

# Audi piloted driving



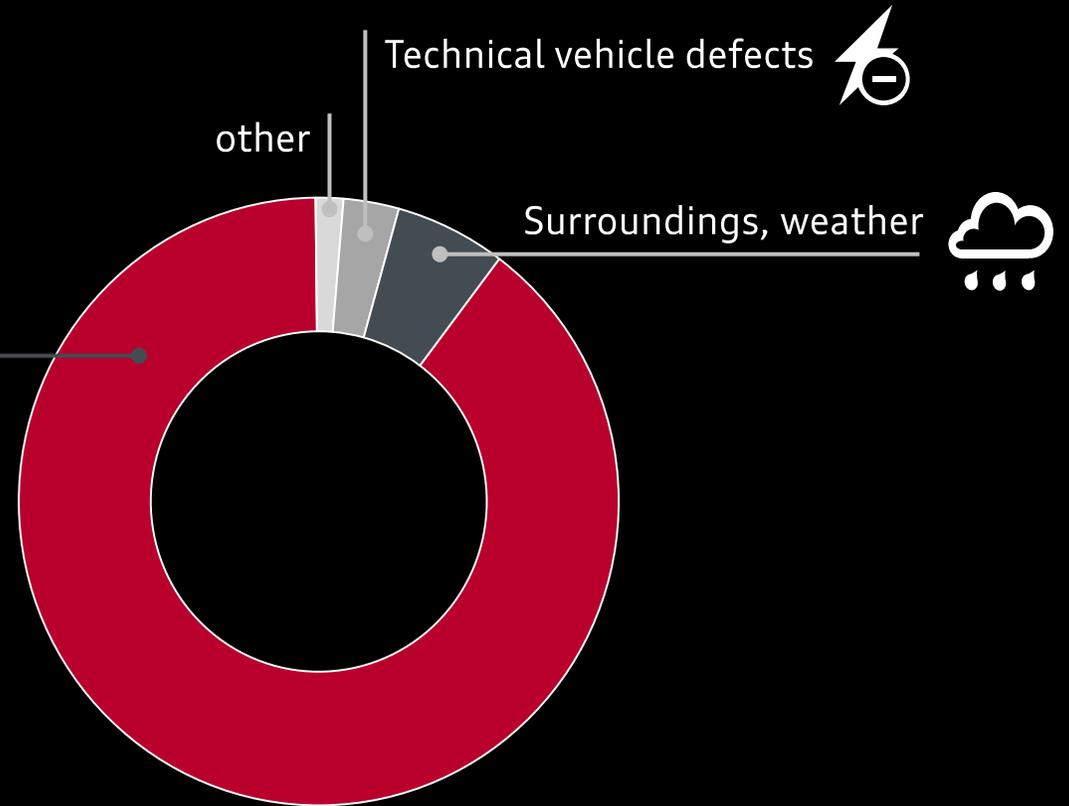
...in the fast lane to the future

## Audi goals for piloted driving

The potential for driver assistance and integral safety functions lies with driver support



**94%** of all  
**Accidents**  
are caused by  
**human errors.**



Source: NHTSA study 2015

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# Audi goals for piloted driving

## 1 Increased safety



## 2 Environmentally friendly driving



Piloted driving

## 3 Enhanced convenience



## 4 Efficient use of transport infrastructure



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# Audi piloted driving history



**January 2015**  
 ▶ 560 miles Test Drive  
 ▶ from Silicon Valley to Las Vegas

**October 2014**  
 ▶ RS7 drives piloted at the limits at Hockenheimring

**September 2014**  
 ▶ Permission to test  
 ▶ piloted driving in California

**August 2014**  
 ▶ Permission to test  
 ▶ piloted driving in Florida

**CES 2013/14**  
 ▶ Park pilot & traffic jam pilot  
 ▶ Permission to test  
 ▶ piloted driving in Nevada

**2010**  
 ▶ Audi TT  
 ▶ Pikes Peak

**2009**  
 ▶ Audi TT  
 ▶ Salt lake  
 ▶ Bonneville



2007

2005

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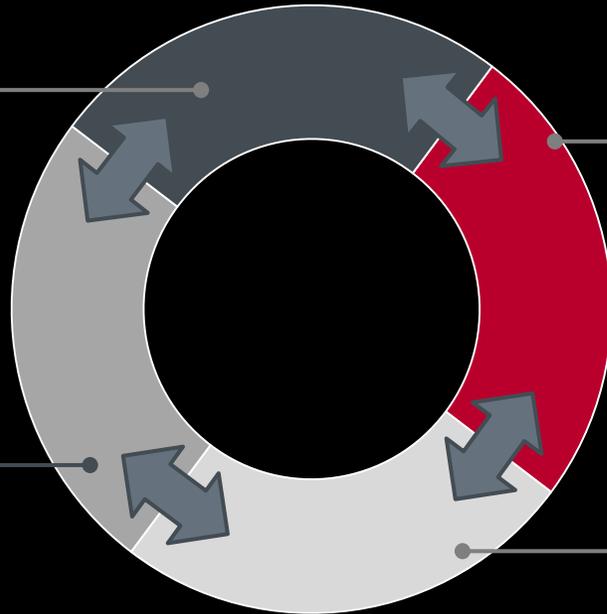
# challenges in piloted driving

## Customer Acceptance

? Do I trust this technology?  
Do I want it?

## Technology

? Is it possible to build a safe  
piloted vehicle



## Legal

? is it allowed to operate a  
piloted vehicle?

## Liability

? Who is responsible in case on an  
accident?

# User studies: Attitudes, needs and expectations around piloted driving

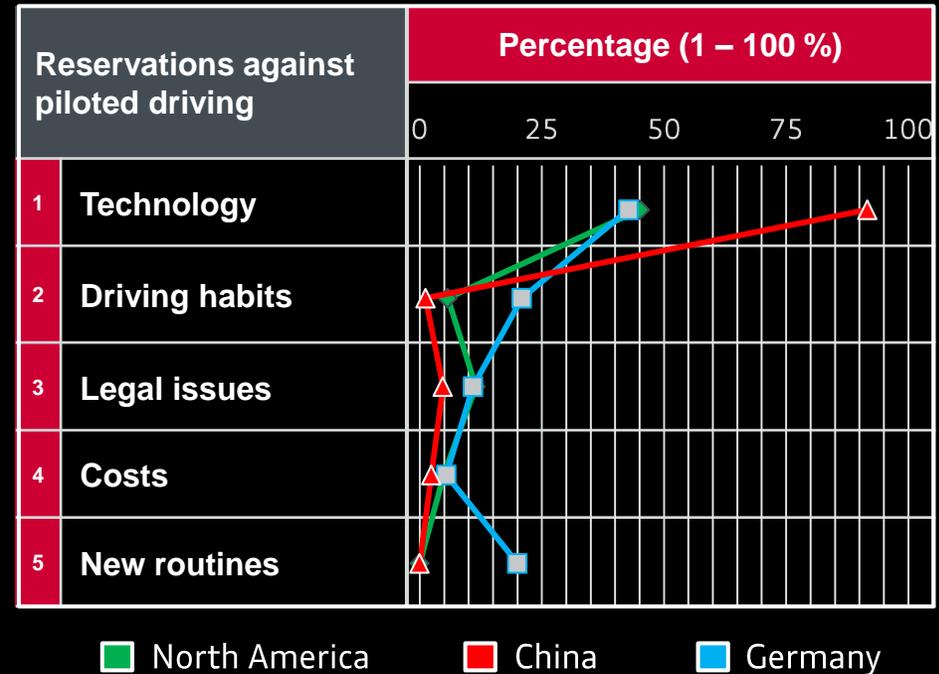
Setup: Online Diaries collected in North America, Germany & China



**comfort**  
**safety**

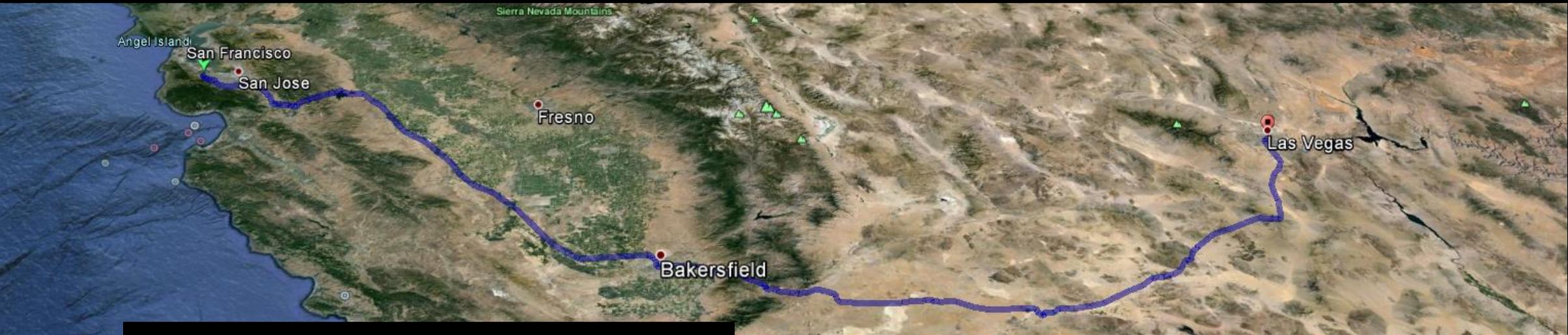


**technological maturity**  
**loss of driving pleasure**  
**change in the everyday life**



## outlines of the test drive

- ▶ Goal: Let “customers” **feel** how-long-distance traffic may look like in a couple of years
- ▶ 10-hour beginning-to-end road test drive will be longest on record involving media **journalists** at the steering wheel for most of the **550 miles+**, with exception of urban traffic environments
- ▶ All drivers were previously trained at the Arizona **Proving Grounds**



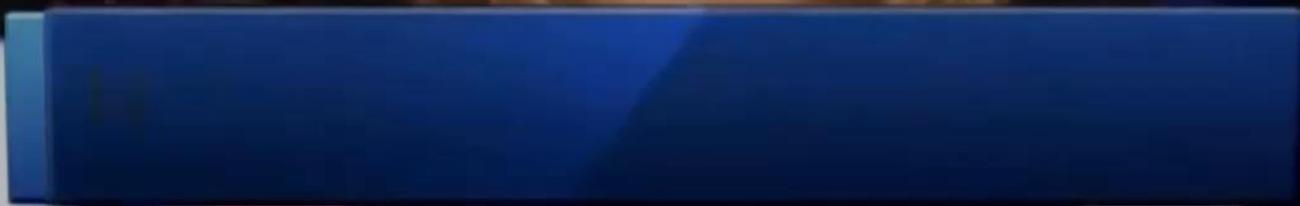
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NYSE

NY

BAY  
REST



NASDAQ	4,669.02
CHANGE	-57.79
% CHANGE	-1.22%

PY) 202.29 ▼ 3.14	Natl. Oilwell (NOV) 61.86 ▼ 3.63	UnitedHealth (UNH)
7 ▼ 4.33	PowerShares QQQ (QQQ) 101.69 ▼ 1.25	Google Class C (GOOG)

 11:21A  
EASTERN

Source: CNBC, Jan 5 2015

## the car

- ▶ the **Highway Pilot** is an evolutionary development continuing the Traffic Jam Pilot shown at the CES 2014
- ▶ the vehicle is equipped with a fully integrated **Piloted Human Machine Interface**
- ▶ The speed range is **0 – 70mph**
- ▶ The system performs automatic **lane changes** (overtaking and routing).



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# Levels of automation

“Jack”  
↓

## Assistance systems

Level 0	Level 1	Level 2
No Automation	Driver Assistance	<b>Partial Automation</b>
the <b>full-time performance by the human driver</b> of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems	the driving mode-specific execution by a driver <b>assistance system of either steering or acceleration/deceleration</b> using information about the driving environment and with the expectation that the <b>human driver perform all remaining aspects of the dynamic driving task</b>	<p>the driving mode-specific execution <b>by one or more driver assistance systems</b> of both <b>steering and acceleration/deceleration</b> using information about the driving environment</p> <p><b>the human driver performs all remaining aspects of the dynamic driving task</b></p>
Today's driver assistance systems		Next generation

## Automated systems

Level 3	Level 4	Level 5
<b>Conditional Automation</b>	<b>High Automation</b>	Full Automation
<p><b>human driver will respond appropriately</b> to a request to intervene</p> <p>the driving mode-specific performance by an <b>automated driving system</b> of all aspects of the dynamic driving task</p>	<p><b>even if a human driver does not respond</b> appropriately to a request <b>to intervene</b></p> <p>the driving mode-specific performance by an <b>automated driving system</b> of all aspects of the dynamic driving task</p>	the <b>full-time performance by an automated driving system</b> of all aspects of the dynamic driving task <b>under all roadway and environmental conditions that can be managed by a human driver</b>
<p><b>New area of activity</b> Piloted driving and parking</p>		

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# meet Jack



- 2x Laser-scanner 1
- 4x Mid-range-radar 2
- 4x Top View 3
- 2x Long-range-radar 4
- 1x 3D-video-camera 5
- 4x Ultrasonic 6
- 1x Stock GPS 7
- 2x Short Range Radar 8

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# ...and his HMI

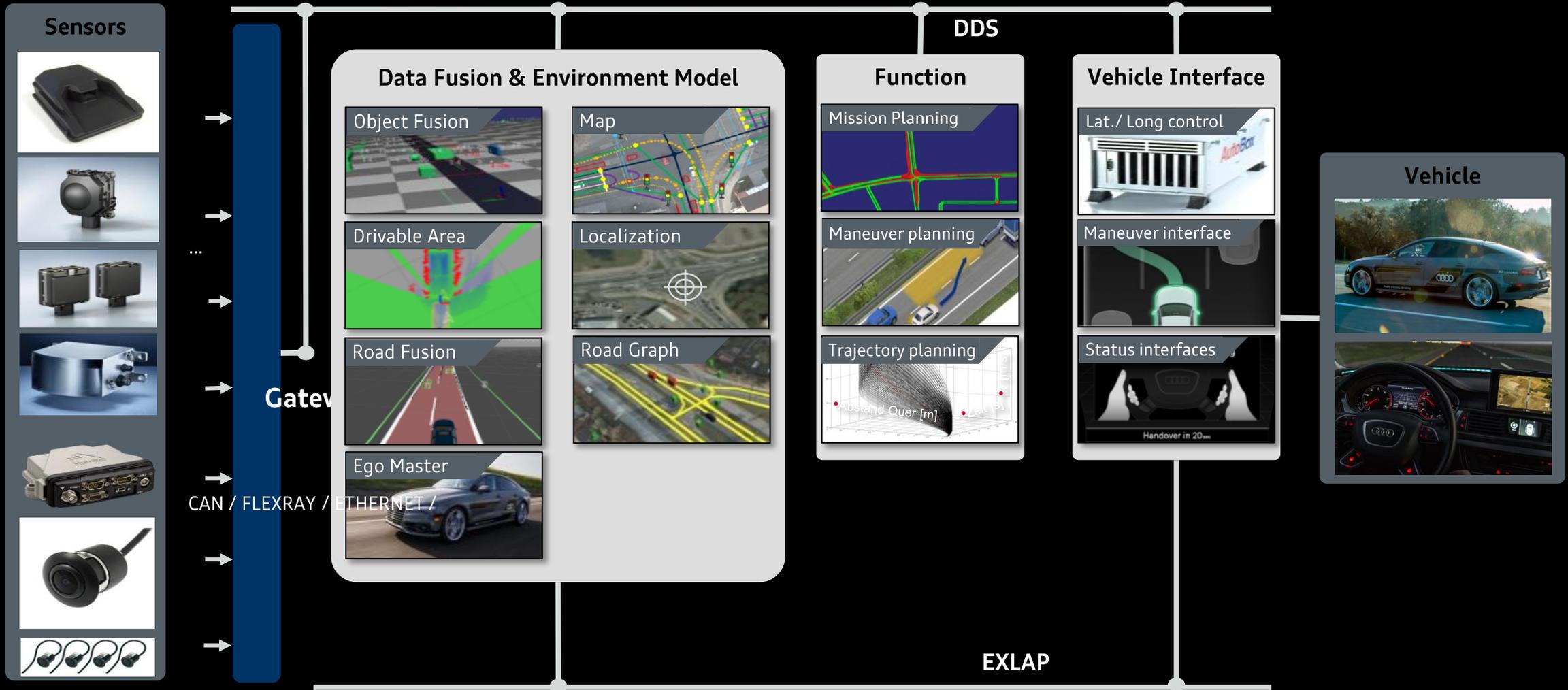


- Central Instrument Cluster 1
- Central Status Indicator 2
- Enhanced Peripheral lights 3
- Retractable steering wheel 4
- Steering Wheel buttons 5
- Speech & Sounds 6

- ▶ Transparent mode indication to enhance mode awareness
- ▶ Multimodal transitions between driver and automation

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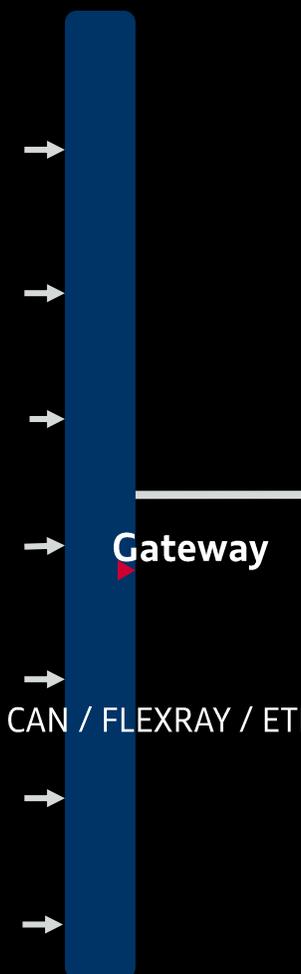
# technology - system architecture



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# technology – future integration

**Sensors**



Data Fusion & Environment Model		Function	Vehicle Interface
Object Fusion	Map	Mission Planning	Lat./ Long control
Drivable Area	Localization	Maneuver planning	Maneuver interface
Road Fusion	Road Graph	Trajectory planning	Status Interfaces
Ego Master			

**Vehicle**

**zFAS** - modular & scalable architecture

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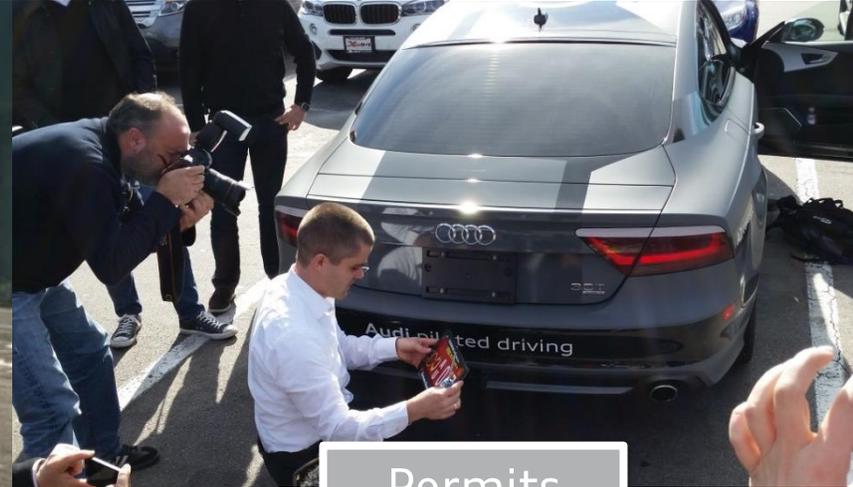
# challenges



weather



Road conditions



Permits



Humans :o)

OCCUPATIONAL LICENSING BRANCH				
AUTONOMOUS VEHICLE TESTING (AVT) PROGRAM				
TEST VEHICLE OPERATOR PERMIT				
<b>NOTICE:</b> This permit must be kept in the vehicle or in possession at all times when operating an autonomous vehicle.				
PERMIT EXPIRATION DATE: 09/15/2015				
<b>SECTION 1 — OPERATOR INFORMATION</b>				
TEST VEHICLE OPERATOR	OPERATOR LICENSE NUMBER			
LIPINSKI DANIEL	F3217179			
ADDRESS	CITY	STATE	ZIP CODE	
393 SAINT MARTIN DR.	REDWOOD SHRS	CA	94065	
<b>SECTION 2 — MANUFACTURER INFORMATION</b>		CITY	STATE	ZIP CODE
MANUFACTURER NAME	AVT NUMBER	HERNDON	VA	20171
VOLKSWAGEN GROUP OF AMERICA INC	AVT001	2200 FERDINAND PORSCHE DRIVE		
This permit enables the above described individual to operate in the capacity as an AVT operator.		ISSUING OFFICE	ISSUE DATE	
		HQ R-1	09/16/2014	
ISSUING EMPLOYEE'S PRINTED NAME		ISSUING EMPLOYEE'S SIGNATURE		
JANNE FRENCH		X <i>Janne French</i>		
See the back of this permit for Acknowledgement and Certification for the operation of an Autonomous Vehicle.				
DL 94 NEW 9/09/14				

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THANK YOU!



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# Electronics Research Laboratory

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Belmont, California, USA 94002

<http://www.vwerl.com>



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