Lecture 12-1

Control Systems:샤시안전제어 및 Level 4 Automated Driving Systems

Automobile Revolution in New Century

- Green
- Connected
- Safe
- Cool

- *comparable*
- *doing well, can do better*
- *need more*
- *improving*

Fuel efficient, comfort, safe, pleasurable, easy to use, dynamic handling, fun to drive, . . .

Real life cars

Status Today

Internet is available in nearly all places

Vehicles are the last white spot.

*Source: 17th ITS World Congress Busan2010, Emergence of the 'iCar', Brian Droessler, Continental

Driver Distraction

Driver distraction is Not New, but temptation has Increased

➔ Common Factor in Driver Distraction is the Driver!

***Source: ITS America, View on driver distraction, Roderick MacKenzie, Chief Technology Officer,ITS America**

Rear-end Collisions/Side Crashes

Expressway

November 9, 2012

Expressway

April 2013

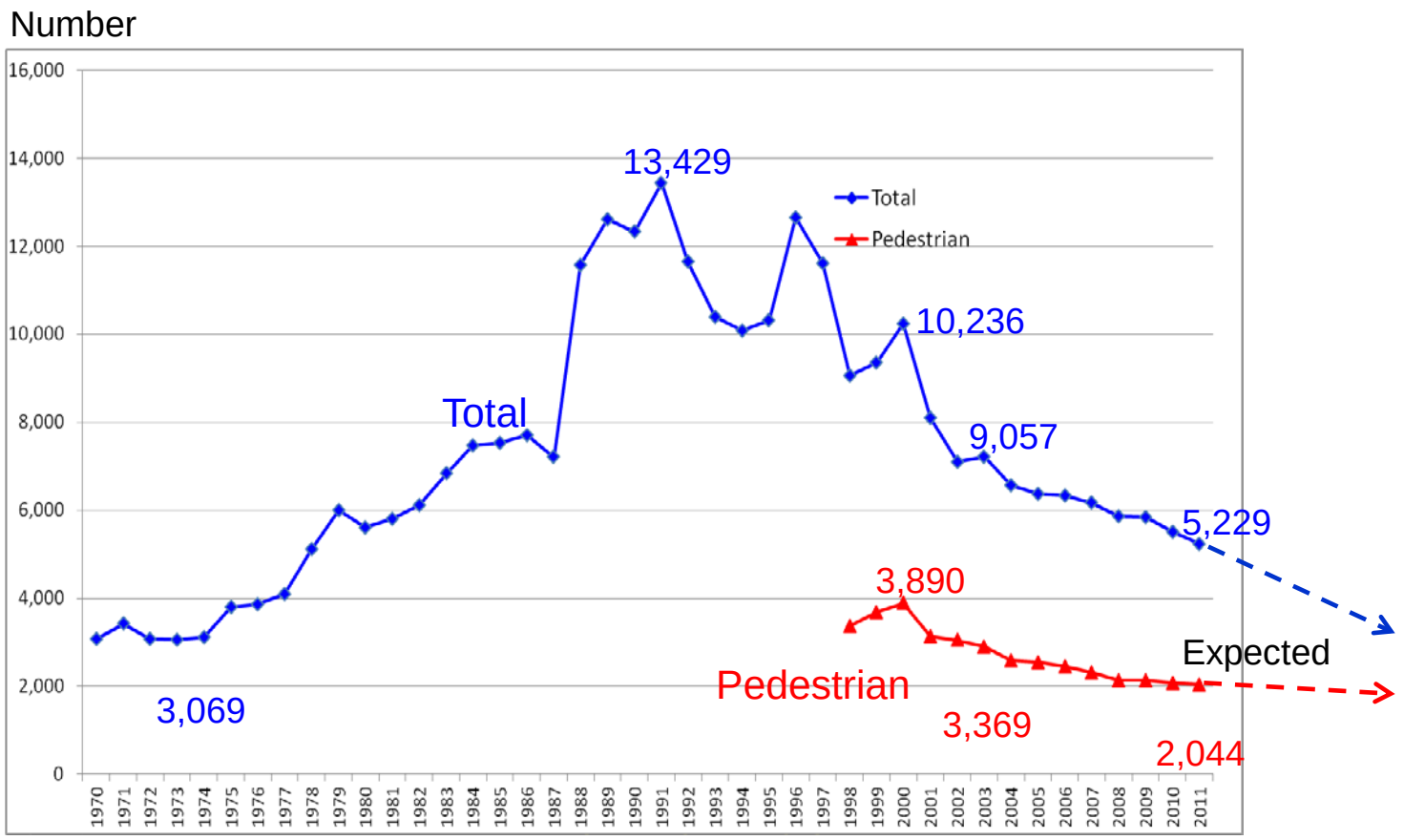
Blind Spot Loss of Lateral Control

Loss of Lateral control/Lane Departure

Due to Collision Avoidance Maneuvering

Incheon International Airport Expressway January 26, 2011

Trends of Road Traffic Fatalities

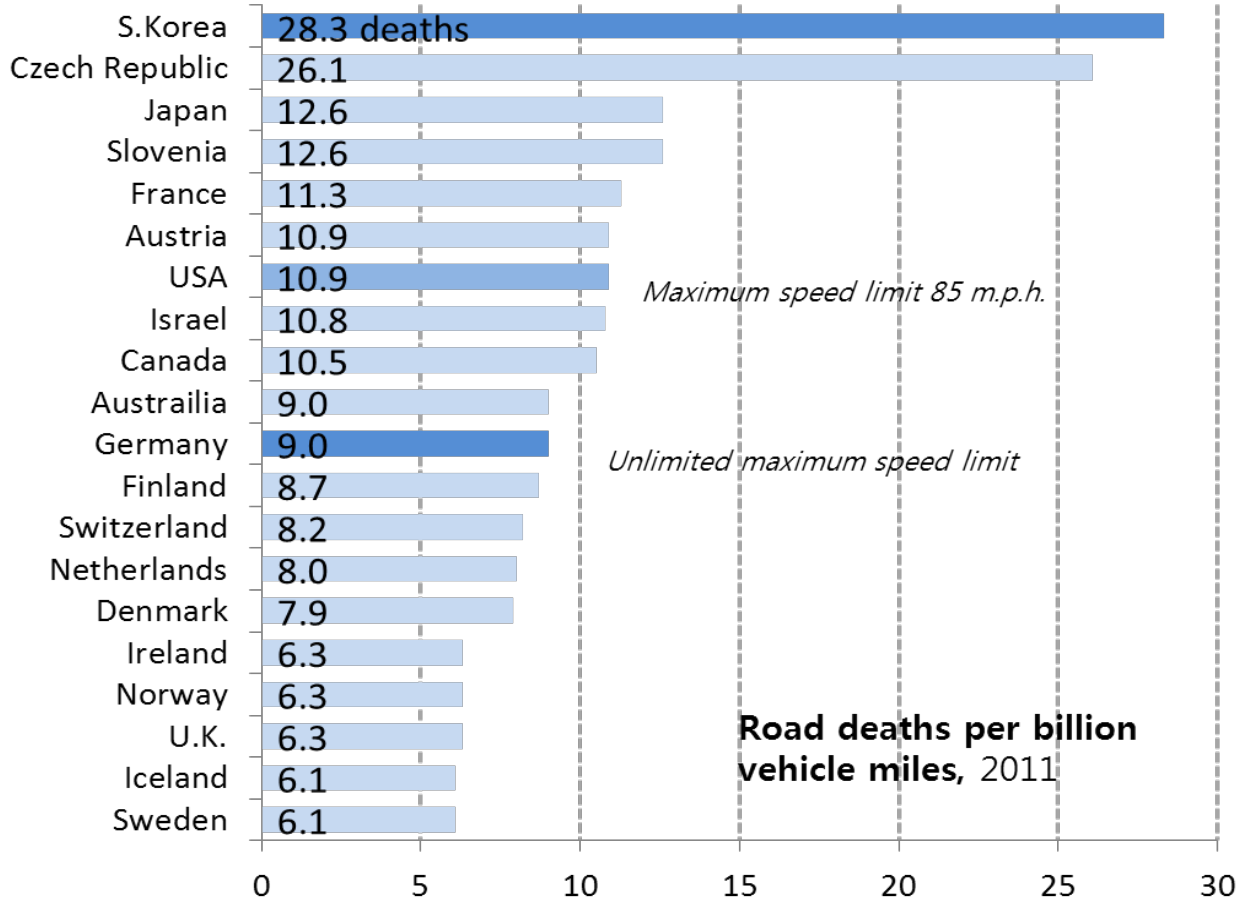


Source: KOROAD(2011)

Korea Key Road Safety Data for 2011

Road Fatalities	5,229
Injury Accidents	341,391
Killed per 100,000 inhabitants	10.7

Not a good idea to drive in Korea?

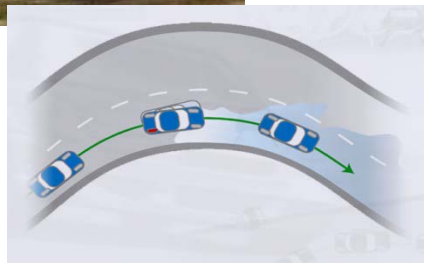


Road fatalities in Germany

Despite the unlimited speeds of parts of German roadways, deaths there rank toward the middle of comparable nations.

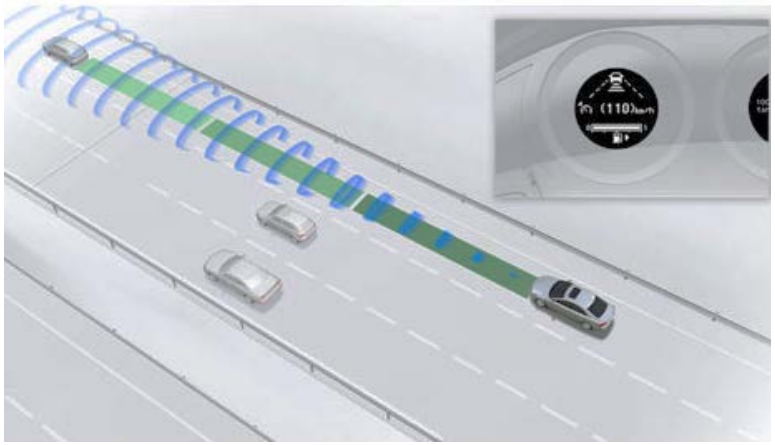
Integrated Vehicle Safety



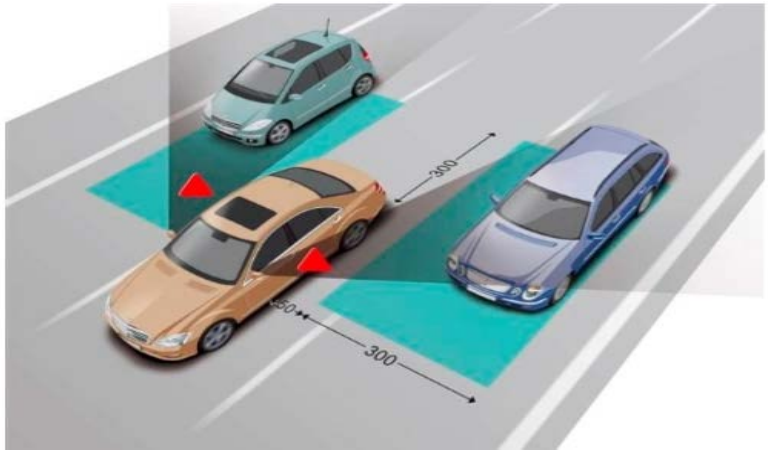
- Vehicle Dynamic Stability
  - Driver don't know how to handle
    - ➢ *Integrated chassis control*
- Driver Distraction
  - Saturated passive safety
    - ➢ *Driver assistance systems,*
    - ➢ *Integrated Safety Systems and automated driving*


Driver Assistance Systems



Smart Cruise Control System

Lane Keeping Assist System

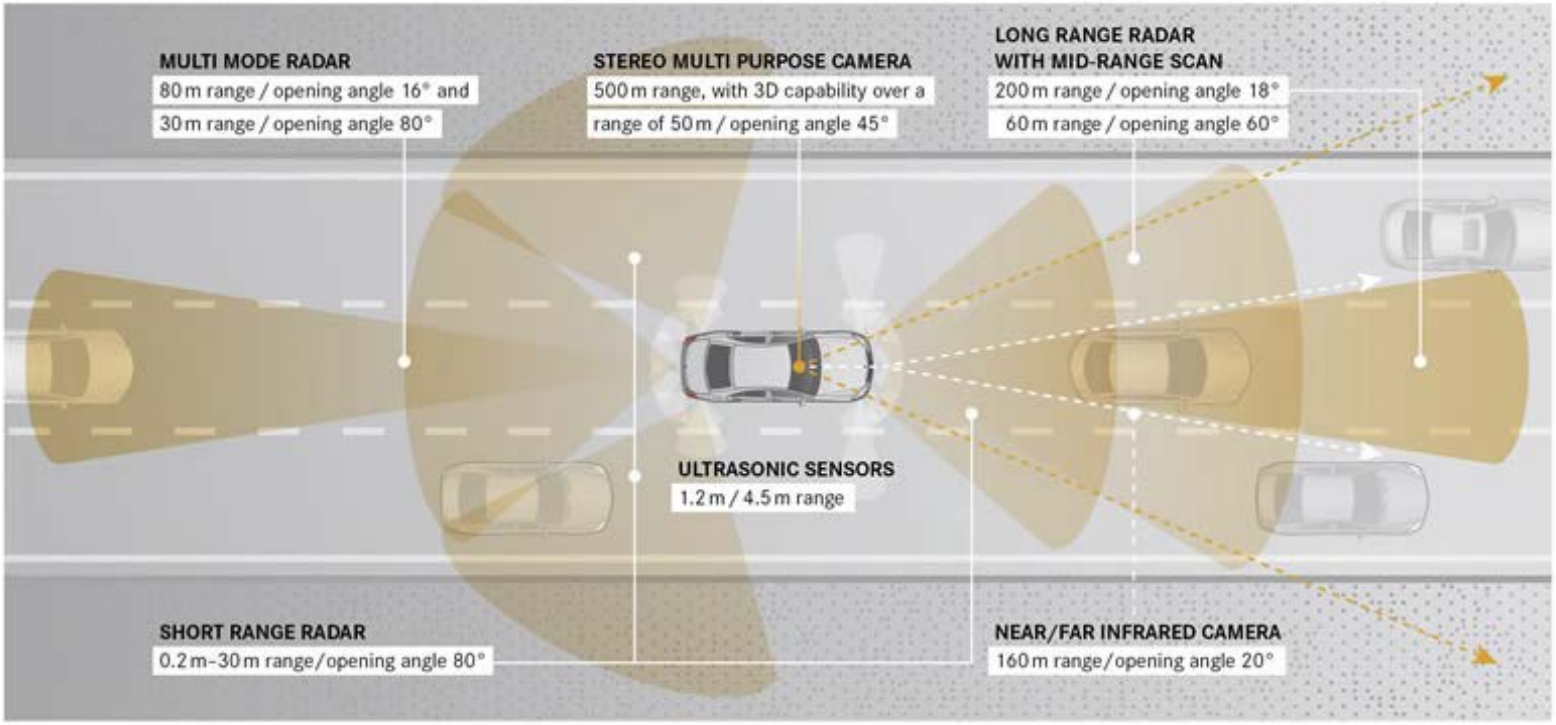


Blind Spot Detection System

New Mercedes S Class

Radar, stereo camera and ultrasonic systems

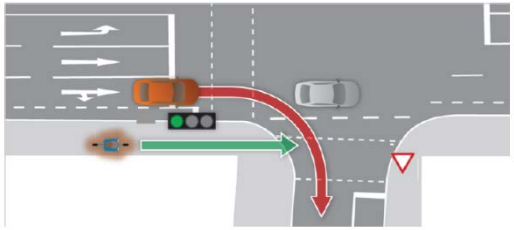
More sensors – more protection



http://www.emercedesbenz.com/autos/mercedes-benz/s-class/top-20-mercedes-benz-assistance-programs/

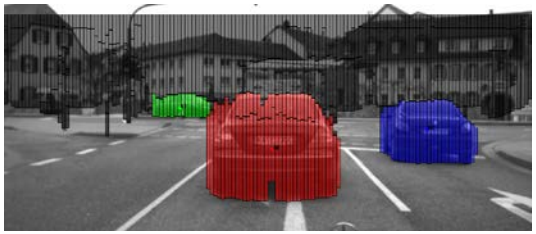
On going developments: safety technologies

- Wireless ped detection



- Path planning for Dynamic Driving Task

- Stereo vision



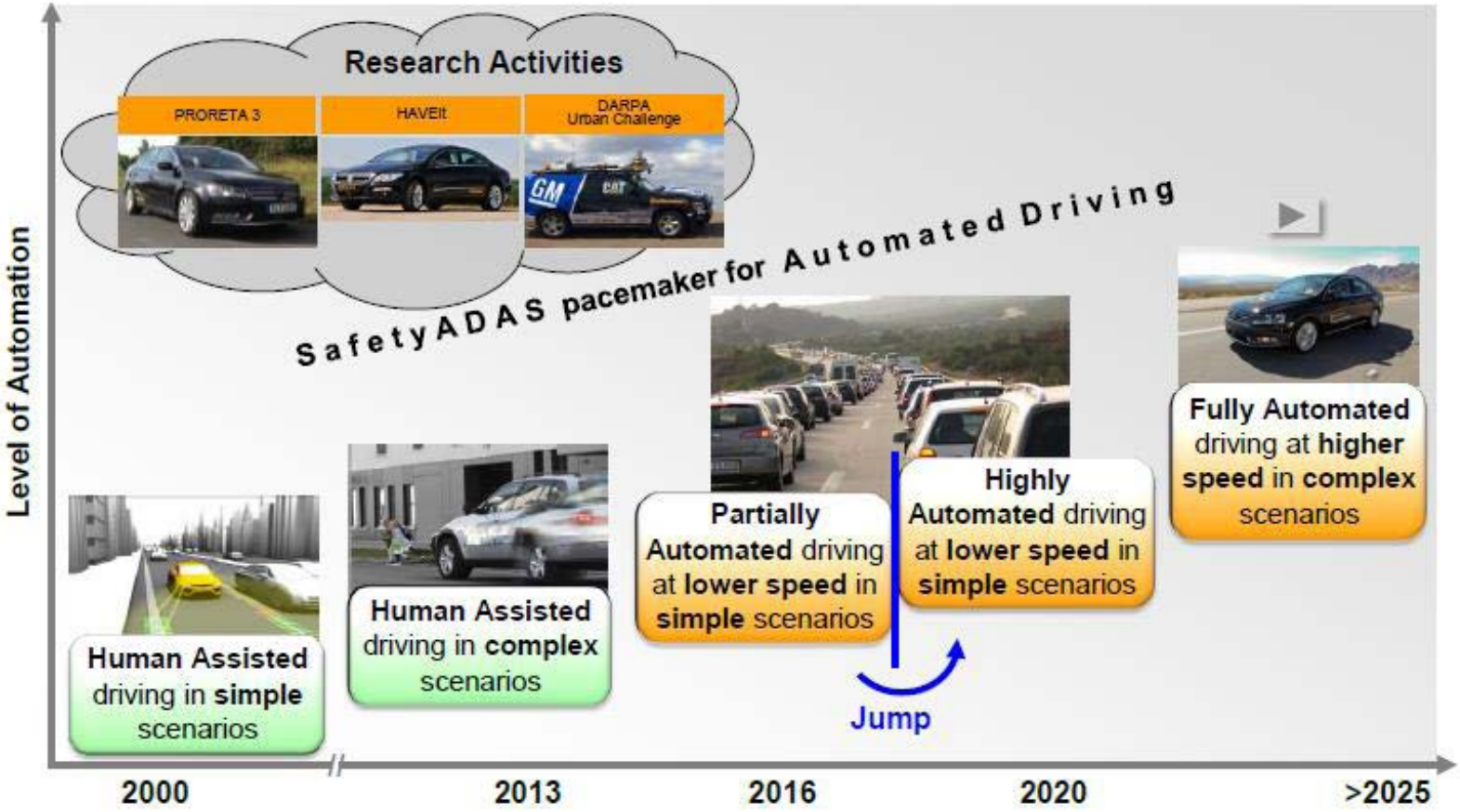
From Stixels to Objects
Friedrich Erbs1, Beate Schwarz2 and Uwe Franke1
IV 2013

- Robust Vehicle Control for Automated Driving with Uncertainties

<Active Safety for Vulnerable Road Users based on Smartphone Position Data, BMW, Karlsruhe Univ. IV 2013>

2013 Conti, Bosch, GM, Ford, BMW, Benz, Volkswagen

From Assisted Driving to Automated Driving
Roadmap

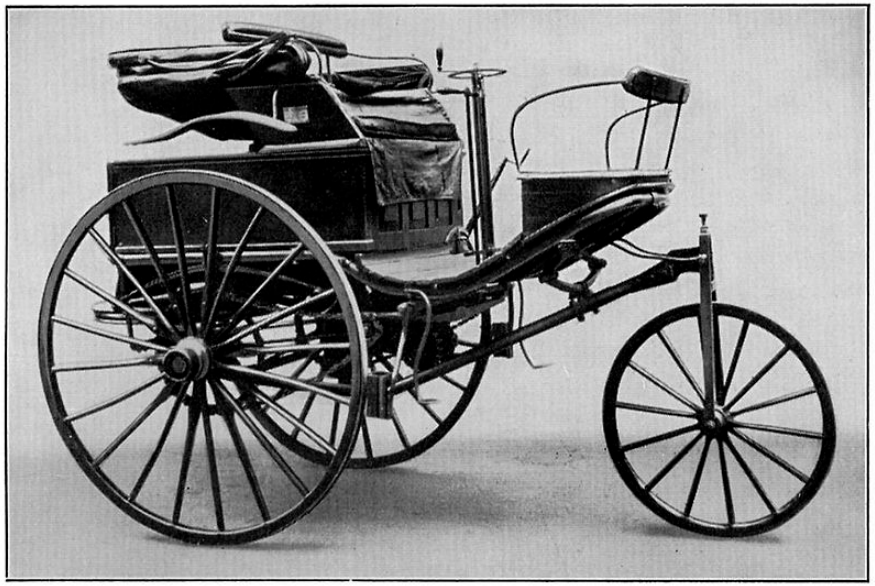


Autonomous Driving

Bertha Benz Route

104 Km from Mannheim to Pforzheim in 1888

World's first overland drive



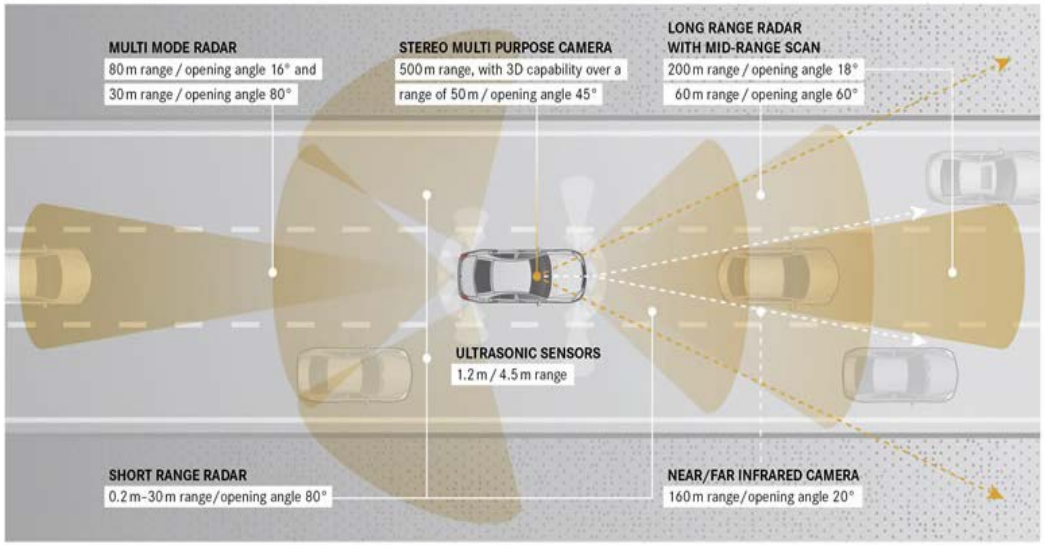
Mein erster Serienwagen von 1886. 1,5 PS

Fully Autonomous Driving on Bertha Benz Route

New Mercedes S Class

Radar, stereo camera and ultrasonic systems

More sensors – more protection



With close-to-production sensors

Stixel

Camera for traffic signals

GPS/Map

http://www.emercedesbenz.com/autos/mercedes-benz/s-class/top-20-mercedes-benz-assistance-programs/

Paradigm Changes*

From: Attention is job 1 for the driver

To: Situation Awareness is job 1 for the car

From: Fully Automated Cars are *wild* dogs

To: Fully Automated Cars are *domesticated* dogs

"what a wonderful companion"

Has any technology been stopped by one accident?

*Prof. Cliff Nass, Stanford, Second Annual Workshop on Vehicle Automation, July 2013

DAS to Automated Driving

AUTOMATED DRIVING SYSTEM

- *the hardware and software*
- *all aspects of the dynamic driving task* for a vehicle (whether part-time or full-time)

DYNAMIC DRIVING TASK

means *all of the real-time functions required to operate a vehicle* in on-road traffic:

- ***Object and event detection, recognition, and classification;***
- ***Object and event response;***
- ***Real-time mission planning;***
- ***Steering, turning, lane keeping, and lane changing;***
- ***Acceleration and deceleration;***
- ***Enhancing conspicuity (lighting, signaling and gesturing, etc.).***

Automated Driving Systems

NTHSA Level of Automation

Summary of SAE International's Draft Levels of Automation for On-Road Vehicles (July 2013)

NHTSA level	SAE level	SAE name	SAE narrative definition	Execution of steering and acceleration/ deceleration	Monitor of driving environment	Backup performance of dynamic driving task	System capability (driving modes)
	Human driver monitors the driving environment						
0	**0**	**Non-Automated**	The full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**1**	**Assisted**	The driving mode-specific execution by a driver assistance system of either steering or acceleration/ deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task	Human driver And system	Human driver	Human driver	Some driving modes
2	**2**	**Partial Automation**	The driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task	**System**	Human driver	Human driver	Some driving modes
	Automated driving system("system") monitors the driving environment						
3	**3**	**Conditional Automation**	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene	System	**System**	Human driver	Some driving modes
4	**4**	**High Automation**	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to request to intervene	System	System	**System**	Some driving modes
	5	**Full Automation**	The full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver	System	System	System	**All driving modes**

ESC CW LDWS

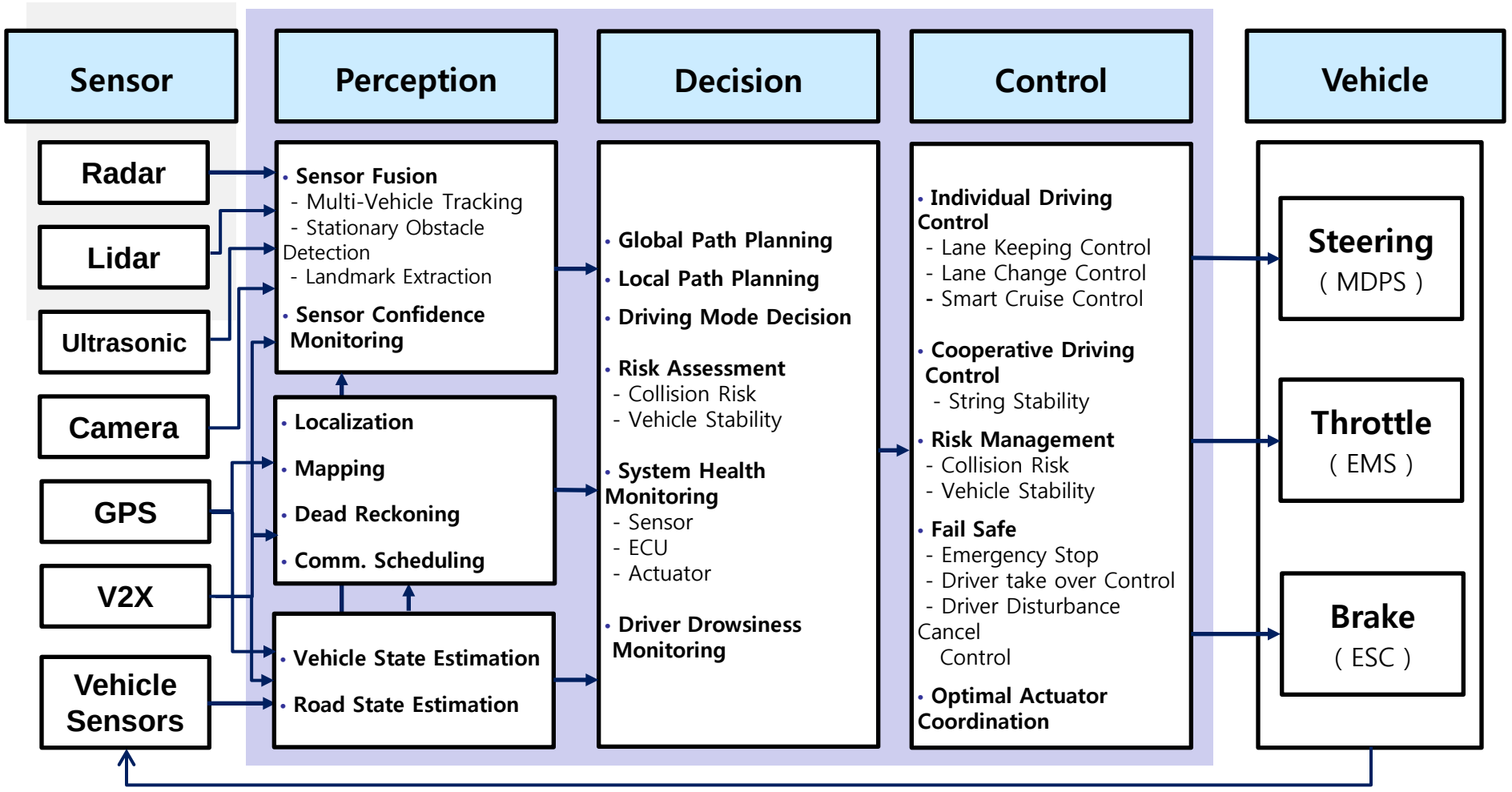
SCC LKAS

AEBS Traffic Jam Assist

Super Smart Cruise

Google Autonomous

Automated Driving Systems



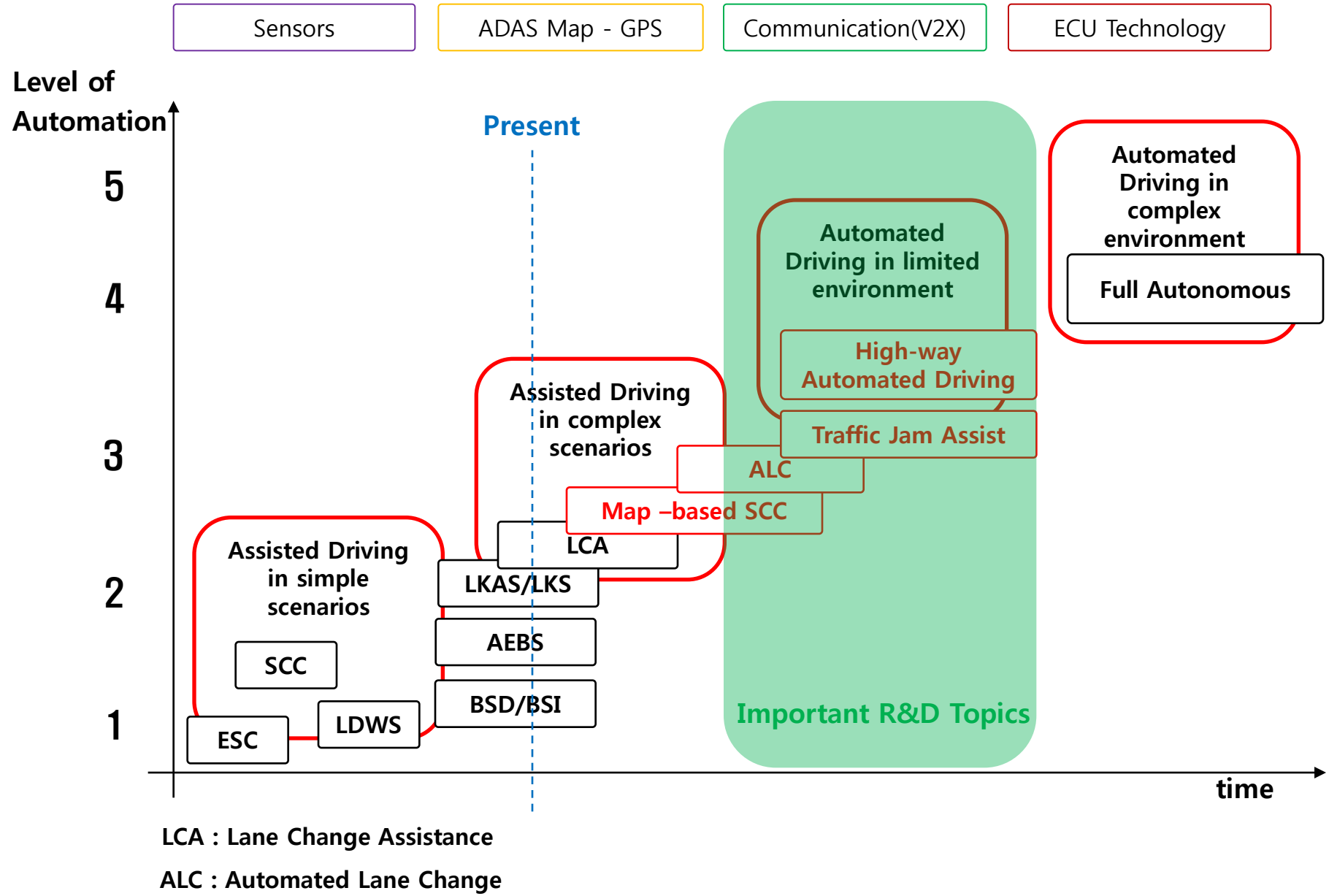
Key Technologies for Global Competitiveness

AUTOMATED DRIVING SYSTEM

- Sensors ???
- Actuators ok
- Soft smartness for Dynamic Driving Task

Processing-assessment-decision-control

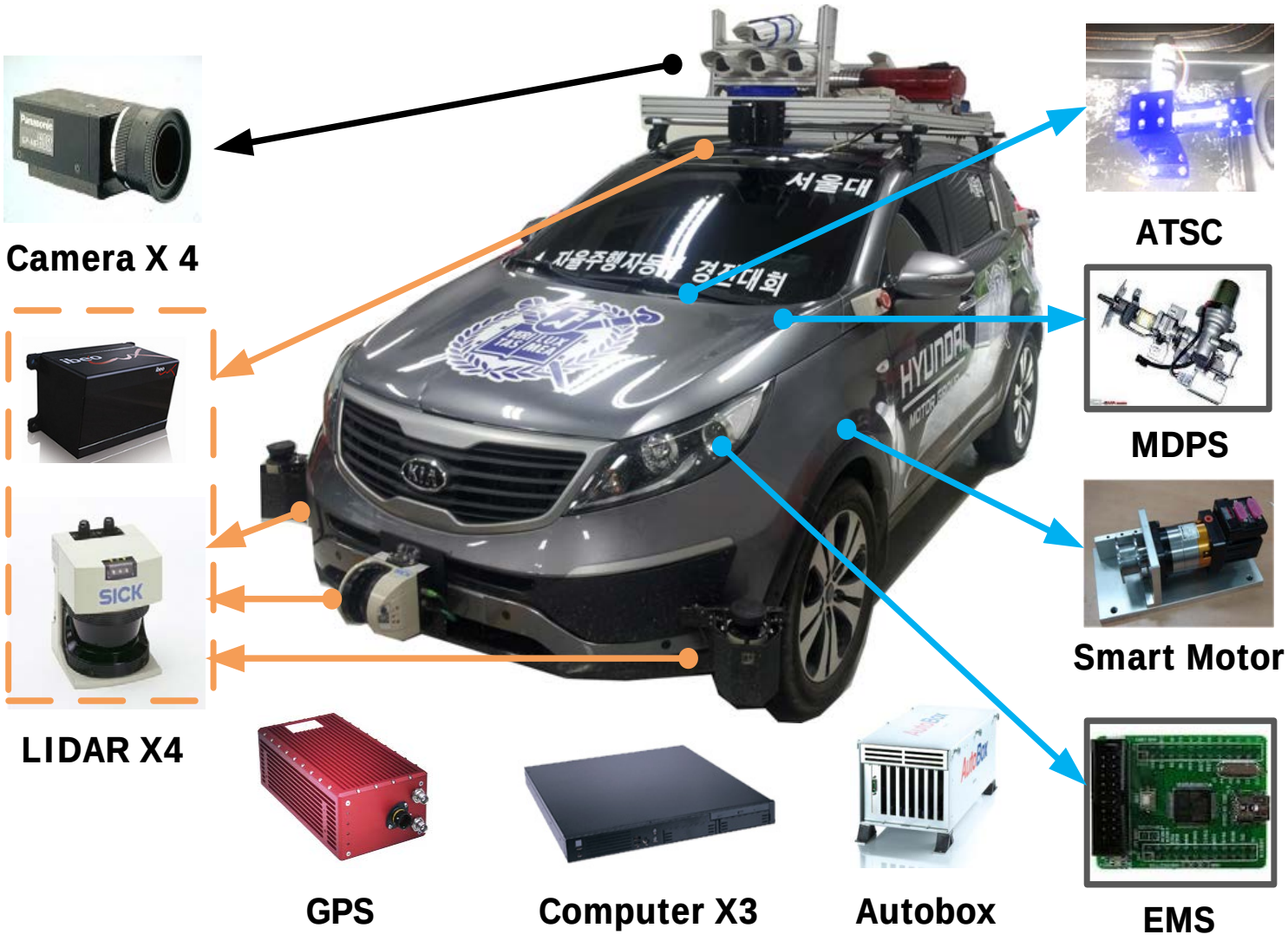
Technology Road Map: from ADAS to Automated



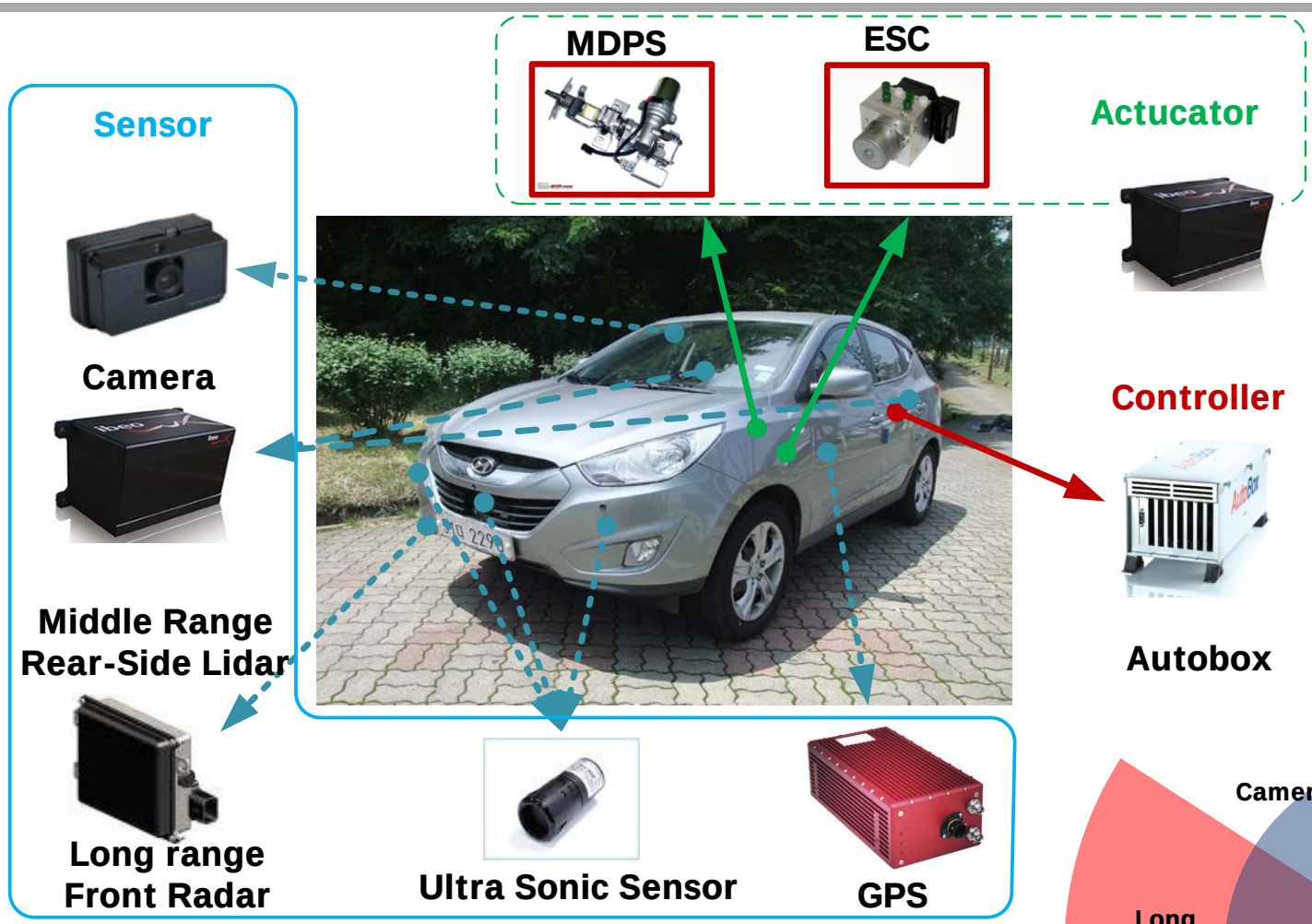
LCA : Lane Change Assistance

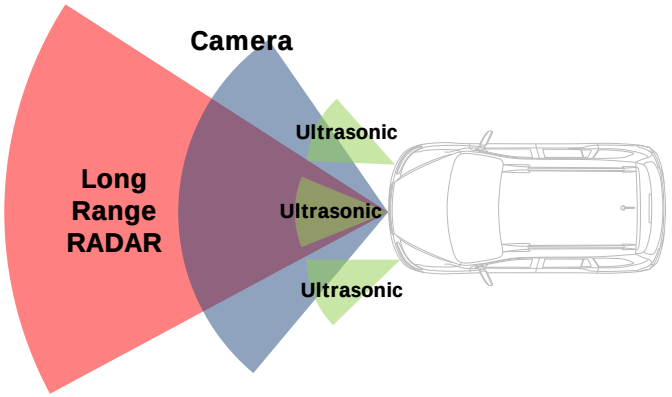
ALC : Automated Lane Change

Autonomous Vehicle ADV 1



IVSS(Integrated Vehicle Safety System) Test Vehicle – LM





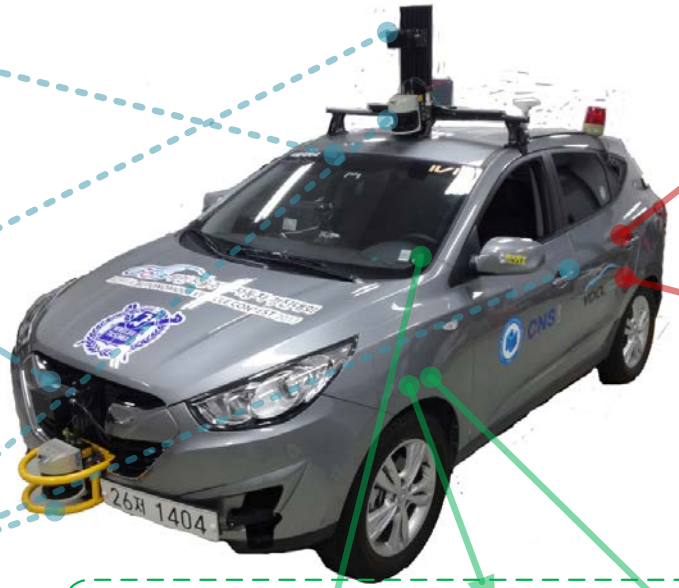
Automated Driving Vehicle ADV 2 – LM

Sensor

Camera

Long-Range Lidar (IBEO)

Middle-Range Lidar (SICK)



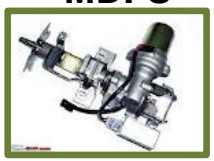
Controller

Autobox

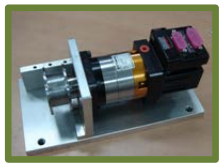
Computer X3

Actucator

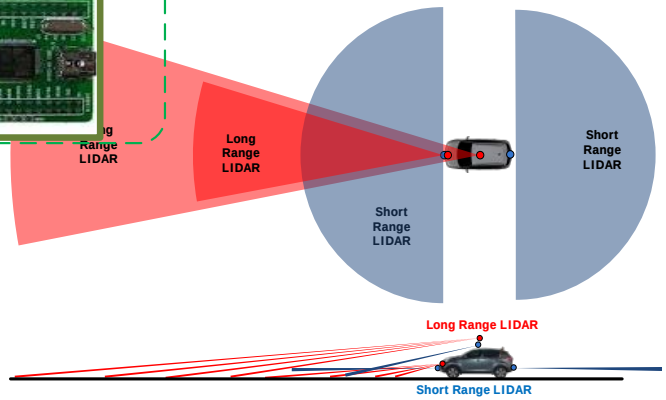
MDPS



MBS



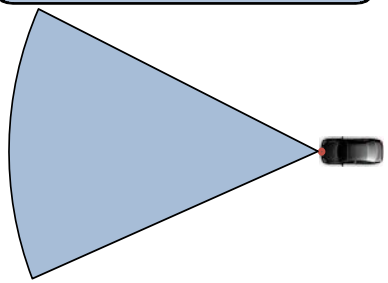
EMS



Automated Driving with Vision and Lidar: ADV 3

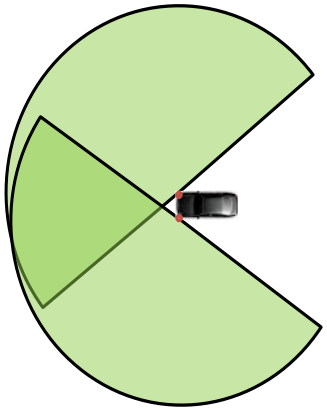
Vehicle Configuration

Front Cam (Mobileye)



Mobileye C2-170
WxH : 40°x30°
FPS : 15fps
Range : 50m

Laser Scanner (SICK)



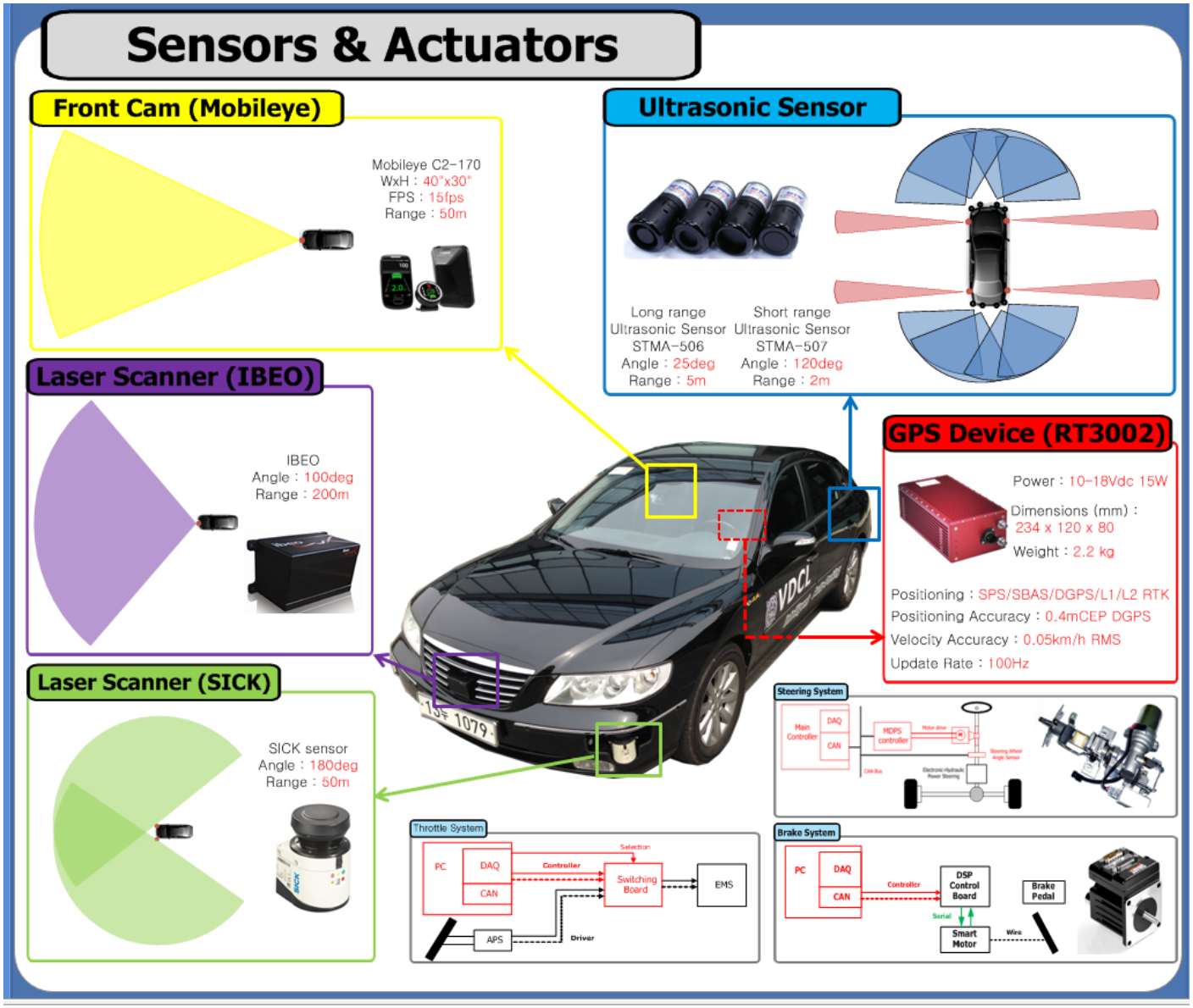
SICK sensor
Angle : 180deg
Range : 50m

Controller

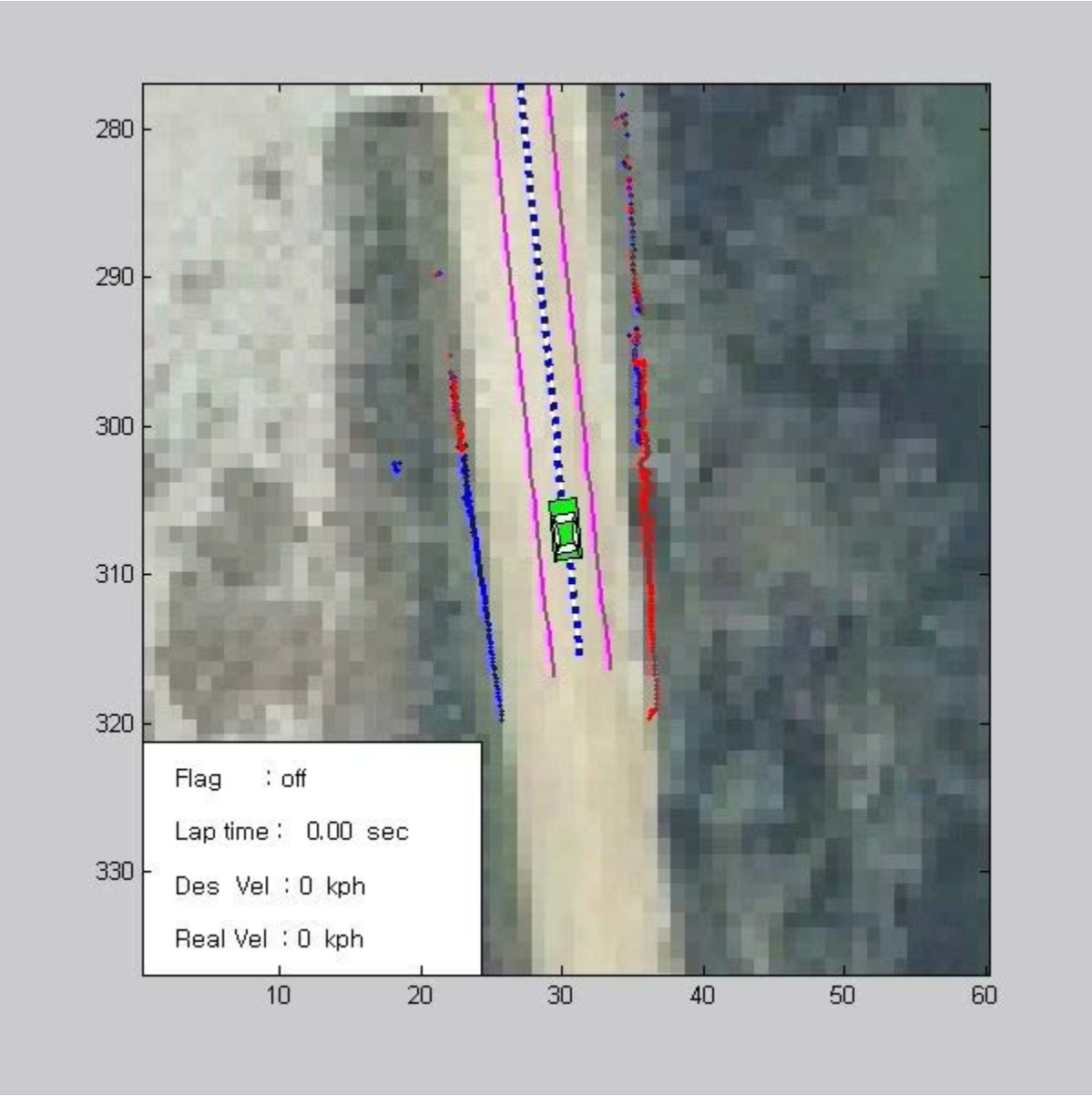
Micro AutoBox
Processor : IBM PPC 750FX,800MHz
Memory : 8 MB main memory
Interface : 8CAN, Serial, ECU, FlexRay

Computer
Processor
Intel Pentium Dualcore 2.7Ghz
Memory
Samsung DDR2 2G PC2-6400

Automated Driving Vehicle ADV 3 – TG

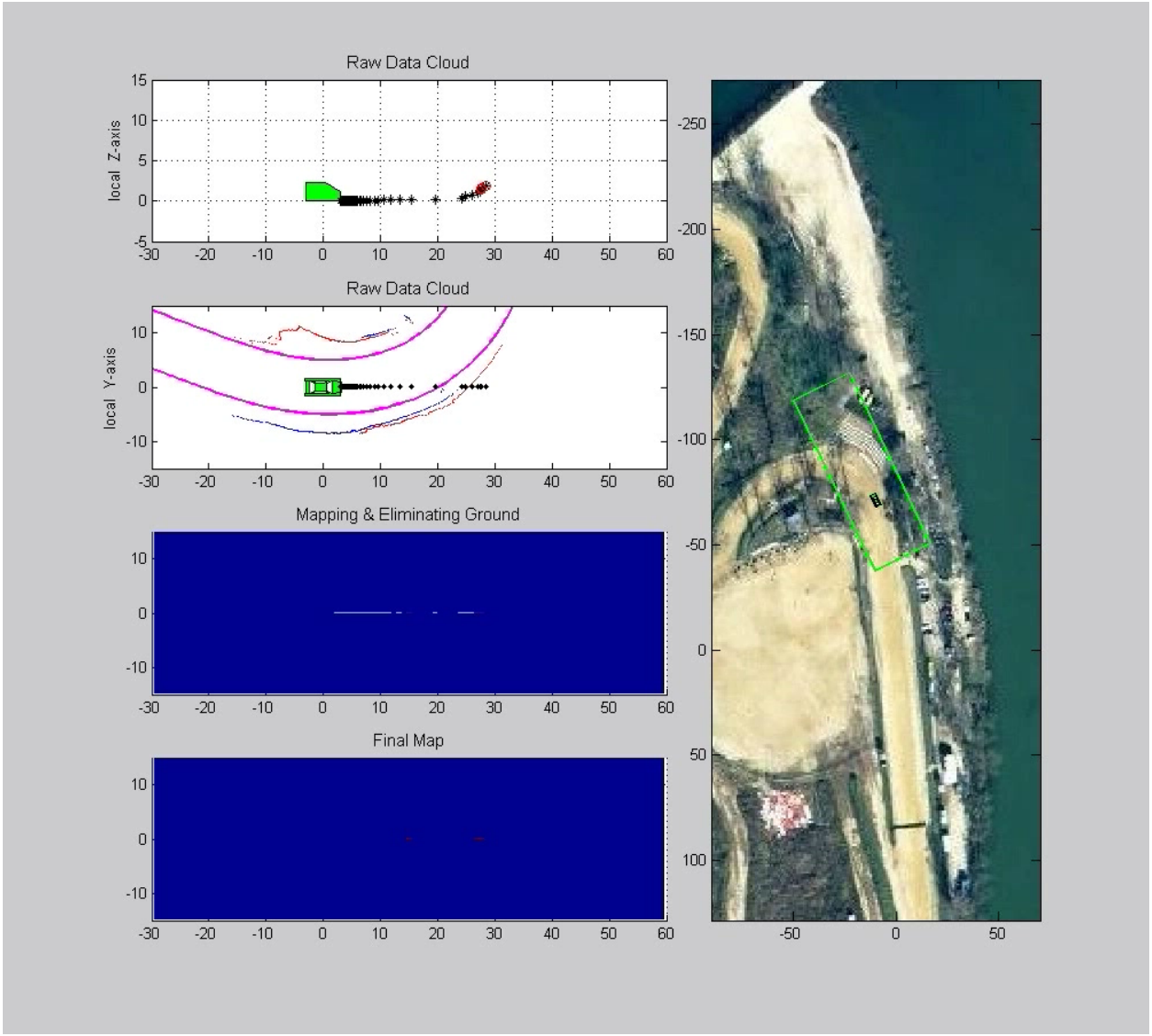


Off-road Automated Driving



b 2배속 final flag on

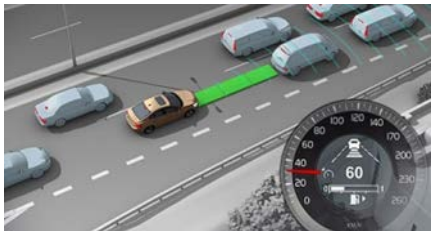
Off-road Automated Driving (2)



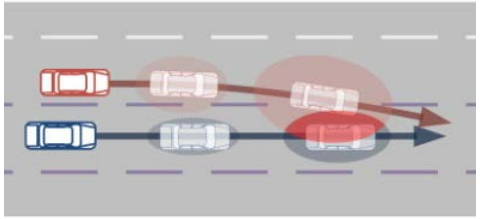
b auto vdcl map final

Level 4: Automated Driving

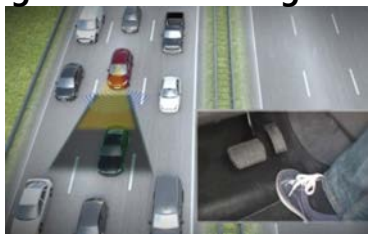
- Close-to-market Sensors
- Integrated Smart Safety
  - manual/autonomous
  - obstacle/target detection and tracking
  - free-space generation
  - throttle/brake/steering control



Smart Cruise Control



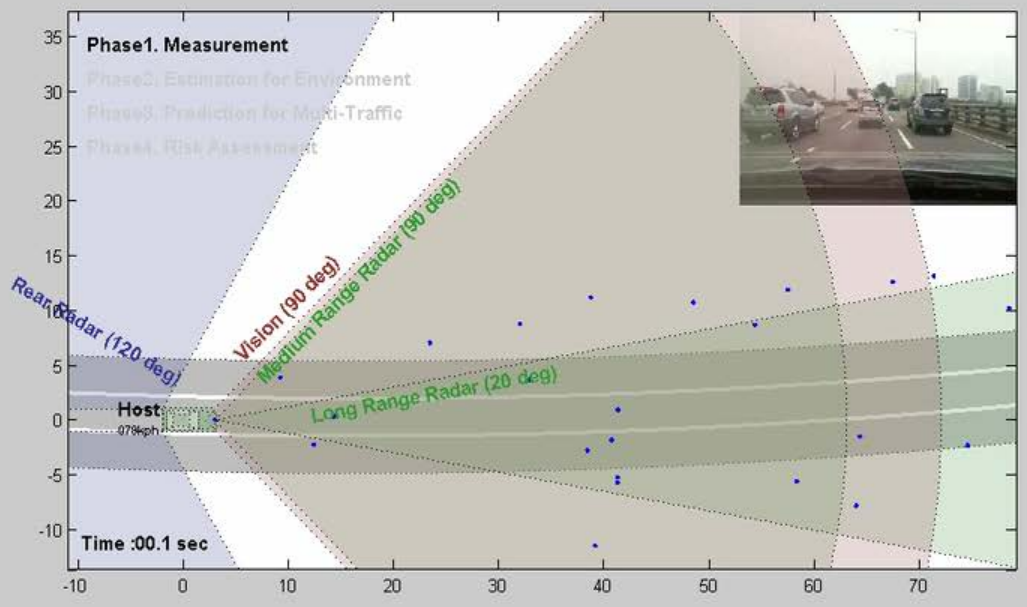
Integrated Risk Management

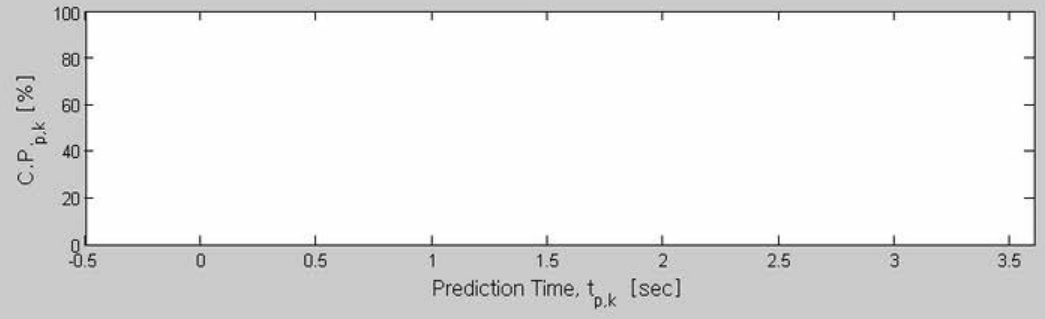


Traffic Jam Assistance

Evasive Steering

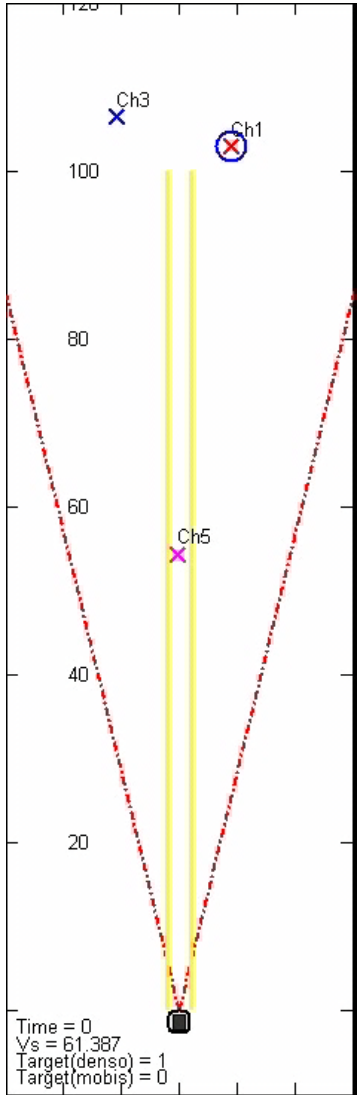
Integrated Risk Assessment and Management for Level 4 Automated Driving





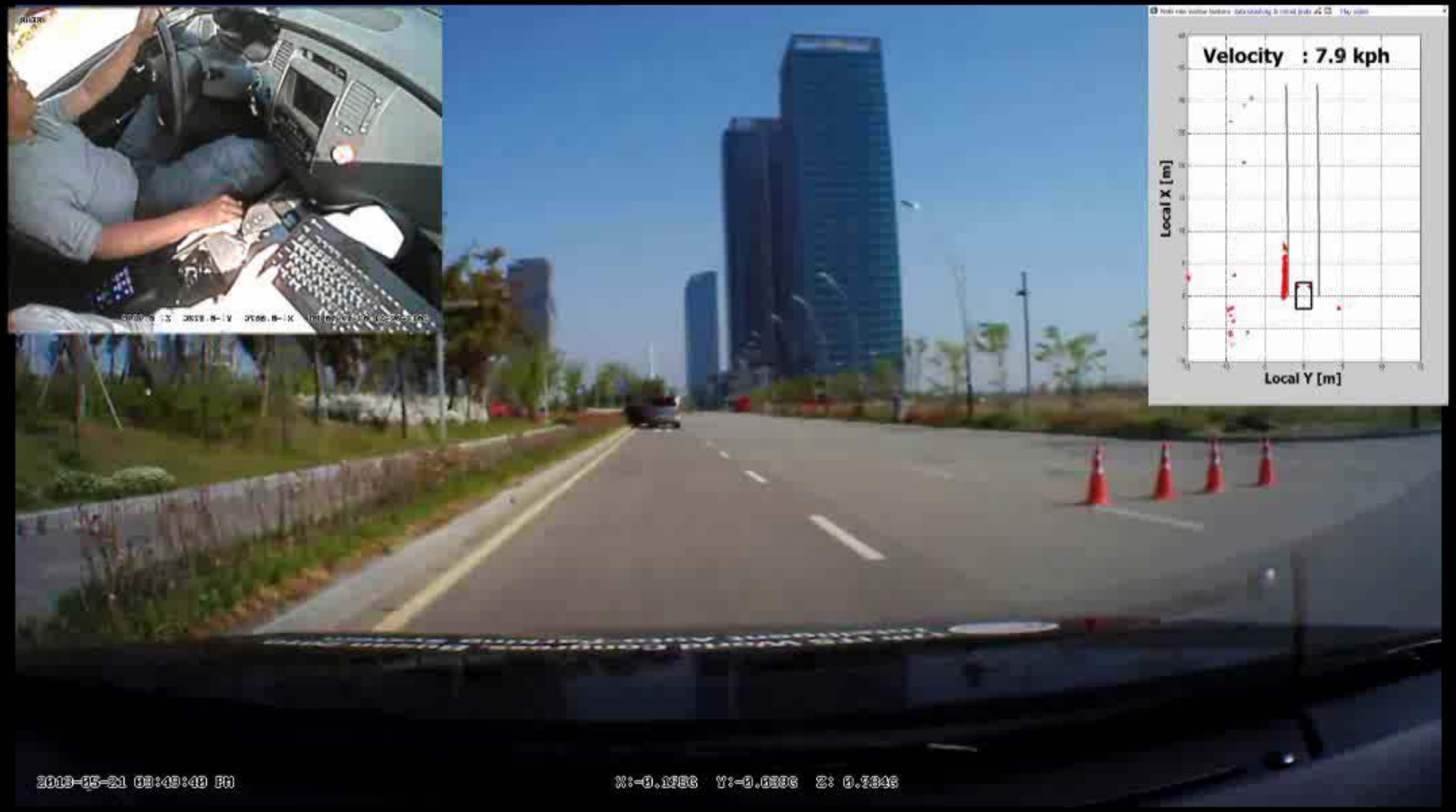
a Risk assessment Final

Level 4 Automated Driving: Test Data



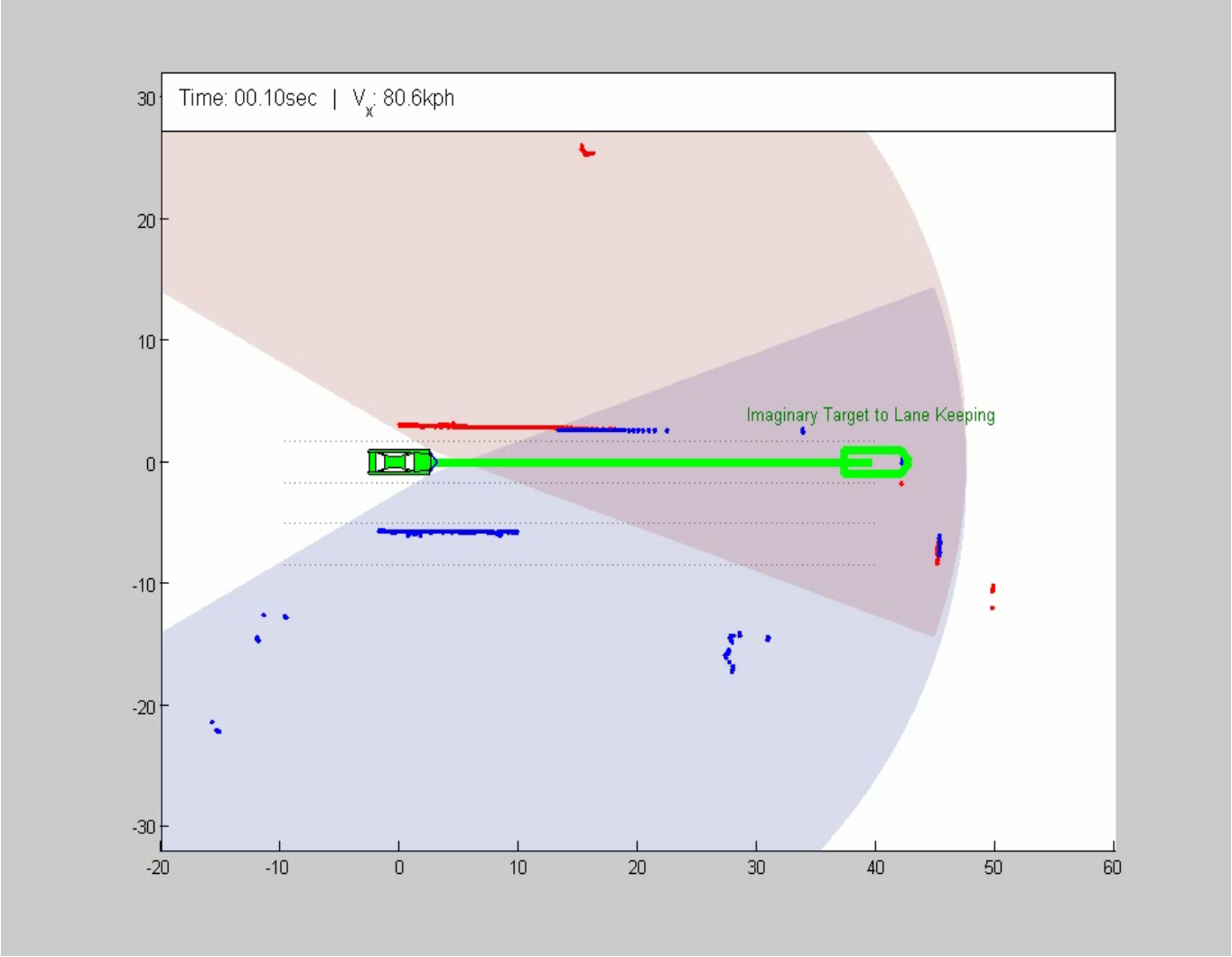
a Cut-in 18 data

Level 4 Automated Driving



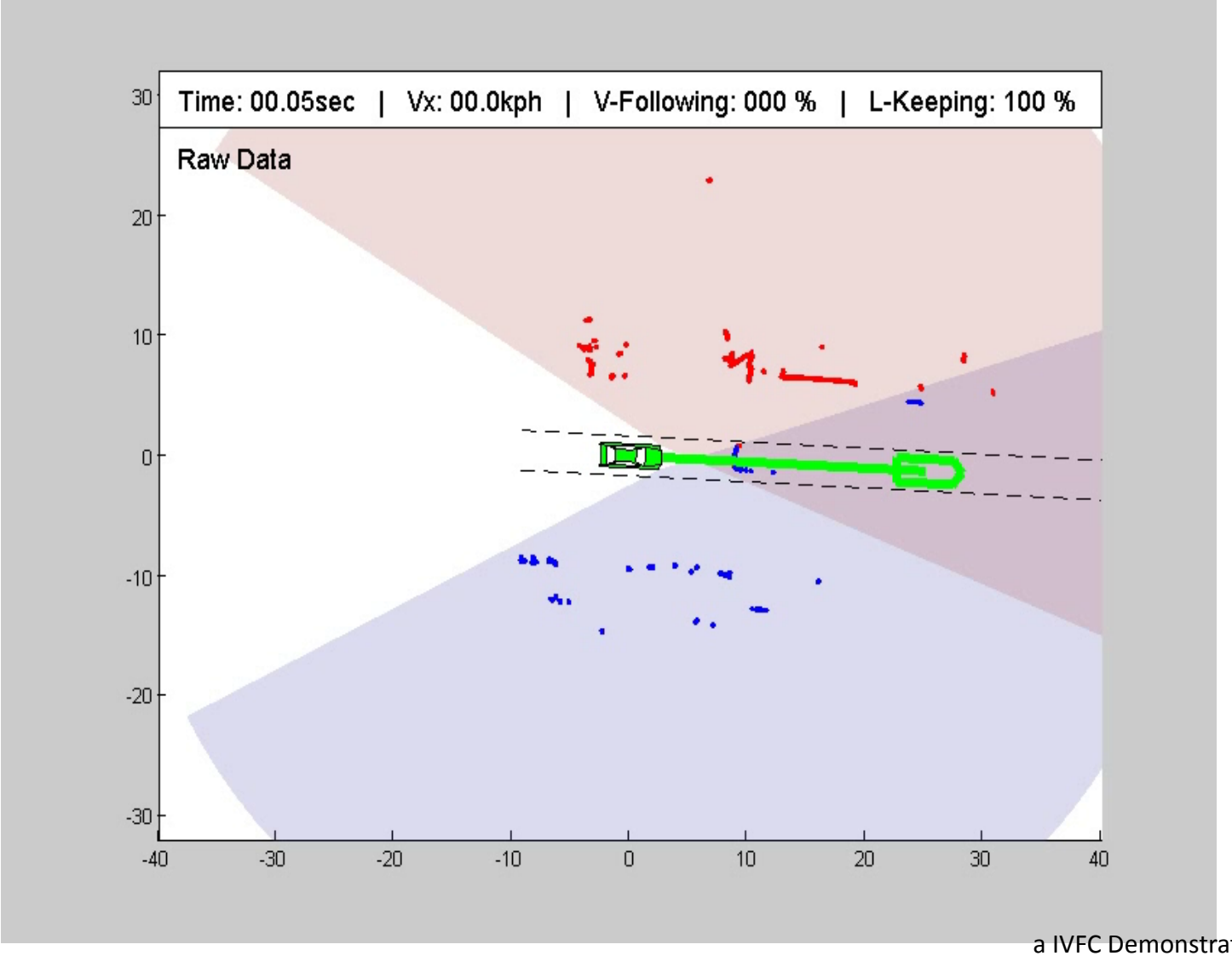
a super cruise ver 1,o

LV4AD: Virtual Target-based Approach with High Speed Localization



a IVFC Test Motorway

LV4AD: Virtual Target-based Driving on Urban Road



a IVFC Demonstration 수정후

Intelligent Vehicle Future Challenge 2013

Autonomous Vehicle Competition in China

未来挑战 Future Challenge

2013

Separation	Contents
Holding Place	➢ **Changshu, Suzhou, Jiangsu in China**
Schedule	➢ **2013. 11. 2 ~ 2013. 11. 4** - 1st day of Challenge : Rural road (18km) - 2nd day of Challenge : Urban road (5km) - 3rd day of Challenge : Human vs. Autonomous vehicle - Chinese Team vs. Korean Team
Teams	➢ **18 University teams** - Tsinghua university, Beijing Institute of Technology, Etc

Autonomous Vehicle of Chinese Teams (1)

Autonomous Vehicle of Chinese Teams (2)

1st day of Challenge

- Mission Description

  - 18 kilometers

  - Competing without test drive on the course

  - Damaged Lane mark

  - Best lap time is 22 minutes

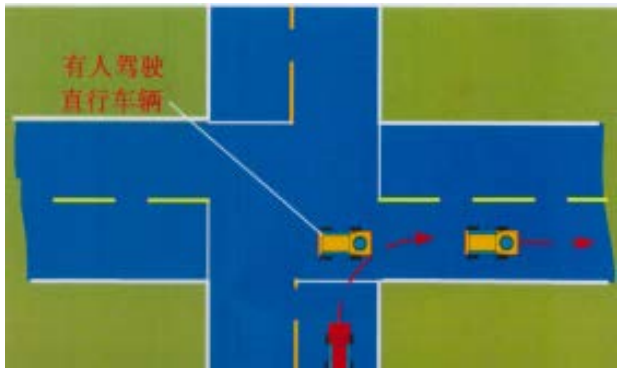
    with 49 km/h of average speed

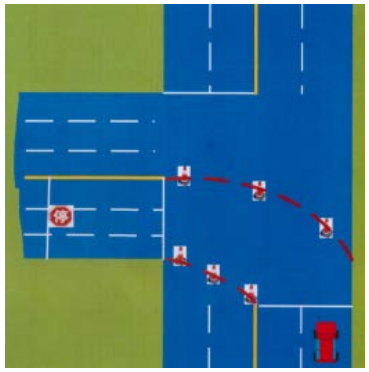
2nd day of Challenge

- Mission Description
  - 5 kilometers
  - Competing without test drive on the course
  - Clear Lane mark

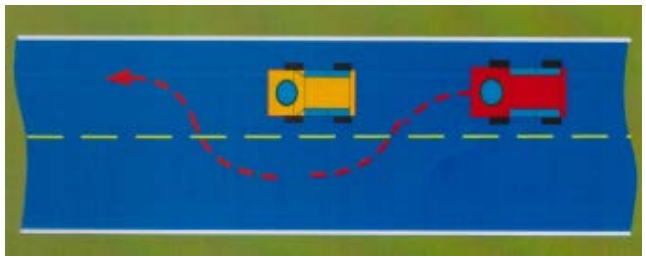
Missions of the challenge

- Intersection Driving Tasks

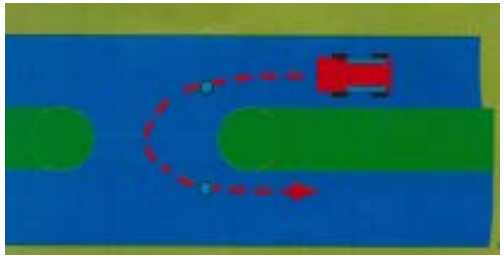




- Intersection Driving Tasks

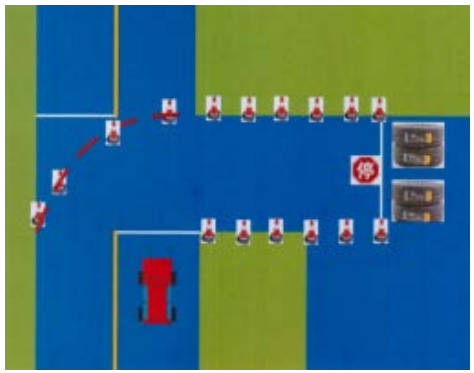


- U-Turn



- Indirect Course

- Parking



Vision missions of the challenge

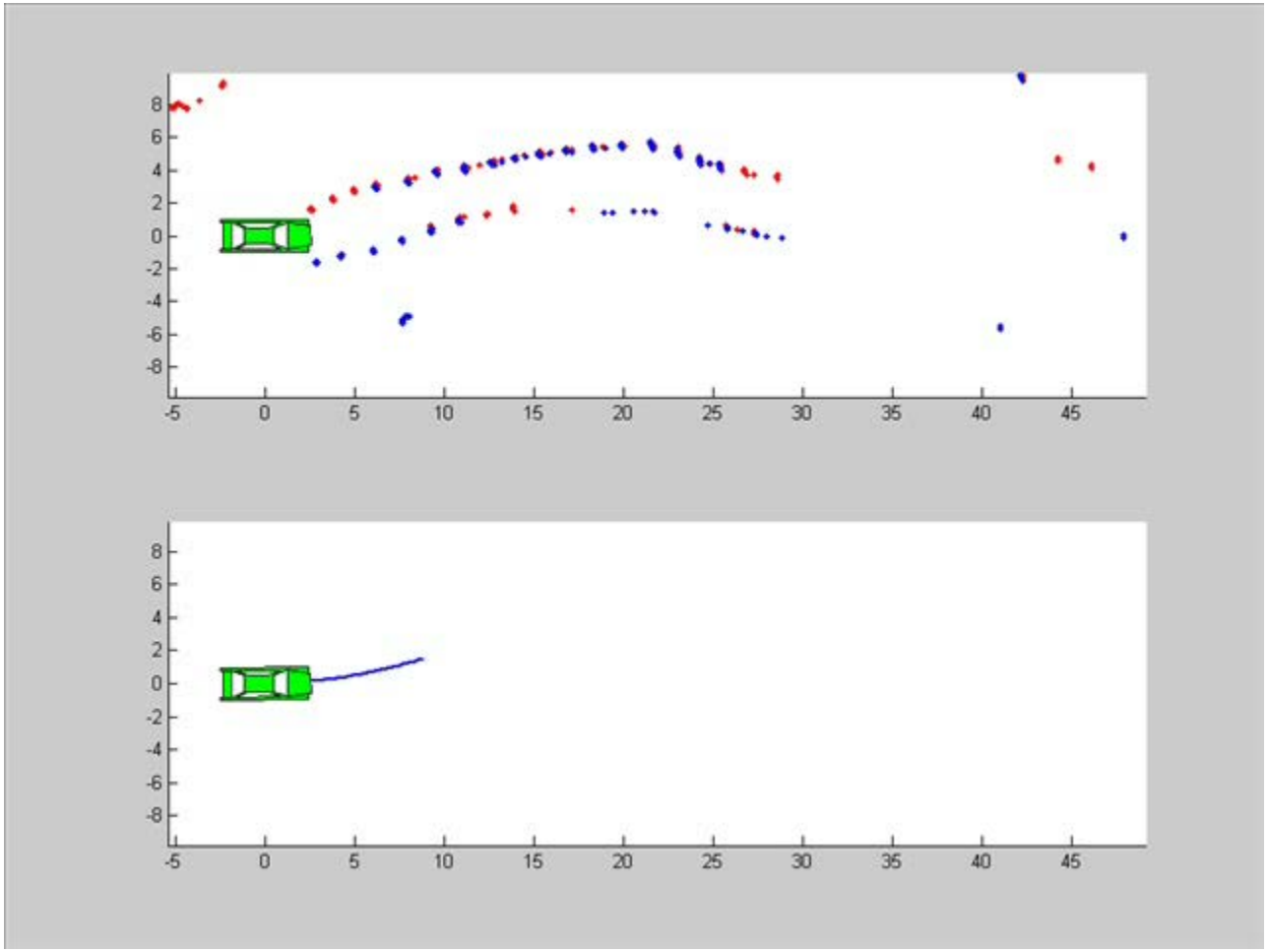
3rd day of Challenge (1)

- Mission Description
  - 500 meters
  - S-curved course
  - Construction area
  - Narrow road
  - Pedestrian detection/stop

Autonomous Vehicle Competition in China

3rd day of Challenge (2)

- Drivable Road Detection



D 주행영역

Conclusions

- Paradigm changes
  - Saturated passive safety
    - Consumers always connected
      - smartphone, texting, APP
      - restricting people – unintended side effect
      - Need for new solutions
- Sensing technologies and electronic controls developed for decades
    - building blocks for automated driving
- Increasing Demand and Continuously Growing Market
    - Renaissance of Electronic Control Systems
- DAS to Automated
    - Key Technology/Control Systems Technology/ s/w intelligence

Automated Cars

Automated cars

- giving drivers a rest, safety, and saving fuel
- Light small vehicles, new tires

2011 IEEE ITSC, Washington DC, USA

Shelley Row, Director

Research and Innovative Technology Administration, USDOT

EOD

Sp 2014