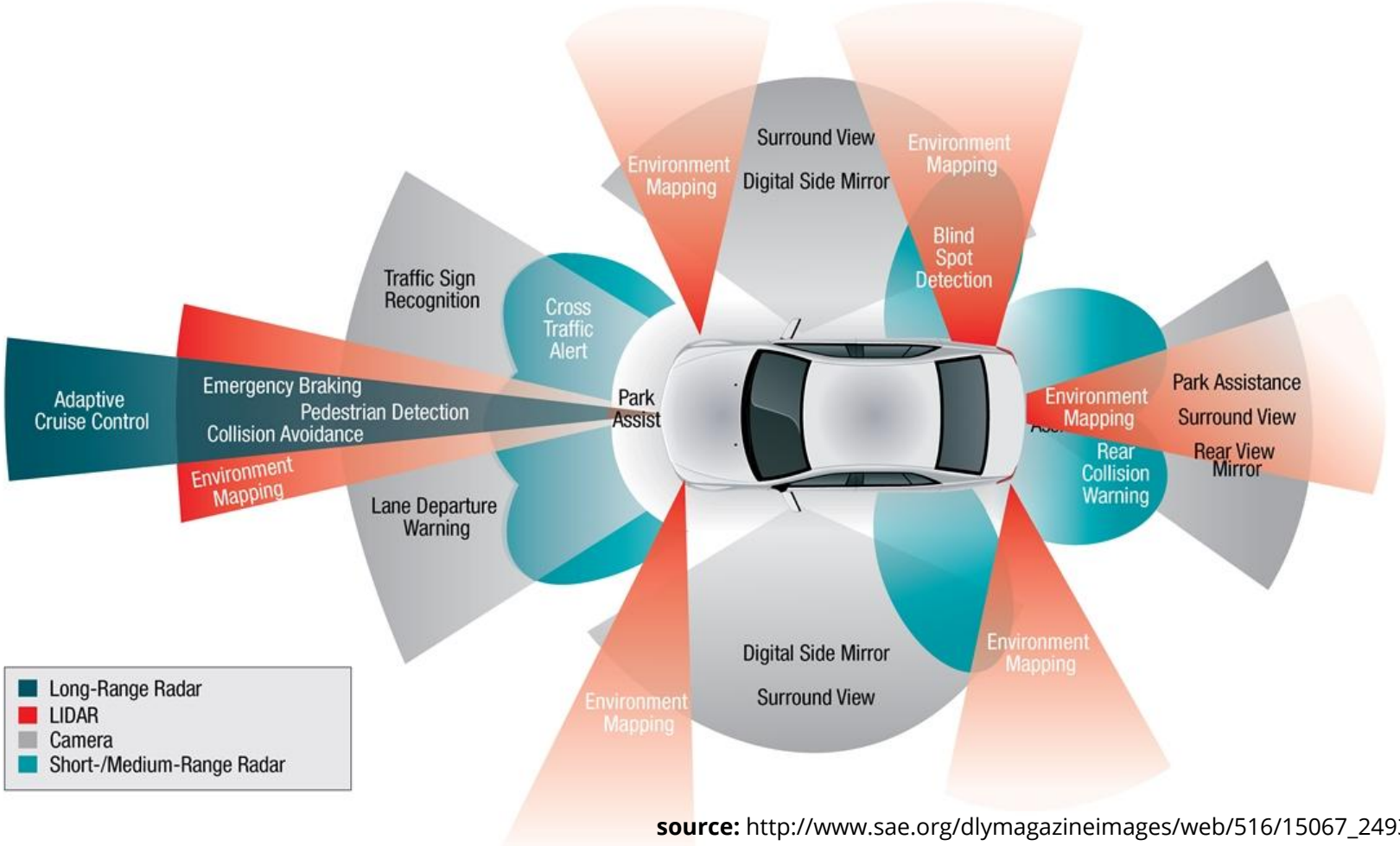
Software Awareness and the autonomous vehicle

On the road to a safer and more efficient traffic

How context awareness can help us improve traffic efficiency? How time awareness can contribute to a more accurate global positioning system? Should we force autonomous vehicles to follow a local norm? How vehicles from different companies could communicate with each other?

Articles

- (2017) A Survey of the Connected Vehicle Landscape — Architectures, Enabling Technologies, Applications, and Development Areas.
  - Joshua E. Siegel ; Dylan C. Erb ; Sanjay E. Sarma
  - http://ieeexplore.ieee.org/document/8058008/
- (2017) The Social Life of Autonomous Cars
  - Barry Brown
  - http://ieeexplore.ieee.org/document/7842858/
- (2016) Self-Driving Cars and the Law
  - Nathan A. Greenblatt
  - http://ieeexplore.ieee.org/document/7419800/



source: http://www.sae.org/dlymagazineimages/web/516/15067_24935.jpg

1. Context Awareness

1.1. Location Awareness

- Most of applications for vehicular environments take advantage of Geopositioning Systems
  - GPS
  - Glonass
- Accuracy of these systems is under ongoing improvement
  - Next-generation for robots and vehicles promises a centimeter accurate GPS <http://articles.sae.org/15067/>
  - Mathematical method estimates centimeter global positioning accuracy <http://ieeexplore.ieee.org/document/7349142/>

1. Context Awareness

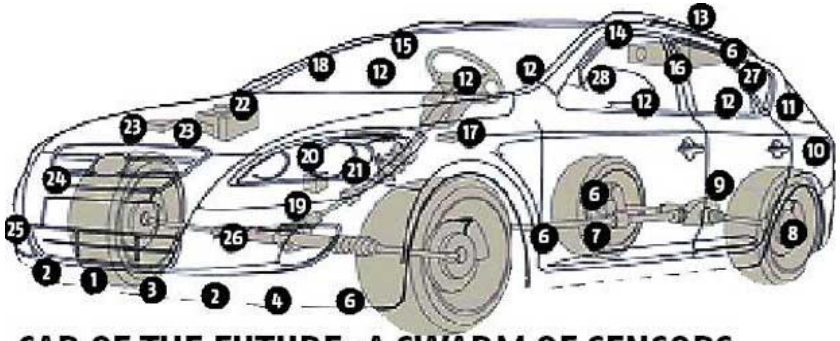
1.1. Location Awareness

- Applications:
  - Pothole mapping application
  - Roadside assistance
  - Automatic collision notification
- Protocols:
  - Geocast

1. Context Awareness

1.2. Physical Environment

- Sensor generate data in and inter-vehicle
- Sensors:
  - OBD Interface
  - Sensor list is enormous



CAR OF THE FUTURE: A SWARM OF SENSORS

1	Road condition sensor	15	Water repelling windshield
2	Magnetic sensor	16	Seatbelt pretensioner
3	Vehicle distance sensor	17	Driver monitoring sensor
4	Forward obstacle sensor	18	Headup display
5	Blind spot monitoring camera	19	Steering angle sensor
6	Drive recorder	20	Electronic control throttle
7	Side obstacle sensor	21	Electronic control brake
8	Air pressure sensor	22	Fire sensor
9	Inside door lock/unlock	23	Vehicle speed sensor
10	Rear obstacle sensor	24	Collision detection sensor
11	GPS sensor	25	Pedestrian collision sensor
12	Airbag	26	Electronic control steering
13	Vehicle to vehicle communication	27	Message display system
14	Rear view camera	28	Hands-free system

Source: Cisco, PI Research

1. Context Awareness

1.3. Computational Environment

- Traditional databases cannot handle real time requests
- Technologies like Hadoop or other approaches to map reduction are used to distribute data storage and processing, helping to execute tasks in parallel
- Applications of data mining and analytics:
    - Fuel consumption analysis
    - Fleet analytics
    - Vehicle benchmarking
    - Driver behavior analytics

2. Time Awareness

- Time matters!
- Geopositionings System could mean a difference between Gávea and Rocinha
  - Time awareness has a distinct operationalization on medium Earth orbit

- For real time applications is critical
  - E.g.: Brake signal application should never use 5G or use client-server architecture

3. Social-context Awareness

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- Operationalization of both **context** and **norm awarenesses**
- *"We won't have truly autonomous cars on the road until this gets sorted out"* **<** Greenblatt (2016) >
- Volvo announced that it would take the blame if accidents occur in autonomous mode

3. Social-context Awareness

- Autonomous vehicles should follow the rules of the country they are in
  - Operationalization of **norm awarenesses** using **context awareness**
  - **Example 1:** A vehicle should not drive past a red light between 6am and 11pm in in 5th avenue NYC
  - **Example 2:** Trolley Problem

3. Social-context Awareness

- Approaches: Exogenous vs endogenous
- Exogenous mechanism
  - **Law:** It's forbidden for an autonomous vehicle drive a red light under any circumstances
  - Regimentation: Internal agents forbid you to go against the law
    - What if your wife is giving birth and you're her helper?
  - Enforcement: You can go against the law, but you should be penalized.
    - You could get a **ticket**.

3. Social-context Awareness

- Approaches: Exogenous vs endogenous
- Endogenous mechanism
  - Autonomous car can’t drive over speed limit

3. Social-context Awareness

- User and social relationships awarenesses between vehicles
  - complex social activity
  - the aim is to bring the “best of the human behavior” into the vehicle
    - Some of autonomous movements in vehicles are aggressive
      - application does not know when another car is being generous
      - **Example:** < www.youtube.com/watch?v=el4OdwtgzNk >

3. Social-context Awareness

- User and social relationships awarenesses between vehicles
  - Our actions — complaints, invitations, and so on — are preceded by “pre-actions”
  - “Human behavior” can lead to dilemmas like the “uncanny valley”
  - It could arise feelings of anger or frustration, especially if they behave “patiently”

Source: The Social Life of Autonomous Cars

A contribution

- Different networks are used in vehicular environments
  - **Mesh Networks**
  - **DSRC** for short range communications
  - Cellular Networks
    - LTE (4G)
    - 5G

- A myriad of communication packets for intervehicular communications:
  - Beacons messaging
  - Flooded messages
  - Intelligent broadcast
  - Geocast messages

Link: File

Q&A

Thank you!