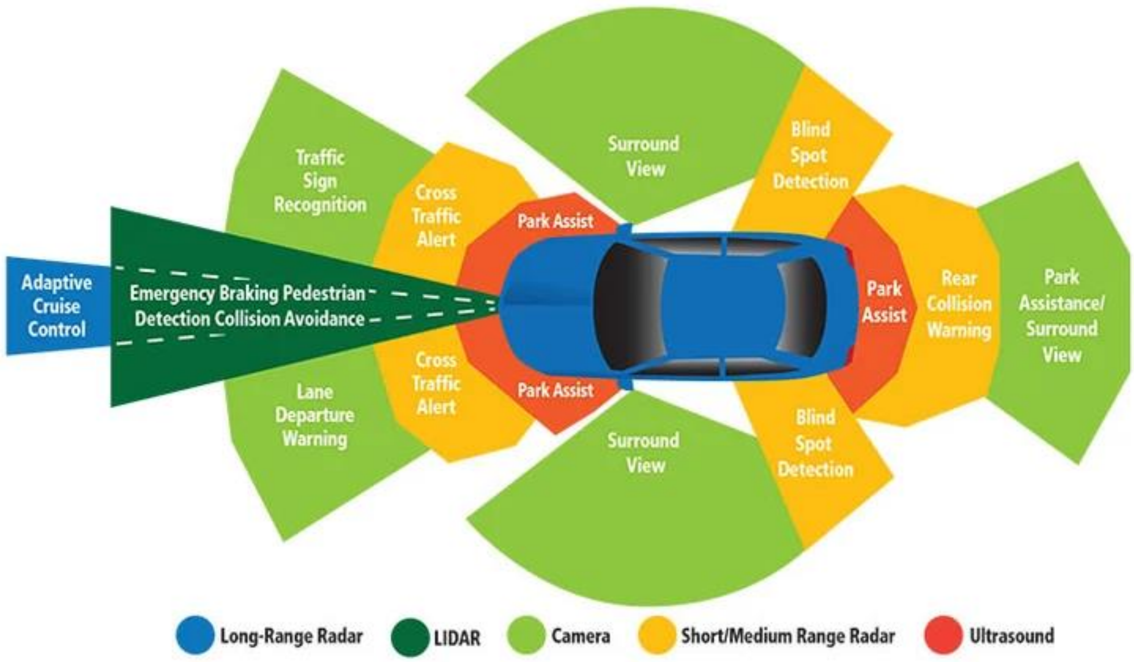


Figure 2-1 Sensing areas by technology type (McCarron, 2019)

ADAS functionality can be classified into two categories: active and passive (Kukkala, Tunnell, Pasricha, & Bradley, 2018). Active systems will take control of one or more driving tasks. Passive systems will monitor and warn a driver of a possible hazard or necessary task, leaving the actual action to the driver to perform. ADAS and AV technologies are further classified by the Society of Automotive Engineers (SAE) (Figure 2-2) (SAE, 2021). At Level 0, all driving tasks (aside from momentary assistance) are performed by a human driver. At Level 1, only one driving task at a time is performed by the technology, such as changing lanes or controlling the vehicle speed. The human driver is still required to perform the vast majority of driving tasks. Level 2 is also known as an active assistance system, which allows the vehicle to control the speed and change lanes simultaneously. Levels 0, 1, and 2 always require the driver to be engaged in the driving task. Starting at Level 3 there are situations or conditions in which driver engagement is not always required. The currently available technologies only achieve up to Level 2 automation and have distinct limitations, which will be discussed in subsequent sections.

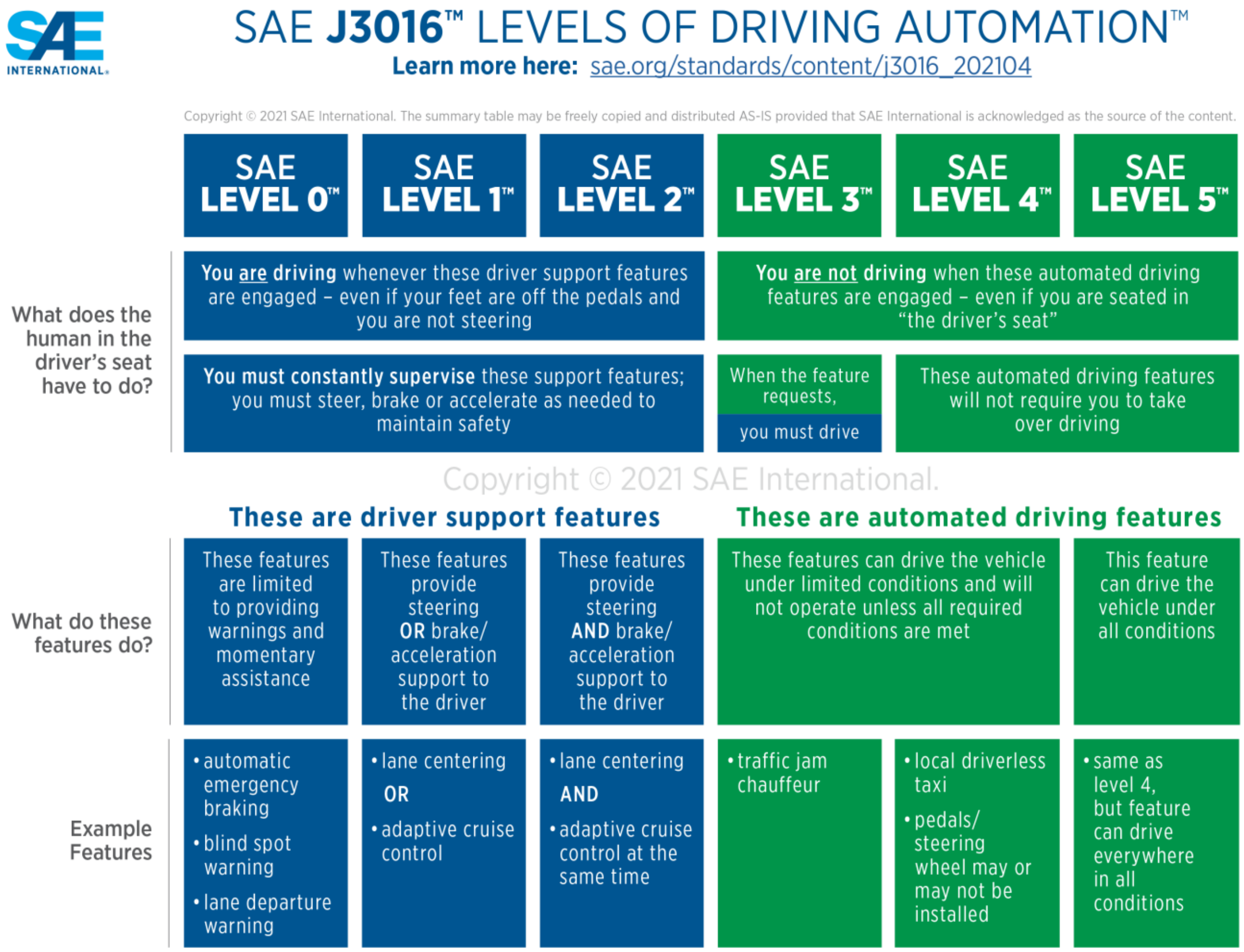


Figure 2-2 Levels of vehicle autonomy (SAE, 2021)

The demand for ADAS-equipped vehicles is growing due to its advantage over traditional vehicles in terms of safety and comfort. ADAS started to gain popularity in the US during the early 2000s. In 2016, 61% of US drivers wanted at least one ADAS technology in their next vehicle (Mcdonald, Carney, & Mcgehee, 2018). As of 2018, at least one ADAS feature was available in 92.7% of new vehicle models available in the US (AAA, 2019). In 2018, the American Automobile Association found that more than three out of four drivers considered ADAS technologies to be useful, and at least seven in ten car owners wanted such features in their next vehicle (AAA, 2019). Figure 2-3 represents the expected market penetration of

ADAS/AVs. While this figure is five years old at the time of this report, it is clear that ADAS availability is expected to increase rapidly. Therefore, transportation professionals have limited time in which to prepare for and accommodate these technologies.

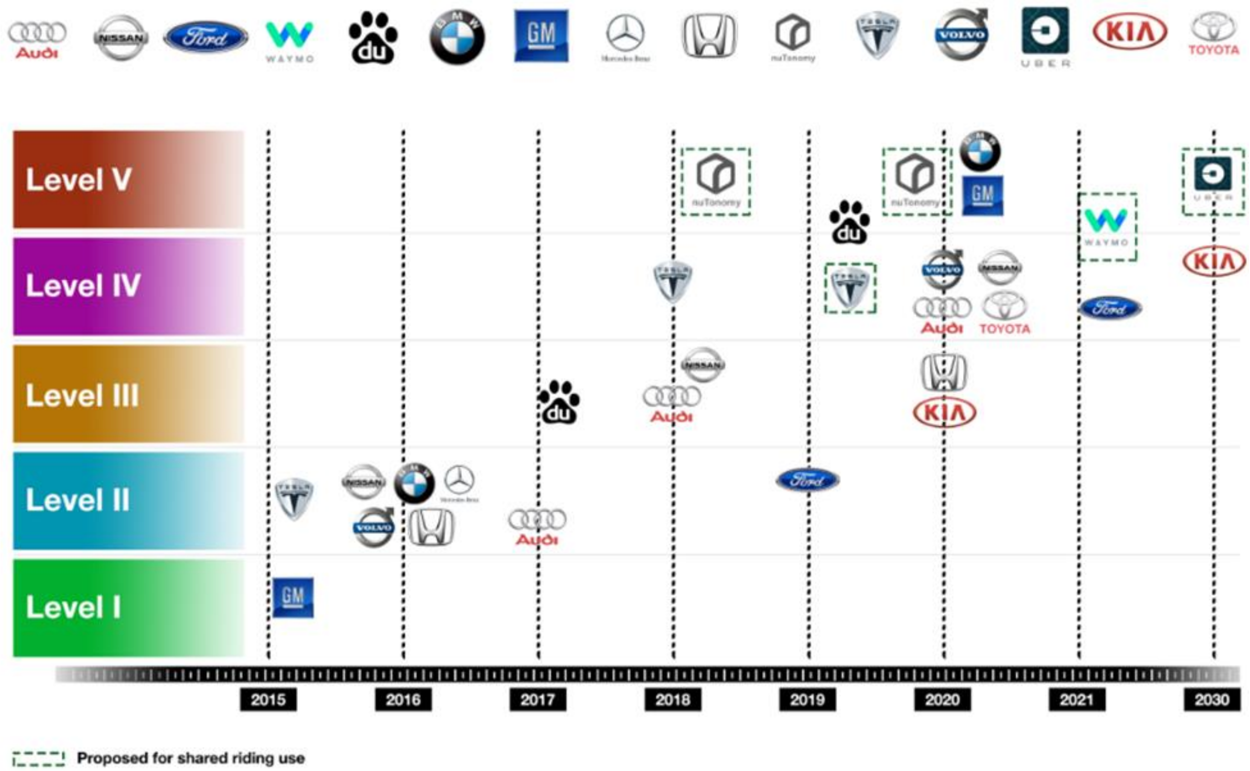


Figure 2-3 Overview of AV market, 2015-2030 estimated timeline (Favarò, Nader, Eurich, Tripp, & Varadaraju, 2017)

Within this report, the acronyms listed in Table 2.1 will be used when discussing various ADAS technologies.

Table 2.1 ADAS Acronyms

Acronym	Definition
ACC	Adaptive Cruise Control
AEB	Automated Emergency Braking
AHB	Automatic High Beams
BSM	Blind-Spot Monitoring
FCW	Forward Collision Warning
LDW	Lane Departure Warning
LKA	Lane-Keeping Assistance
PA	Parking Assistance
PD	Pedestrian Detection
RC	Rearview Camera
RCTW	Rear Cross-Traffic Warning
RDM	Road Departure Mitigation

2.2 Overall Safety Benefits

The driving force behind the development of this technology is the understanding that driver error is the critical factor in 94% of crashes (Highway Traffic Safety Administration & Department of Transportation, 2015). According to the National Highway Traffic Safety Administration (NHTSA), more than 36,000 Americans died in automobile crashes in 2019. The potential of ADAS to prevent or mitigate the severity of crashes could contribute to the goal of Zero Fatalities and improvement of quality of life. According to (Jermakian, 2011), it is possible to prevent or minimize up to 1.8 million crashes every year by using BSM, FCW/AEB, LDW/LKA, and AHB. According to (Khan, Harper, Hendrickson, & Samaras, 2019) combining different ADAS crash avoidance technologies could reduce crash frequency by about 3.5%. A different study found that collision avoidance systems have caused an observed 27% reduction in rear-end crashes (Cicchino & Zuby, 2019).

Vehicles equipped with blind-spot monitoring, lane departure warnings and forward collision warnings could prevent or reduce the severity of 1.3 million crashes annually, including 133,000 injury crashes and 10,100 fatal crashes (Harper, Hendrickson, & Samaras, 2016). ADAS technologies could reduce property damage claims by 19% and bodily injury claims by 27% (LexisNexis Risk Solutions, 2020). Approximately $264 billion in crash-related expenses could be saved if all light-duty vehicle fleets were equipped with ADAS (Khan et al., 2019). Figure 2-4 shows the safety impacts of different ADAS as determined by a study by the University of Michigan and General Motors (Leslie, 2019). Table 2.2 shows the results from a similar study (Benson, Tefft, Svancara, & Horrey, 2018). The Insurance Institute for Highway Safety (IIHS) conducted its own study of ADAS safety impacts as well (IIHS-HLDI, 2022) (Figure 2-5). All of these studies demonstrate that ADAS has a significant impact on real-word traffic safety. If ADAS were more widely accepted and adopted (along with AVs in the future), this impact could become even more pronounced.

Figure 2-4 Effectiveness of vehicle safety systems in the field (Leslie, 2019)

Table 2.2 Total Number of Crashes, Injuries, and Deaths that ADAS Could Potentially Prevent Annually (Benson et al., 2018)

	Crashes	**Injuries**	**Deaths**
Total Passenger-Vehicle Crashes	6,950,000	3,034,000	32,702
Potentially Preventable by FCW/AEB	1,994,000(29%)	884,000 (29%)	4,738 (14%)
Potentially Preventable by LDW/LKA	519,000 (7%)	187,000 (6%)	4,654 (14%)
Potentially Preventable by BSM	318,000 (5%)	89,000 (3%)	274 (1%)
Total Potentially Preventable by All Systems Above	2,748,000(40%)	1,128,000 (37%)	9,496 (29%)

IIHS HLDI

Real-world benefits of crash avoidance technologies

HLDI and IIHS study the effects of crash avoidance features by comparing rates of police-reported crashes and insurance claims for vehicles with and without the technologies. Results below are for passenger vehicles unless otherwise noted.

March 2022

Automatic emergency braking

- ↓ 50% Front-to-rear crashes
- ↓ 56% Front-to-rear crashes with injuries
- ↓ 14% Claim rates for damage to other vehicles
- ↓ 24% Claim rates for injuries to people in other vehicles
- ↓ 41% Large truck front-to-rear crashes

Automatic emergency braking with pedestrian detection

- ↓ 27% Pedestrian crashes
- ↓ 30% Pedestrian injury crashes

Lane departure warning

- ↓ 11% Single-vehicle, sideswipe and head-on crashes
- ↓ 21% Injury crashes of the same types

Blind spot detection

- ↓ 14% Lane-change crashes
- ↓ 23% Lane-change crashes with injuries
- ↓ 7% Claim rates for damage to other vehicles
- ↓ 9% Claim rates for injuries to people in other vehicles

Rear automatic braking

- ↓ 78% Backing crashes (when combined with rearview camera and parking sensors)
- ↓ 10% Claim rates for damage to the insured vehicle
- ↓ 28% Claim rates for damage to other vehicles

Rearview cameras

- ↓ 17% Backing crashes

Rear cross-traffic alert

- ↓ 22% Backing crashes

Added costs

Lower crash rates are a clear benefit of these technologies, but some features can lead to higher repair costs in the crashes that do happen. That's because sensors and other components are often located on the vehicle's exterior. For example, in the case of forward collision warning without autobrake, the average payment per claim for damage to the insured vehicle goes up $117 for vehicles equipped with the feature.

iihs.org |

Figure 2-5 Real-world benefits of crash avoidance technologies (IIHS-HLDI, 2022)

2.3 Adaptive Cruise Control

Adaptive cruise control (ACC) controls the speed of an equipped vehicle. Traditional cruise control maintains the vehicle at a preset speed until the driver changes or disengages the feature. In contrast, ACC adjusts the speed of the equipped vehicle in relation to the speed of and distance to the vehicle immediately in front of it. Often, the driver of the ACC-equipped vehicle can specify a desired following distance. The options for following distance are usually based on minimum braking distances according to achievable deceleration rates. The sensors used for ACC are often constrained by inclement weather and other physical obstructions that can block the view of the sensor. Depending on the manufacturers, ACC may also be known as: dynamic radar cruise control, intelligent cruise control, and radar cruise control system. (Weinberger, Winner, & Bubb, 2001) in their study found that ACC has problems controlling headway with respect to slow-moving or stopped vehicles. The minimum speed threshold of the ACC system to detect the preceding vehicle varies largely by manufacturer as well as by model year. In general, existing ACC systems do not function well in certain situations, such as on steep roads, on vehicles carrying or towing heavy loads (VOLVO, 2020), or on curves. The available ACC systems are mainly designed for flat road surfaces (Polestar, 2020). Also, many ACC systems available in the market do not have the ability to detect pedestrians. (IIHS & MIT, 2021) conducted an experiment with 2017 Volvo S90 and 2016 Land Rover Range Rover Evoque to understand the effects of ACC on speed limit compliance and found that drivers were more likely engaged in speeding while using ACC systems compared to manual driving. Sensors operating ACC systems might also face difficulties while driving through tunnels (Hearst Autos Research, 2020).

2.4 Collision Avoidance and Warning Systems

Automated emergency braking (AEB) systems are designed to detect an impending collision and control the deceleration of an equipped vehicle. AEB is often paired with a warning to the driver. However, if the driver fails to act, the system takes control of the vehicle by engaging the brakes to avoid a crash or to mitigate the crash damage. The AEB system works well at low speeds, though not as well at high speeds. Current sensors have difficulty detecting objects that are a long distance ahead. Therefore, if an AEB-equipped vehicle travels at a high speed, the sensor may not detect an obstacle, like another vehicle or a pedestrian, early enough for the AEB system to begin braking at a sufficient stopping distance (i.e., unable to stop before striking the obstacle). "Vehicles are programmed to ignore stationary objects at higher speeds," stated Sam Abuelsamid, a Principal Research Analyst at Guidehouse Insights (Lee, 2018). Currently available AEB systems have blind spots (different from the driver's blind spots).

Some manufacturer's AEB systems have unique quirks or limitations. Toyota's AEB system can sometimes be turned off if the driver slightly lifts their foot from the accelerator pedal after the AEB warning sound, which can contribute to crashes (Xing, et al., 2018). (IIHS, 2018) in their study found that BMW, Mercedes, and Volvo models all failed to respond to stopped vehicles under some situations. Both Tesla's Model S and Model 3 hit a balloon used as a target under some circumstances. Related, one study found that AEB is less effective at intersections (i.e., where stopped vehicles are present) (Spicer, et al., 2021).

(AAA, 2022) AAA conducted an experiment to evaluate the performance of the active driving assistance system (ADA) of the 2011 Hyundai Santa Fe, 2021 Subaru Forester, and 2020 Tesla Model 3. Only the Tesla model 3 vehicle was able to reduce the speed while crashing with an oncoming target vehicle within in its lane while the other two vehicles failed to detect the approaching target vehicle. This resulted in no braking and impact without speed reduction. However, another study found that rear-end crashes on curves are more likely when the striking vehicle is equipped with AEB, compared to vehicles not equipped with AEB (Cicchino & Zuby, 2019)

Forward collision warning (FCW) provides a visual, audio, and/or tactile warning to the driver about an impending crash. With FCW on its own (i.e., without AEB also being equipped), the system will not take control and apply the brakes. The system monitors the speed of the front vehicle and the distance between the vehicles. According to a survey conducted by the IIHS, the FCW system can reduce rear-end crashes by 27% (Cicchino J., 2017). However, the alert may be inaudible or unnoticed due to exterior noises (i.e., heavy rain or thunderstorm) or interior vehicle noises (i.e., loud music or passengers talking). A field operational test was conducted to understand the efficiency of the forward collision warning system of the 2002 Buick LeSabre, and it was found that false alarms were quite common (Ervin, et al., 2005). About half of the false alerts were generated from stationary objects located along the side of the road. The drivers also noted that many alarms occurred at times when drivers did not consider them to be necessary.

2.5 Parking and Rear/Blind-Spot Systems

This group of features assists the driver by monitoring the nearby surroundings of the vehicle, particularly the driver's blind spots. The rearview camera (RC), rear cross-traffic warning (RCTW), and parking assistance features help the driver to park the vehicle, either by providing increased visibility, warning of objects, or maneuvering assistance. RCTW can increase the range of visibility around the vehicle by 46% (AAA, 2015). A study was conducted by (AAA, 2015) to understand the self-parking feature on five different vehicles: a 2015 Lincoln MKC, a 2015 Mercedes-Benz ML400 4Matic, a 2015 Cadillac CTS-V Sport, a 2015 BMW i3, and a 2015 Jeep Cherokee Limited. The feature exceeded manual parking in speed, accuracy, number of curbs, and maneuvers. However, it was found that some of the selected vehicles were parked extremely close to the curb, causing the wheels and tires to be subject to scratches and expensive repairs. The sideview assist system of the Volvo did not work properly in rain and bad weather (Braitman et al., 2010).

The blind-spot monitoring (BSM) system uses sensors that are usually placed towards the rear of the vehicle. It warns the driver with visual, audio, and/or tactile warning if there is a vehicle in the blind spot of the driver. It may have problems with detecting vehicles moving at faster speeds or very slow speeds (AAA, 2014). As with other alerting/warning systems, the alert may be inaudible or unnoticed due to exterior noises (i.e., heavy rain or thunderstorm) or interior vehicle noises (i.e., loud music or passengers talking). Despite these limitations, BSM systems are reducing crashes by 14%, resulting in about a 50,000-crash reduction per year (Cicchino J., 2018).

2.6 Pedestrian Detection Systems

A pedestrian detection (PD) system uses sensors (i.e., camera, radar, LiDAR, etc.) to specifically detect pedestrians or pedestrian-like objects in front of the vehicle and subsequently alert the driver and/or take emergency action. PD systems are also known by other names, such as front pedestrian braking (Chevrolet) or pre-collision system with pedestrian detection (Toyota). PD systems are often differentiated from other ADAS detection features because pedestrians are traditionally difficult to detect/identify. These systems face troubles in poor environmental conditions, such as snow, rain, fog, twilight, and nighttime. They also often work better at slower speeds. There are also issues with detecting small objects or objects below the horizon of the car.

AAA ran a test on a closed course with dummy pedestrians to evaluate the performance of the pedestrian detection system for four different vehicle makes/models of 2019 (Chevrolet Malibu, a Honda Accord, a Tesla Model 3, and a Toyota Camry) (AAA, 2019). It was found that the adult-sized dummy pedestrians were hit 60% of the time in daylight and 89% of the time at night, both at 20 MPH. None of the vehicles could consistently detect pedestrians at night and the detection system was very poor at high speeds, yielding a higher number of collisions. While encountering a pedestrian after a right-hand turn, the collision rate was 100%. For two pedestrians standing alongside the road with their back to traffic, the collision rate was 80%. The systems were ineffective in all the scenarios while traveling at 30 MPH.

(IIHS & HLDI, 2019) performed a study of pedestrian crash prevention systems on 16 mid-size cars in daylight on dry pavement. Tests were conducted with vehicle speeds of 12 MPH, 15 MPH, 25 MPH, and 37 MPH. The following three scenarios were implemented in the test:

- An adult dummy stepping into the street from the right side of the road into the path of an oncoming vehicle with an unobstructed view.
- A child dummy running into the street from between two parked cars.
- An adult dummy close to the side of the road and facing away from traffic.

The study resulted in qualitative ratings for each vehicle's PD system (Table 2.3). The superior-rated vehicles slowed dramatically to avoid a collision entirely or minimize the crash severity. The Nissan Maxima's system avoided the pedestrian in all tests. Vehicles that failed in multiple scenarios were given the "no credit" rating. For example, the Ford Fusion slowed only slightly for the first scenario and didn't slow down at all for the second scenario. Vehicles that failed in only one scenario received the "basic" rating. Advanced-rated vehicles applied major speed reduction but with no consistency.

AEB systems with PD capabilities have decreased pedestrian crash risk by 25-27% and pedestrian injury risk by 29-30% (Cicchino J. , 2022). (Isaksson-Hellman & Lindman, 2019) found that Volvo vehicles equipped with AEB plus PD had 21% fewer insurance claims compared to Volvo vehicles equipped with AEB without PD. In 2017, nearly 6,000 pedestrians were killed by vehicle crashes (NHTSA, 2017). AEB with PD could reduce the annual number of pedestrian crashes by about 5,000 and the annual number of fatal vehicle-pedestrian crashes by about 810 (Yanagisawa, Azeredo, Najm, & Stasko, 2017). Subaru's EyeSight system, equipped with PD, can reduce the rate of pedestrian-related insurance claims by 35% compared to the same vehicles without the PD system (HLDI, 2017).

Table 2.3 Vehicle Ratings from the IIHS Study (IIHS & HLDI, 2019)

Superior	**Advanced**	**Basic**	**No Credit**
2019 Audi A4 2019-20 BMW 3 Series 2020 Subaru Outback 2019-20 Mercedes-Benz C-Class 2019-20 Nissan Maxima 2019 Volvo S60	2019-20 BMW 3 Series 2019-20 Honda Accord 2019-20 Lexus ES 350 2019 Mazda 6 2019-20 Nissan Altima 2019-20 Tesla Model 3 2019-20 Toyota Camry	2019-20 Chevrolet Malibu 2019-20 Chevrolet Malibu 2019-20 Mercedes-Benz C-Class	2019-20 Ford Fusion 2019 Hyundai Sonata 2019 Kia Optima

2.7 Lane Departure/Keeping Systems

Lane-keeping assistance (LKA) helps to keep the vehicle in the lane by periodically taking control of steering. Dim lighting, poor weather conditions (i.e., snow, rain, fog, tight curves, dirt, mud, leaves), and poor lane-marking quality can affect the functionality of this system. Lane departure warning (LDW) gives the driver a visual, audio, and/or tactile warning when the vehicle drifts out of the lane without an activated turn signal. Both systems primarily use a camera to keep track of the lane-marking position relative to the vehicle.

After five separate trials with varying speeds in a simulator, it was found that 83% of drivers believed the LDW system would work at any speed while it actually worked when the vehicle was traveling above a minimum speed (Aziz, Horiguchi, & Sawaragi, 2013). These systems often only work if they are traveling above a minimum speed (Aziz, Horiguchi, & Sawaragi, 2013). (IIHS, 2018) conducted a study of BMW, Mercedes-Benz, Tesla, and Volvo models to understand the performance of their LKA systems. The systems run well on relatively straight roads, while problems arise in areas with a lot of curves and hills. Figure 2-6 shows how each vehicle model performed in different scenarios.

	Number of times vehicle							
	went over line		touched line		system disengaged		stayed within lane	
	on curves	on hills	on curves	on hills	on curves	on hills	on curves	on hills
BMW 5 series	3	6	1	1	9	7	3	0
Mercedes-Benz E-Class	2	1	5	1	1	1	9	15
Tesla Model 3	0	0	0	1	0	0	18	17
Tesla Model S	1	12	0	1	0	0	17	5
Volvo S90	8	2	0	1	0	4	9	9

Figure 2-6 How active lane-keeping systems performed in IIHS road tests (IIHS, 2018)

A test conducted by (AAA, 2020) found that for every 4,000 miles of real-world driving, a vehicle equipped with ADAS experienced some type of ADAS-related issue on average every eight miles. A 2019 BMW X7, 2019 Cadillac CT6, 2019 Ford Edge, 2020 Kia Telluride, and a 2020 Subaru Outback were used for this test. The most common problem associated with this test was to maintain the LKA in scenarios like changing road surfaces, exit ramps, and sharp curves. It was found that the ADAS (specifically vehicle acceleration and steering) disengage with very short notice. Requiring the driver to instantly take back control of a driving task can be dangerous. In this test, the vehicle (traveling at an average 25 MPH) collided with a simulated disabled vehicle 66% of the time. The 2019 Cadillac CT6 and the 2019 Ford Edge were evaluated only within naturalistic environments while the rest were tested in a closed-course test scenario. (AAA, 2018) found that in almost 90% of the events, the test vehicle required the driver's intervention in order to maintain the lane position.

Based on the performance of a combination of ACC and LKA, (Consumer Reports, 2020) ranked the performance of 17 manufacturers under five different categories (capability and performance, ease of use, keeping the driver engaged, clear when safe to use, and unresponsive driver). Table 2.4 shows a list of the proprietary ADAS and the corresponding test vehicle. Figure 2-7 shows the cumulative rankings of the tested ADAS.

Table 2.4 Selected Vehicles for Performance Measurement (Consumer Reports, 2020)

Active Driving Assistance Suite	Test Vehicle
Cadillac Super Cruise	Cadillac CT6
Tesla Autopilot	Model Y
Lincoln/Ford Co-Pilot 360	Lincoln Corsair
Audi Pre Sense	Audi e-Torn
Hyundai Smart Sense, Kia Drive Wise	Hyundai Palisade
Mercedes-Benz Driver Assistance	Mercedes-Benz GLS450
Subaru EyeSight	Subaru Outback
BMW Active Driving Assistance Pro	BMW 330i
Porsche Active Safe	Porsche Taycan
Volvo Pilot Assist	Volvo S60
Honda/Acura Sensing	Honda CR-V-Hybrid
Nissan/Infiniti ProPILOT Assist	Nissan Leaf
Toyota/Lexus Safety Sense 2.0	Toyota Corolla
Volkswagen Driver Assistance	Volkswagen Passat
Buick/Chevy Driver Confidence	Buick Encore GX
Land Rover InControl	Range Rover Evoque
Mazda i-ACTIVESENSE	Mazda CX-30

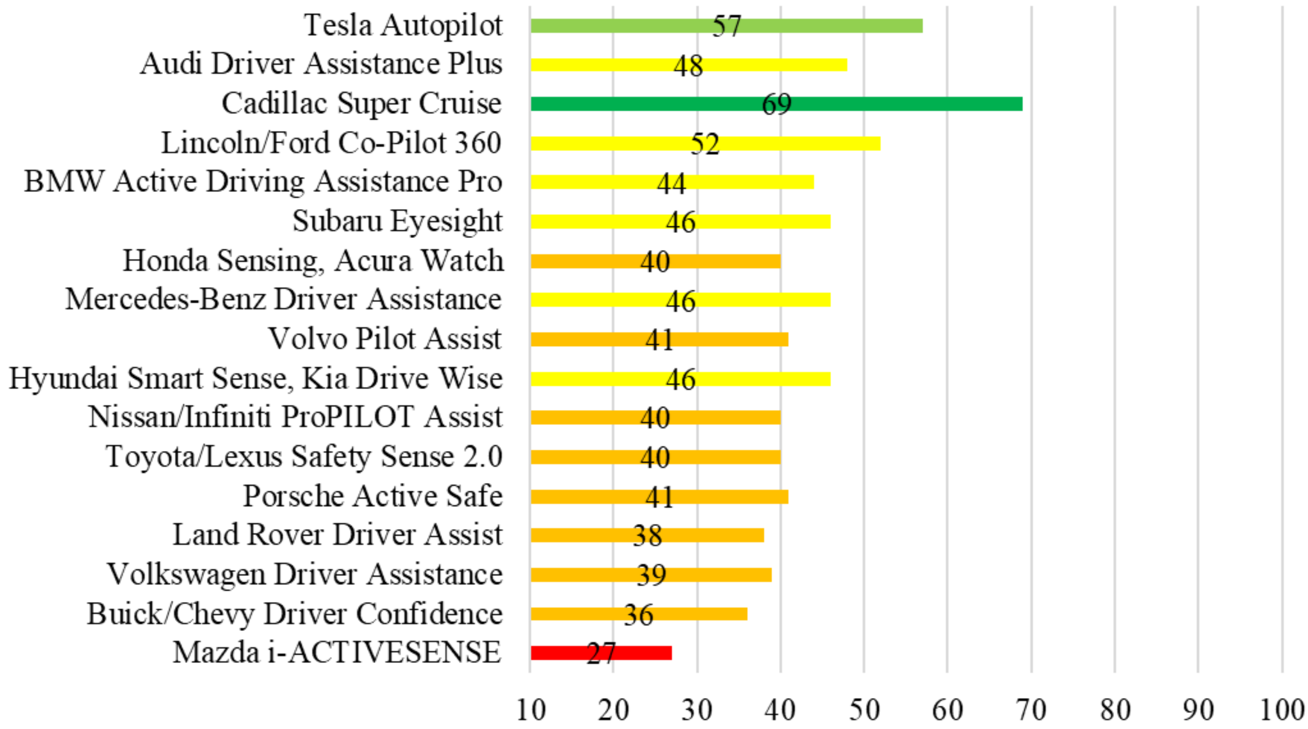


Figure 2-7 CR's 2020 Ranking of Proprietary ADAS (Consumer Reports, 2020)

2.8 Summary

The designers of ADAS systems should consider all of the features as an integrated system instead of considering each feature as independent. The confusion of active vs. passive ADAS very often leads to driving confusion since they function differently. Often, the different features rely on separate sensors, which are produced by different suppliers. Therefore, while operating, they don't necessarily share information or act together. For example, the ACC/AEB system is mostly operated by radar while the LDW uses a camera. ACC/AEB systems would not be able to use the LDW sensor data to supplement their own sensor data. A complex driver assistance system can act in surprising or confusing ways, which may lead to crashes. Furthermore, while ADAS may be able to competently respond to many situations, this could give drivers a false sense of safety and cause overreliance (Lee, 2018). (Reagan et al., 2019) Current ADAS can be used only for specific types of roads, mostly freeways. Some manuals give instructions to use only for "highway," with no clear guidance on use during inclement weather or non-freeways. Present technologies are also not capable of handling situations like faded lane markings, stationary vehicles, and non-ordinary traffic scenarios (AAA, 2018).

With the continuous advancement of ADAS, the industry is facing challenges as consumers are using these continuously developing technologies that have a wide variety of capabilities and limitations. The first step in educating consumers on ADAS capabilities and limitations is to conduct studies and tests to assess and more fully understand what those are. Regardless of the capabilities being advertised by companies, it is necessary that these systems are being used appropriately by drivers in order to achieve their intended benefits and ensure optimal use. The involvement of inter-disciplinary teams is necessary to ensure successful design and adoption of ADAS technologies. This multidisciplinary approach will also influence the trust and acceptance level of drivers, resulting in a positive mental model and human-machine intervention while driving a vehicle equipped with these technologies. So long as ADAS requires full driver attention in the event that its limitations are reached, stakeholders should work to mitigate system limitations, make limitations more transparent and well known, and utilize monitoring technology or education to promote full driver engagement and attention. The industry should place importance on how drivers seek and find knowledge about ADAS technologies to meet their educational and operational needs.

3.0 DRIVER PERSPECTIVES AND EXPERIENCES

3.1 General Perceptions of ADAS

Human factors are one of the major challenges involved in the successful adoption of ADAS technologies. Lower levels of understanding and awareness coupled with overreliance and higher trust may lead to misuse of the technologies. Although the AV industry is continuously evolving, the improvement of safety caused by these technologies is still under question. A national-level survey in the US concluded that people generally have a low level of knowledge about both emerging and currently available ADAS technologies (McDonald et al., 2016). When drivers interact with any new technology, they generally have trust issues regarding its performance. In the US, only 12% of drivers would trust a full AV enough to ride in it, while 28% are unsure about whether they would feel safe or not (AAA, 2020). While driving "most or all of the time," at least 70% of drivers activate an ADAS feature, but at least 40% of drivers feel that their safety has been compromised by activating ADAS (Page, Millar, Bronson, Risamani, & Moon, 2019). In a survey of 1355 Dutch business drivers, it was found that many drivers did not know which ADAS technologies were equipped in their vehicles and some of them reported owning certain ADAS features that were not actually present in their cars (Harms, Bingen, & Steffens, 2020). Age and experience can significantly influence driver attitude and their usage of autonomous and assistive driving features (Crump et al., 2016). (Hagl & Kouabenan, 2020) indicated that drivers feel safer on the road while driving vehicles equipped with ADAS.

One study found that, compared to human-driven vehicles, AVs were more involved in rear-end crashes per vehicle-mile traveled (Goodall, 2021). (Kim, Song, & Doerzaph, 2020) found that 20% of safety-critical events (SCEs) involved vehicles using ADAS. Further, it was revealed that in 57% of those SCEs (involving ADAS) people misused ADAS, such as hands off the wheel and doing secondary activities. Comparatively, for only 13% of the SCEs (involving), the system did not work properly or warn the drivers. This study also noted that people felt more comfortable engaging in secondary activities as they became more familiar with ADAS. (Pyrialakou, Gkartzonikas, Gatlin, & Gkritza, 2020) found that bicyclists and pedestrians feel less safe near AVs compared to those in vehicles driving near AVs. Consumers may not use ADAS as per design because of their misunderstanding, overreliance, or lack of trust. (Reagan I., Cicchino, Teoh, & Cox, 2022) in their study found that owners purchasing new vehicles equipped with ADAS technologies have a higher level of trust, understanding, and awareness about the system compared to owners buying used vehicles. (Eichelberger & McCartt, 2016) noted that ADAS technologies might have an unintentional negative effect on driving behavior, such as by causing drivers to be inattentive while driving. (Page et al., 2019) found that people felt safer with lower-level ADAS features compared to higher-level ADAS features, which may be a result of ADAS system design, driver training, or both. (Lijarcio, Useche, Llamazares, & Montoro, 2019) found that the most-used ADAS features were GPS navigation, windshield wiper sensors, automatic lighting systems, rear-view camera, and tire pressure control. Drivers rarely used emergency braking, E-Call, gestural control, door obstacle detection, and proactive occupant protection systems. One study found that, when purchasing their vehicle, 50% of the buyers did not have any idea their vehicle was equipped with ADAS technologies until they drove it (McDonald et al., 2018). In another survey, it was found that male consumers were overconfident in categorizing ADAS technologies according to their level of automation compared to females (Abraham, Seppelt, Mehler, & Reimer, 2017). Another study found that drivers have more trust in ADAS features compared to other road users (Horrey et al., 2021). However, all road users indicated they have more trust in manual driving.

3.2 Advertising and Terminology Confusion

Confusion regarding ADAS names and terminology can cause major misconceptions among consumers, which can influence real-world driving behavior and cause severe consequences. (Duarte, 2018) according to Dr. David Yang, Executive Director of the AAA Foundation for Traffic Safety, “Vague or confusing terminology may lead someone to overestimate a system’s capability, unintentionally placing the driver and others on the road at risk.” However, lack of communication and collaboration among different manufacturers have resulted in proprietary branding of the same or similar ADAS features, and this problem is growing continuously. Despite having similar names, the capacities and limitations of Ford’s CoPilot 360, Nissan’s ProPilot Assist and Tesla’s Autopilot are quite different, and none of them are fully self-driving (Bradford, 2019). This naming tendency for ADAS in the industry can be over-promising and can encourage lack of driver attention while driving. Another study of over

2,000 drivers assessed their perception of five different SAE Level 2 system names, including Traffic Jam Assist (Audi and Acura), ProPilot (Nissan), Driving Assistant Plus (BMW), Super Cruise (Cadillac), and Autopilot (Tesla) (Teoh, 2020). It was found that the name "Autopilot" had a greater influence on distracted driving behavior compared to the other names (Figure 3-1).

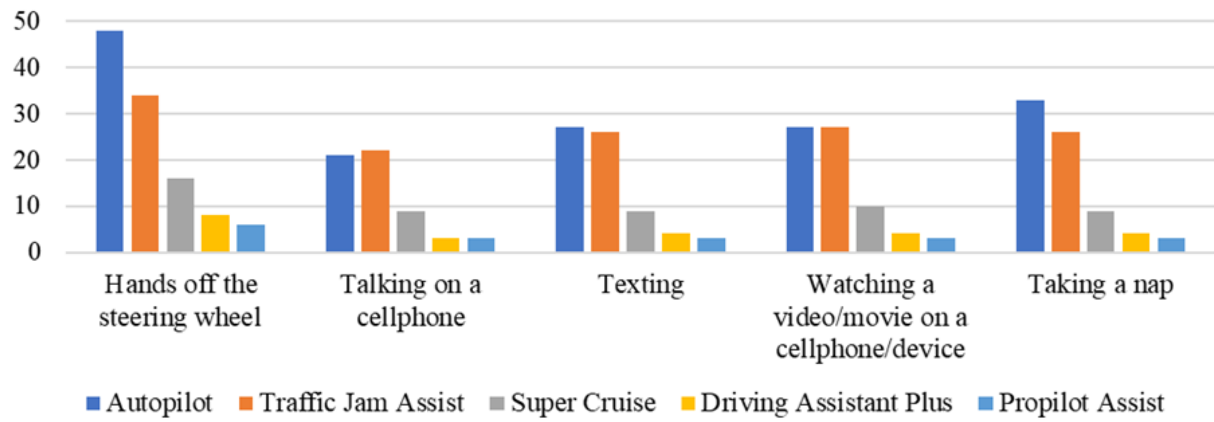


Figure 3-1 Percent of drivers who considered behaviors safe while level 2 system is in operation (Teoh, 2020)

"163 different brand names are used to describe 16 ADAS features. Marketing departments are focused on selling their own unique new aspect of ADAS features, but this hinders customers still struggling to understand the basics of the functions," said Howard Abbey, from SBD Automotive (Bouchard, 2021). Another study found that consumers are confused by the large array of ADAS marketing names (Table 3.1) and what those ADAS features are supposed to do (AAA, 2019).

The contradictory advertising policy of manufactures could be considered liable for drivers 'overreliance on ADAS. Though manufacturers claim that users are solely responsible for their safety, current advertising only strengthens the misconceptions of ADAS capabilities (Neemeh, 2021). Lack of education of salespeople may also keep consumers uninformed or misinformed about the capabilities and limitations of ADAS technologies. A study conducted by (Abraham, McAnulty, Mehler, & Reimer, 2017) found that the level of technology explanations by dealerships vary significantly (Table 3.2).

Table 3.1 Number of Unique Names Marketed for ADAS Features (AAA, 2019)

ADAS Feature	Number of Unique Names
Automated Emergency Braking (AEB)	40
Adaptive Cruise Control (ACC)	20
Surround View Camera	20
Lane-Keeping Assistance (LKA)	19
Blind-Spot Monitoring (BSM)	19
Automatic High Beams	18
Rear Cross-Traffic Warning	15
Driver Monitoring	13
Semi-Automated Parking Assist	12
Forward Collision Warning (FCW)	8
Night Vision and Pedestrian Detection	5

Table 3.2 Number of Dealerships Explaining Level of Technology, by Dealership Categories (Abraham, McAnulty, Mehler, & Reimer, 2017)

Dealership Category	Thorough	Satisfactory	Poor	No Explanation
Safety (Volvo, Subaru)	4	2	0	0
Luxury (BMW, Mercedes)	1	4	0	1
Mass Market (Ford, Chevrolet)	1	1	3	0

(Boelhouwer et al., 2020) conducted separate surveys in the Netherlands among consumers and car sellers to understand how they are informed about ADAS technologies. The study found that brand dealers received more information compared to independent dealers. However, 40% of all car sellers did not receive any information about the ADAS technologies in their vehicles. The study also revealed that, almost a quarter of buyers did not receive information regarding any ADAS from the car seller and only 9% of the drivers who received information were able to have hands-on experience before taking the car home. Marketing approaches focusing on the feature capabilities and driver workload reduction (rather than on feature limitations and driver responsibilities) tended to lead to overreliance and unsafe driving behavior (Singer & Jenness, 2020). Forty percent of Americans expect partially automated driving systems, namely Autopilot, ProPILOT, and Pilot Assist, to be able to operate the car without the driver's intervention (Singer & Jenness, 2020). (AAA, 2020) conducted a study using two fictitious ADAS names - AutonoDrive (capabilities and convenience) and DriveAssist (limitations and responsibilities) - to understand drivers' reliance on ADAS technologies. The study found that a majority of the drivers felt more confident with "AutonoDrive" compared to "DriveAssist" (Figure 3-2).

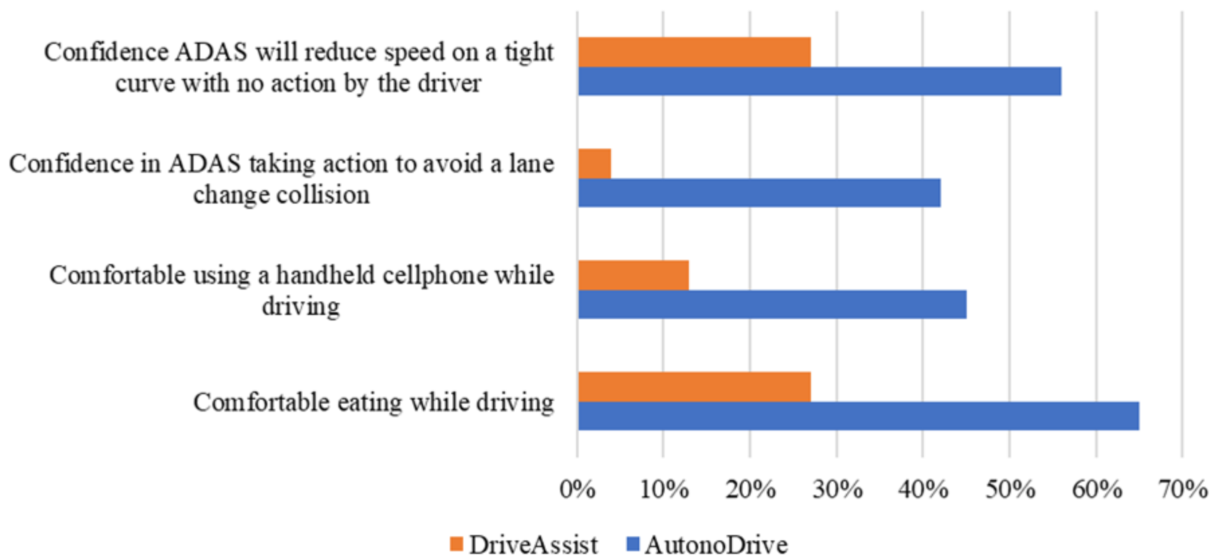


Figure 3-2 Driver perception differences between "AutonoDrive" vs. "DriveAssist" (AAA, 2020)

3.3 Driver Knowledge of Technological Limitations

In this section, misconceptions and knowledge of specific ADAS features are discussed. In general, people with less experience with ADAS underestimate the risk of manual driving while overestimating the risk of automated driving (Brell, Philipsen, & Ziefle, 2019). In the same study, it was concluded that the perceived risk of AVs decreases over time with hands-on experience.

3.3.1 Adaptive Cruise Control

Nearly 30% of drivers were unaware of the limitations of adaptive cruise control (ACC) and the problems associated with its functionality in different situations, such as on curves or roundabouts (Larsson, 2012). Of owners of vehicles equipped with ACC, 72% were unaware of some important issues related to the functionality of ACC (Jennes et al., 2008). Drivers perceived higher risk while driving a car equipped with ACC compared to a car not equipped with ACC (Brell, Philipsen, & Ziefle, 2019).

(Dickie & Boyle, 2009) conducted a survey among drivers to understand their knowledge limitations regarding ACC by dividing them into three different groups (aware, unaware, and unsure). It was found that the unaware or unsure drivers engaged in more hazardous driving behaviors compared to aware drivers. Also, the unaware and unsure drivers had more trust in the technology. In a different study, it was found that drivers using ACC had a 10% higher risk of being involved in a fatal crash compared to drivers driving manually due to selecting a cruise speed above the speed limit (Monfort et al., 2022).

3.3.2 Collision Avoidance and Warning Systems

Based only on vehicle manufacturer advertisements, people with no prior experience with ADAS technologies believed that the purpose of AEB systems was to provide protection against unseen obstacles and to accommodate driver inattention (Crump et al., 2016). About 25% of drivers engaged in a secondary activity while using FCW or LDW (McDonald et al., 2018). In Volvo and Infiniti vehicles, FCW with autobrake and sideview assist were turned on most of the time while many of the drivers were unaware of the lane-departure prevention system (Braitman et al., 2010). Almost 40% of drivers confused forward collision avoidance systems with emergency braking systems (McDonald et al., 2018). It was also concluded that more than 33% of the drivers had no idea that AEB might not function due to dirt, snow, or ice on the necessary sensors and cameras.

Driving behavior has been found to change with the availability of crash avoidance systems. Telephone interviews were conducted with Volvo and Infiniti vehicle owners in early 2009 to understand drivers' experiences with ADAS technologies (Braitman et al., 2010). Nine percent of the owners with sideview assist (Volvo) said they change lanes more often than before having the feature. A small percentage of owners with FCW with autobrake (Volvo) reported that they look away from the road more often or follow the vehicle ahead more closely than before having the feature.

3.3.3 Parking and Rear/Blind-Spot Systems

An average of 81% of owners of vehicles equipped with a radar-based backing aid system believed that these systems were designed to detect the proximity of pedestrians, children, and pets, not just stationary objects (Jenness J., Lerner, Mazor, Osberg, & Tefft, 2007). In another study, 80% of drivers thought blind-spot monitoring systems could monitor the road behind their vehicle, and 25% of drivers depended completely on the blind-spot monitoring system (McDonald et al.,2 018). Only 21% of drivers with vehicles equipped with BSM knew that the system does not function for a high-speed vehicle passing them (McDonald et al., 2018).

3.3.4 Lane Departure/Keeping Systems

One study found that 83% of drivers mistakenly believed that the LKA system would work at any speed, rather than only when the vehicle was traveling above a minimum speed (Aziz et al., 2013). About 25% of drivers engaged in a secondary activity while using FCW or LDW (McDonald et al., 2018). (Denver, 2020) Kelly Funkhouser, Head of the Connected and Automated Vehicle Testing Center for Consumer Reports, said, "Our experience, and the results from CR member surveys, indicate that drivers expect the systems to hold the vehicle in the center of the lane—and if it doesn't do so, they will likely simply stop using the system."

3.4 Driver Behavior

The number of false alarms or missed alarms should be kept as low as possible, otherwise the system will lose acceptance and credibility with drivers. The acceptance of ADAS is dependent upon driver awareness and training about ADAS (Page et al., 2019). Drivers will not accept a system that does not provide a warning for something that drivers consider dangerous and does not perform its tasks appropriately and correctly (Sayed, Abdelgawad, & Said, 2022). One study found that the on-off rates of LKA systems differed significantly by manufacturer (Reagan I., Cicchino, Kerfoot, & Weast, 2018). The same study found that LDW systems were more likely to be turned off compared to LKA systems. Also, vehicles with lower mileage were more likely to have LKA systems turned on. Another study by (Kidd, Cicchino, Reagan, & Kerfoot, 2017) found that drivers' trust of different ADAS features and warnings varied significantly by manufacturer. (Braitman, McCartt, Zuby, Singer, & Mccartt, 2010) conducted a telephone interview with Volvo and Infiniti vehicle owners to understand the drivers' use, acceptance, and experience of ADAS technologies. It was found that the FCW with autobrake and sideview assist were turned on most of the time while many of the drivers were not aware of the lane-departure prevention system. False or not necessary warning was a common opinion of sideview assist, and the lane departure warning was "annoying."

In a study by (Cicchino & Mccartt, 2015), it was found that there is a positive relation between drivers' waiting time for an alert from FCW (before taking action) and the duration of vehicle ownership. The timing of the alerts affects the driver's intervention and effectiveness of the warning. Driver response and acceptance of crash avoidance technologies are critical to their successful application in real-world driving. The response to an alert also varies by gender and age. Deactivation or lack of use of a system depends on many factors, including driving location and the driver's attitude toward the technology. For example, sometimes drivers intentionally change lanes without using the turn signal, which causes a seemingly unnecessary warning from the vehicle. If drivers don't trust the systems or find them annoying and not useful, there is a possibility that they will disable the systems. In a simulation study, drivers reported that auditory warnings were more annoying compared to tactile warnings, and they preferred to have an alert system that combines both (Stanley, 2006). Moreover, if the drivers face warnings they do not understand, are overwhelmed by the warnings, or don't take the necessary steps to respond to the warning, then the systems will be ineffective.

Table 3.3 shows the results of a study of driver opinion of different ADAS features, including trust, usefulness, annoyance, etc. (Mcdonald, Reyes, Roe, & Mcgehee, 2017). Within some ADAS, certain features do not function prior to the activation of another feature. For example, in the Tesla Autopilot system, it is necessary to activate ACC in order to engage LKA. The driver cannot activate LKA alone. Conversely, in the Subaru EyeSight system, ACC and LKA can be activated independent of one another. Many systems and sensors will not activate until the vehicle reaches a certain speed. Also, some ADAS sensors require recalibration after certain intervals or events. For example, features such as ACC, LKA, and AEB do not function once the windshield is broken or replaced, so the camera must be recalibrated properly. In many cases, if the ADAS sensor is obscured or uncalibrated, the feature will not activate. It is critical for drivers to understand these barriers to activation so they know when to get their vehicle repaired/maintained and so they don't get needlessly frustrated when trying to utilize certain ADAS features. It is important for drivers to know when the system will not function and when they should take control of the driving in order to avoid any potential hazard. Driver acceptance of and response to ADAS alerts and actions are critical in the successful use of ADAS (Najm, Stearns, Howarth, Koopmann, & Hitz, 2006).

Table 3.3 Opinions regarding trust, usefulness, safety, and ease of learning of ADAS technologies (Mcdonald, Reyes, Roe, & Mcgehee, 2017)

ADAS	I trust the technology	I think the technology is useful	I think the technology is annoying	The technology makes me feel safer	I think the technology is distracting	I think the technology is easy to learn
ACC in-town	59%	47%	24%	48%	21%	75%
ACC highway	78%	81%	13%	61%	11%	80%
BSM	84%	94%	4%	85%	3%	94%
FCW	69%	85%	11%	68%	9%	85%
AEB	66%	85%	11%	69%	8%	78%
LDW	77%	77%	25%	62%	18%	87%
LKA	73%	79%	17%	65%	15%	88%
RCTW	82%	92%	4%	81%	2%	94%

Drivers were nearly twice as likely to engage in distracted driving while using ADAS systems compared to without them (Dunn, Dingus, & Soccolich, 2019). ADAS is here to assist drivers in terms of mitigating the number of crashes but not to replace drivers. Drivers should always be cautious while driving in any situation. The ultimate task of deploying ADAS can be accomplished by following safety suggestions based on purpose and limitations, by allowing time for testing, and by never completely relying on it (PLAN system) (AAA, 2020). (Norman, 1990) concludes that the problem of automation is not actually over-automation, but rather inappropriate feedback and inadequate interaction. Only 12% of Americans trusted a vehicle to drive itself while they were in it (AAA, 2020). Irritation, overreliance, and comfort/appreciation were found to be the major mental states for drivers while dealing with ADAS (Bouchard, 2021).

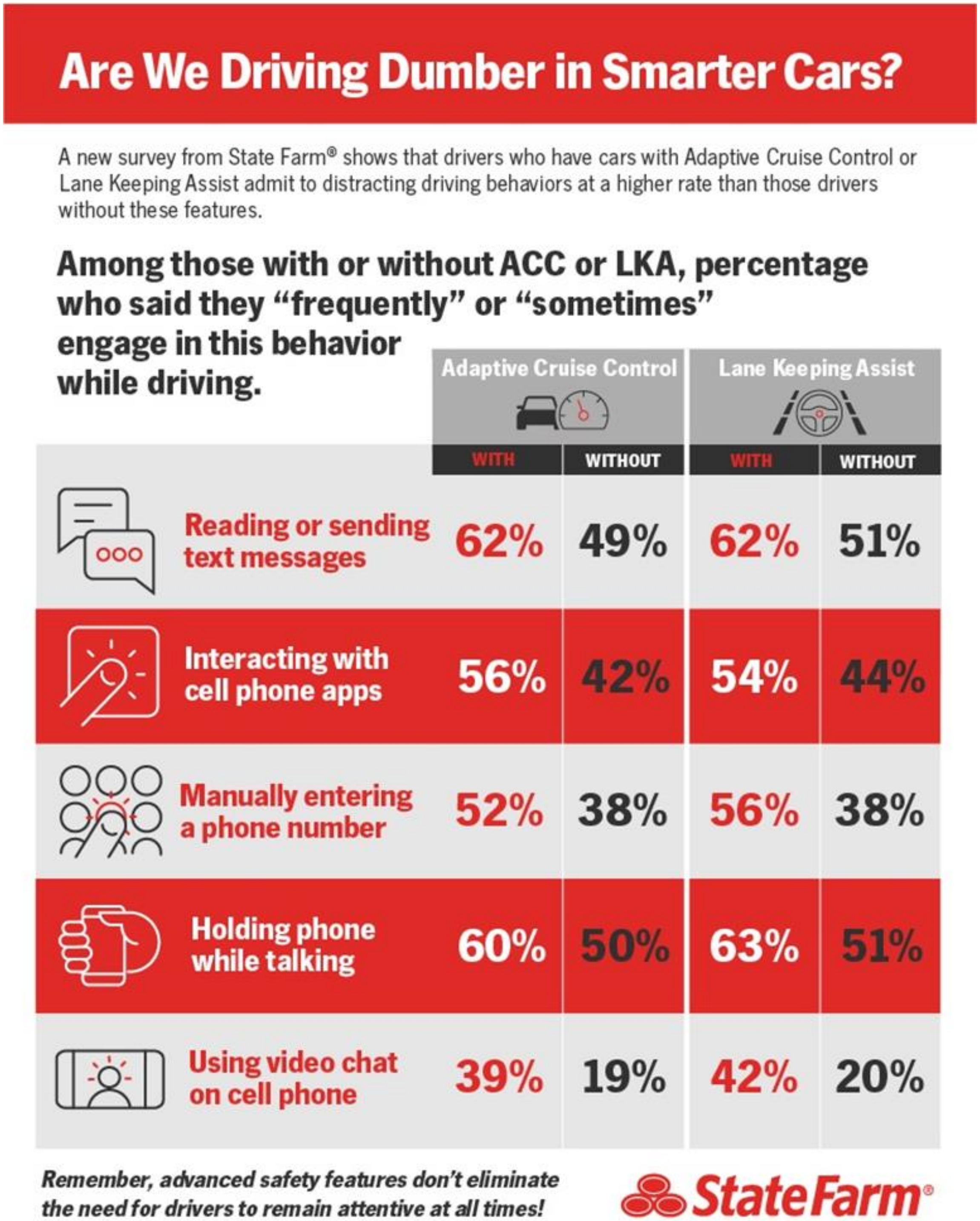


Figure 3-3 Are we driving dumber in smarter cars? (Harper V., 2019)

3.5 Driver Education

Misuse, overreliance, knowledge gap, uncertainty, and confusion are some of the major factors behind crashes involving ADAS. Currently there are no formal training or licensing requirements available or required for drivers to use ADAS (Szilagyi, Millar, Moon, & Rismani, 2021). In-person and on-road demonstrations seemed to be more effective compared to video training and quick-start guides in one study of driver education methods (AAA, 2020). AAA recommends that drivers ask questions at dealerships, schedule a demonstration to understand functions, and to go through the available manuals of the ADAS for their cars in order to achieve the potential benefits. Apart from this, greater consistency (in terms of name and function) across the vehicle industry will help consumers understand the technology their vehicle has and how, when, and where to use it (AAA, 2019). (Ucińska, 2021) also found that experience with ADAS plays a key role in speedy adoption and in ensuring a sense of comfort while using the system. (Page et al., 2019) in an online survey over 1,018 vehicle owners found that 30.1% had little to no knowledge, 33.4% received instruction from the dealership about these systems, most learned by using these systems while driving, and only 7.7% reported taking a driving course to learn about the ADAS technologies of their cars. During the trial-and-error-based learning process, drivers may not understand or remember all of the system limitations (Mehlenbacher, Wogalter, & Laughery, 2016).

The largest proportion of drivers learn about the ADAS features of their vehicle through trial and error (Harms, Bingen, & Steffens, 2020) (Figure 3-4). (Viktorová & Šucha, 2019) found that the majority of owners do not read their user manuals and instead learn about ADAS technologies by trial and error. (Eby et al., 2017) used data from AAA Longitudinal Research on Aging Drivers studies and also found that the majority of the participants learn about the ADAS in their cars by themselves (Figure 3-5). However, when learning by trial and error, drivers may not fully understand or remember all of the system limitations (Mehlenbacher et al., 2016). Another study by (Harms, Bingen, & Steffens, 2020) found similar results. In short, the trial-and-error method of learning is not sufficient for developing trust and acceptance of ADAS. It is interesting to note, though, that one study by (Zanier, et al., 2019) found that, except for voice control features, most vehicle owners are able to correctly identify which ADAS features their vehicle is equipped with on their own (Figure 3-6).

Very few drivers read the manuals (Figure 3-4 and Figure 3-5) and, even if they do, it is difficult for them to transfer knowledge from the book to real-world application (Mehlenbacher et al., 2016). Similarly, drivers reading the manual may not fully read or understand all important content in it and may have difficulty transferring what they read to real-world driving (Leonard & Karnes, 2000). User manuals often do not have adequate information and are difficult to understand (Jermakian, 2011). (Oviedo-Trespalacios, Tichon, & Briant, 2021) also found that manuals provided by vehicle manufacturers regarding ADAS require years of education in order to be understood by an audience older than eight years. The study also concluded that ADAS user manuals are lacking in standardization regarding content and information delivery. "Findings from this new research show that there is still a lot of work to be done in educating drivers about proper use of ADAS technologies and their limitations," by David Yang, Executive Director of the AAA Foundation for Traffic Safety.

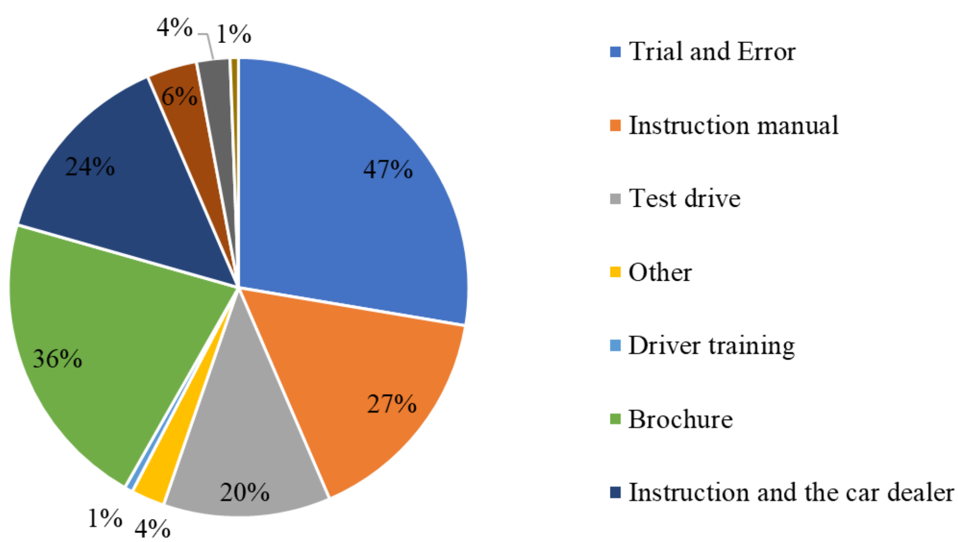


Figure 3-4 How participants learned about their ADAS (Harms, Bingen, & Steffens, 2020)

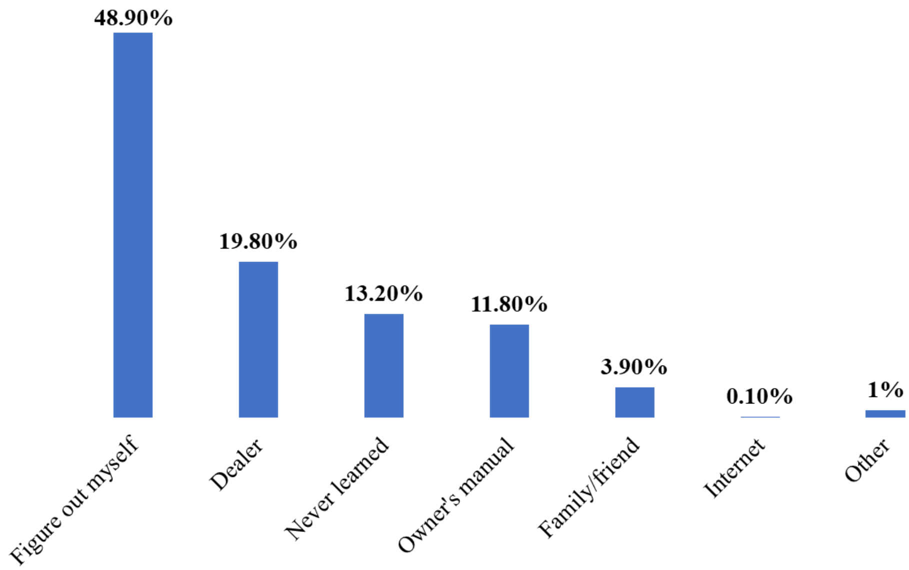


Figure 3-5 Reported percentages of learning methods in how to use technologies, averaged across technologies (Eby et al., 2017)

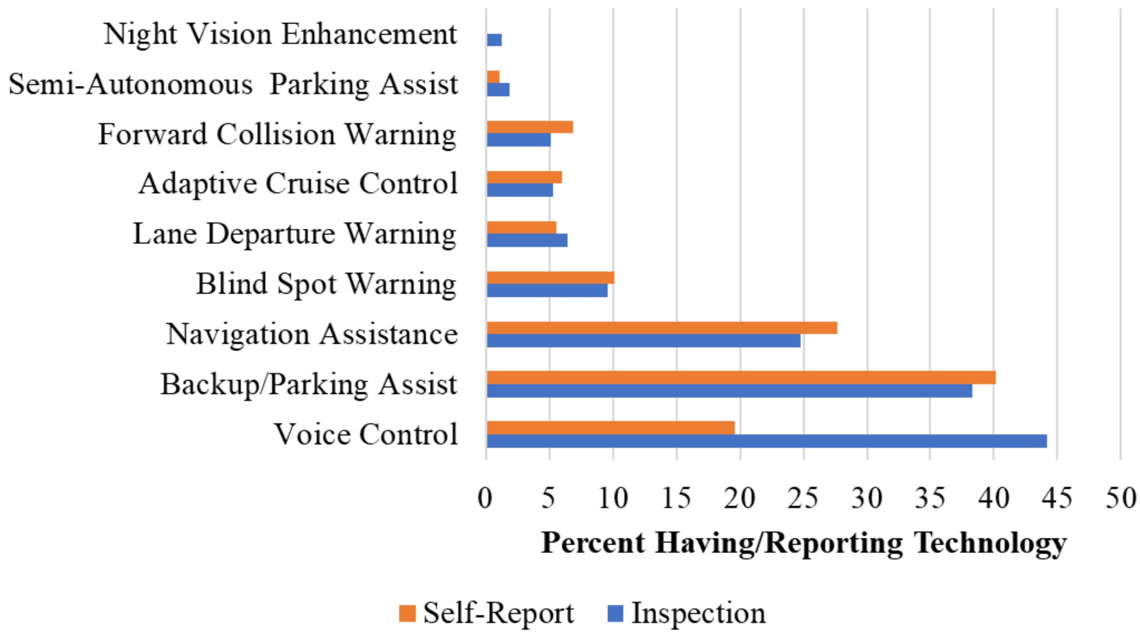


Figure 3-6 Identification of ADAS features by owners and professional inspections (Zanier et al., 2019)

Men were more active than women in learning about their vehicle's ADAS from on-road experience, practice, and by reading the manual (Jenness et al., 2008). (Blömacher, Nöcker, & Huff, 2018) found that incorrect preliminary education about ADAS can lead to poor comprehension and situational awareness of ADAS. (Douglas et al., 2018) ranked the user preference to learn about a new safety feature using a scale of 1 to 8, where 8 is the preferred choice (Figure 3-7). A study conducted by (Abraham et al., 2017) found that most of the current available methods to learn the in-vehicle technology are not preferred by the consumers.

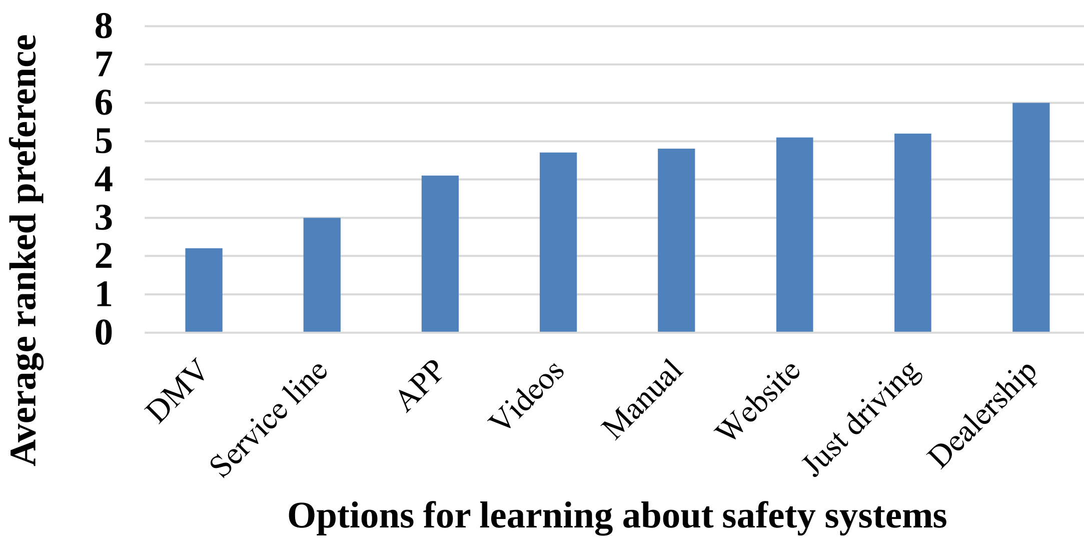
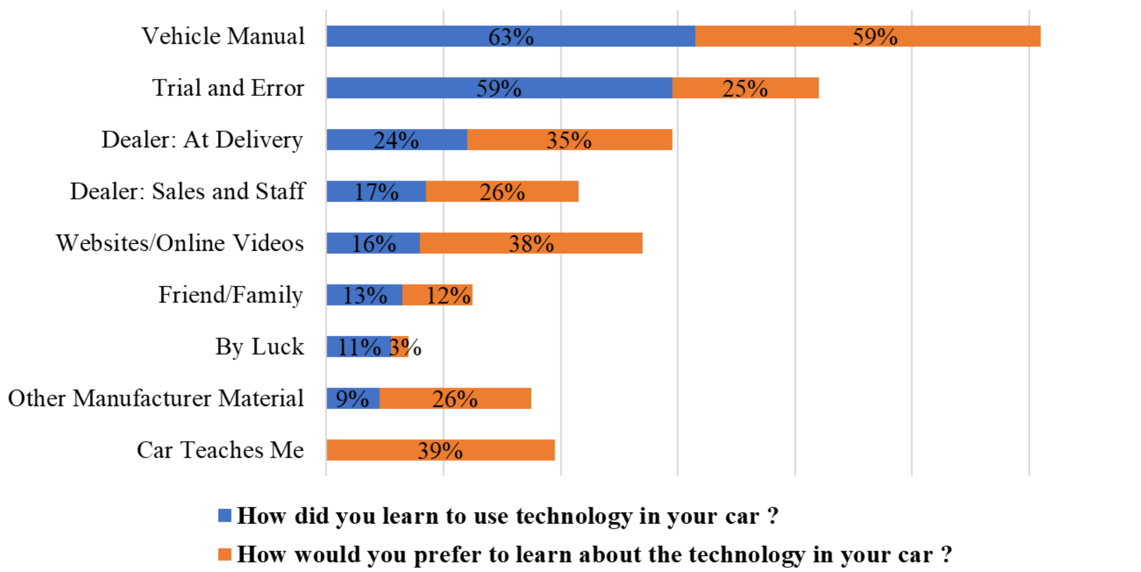


Figure 3-7 Average ranked preferences of how respondents would like to learn about a safety system in a new vehicle (Douglas et al., 2018)



Note: The "car teaches me" option was only presented for "How would you prefer to learn?"

Figure 3-8 Current and preferred methods for learning to use in-vehicle technologies (Abraham et al., 2017)

(Llaneras, 2006) conducted a survey of over 480 vehicle owners to understand the real-world experience of drivers with the use of ADAS technologies. They found that many drivers have misconceptions about the actual performance of the ADAS in their vehicles, indicating that the expectations of drivers do not match with the performance capacity of the technologies. In fact, (Beggiato & Krems, 2013) concluded that failure of ADAS does not negatively affect the driver's trust and acceptance of that technology if the driver knows about the possibility beforehand. (Kazi, Stanton, Walker, & Young, 2007) also found that trust mostly depends on whether the performance of the technology matches the driver's expectations.

3.6 Summary

"Consumers have made it clear what it will take to overcome their doubts – consistent and transparent information – which will help make them feel safer about the idea of riding in a self-driving car," by Greg Brannon, AAA's Director of Automotive Engineering and Industry Relations (Edelstein, 2020). The continuous development of vehicle automation presents an opportunity to enhance transportation safety by minimizing driver error with different, complex, sensor-based systems. However, one of the major challenges towards the successful adoption of

ADAS lies in lack of established education for drivers to learn about and practice with these technologies. More research should be conducted on understanding drivers' knowledge and expectation from ADAS technologies. The level of understanding regarding limitations and operational aspects can play a major role in the safe operation of ADAS technologies in the real-world environment. ADAS developers should make safety assessment reports and instruction manuals publicly available, as this will help to promote public understanding and awareness regarding the limitations and capabilities of the systems. Policymakers and practitioners should also work towards standardizing ADAS terminology, definitions, and education.

4.0 OVERVIEW OF ADAS CRASH REPORTING

4.1 Overview

The following section provides an overview of crashes across the US that involved ADAS and have garnered media attention. This list does not by any means include all crashes involving ADAS. This list is also not a representative sample of vehicle makes, models, or features. Due to limited crash reporting capabilities, accurate data on ADAS-involved crashes is functionally nonexistent in the US. Therefore, media coverage of high-profile incidents provides the best surface-level view of ADAS crashes. As a result of this, Tesla vehicles, anecdotally the most well-known vehicle make with ADAS features and automated capabilities, appear on this list most frequently. This phenomenon does not imply that Tesla vehicles are most frequently involved in ADAS crashes. Links to the corresponding National Transportation Safety Board (NTSB) reports are provided where available.

4.2 Media- and NHTSA-Reported Crashes

4.2.1 May 17, 2016, Williston, FL

On May 7, 2016, a 2015 Tesla Model S crashed into a left-turning vehicle in Williston, FL, resulting in the death of the Tesla driver (Figure 4-1). The Tesla had Traffic-Aware Cruise Control and Autosteer lane-keeping systems (part of the Autopilot suite) active. The Tesla impacted the right, underside of a semitrailer making a left turn from the opposing direction. (NTSB, 2017) determined that the probable cause was the “truck driver’s failure to yield the right of way to the car, combined with the car driver’s inattention due to overreliance on vehicle automation.” It was also determined that the Autopilot system was not designed to and therefore did not recognize the impending crash. Allegedly, the driver was watching a movie at the time of the incident, but NTSB could not confirm this (Lowy & Krisher, 2016). This was the first known “automated vehicle crash” in the US.

Figure 4-1 Overhead view of the crash intersection, showing the route of the eastbound car toward the crash location with a straight arrow, and the route of the left-turning truck, with a curved arrow (NTSB, 2017)

4.2.2 April 29, 2016, Lindon, UT

The vehicles involved were a 2015 Tesla Model S P85D and a parked truck/trailer (Figure 4-2). There were no injuries. The driver alleges that the vehicle crashed into the back of a trailer on its own after being parked. Tesla stated that the ‘Summon’ feature was activated seconds after the car was parked (Lambert, 2016).

Figure 4-2 Crash photo, Lindon, UT (Lambert, 2016)

4.2.3 June 6, 2016, Irvine, CA

The incident involved a 2015 Tesla Model X and minor injuries to a passenger in the vehicle. The driver alleges that the vehicle accelerated unexpectedly while parking and hit a building (Figure 4-3). The car was not in Autopilot mode. Tesla reviewed the vehicle logs, which showed that the driver hit the accelerator (Lambert, 2016).

Figure 4-3 Crash photo, Irvine, CA (Lambert, 2016)

4.2.4 June 22, 2018, Culver City, CA

A fire truck was positioned in the high-occupancy-vehicle (HOV) lane, responding to a previous crash. A 2014 Tesla Model S P85 was in Autopilot mode and had been engaged for a total amount of 29 minutes and 4 seconds (only 78 seconds of which the driver's hands were on the wheel). When the vehicle traveling in front of the Tesla changed lanes to maneuver around the fire truck, the Tesla accelerated, with a forward collision warning given to the driver about 0.48 seconds prior to impact (Figure 4-4). NTSB determined that the probable cause was the "driver's lack of response to the stationary fire truck in his travel lane, due to inattention and overreliance on the vehicle's" ADAS (NTSB, 2018).

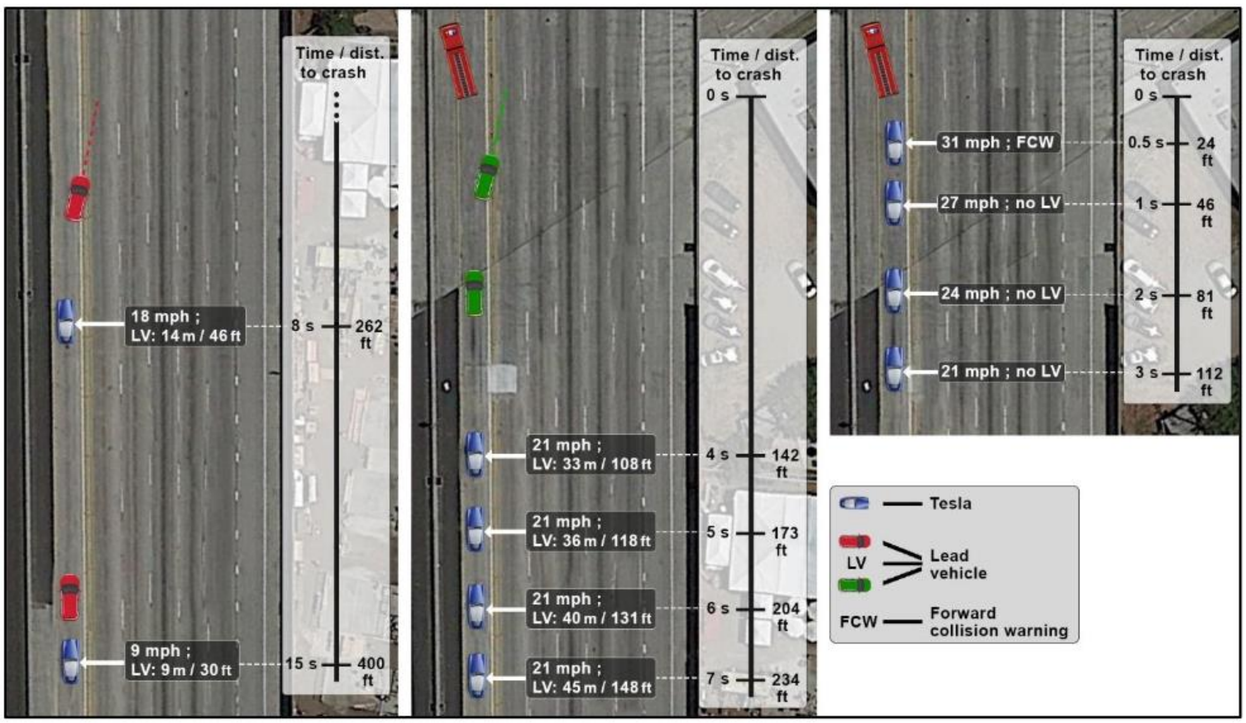


Figure 4-4 Illustration of vehicle positions and movements leading up to the moment of the crash (NTSB, 2018)

4.2.5 March 18, 2018, Tempe, AZ

The automated test vehicle (a 2017 Volvo XC90), operated by the Advanced Technologies Group of Uber Technologies, Inc., struck a female pedestrian walking across the road (Figure 4.5) (Wamsley, 2019). The system detected the pedestrian 5.6 s before impact but never accurately classified the pedestrian or predicted her path. The system also did not alert the driver or apply emergency braking, as these features were disabled. Video shows the driver frequently glancing away from the road toward her cell phone. NTSB determined that the probable cause was “the failure of the vehicle operator to monitor the driving environment and the operation of the automated driving system because she was visually distracted throughout the trip by her personal cell phone. Contributing to the crash were the Uber Advanced Technologies Group’s (1) inadequate safety risk assessment procedures, (2) ineffective oversight of vehicle operators, and (3) lack of adequate mechanism for addressing operators’ automation complacency – all a consequence of its inadequate safety culture. Further factors contributing to the crash were (1) the impaired pedestrian’s crossing of N. Mill Avenue outside a crosswalk, and (2) the Arizona Department of Transportation’s insufficient oversight of automated vehicle testing” (NTSB, 2019).

Figure 4-5 (Left) Location of the crash, showing the paths of the pedestrian and of the Uber test vehicle. (Right) Post-crash view of the Uber test vehicle, showing damage to the right front side (NTSB, 2018)

4.2.6 <u>March 23, 2018, Mountain View, CA</u>

A 2017 Tesla Model X P100D struck a concrete barrier and a crash attenuator (**Error! Reference source not found.**). It was then hit by two more vehicles, causing the lithium battery to catch fire and resulting in the death of the driver. This driver had made documented complaints prior to this crash about lane-keeping issues with the vehicle at this same location (CBS San Francisco, 2020). Specifically, the driver had complained to the dealership about the Autopilot's poor steering of the vehicle between the lane and highway ramp at the same location multiple times. The driver claimed to have to take control of the wheel manually on prior trips. Data from the car showed that the driver did not take steering control or brake the vehicle prior to the crash. He was allegedly playing a mobile game.

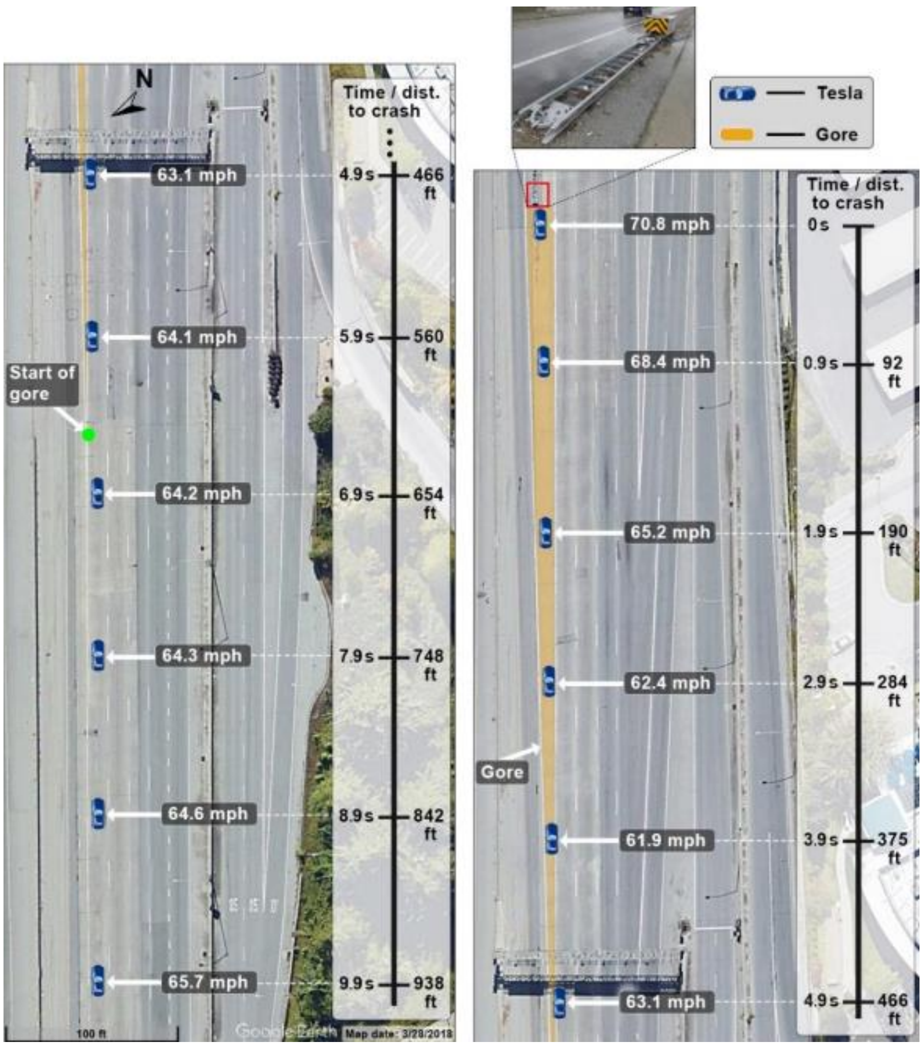


Figure 4-6 Movement of Tesla in the 10 s leading up to the crash (NTSB, 2018).

4.2.7 <u>May 11, 2018, South Jordan, UT</u>

A 2016 Tesla Model S hit a fire department vehicle stopped at a red light (Figure 4-7), resulting in moderate injury to the driver. At the moment of impact, the Autopilot mode was engaged. When the driver tried to apply the brake manually just the moment before the impact, the vehicle's brake failed to engage (Raymond, 2018). The company was sued by the driver. The driver thought, based on her conversation with the salesman, that the car would stop by itself while facing any obstacle on the road. She also believed that she could drive while touching the wheel only occasionally in Autopilot mode. The driver was using her phone to look for her destination at the time of the crash.

Figure 4-7 Crash Photo, South Jordan, UT (Raymond, 2018)

4.2.8 May 29, 2018, Laguna Beach, CA

A Tesla Model S of unknown year was in Autopilot mode and crashed into an unoccupied, parked police car (Figure 4-8) (Allen, 2018). The driver had minor injuries. In the article, it states that Tesla's manual warns: "Traffic-Aware Cruise Control cannot detect all objects and may not brake/decelerate for stationary vehicles or objects, especially in situations when you are driving over 50mph (80kmh) and in situations where a vehicle you are following moves out of your driving path and a stationary vehicle or object is in front of you."

Figure 4-8 Crash Photo, Laguna Beach, CA (Allen, 2018)

4.2.9 <u>September 16, 2018, Hesperia, CA</u>

A 2017 Tesla Model S was involved in a head-on collision with a Dodge Ram pickup truck, resulting in driver injury. The Tesla had crossed over into the opposing lanes to pass other vehicles when it struck the Dodge Ram traveling in the opposite direction (Figure 4.9). It was not reported whether the car was in Autopilot mode or not (Espinoza, 2018)

Figure 4-9 Crash Photo, Hesperia, CA (Espinoza, 2018)

4.2.10 <u>February 18, 2019, Fremont, CA</u>

A Tesla Model X of unknown year crashed into a tree at high speed, and the car caught fire (Figure 4-10). The driver had minor injuries. There was no report of whether the vehicle was in Autopilot mode or not (Louie, 2019).

Figure 4-10 Crash Photo, Fremont, CA (Louie, 2019)

4.2.11 March 1, 2019, Palm Beach County, Florida

A 2018 Tesla Model 3 crashed into a semitrailer (Figure 4-11), resulting in the death of the driver. The driver turned on the Autopilot mode about 10 seconds before the crash and, once it was on, took their hands off the wheel (Youn, 2019). The Autopilot mode failed to prevent the crash.

Figure 4-11 Crash Photo, Palm Beach County, FL (NTSB, 2019)

4.2.12 December 9, 2019, Norwalk, CT

The driver of a 2018 Tesla Model 3 engaged Autopilot in order to check the dog in the back seat. The vehicle then crashed into a police car and another car (Figure 4-12), both of which were stationary (BBC, 2019).

Figure 4-12 Crash Photo, Norwalk, CT (BBC, 2019)

4.2.13 <u>December 29, 2019, Lafayette, CA</u>

A 2016 Tesla Model S ran a red light at high speed and struck a Honda Civic in the intersection. The autopilot mode of the car went off 40 seconds before the impact as the forward collision warning was chiming (Figure 4-13). Also, an FCW warning about 2+ seconds before the impact was given. The occupants of the Honda Civic both were killed instantly and the occupants of the Tesla were taken to a hospital. The FCW system of the Tesla model 3 does not apply any AEB or the brakes. The FCW system just gives a warning to the driver and goes off if precautionary measures are taken by the driver. The speed difference between the Tesla and the Honda Civic was about 63 mph (Anderson, 2020).

Figure 4-13 Crash Photo, Lafayette, CA (Associated Press, 2019)

4.2.14 <u>December 29,2019, Putnam County, IN</u>

A 2019 Tesla Model 3 struck a fire truck that was parked with its emergency lights activated in the passing lane of a divided highway (Figure 4-14). The driver noted that they regularly used Autopilot, but due to the crash impact, they forgot whether Autopilot was engaged at the time of the crash (Associated Press, 2019). The crash resulted in serious injury to the driver and death of the passenger.

Figure 4-14 Crash Photo, Putnam County, IN (Associated Press, 2019)

4.2.15 August 26, 2020, Nash County, NC

A 2020 Tesla Model S struck a police vehicle that was stopped to investigate a prior crash (Figure 4-15) (Rapier, 2020). The driver of the Tesla was watching a movie on his phone while Autopilot was engaged. No one was injured. Autopilot has difficulty detecting stationary objects, especially at night.

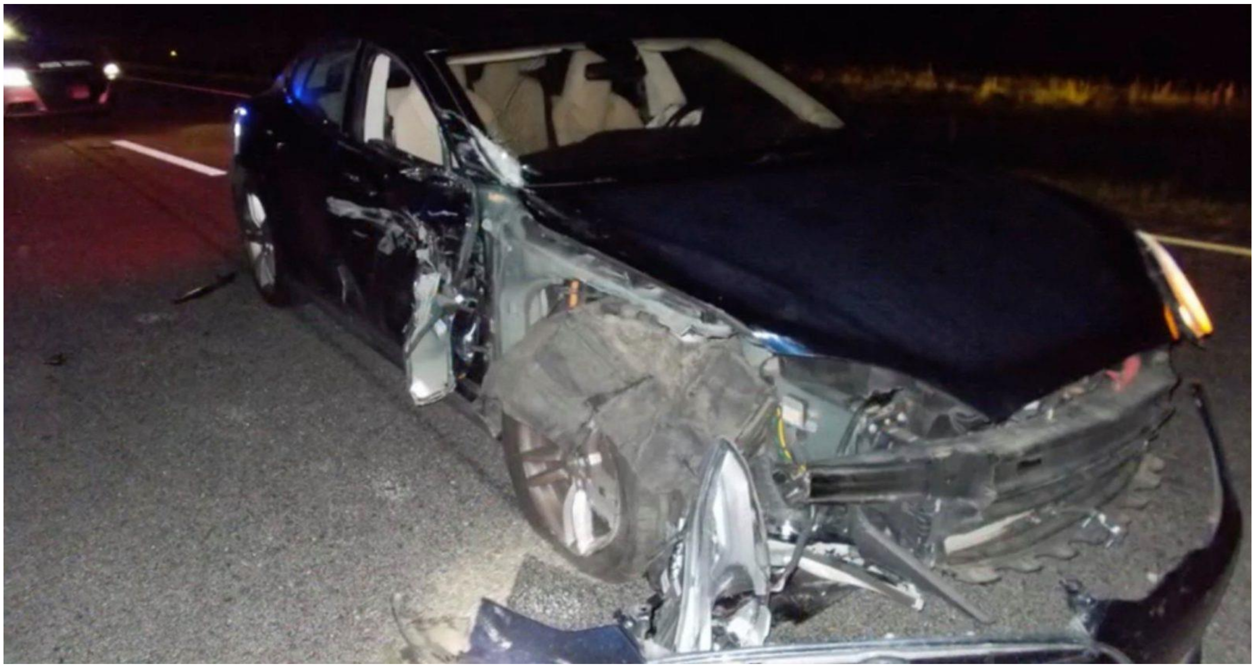


Figure 4-15 Crash Photo, Nash County, NC (Rapier, 2020)

4.2.16 <u>May 20, 2018, Castro Valley, CA</u>

The incident involved a 2018 Tesla Model S. The driver was drunk and operating the vehicle at a high speed. The vehicle went off the road, crashed through a fence, and plunged into a pond (Figure 4-16). It was not reported whether Autopilot was engaged (CBS San Francisco, 2018).

Figure 4-16 Crash Photo, Castro Valley, CA (CBS San Francisco, 2018)

4.2.17 May 8, 2018, Fort Lauderdale, FL

A 2014 Tesla model S P85D was traveling at high speed when it crashed into the wall of a building and caught fire (NTSB, 2018). The driver and one passenger died on scene while a third person was rescued and taken to the hospital (**Error! Reference source not found.**). It was not reported whether Autopilot was engaged (Magnoli, 2018).

Figure 4-17 Crash Photo, Fort Lauderdale, FL (Magnoli, 2018)

4.2.18 <u>July 21, 2019, Greenwood, DE</u>

A 2018 Tesla Model 3 veered off the road and crashed into a building, hitting one woman working in the building (Figure 4-18). While taking a left turn, the vehicle allegedly accelerated suddenly. It was not reported whether Autopilot was engaged (Bies, 2019).

Figure 4-18 Crash Photo, Greenwood, DE (Delaware State Police, 2019)

4.2.19 <u>April 17, 2021, Spring, TX</u>

A 2019 Tesla Model S P100D veered off the road after being unable to navigate a curve and hit some trees. From the site evidence, it was determined that the vehicle was operating at high speed (Figure 4-19). A possible factor in this crash could have been the malfunction of Autopilot (Isidore, 2021).

Figure 4-19 Crash Photo, Spring, TX (Isidore, 2021)

4.2.20 <u>May 5, 2021, Fontana, CA</u>

A 2018 Tesla Model 3 sedan crashed into a semi-trailer, which had crashed and overturned five minutes earlier (**Error! Reference source not found.**). The driver of the Tesla was killed, and the truck driver and one other motorist were injured. Autopilot was engaged at the time of the crash. Prior to the crash, the driver of the Tesla had posted a video on social media of them driving the vehicle without their hands on the wheel or their foot on the pedal (Dazio & Krisher, 2021).

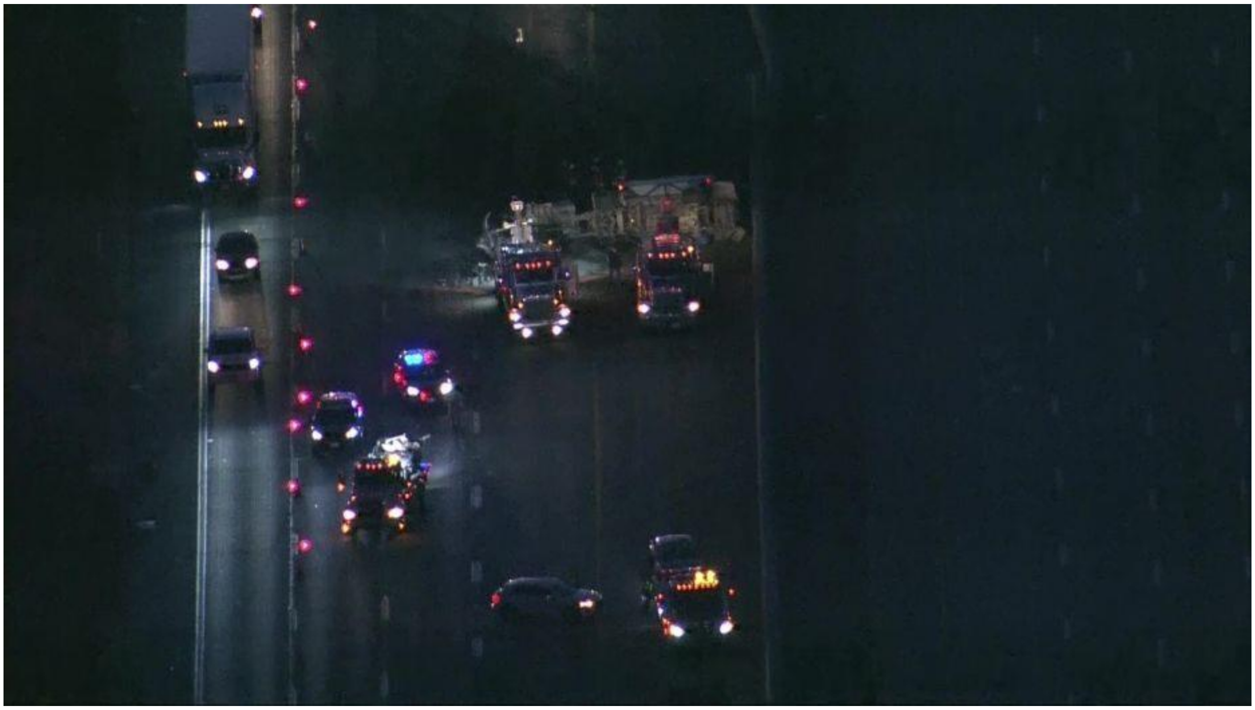


Figure 4-20 Crash Photo, Fontana, California (Dazio & Krisher, 2021)

4.2.21 August 18, 2021, Orange County, FL

A 2019 Tesla Model 3 sedan crashed into a stopped state patrol car, which was assisting a disabled Mercedes Benz GLK350 (which was also struck) on the interstate (Figure 4-21). Autopilot was engaged at the time of the crash (Ramey, 2021).

Figure 4-21 Crash Photos, Orange County, FL (Ramey, 2021)

4.2.22 November 3, 2021, Brea, CA

A 2021 Tesla Model Y was operating in Tesla’s full self-driving (FSD) beta mode. The vehicle took a left turn, went into the wrong lane, and was hit by another car. Although the Tesla alerted the driver halfway through the maneuver into the wrong lane, the driver could not take control of the steering due to the FSD mode (Hawkins, 2021).

4.2.23 April 1, 2022, San Francisco, CA

A driverless car, operated by Cruise (a GM subsidiary), was pulled over by a police officer who noticed that the vehicle did not have anyone behind the wheel. While the vehicle did initially stop, it accelerated away from the police vehicle when the officer approached it. Later, it was pulled over again by the police without incident and no citations were issued (Leswing, 2022). Cruise is currently offering free late-night, driverless rides in downtown San Francisco.

4.3 Summary

This section provided a broad, though incomplete, overview of media coverage of ADAS-related crashes in recent years. It is important to note that nearly all of the crashes covered here involved Tesla models. However, this is not meant to imply that only Tesla vehicles have safety issues. The more likely reason is that Tesla vehicles and the Tesla Autopilot system are more commonly known and recognized as automated vehicle technology. Also, as discussed in the previous chapter, the naming of the Autopilot system itself has been shown to influence overreliance on ADAS.

It should also be noted that many of the crashes covered here involved the ADAS-equipped vehicle striking a stationary object, often a stopped vehicle. This reinforces findings discussed in Chapter 2.0 of ADAS limitations in detecting and reacting to stationary objects. Unfortunately, from this cross-section of media coverage, it seems that this often results in the striking of emergency vehicles and injury of first responders. In the efforts of improving safety for first responders, it is important to take these limitations (and the growing number of vehicles equipped with these systems) into account in TIM strategies.

5.0 RECOMMENDED PUBLIC EDUCATIONAL MESSAGING

5.1 Overview

"Based on data collected from our research, subtle differences in tone and emphasis significantly influenced people's understanding of the technology and their expectations of its capability," said Dr. David Yang, Executive Director of the AAA Foundation for Traffic Safety (Singer & Jenness, 2020), "These systems assist the driver and take some of the stress out of driving, but they don't eliminate the need for drivers to pay attention." This chapter presents recommendations for public messaging regarding ADAS terminology, capabilities, and limitations for the purpose of driver education. These messages are intended to be more general, not manufacturer specific.

5.2 Level of Automation

- All driver assistance and "self-driving" systems currently available on the market are Level 2 automation or less, meaning the driver must always be attentive and in control.
- There are currently no true "self-driving" vehicles (Level 3 or higher) that are legal to use (except in authorized tests).

(Brannon, Funkhouser, Epstein, & Kolodge, 2019) categorized the available ADAS technologies into different categories to minimize confusion and provide consistency regarding the functions of ADAS (Table 5.1).

Table 5.1 Categories of ADAS (Brannon, Funkhouser, Epstein, & Kolodge, 2019)

Category	ADAS Technologies
Driving control assistance	• Adaptive cruise control • Active driving assistance • Lane-keeping assistance
Collision warnings	• Blind-spot warning • Forward collision warning • Lane departure warning • Parking obstruction warning • Rear cross-traffic warning
Collision interventions	• Automated emergency braking • Automated emergency steering • Rear automatic braking
Parking assistance	• Active parking assistance • Remote parking
Other driving assistance systems	• Automatic high beams • Backup camera • Driver monitoring • Head-up display • Night vision • Surround view camera

5.3 Lane Departure Warning and Lane-Keeping Assist

- Lane-keeping assistance actively steers the vehicle to keep it in the lane. Lane departure warning only warns the driver that the vehicle is leaving the lane.
- LKA/LDW work best on straight roads.
- LKA/LDW do not work well on hills or curves.
- LKA/LDW do not work well in cases of: poor pavement or paint condition, exit ramps, sharp curves, construction/temporary markings, missing markings, etc.
- LKA/LDW do not work well at slow speeds.
- If the windshield is broken or replaced, the cameras/sensors should be recalibrated.

5.4 Adaptive Cruise Control

- ACC keeps the vehicle at a consistent speed while maintaining a specified following distance from the vehicle directly in front of it.
- ACC can help to avoid speeding and provide comfort during long drives.
- ACC does not work well on curves or roundabouts.
- ACC works best on roads with good pavement condition and no non-vehicle obstacles/hazards, such as pedestrians or bicyclists.
- ACC may not maintain following distance on steep downslopes.
- ACC should not be used if visibility is impeded by rain, snow, mist, etc.
- ACC does not account for slippery road conditions.
- ACC works best for highway driving, not city driving.
- If the windshield is broken or replaced, the cameras/sensors should be recalibrated.

5.5 Automated Emergency Braking

- AEB monitors the distance to the vehicle directly in front of it and applies the brakes when a minimum distance is reached.
- AEB works best at slow speeds.
- AEB may turn off (with or without notice) due to decreased visibility or vehicle underperformance.
- AEB does not work well for detecting long distance objects – drivers should always look far ahead for upcoming hazards.
- AEB ignores stationary objects and pedestrians.
- AEB does not account for slippery road conditions.
- AEB can reduce crashes due to momentary distractions or sudden, unexpected events.
- AEB does not work well on curves, intersections, or roundabouts.
- If the windshield is broken or replaced, the cameras/sensors should be recalibrated.

5.6 Collision Avoidance Systems

- Collision avoidance systems are often a combination of LDW, FCW, BSM, AEB, RCTW, and other systems.
- Collision avoidance systems may not work if visibility is impeded by rain, snow, mist, bright lights, etc.
- Collision avoidance systems may have false alarms (due to conservative or risk-averse programming).
- Alarms and alerts will be more frequent with risky or aggressive driving habits.
- Collision avoidance systems can drastically reduce rear-end crashes.
- Collision avoidance systems have a limited range for detecting pedestrians and bicyclists.
- Collision avoidance systems do not account for slippery road conditions.

5.7 Parking Assistance

- Parking assistance systems help drivers park, most commonly in situations where blind spots or technical difficulty pose challenges to the driver.
- Parking assistance systems may be available for both perpendicular and parallel parking with some vehicle makes/models.
- Parking assistance systems may park the vehicle very close to the curb or other cars.
- Parking assistance systems can detect stationary objects but are not effective at detecting pedestrians or small children.

5.8 Rear Cross-Traffic Warning

- RCTW monitors traffic behind the vehicle when it is reversing and alerts the driver when there is an obstacle.
- RCTW may have difficulty detecting pedestrians or short objects.
- RCTW may not perform well in situations with low visibility.
- RCTW increases the range of visibility around the vehicle.

5.9 Blind-Spot Monitoring

- BSM monitors the area next to and/or directly behind the vehicle and provides a warning to the driver when another vehicle is present.
- BSM works best at slow speeds.
- BSM may miss high-speed or low-speed objects.
- BSM may not work well during inclement weather.

5.10 Pedestrian Detection Systems

- PD alerts the driver and/or applies the brakes when a pedestrian is detected in the vehicle's path.
- PD works best at slow speeds.
- PD does not work well during inclement weather, at night, or in low-visibility conditions.
- PD may not detect small objects or children.
- PD may not recognize groups of pedestrians (i.e., crowds).
- PD does not function well while making a turn.
- PD is a relatively new and uncommon feature.

6.0 RECOMMENDED FIRST RESPONDER EDUCATION

6.1 Overview

In this chapter, two tools developed for first responders and TIM personnel are discussed. First, a database was created to list the vehicle makes/models/years that are commercially available that have at least one ADAS feature. The database also includes any information that could be found regarding proprietary names for ADAS features and which features are available for each model. Second, a slide deck, materials, and a proposed transcript for a workshop was developed. The goal of this workshop would be to educate first responders and TIM personnel about ADAS terminology, ADAS limitations, driver behavior, and how to use the ADAS vehicle database.

6.2 ADAS Vehicle Database

The list of commercially available ADAS was developed by collecting data from manufacturers' websites, vehicle manuals, and consumer reports. This list will help traffic incident management personnel and other transportation professionals to identify vehicles that are equipped with ADAS technologies. Different sources were used since the majority of manufacturers do not have strong documentation about their available ADAS features. In some cases, the list of available features varies from one source to another. Thus, our database is subject to partial error and incompleteness. However, it has to be noted that this dataset is as accurate as the selected sources are. Besides some of the ADAS features are available in only a limited number of vehicles, which we avoided. We tried to cover the most common features. The Microsoft Excel platform was used to store the data. Appendix A includes the list of ADAS names from the selected manufacturers. Appendix B includes the list of vehicles equipped with ADAS features for the selected time period.

This study attempted to cover the ADAS features of 300 vehicle models from 35 different manufacturers. This database mainly contains information from 2016 to 2021 vehicle models although a small number from the 2015 model year are included. The name of the ADAS feature not only differs from one manufacturer to another--for example, lane tracing assist

(Toyota) vs. lane-keeping aid (Volvo)--but it also changes within the same manufacturer from one year to another, such as blind-spot warning (G70,2021), blind-spot collision avoidance test (GV80, 2021), and smart blind-spot detection (G90, 2019). Having this wide array of terminology, it was difficult to list the same ADAS feature across different manufacturers and years. In order to maintain simplicity and avoid confusion, we considered the most common terminology to indicate the availability of that feature and to store the data.

The increasing demand for safety and convenient driving experience is pushing the automotive industry forward continuously. This cutting-edge technology covers a wide variety of active and passive driving assistance features that improve driver performance by providing safety and comfort. Apart from this, governments of different countries and original equipment manufacturers (OEM) are onboarding different regulations to support the growth of ADAS features for ensuring road safety. The market size and share revenue of ADAS features is expected to yield a compound annual growth rate of 10.2 % between 2022 to 2028 (Facts&Factors, 2021). Overall, ADAS features are fast becoming commercially available and affordable.

Figure 6-1 to Figure 6-9 represent the change in availability of ADAS features over time. Figure 6-1 shows that ACC is the least common feature available among the selected vehicle models. Figure 6-4 shows that the number of vehicles equipped with FCW has increased the most. Figure 6-7 shows that although the number of vehicles equipped with pedestrian detection was low until 2018, after 2019 this feature became very common. Figure 6-9 indicates that from 2016 to 2021, more than 50% of the selected vehicle models are equipped with RCTW, AEB, FCW, LDW and BSM. Also, the availability of RCs has decreased.

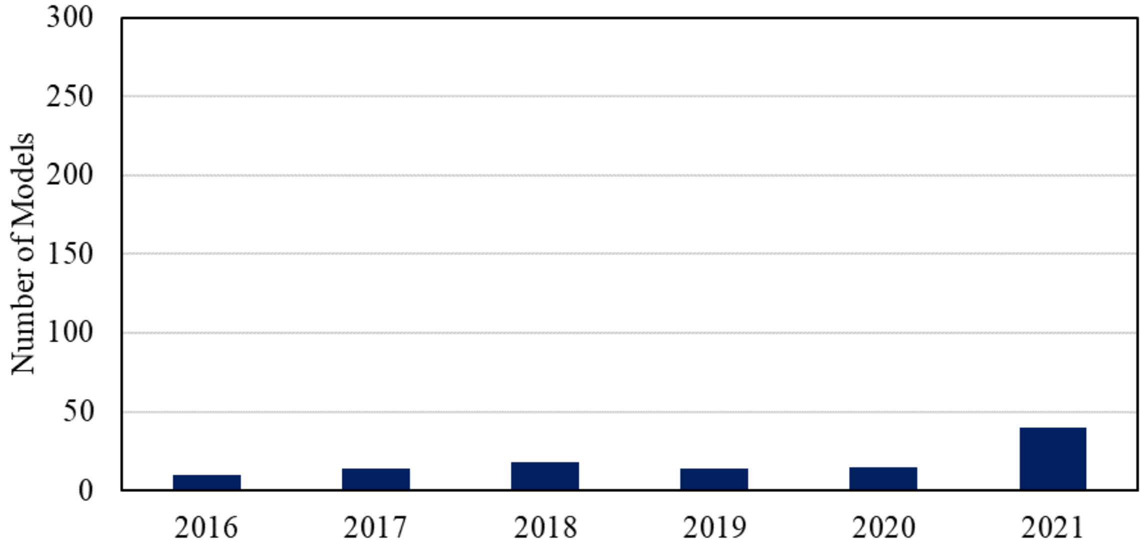


Figure 6-1 Number of Models with Adaptive Cruise Control

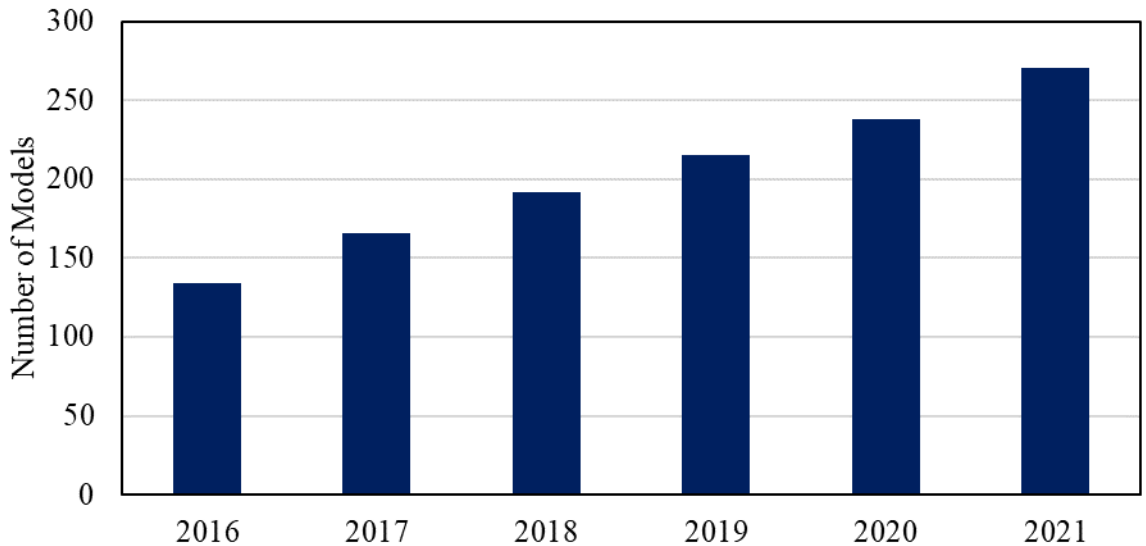


Figure 6-2 Number of Models with Automated Emergency Braking

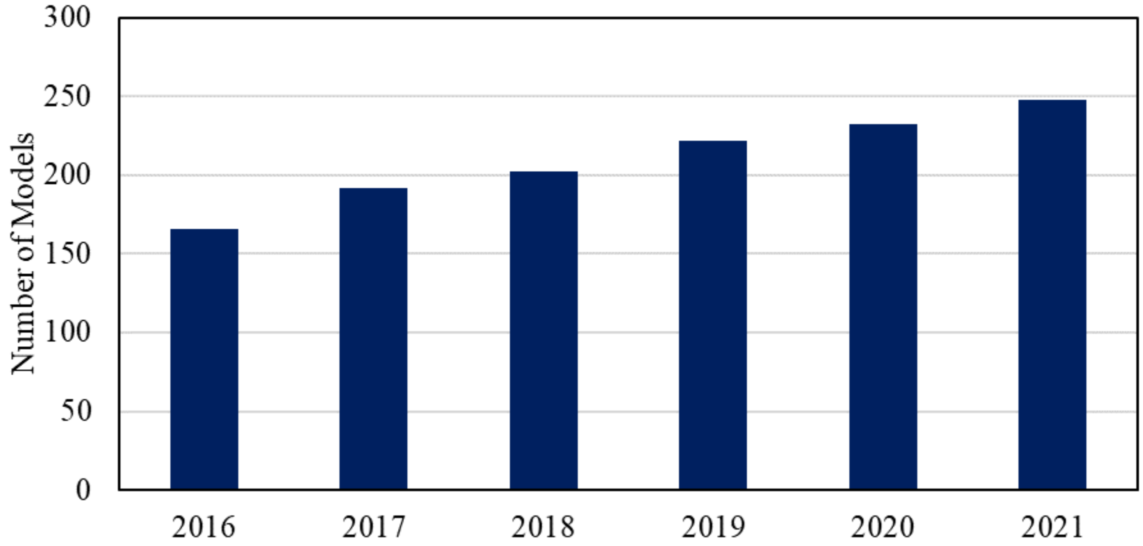


Figure 6-3 Number of Models with Blind-Spot Monitoring

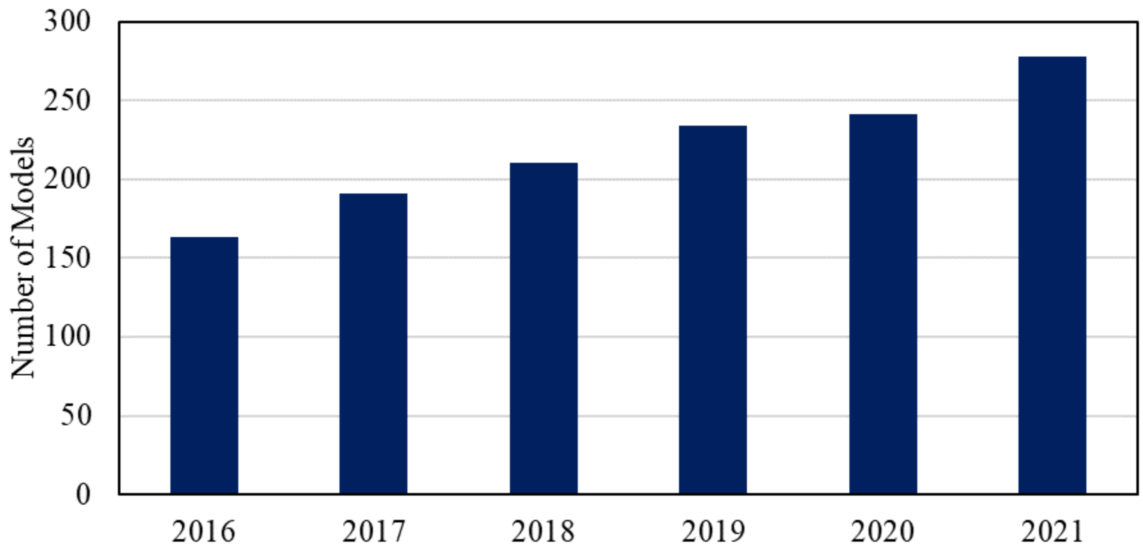


Figure 6-4 Number of Models with Forward Collision Warning

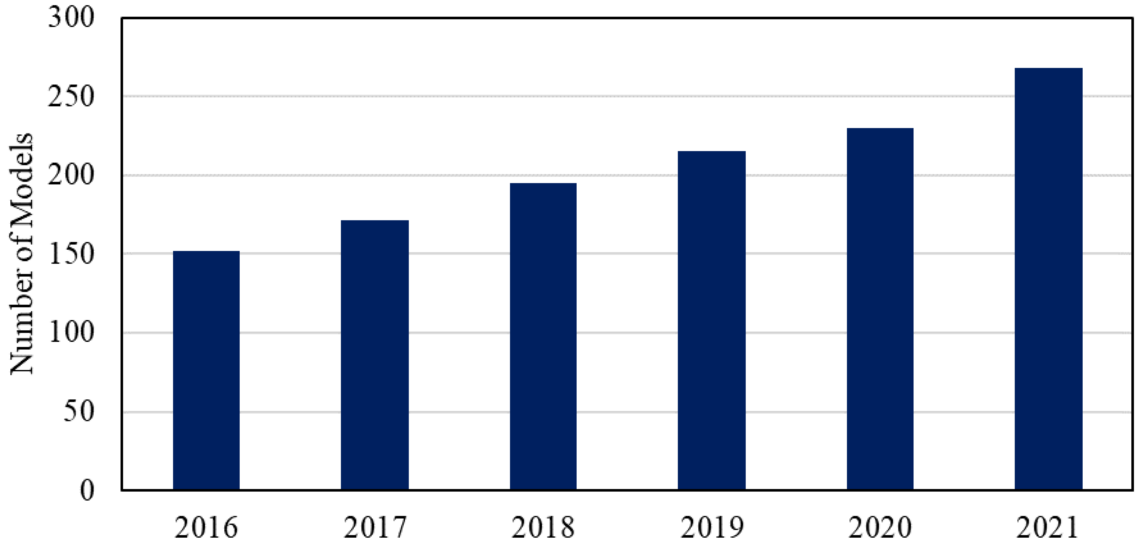


Figure 6-5 Number of Models with Lane Departure Warning

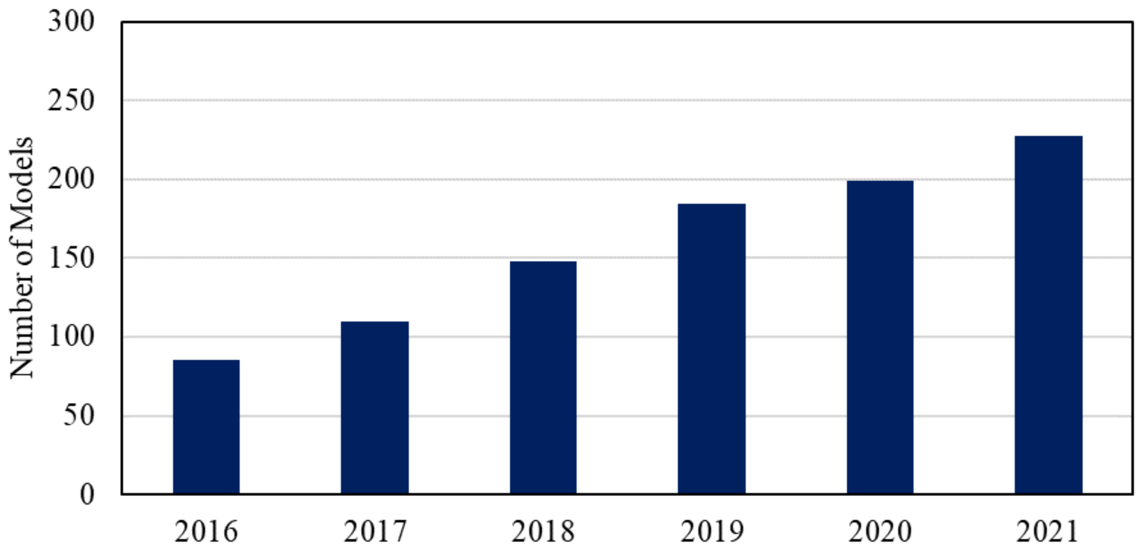


Figure 6-6 Number of Models with Lane-Keeping Assistance

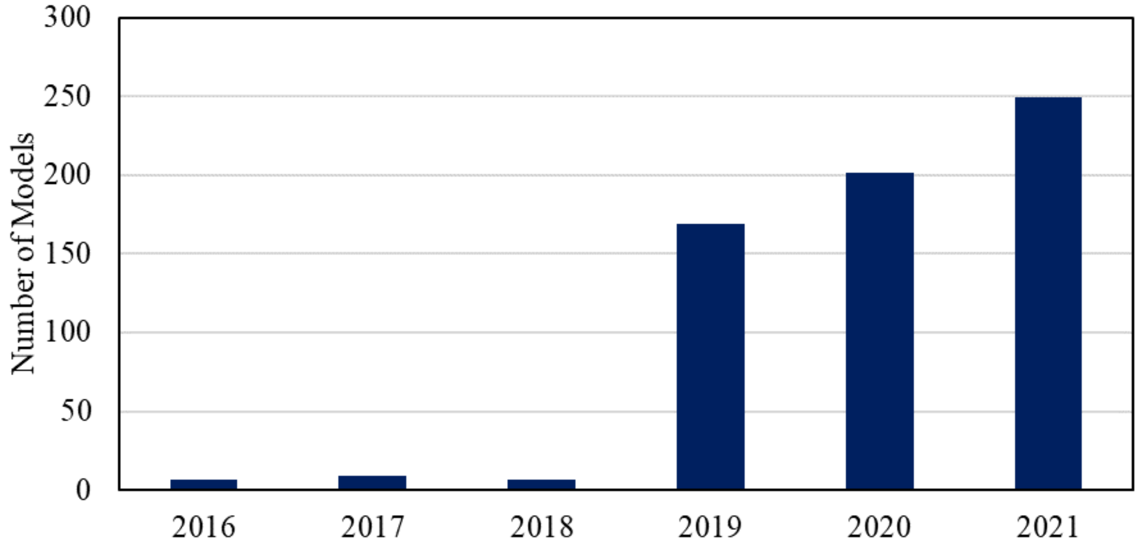


Figure 6-7 Number of Models with Pedestrian Detection

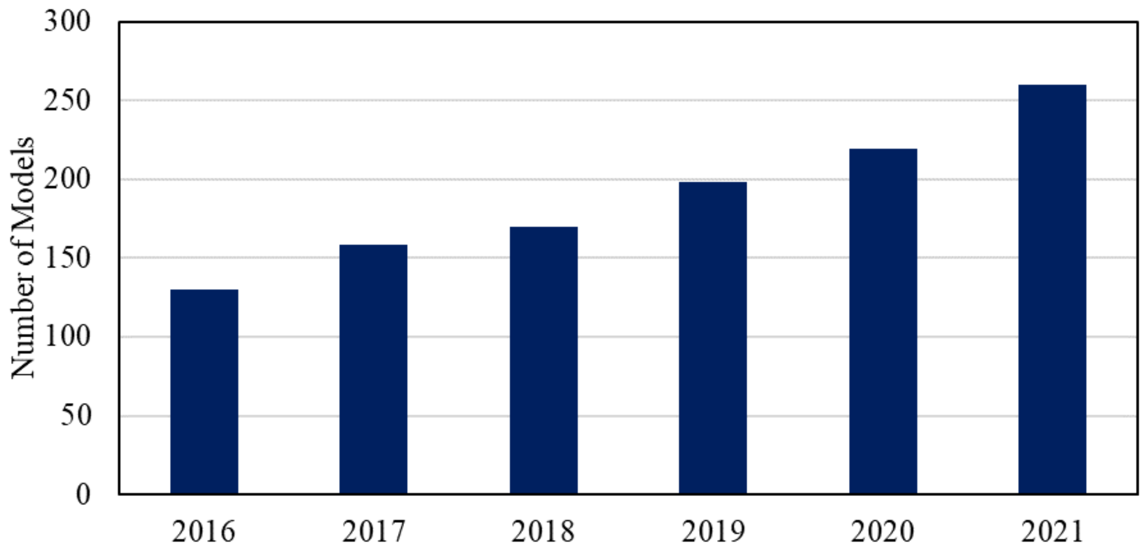


Figure 6-8 Number of Models with Rear Cross-Traffic Warning

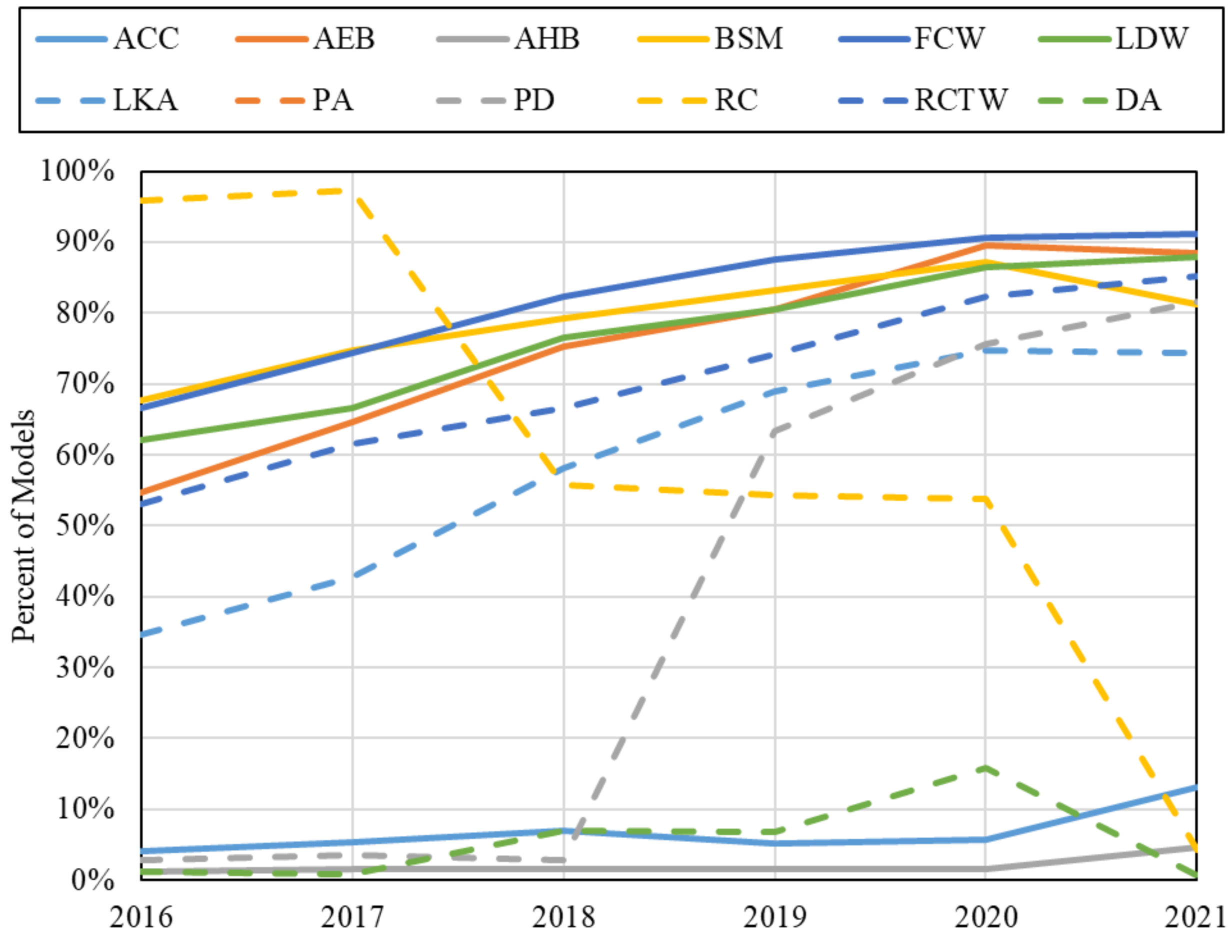


Figure 6-9 Percent of Models with ADAS Features

6.3 Workshop

A workshop was developed for first responders and TIM personnel to provide information and education on ADAS. In particular, a slide deck with accompanying transcript (i.e., suggested talking points) was developed. It is intended to debut at the UDOT Annual Conference after the publication of this report. Afterwards, the transcript will enable other presenters besides the authors of this report to continue implementation of the workshop. The anticipated length of the workshop is 50-60 minutes, and it can be conducted either in person or virtually (with break-out rooms).

The detailed information from the previous chapters in this report was condensed and simplified into the slide deck. The focus of the workshop presentation is on the implications of

ADAS on TIM operations. The workshop begins with an overview of ADAS technology and common definitions/terminology. This introduction to ADAS covers both the increasing availability and general safety benefits of ADAS. In short, this demonstrates that the continued advancement and increased prominence of ADAS is inevitable and is therefore important to understand. Also, this shows how terminology and definitions can help to identify the capabilities of the ADAS.

After the overview and terminology of ADAS, the workshop covers the common technology limitations. The major ADAS features are covered here. It should become relevant to workshop participants that some ADAS features have a lot of overlap in “best conditions for use” while other features may work best in opposing conditions. While having an understanding of these limitations will not imply automatic fault in crashes, first responders may use this understanding to better determine factors that may have impacted a crash.

The limitations section is also followed by the first small-group discussion of the workshop. The discussions are intended to promote inter-disciplinary networking and understanding as well as to promote critical thinking about ADAS and its implications on TIM. Discussion and other forms of in-class participation help to reinforce learning and retention of information. The proposed questions for the first discussion are as follows (but can be edited as necessary):

- What were some of the most common limitations to ADAS?
- What limitations were most concerning to you (in the context of your TIM area of expertise) and why?
- How might this knowledge impact how you respond to/investigate a crash?
- Were there any ADAS limitations listed here that you already knew? Any that you were surprised by?

Next, the workshop covers driver behaviors, perceptions, and education regarding ADAS. While first responders and UDOT cannot directly change driver behavior, understanding how ADAS may impact driver behavior can help to improve safety. For example, if first responders know that distracted driving is more common with ADAS, they may take steps to better notify drivers of or better protect crash scenes. This leads directly into slides discussing TIM implications, particularly noting a list of ADAS-related crashes that involved first responders or first responder vehicles. This is followed by the second small-group discussion with the following proposed questions:

- How does this relate to your concerns about ADAS that were discussed earlier?
- How might this knowledge impact how you respond to/investigate a crash?

Finally, the workshop introduces the ADAS vehicle and name databases discussed in the previous subsection. This will ideally promote the use of this resource in crash response and investigation activities. In the interest of future research, promoting the use of this database would also ideally increase the use of greater consistency of noting ADAS in crash reports. This section of the workshop concludes with a small-group activity where participants are asked to use the database to determine which ADAS features their vehicle (real or hypothetical) possesses. This provides an opportunity for first responders to practice using the database before potentially using it in the field.

There is a brief wrap-up at the end of the slide deck, which emphasizes the key points from the workshop. The end of the slide deck also includes a list of sources for specific citations and figures used. The proposed transcript for the workshop is provided in Appendix C.

6.4 Summary

In this chapter, the resources developed for first responders and TIM personnel were discussed. A database of ADAS names and vehicles was developed for use in crash response and investigation (as well as possible future research). A workshop was developed to educate first responders on ADAS, how it may impact their work, and how to use the ADAS database. As ADAS (and, in the future, autonomous vehicles) become more prevalent, it is important for first responders to understand how these technologies work, both for responding to crashes and protecting themselves and others during crash response.

7.0 CONCLUSIONS

7.1 Summary

The overall goal of this study was to develop educational and informational materials for the public and first responders regarding advanced driving assistance systems. With this primary goal, the following research tasks were completed:

- Review previous studies of ADAS limitations and publicly reported crashes.
- Develop a list of commercially available ADAS technologies.
- Summarize necessary information related to ADAS technologies for the public and first responders.

Chapter 1.0 provided a general background about the study, while Chapter 2.0 covered the technical limitations of the existing ADAS features from previous studies and field tests. Chapter 3.0 described driver behavior, education, and overall perception of ADAS technologies. Chapter 4.0 reported a selection of media reports of ADAS crashes. Chapter 5.0 outlined recommended public messaging regarding ADAS. Chapter 6.0 discussed the ADAS database and educational workshop developed for first responders. This chapter summarizes the key findings as well as the limitations and challenges of this study.

7.2 Findings

7.2.1 ADAS Technology Limitations

The usage and availability of ADAS is increasing continuously. In general, ADAS has improved overall road safety. However, there are some concerning new trends emerging regarding driver behavior in relation to ADAS. Although a wide range of ADAS technologies are commercially available on the market, there are still major challenges ahead for their successful adoption. Most ADAS features do not communicate with each other or with their surroundings, such as other cars or infrastructure. Apart from this, different ADAS features have their own specific shortcomings. Therefore, drivers should always maintain control and attention while driving the currently available ADAS-equipped vehicles.

7.2.2 Driver Perspective

ADAS has changed the driving experience by alerting the driver or taking control of the vehicle in order to avoid a potential collision. The main purpose of ADAS is to assist drivers with their driving tasks, not to replace them. The majority of drivers are familiar with ADAS but are also skeptical about the technology (CCC , 2021). In general, manufacturers should observe driver behavior with ADAS in order to understand the user-system relationship in depth. However, drivers need more thorough and consistent education about the capabilities and limitations of ADAS technologies to promote proper use.

7.2.3 ADAS Crash Coverage

The ADAS crash coverage section of this study covered a selection of crashes involving vehicles equipped with ADAS. However, because Tesla is often very closely associated with autonomous vehicle technologies, most of the crashes discussed involved Tesla vehicles. Since there is no consistent, established practice across the US to report ADAS-related crashes, media coverage is the main source of information on this topic. There may be many other non-Tesla ADAS crashes but, due to the insufficient media coverage, they could not be included in this report. Based on the media coverage and official crash investigation that do exist, it can be said that over-reliance and lack of knowledge seem to be some of the common factors in ADAS-related crashes.

7.2.4 Public Messaging

Most of the driving assistance features currently available on the market are automation Level 2, which means that drivers are meant to always maintain control and attention. These technologies are not capable of driving alone without the driver's intervention. The goal of the recommended public messaging was to provide a mix of both positive and negative statements about ADAS capabilities, so as to not discourage use of ADAS but promote proper use. The messages contain simplified information about both "best conditions for use" and when not to rely on ADAS. There are also messages that place emphasis on driver attention and control.

7.2.5 First Responder Education

In addition to improving driver knowledge and behavior with ADAS, increasing first responder knowledge and safety can also be achieved. A database of ADAS features names and vehicles was developed for first responders and TIM personnel. Additionally, a workshop was developed to provide directed education on ADAS and the database to first responders. By promoting safe TIM surrounding ADAS, UDOT will get one step closer to Zero Fatalities.

7.3 Limitations and Challenges

One of the major challenges associated with this study was the collection of the commercially available ADAS features of different vehicles. For most vehicles, documentation (if it exists) does not provide clear (or any) information regarding ADAS availability. Many manufacturer websites only contain information about the latest year models or do not have any information regarding ADAS features. Given the amount of available ADAS features and the range of years covered in this study, only the most common ADAS were included in the database. Since there were so many different names for a single ADAS feature, a single, common name was used to simplify the terminology issue of the database, meaning that there may be some slight variation in the exact capabilities of an ADAS feature between vehicle models.

Another challenge was that are very few ADAS-related crashes that have been officially investigated where the findings are publicly available and easily findable. For this research, National Transportation Safety Bureau reports provided the greatest detail but only covered very severe crashes. In media coverage, it was quite difficult to find the description of the crash details. Additionally, accompanying pictures or figures were not available for some crashes.

8.0 RECOMMENDATIONS AND IMPLEMENTATION

First, the authors recommend publishing the public messaging on UDOT's website. One suggestion would be on the "Public" page (https://www.udot.utah.gov/connect/public/), perhaps similarly to the button "How do traffic signals work?" Alternatively, the messages could be periodically published via social media or variable message signs where appropriate. Using an informational poster or distributing brochures at outreach events could also be effective. UDOT may also consider providing the public messaging to vehicle dealerships.

Second, the authors recommend making the ADAS name and vehicle databases publicly available and downloadable (preferably as an uneditable PDF). Links to these databases should be included with public messaging and first responder resources (particularly the workshop).

Third, the authors recommend making the first responder workshop publicly available and downloadable. While the workshop will be debuted at the UDOT Annual Conference following the publication of this report, continued promotion of the workshop is important. In particular, promoting the workshop at Utah TIM Coalition meetings and activities is recommended. Though the discussion activities in the workshop are important, it could be possible to incorporate the workshop as a video on the UDOT or UDOT University YouTube channels.

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APPENDIX A: Alternative ADAS Names

Make	Overall ADAS	Adaptive Cruise Control (ACC)	Automated Emergency Braking (AEB)
Acura	AcuraWatch™	Adaptive Cruise Control	Collision Mitigation Braking System
Alfa Romeo	Active Driver Assistance	Active Cruise Control	Highway and Traffic Jam Assist
Audi	pre sense®	Adaptive Cruise Control	Pedestrian and Stationary Vehicle Detection and Preparation
Bentley		Adaptive Cruise Control	
BMW		Cruise Control	Emergency Brake Assist
Buick		Adaptive Cruise Control	Enhanced Automatic Emergency Braking
Cadillac			Automatic Emergency Braking
Chevrolet	Chevy Safety Assist	Adaptive Cruise Control	Automatic Emergency Braking
Chrysler		Adaptive Cruise Control	
Dodge		Adaptive Cruise Control	
Fiat		Adaptive Cruise Control	
Ford	Safe and Smart	Intelligent Adaptive Cruise Control	Pre-Collision Assist with Automatic Emergency Braking/ Evasive Steering Assist
Genesis		Smart Cruise Control with Stop and Go	Forward Collision Avoidance
GMC	ProSafety Package	Adaptive cruise control	Enhanced Automatic Emergency Braking
Honda	HondaSensing	Adaptive Cruise Control	Collision Mitigation Breaking System™
Hyundai	Hyundai SmartSense	Smart Cruise Control with Stop and Go	Automatic Emergency Braking
Infiniti	Propilot Assist		Forward Emergency Braking
Jaguar	InControl	Adaptive Cruise Control with que Assist	Autonomous Emergency Breaking/ Intelligent Emergency Braking
Jeep		Adaptive Cruise Control with Stop and Go	Autonomous Emergency Braking
Kia		Smart Cruise Control	
Land Rover	InControl	Adaptive Cruise Control	Emergency Braking
Lexus	Lexus Safety System+	Dynamic Radar Cruise Control	
Maserati		Adaptive Cruise Control with Stop and Go	
Mazda	I-Activesense	Mazda Radar Cruise Control	

Make	Overall ADAS	Adaptive Cruise Control (ACC)	Automated Emergency Braking (AEB)
Mercedes-Benz	Intelligent Drive	Active Distance Assist Distronic	
Mini Cooper		Adaptive Cruise Control	
Mitsubishi			
Nissan	Intelligent Safety Shield		Automatic Emergency Braking
Porsche		Adaptive Cruise Control	Collision and Brake Assist
Ram		Adaptive Cruise Control with Stop and Go	Smart Braking Technology
Subaru	EyeSight®	Adaptive Cruise Control/ Advanced Adaptive Cruise Control	Pre-Collision Braking/Pre-Collision Throttle Management
Tesla	Enhanced Autopilot		Automatic Emergency Braking
Toyota	Safety Sense™	Dynamic Radar Cruise Control	Pre-Collision System with Pedestrian Detection
Volkswagen		Adaptive Cruise Control	Front Assist
Volvo	IntelliSafe	Adaptive Cruise Control	Collision Avoidance

Make	Automatic High Beams (AHB)	Blind-Spot Monitoring (BSM)	Forward Collision Warning (FCW)
Acura	Auto High-Beam Headlights	Blind Spot Assist	
Alfa Romeo	Automated High Beams	Active Blind Spot Assist	Forward Collision Warning Plus
Audi		Side Assist	
Bentley			
BMW			
Buick	IntelliBeam Auto High Beams	Lane Change Alert with Side Blind Zone	Forward Collision Alert/ Following Distance Indicator
Cadillac		Lane Change Alert with Side Blind Zone Alert	Forward Collision Alert
Chevrolet	Intellibeam® Auto High Beam Assist	Lane Change Alert with Side Blind Zone Alert	Forward Collision Alert/ Following Distance Indicator
Chrysler		Blind Spot Monitoring	Forward Collision Warning with Active Braking
Dodge	Automatic High Beam Headlamps	Blind Spot Monitoring	Full Speed Forward Collision Warning
Fiat		Blind Spot Monitoring	Forward Collision Warning
Ford	Auto High-Beam Headlamps	Blind Spot Information System	
Genesis		Blind Spot Collision Avoidance Assist	

Make	**Automatic High Beams (AHB)**	**Blind-Spot Monitoring (BSM)**	**Forward Collision Warning (FCW)**
GMC		Side Blind Zone Alert	Forward Collision Alert/ Following Distance indicator
Honda	Auto High-Beam Headlights	LaneWatch™/Blind Spot Information System	
Hyundai	High Beam Assist	Blind Spot Collision Avoidance Assist	
Infiniti	High Beam Assist		Forward Thinking Detection
Jaguar		Blind Spot Monitor/ Blind Spot Assist	
Jeep		Blind Spot Monitoring and Rear Cross Path Detection	Forward Collision Warning with Active Braking
Kia		Blind Spot Collision Warning/ Blind Spot Detection	Forward Collsion Warning Systems
Land Rover			
Lexus	Intelligent High Beams		Pre Collision System
Maserati		Active Blind Spot Assist	Forward Collision Warning Plus
Mazda	High Beam Control	Blind Spot Monitoring	Forward Obstruction Warning
Mercedes-Benz	Adaptive Highbeam Assist		Pre-Safe
Mini Cooper			Crash Sensor System
Mitsubishi	Automatic High Beam Headlights	Blind Spot Warning and Lane Change Assist	Forward Collision Mitigation
Nissan	High Beam Assist	Blind Spot Warning	
Porsche	Advanced Lighting/ Light Assistance Systems		
Ram		Blind Spot Monitoring	Forward Collision Warning
Subaru			
Tesla		Blind Spot Collision Warning Chime	Forward Collision Warning
Toyota	Automatic High Beams		
Volkswagen		Side Assist	
Volvo	Active High Beam	Blind Spot Information System	
Make	**Lane Departure Warning (LDW)**	**Lane-Keeping Assistance (LKA)**	**Parking Assistance (PA)**
Acura		Lane Keeping Assist	
Alfa Romeo	Lane Departure Warning	Lane Keeping Assist	Rear Park Sensors
Audi		Active Lane Assist	
Bentley	Lane Assist Lane Departure Warning	Lane Assist	Front and Rear Parking Sensors/ Park Assist

Make	Lane Departure Warning (LDW)	Lane-Keeping Assistance (LKA)	Parking Assistance (PA)
BMW	Lane Departure Warning	Lane Keeping Assistant/ Steering and Lane Control Assist	Parking Assist
Buick	Lane Keep Assist with Lane Departure Warning		Rear Park Assist/ Enhanced Automatic Parking Assist
Cadillac	Lane Keep Assist with Lane Departure Warning		Front and Rear Park Assist/ Automatic Parking Assist with Braking
Chevrolet	Lane Keep Assist with Lane Departure Warning	Lane Keep Assist with Lane Departure Warning	Rear Park Assist
Chrysler	Lane Departure Warning with Lane Keeping Assist		Rear and Front Park Assist/ Parallel and Perpendicular Park Assist
Dodge			
Fiat	Lane Departure Warning with Lane Keeping Assist		
Ford		Lane Keeping System	Active Park Assist 2.0
Genesis			Reverse Parking Collision Avoidance Assist
GMC	Lane Departure Warning	Lane Change Alert with Side Blind Zone Assist	Front and Rear Park Assist/ Automatic Parking Assist with Braking
Honda	Road Departure Mitigation Systems	Lane Keeping Assist System	
Hyundai	Lane Departure Warning	Lane Keeping Assistance/ Lane Change Assist	Advanced Smart Parking Assist System
Infiniti	Lane Departure Warning		
Jaguar	Lane Departure Warning	Lane Keeping Assist	Front and Rear Parking/ Park Assist
Jeep	Lane Departure Warning	Lane Keeping Assist	Rear Park Assist System
Kia		Lane Keeping Assist/ Lane Following Assist	
Land Rover		Lane Keep Assist	Front and Rear Parking AID
Lexus		Lane Assistance	
Maserati		Lane Keeping Assist	
Mazda	Lane Departure Warning	Lane Keep Assistance	
Mercedes-Benz			
Mini Cooper		Dynamic Stability Control	
Mitsubishi	Lane Departure Warning		
Nissan			
Porsche	Lane Change Assist	Lane Keeping Assist	Parking Assistance System
Ram	Lane Departure Warning	Lane Keeping Assist	Guided Parking
Subaru	Sway Warning	Lane Keep Assist	
Tesla	Lane Departure Avoidance		Autopark

Make	Lane Departure Warning (LDW)	Lane-Keeping Assistance (LKA)	Parking Assistance (PA)
Toyota	Lane Departure Alert	Lane Tracing Assist	
Volkswagen		Lane Assist	Park Assist
Volvo	Lane Departure Warning	Lane Keeping Aid	
Make	**Pedestrian Detection (PD)**	**Rearview Camera (RC)**	**Rear Cross-Traffic Warning (RCTW)**
Acura			Rear Cross Traffic Monitor
Alfa Romeo		Back Up Camera	
Audi	Pedestrian and Stationary Vehicle Detection and Preparation	Parking System Plus	Rear Collision Detection
Bentley			Rear Cross Traffic Warning
BMW			
Buick	Front Pedestrian Braking	HD Surround Vision	Rear Cross Traffic Alert
Cadillac	Front Pedestrian Braking		Rear Cross Traffic Alert
Chevrolet	Front Pedestrian Braking	Rear Camera Mirror/ High Definition Surround Vision	Rear Cross Traffic Alert
Chrysler	Pedestrian Automated Emergency Braking	360° Surround View	Rear Cross Path Detection
Dodge		Parkview Rear Back Up Camera	
Fiat		Parkview Rear Back Up Camera	Rear Cross Path Detection
Ford	Pre-Collision Assist with Automatic Emergency Braking	Rear View Camera	Cross-Traffic Alert/ Reverse Brake Assist
Genesis			Rear Cross-Traffic Collision Avoidance Assist
GMC	Front Pedestrian Braking	High Definition Rear Vision Camera	Rear Cross Traffic Alert
Honda		Multi-Angle Rearview Camera	Cross Traffic Monitor
Hyundai	Pedestrian Detection	Surround View Monitor	Rear Cross Traffic Alert
Infiniti	Pedestrian Detection	Around View	Rear Cross Traffic Alert
Jaguar		Rear View Camera/ 360° Surround Camera	
Jeep			Rear Cross Path Detection System
Kia		Rear Camera Display	Rear Cross Traffic Collision Avoidance Assist
Land Rover			
Lexus			
Maserati		Surround View Camera	

Make	Pedestrian Detection (PD)	Rearview Camera (RC)	Rear Cross-Traffic Warning (RCTW)
Mazda			
Mercedes-Benz			
Mini Cooper			
Mitsubishi	Pedestrian Detection		Rear Cross Traffic Alert
Nissan	Pedestrian Detection		Rear Cross Traffic Alert/ Rear Automatic Braking
Porsche			
Ram	Pedestrian Emergency Braking	360° Surround View Camera	
Subaru			
Tesla	Pedestrian Warning System	Rearview camera	
Toyota	Pre-Collision System with Pedestrian Detection		
Volkswagen		Rear View Camera	
Volvo			Cross Traffic Alert

Make	Traffic Sign Recognition (TSR)	Driver Attention (DA)	Miscellaneous
Acura	Traffic Sign Recognition		Road Departure Mitigation, Traffic Jam Assist
Alfa Romeo	Traffic Sign Recognition	Driver Attention Assist	Highway and Traffic Jam Assist, Hill Descent Control
Audi			Night Vision Assistant, Traffic Jam Assist
Bentley	Traffic Sign Recognition		Electronic Night Vision
BMW	Road Sign Recognition		Night Vision, Traffic Jam Assistant, Hill Start Assist
Buick			
Cadillac			Night Vision
Chevrolet			
Chrysler			
Dodge			Hill Start Assist
Fiat			
Ford			Rain Sensing Wipers, Hill Descent Control
Genesis			Highway Driving Assist
GMC			
Honda	Traffic Sign Recognition		Road Departure Mitigation System
Hyundai		Driver Attention Alert	Safety Exit Assist
Infiniti			
Jaguar	Traffic Sign Recognition	Driver Condition Monitoring	
Jeep			
Kia			

Make	Traffic Sign Recognition (TSR)	Driver Attention (DA)	Miscellaneous
Land Rover			Hill Descent Control
Lexus	Road Sign Assist		
Maserati	Traffic Sign Recognition		Highway Assist System, Hill Descent Control
Mazda		Driver Attention Alert	Adaptive Front Lighting, Hill Launch Assist
Mercedes-Benz		Attention Assist	Night View Assist Plus
Mini Cooper			
Mitsubishi			Active Stability Control, Rain Sensing Wipers
Nissan			
Porsche	Traffic Sign Recognition		Night Vision Assist, Traffic Jam Assistant
Ram			Hill Start Assist
Subaru			
Tesla			
Toyota	Road Sign Assist		
Volkswagen	Sign Assist		Driver Profile Selection, Night Vision, Traffic Jam Assist, Auto Hold
Volvo			

Make	Reference Website
Acura	https://www.acura.com/safety
Alfa Romeo	https://www.alfaromeo.com/advanced-driver-assistance-systems-adas
Audi	https://www.audiusa.com/us/web/en/innovation/driver-assistance.html
Bentley	https://safecarnews.com/staging/new-bentley-bentayga-fitted-with-range-of-driver-assistance-systems_s6157/
BMW	https://www.bmw.com/en/innovation/the-main-driver-assistance-systems.html
Buick	https://www.buick.com/suvs/envision
Cadillac	https://www.cadillac.com/suvs/xt5
Chevrolet	https://www.chevrolet.com/safety
Chrysler	https://www.chrysler.com/pacifica/safety-security.html
Dodge	https://www.dodge.com/challenger/safety-security.html
Fiat	https://www.fiatusa.com/2021/500x/safety-security.html
Ford	https://www.ford.com/technology/driver-assist-technology/
Genesis	https://www.genesis.com/worldwide/en/models/luxury-sedan-genesis/g80/safety.html
GMC	https://www.gmc.com/safety-features
Honda	https://automobiles.honda.com/safety
Hyundai	https://www.hyundai.com/au/en/why-hyundai/autonomous-driving/safety
Infiniti	https://www.infinitiusa.com/vehicles/crossovers/qx50/features.html
Jaguar	https://www.jaguar.com/incontrol-global/incontrol/driver-assistance/index.html
Jeep	https://www.jeep.com/compass/safety-security.html
Kia	https://www.kiastore.com/kia-safety-features/
Land Rover	https://www.landroverusa.com/vehicles/range-rover/key-features.html
Lexus	https://drivers.lexus.com/lexusdrivers/technology/safety
Maserati	https://www.maseratiusa.com/us/en/ownership/guides-and-documentation/safety

Make	Reference Website
Mazda	https://www.mazda.com/en/innovation/technology/safety/active_safety/
Mercedes-Benz	https://www.mbusa.com/en/best-or-nothing/safety
Mini Cooper	https://www.miniusa.com/why-mini/why-mini/exceptional-safety.html
Mitsubishi	https://www.mitsubishicars.com/outlander-sport/2021/features/safety
Nissan	https://www.nissanusa.com/experience-nissan/news-and-events/car-safety-features-technology.html
Porsche	https://www.porschefremont.com/porsche-cayenne-safety/
Ram	https://www.ramtrucks.com/ram-1500/safety-security.html
Subaru	https://www.subaru.com/engineering/eyesight.html
Tesla	https://www.tesla.com/sites/default/files/model_3_owners_manual_north_america_en.pdf
Toyota	https://www.toyota.com/safety-sense/animation/pcspd
Volkswagen	https://www.volkswagen.co.uk/technology/driver-assist
Volvo	https://www.volvocars.com/ph/why-volvo/human-innovation/future-of-driving/safety

Note: A blank space simply denotes that the manufacturer does not specify a name for this feature. It does not necessarily mean that the manufacturer does not implement that feature.

APPENDIX B: List of Vehicles with ADAS

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Acura	MDX	2022	Y	Y		Y			Y			Y	Y	
	ILX	2021	Y	Y		Y	Y	Y	Y		Y	Y	Y	
	MDX	2021												
	NSX	2021										Y		
	RDX	2021	Y	Y		Y	Y	Y	Y		Y	Y	Y	
	TLX	2021	Y	Y		Y	Y	Y	Y		Y	Y	Y	
	ILX	2020	Y	Y		Y		Y	Y			Y	Y	
	MDX	2020	Y	Y		Y			Y			Y	Y	
	NSX	2020										Y		
	RDX	2020	Y	Y		Y	Y	Y	Y		Y	Y	Y	
	TLX	2020	Y	Y		Y			Y			Y	Y	
	ILX	2019	Y	Y		Y		Y	Y			Y	Y	
	MDX	2019	Y	Y		Y			Y			Y	Y	
	NSX	2019										Y		
	RDX	2019	Y	Y		Y	Y		Y			Y	Y	
	TLX	2019	Y	Y		Y			Y			Y	Y	
	ILX	2018	Y	Y		Y		Y	Y			Y	Y	
	MDX	2018	Y	Y		Y			Y			Y	Y	
	NSX	2018										Y		
	RDX	2018	Y	Y		Y	Y		Y			Y	Y	
	TLX	2018	Y	Y		Y			Y			Y	Y	
	ILX	2017	Y	Y		Y		Y	Y			Y	Y	
	MDX	2017	Y	Y		Y			Y			Y	Y	
	RDX	2017	Y	Y		Y			Y			Y	Y	
	TLX	2017	Y	Y		Y			Y			Y	Y	
	ILX	2016	Y	Y		Y		Y	Y			Y	Y	
	MDX	2016	Y	Y		Y	Y	Y	Y			Y	Y	
	RDX	2016	Y	Y		Y		Y	Y			Y	Y	
	TLX	2016	Y	Y		Y		Y	Y			Y	Y	
	ILX	2015										Y		
	MDX	2015	Y	Y		Y	Y	Y	Y			Y		
	RDX	2015										Y		
	TLX	2015	Y	Y		Y	Y	Y	Y				Y	
Alfa Romeo	Giulia	2021		Y		Y	Y	Y	Y		Y		Y	
	Stelvio	2021		Y		Y	Y	Y	Y		Y		Y	
	4C	2020										Y		
	Giulia	2020	Y	Y		Y	Y	Y	Y		Y		Y	
	Stelvio	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	4C	2019												
	Giulia	2019		Y		Y	Y	Y		Y		Y	Y	
	Stelvio	2019		Y		Y	Y	Y					Y	
	4C	2018												
	Giulia	2018		Y		Y	Y	Y				Y	Y	
	Stelvio	2018		Y		Y	Y	Y				Y	Y	
	4C	2017								Y				
	Giulia	2017		Y		Y	Y	Y				Y	Y	
	4C	2016								Y				

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Audi	A4	2021		Y		Y	Y	Y	Y		Y		Y	
	A5	2021		Y		Y	Y	Y	Y		Y		Y	
	A6	2021		Y		Y	Y	Y	Y		Y		Y	
	A7	2021		Y		Y	Y	Y	Y		Y		Y	
	A8	2021		Y		Y	Y	Y	Y		Y		Y	
	Q3	2021		Y		Y	Y	Y	Y		Y		Y	
	Q5	2021		Y		Y	Y	Y	Y		Y		Y	
	Q7	2021		Y		Y	Y	Y	Y		Y		Y	
	Q8	2021		Y		Y	Y	Y	Y		Y		Y	
	R8	2021												
	TT	2021				Y								
	E-Tron	2021		Y		Y	Y	Y	Y		Y		Y	
	A3	2020		Y		Y	Y	Y	Y			Y	Y	
	A4	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	A5	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	A6	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	A7	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	A8	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Q3	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Q5	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Q7	2020		Y		Y	Y	Y	Y	Y	Y		Y	
	Q8	2020		Y		Y	Y	Y	Y	Y	Y		Y	
	R8	2020								Y		Y		
	TT	2020				Y				Y		Y		
	E-tron	2020		Y		Y	Y	Y	Y		Y		Y	
	A3	2019		Y		Y	Y	Y	Y			Y	Y	
	A4	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	A5	2019		Y		Y	Y	Y	Y		Y		Y	
	A6	2019		Y		Y	Y	Y	Y	Y	Y		Y	
	A7	2019		Y		Y	Y	Y	Y		Y		Y	
	A8	2019		Y		Y	Y	Y	Y	Y	Y		Y	
	E-tron	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Q3	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Q5	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Q7	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Q8	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	R8	2019												
	S4	2019		Y		Y	Y	Y	Y		Y		Y	
	TT	2019				Y						Y		
	A3	2018		Y		Y	Y	Y	Y			Y	Y	
	A4	2018		Y		Y	Y	Y	Y			Y	Y	
	A5	2018	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	A6	2018	Y	Y		Y	Y	Y	Y	Y		Y		
	A7	2018	Y	Y		Y	Y	Y	Y	Y		Y		
	A8	2018	Y	Y		Y	Y	Y	Y	Y		Y		
	Q3	2018				Y				Y		Y		
	Q5	2018	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	Q7	2018	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	R8	2018								Y		Y		
	S4	2018	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	TT	2018				Y				Y		Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Audi	A3	2017	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	A4	2017	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	A5	2017				Y				Y		Y		
	A6	2017	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	A7	2017	Y	Y		Y	Y	Y	Y	Y		Y		
	A8	2017	Y	Y		Y	Y	Y	Y	Y		Y		
	Q3	2017				Y				Y		Y		
	Q5	2017		Y		Y	Y					Y		
	Q7	2017	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	R8	2017								Y		Y		
	S4	2017		Y		Y	Y					Y		
	S5	2017		Y		Y	Y					Y		
	TT	2017				Y						Y		
	A3	2016	Y	Y		Y	Y	Y	Y	Y		Y		
	A4	2016				Y						Y		
	A5	2016				Y						Y		
	A6	2016		Y		Y	Y	Y	Y			Y		
	A7	2016	Y	Y		Y	Y	Y	Y	Y		Y		
	A8	2016	Y	Y		Y	Y	Y	Y	Y		Y		
	Q3	2016				Y				Y		Y		
	Q5	2016		Y		Y	Y					Y		
	R8	2016										Y		
	S4	2016		Y		Y	Y					Y		
	S5	2016		Y		Y	Y					Y		
	TT	2016				Y						Y		
BMW	2 Series	2021		Y		Y	Y	Y	Y		Y		Y	
	Gran Coupe	2021		Y		Y	Y	Y	Y		Y		Y	
	3 Series	2021		Y		Y	Y	Y	Y		Y		Y	
	4 Series	2021		Y		Y	Y	Y	Y		Y		Y	
	5 Series	2021		Y		Y	Y	Y	Y		Y		Y	
	7 Series	2021		Y		Y	Y	Y	Y		Y		Y	
	8 Series	2021		Y		Y	Y	Y	Y		Y		Y	
	i3	2021		Y			Y				Y			
	X1	2021		Y			Y	Y			Y			
	X2	2021		Y			Y	Y			Y			
	X3	2021		Y		Y	Y	Y	Y		Y		Y	
	X4	2021		Y		Y	Y	Y	Y		Y		Y	
	X5	2021		Y		Y	Y	Y	Y		Y		Y	
	X6	2021		Y		Y	Y	Y	Y		Y		Y	
	X7	2021		Y		Y	Y	Y	Y		Y		Y	
	Z4	2021		Y		Y	Y	Y	Y		Y		Y	
	2 Series	2020		Y			Y	Y		Y	Y	Y		
	3 Series	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	4 Series	2020		Y		Y	Y	Y		Y	Y	Y		
	5 Series	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	7 Series	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	8 Series	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	i8	2020		Y			Y	Y		Y	Y	Y		
	X1	2020		Y			Y	Y		Y	Y	Y		
	X2	2020		Y			Y	Y		Y	Y	Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
BMW	X3	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	X4	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	X5	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	X6	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	X7	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Z4	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	2 Series	2019		Y			Y	Y		Y	Y	Y		
	3 Series	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	4 Series	2019		Y		Y	Y	Y		Y	Y	Y		
	5 Series	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	6 Series	2019		Y		Y	Y	Y	Y	Y	Y	Y		Y
	7 Series	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	8 Series	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	i3	2019		Y			Y			Y	Y	Y		
	i8	2019		Y			Y	Y		Y	Y	Y		
	X1	2019		Y			Y	Y		Y	Y	Y		
	X2	2019		Y			Y	Y	Y	Y	Y	Y		
	X3	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	X4	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	X5	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	X6	2019		Y		Y	Y	Y		Y	Y	Y		
	X7	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Z4	2019		Y		Y	Y	Y	Y		Y	Y	Y	Y
	2 Series	2018		Y			Y	Y				Y		
	3 Series	2018		Y		Y	Y	Y				Y		
	4 Series	2018		Y		Y	Y	Y				Y		
	5 Series	2018		Y		Y	Y	Y	Y			Y	Y	Y
	6 Series	2018		Y		Y	Y	Y		Y		Y		
	7 Series	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	i3	2018		Y			Y					Y		
	i8	2018		Y			Y			Y		Y		
	M3	2018		Y		Y	Y	Y				Y		
	X1	2018		Y			Y	Y				Y		
	X2	2018		Y			Y	Y		Y		Y		
	X3	2018		Y		Y	Y	Y	Y	Y		Y	Y	Y
	X4	2018		Y		Y	Y	Y		Y		Y		
	X5	2018		Y		Y	Y	Y		Y		Y		Y
	X6	2018		Y		Y	Y	Y		Y		Y		
	2 Series	2017		Y			Y	Y				Y		
	3 Series	2017		Y		Y	Y	Y				Y		
	4 Series	2017		Y		Y	Y	Y				Y		
	5 Series	2017		Y		Y	Y	Y	Y			Y		
	GranTurismo	2017		Y		Y	Y	Y				Y		
	6 Series	2017		Y		Y	Y	Y		Y		Y		
	7 Series	2017		Y		Y	Y	Y	Y	Y		Y	Y	Y
	i3	2017		Y			Y			Y		Y		
	i8	2017		Y			Y			Y		Y		
	M3	2017		Y		Y	Y	Y				Y		
	X1	2017		Y			Y	Y				Y		
	X3	2017		Y		Y	Y	Y		Y		Y		Y
	X4	2017		Y		Y	Y	Y				Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
BMW	X5	2017		Y		Y	Y	Y		Y		Y		
	X6	2017		Y		Y	Y	Y		Y		Y		
	Z4	2017												
	2 Series	2016		Y			Y	Y				Y		
	3 Series	2016		Y		Y	Y	Y				Y		Y
	4 Series	2016		Y		Y	Y	Y		Y		Y		Y
	5 Series	2016		Y		Y	Y	Y	Y	Y		Y		
	GranTurismo	2016		Y		Y	Y	Y		Y		Y		
	6 Series	2016		Y		Y	Y	Y		Y		Y		
	7 Series	2016		Y		Y	Y	Y	Y			Y	Y	
	i3	2016		Y			Y			Y		Y		
	i8	2016		Y			Y			Y		Y		
	M3	2016		Y		Y	Y	Y				Y		
	X1	2016		Y			Y	Y				Y		
	X3	2016		Y		Y	Y	Y		Y		Y		Y
	X4	2016		Y		Y	Y	Y				Y		
	X5	2016		Y		Y	Y	Y		Y		Y		
	X6	2016		Y		Y	Y	Y		Y		Y		
	Z4	2016										Y		
Buick	Enclave	2021		Y		Y	Y	Y	Y		Y		Y	
	Encore	2021				Y	Y	Y					Y	
	Encore GX	2021		Y		Y	Y	Y	Y		Y		Y	
	Envision	2021		Y		Y	Y	Y	Y		Y		Y	
	Enclave	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Encore	2020				Y	Y	Y				Y	Y	
	Encore GX	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Envision	2020		Y		Y	Y	Y	Y	Y		Y	Y	
	Regal	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Regal TourX	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Cascada	2019					Y	Y		Y		Y		
	Enclave	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Encore	2019				Y	Y	Y				Y	Y	
	Envision	2019		Y		Y	Y	Y	Y	Y		Y	Y	
	LaCrosse	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Regal	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Regal TourX	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Cascada	2018					Y	Y		Y		Y		
	Enclave	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Encore	2018				Y	Y	Y		Y		Y	Y	
	Envision	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	LaCrosse	2018		Y		Y	Y	Y	Y			Y	Y	
	Regal	2018		Y		Y	Y	Y	Y			Y	Y	
	Regal TourX	2018		Y		Y	Y	Y	Y			Y	Y	
	Cascada	2017					Y	Y		Y		Y		
	Enclave	2017				Y	Y	Y		Y		Y	Y	
	Encore	2017				Y	Y	Y				Y	Y	
	Envision	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	LaCrosse	2017		Y		Y	Y	Y		Y		Y	Y	
	Regal	2017		Y		Y	Y	Y		Y		Y	Y	
	Verano	2017				Y	Y	Y		Y		Y	Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Buick	Cascada	2016					Y	Y		Y		Y		
	Enclave	2016				Y	Y	Y		Y		Y	Y	
	Encore	2016				Y	Y	Y		Y		Y	Y	
	Envision	2016		Y		Y	Y	Y	Y	Y		Y	Y	
	LaCrosse	2016		Y		Y	Y	Y		Y		Y	Y	
	Regal	2016		Y		Y	Y	Y		Y		Y	Y	
	Verano	2016				Y	Y	Y		Y		Y	Y	
Cadillac	CT4	2021		Y		Y	Y	Y	Y		Y		Y	
	CT5	2021		Y		Y	Y	Y	Y		Y		Y	
	Escalade	2021		Y		Y	Y	Y	Y		Y		Y	
	XT4	2021		Y		Y	Y	Y	Y		Y		Y	
	XT5	2021		Y		Y	Y	Y	Y		Y		Y	
	XT6	2021		Y		Y	Y	Y	Y		Y		Y	
	CT4	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	CT5	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	CT6	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Escalade	2020		Y		Y	Y	Y	Y	Y		Y	Y	
	XT4	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	XT5	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	XT6	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	ATS	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	CT6	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	CTS	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	CTS-V	2019				Y	Y	Y	Y		Y	Y	Y	
	Escalade	2019		Y		Y	Y	Y	Y	Y		Y	Y	
	XT4	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	XT5	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	XTS	2019		Y		Y	Y	Y	Y	Y		Y	Y	
	ATS	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	ATS-V	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	CT6	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	CTS	2018		Y		Y	Y	Y	Y			Y	Y	
	CTS-V	2018				Y	Y	Y	Y			Y	Y	
	Escalade	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	XT5	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	XTS	2018		Y		Y	Y	Y	Y	Y		Y	Y	
Chevrolet	Bolt	2021		Y		Y	Y	Y	Y		Y		Y	
	Blazer	2021		Y		Y	Y	Y	Y		Y		Y	
	Camaro	2021				Y	Y						Y	
	Corvette	2021				Y							Y	
	Colorado	2021					Y	Y						
	Equinox	2021		Y		Y	Y	Y	Y		Y		Y	
	Malibu	2021		Y		Y	Y	Y	Y		Y		Y	
	Silverado 1500	2021		Y		Y	Y	Y	Y		Y		Y	
	Silverado 2500HD	2021		Y		Y	Y	Y					Y	
	Silverado 3500HD	2021		Y		Y	Y	Y					Y	
	Spark	2021		Y			Y	Y						
	Suburban	2021		Y		Y	Y	Y	Y		Y		Y	
	Tahoe	2021		Y		Y	Y	Y	Y		Y		Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Chevrolet	TrailBlazer	2021		Y		Y	Y	Y	Y		Y		Y	
	Traverse	2021		Y		Y	Y	Y	Y		Y		Y	
	Trax	2021				Y							Y	
	Blazer	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Bolt	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Camaro	2020				Y	Y					Y	Y	
	Colorado	2020					Y	Y				Y		
	Corvette	2020				Y				Y		Y	Y	
	Equinox	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Impala	2020		Y		Y	Y	Y		Y		Y	Y	
	Malibu	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Silverado 1500	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Silverado 2500HD	2020		Y		Y	Y	Y				Y	Y	
	Silverado 3500HD	2020		Y		Y	Y	Y				Y	Y	
	Sonic	2020					Y	Y				Y		
	Spark	2020		Y			Y	Y				Y		
	Suburban	2020		Y		Y	Y	Y	Y	Y		Y	Y	
	Tahoe	2020		Y		Y	Y	Y	Y	Y		Y	Y	
	Traverse	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Trax	2020				Y	Y	Y				Y	Y	
	Bolt	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Blazer	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Camaro	2019				Y	Y					Y	Y	
	Corvette	2019										Y		
	Colorado	2019					Y	Y		Y		Y		
	Cruze	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Equinox	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Impala	2019		Y		Y	Y	Y		Y		Y	Y	
	Malibu	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Silverado 1500	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Silverado 1500 LD	2019										Y		
	Silverado 2500HD	2019					Y	Y				Y		
	Silverado 3500HD	2019					Y	Y		Y		Y		
	Sonic	2019					Y	Y				Y		
	Spark	2019		Y			Y	Y				Y		
	Suburban	2019	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	Tahoe	2019	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	Traverse	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Trax	2019				Y	Y	Y				Y	Y	
	Volt	2019		Y		Y	Y	Y	Y	Y		Y	Y	
	Bolt	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Camaro	2018				Y						Y	Y	
	Corvette	2018										Y		
	Colorado	2018					Y	Y				Y		
	Cruze	2018				Y	Y	Y	Y			Y	Y	
	Equinox	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Impala	2018		Y		Y	Y	Y		Y		Y	Y	
	Malibu	2018		Y		Y	Y	Y	Y			Y	Y	
	Silverado 1500	2018		Y			Y	Y	Y			Y		
	Silverado 2500HD	2018					Y	Y		Y		Y		
	Silverado 3500HD	2018					Y	Y		Y		Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Chevrolet	Sonic	2018					Y	Y				Y		
	Spark	2018					Y	Y				Y		
	Suburban	2018	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	Tahoe	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Traverse	2018		Y		Y	Y	Y	Y			Y	Y	
	Trax	2018				Y	Y	Y				Y	Y	
	Volt	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Bolt	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Camaro	2017				Y						Y	Y	
	Corvette	2017								Y		Y		
	Cruze	2017				Y	Y	Y	Y			Y	Y	
	Cruze Hatch	2017				Y	Y	Y	Y			Y	Y	
	Equinox	2017				Y	Y	Y				Y	Y	
	Express	2017										Y		
	Impala	2017		Y		Y	Y	Y				Y	Y	
	Malibu	2017		Y		Y	Y	Y	Y			Y	Y	
	Silverado 1500	2017		Y			Y	Y	Y			Y		
	Silverado 2500HD	2017					Y	Y				Y		
	Silverado 3500HD	2017					Y	Y		Y		Y		
	Sonic	2017					Y	Y				Y		
	Spark	2017					Y	Y				Y		
	SS	2017				Y	Y	Y		Y		Y	Y	
	Suburban	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Tahoe	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Traverse	2017				Y	Y	Y				Y	Y	
	Trax	2017				Y	Y	Y		Y		Y	Y	
	Volt	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Camaro	2016				Y						Y	Y	
	Corvette	2016										Y		
	Colorado	2016					Y	Y				Y		
	Cruse Limited	2016				Y						Y	Y	
	Cruze	2016				Y	Y	Y	Y			Y	Y	
	Equinox	2016				Y	Y	Y				Y	Y	
	Express	2016										Y		
	Impala	2016		Y		Y	Y	Y		Y		Y	Y	
	Malibu	2016		Y		Y	Y	Y	Y			Y	Y	
	Malibu Limited	2016				Y	Y	Y				Y	Y	
	Silverado 1500	2016					Y	Y	Y			Y		
	Silverado 2500HD	2016					Y	Y		Y		Y		
	Silverado 3500HD	2016					Y	Y				Y		
	Sonic	2016					Y	Y				Y		
	Spark	2016					Y	Y		Y		Y		
	SS	2016				Y	Y	Y		Y		Y	Y	
	Suburban	2016		Y		Y	Y	Y	Y	Y		Y	Y	
	Tahoe	2016		Y		Y	Y	Y	Y	Y		Y	Y	
	Traverse	2016				Y	Y	Y				Y	Y	
	Trax	2016										Y		
	Volt	2016		Y		Y	Y	Y	Y	Y		Y	Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Chrysler	300	2021		Y		Y	Y	Y	Y				Y	
	Pacifica	2021		Y		Y	Y	Y	Y		Y		Y	
	Voyager	2021		Y		Y	Y				Y		Y	
	300	2020		Y		Y	Y	Y	Y			Y	Y	
	Pacifica	2020		Y		Y	Y	Y	Y	Y		Y	Y	
	Voyager	2020				Y						Y	Y	
	300	2019		Y		Y	Y	Y	Y			Y	Y	
	Pacifica	2019		Y		Y	Y	Y	Y	Y		Y	Y	
	300	2018		Y		Y	Y	Y	Y			Y	Y	
	Pacifica	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	200	2017		Y		Y	Y	Y	Y			Y	Y	
	300	2017		Y		Y	Y	Y	Y			Y	Y	
	Pacifica	2017		Y		Y	Y	Y	Y			Y	Y	
	Town & Country	2017				Y				Y		Y	Y	
	200	2016		Y		Y	Y	Y	Y			Y	Y	
	300	2016		Y		Y	Y	Y	Y			Y	Y	
	Town & Country	2016				Y				Y		Y	Y	
Dodge	Challenger	2021				Y	Y						Y	
	Charger	2021		Y		Y	Y	Y	Y				Y	
	Durango	2021		Y		Y	Y	Y	Y				Y	
	Challenger	2020	S			Y	Y						Y	
	Charger	2020		Y		Y	Y	Y	Y	Y		Y	Y	
	Durango	2020	O	Y		Y	Y	Y	Y				Y	
	Grand Caravan	2020												
	Journey	2020								Y		Y		
	Challenger	2019				Y	Y			Y		Y	Y	
	Charger	2019		Y		Y	Y	Y	Y	Y		Y	Y	
	Durango	2019		Y		Y	Y	Y	Y	Y		Y	Y	
	Grand Caravan	2019												
	Journey	2019										Y		
	Challenger	2018				Y	Y			Y		Y	Y	
	Charger	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Durango	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Grand Caravan	2018				Y							Y	
	Journey	2018												
	Challenger	2017				Y	Y			Y		Y	Y	
	Charger	2017		Y		Y	Y	Y	Y			Y	Y	
	Dart	2017				Y						Y	Y	
	Durango	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Grand Caravan	2017				Y						Y	Y	
	Journey	2017										Y		
	SRT Viper	2017										Y		
	Challenger	2016				Y	Y					Y	Y	
	Charger	2016		Y		Y	Y	Y	Y			Y	Y	
	Dart	2016				Y						Y	Y	
	Durango	2016		Y		Y	Y	Y	Y	Y		Y	Y	
	Grand Caravan	2016				Y						Y	Y	
	Journey	2016										Y		
	SRT Viper	2016										Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Fiat	500x	2021		Y		Y	Y	Y	Y				Y	
	124	2020				Y						Y	Y	
	500L	2020								Y		Y		
	500x	2020		Y		Y	Y	Y	Y			Y	Y	
	500	2019								Y		Y		
	124	2019				Y						Y	Y	
	500L	2019								Y		Y		
	500x	2019		Y		Y	Y	Y	Y			Y	Y	
	500	2018								Y		Y		
	124 Spider	2018				Y						Y	Y	
	500L	2018										Y		
	500x	2018		Y		Y	Y	Y	Y			Y	Y	
	500	2017												
	124 Spider	2017				Y						Y	Y	
	500e	2017								Y				
	500L	2017										Y		
	500x	2017		Y		Y	Y		Y			Y	Y	
	500	2016								Y				
	500e	2016								Y				
	500L	2016										Y		
	500x	2016		Y		Y	Y		Y	Y		Y	Y	
Ford	Bronco	2021		Y		Y	Y	Y	Y		Y		Y	
	Bronco Sport	2021		Y		Y	Y	Y	Y		Y		Y	
	EcoSport	2021				Y							Y	
	Escape	2021		Y		Y	Y	Y	Y		Y		Y	
	Edge	2021		Y		Y	Y	Y	Y		Y		Y	
	Expedition	2021		Y		Y	Y	Y	Y		Y		Y	
	Explorer	2021		Y		Y	Y	Y	Y		Y		Y	
	F-150	2021		Y		Y	Y	Y	Y		Y		Y	
	F-250	2021		Y		Y	Y	Y			Y		Y	
	F-350	2021		Y		Y	Y	Y			Y		Y	
	GT	2021												
	Fusion	2021		Y		Y	Y	Y	Y		Y		Y	
	Mustang	2021		Y		Y	Y	Y	Y		Y		Y	
	Mach-E	2021		Y		Y	Y	Y	Y		Y		Y	
	Ranger	2021		Y		Y	Y	Y	Y		Y		Y	
	Transit	2021		Y		Y	Y	Y	Y		Y		Y	
	TransitConnect	2021		Y		Y	Y	Y	Y		Y		Y	
	EcoSport	2020				Y				Y		Y	Y	
	Edge	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	Escape	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Expedition	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	Explorer	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	F-150	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	F-250	2020		Y		Y	Y	Y			Y	Y	Y	
	F-350	2020		Y		Y	Y	Y			Y	Y	Y	
	Fusion	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	Mustang	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Mustang Mach-E	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	Ranger	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	Transit	2020		Y		Y	Y	Y	Y		Y	Y	Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Ford	TransitConnect	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	EcoSport	2019				Y						Y	Y	
	Edge	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Escape	2019				Y	Y	Y	Y	Y		Y	Y	
	Expedition	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Explorer	2019				Y	Y	Y	Y	Y		Y	Y	
	F-150	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	F-250	2019				Y	Y	Y		Y		Y	Y	
	F-350	2019				Y	Y	Y		Y		Y	Y	
	Fiesta	2019										Y		
	Flex	2019				Y	Y			Y		Y	Y	
	Fusion	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Mustang	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Ranger	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Taurus	2019				Y	Y	Y	Y	Y		Y	Y	
	Transit	2019						Y				Y		
	TransitConnect	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	C-MAX	2018				Y				Y		Y	Y	
	EcoSport	2018				Y				Y		Y	Y	
	Edge	2018				Y	Y	Y	Y	Y		Y	Y	
	Escape	2018				Y	Y	Y	Y	Y		Y	Y	
	Expedition	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Explorer	2018				Y	Y	Y	Y	Y		Y	Y	
	F-150	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	F-250	2018				Y	Y	Y		Y		Y	Y	
	F-350	2018				Y	Y	Y		Y		Y	Y	
	Fiesta	2018										Y		
	Flex	2018				Y	Y			Y		Y	Y	
	Focus	2018				Y		Y	Y	Y		Y	Y	
	Fusion	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Mustang	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Taurus	2018				Y	Y	Y	Y	Y		Y	Y	
	Transit	2018						Y				Y		
	TransitConnect	2018				Y							Y	
	C-MAX	2017				Y						Y	Y	
	Edge	2017				Y	Y	Y	Y	Y		Y	Y	
	Escape	2017				Y	Y	Y	Y			Y	Y	
	Expedition	2017				Y				Y		Y	Y	
	Explorer	2017				Y	Y	Y	Y	Y		Y	Y	
	F-150	2017				Y	Y	Y	Y	Y		Y	Y	
	F-250	2017				Y	Y	Y		Y		Y	Y	
	F-350	2017				Y	Y	Y				Y	Y	
	Fiesta	2017										Y		
	Flex	2017				Y	Y			Y		Y	Y	
	Focus	2017				Y		Y	Y	Y		Y	Y	
	Fusion	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Mustang	2017				Y	Y					Y	Y	
	Taurus	2017				Y	Y	Y	Y	Y		Y	Y	
	Transit	2017										Y		
	TransitConnect	2017				Y				Y		Y	Y	
	C-MAX	2016								Y		Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Ford	Edge	2016				Y	Y	Y	Y	Y		Y	Y	
	Escape	2016				Y				Y		Y	Y	
	Expedition	2016				Y				Y		Y	Y	
	Explorer	2016				Y	Y	Y	Y	Y		Y	Y	
	F-150	2016				Y	Y	Y	Y			Y	Y	
	F-250	2016				Y		Y		Y		Y	Y	
	F-350	2016				Y		Y		Y		Y	Y	
	Fiesta	2016										Y		
	Flex	2016				Y	Y			Y		Y	Y	
	Focus	2016				Y		Y	Y	Y		Y	Y	
	Fusion	2016				Y	Y	Y	Y	Y		Y	Y	
	Mustang	2016				Y	Y					Y	Y	
	Taurus	2016				Y	Y	Y	Y	Y		Y	Y	
	Transit	2016										Y		
	TransitConnect	2016				Y						Y	Y	
Genesis	G70	2021	Y	Y		Y	Y	Y	Y		Y		Y	
	G80	2021	Y	Y		Y	Y	Y	Y		Y		Y	
	GV80	2021	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y
	G90	2021		Y		Y	Y	Y	Y	Y	Y		Y	Y
	G70	2020	Y	Y		Y	Y	Y	Y		Y		Y	
	G80	2020	Y			Y	Y		Y				Y	Y
	G90	2020				Y	Y		Y	Y			Y	Y
	G70	2019	Y			Y	Y		Y				Y	Y
	G80	2019	Y			Y	Y		Y					Y
	G90	2019	Y	Y		Y			Y			Y		Y
	G80	2018	Y	Y		Y		Y	Y					Y
	G90	2018	Y	Y		Y			Y					
	G80	2017												
	G80	2017		Y		Y	Y	Y	Y			Y	Y	
	G90	2017		Y		Y	Y	Y	Y			Y	Y	
GMC	Terrain	2021						Y		Y			Y	
	Terrain Denali	2021						Y		Y			Y	
	Acadia	2021	Y	Y				Y		Y	Y		Y	
	Acadia AT4	2021	Y	Y			Y	Y		Y	Y		Y	
	Acadia Denali	2021	Y	Y			Y	Y		Y	Y		Y	
	Yukon	2021	Y	Y	Y		Y	Y	Y	Y	Y		Y	
	Yukon XL	2021	Y	Y	Y		Y	Y	Y	Y	Y		Y	
	Yukon AT4	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Yukon XL AT4	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Yukon Denali	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Yukon Denali XL	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Canyon	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Canyon Denali	2021	Y	Y			Y	Y	Y	Y	Y	Y	Y	
	Sierra 1500	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Sierra1500 AT4	2021	Y	Y			Y	Y	Y	Y	Y			
	Sierra 1500 Denali	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Sierra 2500 HD	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Sierra 3500 HD	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Sierra 2500 HD AT4	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Sierra 3500 HD AT4	2021	Y	Y			Y	Y	Y	Y	Y		Y	
	Sierra 2500 HD Denali	2021					Y	Y		Y		Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
GMC	Sierra 3500 HD Denali	2021					Y	Y		Y				
	Savana Cargo	2021										Y		
	Savana Passenger	2021										Y		
	Savana Cutway	2021					Y	Y				Y		
Honda	Pilot	2021		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Accord	2021		Y		Y	Y	Y	Y		Y		Y	
	Civic	2021		Y		Y	Y	Y	Y		Y		Y	
	Clarity	2021		Y		Y	Y	Y	Y		Y		Y	
	CR-V	2021		Y		Y	Y	Y	Y		Y		Y	
	HR-V	2021		Y		Y	Y	Y	Y		Y		Y	
	Odyssey	2021		Y		Y	Y	Y	Y		Y		Y	
	Passport	2021		Y		Y	Y	Y	Y		Y		Y	
	Insight	2021		Y		Y	Y	Y	Y		Y		Y	
	Ridgeline	2021		Y		Y	Y	Y	Y		Y		Y	
	Accord	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Civic	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Clarity	2020		Y			Y	Y	Y		Y	Y		
	CR-V	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Fit	2020		Y			Y	Y	Y		Y	Y		
	HR-V	2020		Y			Y	Y	Y		Y	Y		
	Insight	2020		Y			Y	Y	Y		Y	Y		Y
	Odyssey	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Passport	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Pilot	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Ridgeline	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Accord	2019		Y			Y	Y	Y		Y	Y		
	Civic	2019		Y			Y	Y	Y		Y	Y		
	Clarity	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	CR-V	2019		Y			Y	Y	Y		Y	Y		
	Fit	2019		Y			Y	Y	Y		Y	Y		
	HR-V	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Odyssey	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Passport	2019		Y			Y	Y	Y	Y	Y	Y	Y	
	Insight	2019		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Pilot	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Ridgeline	2019		Y		Y	Y	Y	Y			Y	Y	
	Accord	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Accord Hybrid	2018		Y			Y	Y	Y			Y		
	Civic	2018		Y			Y	Y	Y			Y		
	Clarity	2018		Y		Y	Y	Y	Y			Y	Y	
	CR-V	2018		Y			Y	Y	Y			Y		
	Fit	2018										Y		
	HR-V	2018		Y		Y	Y	Y	Y			Y	Y	
	Odyssey	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Pilot	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Ridgeline	2018		Y			Y	Y	Y	Y		Y		
	Accord	2017		Y			Y	Y	Y	Y		Y		
	Accord Hybrid	2017		Y			Y	Y	Y	Y		Y		
	Civic	2017		Y			Y	Y	Y			Y		
	Clarity	2017		Y		Y	Y	Y	Y			Y	Y	
	CR-V	2017										Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Honda	CR-Z	2017										Y		
	Fit	2017										Y		
	HR-V	2017				Y	Y	Y				Y		
	Odyssey	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Pilot	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Ridgeline	2017		Y			Y	Y	Y			Y	Y	
	Accord	2016		Y			Y	Y	Y	Y		Y		
	Civic	2016		Y			Y	Y	Y			Y		
	CR-V	2016										Y		
	CR-Z	2016										Y		
	Fit	2016										Y		
	HR-V	2016				Y	Y	Y				Y		
	Odyssey	2016		Y		Y	Y	Y	Y	Y		Y	Y	
	Pilot	2016						Y	Y	Y		Y		
Hyundai	Accent	2021		Y			Y							
	Elantra	2021		Y		Y	Y	Y	Y		Y		Y	
	Ioniq	2021		Y		Y	Y	Y	Y		Y		Y	
	Kona	2021		Y		Y	Y	Y	Y		Y		Y	
	Kona EV	2021		Y		Y	Y	Y	Y		Y		Y	
	Nexo	2021				Y	Y	Y	Y		Y		Y	
	Palisade	2021		Y		Y	Y	Y	Y		Y		Y	
	Santa Fe	2021		Y		Y	Y	Y	Y		Y		Y	
	Sonata	2021		Y		Y	Y	Y	Y		Y		Y	
	Tucson	2021		Y		Y	Y	Y	Y		Y		Y	
	Venue	2021		Y		Y	Y	Y	Y		Y		Y	
	Veloster	2021		Y		Y	Y	Y	Y		Y		Y	
	Accent	2020		Y			Y					Y		
	Elantra	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Elantra GT	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Ioniq	2020		Y		Y	Y	Y	Y		Y		Y	Y
	Kona	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Kona EV	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Nexo	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Pallasade	2020		Y		Y	Y	Y	Y	Y	Y		Y	Y
	SantaFe	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Sonata	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Tucson	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Veloster	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Venue	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Accent	2019		Y			Y					Y		
	Elantra	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Elantra GT	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Ioniq	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Nexo	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Sante Fe XL	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	SantaFe	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Sonata	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Tucson	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Kona	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Veloster	2019		Y		Y	Y	Y	Y		Y		Y	
	Accent	2018		Y			Y					Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Hyundai	Elantra	2018		Y		Y	Y	Y	Y			Y	Y	
	Ioniq	2018		Y		Y	Y	Y	Y			Y	Y	
	SantaFe	2018		Y		Y	Y	Y		Y			Y	
	SantaFe Sport	2018		Y		Y	Y	Y		Y			Y	
	Sonata	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Tucson	2018		Y		Y	Y	Y	Y			Y	Y	
	Kona	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Accent	2017												
	Azera	2017				Y	Y	Y		Y		Y	Y	
	Elantra	2017		Y		Y	Y	Y	Y			Y	Y	
	Equus	2017				Y	Y	Y		Y		Y	Y	
	Ioniq	2017		Y		Y	Y	Y				Y	Y	
	SantaFe	2017		Y		Y	Y	Y				Y	Y	
	SantaFe Sport	2017		Y		Y	Y	Y		Y		Y	Y	
	Sonata	2017		Y		Y	Y	Y				Y	Y	
	Sonata Hybrid	2017				Y	Y	Y				Y	Y	
	Tucson	2017		Y		Y	Y	Y		Y		Y	Y	
	Accent	2016												
	Azera	2016				Y	Y	Y				Y	Y	
	Elantra	2016										Y		
	Equus	2016				Y	Y	Y		Y		Y	Y	
	Genesis	2016		Y		Y	Y	Y	Y			Y	Y	
	Genesis Coupe	2016								Y				
	SantaFe	2016				Y						Y	Y	
	SantaFe Sport	2016				Y						Y	Y	
	Sonata	2016		Y		Y	Y	Y				Y	Y	
	Sonata Hybrid	2016				Y	Y	Y				Y	Y	
	Tucson	2016		Y		Y	Y	Y				Y	Y	
	Veloster	2016										Y		
Infiniti	Q50	2021		Y		Y	Y	Y	Y				Y	
	Q60	2021		Y		Y	Y	Y	Y		Y		Y	
	QX50	2021		Y		Y	Y	Y	Y		Y		Y	
	QX80	2021		Y		Y	Y	Y	Y		Y		Y	
	Q50	2020		Y		Y	Y	Y	Y			Y	Y	
	Q60	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	QX50	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	QX60	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	QX80	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Q50	2019		Y		Y	Y	Y	Y			Y	Y	
	Q60	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	Q70	2019		Y		Y	Y	Y	Y			Y	Y	
	QX30	2019		Y		Y	Y	Y				Y		
	QX50	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	QX60	2019		Y		Y	Y	Y	Y		Y	Y	Y	
	QX80	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Q50	2018		Y		Y	Y	Y	Y			Y	Y	
	Q60	2018		Y		Y	Y	Y	Y			Y	Y	
	Q70	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	QX30	2018		Y			Y	Y				Y		
	QX50	2018		Y			Y	Y	Y	Y		Y		
	QX60	2018		Y		Y	Y	Y	Y			Y	Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Infiniti	QX80	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Q50	2017		Y		Y	Y	Y	Y			Y	Y	
	Q60	2017		Y		Y	Y	Y	Y			Y	Y	
	Q70	2017		Y		Y	Y	Y	Y			Y	Y	
	QX30	2017		Y		Y	Y	Y				Y		
	QX50	2017		Y			Y	Y	Y			Y		
	QX60	2017		Y		Y	Y	Y	Y			Y	Y	
	QX70	2017		Y			Y	Y	Y			Y		
	QX80	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Q50	2016		Y		Y	Y	Y	Y			Y	Y	
	Q60	2016		Y		Y	Y	Y	Y			Y	Y	
	Q70	2016		Y		Y	Y	Y	Y			Y	Y	
	QX30	2016		Y		Y	Y	Y				Y		
	QX50	2016		Y			Y	Y	Y			Y		
	QX60	2016		Y		Y	Y	Y	Y			Y	Y	
	QX70	2016		Y			Y	Y	Y			Y		
	QX80	2016		Y		Y	Y	Y	Y	Y		Y	Y	
Jaguar	E-Pace	2021		Y		Y	Y	Y	Y		Y		Y	
	F-Pace	2021		Y		Y	Y	Y	Y		Y		Y	
	F-Type	2021		Y		Y	Y	Y	Y		Y		Y	
	I-Pace	2021		Y		Y	Y	Y	Y		Y		Y	
	XF	2021		Y		Y	Y	Y	Y		Y		Y	
	E-Pace	2020		Y		Y	Y	Y	Y		Y		Y	
	F-Pace	2020		Y		Y	Y	Y	Y		Y		Y	
	F-Type	2020		Y		Y	Y	Y	Y		Y		Y	
	I-Pace	2020		Y		Y	Y	Y	Y		Y		Y	
	XE	2020		Y		Y	Y	Y	Y		Y		Y	
	XF	2020		Y		Y	Y	Y	Y		Y		Y	
	E-Pace	2019		Y		Y	Y	Y	Y		Y		Y	
	F-Pace	2019		Y		Y	Y	Y	Y		Y		Y	
	F-Type	2019		Y		Y	Y	Y	Y		Y		Y	
	I-Pace	2019		Y		Y	Y	Y	Y		Y		Y	
	XE	2019		Y		Y	Y	Y	Y		Y		Y	
	XF	2019		Y		Y	Y	Y	Y		Y		Y	
	XJ	2019		Y		Y	Y	Y	Y		Y		Y	
	E-Pace	2018		Y		Y	Y	Y	Y				Y	
	F-Pace	2018		Y		Y	Y	Y	Y				Y	
	F-Type	2018		Y		Y	Y	Y	Y				Y	
	XE	2018		Y		Y	Y	Y	Y				Y	
	XF	2018		Y		Y	Y	Y	Y				Y	
	XJ	2018		Y		Y	Y	Y	Y				Y	
	F-Pace	2017		Y		Y	Y	Y	Y			Y	Y	
	F-Type	2017				Y						Y	Y	
	XE	2017		Y		Y	Y	Y	Y			Y	Y	
	XF	2017		Y		Y	Y	Y	Y			Y	Y	
	XJ	2017				Y						Y	Y	
	F-Pace	2016		Y		Y	Y	Y	Y			Y	Y	
	F-Type	2016				Y						Y	Y	
	XE	2016		Y		Y	Y	Y	Y			Y	Y	
	XF	2016		Y		Y	Y	Y	Y			Y	Y	
	XJ	2016				Y						Y	Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Jeep	Cherokee	2021		Y		Y	Y	Y	Y				Y	
	Compass	2021		Y		Y	Y	Y	Y				Y	
	Gladiator	2021		Y		Y	Y						Y	
	Grand Cherokee	2021		Y		Y	Y	Y	Y				Y	
	Renegade	2021		Y		Y	Y	Y	Y				Y	
	Wrangler	2021		Y		Y	Y						Y	
	Cherokee	2020	Y	Y	Y	Y	Y	Y	Y				Y	
	Compass	2020	Y	Y	Y	Y	Y	Y	Y				Y	
	Grand Cherokee	2020	Y	Y	Y	Y	Y	Y	Y				Y	
	Gladiator	2020	Y	Y		Y	Y						Y	
	Renegade	2020	Y	Y	Y	Y	Y	Y	Y				Y	
	Wrangler	2020	Y	Y		Y	Y						Y	
	Cherokee	2019	Y	Y	Y	Y	Y	Y	Y				Y	
	Compass	2019	Y	Y	Y	Y	Y	Y	Y				Y	
	Grand Cherokee	2019	Y	Y	Y	Y	Y	Y	Y				Y	
	Renegade	2019	Y	Y	Y	Y	Y	Y	Y				Y	
	Wrangler	2019	Y	Y		Y	Y						Y	
	Cherokee	2018	Y	Y	Y	Y	Y	Y	Y				Y	
	Compass	2018	Y	Y	Y	Y	Y	Y	Y				Y	
	Grand Cherokee	2018	Y	Y	Y	Y	Y	Y	Y				Y	
	Renegade	2018	Y	Y	Y	Y	Y	Y	Y				Y	
	Wrangler JK (old)	2018												
	New Wrangler	2018				Y							Y	
	Cherokee	2017	Y	Y	Y	Y	Y	Y	Y			Y	Y	
	Compass	2017	Y	Y	Y	Y	Y	Y	Y			Y	Y	
	Grand Cherokee	2017	Y	Y	Y	Y	Y	Y	Y			Y	Y	
	Patriot	2017										Y		
	Renegade	2017	Y	Y	Y	Y	Y	Y	Y			Y	Y	
	Wrangler	2017												
	Cherokee	2016	Y	Y	Y	Y	Y	Y	Y			Y	Y	
	Compass	2016										Y		
	Grand Cherokee	2016	Y	Y	Y	Y	Y	Y	Y			Y	Y	
	Patriot	2016												
	Renegade	2016	Y	Y	Y	Y	Y	Y	Y			Y	Y	
	Wrangler	2016												
Kia	Forte	2021		Y		Y	Y	Y	Y		Y		Y	
	K5	2021		Y		Y	Y	Y	Y		Y		Y	
	Rio	2021		Y			Y				Y			
	Sedona	2021		Y		Y	Y	Y			Y		Y	
	Seltos	2021		Y		Y	Y	Y	Y		Y		Y	
	Sorento	2021		Y		Y	Y	Y	Y		Y		Y	
	Soul	2021		Y		Y	Y	Y	Y		Y		Y	
	Sportage	2021		Y		Y	Y	Y	Y		Y		Y	
	Stinger	2021		Y		Y	Y	Y	Y		Y		Y	
	Telluride	2021		Y		Y	Y	Y	Y		Y		Y	
	Forte	2020		Y		Y	Y	Y	Y		Y		Y	
	K900	2020		Y		Y	Y	Y	Y		Y		Y	
	Niro	2020		Y		Y	Y	Y	Y		Y		Y	
	Optima	2020		Y		Y	Y	Y	Y		Y		Y	
	Rio	2020		Y			Y							
	Sedona	2020		Y		Y	Y	Y			Y		Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Kia	Sorento	2020		Y		Y	Y	Y	Y		Y		Y	
	Soul	2020		Y		Y	Y	Y	Y		Y		Y	
	Sportage	2020		Y		Y	Y	Y	Y		Y		Y	
	Stinger	2020		Y		Y	Y	Y	Y		Y		Y	
	Telluride	2020		Y		Y	Y	Y	Y		Y		Y	
	Cadenza	2019		Y		Y	Y	Y	Y		Y		Y	
	Forte	2019		Y		Y	Y	Y	Y		Y		Y	
	K900	2019		Y		Y	Y	Y	Y		Y		Y	
	Niro	2019		Y		Y	Y	Y	Y		Y		Y	
	Optima	2019		Y		Y	Y	Y	Y		Y		Y	
	Rio	2019		Y			Y							
	Sedona	2019		Y		Y	Y	Y			Y		Y	
	Sorento	2019		Y		Y	Y	Y	Y		Y		Y	
	Soul	2019		Y		Y	Y	Y			Y		Y	
	Sportage	2019		Y		Y	Y	Y			Y		Y	
	Stinger	2019		Y		Y	Y	Y	Y		Y		Y	
	Cadenza	2018		Y		Y	Y	Y					Y	
	Forte	2018		Y		Y	Y	Y	Y				Y	
	Niro	2018		Y		Y	Y	Y					Y	
	Optima	2018		Y		Y	Y	Y					Y	
	Rio	2018		Y			Y							
	Sedona	2018		Y		Y	Y	Y					Y	
	Sorento	2018		Y		Y	Y	Y					Y	
	Soul	2018		Y		Y	Y	Y					Y	
	Sportage	2018		Y		Y	Y	Y					Y	
	Stinger	2018		Y		Y	Y	Y	Y				Y	
	Cadenza	2017		Y		Y	Y	Y				Y	Y	
	Forte	2017		Y		Y	Y	Y	Y			Y	Y	
	K900	2017		Y		Y	Y	Y				Y	Y	
	Niro	2017		Y		Y	Y	Y				Y	Y	
	Optima	2017		Y		Y	Y	Y				Y	Y	
	Rio	2017										Y		
	Sedona	2017		Y		Y	Y	Y				Y	Y	
	Sorento	2017		Y		Y	Y	Y				Y	Y	
	Soul	2017				Y	Y	Y				Y	Y	
	Sportage	2017		Y		Y	Y	Y				Y	Y	
	Cadenza	2016				Y		Y				Y	Y	
	Forte	2016										Y		
	K900	2016		Y		Y	Y	Y				Y	Y	
	Optima	2016		Y		Y	Y	Y				Y	Y	
	Rio	2016										Y		
	Sedona	2016				Y	Y	Y				Y	Y	
	Sorento	2016				Y	Y	Y				Y	Y	
	Soul	2016					Y	Y				Y		
	Sportage	2016										Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Land Rover	Range Rover	2021		Y		Y	Y	Y	Y		Y		Y	
	Defender	2021		Y		Y	Y	Y	Y		Y		Y	
	Discovery	2021		Y		Y	Y	Y	Y		Y		Y	
	Discovery Sport	2021		Y		Y	Y	Y	Y		Y		Y	
	Range Rover Evoque	2021		Y		Y	Y	Y	Y		Y		Y	
	Range Rover Sport	2021		Y		Y	Y	Y	Y		Y		Y	
	Range Rover Velar	2021		Y		Y	Y	Y	Y		Y		Y	
Lexus	ES	2021		Y		Y	Y	Y	Y		Y		Y	
	GX	2021		Y		Y	Y	Y			Y		Y	
	IS	2021		Y		Y	Y	Y	Y		Y		Y	
	LC	2021		Y		Y	Y	Y	Y		Y		Y	
	LS	2021		Y		Y	Y	Y	Y		Y		Y	
	LX	2021		Y		Y	Y	Y			Y		Y	
	NX	2021		Y		Y	Y	Y	Y		Y		Y	
	RC	2021		Y		Y	Y	Y	Y		Y		Y	
	RX & RXL	2021		Y		Y	Y	Y	Y		Y		Y	
	UX	2021		Y		Y	Y	Y	Y		Y		Y	
	EY	2020		Y		Y	Y	Y	Y		Y		Y	
	GY	2020		Y		Y	Y	Y	Y		Y		Y	
	GX	2020		Y		Y	Y	Y			Y		Y	
	IY	2020		Y		Y	Y	Y	Y		Y		Y	
	LC	2020		Y		Y	Y	Y	Y		Y		Y	
	LY	2020		Y		Y	Y	Y	Y		Y		Y	
	LX	2020		Y		Y	Y	Y			Y		Y	
	NX	2020		Y		Y	Y	Y	Y		Y		Y	
	RC	2020		Y		Y	Y	Y	Y		Y		Y	
	RX	2020		Y		Y	Y	Y	Y		Y		Y	
	UX	2020		Y		Y	Y	Y	Y		Y		Y	
	EY	2019		Y		Y	Y	Y	Y		Y		Y	
	GY	2019		Y		Y	Y	Y	Y		Y		Y	
	GX	2019		Y		Y	Y	Y					Y	
	IY	2019		Y		Y	Y	Y	Y		Y		Y	
	LC	2019		Y		Y	Y	Y	Y		Y		Y	
	LY	2019		Y		Y	Y	Y	Y		Y		Y	
	LX	2019		Y		Y	Y	Y			Y		Y	
	NX	2019		Y		Y	Y	Y	Y		Y		Y	
	RC	2019		Y		Y	Y	Y	Y		Y		Y	
	RX	2019		Y		Y	Y	Y	Y		Y		Y	
	UX	2019		Y		Y	Y	Y	Y		Y		Y	
	EY	2018		Y		Y	Y	Y	Y				Y	
	GY	2018		Y		Y	Y	Y	Y				Y	
	GX	2018		Y		Y	Y	Y					Y	
	IY	2018		Y		Y	Y	Y	Y				Y	
	LC	2018		Y		Y	Y	Y	Y				Y	
	LY	2018		Y		Y	Y	Y	Y				Y	
	LX	2018		Y		Y	Y	Y					Y	
	NX	2018		Y		Y	Y	Y	Y				Y	
	RC	2018		Y		Y	Y	Y	Y				Y	
	RX	2018		Y		Y	Y	Y	Y				Y	
	CT 200h	2017		Y			Y					Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Lexus	EY	2017		Y		Y	Y	Y	Y			Y	Y	
	GY	2017		Y		Y	Y	Y	Y			Y	Y	
	GX	2017		Y		Y	Y	Y				Y	Y	
	IY	2017		Y		Y	Y	Y	Y			Y	Y	
	LY	2017		Y		Y	Y	Y	Y			Y	Y	
	LX	2017		Y		Y	Y	Y	Y			Y	Y	
	NX	2017		Y		Y	Y	Y	Y			Y	Y	
	RC	2017		Y		Y	Y	Y				Y	Y	
	RX	2017		Y		Y	Y	Y	Y			Y	Y	
	CT 200h	2016		Y			Y					Y		
	EY	2016		Y		Y	Y	Y	Y			Y	Y	
	GY	2016		Y		Y	Y	Y	Y			Y	Y	
	GX	2016		Y		Y	Y	Y				Y	Y	
	IY	2016		Y		Y	Y	Y				Y	Y	
	LY	2016		Y		Y	Y	Y	Y			Y	Y	
	LX	2016		Y			Y	Y				Y		
	NX	2016		Y		Y	Y	Y	Y			Y	Y	
	RC	2016		Y		Y	Y	Y				Y	Y	
	RX	2016		Y		Y	Y	Y	Y			Y	Y	
Lincoln	Aviator	2021		Y		Y	Y	Y	Y		Y		Y	
	Corsair	2021		Y		Y	Y	Y	Y		Y		Y	
	Navigator	2021		Y		Y	Y	Y	Y		Y		Y	
	Nautilus	2021		Y		Y	Y	Y	Y		Y		Y	
Maserati	Ghibli	2021		Y		Y	Y	Y	Y		Y		Y	
	Levante	2021		Y		Y	Y	Y	Y		Y		Y	
	Quattroporte	2021		Y		Y	Y	Y	Y		Y		Y	
	Ghibli	2020		Y		Y	Y	Y	Y		Y		Y	
	Levante	2020		Y		Y	Y	Y	Y		Y		Y	
	Ghibli	2019		Y		Y	Y	Y	Y		Y		Y	
	Levante	2019		Y		Y	Y	Y	Y		Y		Y	
	Ghibli	2018		Y		Y	Y	Y	Y				Y	
	Levante	2018		Y		Y	Y	Y	Y				Y	
	Ghibli	2017		Y			Y	Y				Y		
	Levante	2017		Y			Y	Y				Y		
	Ghibli	2016										Y		
Mazda	CX-3	2021		Y		Y	Y	Y			Y	Y	Y	
	CX-30	2021	Y	Y		Y	Y	Y	Y		Y		Y	
	CX-5	2021	Y			Y					Y		Y	
	CX-9	2021	Y	Y		Y	Y	Y	Y		Y		Y	
	A3 Sedan	2021	Y							Y		Y	Y	
	A3Hatchback	2021	Y							Y		Y	Y	
	A6	2021	Y			Y		Y					Y	
	MX-5 Miata	2021		Y		Y	Y	Y					Y	
	MX-5 Miata RF	2021			Y	Y		Y					Y	
	3	2020		Y		Y	Y	Y	Y		Y		Y	
	6	2020		Y		Y	Y	Y	Y		Y		Y	
	CX-3	2020		Y		Y	Y	Y			Y		Y	
	CX-5	2020		Y		Y	Y	Y	Y		Y		Y	
	CX-9	2020		Y		Y	Y	Y	Y		Y		Y	
	CX-30	2020		Y		Y	Y	Y	Y		Y		Y	
	3	2019		Y		Y	Y	Y	Y		Y		Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Mazda	6	2019		Y		Y	Y	Y	Y		Y		Y	
	CX-3	2019		Y		Y	Y	Y			Y		Y	
	CX-5	2019		Y		Y	Y	Y	Y		Y		Y	
	CX-9	2019		Y		Y	Y	Y	Y		Y		Y	
	MX-5 Miata	2019		Y		Y	Y	Y					Y	
	3	2018		Y		Y	Y	Y	Y				Y	
	6	2018		Y		Y	Y	Y	Y				Y	
	CX-3	2018		Y		Y	Y	Y					Y	
	CX-5	2018		Y		Y	Y	Y	Y				Y	
	CX-9	2018		Y		Y	Y	Y	Y				Y	
	MX-5 Miata	2018							Y			Y	Y	
	3	2017		Y		Y	Y	Y	Y			Y	Y	
	6	2017		Y		Y	Y	Y	Y			Y	Y	
	CX-3	2017		Y		Y	Y	Y				Y	Y	
	CX-5	2017		Y		Y	Y	Y				Y	Y	
	CX-9	2017		Y		Y	Y	Y	Y			Y	Y	
	3	2016		Y		Y	Y	Y				Y	Y	
	6	2016		Y		Y	Y	Y				Y	Y	
	CX-3	2016		Y		Y	Y	Y				Y	Y	
	CX-5	2016		Y		Y	Y	Y				Y	Y	
	CX-9	2016		Y		Y	Y	Y	Y			Y	Y	
	MX-5 Miata	2016				Y		Y					Y	
Mercedes-Benz	A-Class	2021		Y		Y	Y	Y	Y		Y		Y	
	AMG GT	2021		Y		Y	Y	Y	Y		Y		Y	
	C-Class	2021		Y		Y	Y	Y	Y		Y		Y	
	CLA	2021		Y		Y	Y	Y	Y		Y		Y	
	CLS	2021		Y		Y	Y	Y	Y		Y		Y	
	E-Class	2021		Y		Y	Y	Y	Y		Y		Y	
	EQC	2021		Y		Y	Y	Y	Y		Y		Y	
	G-Class	2021		Y		Y	Y	Y	Y		Y		Y	
	GLA	2021		Y		Y	Y	Y	Y		Y		Y	
	GLB	2021		Y		Y	Y	Y	Y		Y		Y	
	GLC	2021		Y		Y	Y	Y	Y		Y		Y	
	GLC Coupe	2021		Y		Y	Y	Y	Y		Y		Y	
	GLE Coupe	2021		Y		Y	Y	Y	Y		Y		Y	
	GLE	2021		Y		Y	Y	Y	Y		Y		Y	
	GLS	2021		Y		Y	Y	Y	Y		Y		Y	
	Metris	2021		Y		Y	Y	Y						
	S-Class	2021		Y		Y	Y	Y	Y		Y		Y	
	A-Class	2020		Y		Y	Y	Y	Y		Y		Y	
	AMG GT	2020		Y		Y	Y	Y	Y		Y		Y	
	C-Class	2020		Y		Y	Y	Y	Y		Y		Y	
	CLA	2020		Y		Y	Y	Y	Y		Y		Y	
	CLS	2020		Y		Y	Y	Y	Y		Y		Y	
	E-Class	2020		Y		Y	Y	Y	Y		Y		Y	
	EQC	2020		Y		Y	Y	Y	Y		Y		Y	
	G-Class	2020		Y		Y	Y	Y	Y		Y		Y	
	GLA	2020		Y		Y	Y	Y					Y	
	GLB	2020		Y		Y	Y	Y	Y		Y		Y	
	GLC	2020		Y		Y	Y	Y	Y		Y		Y	
	GLC coupe	2020		Y		Y	Y	Y	Y		Y		Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Mercedes-Benz	GLE	2020		Y		Y	Y	Y	Y		Y		Y	
	GLS	2020		Y		Y	Y	Y	Y		Y		Y	
	Metris	2020		Y		Y	Y	Y						
	S-Class	2020		Y		Y	Y	Y	Y		Y		Y	
	SL	2020		Y		Y	Y	Y	Y		Y			
	SLC	2020		Y		Y	Y	Y						
	Sprinter	2020		Y		Y	Y	Y	Y		Y		Y	
	A-Class	2019		Y		Y	Y	Y	Y		Y		Y	
	AMG GT	2019		Y		Y	Y	Y			Y			
	C-Class	2019		Y		Y	Y	Y	Y		Y		Y	
	CLA	2019		Y		Y	Y	Y						
	CLS	2019		Y		Y	Y	Y	Y		Y		Y	
	E-Class	2019		Y		Y	Y	Y	Y		Y		Y	
	G-Class	2019		Y		Y	Y	Y	Y		Y		Y	
	GLS	2019		Y		Y	Y	Y	Y		Y			
	GLA	2019		Y		Y	Y	Y						
	GLC	2019		Y		Y	Y	Y	Y		Y			
	GLC coupe	2019		Y		Y	Y	Y	Y		Y			
	GLE	2019		Y		Y	Y	Y	Y		Y			
	GLE coupe	2019		Y		Y	Y	Y	Y		Y			
	Metris	2019				Y	Y	Y						
	S-Class	2019		Y		Y	Y	Y	Y		Y		Y	
	SL	2019		Y		Y	Y	Y	Y		Y			
	SLC	2019		Y		Y	Y	Y						
	Sprinter	2019		Y		Y	Y	Y			Y		Y	
	C-Class	2018		Y		Y	Y	Y	Y					
	CLA	2018		Y		Y	Y	Y						
	CLS	2018		Y		Y	Y	Y	Y					
	E-Class	2018		Y		Y	Y	Y	Y				Y	
	G-Class	2018				Y								
	GLS	2018		Y		Y	Y	Y	Y					
	GLA	2018		Y		Y	Y	Y						
	GLC	2018		Y		Y	Y	Y	Y					
	GLC coupe	2018		Y		Y	Y	Y	Y					
	GLE	2018		Y		Y	Y	Y	Y					
	GLE coupe	2018		Y		Y	Y	Y	Y					
	Metris	2018				Y	Y	Y						
	S-Class	2018		Y		Y	Y	Y	Y				Y	
	SL	2018		Y		Y	Y	Y	Y					
	SLC	2018		Y		Y	Y	Y						
	Sprinter	2018				Y	Y	Y						
	AMG GT	2017		Y		Y	Y	Y				Y		
	B-Class Electric	2017		Y		Y	Y					Y		
	C63	2017		Y		Y	Y	Y	Y			Y	Y	
	C-Class	2017		Y		Y	Y	Y	Y			Y	Y	
	CLA	2017		Y		Y	Y	Y				Y		
	E-Class	2017		Y		Y	Y	Y	Y			Y	Y	
	G-Class	2017				Y						Y		
	GLS	2017		Y		Y	Y	Y	Y			Y	Y	
	GLA	2017		Y		Y	Y	Y				Y		
	GLC	2017		Y		Y	Y	Y	Y			Y	Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Mercedes-Benz	GLS	2017		Y		Y	Y	Y	Y			Y	Y	
	GLE	2017		Y		Y	Y	Y	Y			Y	Y	
	GLE coupe	2017		Y		Y	Y	Y	Y			Y	Y	
	S-Class	2017		Y		Y	Y	Y	Y			Y	Y	
	SL	2017		Y		Y	Y	Y	Y			Y		
	SLC	2017		Y		Y	Y	Y				Y		
	Sprinter	2017				Y	Y	Y				Y		
	AMG GT	2016		Y		Y	Y	Y				Y		
	B-Class Electric	2016		Y		Y	Y					Y		
	C63	2016		Y		Y	Y	Y	Y			Y	Y	
	C-Class	2016		Y		Y	Y	Y	Y			Y	Y	
	CLA	2016		Y		Y	Y	Y				Y		
	CLS	2016		Y		Y	Y	Y	Y			Y	Y	
	E-Class	2016		Y		Y	Y	Y	Y			Y	Y	
	G-Class	2016				Y						Y		
	GLA	2016		Y		Y	Y	Y				Y		
	GLC	2016		Y		Y	Y	Y	Y			Y	Y	
	GL-Class	2016		Y		Y	Y	Y	Y			Y		
	GLS	2016		Y		Y	Y	Y	Y			Y	Y	
	GLE	2016		Y		Y	Y	Y	Y			Y	Y	
	GLE coupe	2016		Y		Y	Y	Y	Y			Y	Y	
	Metris	2016				Y	Y	Y				Y		
	S-Class	2016		Y		Y	Y	Y	Y			Y	Y	
	SL	2016		Y		Y	Y	Y	Y			Y		
	SLK	2016				Y		Y				Y		
	Sprinter	2016				Y	Y	Y				Y		
Mini Cooper	Hardtop/Convertible	2021		Y			Y				Y			
	Clubman	2021		Y			Y				Y			
	Countryman	2021		Y			Y				Y			
	Hardtop	2020		Y			Y				Y			
	Clubman	2020		Y			Y				Y			
	Countryman	2020		Y			Y				Y			
	Hardtop	2019		Y			Y				Y			
	Clubman	2019		Y			Y				Y			
	Countryman	2019		Y			Y				Y			
	Hardtop	2018		Y			Y							
	Clubman	2018		Y			Y							
	Countryman	2018		Y			Y							
	Countryman	2017		Y			Y					Y		
	Countryman	2016		Y			Y					Y		
	Paceman	2016		Y			Y					Y		
Mitsubishi	Mirage	2021		Y			Y				Y			
	Outlander	2021		Y		Y	Y	Y			Y		Y	
	Outlander Sport	2021		Y		Y	Y	Y			Y		Y	
	Eclipse Cross	2020		Y		Y	Y	Y			Y		Y	
	Mirage	2020												
	Outlander	2020		Y		Y	Y	Y			Y		Y	
	Outlander Sport	2020		Y		Y	Y	Y			Y		Y	
	Eclipse Cross	2019		Y		Y	Y	Y			Y		Y	
	Mirage	2019												
	Outlander	2019		Y		Y	Y	Y			Y		Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Mitsubishi	Outlander Sport	2019		Y		Y	Y	Y			Y		Y	
	Eclipse Cross	2018		Y		Y	Y	Y					Y	
	Mirage	2018												
	Outlander	2018		Y		Y	Y	Y					Y	
	Outlander Sport	2018		Y			Y	Y						
	i-MiEV	2017										Y		
	Lancer	2017										Y		
	Mirage	2017										Y		
	Outlander	2017		Y		Y	Y		Y		Y	Y	Y	
	Outlander Sport	2017										Y		
	i-MiEV	2016										Y		
	Lancer	2016										Y		
	Mirage	2016										Y		
	Outlander	2016		Y			Y				Y	Y	Y	
	Outlander Sport	2016										Y		
Nissan	Altima	2021		Y		Y	Y	Y	Y		Y		Y	
	Armada	2021		Y		Y	Y	Y	Y		Y		Y	
	GT-R	2021												
	Kicks	2021		Y		Y	Y	Y			Y		Y	
	Leaf	2021		Y		Y	Y	Y	Y		Y		Y	
	Maxima	2021		Y		Y	Y	Y	Y		Y		Y	
	Murano	2021		Y		Y	Y	Y	Y		Y		Y	
	NV	2021												
	NV200	2021												
	Sentra	2021		Y		Y	Y	Y			Y		Y	
	Rogue	2021		Y		Y	Y	Y	Y		Y		Y	
	Rogue Sport	2021		Y		Y	Y	Y	Y		Y		Y	
	Titan	2021		Y		Y	Y	Y			Y		Y	
	Titan XD	2021		Y		Y	Y	Y			Y		Y	
	Versa	2021		Y		Y	Y	Y			Y		Y	
	Z	2021												
	Altima	2020		Y		Y	Y	Y	Y		Y		Y	
	Armada	2020		Y		Y	Y	Y	Y				Y	
	GT-R	2020												
	Kick	2020		Y		Y	Y	Y			Y		Y	
	Leaf	2020		Y		Y	Y	Y	Y		Y		Y	
	Maxima	2020		Y		Y	Y	Y	Y		Y		Y	
	Murano	2020		Y		Y	Y	Y	Y		Y		Y	
	NV	2020												
	NV200	2020												
	Pathfinder	2020		Y		Y	Y						Y	
	Sentra	2020		Y		Y	Y	Y			Y		Y	
	Rogue	2020		Y		Y	Y	Y	Y		Y		Y	
	Rogue Sport	2020		Y		Y	Y	Y	Y		Y		Y	
	Titan	2020		Y		Y	Y	Y			Y		Y	
	TitanXD	2020		Y		Y	Y	Y			Y		Y	
	Versa	2020		Y		Y	Y	Y			Y		Y	
	Z	2020												
	Altima	2019		Y		Y	Y	Y	Y		Y		Y	
	Armada	2019		Y		Y	Y	Y	Y				Y	
	Frontier	2019												

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Nissan	GT-R	2019												
	Kick	2019		Y		Y	Y						Y	
	Leaf	2019		Y		Y	Y	Y	Y		Y		Y	
	Maxima	2019		Y		Y	Y	Y	Y		Y		Y	
	Murano	2019		Y		Y	Y	Y	Y		Y		Y	
	NV	2019												
	NV200	2019												
	Pathfinder	2019		Y		Y	Y						Y	
	Rogue	2019		Y		Y	Y	Y	Y		Y		Y	
	Rogue Sport	2019		Y		Y	Y	Y	Y		Y		Y	
	Titan	2019				Y							Y	
	Sentra	2019		Y		Y	Y						Y	
	TitanXD	2019				Y							Y	
	Versa	2019												
	VersaNote	2019												
	Z	2019												
	Altima	2018		Y		Y	Y						Y	
	Armada	2018		Y		Y	Y	Y	Y				Y	
	Frontier	2018												
	GT-R	2018												
	Kick	2018		Y		Y	Y						Y	
	Leaf	2018		Y		Y	Y	Y	Y				Y	
	Maxima	2018		Y		Y	Y						Y	
	Murano	2018		Y		Y	Y						Y	
	NV	2018												
	NV200	2018												
	Pathfinder	2018		Y		Y	Y						Y	
	Rogue	2018		Y		Y	Y	Y	Y				Y	
	Rogue Sport	2018		Y		Y	Y	Y	Y				Y	
	Sentra	2018		Y		Y	Y						Y	
	Titan	2018				Y							Y	
	TitanXD	2018				Y							Y	
	Versa	2018												
	VersaNote	2018												
	Z	2018												
	Altima	2017		Y		Y	Y					Y	Y	
	Armada	2017		Y		Y	Y	Y	Y			Y	Y	
	Frontier	2017										Y		
	GT-R	2017										Y		
	Juke	2017										Y		
	Leaf	2017										Y		
	Maxima	2017		Y		Y	Y					Y	Y	
	Murano	2017		Y		Y	Y					Y	Y	
	NV	2017										Y		
	NV200	2017										Y		
	Pathfinder	2017		Y		Y	Y					Y	Y	
	Quest	2017				Y						Y	Y	
	Rogue	2017		Y		Y	Y	Y	Y			Y	Y	
	Rogue Sport	2017		Y		Y	Y	Y	Y			Y	Y	
	Sentra	2017		Y		Y	Y					Y	Y	
	Titan	2017				Y						Y	Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Nissan	TitanXD	2017				Y						Y	Y	
	Versa	2017										Y		
	VersaNote	2017										Y		
	Z	2017										Y		
	Altima	2016		Y		Y	Y					Y	Y	
	Armada	2016										Y		
	Frontier	2016										Y		
	GT-R	2016										Y		
	Juke	2016										Y		
	Leaf	2016										Y		
	Maxima	2016		Y		Y	Y					Y	Y	
	Murano	2016		Y		Y	Y					Y	Y	
	NV	2016										Y		
	NV200	2016										Y		
	Pathfinder	2016				Y						Y	Y	
	Quest	2016				Y						Y	Y	
	Rogue	2016		Y		Y	Y	Y	Y			Y	Y	
	Sentra	2016		Y		Y	Y					Y	Y	
	TitanXD	2016				Y						Y	Y	
	Versa	2016										Y		
	VersaNote	2016										Y		
	Z	2016										Y		
Porsche	911	2021		Y		Y	Y	Y	Y		Y			
	718 Boxster	2021				Y	Y							
	718 Cayman	2021				Y	Y							
	Cayenne	2021		Y		Y	Y	Y	Y		Y			
	Cayenne Coupe	2021		Y		Y	Y	Y	Y		Y			
	Macan	2021		Y		Y	Y	Y	Y		Y			
	Panamera	2021		Y		Y	Y	Y	Y		Y			
	Taycan	2021		Y		Y	Y	Y	Y		Y		Y	
	911	2020		Y		Y	Y	Y	Y	Y	Y	Y		
	Cayenne	2020		Y		Y	Y	Y	Y	Y	Y	Y		
	Cayenne Coupe	2020		Y		Y	Y	Y	Y	Y	Y	Y		
	Macan	2020		Y		Y	Y	Y	Y	Y	Y	Y		
	Panamera	2020		Y		Y	Y	Y	Y	Y		Y		
	Tayan	2020		Y		Y	Y	Y	Y	Y	Y	Y		
	911	2019				Y	Y			Y		Y		
	718 Boxster	2019				Y	Y			Y		Y		
	718 Cayman	2019				Y	Y			Y		Y		
	Cayenne	2019		Y		Y	Y	Y	Y	Y	Y	Y		
	Macan	2019				Y	Y	Y	Y	Y		Y		
	Panamera	2019		Y		Y	Y	Y	Y	Y		Y		
	911	2018				Y	Y			Y		Y		
	718 Boxster	2018				Y	Y			Y		Y		
	718 Cayman	2018				Y	Y			Y		Y		
	Macan	2018				Y	Y	Y	Y	Y		Y		
	Panamera	2018		Y		Y	Y	Y	Y	Y		Y		
	911	2017		Y		Y	Y			Y		Y		
	718 Boxster	2017		Y		Y	Y			Y		Y		
	718 Cayman	2017		Y		Y	Y			Y		Y		
	Cayenne	2017		Y		Y	Y	Y		Y		Y		

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Porsche	Macan	2017		Y		Y	Y	Y	Y	Y		Y		
	Panamera	2017		Y		Y	Y	Y		Y		Y		
	Boxster	2016		Y			Y					Y		
	Cayenne	2016		Y		Y	Y	Y		Y		Y		
	Cayman	2016		Y			Y			Y		Y		
	Macan	2016		Y		Y	Y	Y	Y			Y		
	Panamera	2016		Y		Y	Y	Y		Y		Y		
Ram	1500	2021		Y		Y	Y	Y	Y		Y		Y	
	1500 Classic	2021												
	2500	2021		Y		Y	Y	Y	Y				Y	
	3500	2021		Y		Y	Y	Y	Y				Y	
	ProMaster City	2021												
	ProMaster	2021												
	1500	2020		Y		Y	Y	Y	Y	Y		Y	Y	
	1500 Classic	2020										Y		
	2500	2020		Y		Y	Y	Y	Y			Y	Y	
	3500	2020		Y		Y	Y	Y	Y	Y		Y	Y	
	1500	2019		Y		Y	Y	Y	Y			Y	Y	
	1500 Classic	2019										Y		
	2500	2019		Y		Y	Y					Y	Y	
	3500	2019		Y		Y	Y					Y	Y	
	1500	2018										Y		
	2500	2018								Y		Y		
	3500	2018								Y		Y		
	1500	2017										Y		
	2500	2017								Y		Y		
	3500	2017								Y		Y		
	1500	2016										Y		
	2500	2016										Y		
	3500	2016										Y		
Subaru	Ascent	2021		Y		Y	Y	Y	Y		Y		Y	
	Crosstrek	2021		Y		Y	Y	Y	Y		Y		Y	
	Forester	2021		Y		Y	Y	Y	Y		Y		Y	
	Impreza	2021		Y		Y	Y	Y	Y		Y		Y	
	Legacy	2021		Y		Y	Y	Y	Y		Y		Y	
	Outback	2021		Y		Y	Y	Y	Y		Y		Y	
	WRX	2021		Y		Y	Y	Y	Y		Y		Y	
	Ascent	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	BRZ	2020										Y		
	Crosstrek	2020		Y		Y	Y	Y	Y		Y		Y	
	Forester	2020		Y		Y	Y	Y	Y		Y		Y	Y
	Impreza	2020		Y		Y	Y	Y	Y		Y		Y	
	Legacy	2020	Y	Y		Y	Y	Y	Y		Y	Y	Y	
	Outback	2020	Y	Y		Y	Y	Y	Y		Y	Y	Y	
	WRX	2020		Y		Y	Y	Y	Y		Y		Y	
	Ascent	2019		Y		Y	Y	Y	Y		Y	Y	Y	Y
	BRZ	2019										Y		
	Forester	2019		Y		Y	Y	Y	Y		Y		Y	Y
	Impreza	2019		Y		Y	Y	Y	Y		Y		Y	
	Legacy	2019		Y		Y	Y	Y	Y		Y		Y	Y
	Outback	2019		Y		Y	Y	Y	Y		Y		Y	Y

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Subaru	WRX	2019		Y		Y	Y	Y	Y		Y		Y	
	Crosstrek	2019		Y		Y	Y	Y	Y		Y	Y	Y	Y
	BRZ	2018										Y		
	Forester	2018		Y		Y	Y	Y	Y				Y	
	Impreza	2018		Y		Y	Y	Y	Y				Y	
	Legacy	2018		Y		Y	Y	Y	Y			Y	Y	
	Outback	2018		Y		Y	Y	Y	Y				Y	
	WRX	2018		Y		Y	Y	Y	Y				Y	
	Crosstrek	2018		Y		Y	Y	Y	Y			Y	Y	
	BRZ	2017										Y		
	Forester	2017		Y		Y	Y	Y	Y			Y	Y	
	Impreza	2017		Y		Y	Y	Y	Y			Y	Y	
	Legacy	2017		Y		Y	Y	Y	Y			Y	Y	
	Outback	2017		Y		Y	Y	Y	Y			Y	Y	
	WRX/STi	2017		Y		Y	Y	Y	Y			Y	Y	
	Crosstrek	2016		Y		Y	Y	Y				Y	Y	
	BRZ	2016										Y		
	Forester	2016		Y			Y	Y	Y			Y		
	Impreza	2016		Y			Y	Y	Y			Y		
	Legacy	2016		Y		Y	Y	Y	Y			Y	Y	
	Outback	2016		Y		Y	Y	Y	Y			Y	Y	
	WRX/STi	2016		Y		Y	Y	Y	Y			Y	Y	
Tesla	Model 3	2021		Y			Y	Y	Y		Y			
	Model S	2021		Y			Y	Y	Y		Y			
	Model X	2021		Y			Y	Y	Y		Y			
	Model Y	2021		Y			Y	Y	Y		Y			
	Model 3	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Model S	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Model X	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Model Y	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Model 3	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Model S	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Model X	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	
	Model 3	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Model S	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Model X	2018		Y		Y	Y	Y	Y	Y		Y	Y	
	Model S	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Model X	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Model S	2016		Y		Y	Y	Y		Y		Y	Y	
	Model X	2016		Y		Y	Y	Y		Y		Y	Y	
Toyota	Prius	2021	Y	Y	Y	Y	Y	Y	Y		Y		Y	
	Prius Prime	2021		Y		Y	Y	Y	Y	Y	Y		Y	
	Corolla	2021	Y	Y	Y		Y	Y			Y			
	Corolla Hybrid	2021	Y	Y	Y	Y	Y	Y	Y		Y		Y	
	Corolla Hatchback	2021	Y	Y	Y	Y	Y	Y			Y		Y	
	Camry	2021	Y	Y	Y	Y	Y	Y	Y		Y		Y	
	Camry Hybrid	2021	Y	Y	Y	Y	Y	Y			Y		Y	
	Avalon	2021	Y	Y	Y	Y	Y	Y			Y		Y	
	Avalon Hybrid	2021	Y	Y	Y									
	Mirai	2021	Y		Y					Y				
	GR SUPRA	2021		Y	Y	Y	Y	Y	Y	Y			Y	

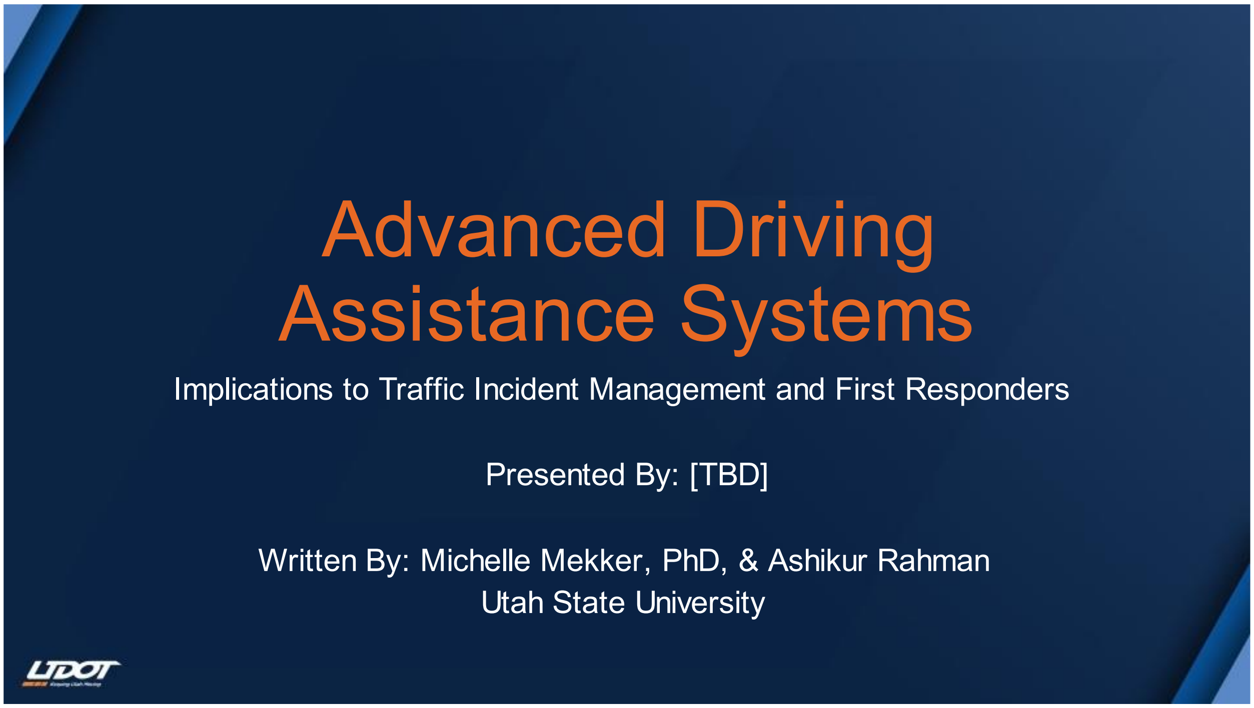
Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Toyota	Sienna	2021	Y	Y	Y	Y	Y	Y	Y				Y	
	4Runner	2021		Y			Y	Y			Y			
	Avalon	2021		Y		Y	Y	Y	Y		Y		Y	
	C-HR	2021		Y		Y	Y	Y	Y		Y		Y	
	Camry	2021		Y		Y	Y	Y	Y		Y		Y	
	Corolla	2021		Y		Y	Y	Y	Y		Y		Y	
	Corolla Hatchback	2021		Y		Y	Y	Y	Y		Y		Y	
	Highlander	2021		Y		Y	Y	Y	Y		Y		Y	
	Land Cruiser	2021		Y		Y	Y	Y			Y		Y	
	Mirai	2021		Y		Y	Y	Y	Y		Y		Y	
	Prius	2021		Y		Y	Y	Y	Y		Y		Y	
	Prius Prime	2021		Y		Y	Y	Y	Y		Y		Y	
	RAV4	2021		Y		Y	Y	Y	Y		Y		Y	
	RAV4 Prime	2021		Y		Y	Y	Y	Y		Y		Y	
	Sequoia	2021		Y		Y	Y	Y			Y		Y	
	Sienna	2021		Y		Y	Y	Y	Y		Y		Y	
	Supra	2021		Y		Y	Y	Y	Y		Y		Y	
	Tacoma	2021		Y		Y	Y	Y			Y		Y	
	Tundra	2021		Y		Y	Y	Y			Y		Y	
	Venza	2021		Y		Y	Y	Y	Y		Y		Y	
	4Runner	2020		Y			Y	Y		Y	Y			
	86	2020												
	Avalon	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	C-HR	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Camry	2020		Y		Y	Y	Y	Y		Y		Y	Y
	Corolla	2020		Y		Y	Y	Y	Y		Y	Y		Y
	Corolla Hatchback	2020		Y		Y	Y	Y	Y		Y	Y		Y
	Highlander	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Land Cruiser	2020		Y		Y	Y	Y		Y	Y	Y	Y	Y
	Prius	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Prius prime	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	RAV4	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Sequoia	2020		Y		Y	Y	Y		Y	Y	Y	Y	Y
	Sienna	2020		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Supra	2020		Y		Y	Y	Y	Y		Y	Y	Y	
	Tacoma	2020		Y		Y	Y	Y			Y	Y	Y	Y
	Tundra	2020		Y		Y	Y	Y			Y	Y	Y	Y
	Yaris Sedan (iA)	2020		Y										
	Yaris Hatchback	2020		Y										
	86	2020												
	86	2019										Y		
	4Runner	2019								Y				
	Avalon	2019		Y		Y	Y	Y	Y		Y	Y	Y	Y
	C-HR	2019		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Camry	2019		Y		Y	Y	Y	Y		Y	Y	Y	Y
	Corolla sedan	2019		Y			Y	Y	Y		Y	Y		Y
	Corolla hatchback	2019		Y		Y	Y	Y	Y		Y	Y		Y
	Highlander	2019		Y		Y	Y	Y	Y		Y		Y	
	Land Cruiser	2019		Y		Y	Y	Y		Y	Y	Y	Y	Y
	Mirai	2019		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
	C-HR	2018		Y		Y	Y	Y	Y			Y	Y	Y

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Toyota	Camry	2018		Y			Y	Y	Y			Y		Y
	Corolla	2018		Y		Y	Y	Y	Y			Y	Y	Y
	Highlander	2018		Y			Y	Y						Y
	Corolla iM	2018		Y		Y	Y	Y				Y	Y	Y
	Land Cruiser	2018		Y		Y	Y	Y		Y		Y	Y	Y
	Mirai	2018		Y		Y	Y	Y	Y	Y		Y	Y	Y
	Prius	2018		Y		Y	Y	Y	Y			Y	Y	Y
	Prius prime	2018		Y			Y	Y				Y		Y
	PriusC	2018		Y		Y	Y	Y	Y			Y	Y	Y
	RAV4	2018		Y		Y	Y	Y					Y	
	Sequia	2018		Y		Y	Y	Y	Y			Y	Y	Y
	Sienna	2018		Y		Y	Y	Y				Y	Y	Y
	Tacoma	2018		Y		Y	Y	Y					Y	Y
	Tundra	2018		Y										Y
	Yaris iA	2018										Y		
	86	2017										Y		
	4Runner	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Avalon	2017		Y		Y	Y	Y				Y	Y	
	Camry	2017		Y			Y	Y	Y			Y		
	Corolla	2017		Y			Y	Y				Y		
	Corolla iM	2017		Y		Y	Y	Y				Y	Y	
	Highlander	2017		Y		Y	Y	Y				Y	Y	
	Land Cruiser	2017		Y		Y	Y	Y	Y	Y		Y	Y	
	Prius	2017		Y		Y	Y	Y	Y			Y	Y	
	Prius prime	2017		Y			Y	Y				Y		
	PriusC	2017		Y			Y	Y				Y		
	PriusV	2017		Y		Y	Y	Y	Y			Y	Y	
	RAV4	2017				Y						Y		
	Sequia	2017		Y		Y	Y			Y		Y	Y	
	Sienna	2017				Y						Y	Y	
	Tundra	2017		Y								Y		
	YARIS iA	2017										Y		
	4Runner	2016		Y		Y	Y	Y	Y			Y	Y	
	Avalon	2016		Y		Y	Y	Y				Y	Y	
	Camry	2016										Y		
	Corolla	2016		Y		Y	Y	Y				Y	Y	
	Highlander	2016		Y		Y	Y	Y		Y		Y	Y	
	Land Cruiser	2016		Y		Y	Y	Y		Y		Y	Y	
	Mirai	2016		Y		Y	Y	Y	Y	Y		Y	Y	
	Prius	2016		Y			Y	Y				Y		
	PriusC	2016		Y			Y	Y				Y		
	PriusV	2016		Y		Y	Y	Y	Y			Y	Y	
	RAV4	2016		Y		Y	Y			Y		Y	Y	
	Sienna	2016				Y						Y	Y	
	Tundra	2016												
	Yaris	2016												
Volkswagen	Arteon	2021		Y		Y	Y	Y	Y		Y		Y	
	Atlas	2021		Y		Y	Y	Y	Y		Y		Y	
	Atlas Cross Sport	2021		Y		Y	Y	Y	Y		Y		Y	
	Golf	2021		Y		Y	Y				Y		Y	
	GTI	2021		Y		Y	Y	Y	Y		Y		Y	

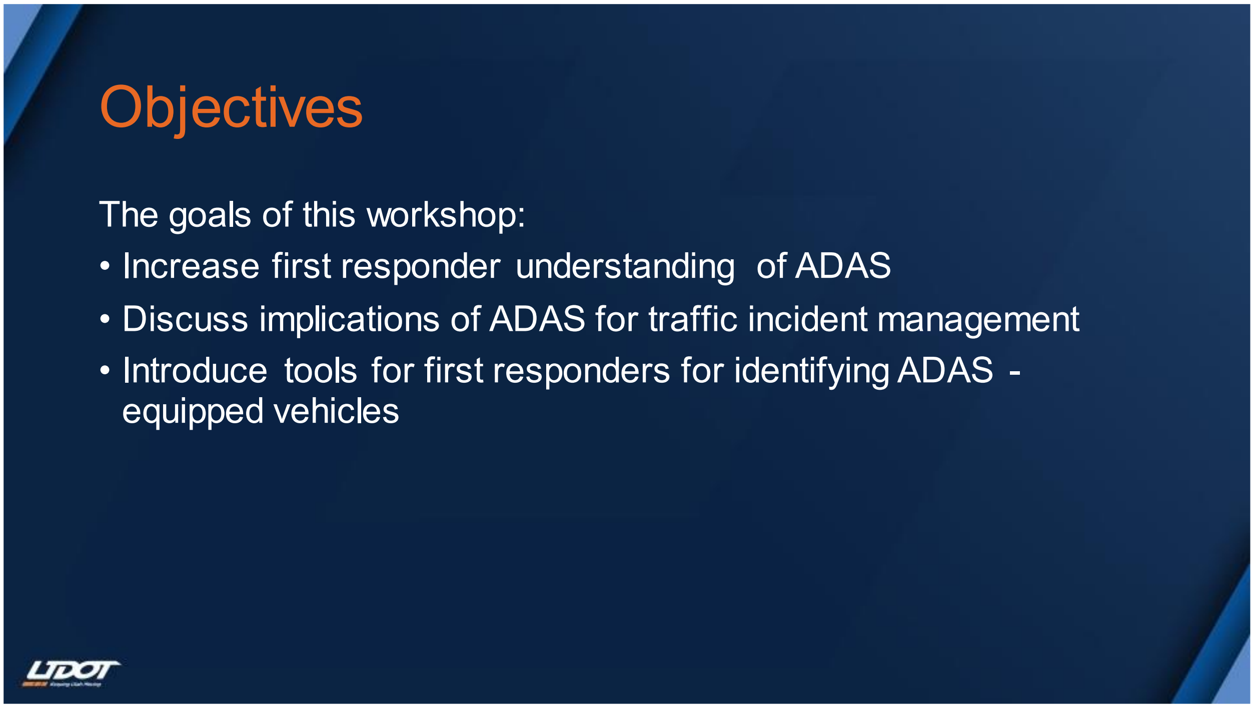
Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Volkswagen	Jetta	2021		Y		Y	Y	Y	Y				Y	
	Passat	2021		Y		Y	Y	Y	Y		Y		Y	
	Tiguan	2021		Y		Y	Y	Y	Y		Y		Y	
	ID4	2021		Y		Y	Y	Y	Y		Y		Y	
	Arteon	2020		Y		Y	Y	Y	Y		Y		Y	
	Atlas	2020		Y		Y	Y	Y	Y		Y		Y	
	Atlas Cross Pilot	2020		Y		Y	Y	Y	Y		Y		Y	
	Golf	2020		Y		Y	Y	Y	Y		Y		Y	
	GTI	2020		Y		Y	Y	Y	Y		Y		Y	
	Jetta	2020		Y		Y	Y	Y	Y		Y		Y	
	Passat	2020		Y		Y	Y	Y	Y		Y		Y	
	Tiguan	2020		Y		Y	Y	Y	Y		Y		Y	
	Arteon	2019		Y		Y	Y	Y	Y		Y		Y	
	Atlas	2019		Y		Y	Y	Y	Y		Y		Y	
	Beetle	2019				Y							Y	
	Golf	2019		Y		Y	Y	Y	Y		Y		Y	
	Golf Sportwagon	2019		Y		Y	Y	Y	Y		Y		Y	
	Alltrack	2019		Y		Y	Y	Y	Y		Y		Y	
	GTI	2019		Y		Y	Y	Y	Y		Y		Y	
	Jetta	2019		Y		Y	Y	Y	Y				Y	
	Passat	2019		Y		Y	Y	Y	Y				Y	
	Tiguan	2019		Y		Y	Y	Y	Y		Y		Y	
	Atlas	2018		Y		Y	Y	Y	Y				Y	
	Beetle	2018				Y							Y	
	Golf	2018		Y		Y	Y	Y	Y		Y		Y	
	Golf Sportwagon	2018		Y		Y	Y	Y	Y		Y		Y	
	Alltrack	2018		Y		Y	Y	Y	Y		Y		Y	
	GTI	2018		Y		Y	Y	Y	Y		Y		Y	
	Jetta	2018		Y		Y	Y	Y	Y		Y		Y	
	Passat	2018		Y		Y	Y	Y	Y		Y		Y	
	Tiguan	2018		Y		Y	Y	Y	Y		Y		Y	
	Beetle	2017				Y						Y	Y	
	CC	2017		Y		Y	Y	Y	Y		Y	Y	Y	
	Golf	2017		Y		Y	Y	Y	Y		Y	Y	Y	
	Golf Wagon	2017		Y		Y	Y	Y	Y		Y	Y	Y	
	Golf Sport	2017		Y		Y	Y	Y	Y		Y	Y	Y	
	GTI	2017		Y		Y	Y	Y	Y		Y	Y	Y	
	Jetta	2017		Y		Y	Y	Y	Y		Y	Y	Y	
	Passat	2017		Y		Y	Y	Y	Y		Y	Y	Y	
	Tiguan	2017										Y		
	Touareg	2017		Y		Y	Y	Y	Y		Y	Y	Y	
	Beetle	2016				Y						Y	Y	
	CC	2016		Y			Y	Y	Y			Y		
	Golf	2016		Y		Y	Y	Y	Y		Y	Y	Y	
	Golf Wagon	2016		Y		Y	Y	Y	Y		Y	Y	Y	
	GTI	2016		Y		Y	Y	Y	Y		Y	Y	Y	
	Jetta	2016		Y		Y	Y	Y	Y		Y	Y	Y	
	Passat	2016		Y		Y	Y	Y	Y		Y	Y	Y	
	Tiguan	2016										Y		
	Touareg	2016		Y		Y	Y	Y	Y		Y	Y	Y	

Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA
Volvo	S60	2021		Y		Y	Y	Y	Y		Y		Y	
	S90	2021		Y		Y	Y	Y	Y		Y		Y	
	V90	2021		Y		Y	Y	Y	Y		Y		Y	
	V60	2021		Y		Y	Y	Y	Y		Y		Y	
	XC40	2021		Y		Y	Y	Y	Y		Y		Y	
	XC60	2021		Y		Y	Y	Y	Y		Y		Y	
	XC90	2021		Y		Y	Y	Y	Y		Y		Y	
	S60	2020		Y		Y	Y	Y	Y		Y		Y	
	S90	2020		Y		Y	Y	Y	Y		Y		Y	
	V60	2020		Y		Y	Y	Y	Y		Y		Y	
	V90	2020		Y		Y	Y	Y	Y		Y		Y	
	XC40	2020		Y		Y	Y	Y	Y		Y		Y	
	XC60	2020		Y		Y	Y	Y	Y		Y		Y	
	XC90	2020		Y		Y	Y	Y	Y		Y		Y	
	S60	2019		Y		Y	Y	Y	Y		Y		Y	
	S90	2019		Y		Y	Y	Y	Y		Y		Y	
	V90	2019		Y		Y	Y	Y	Y		Y		Y	
	V60	2019		Y		Y	Y	Y	Y		Y		Y	
	XC40	2019		Y		Y	Y	Y	Y		Y		Y	
	XC60	2019		Y		Y	Y	Y	Y		Y		Y	
	XC90	2019		Y		Y	Y	Y	Y		Y		Y	
	S60	2018		Y		Y	Y	Y	Y				Y	
	S90	2018		Y		Y	Y	Y	Y				Y	
	V90	2018		Y		Y	Y	Y	Y				Y	
	V60	2018		Y		Y	Y	Y	Y				Y	
	XC40	2018		Y		Y	Y	Y	Y				Y	
	XC60	2018		Y		Y	Y	Y	Y				Y	
	XC90	2018		Y		Y	Y	Y	Y				Y	
	S60	2017		Y		Y	Y	Y	Y			Y	Y	
	S90	2017		Y		Y	Y	Y	Y			Y	Y	
	V90	2017		Y		Y	Y	Y	Y			Y	Y	
	V60	2017		Y		Y	Y	Y	Y			Y	Y	
	XC60	2017		Y		Y	Y	Y	Y			Y	Y	
	XC90	2017		Y		Y	Y	Y	Y			Y	Y	
	S60	2016		Y		Y	Y	Y	Y			Y	Y	
	S80	2016		Y		Y	Y	Y	Y			Y		
	V60	2016		Y		Y	Y	Y	Y			Y	Y	
	XC60	2016		Y		Y	Y	Y	Y			Y	Y	
	XC90	2016		Y		Y	Y	Y	Y			Y	Y	

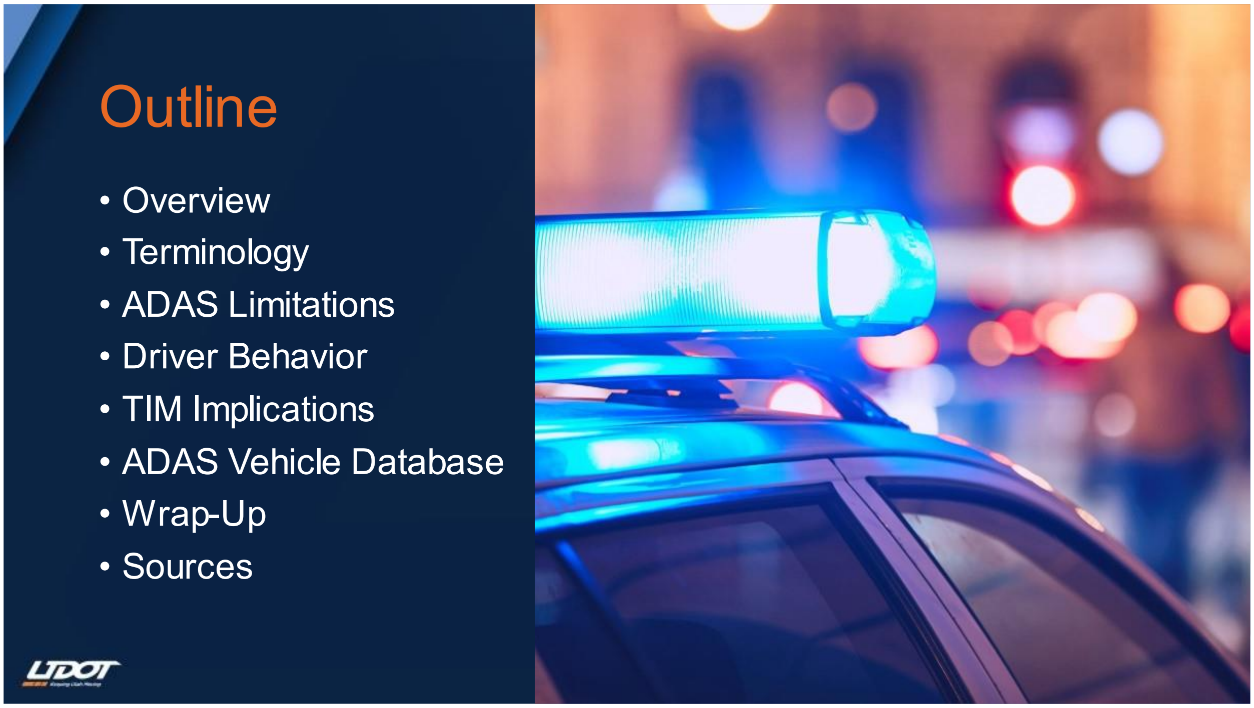
APPENDIX C: Workshop Materials



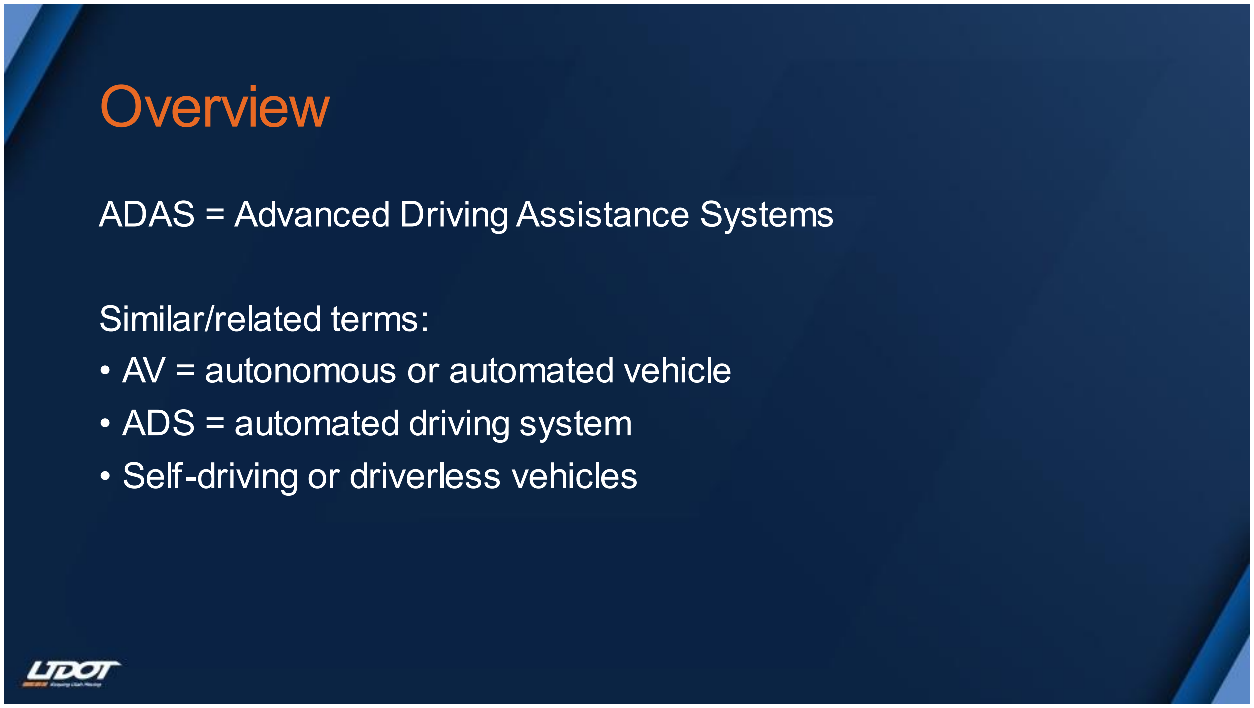
- Welcome attendees to the workshop.
- The presenter/s should introduce themselves.
- Discuss any relevant house-keeping items.
- Have attendees introduce themselves.
    - Name
    - TIM specialty
    - Agency/Organization
    - Years of experience



- The goals of this workshop are to:
  - Increase first responder understanding of ADAS
  - Discuss implications of ADAS for traffic incident management
  - Introduce tools for first responders for identifying ADAS-equipped vehicles

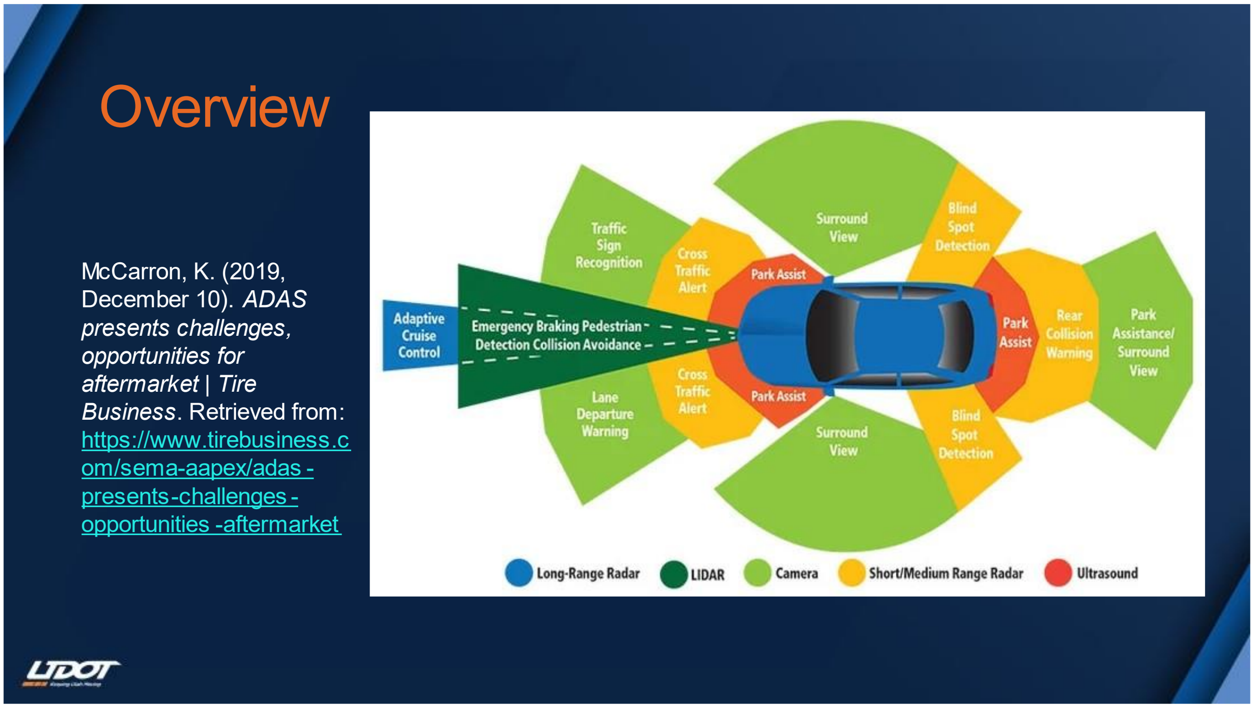


- This workshop will begin with an overview of ADAS, followed by terminology and general technological limitations. Then, we will discuss driver behavior regarding ADAS and its implications for traffic incident management. The workshop will wrap up with the introduction of a database of ADAS-equipped vehicles, which was developed as a tool for first responders.
- There will be scattered discussion and activities (i.e., class participation).

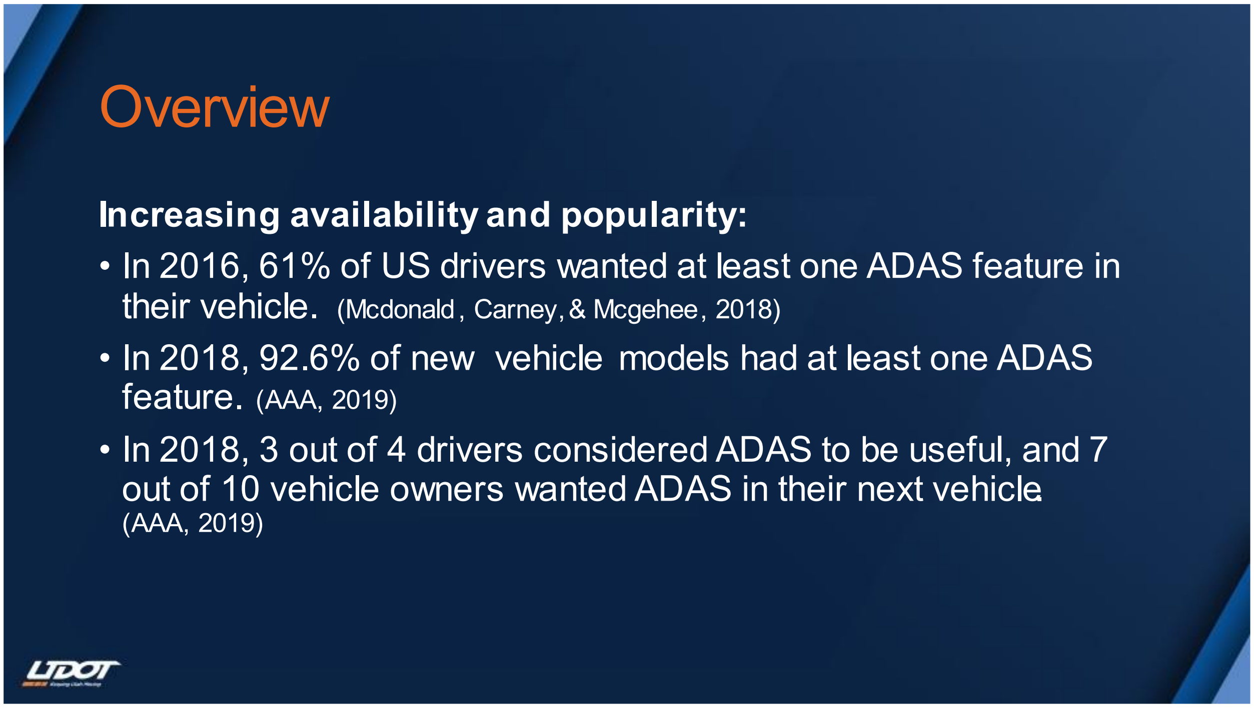


- The chosen term/abbreviation in this workshop is ADAS, which stands for Advanced Driving Assistance Systems.
- Some people might also refer to these technologies as autonomous vehicles, automated driving systems, self-driving or driverless vehicles, etc.
- These terms tend to be used interchangeably but do technically have specific definitions/scopes.

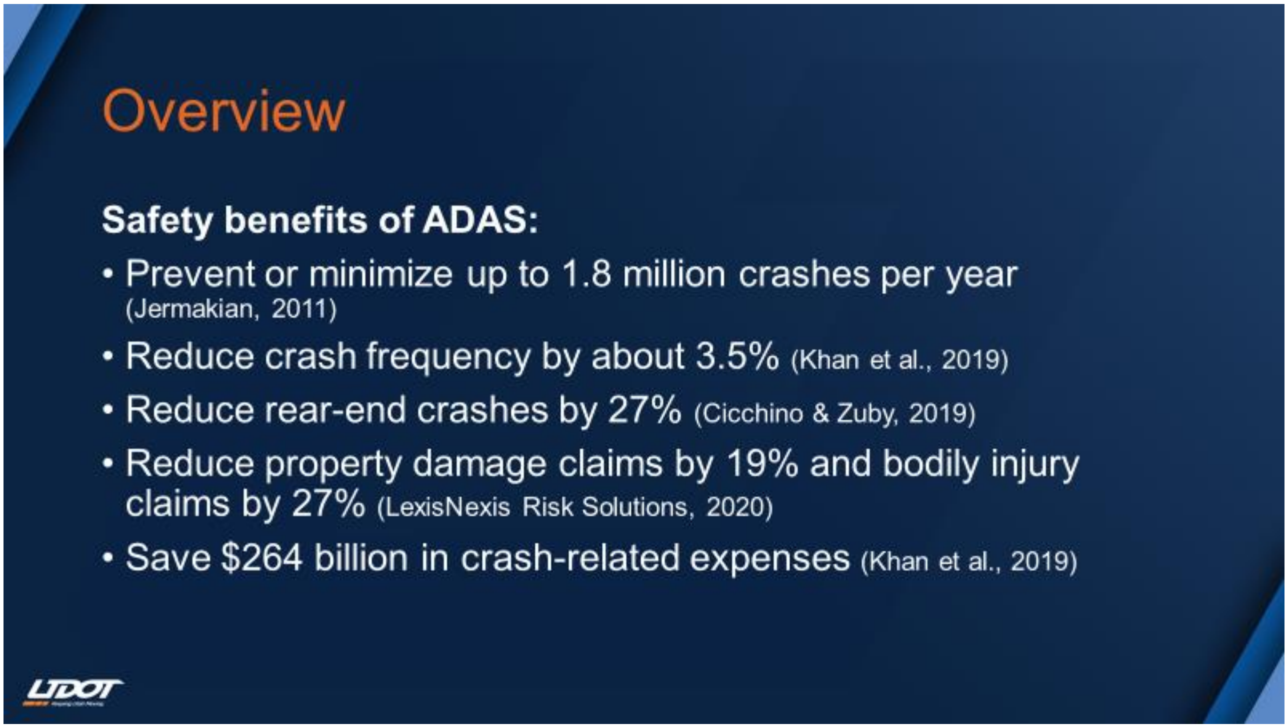
- ADAS is related to vehicle automation.
- Despite some vehicle manufacturer claims, the only legal, commercially available "automated vehicles" are at SAE Level 2 or less.
- Currently available ADAS features fall within SAE Levels 0-2 and always require driver control.



- ADAS relies on sensors, which can vary by feature, manufacturer, and model year. Therefore, sensor capabilities can vary drastically.
- While a sensor's range/accuracy of "vision" may be superior to that of a human driver, the processing of that "vision" – to understand what it's seeing – is under constant development and is generally considered to be inferior to human pattern recognition (as of now).

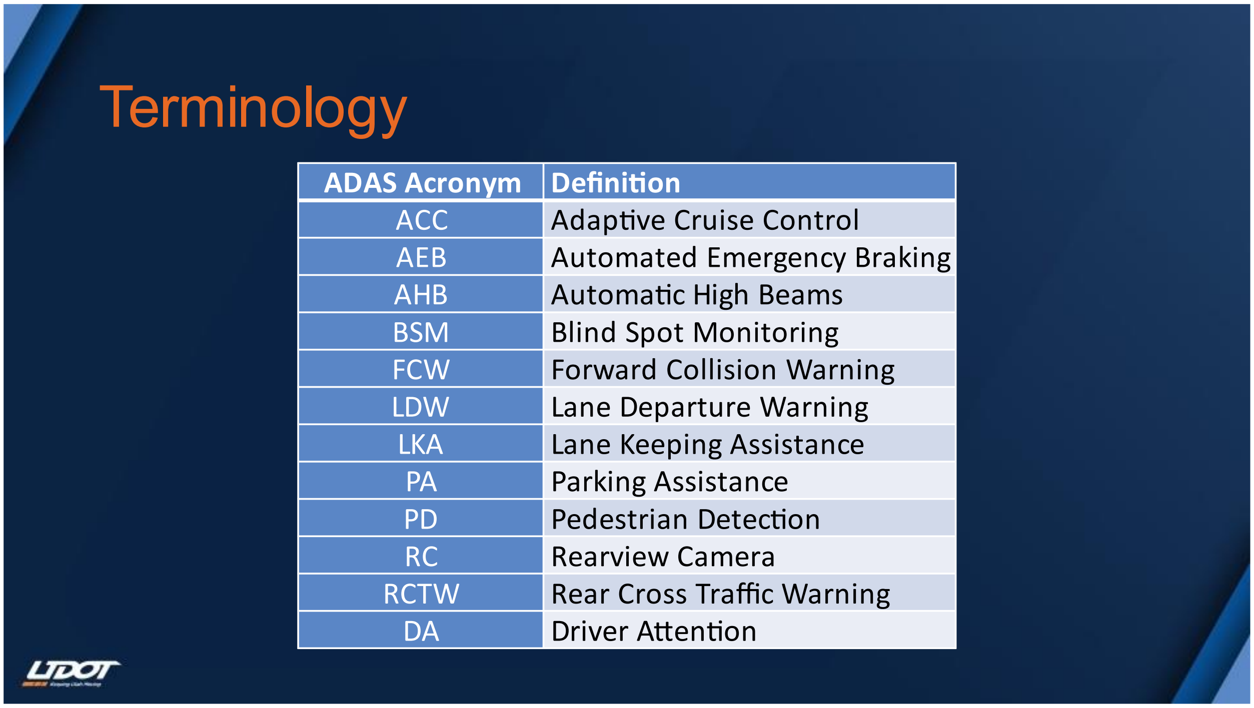


- The market share and demand for vehicles with ADAS has been growing quickly in the last few years:
  - In 2016, 61% of US drivers wanted at least one ADAS feature in their vehicle.
  - In 2018, 92.6% of new vehicle models had at least one ADAS feature.
  - In 2018, 3 out of 4 drivers considered ADAS to be useful, and 7 out of 10 vehicle owners wanted ADAS in their next vehicle.
- As ADAS vehicles become more popular and more common in vehicles, you will encounter them in your day-to-day life with increasing frequency.



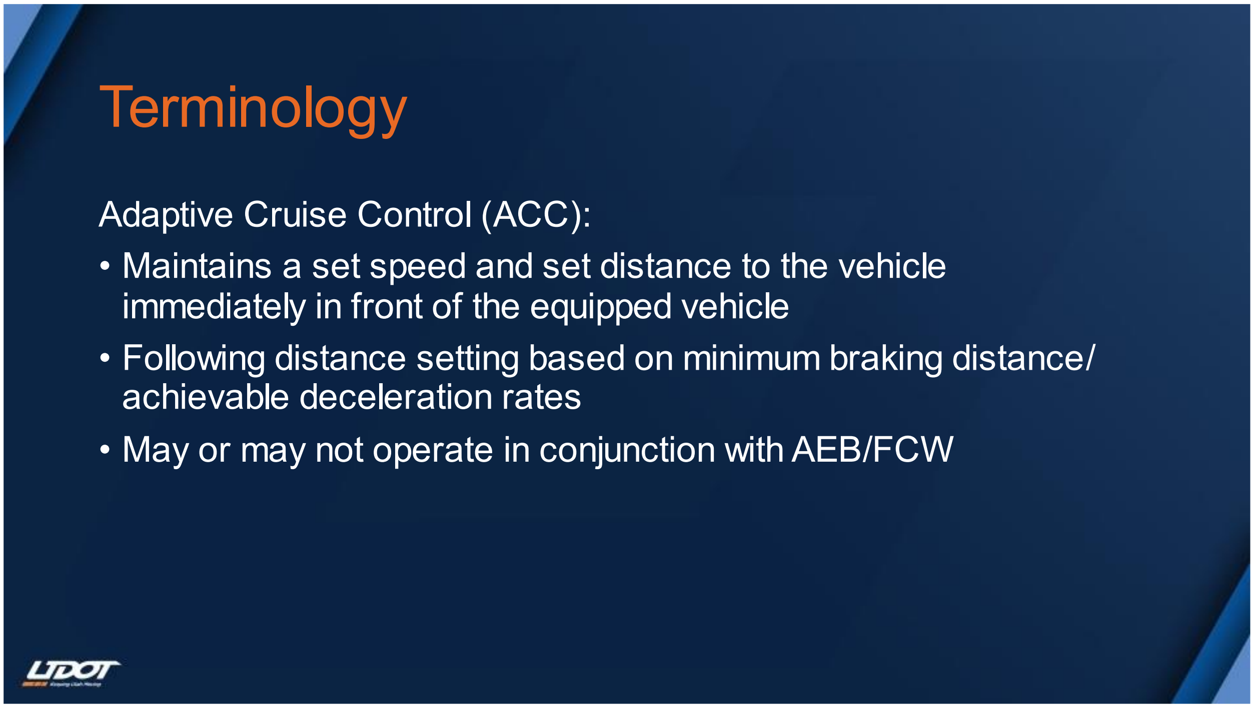
- ADAS features have been found to have a significant impact on safety:
  - Prevent or minimize up to 1.8 million crashes per year
  - Reduce crash frequency by about 3.5%
  - Reduce rear-end crashes by 27%
  - Reduce property damage claims by 19% and bodily injury claims by 27%
  - Save $264 billion in crash-related expenses
- So, we want to encourage the appropriate use of these technologies.

- There have been numerous studies in this area. You can find some references in the Sources at the end of this presentation.
- However, most of these studies have been conducted on a small number of vehicles, in simulations, in controlled environments, etc.
- These studies also assume "proper" use of ADAS. In other words, they assume that drivers will use ADAS within the scope of their capabilities.
- Going forward in this workshop, we will discuss ADAS technology limitations and driver behavior, focusing on implications for crashes and first responders.
- **Are there any question about ADAS in general?**

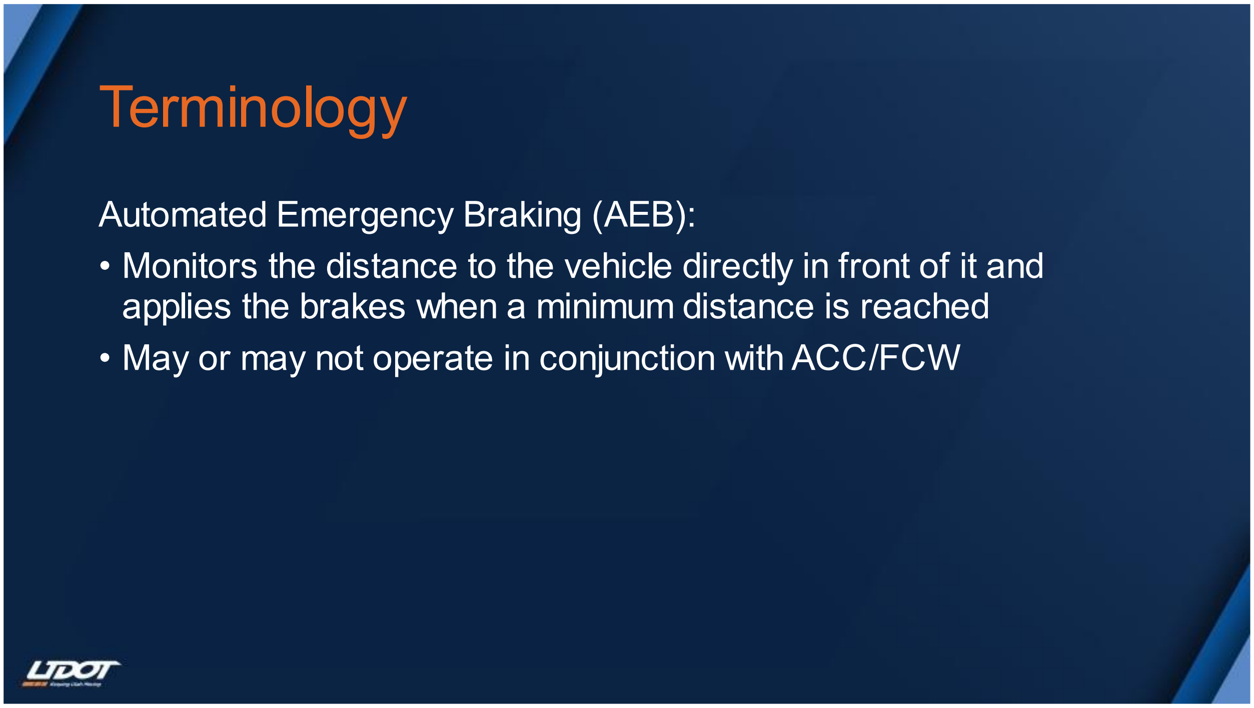


ADAS Acronym	Definition
ACC	Adaptive Cruise Control
AEB	Automated Emergency Braking
AHB	Automatic High Beams
BSM	Blind Spot Monitoring
FCW	Forward Collision Warning
LDW	Lane Departure Warning
LKA	Lane Keeping Assistance
PA	Parking Assistance
PD	Pedestrian Detection
RC	Rearview Camera
RCTW	Rear Cross Traffic Warning
DA	Driver Attention

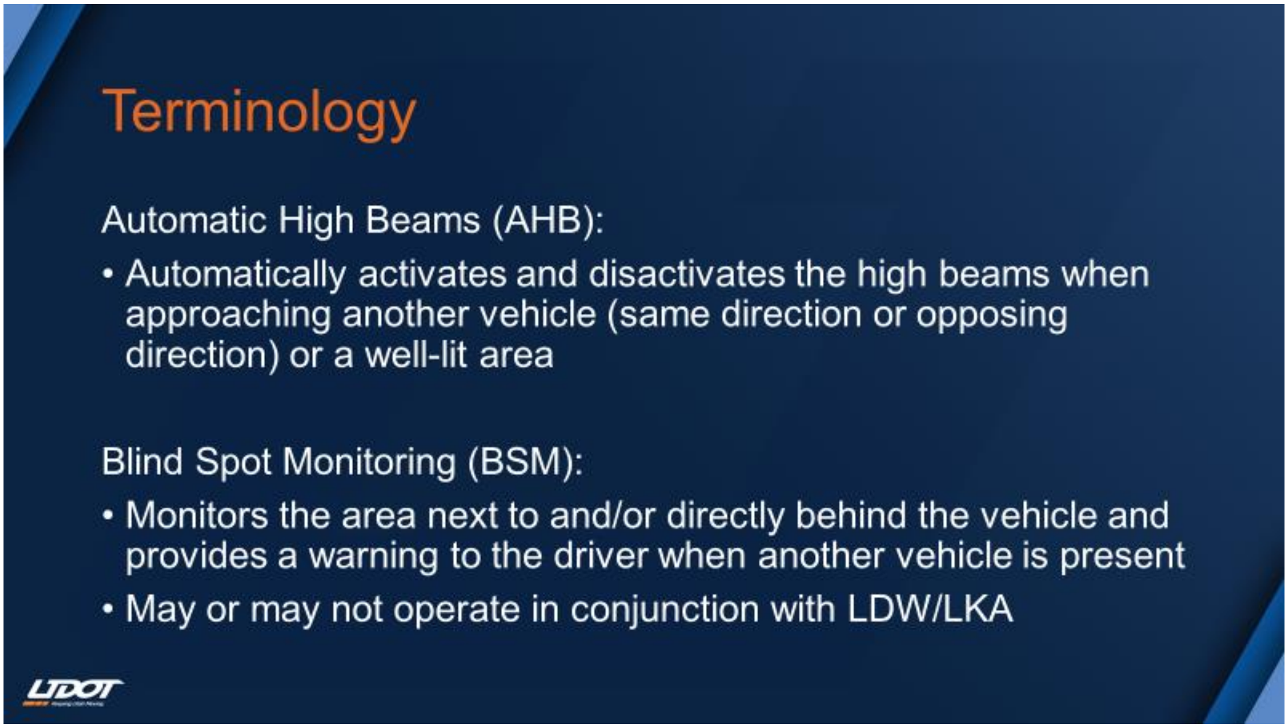
- First, let's go over common terminology in the field. We'll go over more detailed definitions in the following slides.
- It is important to note that these abbreviations and definitions are just the most common names for these ADAS features. Some manufacturers or transportation professionals may refer to them as something similar.
- It is also important to note that the following definitions are general. There are very often variations in ADAS scopes/capabilities between manufacturers. But these definitions cover the general scope.



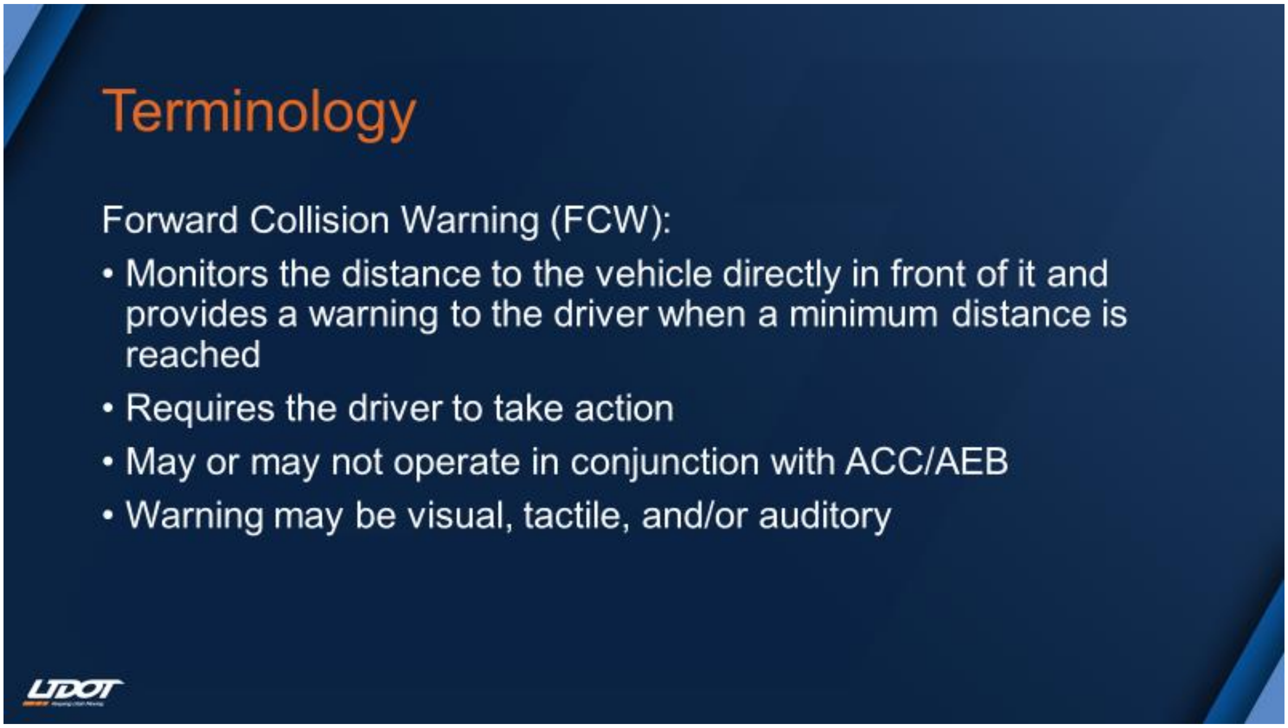
- Adaptive Cruise Control is one of the more well-known ADAS.
- It maintains a set speed and set distance to the vehicle immediately in front of the equipped vehicle.
- The following distance setting is based on minimum braking distance/achievable deceleration rates.
- ACC may or may not operate in conjunction with AEB/FCW. As we'll see going forward, many ADAS features may work together with or completely separate from other ADAS features in the vehicle. It is also very difficult to know which case it is without scouring the owner's manual or diving into the programming.



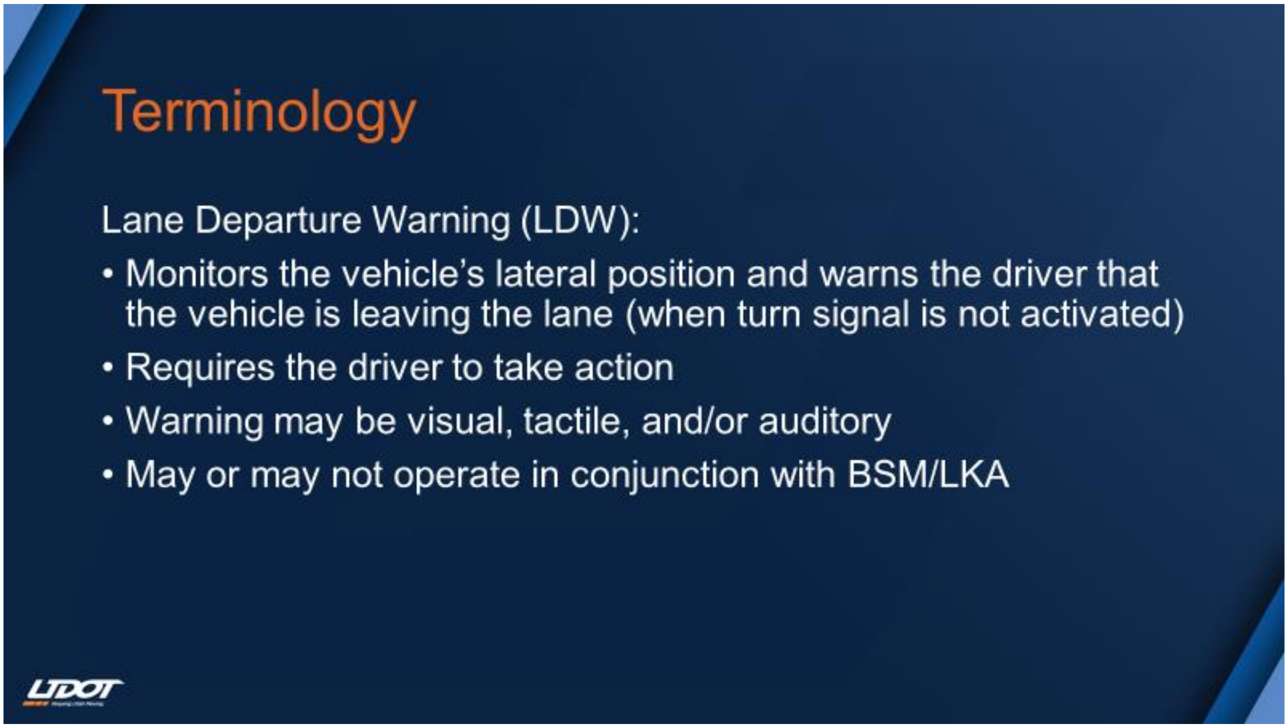
- Automated Emergency Braking, together with ACC, tends to cause the most problems for first responders. We’ll discuss this in more detail later.
- AEB monitors the distance to the vehicle directly in front of it and applies the brakes when a minimum distance is reached.



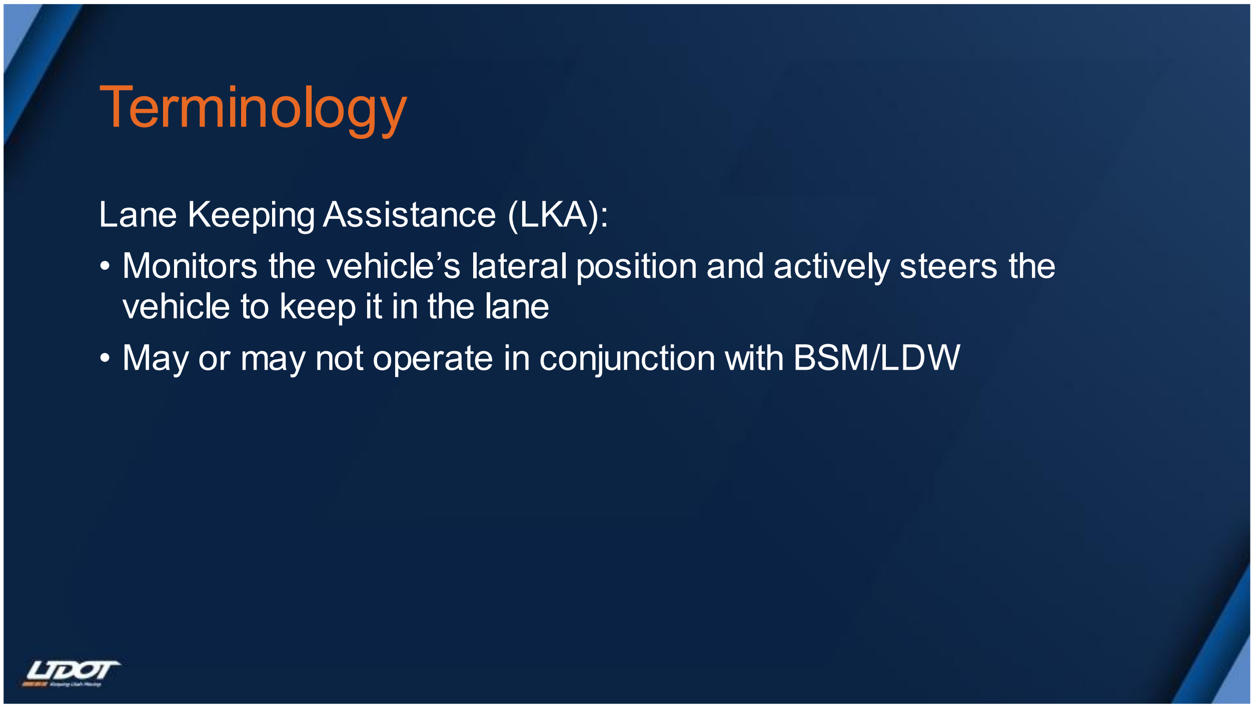
- The Automatic High Beams feature is less well-known to drivers and is generally less relevant in TIM.
- AHB automatically activates and disactivates the high beams when approaching another vehicle (same direction or opposing direction) or a well-lit area.
- Blind-Spot Monitoring is more well-known and more relevant to TIM.
- BSM monitors the area next to and/or directly behind the vehicle and provides a warning to the driver when another vehicle is present, especially if the driver changes lanes or indicates a lane change.



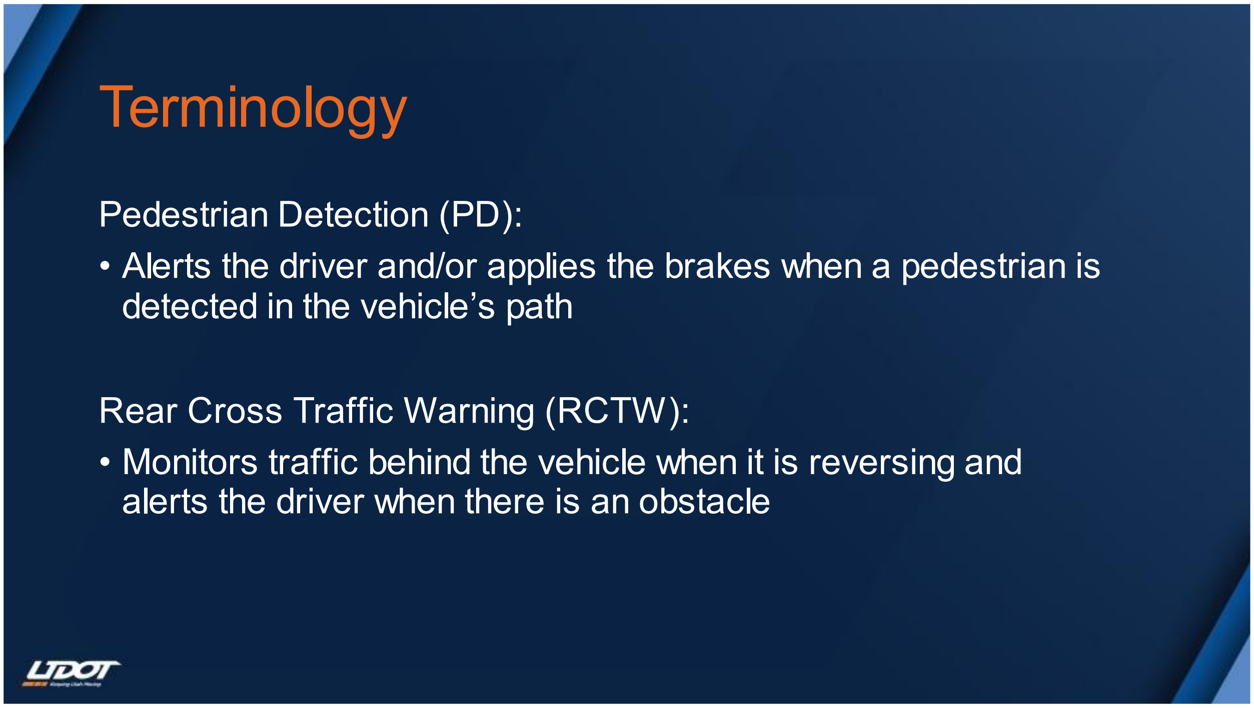
- Forward Collision Warning is often confused with Automated Emergency Braking and, thus, is relevant to TIM.
- FCM monitors the distance to the vehicle directly in front of it and provides a warning to the driver when a minimum distance is reached.
- This feature requires the driver to take action instead of the vehicle taking action (like with AEB). The warning may be visual, tactile, and/or auditory.



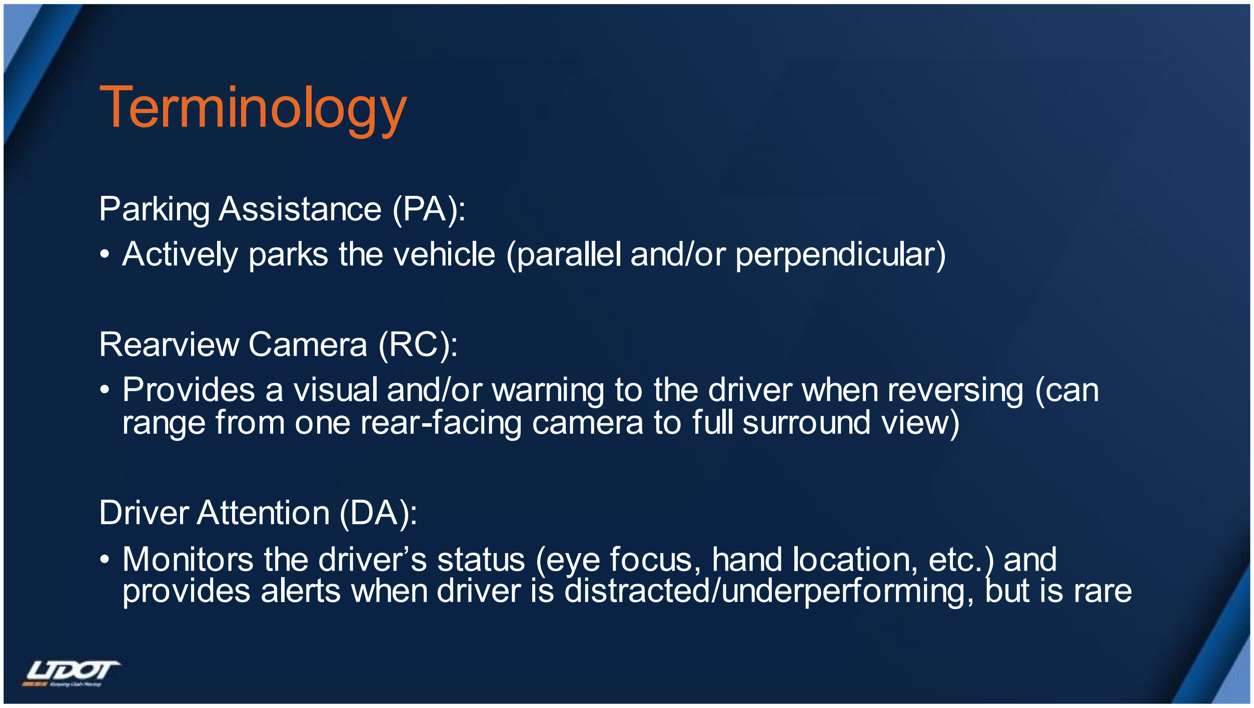
- Lane Departure Warning and Lane-Keeping Assistance (which we'll talk about next) are very often confused with each other. They are also often confused with Blind-Spot Monitoring.
- LDW monitors the vehicle's lateral position and warns the driver that the vehicle is leaving the lane (when the turn signal is not activated).
- This feature requires the driver to take action. The warning may be visual, tactile, and/or auditory.



- Very similarly, Lane-Keeping Assistance monitors the vehicle's lateral position and actively steers the vehicle to keep it in the lane.
- So, the key difference between these two features is, in response to drifting out of the lane:
    - LDW provides a warning only and requires driver action.
    - LKA takes action for the driver.

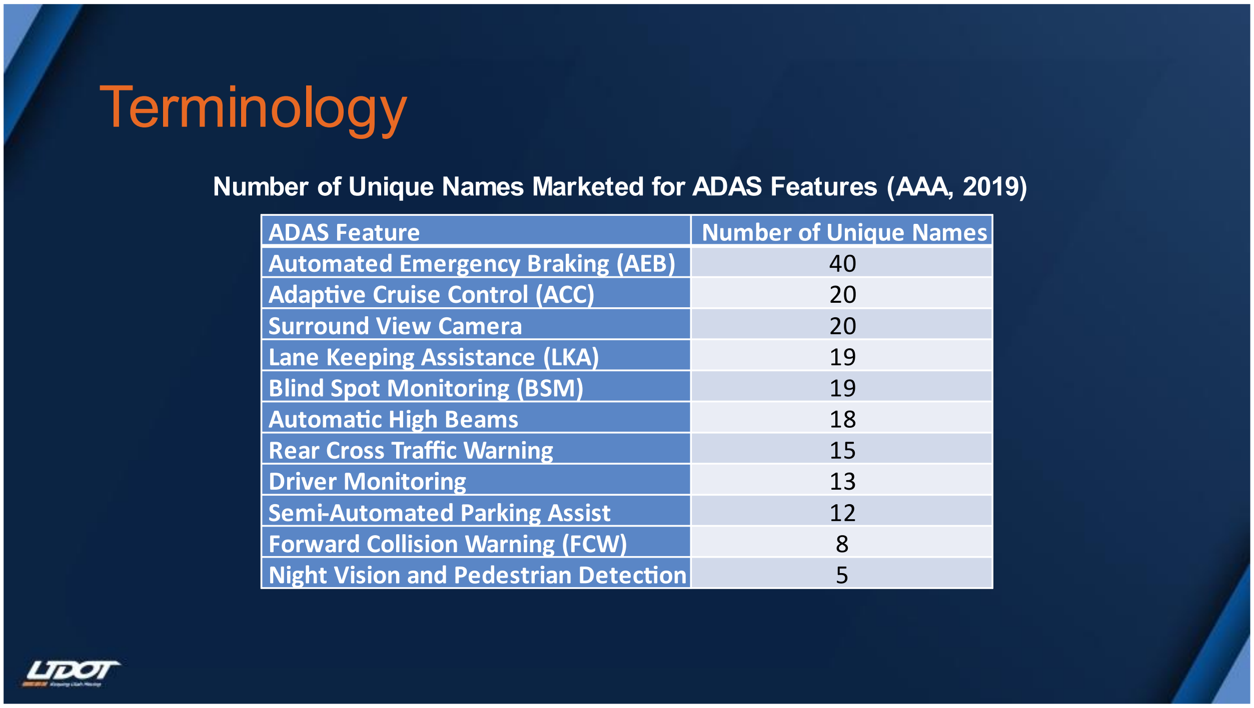


- Pedestrian Detection is most relevant on non-freeway roads but is also less common in vehicles. It is a relatively new ADAS and thus less developed.
- In general, PD alerts the driver and/or applies the brakes when a pedestrian is detected in the vehicle’s path.
- Rear Cross-Traffic Warning is less relevant to TIM, as it monitors traffic behind the vehicle when it is reversing and alerts the driver when there is an obstacle.



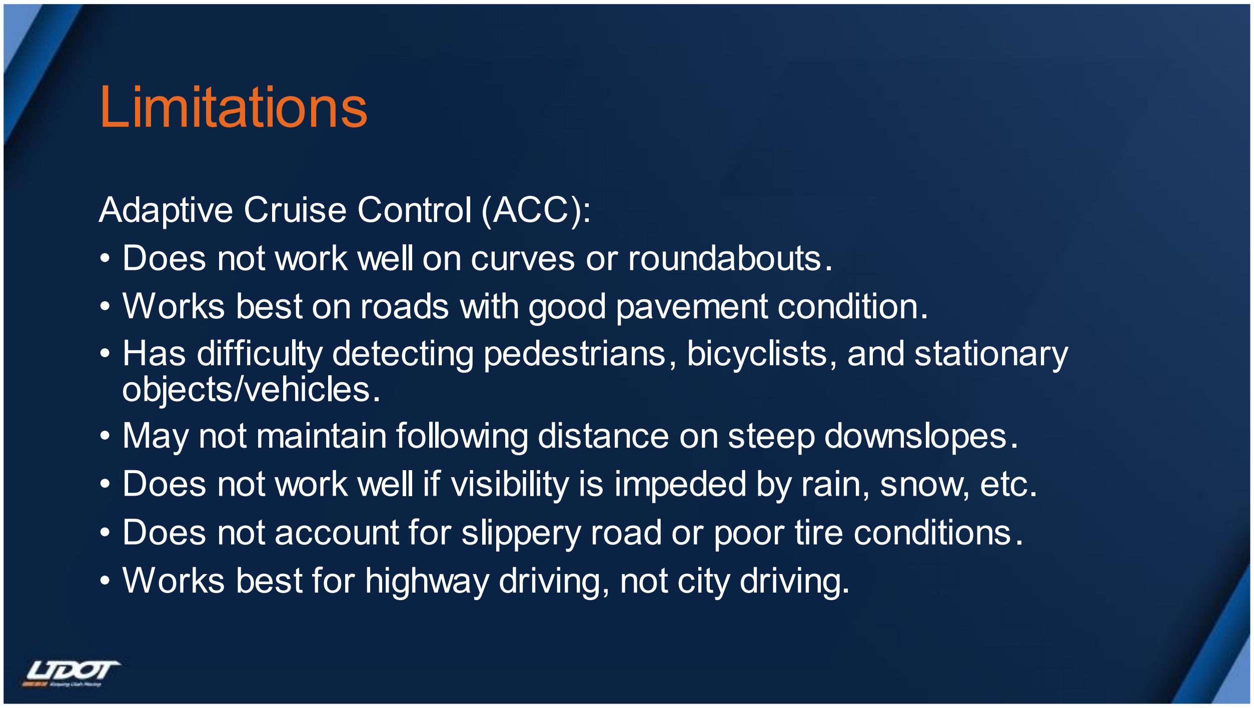
- Similar to RCTW, Parking Assistance and Rearview Camera will be less relevant for TIM.
- PA actively parks the vehicle and may include parallel and/or perpendicular parking.
- RC is one of the oldest ADAS and provides a visual and/or warning to the driver when reversing. This can range from one rear-facing camera to full surround view.
- One of the newest and least common (and least developed or understood) ADAS features is Driver Attention, which monitors the driver's status (eye focus, hand location, etc.) and provides alerts when the driver is distracted or underperforming.

- In general, if an ADAS feature includes terms like "warning," "alert," or similar, it requires the driver to take action in response to a hazard, obstacle, or problem.
- If an ADAS feature includes terms like "assistance," "control," "braking," "steering," "automatic," etc., then the vehicle will generally take action in response to a hazard, obstacle, or problem.
- However, this is a general rule of thumb and regardless of wording, current ADAS still requires drivers' full attention and control.
- Also, warning vs. assistance is not necessarily implied to be "better" or "worse."

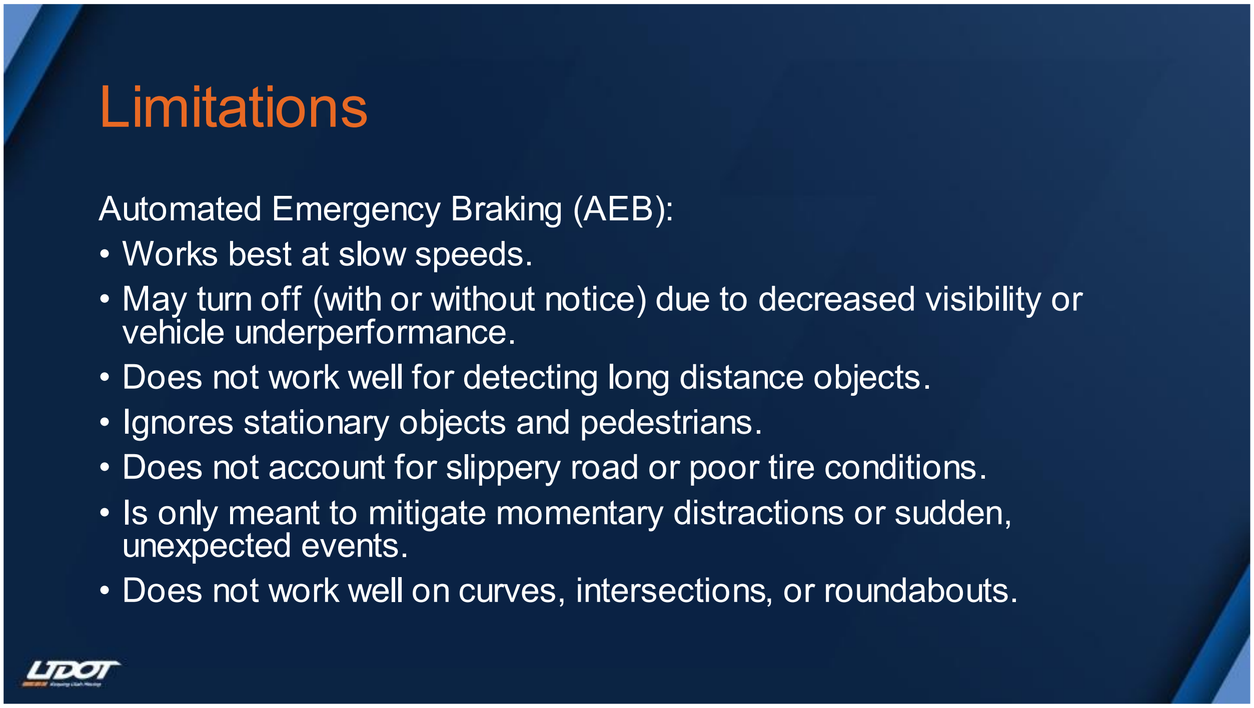


ADAS Feature	Number of Unique Names
Automated Emergency Braking (AEB)	40
Adaptive Cruise Control (ACC)	20
Surround View Camera	20
Lane Keeping Assistance (LKA)	19
Blind Spot Monitoring (BSM)	19
Automatic High Beams	18
Rear Cross Traffic Warning	15
Driver Monitoring	13
Semi-Automated Parking Assist	12
Forward Collision Warning (FCW)	8
Night Vision and Pedestrian Detection	5

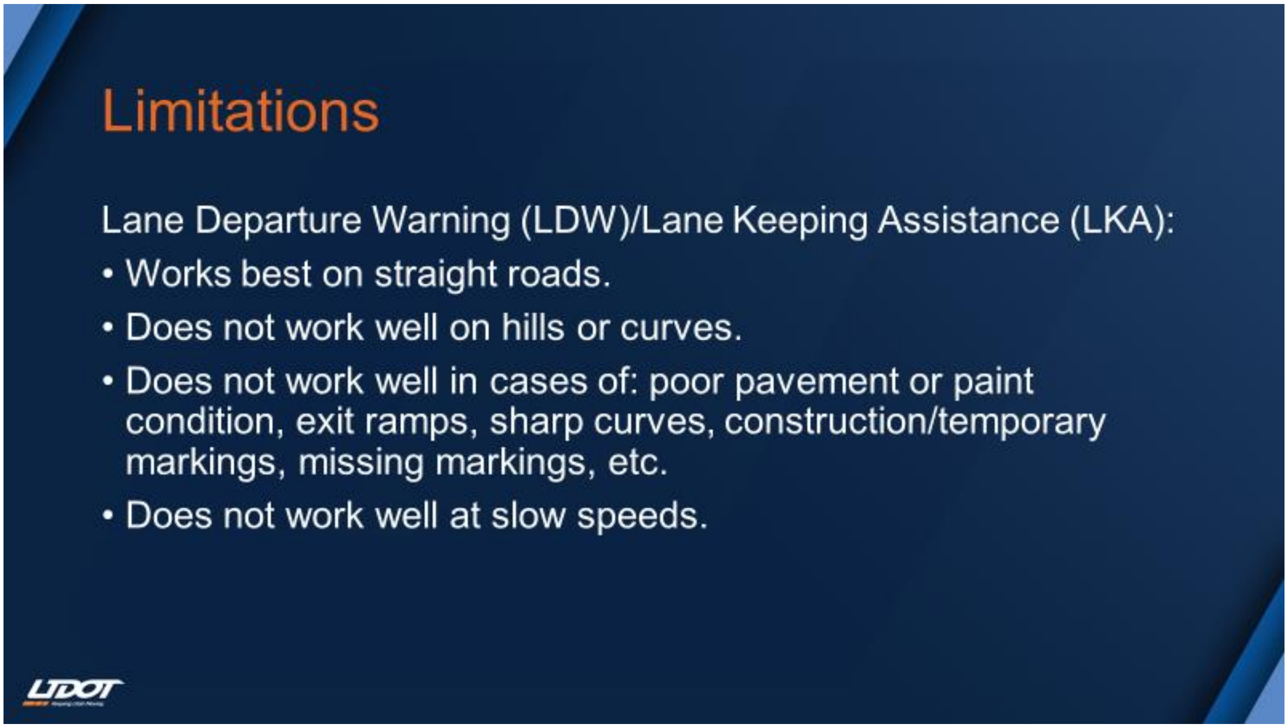
- These general definitions and terms are all confounded by the large number of unique and proprietary names for ADAS.
- This variation and inconsistency can make the job of first responders and TIM personnel difficult.
- However, later in this workshop, we will discuss some new tools and resources that can help.
- **Are there any question about ADAS terminology?**
- Next, we'll go over in more detail what different ADAS can and cannot do.



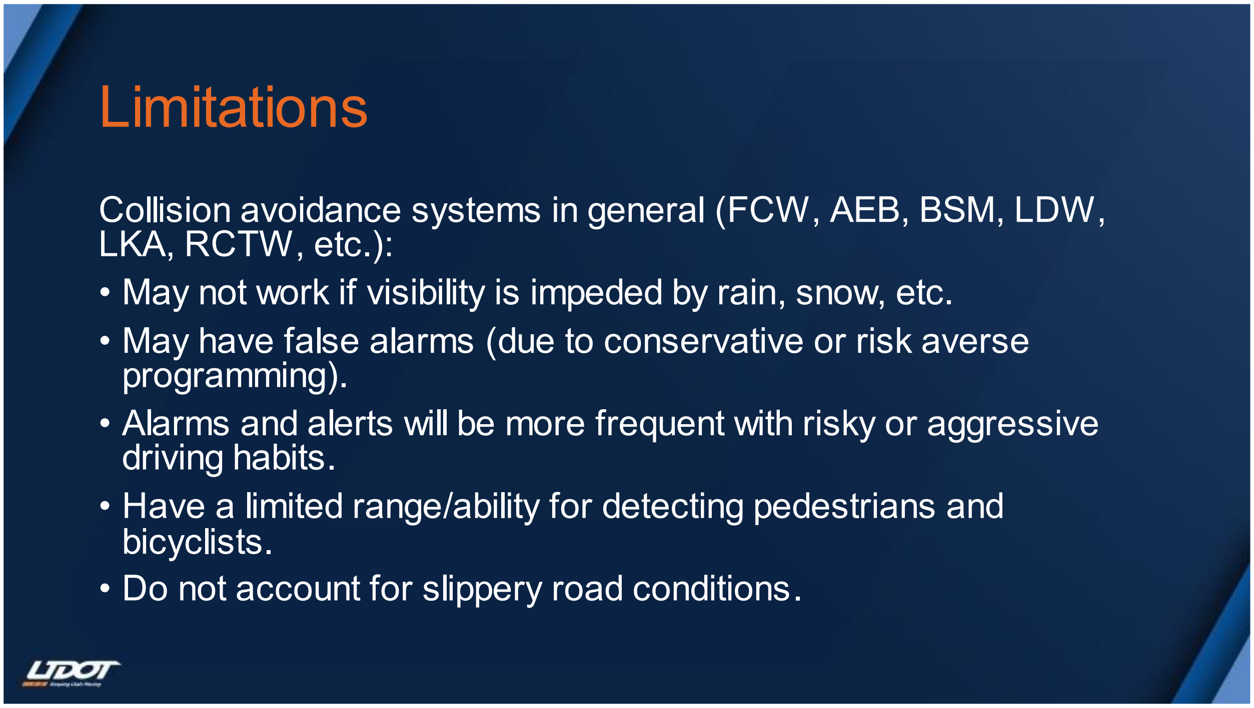
- As we go through the different ADAS limitations, you'll notice that there are some situations where multiple features don't work well or at all. There are also scenarios where some features work well but others don't.
- For adaptive cruise control:
    - Does not work well on curves or roundabouts.
    - Works best on roads with good pavement condition.
    - Has difficulty detecting pedestrians, bicyclists, and stationary objects/vehicles.
    - May not maintain following distance on steep downslopes.
    - Does not work well if visibility is impeded by rain, snow, etc.
    - Does not account for slippery road or poor tire conditions.
    - Works best for highway driving, not city driving.



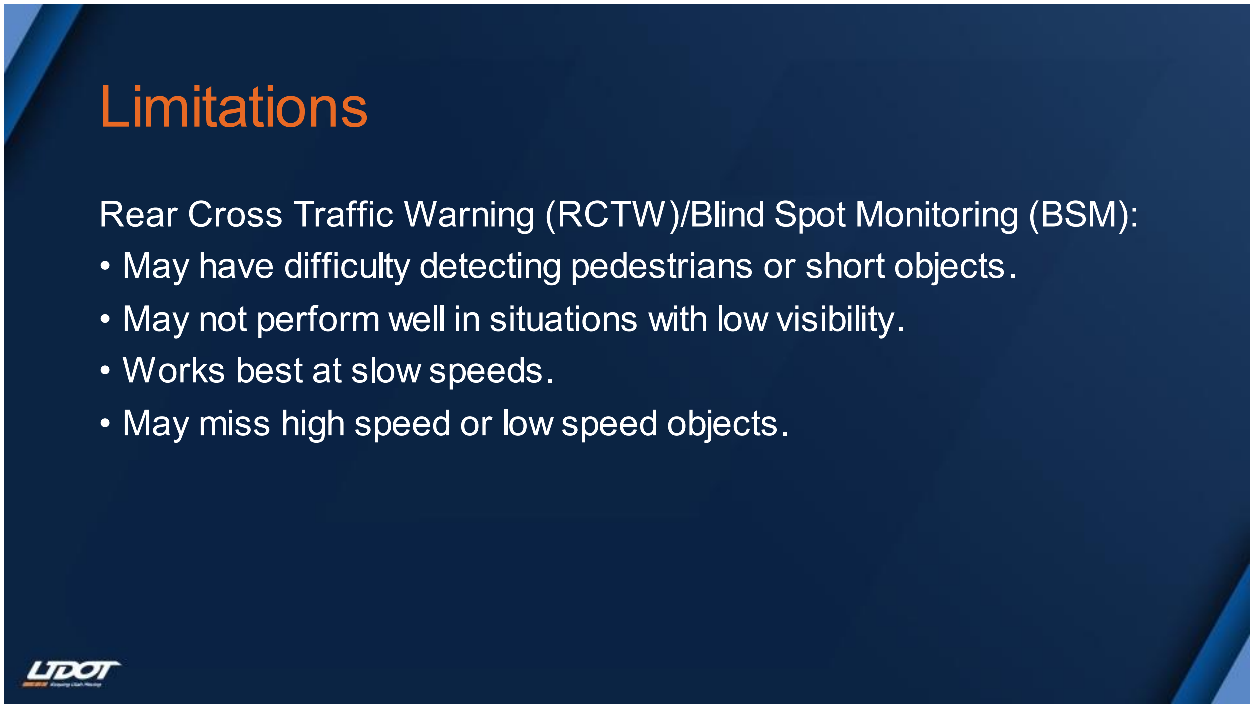
- Automated emergency braking:
    - Works best at slow speeds.
    - May turn off (with or without notice) due to decreased visibility or vehicle underperformance.
    - Does not work well for detecting long distance objects.
    - Ignores stationary objects and pedestrians.
    - Does not account for slippery road or poor tire conditions.
    - Is only meant to mitigate momentary distractions or sudden, unexpected events.
    - Does not work well on curves, intersections, or roundabouts.



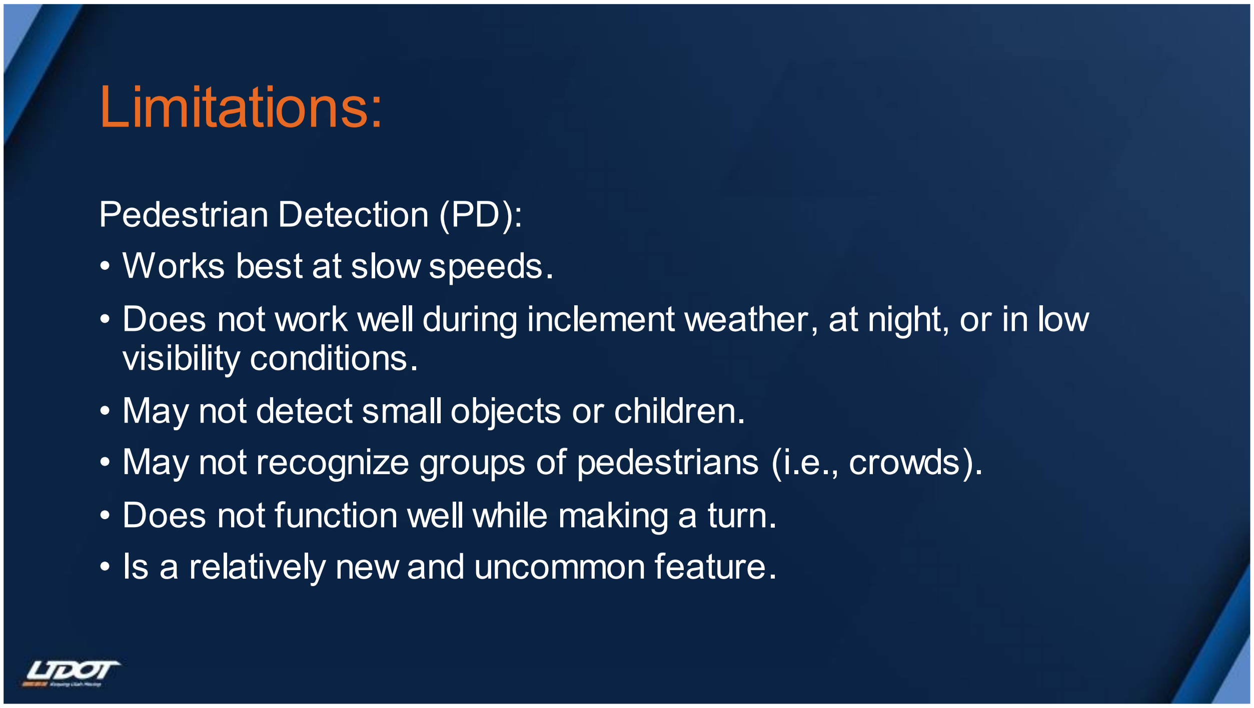
- Lane Departure Warning and Lane-Keeping Assistance have very similar limitations:
  - Works best on straight roads.
  - Does not work well on hills or curves.
  - Does not work well in cases of: poor pavement or paint condition, exit ramps, sharp curves, construction/temporary markings, missing markings, etc.
  - Does not work well at slow speeds.



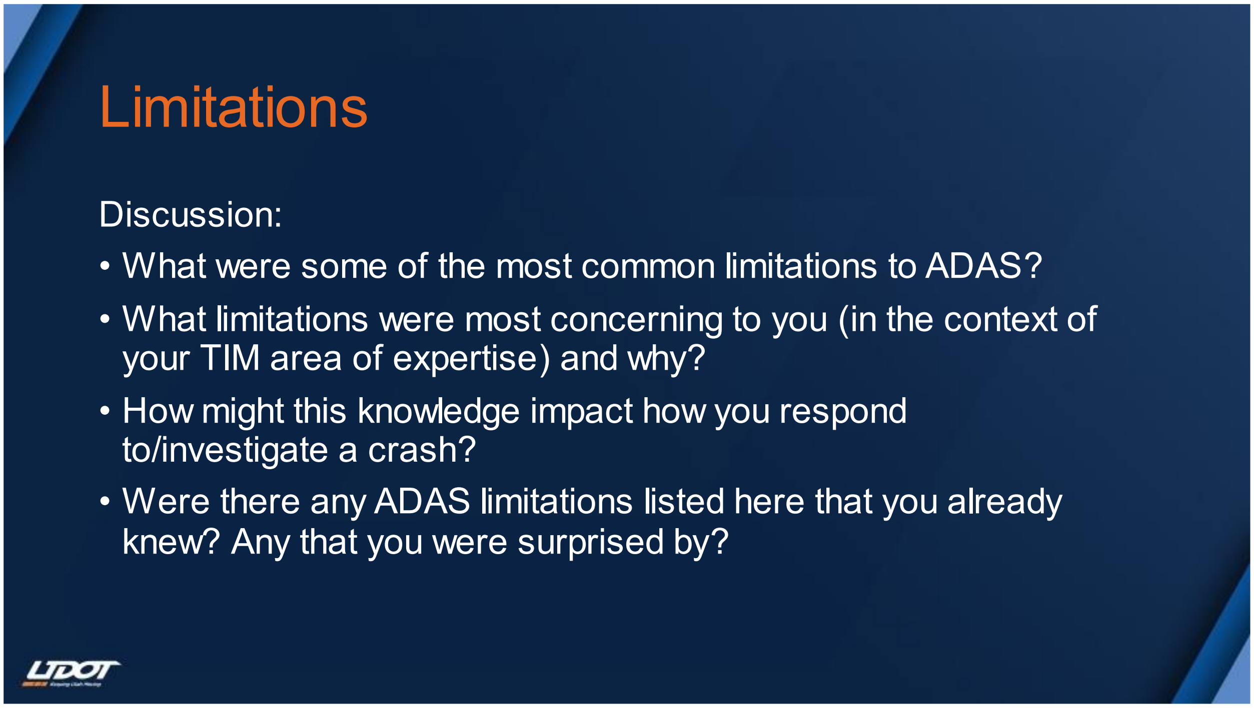
- Sometimes, ADAS features are individually or collectively called a collision avoidance system. These may include forward collision warning, automated emergency braking, blind-spot monitoring, lane departure warning, lane-keeping assistance, rear cross-traffic warning, etc.
- For these types of ADAS, in general:
    - May not work if visibility is impeded by rain, snow, etc.
    - May have false alarms (due to conservative or risk-averse programming).
    - Alarms and alerts will be more frequent with risky or aggressive driving habits.
    - Have a limited range/ability for detecting pedestrians and bicyclists.
    - Do not account for slippery road conditions.



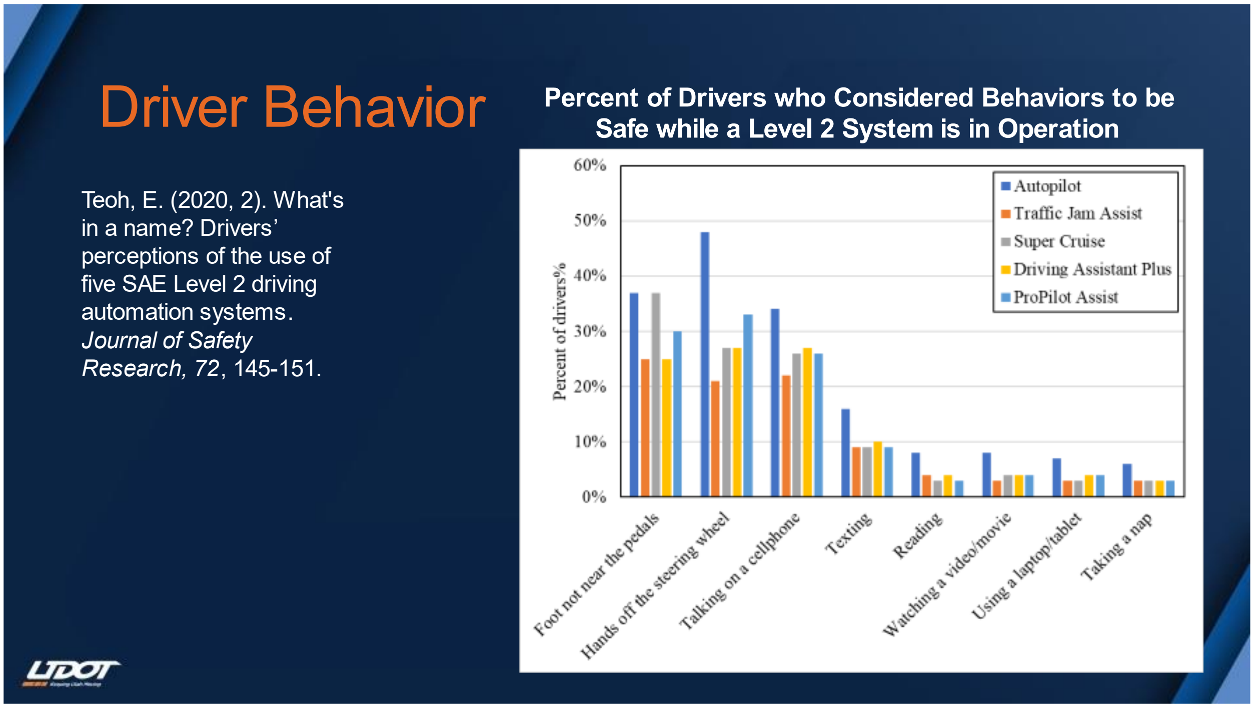
- For Rear Cross-Traffic Warning and Blind-Spot Monitoring:
  - May have difficulty detecting pedestrians or short objects.
  - May not perform well in situations with low visibility.
  - Works best at slow speeds.
  - May miss high-speed or low-speed objects.



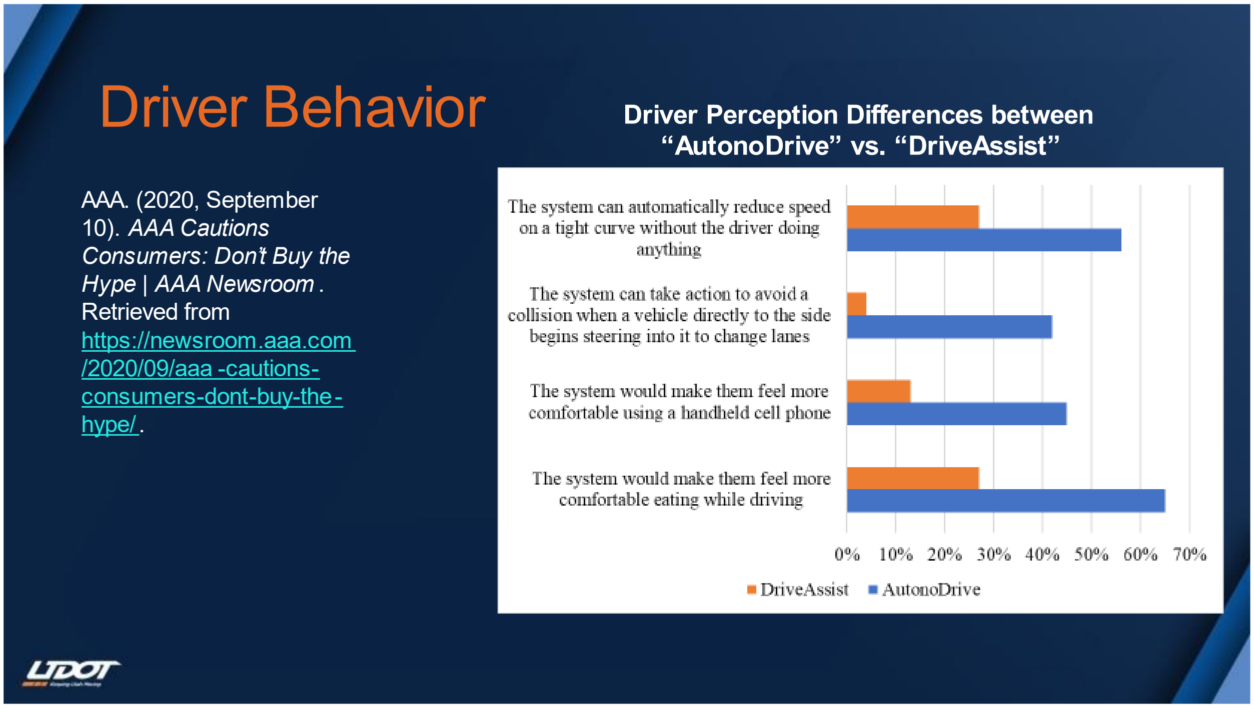
- Pedestrian Detection, as stated before, is relatively new and has more variation/inconsistency across manufacturers.
- In general:
    - Works best at slow speeds.
    - Does not work well during inclement weather, at night, or in low-visibility conditions.
    - May not detect small objects or children.
    - May not recognize groups of pedestrians (i.e., crowds).
    - Does not function well while making a turn.
- **Are there any questions about ADAS limitations?**



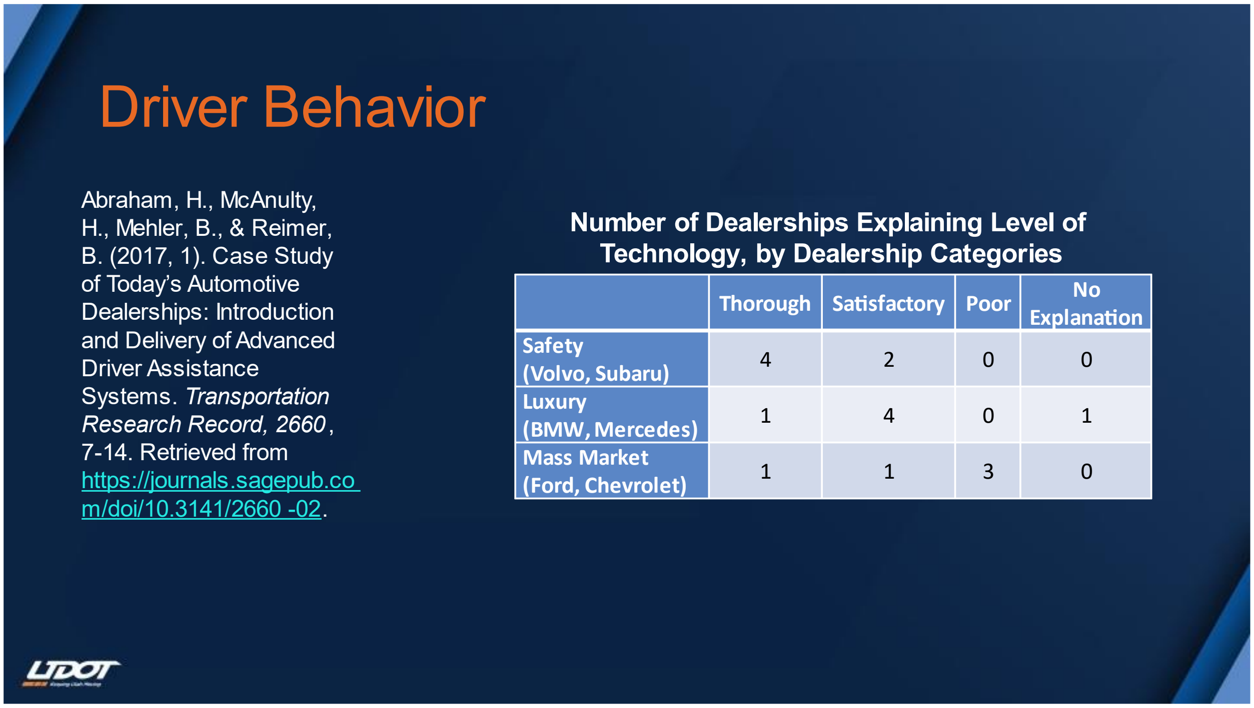
- Now, we'll have our first group discussion. Take a moment to split into small groups of [TBD depending on total attendees].
- Take about 5 minutes to discuss the following questions in your small group.
    - What were some of the most common limitations to ADAS?
    - What limitations were most concerning to you (in the context of your TIM area of expertise) and why?
    - How might this knowledge impact how you respond to/investigate a crash?
    - Were there any ADAS limitations listed here that you already knew? Any that you were surprised by?
- As a large group [after the 5-minute small group discussion], report out what your small group discussed.
- Does anybody have anything to add?
- **Does anybody have further questions before we move on?**



- There is significant variation in driver behavior and ability due to factors like age, gender, driving experience, health/condition, etc.
- There is also significant variation in how drivers understand and perceive ADAS and vehicle automation.
- Earlier, we briefly discussed the safety benefits of ADAS when it is used properly. We also discussed the variations in names for ADAS.
- Several studies, like the one here, have shown how naming convention and driver behavior interact, and how this may impact safety.
- There is a lot of contention regarding the use of "pilot" or "autonomous" in ADAS names. In this graph, we can see that two ADAS with "pilot" in the name tend to lead drivers to believe that distracted driving is OK with these systems.
- As a note, all of these ADAS names are actually being used by certain manufacturers right now.

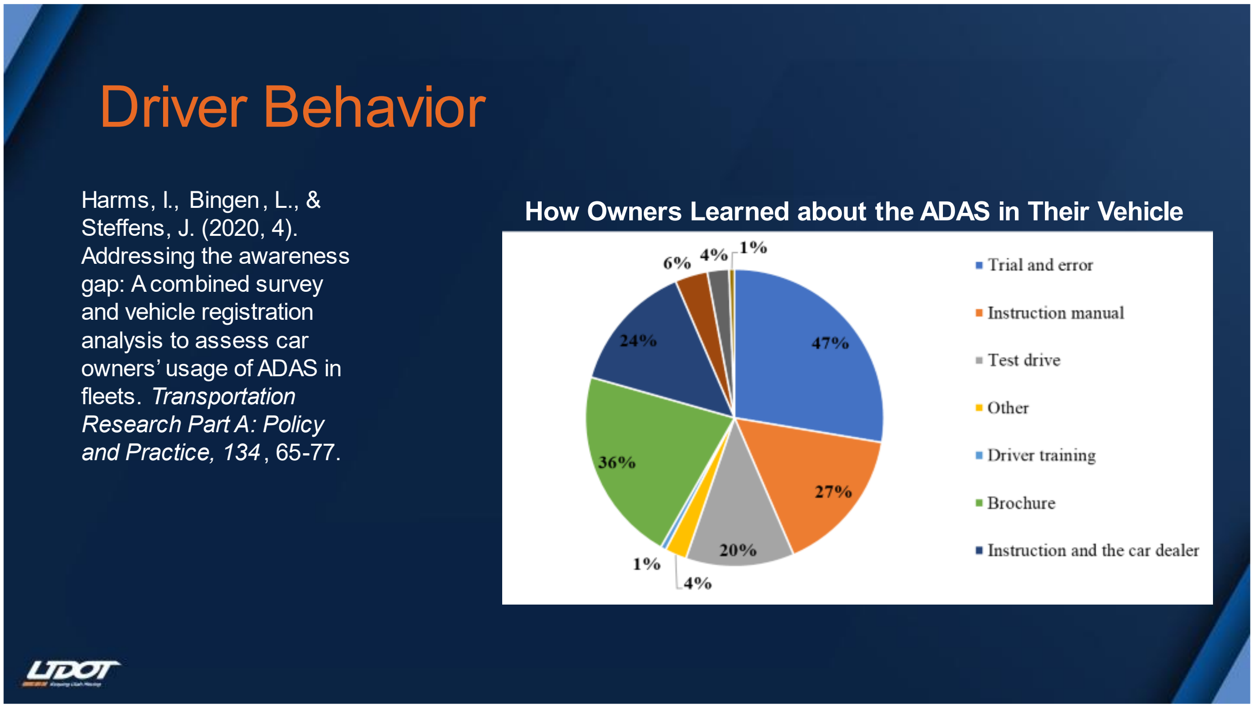


- Even when we use fake names for ADAS, it impacts drivers' perceptions of what these systems are capable of.
- Therefore, there is much work to be done in both regulation/standardization of ADAS as well as driver education on ADAS.



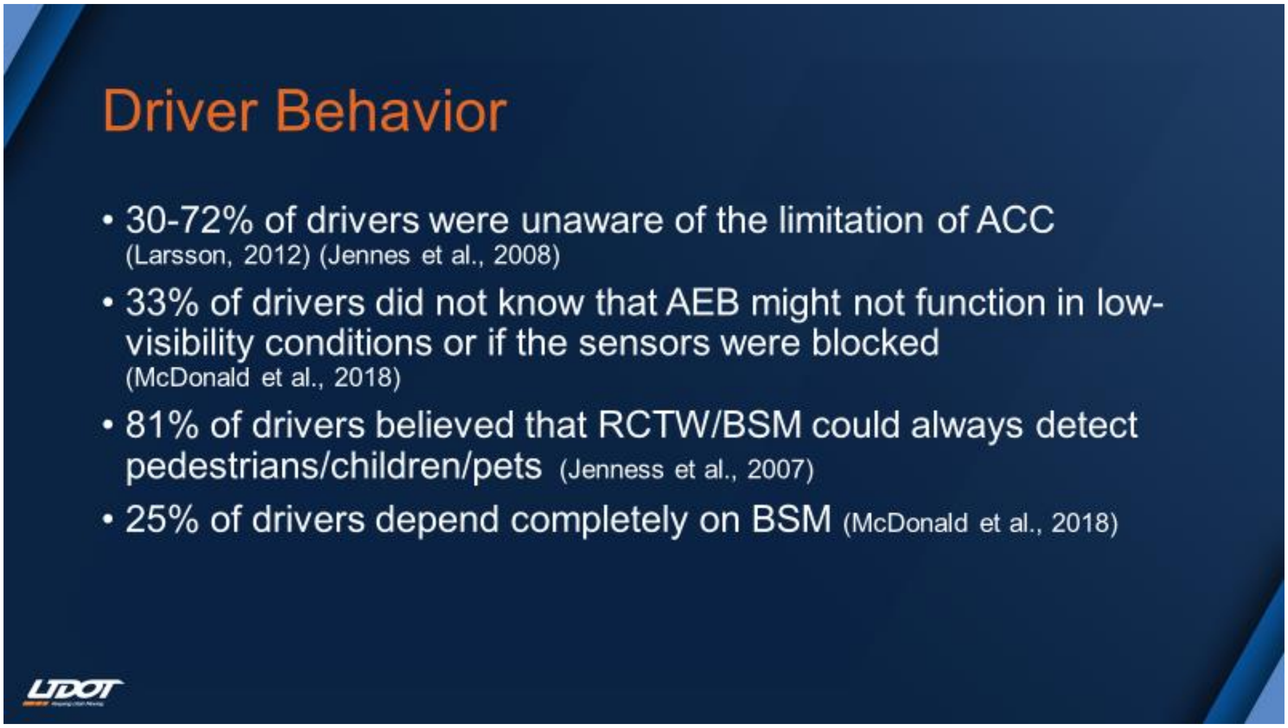
	Thorough	Satisfactory	Poor	No Explanation
Safety (Volvo, Subaru)	4	2	0	0
Luxury (BMW, Mercedes)	1	4	0	1
Mass Market (Ford, Chevrolet)	1	1	3	0

- Unfortunately, there isn't much consistency in driver education, at least at the point of purchase.
- Studies have shown that often the salesperson has little to no accurate knowledge of available ADAS features. And some drivers even leave the lot without knowing what features are installed in their vehicle.
- There are two gaps that need to be closed:
    - Encouraging use of ADAS features in order to achieve the potential safety benefits.
    - Educating drivers about appropriate use of ADAS in order to discourage unsafe driving habits

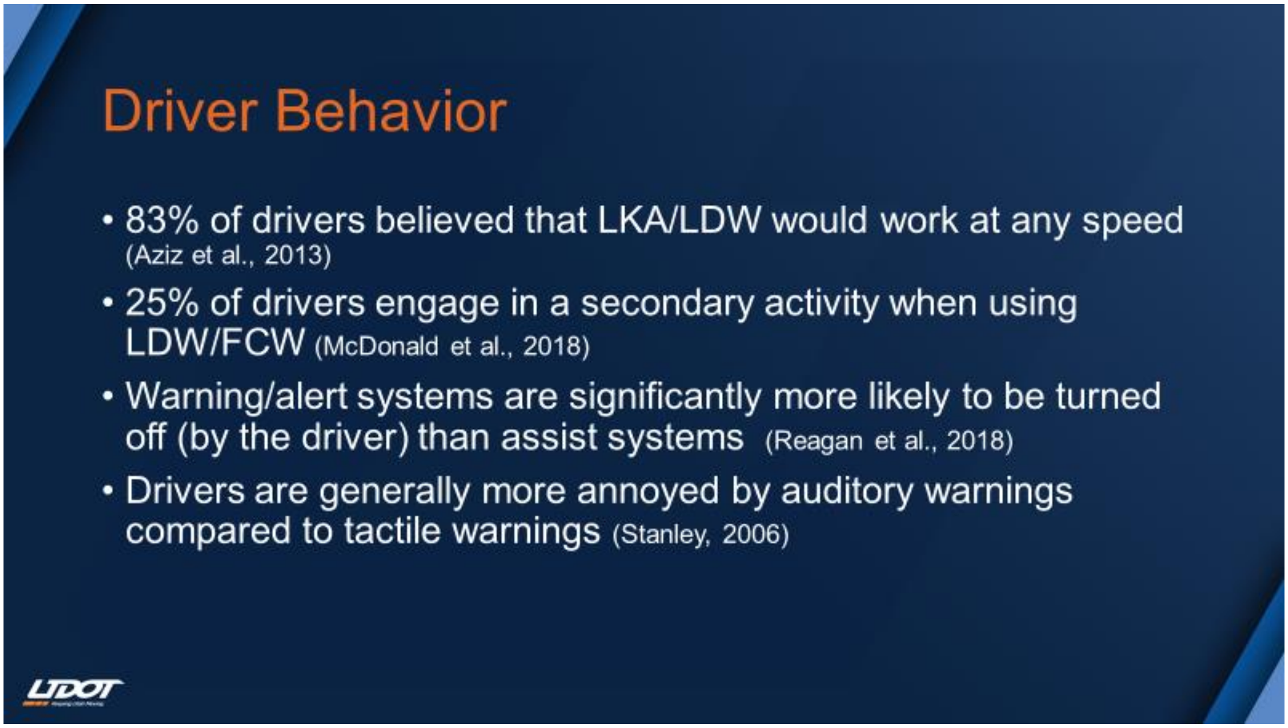


- Most drivers learn about the ADAS in their vehicle through trial and error, or other self-taught methods.
- When drivers learn through trial and error or abridged materials (such as brochures), they often do not learn about the limitations we discussed earlier.

- Multiple studies have shown that most drivers learn about ADAS on their own.
- Some drivers may be more inclined to learn the details than others, so lack of consistency in education is an issue.



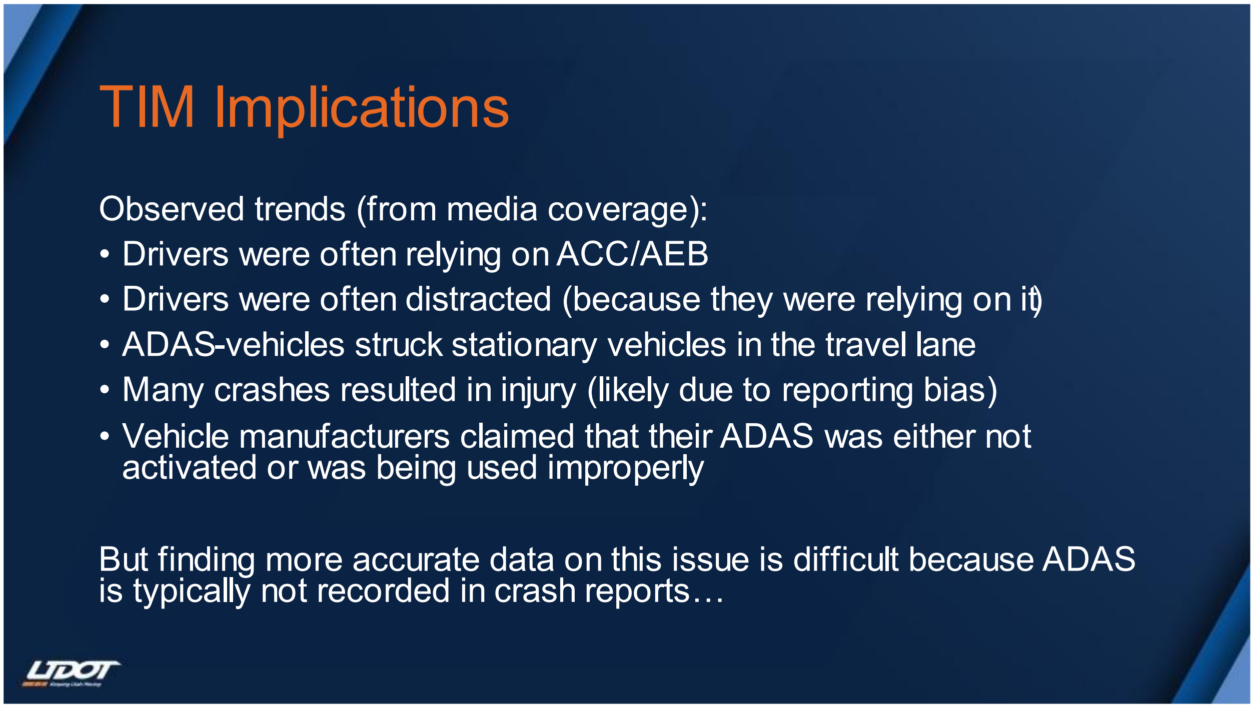
- As a result:
  - 30-72% of drivers were unaware of the limitations of ACC
  - 33% of drivers did not know that AEB might not function in low-visibility conditions or if the sensors were blocked
  - 81% of drivers believed that RCTW/BSM could always detection pedestrians, children, pets, etc.
  - 25% of drivers depend completely on BSM



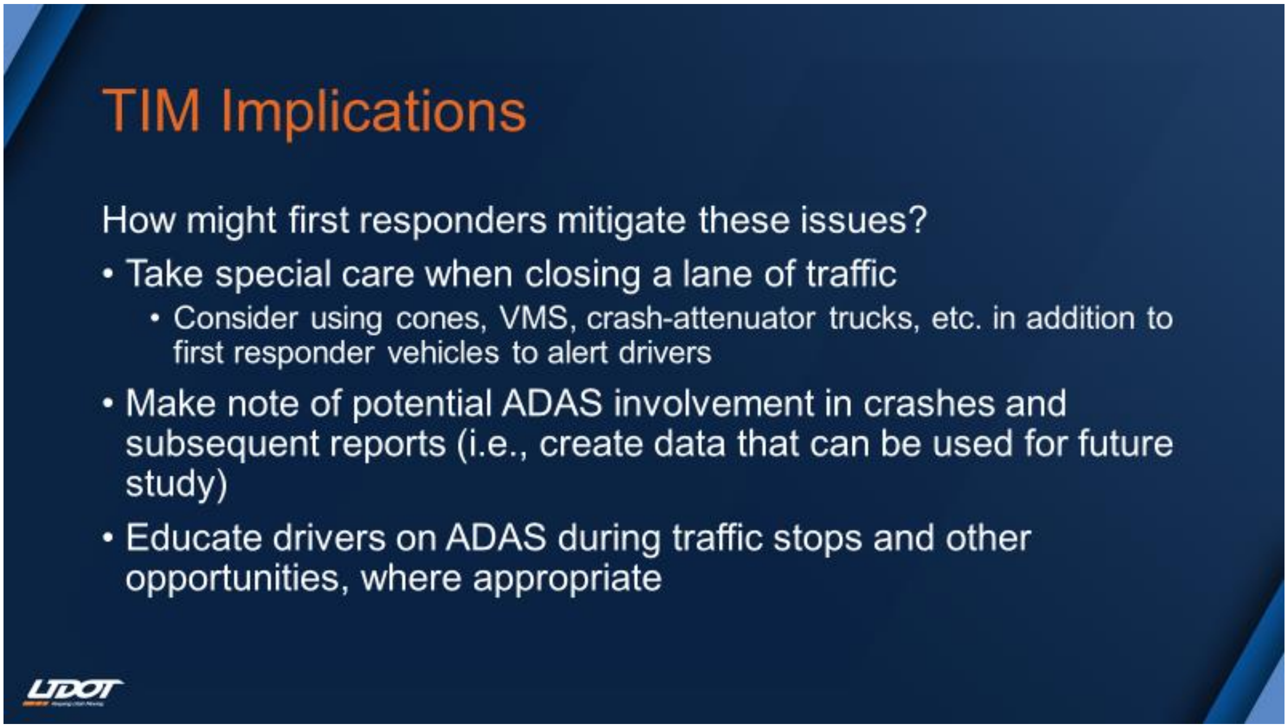
  - 83% of drivers believed that LKA/LDW would work at any speed
  - 25% of drivers engage in a secondary activity when using LDW/FCW
  - Warning/alert systems are significantly more likely to be turned off (by the driver) than assist systems
  - Drivers are generally more annoyed by auditory warnings compared to tactile warnings
- This is a list of only some findings, but it demonstrates the lack of adequate driver knowledge.
- **Are there any question about driver behavior regarding ADAS?**

- This all leads into implications for crashes, traffic incident management, and first responders.
- What does all this information mean for you and your job?
- Use of ADAS has caused some new patterns to emerge in crash occurrence.

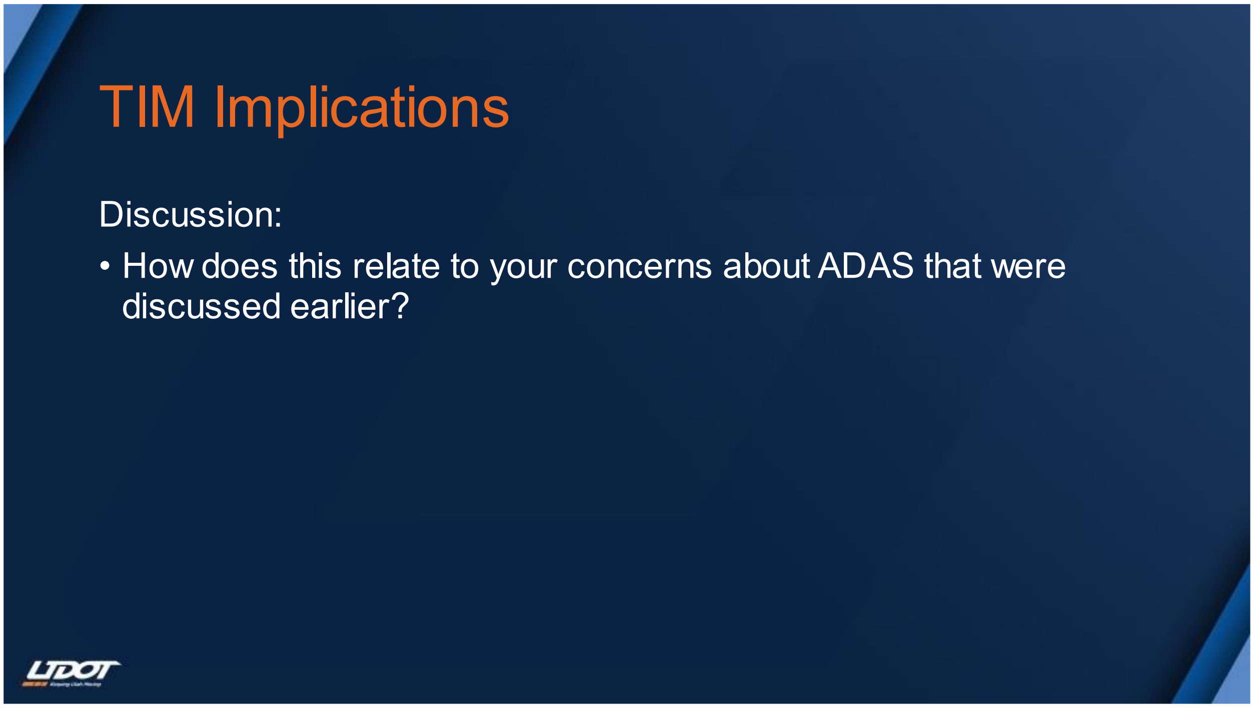
- Of concern is what seems to be a trend of ADAS vehicles striking first responder vehicles.
- This is a list of only some first responder-ADAS crashes we were able to find.
- While ADAS is likely also a factor in non-first responder-related crashes, we will focus on these first responder-ADAS crashes.



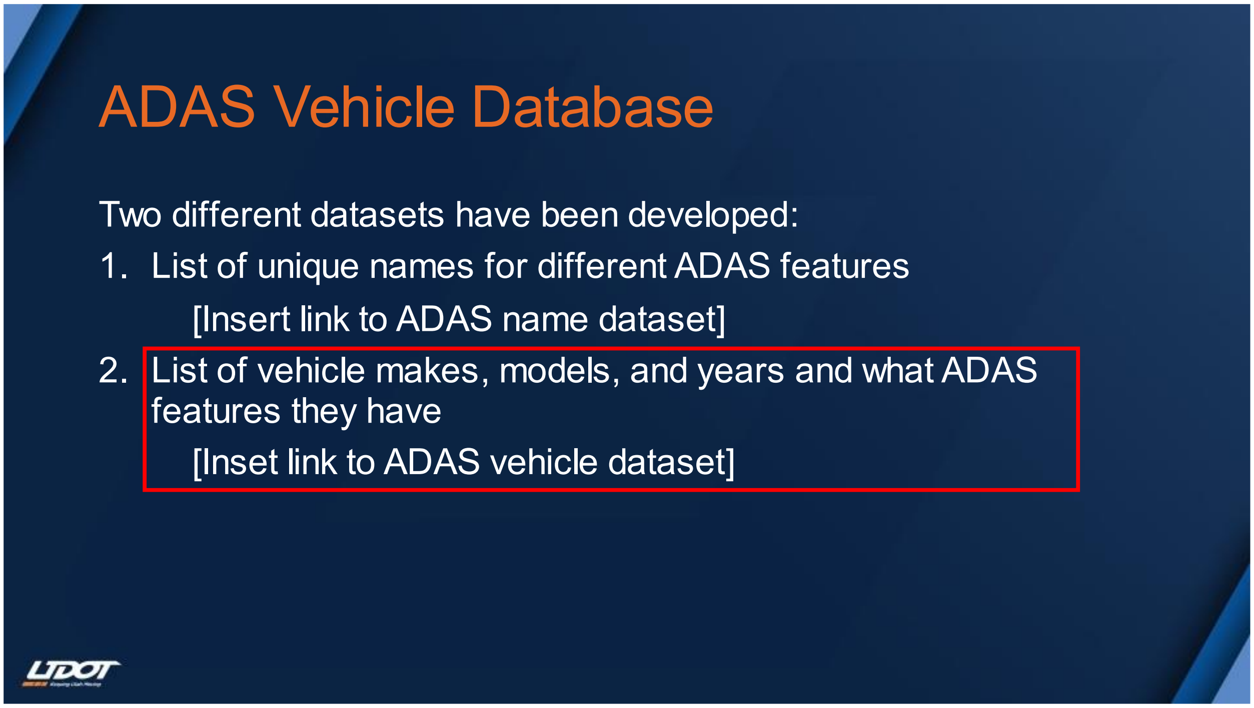
- From the media coverage, some trends emerge for crashes involving ADAS:
  - Drivers were often relying on ACC/AEB
  - Drivers were often distracted (because they were relying on it)
  - ADAS vehicles struck stationary vehicles in the travel lane
  - Many crashes resulted in injury (likely due to reporting bias)
  - Vehicle manufacturers claimed their ADAS was either not activated or was being used improperly
- These trends are supported by anecdotal evidence only, relying on media coverage. So there is an inherent bias toward more serious crashes and crashes involving first responders.
- Very little accurate data currently exists that could be used to truly assess this issue.



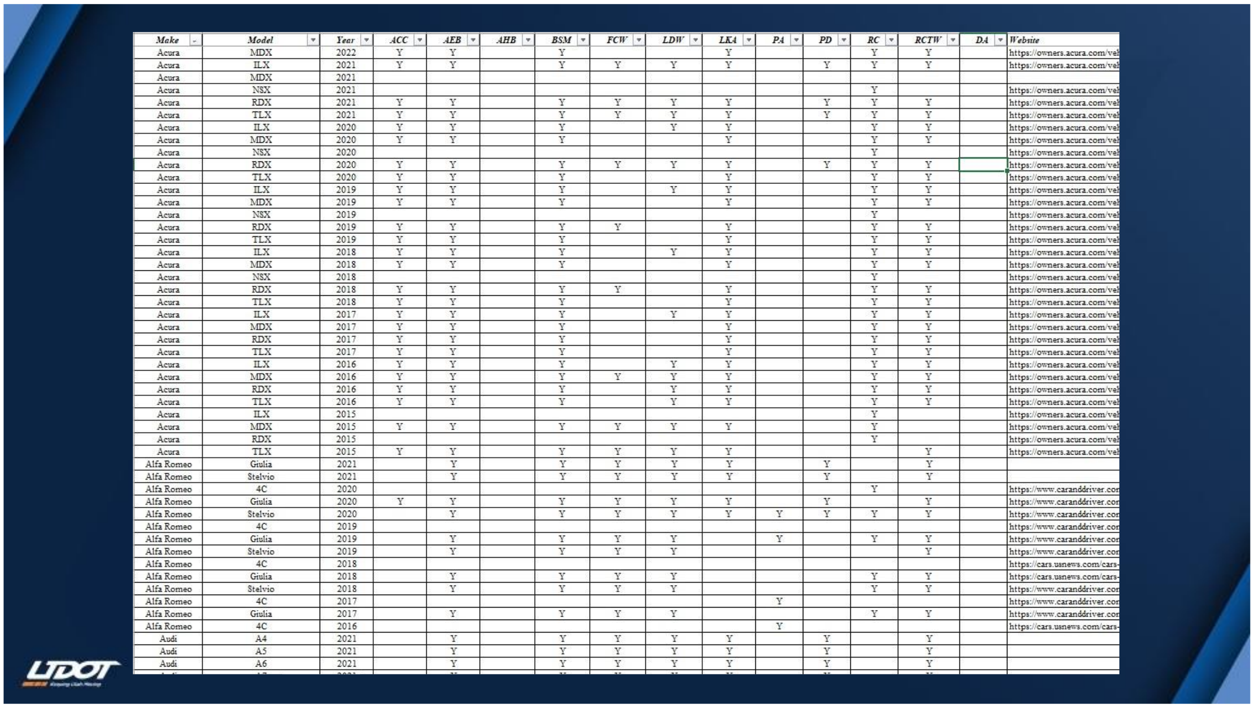
- While improving ADAS safety will be a multi-pronged and multi-disciplinary approach, there are some ways that first responders can mitigate these issues in the field.
- First, take special care when closing a lane of traffic. This could include using extra traffic control devices or strategies to protect a crash scene and alert drivers, such as using cones, variable message signs, crash-attenuator trucks, etc.
- Second, help generate data that can be used in further study by making note of potential ADAS involvement in crash reports. While there may not be adequate fields in the report, making a note in crash narratives could make a significant difference in future safety research.
    - Note: We are not advocating for assessment of fault based on ADAS involvement.
- Lastly, educate drivers on ADAS when appropriate. This could be during traffic stops if an officer notices distracted driving of an ADAS vehicle or when interviewing crash participants. It could also happen at formal or informal outreach activities.



- Now, we'll have our second group discussion. Take a moment to split into small groups of [TBD depending on total attendees].
- Take about 5 minutes to discuss the following questions in your small group.
    - How does this relate to your concerns about ADAS that were discussed earlier?
    - How might this knowledge impact how you respond to/investigate a crash?
- As a large group [after the 5-minute small group discussion], report out what your small group discussed.
- Does anybody have anything to add?
- **Does anybody have further questions before we move on?**

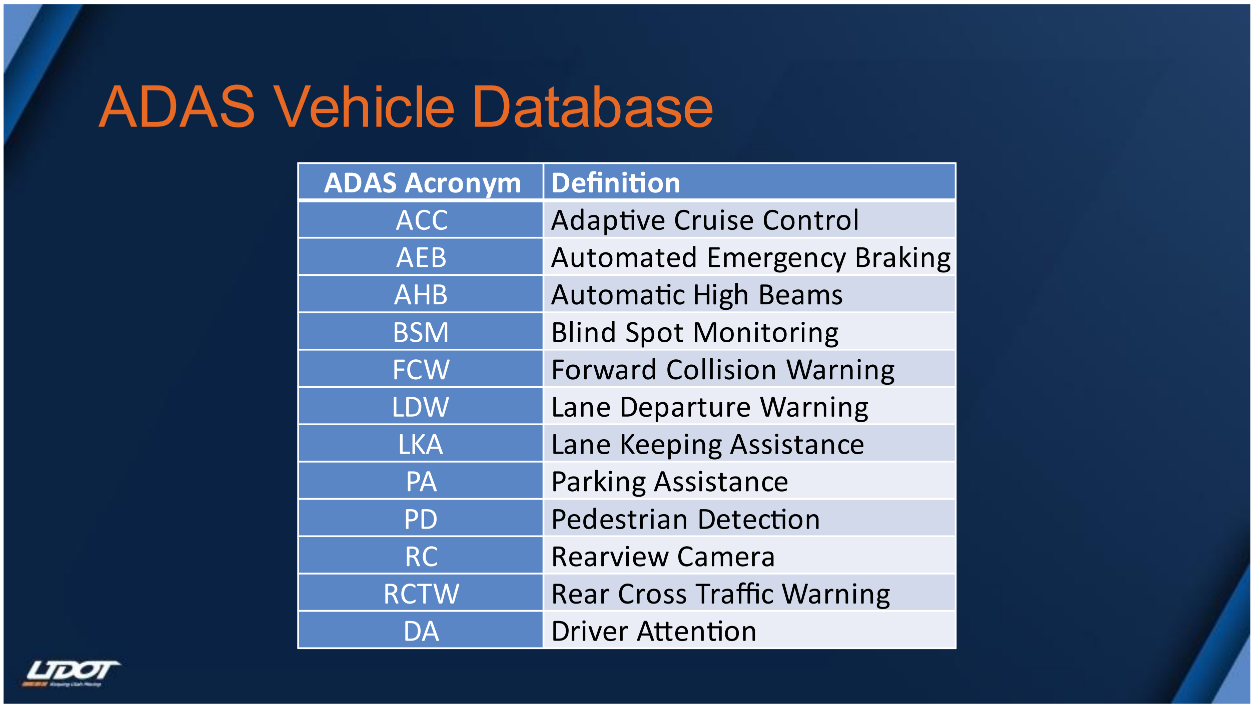


- To help, two different datasets were developed for use by first responders and TIM personnel.
- First, a list of unique names for different ADAS features. This list is sorted by vehicle manufacturer and ADAS feature. This dataset will likely be less relevant in the field than the second dataset.
- Second, is a list of vehicle makes, models, and years and what ADAS features they have. This could be useful when trying to determine factors that caused or influenced crashes.



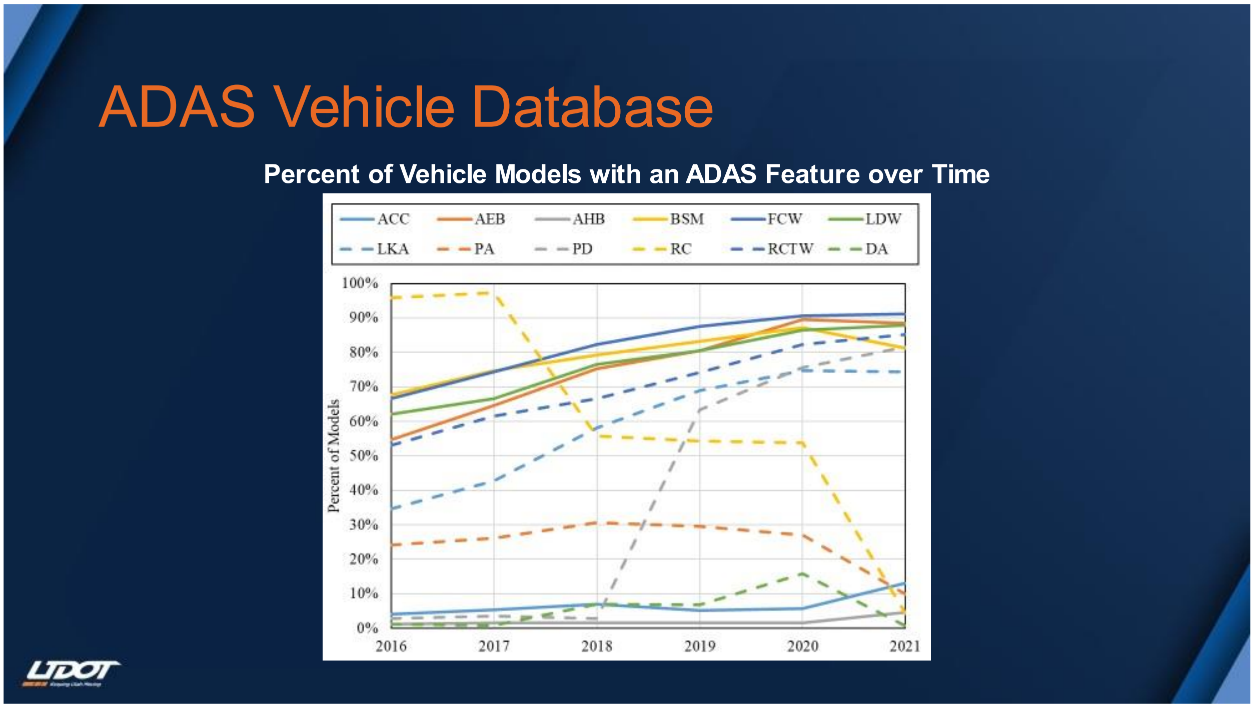
Make	Model	Year	ACC	AEB	AHB	BSM	FCW	LDW	LKA	PA	PD	RC	RCTW	DA	Website
Acura	MDX	2022	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	ILX	2021	Y	Y		Y	Y	Y	Y		Y	Y	Y		https://owners.acura.com/ve
Acura	MDX	2021													
Acura	NSX	2021										Y			https://owners.acura.com/ve
Acura	RDX	2021	Y	Y		Y	Y	Y	Y		Y	Y	Y		https://owners.acura.com/ve
Acura	TLX	2021	Y	Y		Y	Y	Y	Y		Y	Y	Y		https://owners.acura.com/ve
Acura	ILX	2020	Y	Y		Y		Y	Y			Y	Y		https://owners.acura.com/ve
Acura	MDX	2020	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	NSX	2020										Y			https://owners.acura.com/ve
Acura	RDX	2020	Y	Y		Y	Y	Y	Y		Y	Y	Y		https://owners.acura.com/ve
Acura	TLX	2020	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	ILX	2019	Y	Y		Y		Y	Y			Y	Y		https://owners.acura.com/ve
Acura	MDX	2019	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	NSX	2019										Y			https://owners.acura.com/ve
Acura	RDX	2019	Y	Y		Y	Y		Y			Y	Y		https://owners.acura.com/ve
Acura	TLX	2019	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	ILX	2018	Y	Y		Y		Y	Y			Y	Y		https://owners.acura.com/ve
Acura	MDX	2018	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	NSX	2018										Y			https://owners.acura.com/ve
Acura	RDX	2018	Y	Y		Y	Y		Y			Y	Y		https://owners.acura.com/ve
Acura	TLX	2018	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	ILX	2017	Y	Y		Y		Y	Y			Y	Y		https://owners.acura.com/ve
Acura	MDX	2017	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	RDX	2017	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	TLX	2017	Y	Y		Y			Y			Y	Y		https://owners.acura.com/ve
Acura	ILX	2016	Y	Y		Y		Y	Y			Y	Y		https://owners.acura.com/ve
Acura	MDX	2016	Y	Y		Y	Y	Y	Y			Y	Y		https://owners.acura.com/ve
Acura	RDX	2016	Y	Y		Y		Y	Y			Y	Y		https://owners.acura.com/ve
Acura	TLX	2016	Y	Y		Y		Y	Y			Y	Y		https://owners.acura.com/ve
Acura	ILX	2015										Y			https://owners.acura.com/ve
Acura	MDX	2015	Y	Y		Y	Y	Y	Y			Y			https://owners.acura.com/ve
Acura	RDX	2015										Y			https://owners.acura.com/ve
Acura	TLX	2015	Y	Y		Y	Y	Y	Y				Y		https://owners.acura.com/ve
Alfa Romeo	Giulia	2021		Y		Y	Y	Y	Y		Y		Y		
Alfa Romeo	Stelvio	2021		Y		Y	Y	Y	Y		Y		Y		
Alfa Romeo	4C	2020										Y			https://www.caranddriver.co
Alfa Romeo	Giulia	2020	Y	Y		Y	Y	Y	Y		Y		Y		https://www.caranddriver.co
Alfa Romeo	Stelvio	2020		Y		Y	Y	Y	Y	Y	Y	Y	Y		https://www.caranddriver.co
Alfa Romeo	4C	2019													https://www.caranddriver.co
Alfa Romeo	Giulia	2019		Y		Y	Y	Y		Y		Y	Y		https://www.caranddriver.co
Alfa Romeo	Stelvio	2019		Y		Y	Y	Y					Y		https://www.caranddriver.co
Alfa Romeo	4C	2018													https://cars.usnews.com/cars-
Alfa Romeo	Giulia	2018		Y		Y	Y	Y				Y	Y		https://cars.usnews.com/cars-
Alfa Romeo	Stelvio	2018		Y		Y	Y	Y				Y	Y		https://www.caranddriver.co
Alfa Romeo	4C	2017								Y					https://www.caranddriver.co
Alfa Romeo	Giulia	2017		Y		Y	Y	Y				Y	Y		https://www.caranddriver.co
Alfa Romeo	4C	2016								Y					https://cars.usnews.com/cars-
Audi	A4	2021		Y		Y	Y	Y	Y		Y		Y		
Audi	A5	2021		Y		Y	Y	Y	Y		Y		Y		
Audi	A6	2021		Y		Y	Y	Y	Y		Y		Y		

- This dataset includes information for different makes, models, and years. If a vehicle has ADAS, a “Y” will be present in the corresponding column.
- If an easily referenced website exists where this information can be found, it is also listed in this database.

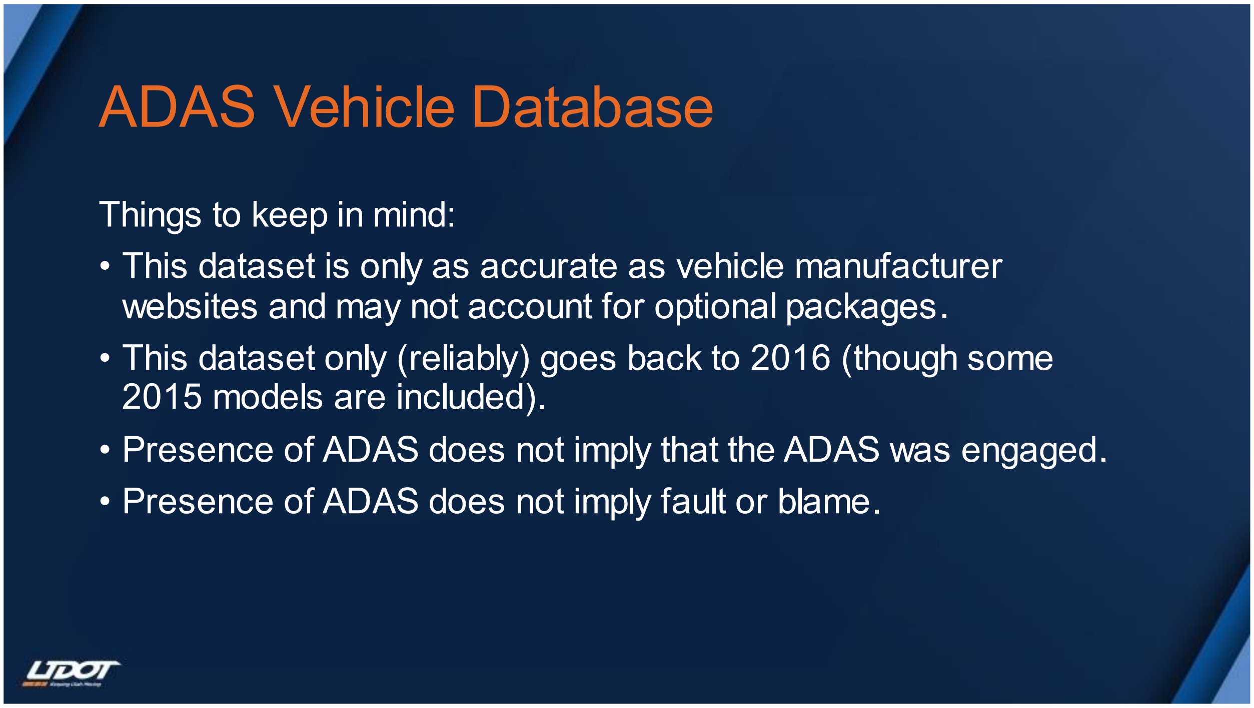


ADAS Acronym	Definition
ACC	Adaptive Cruise Control
AEB	Automated Emergency Braking
AHB	Automatic High Beams
BSM	Blind Spot Monitoring
FCW	Forward Collision Warning
LDW	Lane Departure Warning
LKA	Lane Keeping Assistance
PA	Parking Assistance
PD	Pedestrian Detection
RC	Rearview Camera
RCTW	Rear Cross Traffic Warning
DA	Driver Attention

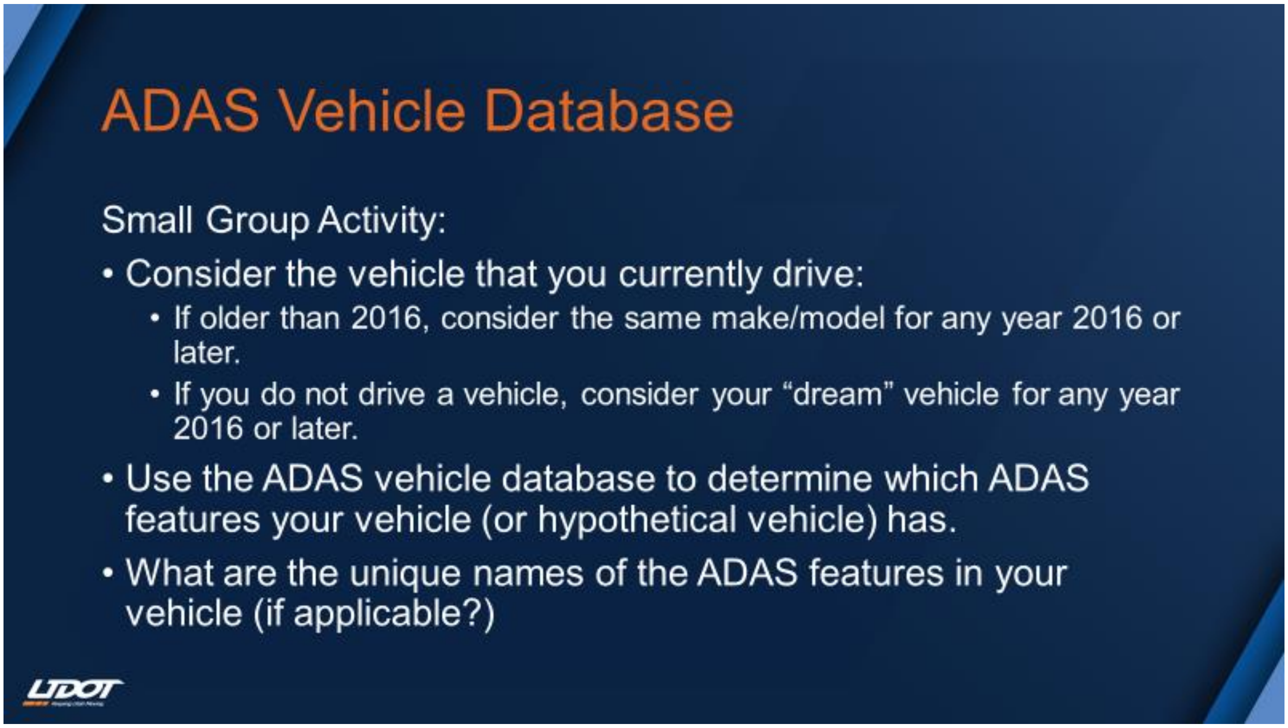
- As a reminder, the abbreviations used in this database are listed here.



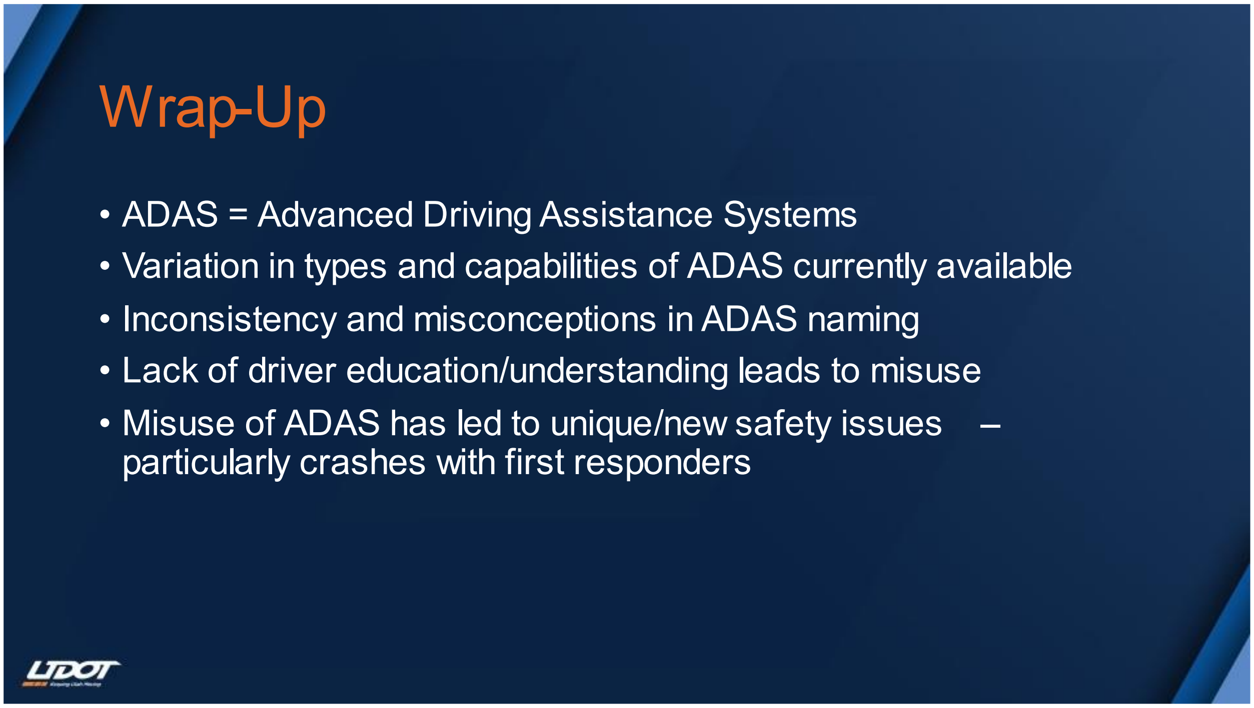
- Over the last few years, the number of and percent of new vehicles with different ADAS features has changed.
- In general, the prevalence of ADAS features has increased.
- Some features that appear to decrease are actually due to decreases in reporting of those features as they become standard in the industry (e.g., rearview cameras).



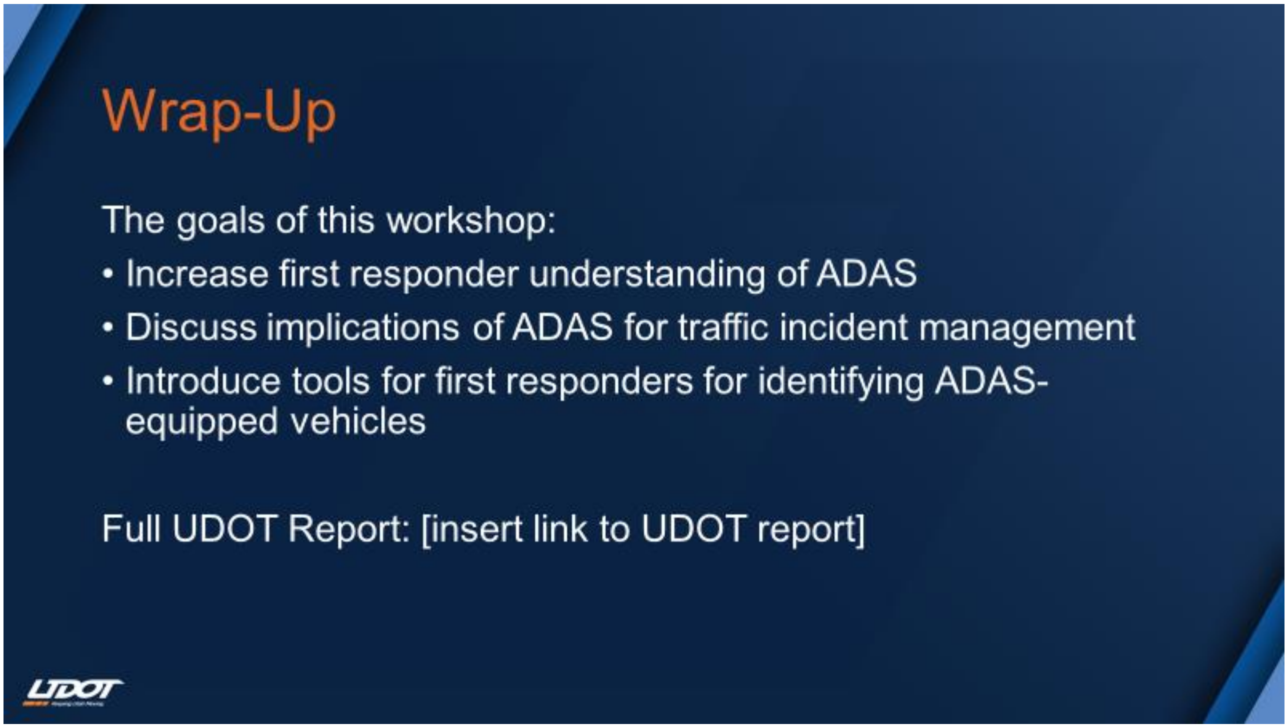
- While this database can be a useful tool, there are some things to keep in mind when using it:
    - This dataset is only as accurate as vehicle manufacturer websites and may not account for optional packages.
    - This dataset only (reliably) goes back to 2016 (though some 2015 models are included).
    - Presence of ADAS does not imply that the ADAS was engaged.
    - Presence of ADAS does not imply fault or blame.
- Unfortunately, without the ability to easily pull data from the vehicle (often only done in the case of severe crashes), it will be difficult to tell for certain if/when ADAS was engaged or if it malfunctioned.
- **Are there any questions about the ADAS vehicle database?**



- For this final activity, split into your small groups again.
- You will be identifying which ADAS features are available in the vehicle you currently drive.
  - If your current vehicle is older than 2016, pretend it is a model year 2016 or later.
  - If you do not have a vehicle, do the activity with your "dream" vehicle of 2016 or later.
- Which ADAS features does your vehicle have? What are the unique names of the ADAS features in your vehicle?
- How many people in your group had vehicles with:
  - Adaptive cruise control
  - Automated emergency braking
  - Forward collision warning
  - Blind-spot monitoring
  - Lane departure warning
  - Lane-keeping assistance
  - Pedestrian detection
  - Driver attention
- Were you surprised to find out about any of the features in (or not in) your vehicle?



- To wrap up, ADAS stands for Advanced Driving Assistance Systems.
- There is currently a lot of variation in types and capabilities of ADAS.
- There is also inconsistency in naming of ADAS. And some naming conventions have led to driver misconceptions of ADAS capabilities and limitations.
- Lack of driver education and understanding of ADAS has led to overreliance and misuse, which has caused safety issues for first responders.



- Through this workshop, we hope to mitigate these issues via the following goals:
    - Increase first responder understanding of ADAS
    - Discuss implications of ADAS for traffic incident management
    - Introduce tools for first responders for identifying ADAS-equipped vehicles
- **Are there any remaining questions, concerns, or comments about ADAS?**
- Following this slide is a list of sources used in this presentation.