

# AUTOMATED VEHICLES

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# What does autonomous transport really mean?

## Sensorene i en selvkjørende bil

Akkurat som et menneske har fem sanser, har Googles selvkjørende bil en rekke apparater som oppdager hindringer i nærheten så de kan unngås.

**GPS-programvare**  
Bidrar til å fastslå bilens posisjon.

**Posisjonssensor**  
Plassert i hjulkapselen, bidrar til å fastslå bilens posisjon ut fra hjulomdreininger.

**Radar**  
Måler farten på biler foran.

**Orienteringssensor**  
Sitter inne i bilen og opptrer som bilens indre øre ved å registrere bevegelse og balanse.



**Laser**  
Gir 360 graders overblikk rundt bilen og bidrar til å fastslå posisjon.



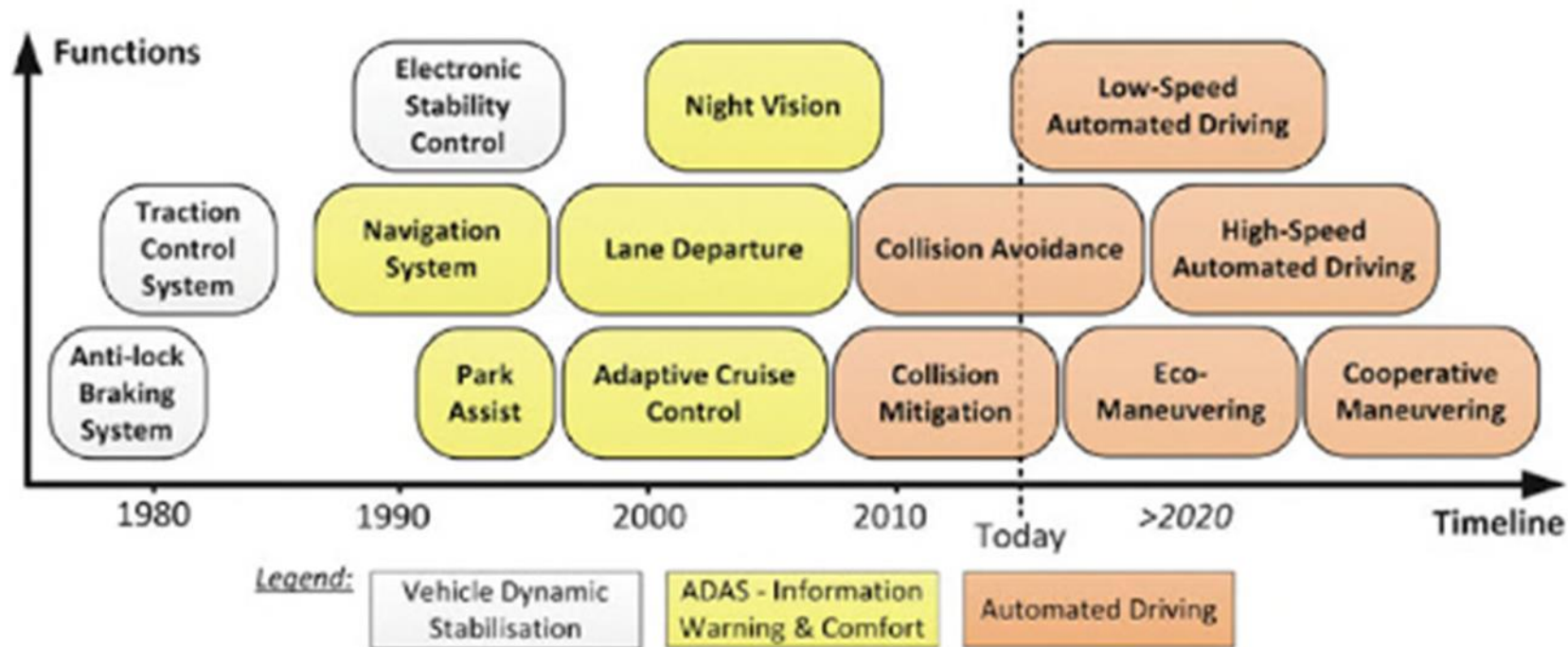
**Mikrofon**  
Kan registrere sirener fra utrykningskjøretøy som nærmer seg.



**Videokameraer**  
Med ett på hvert hjørne av bilen og et femte på taket, hjelper de bilen å gjenkjenne ting rundt seg.



# Evolution of key technologies



Kilde H Martin et al. 2017

# Society of Automotive Engineers

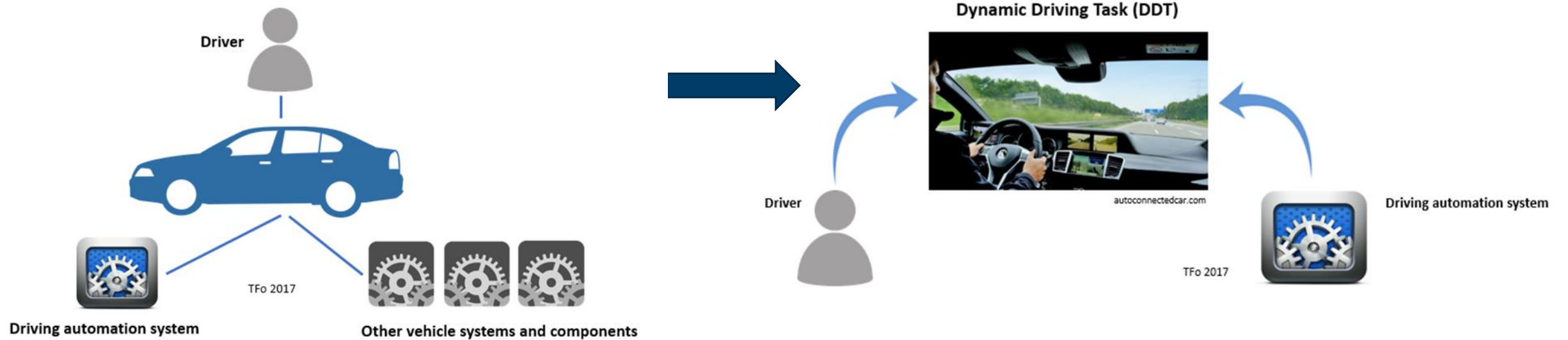
## SAE J3016

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*Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles*

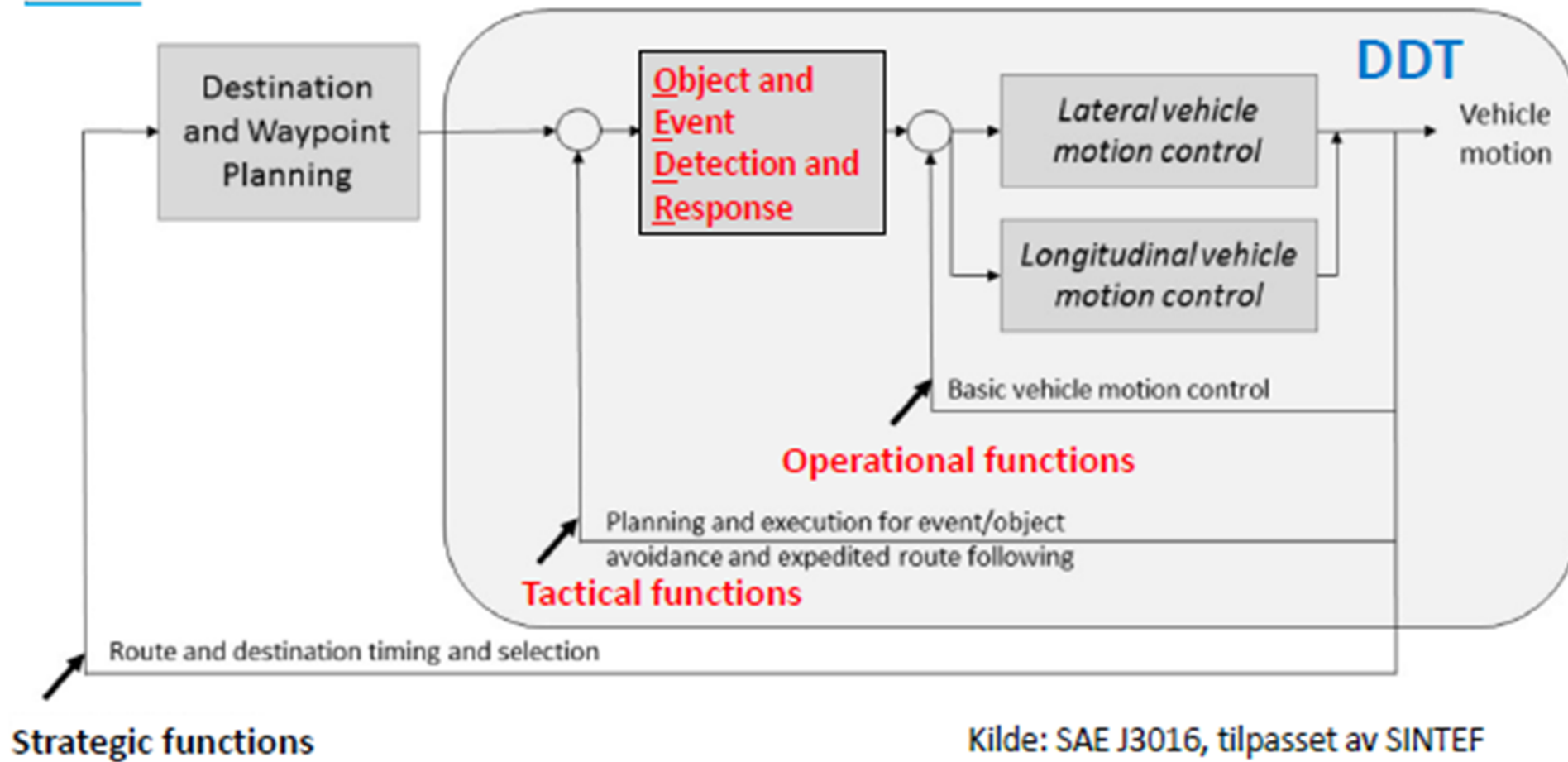
- **6 levels of automation: From no driving automation (level 0) to full driving automation (level 5)**
- **Role of driver and ADS: Automated Driving System**

# Three primary actors





# SAE J3016, Dynamic Driving Task (DDT)



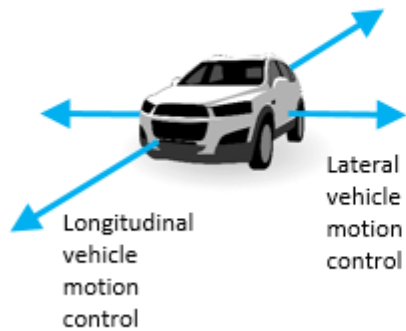
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Kilde: SAE J3016, tilpasset av SINTEF

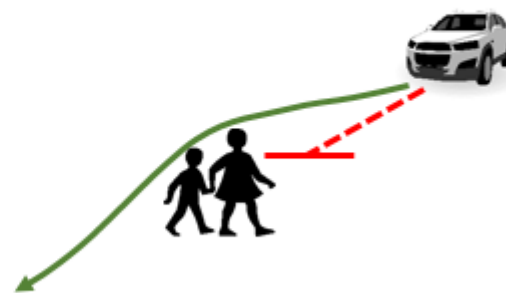
# Levels of automation

## Dynamic Driving Task (DDT)

### Basic vehicle motion control



### Object and Event Detection and Response (OEDR)



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DDT fallback

Operational Domain  
Design (ODD)

# Driving automation system

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Categorized into levels based on:

1. Whether the driving automation system performs either the longitudinal or the lateral vehicle motion control subtask of the DDT.
2. Whether the driving automation system performs both the longitudinal and the lateral vehicle motion control subtasks of the DDT simultaneously.
3. Whether the driving automation system also performs the OEDR subtask of the DDT.
4. Whether the driving automation system also performs DDT fallback.
5. Whether the driving automation system is limited by an ODD.



# Levels of driving automation

## 6 levels of automation

DDT: Dynamic Driving Task

OEDR: Object and event detection and response

DDT Fallback

ODD: Operational domain design

Society of Automotive Engineers, Revised 2016-09

Level	Name	Narrative definition	DDT		DDT fallback	ODD
			Sustained lateral and longitudinal vehicle motion control	OEDR		
Driver performs part or all of the DDT						
0	No Driving Automation	The performance by the driver of the entire DDT, even when enhanced by active safety systems.	Driver	Driver	Driver	n/a
1	Driver Assistance	The sustained and ODD-specific execution by a driving automation system of either the lateral or the longitudinal vehicle motion control subtask of the DDT (but not both simultaneously) with the expectation that the driver performs the remainder of the DDT.	Driver and System	Driver	Driver	Limited
2	Partial Driving Automation	The sustained and ODD-specific execution by a driving automation system of both the lateral and longitudinal vehicle motion control subtasks of the DDT with the expectation that the driver completes the OEDR subtask and supervises the driving automation system.	System	Driver	Driver	Limited
ADS ("System") performs the entire DDT (while engaged)			System	System	Fallback-ready user (becomes the driver during fallback)	Limited
3	Conditional Driving Automation	The sustained and ODD-specific performance by an ADS of the entire DDT with the expectation that the DDT fallback-ready user is receptive to ADS-issued requests to intervene, as well as to DDT performance-relevant system failures in other vehicle systems, and will respond appropriately.				
4	High Driving Automation	The sustained and ODD-specific performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene.	System	System	System	Limited
5	Full Driving Automation	The sustained and unconditional (i.e., not ODD-specific) performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene.	System	System	System	Unlimited

## ADS-equipped vehicles = Automated vehicles (levels 3-5)

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- Remotely operated - monitored and / or controlled from outside
- Autonomous - based solely on vehicle's sensors
- Cooperative - Based on vehicle's sensors and other road information (C-ITS, V2X),

# Examples

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- A vehicle equipped with Adaptive Cruise Control that experiences a system failure. The driver complete the DDT: **Level 1**
- User stands outside the vehicle to initiate an automated parking maneuver (wireless device): **Level 2**
- ADS – equipped vehicles performing the entire DDT during traffic jams on freeways but not able to do so when it encounters a crash scene and issues a request to intervene: **Level 3**
- ADS – equipped vehicles designed to operate within a campus where they pick up and discharge passengers along a specific route: **Level 4**
- ADS – equipped vehicles capable of automatically navigating on all roads with the user input of the destination: **Level 5**



Teknologi for et bedre samfunn