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Automotive embedded systems and internet of things for future vehicle

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Abstract
Our cars have been connected for years, in ways that by now seem routine: They seamlessly link to our smart phones, register real-time traffic alerts, stream our Spotify playlists, and offer emergency roadside assistance at the touch of a button. Indeed, automakers began linking vehicles to information streams back in the early days of the Internet. When it comes to connecting drivers and technology, the auto industry has a longer and richer track record than any other sector. The Internet of Vehicles will be a distributed transport fabric capable to make its own decisions about driving customers to their destinations. Like other important instantiations of the Internet of Things. The Internet of Vehicles will have communications, storage, intelligence, and learning capabilities to anticipate the customers' intentions. The concept that will help transition to the Internet of Vehicles is the Vehicular Cloud, the equivalent of Internet cloud for vehicles, providing all the services required by the autonomous vehicles. In this article, we discuss the evolution from Intelligent Vehicle Grid to Autonomous, Internet-connected Vehicles, and Vehicular Cloud.

Keywords: automotive embedded systems, internet, vehicle

1. Introduction
There has been a constant driving force towards development of vehicle network technology. Today there is a need to make the automobiles environmental friendly as per the regulations laid down by government. Advancement in electronic industry has forced the automobile developers to use new sensor modules with the existing vehicle technology. A typical vehicle today consists of electronics modules such as ECU, TCU, ABS, BCM etc.
ECU unit plays important role in fetching data from different sensors and actuators to other modules. This leads to huge amount of data transfer in the real time scenario. A sluggish response may lead to disaster conditions and may be fatal if not addressed properly. The number of wirings has increased and busy complex network is formed consisting of different modules transmitting data at.

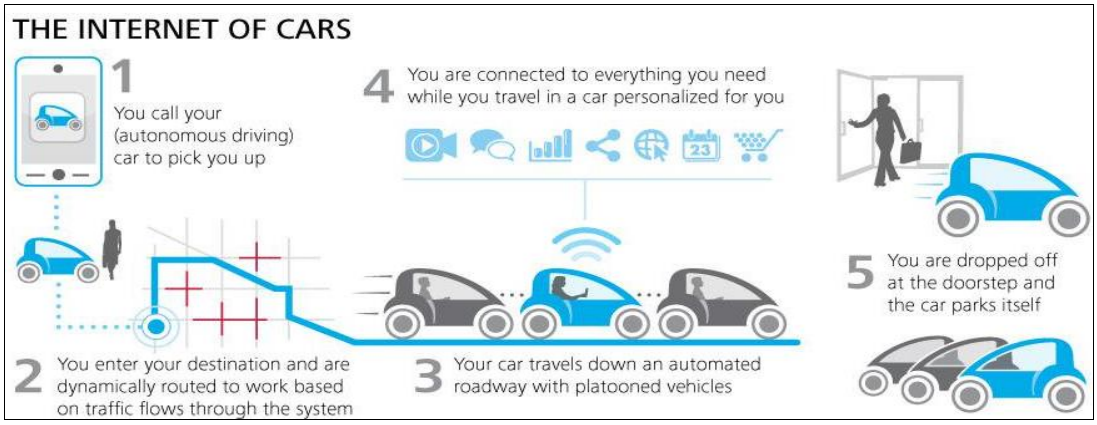

Fig 1: the future of urban mobility: scenario

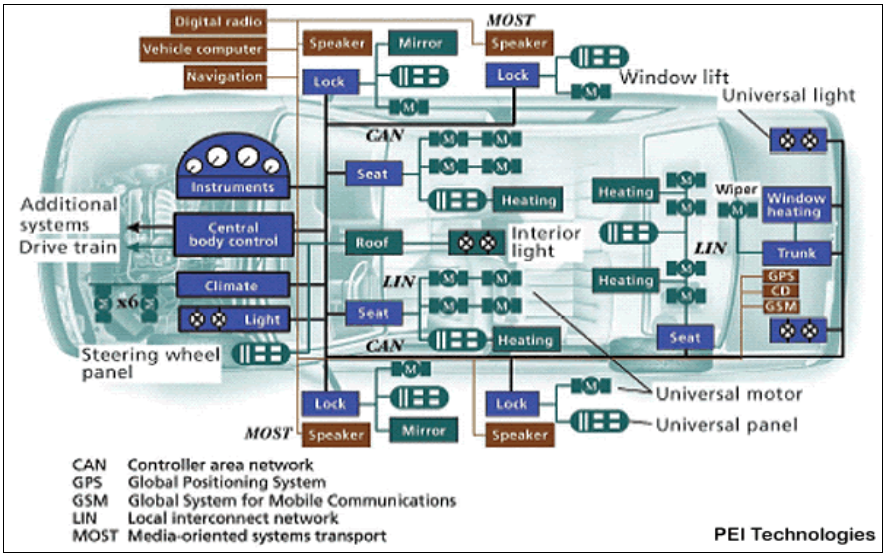

Fig 2

Therefore there is a need of centralized network wherein the module or nodes are attached in play and plugged action. The data from separate units flow through communication bur or protocol that has been developed over years. The most widely used communications protocols in vehicular domains are LIN, CAN, Flex ray, MOST etc.

Table 1

	LIN	CAN
Automotive Use	Sub-networks	Networks
Medium Access Control	Single Master	Multiple Master
Bus Speed	2.4 – 19.6 KBaud (limited by EMI and clock synchronization considerations)	62.5 – 500KBaud
Typical Number of Nodes	2 – 10	4 – 20
Physical Layer	Single wire at battery voltage plus ground	Twisted Pair at 5V
Master Clock Generation	Crystal	Crystal
Slave Clock Generation	RC	Crystal or Resonator
Relative Cost	½	1

It would be easy to say the modern car is a computer on a wheels, but it's more like 30 or more computers on wheel.

2. Automotive Embedded System

Classification

a) Powertrain and Control
   - Engine, automatic transmission, hybrid control,
   - Steering, brake, suspension,

b) Body Electronics
   - Instrument panel, key, door, window, lighting,
   - Air bag, seat belt,

c) Multimedia Applications
   - Car audio, car navigation, traffic information,
   - Electronic toll collection (ETC), back guide monitor,

d) Integrated Systems/Services
   - Electronic stability control, pre-crash safety,
   - Parking assistance, lane keeping assistance,

Evolution steps of Automotive Control System

Evolution of automotive control systems and networks is well understood with the following 4 stages.

a) Stage 1: ECU is applied to various component independently network is not used.
b) Stage 2: ECU exchanges data for improving the quality
c) Stage 3:
   - Each system still operates autonomously.
   - Some services are provided with multiple ECUs connected via networks.
   - Mechanical backup system still exists even if an electronic system fails.
d) Stage 4:
   - Networks with outside of the car (communication with another car and the road) are intensively used.
   - Mechanical systems (incl. backups) are replaced with ECUs and networks.
   - A failure of electronic systems is life-critical.

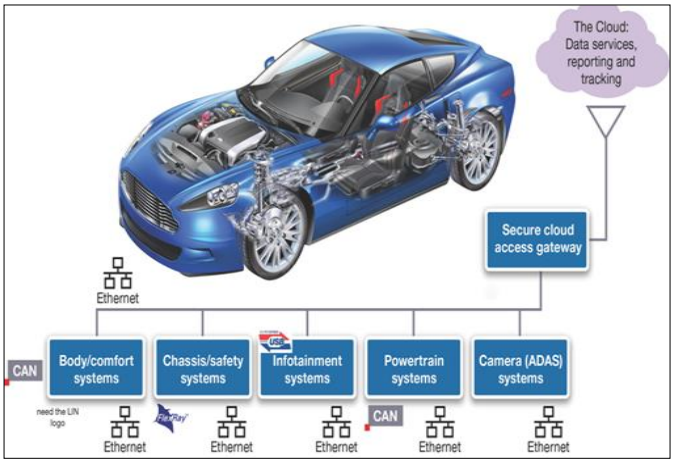

Fig 4

3. Applications of Automotive Embedded System

Few applications are listed below"

3.1 Antilock Breaking System

The speed of the car and the rotational speed of the wheel are monitored, and a skid is detected. When a skid is detected, hydraulic pressure to the brake is reduced to stop the skid. Safety Requirement Design: Continuous reduction of hydraulic pressure causes non-braking. If some fault is detected, ABS stops functioning, and the brake works though a skid cannot be avoided

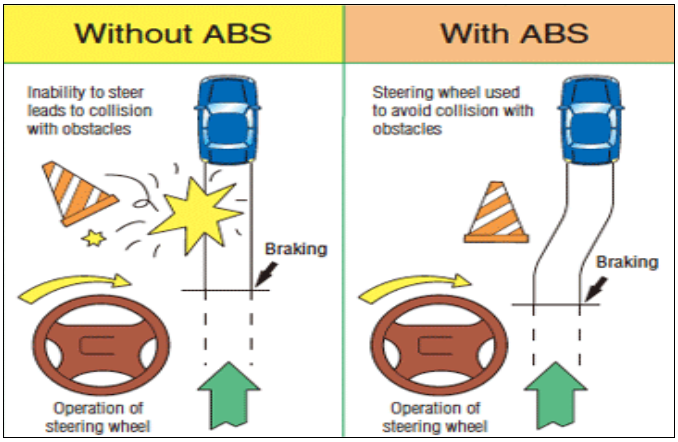

Fig 5

3.2 Traction Control System

- Prevent loss of traction of driven road wheels.
- Enhances driver control as throttle input applied is mismatched to road surface conditions (due to varying factors) being unable to manage applied torque.

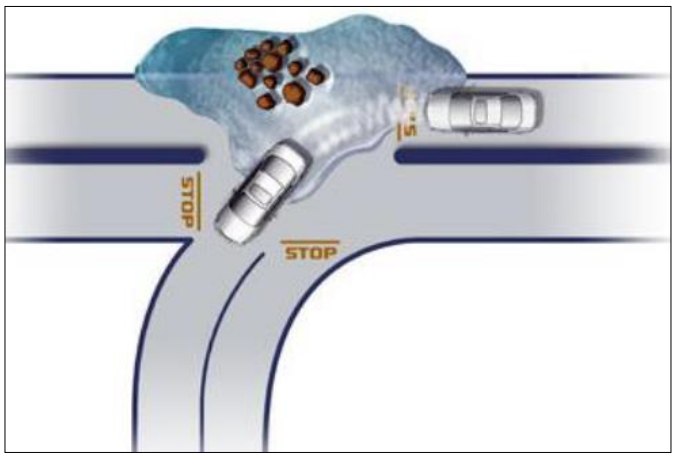

Fig 6

3.3 Electronic Stability Control

Improves the safety of a vehicle's stability by detecting and reducing loss of traction (skidding). When ESC detects loss of steering control, it automatically applies the brakes to help "steer" the vehicle where the driver intends to go.

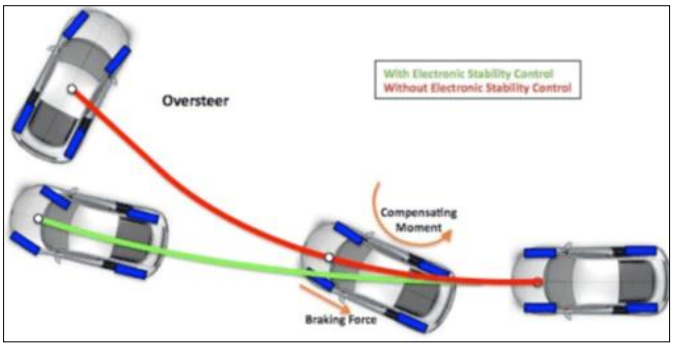

Fig 7

3.4 Air Bag Control System

- Monitors various sensors including accelerometers and detects a collision.
- If a collision is detected, the ignition of a gas generator propellant is triggered to inflate a bag.
- Real-Time Constraint:
- •The trigger must be within 10-20msec. after the collision

3.5 Car Navigation System

The current position of the car obtained from GPS, gyroscope, and others is displayed with the map.

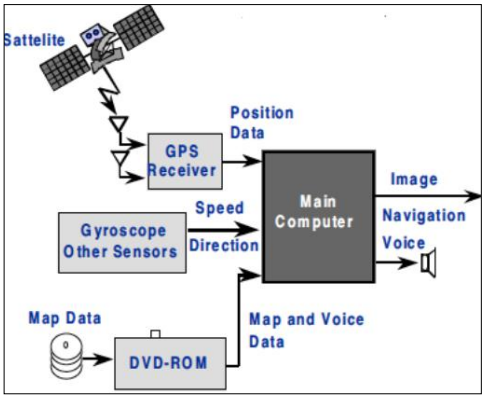

Fig 8

4. IoT Market Forecast for Connected Vehicles

The automotive industry has been around for quite some time and it has evolved ever since, but the major transformation that is happening now from vehicles driven by humans to vehicles driven by themselves will have a long term impact on society. Today's cars are already connected and have been connected for some time, since they can link to smart phones, offer emergency roadside assistance, register real-time traffic alerts etc., but this evolution is about to change.

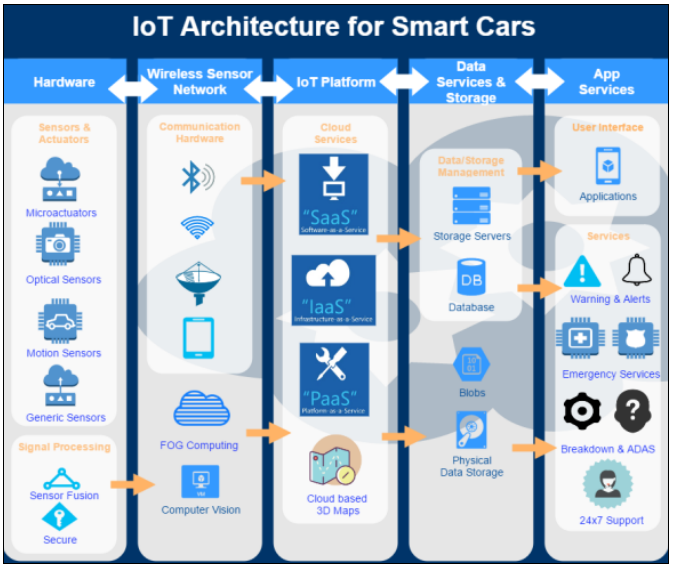

Fig 9

The automobile industry is on the brink of a revolution, to move to self-driving automobile industry, and the driving force behind this the fast developing technology, the Internet of Things (IoT). IoT will transform automobile industry and at the same time, the automobile industry will provide a big boost to IoT. The potential and the prospects of this technology is astonishing

As the main driver for Autonomous vehicle industry, the IoT market has seen a steady growth since 2014 and is projected to continue with this growth as shown in the figure below.

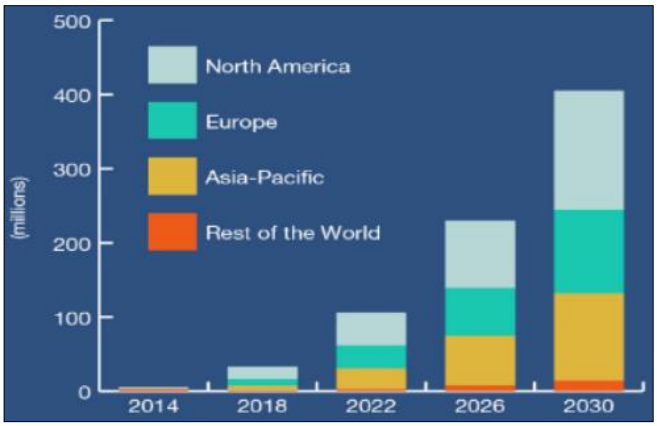

Fig 10

5. Conclusion

The urban fleet of vehicles is evolving from a collection of sensor platforms to the Internet of Autonomous Vehicles. Like other instantiations of the Internet of Things, the Internet of Vehicles will have communications, storage, intelligence and learning capabilities to anticipate the customers' intentions. This article claims that the Vehicular Cloud, the equivalent of Internet Cloud for vehicles, will be the core system environment that makes the evolution possible and that the autonomous driving will be the major beneficiary in the cloud architecture. We showed a vehicular cloud model in detail and discussed potential design perspective with highlights on autonomous vehicle, AUV, for future research.

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