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Smart-Vehicle Implementation using Internet-of-Things and Cloud Computing Extension

Adhish Nanda[1] and Varsha P Hotur[2]

[1]*UG Student, Department of ECE, MVJ College of Engineering, Whitefield, Bengaluru, Karnataka, India.*
[2]*Assistant Professor, Department of ECE, MVJ College of Engineering, Whitefield, Bengaluru, Karnataka, India.*

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ABSTRACT

The vehicle of the future will be safer for passengers and other road users too. This will offer pay-as-you-go services and thus will lead to a better driving experience. Beyond the basic concept of connected vehicle being provided with only internet access, we can establish a Vehicle-to-Vehicle, Vehicle-to-Pedestrian, Vehicle-to-Infrastructure and Vehicle-to-Mobile or Vehicle-to-Cloud communication links. With the introduction of 4G and 5G networks, the capabilities of such Smart Vehicles will increase which will also facilitate faster transmission and processing of various forms of data. This can be implemented by integrating two most important technologies namely Cloud Computing and Internet-Of-Things, together known as Cloud-of-Things.

Keywords: Cloud computing and IoT

1. INTRODUCTION

The successful implementation, functioning and development of the road transport within a market economy requires a sound approach. [1] As the number of vehicles connected to each other continue to grow, there are several possible categories where their advantages can be grouped. These are infotainment like voice communications, personalized music or suggested playlist based on the type of music we listen, then we have navigation, which includes traffic information, automatic route planning etc. Along we this we have different safety measures like smart SOS or a panic button, roadside assistance, informing the police automatically if the driver doesn't follow traffic rules like over speeding or breaking a signal, also automatic Fog Computing and Smart Getaway [2].

Then there are other features like remote-diagnostics, condition-based-maintenance, automatic electronic toll collection, parking & reservation payments. These interactions which include requesting real-time services from the vehicle (i.e., booking a maintenance appointment), will lead to new digital business models for existing and new services.

The cars those which will be used in the future should be safer for passengers, and other road users too. Concepts such as Swarm Intelligence [3] will enable drivers to be given accurate real-time information on road and weather conditions sourced from other vehicles which have already encountered those conditions—imagine knowing not just that there may be potholes in the road ahead, but know exactly where those potholes are or if there was an accident or traffic jam based on information from the cars ahead of you.

Also, being able to pay for goods like petrol or services like parking from your car, the connected car will also be able to offer not just pay-as-you-drive insurance, but also pay insurance based on how you drive, rewarding good drivers and penalizing bad driver behavior. Such a concept is explained in Fig 1.

2. METHOD

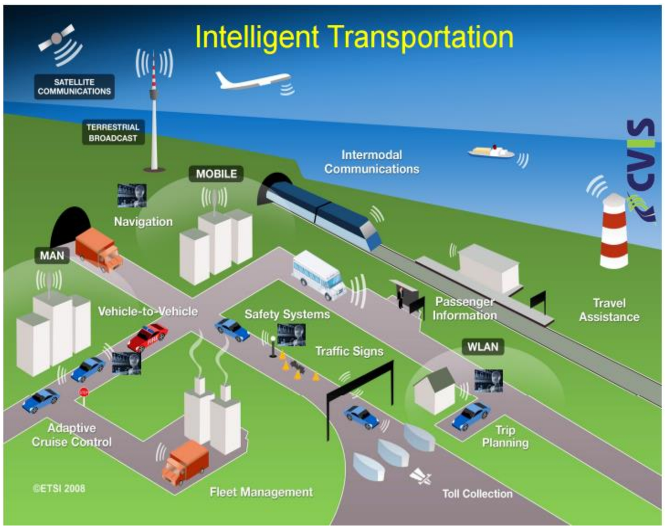

Fig 1. Intelligent Transportation Overview

The most important part of IOT is cloud computing. It is a model for enabling convenient on demand network access to a shared pool of configurable resources that can be rapidly provisioned and released with minimum management or service provider interaction. The cloud makes it possible for you to access your information from anywhere at any time.

There are different types of clouds based services that you can subscribe to depending on your needs. As a home user or small business owner, you will most likely use public cloud services. 1. Public Cloud – This is provided by the service provider and can be accessed by anyone with an internet connection because these may be free or pay-per-use type services. 2. Private Cloud - This is established for a specific group of people like an organization or companyso that only these can access the services provided by the cloud. 3. Community Cloud - A community cloud is a type of cloud space that is shared among different organizations belonging to a community that have similar goals like security, storage etc. These are managed and hosted internally or externally or by a third-party. 4. Hybrid Cloud - A hybrid cloud is essentially a combination or a mix of at least two different clouds among aforementioned and can be orchestrated with on-premise third-parties and different platforms too.

The Cloud Computing model is an efficient alternative to owning and managing private Data Centers (DCs) for customers.

Cloud computing frees the service provider and the user from the specifications and details involved in the communication process. The Internet of Things (IoTs), requires mobility support and geographical distribution in addition to location awareness and low latency.

There are three main models in cloud computing, namely Software as a Service (SaaS) model, Infrastructure as a Service (IaaS) model and Platform as a Service (PaaS) model. 1- Software as a Service (SaaS) is a cloud computing model where specific software is provided to the client by a Web interface or a website. The user of the software does not need to install and run the software, he connects and uses the service of the Web Browser application. Famous examples for this type of model are Gmail for managing emails online, or yahoo mail or Google Docs as an online office application. 2- Infrastructure as a Service (IaaS) IaaS is a cloud computing model which provides virtualized computing resources over the internet or where specific infrastructure is often virtual Machines on real computers and are used for accessing, monitoring, remote management of datacenters etc. Some examples are Amazon Web Services (AWS), Cisco Metapod, Microsoft Azure, Google Compute Engine (GCE), Joyent etc. The virtual machine image has to be compatible with the IaaS system so that it can be deployed.

Vendors generally provide some basic images to be modified as needed. In this case the clients can use and upload their own system image to the cloud which is automatically copied by the main system. The client can use all the technologies that he wants in the virtual machine and has therefore more possibilities available to him as needed, but he/she also has more configuration effort. 3- Platform as a Service (PaaS) is a cloud computing model which includes all the hardware and software needed for deploying a Web application to the cloud. The required resources are provided to the developer by the organization that offers the Platform as a Service. The developer while designing or developing the application using PaaS has to think only about the functionality of his application. He can use the API to access important features of the PaaS like for managing the people using his application by performing database operations and various other user-specific or user-related operations. Another important advantage of PaaS is that developers have a shear platform to develop for as its market demand is high.

The basic architecture of IOT computing is shown below in Fig 2. It contains a hierarchy of different systems and layers. This architecture can be used in smart vehicles. The centralized intelligence is a complete database that is responsible Security and Environmental Study. Then the distributed intelligence is responsible for user experience, network performance, intrusion detection, fraud detection, sensor monitoring, environmental monitoring, contact center, traffic information etc. The end point intelligence forms a part of smart grid.

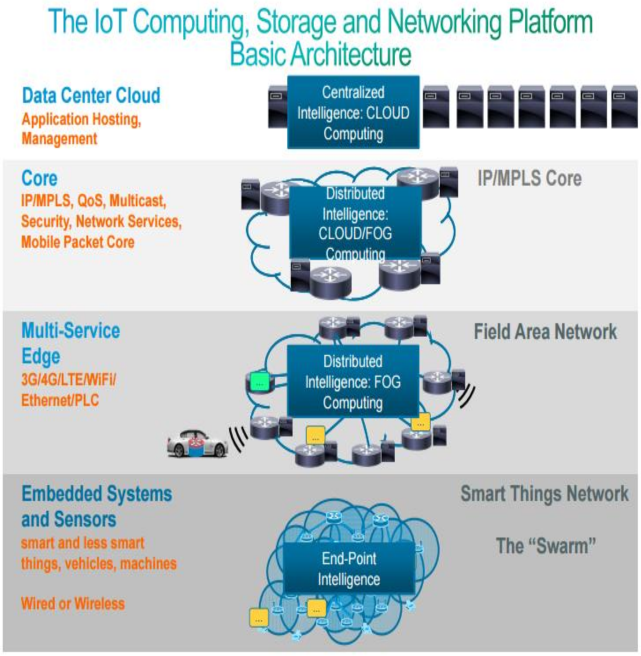

Fig 2. IOT, Storage and Network Platform's Basic Architecture

A popular technique that can be used to implement this smart vehicle is known as Fog Computing. "Fog Computing" is a highly-virtualized platform that provides computing, networking and storage services between users' devices and the Cloud Computing Data Centers, typically, but not exclusively located at the edge of network. Cloud and Fog are built around the same basic services. However, there are a number of characteristics that make Fog an extension of Cloud.

The Fog supports endpoints with rich services having low latency at the edge of the network.

The services and application required by the Fog demand widely distributed deployments. For e.g. Fog helps in delivering high quality streaming video in moving vehicles through proxies and access points positioned along the way.

It is important for many applications to communicate directly with mobile devices, Fog supports mobility techniques such as LISP protocol, decoupling host identity from location identity, and requiring a distributed directory system.

Fog applications [4] involve real-time interactions rather than batch processing.

Predominance of wireless access.

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Fog nodes can be deployed in variety of environments. Also, the Fog components interoperate and federate across different domains.

There are different types of Fog components or models. Based on the nature of the major services and applications, these models can vary.

• Subscriber models will play a major role in the Fog. These models can be a part of or as whole of projects like Smart Grid or Smart Cities and can be used to improve many needed facilities like HealthCare Services. Also, they can be used to provide remote entertainment services to a user in a vehicle.

• The Fog will give rise to new forms of competition between providers angling to provide global services. New players will enter the arena as users and providers, including utilities, car manufacturers, transportation agencies etc.

This is how Fog interacts in a Connected Vehicle as shown in Fig 3.

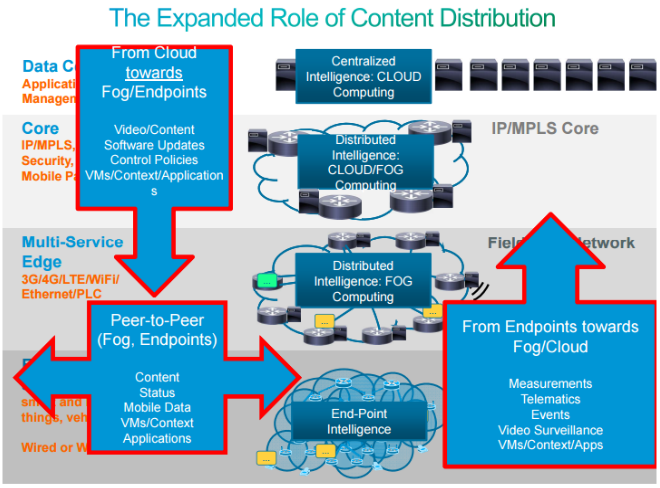

Fig3. Content Distribution in Fog Computing

The Connected Vehicle deployment involves a rich network for connectivity and interactions: vehicle-to-vehicle, vehicle-to-Infrastructure, vehicle to different access points like roadside units [RSUs], smart traffic lights and access points to access points via Wi-Fi, 5G, 4G LTE networks.

The Fog has a number of characteristics that makes it the perfect platform to deliver such a variety of SCV services in infotainment, safety, traffic support, and analytics like geo-distribution (throughout cities and along roads), mobility and awareness of one's location, reduced latency and support for real-time interactions with other vehicles or access points.

For e.g. [5,6,7] Consider a smart traffic light (STL). The smart traffic light node interacts locally with a number of sensors, which detect the presence of pedestrians and bikers, and measures the speed of approaching vehicles and the distance of those vehicles from itself. It also interacts with the other smart traffic lights in its vicinity and coordinate the green light signal traffic-wave. Based on this information the STL sends signals to vehicles inbound towards it, thus warning or notifying them about approaching vehicles and even modifies its own cycle to prevent accidents. Modification of the cycle is followed by re-coordination of the STL with neighboring STLs through the orchestration layer of the Fog. The data accumulated by the STLs is processed for real-time analytics (like changing the timing of the cycles in response to the traffic conditions). The data from clusters of smart traffic lights is sent to the Cloud for global, long term analytics.

Just like this to make a fully smart vehicle or a connected vehicle, we also need a large number of sensors as shown below in Fig 4.

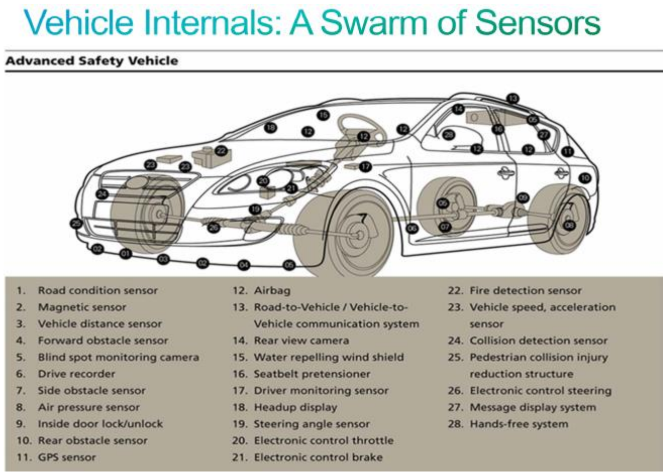

Fig 4. An Array of Sensors

3. CONCLUSION

In this paper, we conclude that we were able to successfully incorporate all the features mentioned in this paper into our prototype model. This will be useful for mankind. Accidents occurring due to carelessness of humans can be avoided completely. It will be useful for people with disabilities and people who are not well-versed in driving.

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