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A Novel Method for VANET Improvement using Cloud Computing

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Abstract

In this paper, we present a novel algorithm for VANET using cloud computing. We accomplish processing, routing and traffic control in a centralized and parallel way by adding one or more server to the network. Each car or node is considered a Client, in such a manner that routing, traffic control, getting information from client and data processing and storing are performed by one or more server in different bases. The procedure is about each client that receives its situation by GPS system and sends it online to the concerned server via GPRS networks. In order to perform routing and displaying data, each client sends a request to server. All processes and operations will be executable by the software which is inside the server. Finally, we propose an algorithm to work in server and make decision on route selection on the basis of three priorities of traffic, safety and shortest route. This algorithm is represented for the first time. The results indicate that by using this method VANET network is improved. By using this algorithm, we can communicate generally, not regionally, and improvement of processing and accurate statistics is achieved. In fact, the processing in the server is Fuzzy. It means that these priorities are Fuzzy.

Keywords: cloud computing, monitoring, LISP, Algorithm, VANET, MANET, GPS.

1. Introduction

VANET is a combination of mobile nodes equipped with receiver and transmitter in order to establish wireless communications. These networks lack central infrastructure and do not follow any specific topology. There is no router in this network, as the result of which any station acts as a router as well. Since the stations are wireless and mobile, there are a number of problems in routing and safety of such networks [16].

VANET is a technology which uses mobile vehicles as nodes in the network, thereby creating a mobile network. Each car acts as a node or router and this lets the cars to communicate with each other within the distance of 100 to 300 meters. Due to this limitation and lack of sufficient information from farther nodes, routing of long distances and traffic control is not possible [23].

The main purpose of this paper is to expand VANET networks by cloud computing and to add traffic control specifications and to optimize routing from origin to destination. In this paper, we add one or more server to the network in order to perform processing, routing and traffic control in a centralized and parallel way.

Each car or node is considered a Client, this means that routing, traffic control, getting information from the clients and data processing and storing are performed by one or more servers in different servers. The procedure is that each client receives its situation by GPS system and sends it to the concerned server via GPRS networks moment by moment. In order to accomplish routing operation and display the data, each client sends a request to the server. Therefore all processes and operations will be executable by the software which is inside the server.

In order to optimize network communications in cloud computing, we utilize LISP (Location Identity Separation Protocol) which is able to identify devices as well as hosts. LISP provides a comprehensive and standard solution to meet mobility, segmentation and scalability demands. LISP enables mobility of VMs (Virtual Machines) among clouds as well as long distances for the purpose of multiple communications of clouds without changing IP address. This protocol can be scaled for any number of movements and routings of traffic, so each node (car) has a unique IP address which does not change under any condition. We can always identify the situation of cars online in the network [33].

The rest of this paper is as following: Section 2 explains the history and background of the research and section 3 describes the adopted method in this paper. The results can be found in section 4 and the conclusion is provided in the final section.

2. Related Work

2.1 VANET

Ad-hoc network acts without a central management. Investigations indicate that the function of ad-hoc networks highly depends on choosing mobile model [7, 9, 13]. Studies made in the field of ad-hoc network have used stochastic directions and models in which nodes change their speed and direction [6, 8, 9, 11]. Vehicular to vehicular (V2V) movement is often based on stochastic models with maximum speed of node [11, 12].

Sawant et al., Hoover et al., Misener et al., Sengupta et al. have considered many solutions to reduce the impacts of congestion, such as adding more lanes to the roads and streets.

Although this solution seems logical at the first glance, the recent researches have denoted that this strategy is fruitless and even causes an increase in congestion of cars as well as pollution. On the other hand, Fontaine [22] declared that drivers must be trained to choose the best routes, which results in decrease of traffic congestion as well as saving time and fuel.

In modern technology, traffic supervision systems and accident reporting systems utilize inductive loop detectors (ILD) and video cameras, acoustic router systems and microwave radar sensors [38]. ILDs measures the amount of traffic by registering a signal in each time that a car passes [39, 28]. It has been stated by [28, 39] that among these devices, ILDs are used in highways, in such a way that traffic is measured in each mile by ILDs. This is performed by registering a signal any time a car is passing.

Researches [22, 28] state that each ILD costs about 8200$. In addition, ILDs are connected by optical fiber which costs $300000 for each mile. Official statistics indicate that over 50% of ILDs and 30% of video cameras are defective. World's Transportation Department is searching for solutions with lower costs, more reliability and higher efficiency in the field of monitoring traffic. One of the important issues in VANET is to provide safety, about which many studies have been conducted, such as [15, 24, 25, 29, 30].

Most of VANET's applications have been allocated to reporting traffic, emergency warnings and the like [23, 31]. Empirical and academic studies have been recently conducted in the field of using broadband connections and wireless technology more efficiently in order to provide Internet connections when traveling with car [10, 16, 17, 19, 32].

This system which has been presented by Otta and Kutscher is called Drive-thru Internet. Drive-thru Internet is based on APs (Access Points) of city roads and streets and provides Internet at least within the covered area when traveling. The significant feature of this system is that if there are several cars in the covered area, it can provide the Internet for all of them [12, 18].

Due to fast movement of cars and limitation in covering APs, little data can be transmitted and downloaded. Therefore, the use of P2P connection (Peer to Peer) reduces the limitation [14, 16, 17, 23, 32]. Utilizing Cloud computing in VANET is quite a new development.

2.2 Cloud Computing

The concept of cloud computing comes from the fact that it is better to provide infrastructure from elsewhere and execute software in elsewhere rather than investing on structure [20, 21]and this requires high-speed Internet, virtualization, distributed and parallel processing and distributed databases. Three types of cloud computing have been defined: Iaas (Infrastructure as a Service), Paas (Platform as a Service) and Saas (Software as a Service) [20, 21, 22, 40].

The idea of Internet routing promotion and addressing architecture, in which separation between identity and system and their location in Internet topology has been discussed, dates back to the 90s [2, 3, 4, 5]. Some protocols have been provided in the field of separation, such as HIP (Host Identity Protocol) [1]. LISP Protocol (Locator/ID Separation Protocol) and advantages of LISP in cloud computing is a new routing architecture which can intelligently activate a cloud ecosystem.

LISP implements a new model for IP addressing, which used two IP addresses to create two parts [41]:

1. EDI-Endpoint Identifier
2. RLOC-Routing Locator which is allocated to devices and routes of primary routers which create global routing system.

LISP produces an essential routing structure required for expansion of combined cloud.

In line with generalization of addressing solutions and in order to work with both IPV4 and IPV6, LISP was developed into a complete dynamic scheme, in which location and identification have been separated. This new scheme is named LISP. The primary idea of LOC/ID Split or LISP is that current Internet addressing and addressing architecture includes two functions [33].

LISP is a new routing architecture which gives more scalability to Internet routing. Finding host location requires a writing system to send appropriate location in reply to request for specified identifiers. As illustrated in Fig. 1, in today's Internet, IP address specifies identity and location. This is why a device gets a new IP address including identity and location when its location changes.

However, this is different in LISP protocol. IP address only represents identity. Considering the added layer named identity, when a device moves, only the location changes while keeping the same identity, so the identification of device is represented [34].

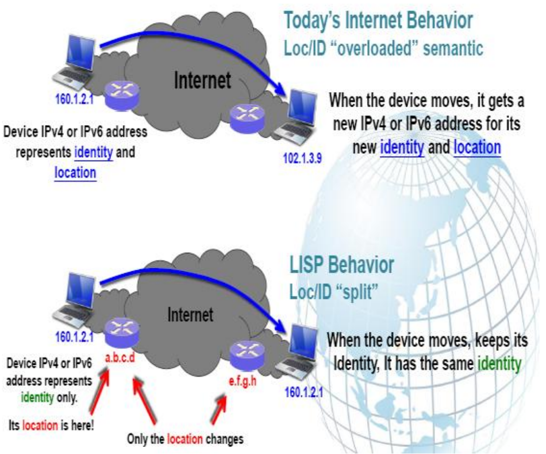

Fig.1. IP & LISP Behavior.

In this protocol, as shown in Fig. 2, there is a separate layer (identity) for IP address of each node, which allows the nodes to move without changing their IP address [35].

3. Algorithm and Model

3.1 Designed Algorithm

This algorithm has been developed on three bases of traffic, shortest route and road safety. The Fig.3 shows the flowchart of the protocol.

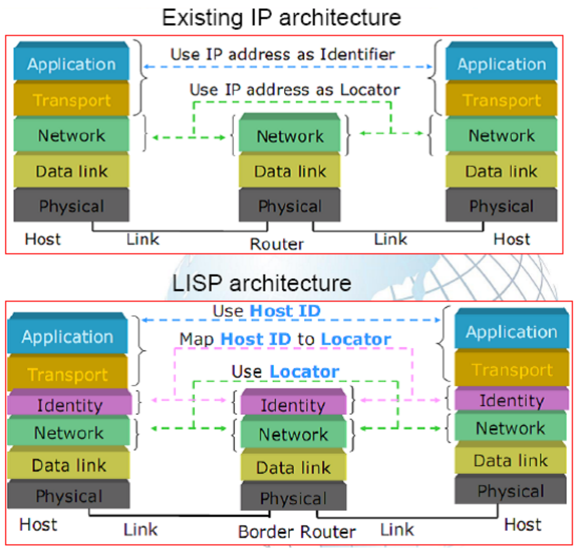

Fig. 2. LISP architecture.

First, it is necessary to say that all processing by the following protocol are performed in servers and not in clients. In fact, the processing in the server is Fuzzy. It means that these priorities are Fuzzy.

Three main Fuzzy parameters are traffic, safety and shortest route.

In clients, data is given by user, such as destination, existing priority and display of protocol output. In the following protocol, there are three fundamental priorities of shortest route, traffic and safety, which are prioritized in clients. In the following protocol we have three variables of p1, p2 and p3 which are prioritized by the user. For example, a person in a car gives the first priority (p1) to the shortest route, the second priority (p2) to traffic and the third priority (p3) to road safety. Type and selection of route is performed by the following protocol and server which highly depends on priorities. First, the origin is sent to server via GPS placed on the car. Then the user gives the destination to the car client. Next, priorities are also given to the client and then client sends the data to server for processing. The server acts as follows: first, in view of geographical map in which origin and destination points are located, different routes are depicted and then all routes are investigated simultaneously. The routes are divided into three groups on the basis of the priorities. The first group is named L which belongs to the first priority; the second group is named M which belongs to the second priority and the third group is named H which belongs to the third priority.

L, M and H structures represent the number of routes prioritized as p1, p2 and p3. For example, when the first priority is given to shortest route, the second priority is given to traffic and the third priority is given to safety, the number of selected routes will be limited, because there are less routes in the first priority and there are more routes in the second priority than the first priority and there are more routes in the third priority than the second one.

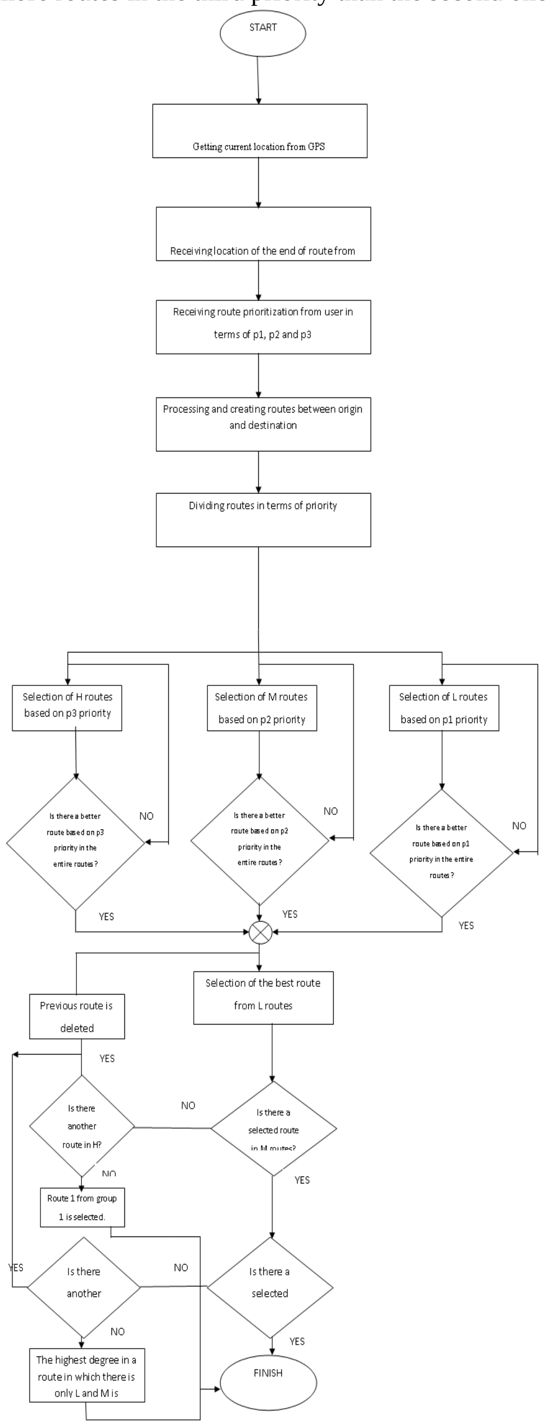

Fig. 3. Flowchart of the algorithm.

3.2 Improvement of VANET network by using cloud computing

As previously mentioned, VANET is a vehicular network in which there is an ad-hoc relation between cars and each car independently determines which works should be done based on a series of prescribed rules, in such a manner that no other unit makes decision for a car. The cars communicate with each other within a distance of 100-300 meters.

However, there are some possible problems in MANET and VANET networks, as follows:

1. Since no central management exists and each node makes decision itself, there might be some problems in decision making.

2. Nodes can make decision on regional basis because their information is limited to a distance of 100-300 meters.

Therefore, there might be some problems in general. For example, imagine a situation where a node is moving from the far west toward the far east and there are several ways to reach the destination. Since the node is unable to identify traffic in all of the regions, it cannot select the best route.

To improve this issue, we can use cloud computing as follows:

We need a central unit for decision making and data storing, to which all nodes are connected. In this way, the nodes are unable to make decision and can only display and record data. All decisions are adopted in a central server or reference node in such a way that each node has an IP address permanently exchanging data with the reference node (server). Each of these nodes is called thin client.

But the problem here is that IP address of each node changes when it exits a region and enters another region (connecting to another AP) and this makes it impossible to identify nodes. This problem can be solved by LISP protocol in cloud computing system.

3.3 Advantages of this algorithm

Among advantages of this algorithm is that a general relation is established. This means that we can identify the location of cars in all regions and not only a certain region. This improves the processing and outputs in comparison with VANET networks and provides more processing equipment for us. In addition, we can obtain an accurate statistical data from the network. For example, we can send data of a car's fuel system to server and the server can investigate total consumption of the car during the needed hours. Among other advantages we can mention the improvement of messaging system, as each thin-client can send message to another thin-client.

4. Implementation and Results

As shown in Fig. 4, each car or node is considered as a client, so that routing, traffic control, getting information from client and data processing and storing are performed by one or more server in different servers. The procedure is that each client receives its situation by GPS system and sends it online to the concerned server via GPRS networks. In order to accomplish routing and displaying data, each client sends a request to server. This way all processes and operations will be executable by the software inside the server.

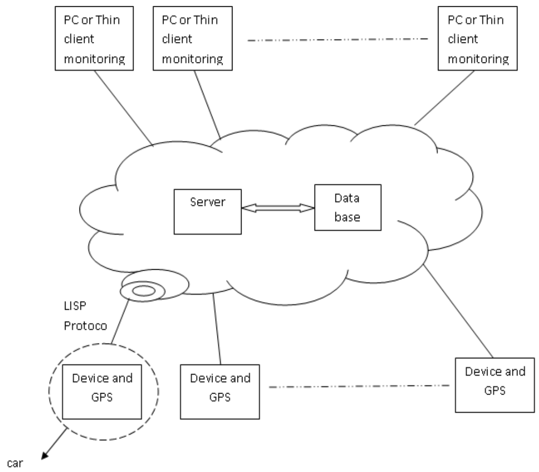

Fig.4. VANET Improvement using Cloud Computing.

Not only can the cars get aware of their location, but we can also monitor a car's location via Internet by PC or thin-client monitoring. The cars and cloud are connected by LISP protocol. The work that we performed is to create an algorithm to work in server and make decision on route selection on the basis of three priorities of traffic, safety and fastest route. This algorithm and its flowchart have been represented. We used LISP protocol to establish connection between cars and cloud and the algorithm that we designed indicates which works must be done in the server.

It should be mentioned that there is an ARM processor in every node or client. Also this algorithm is programmed inside server by ASP.NET. This implementation, performed for the first time, and our main kernel is constructed.

Result of this implementation is that we can connect to server by browser (such as Internet explorer) in every computer everywhere. So getting information from nodes and car's location is accessed. Therefore, we use Cloud computing in Vehicular ad-hoc network.

5. Conclusion

In this paper, we demonstrated that VANET network improved by using cloud computing and proposed algorithm. Furthermore, we proposed an algorithm which works in the server. This algorithm has been developed on the basis of three priorities of traffic, shortest route and road safety. Therefore, we managed to improve VANET networks. Among advantages of this algorithm is that, we can communicate in general, not regional, and improvement of processing and accurate statistics is achieved. In fact, the processing in the server is Fuzzy. We can use other Fuzzy variables such as measuring traffic plan.

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