Project Report on
PERFORMANCE EVALUATION OF VANET

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Certificate

This is to certify that the project work entitled "**Performance Evaluation of Vanet**" being submitted by Mr. Nilotpal Neelmani and Mr.Ravi Kuril in partial fulfillment of the requirement for the award of the degree of B.Sc. (H) Computer Science, University of Delhi is a record of the work carried out under the supervision of Mr. Chandra Kanta Samal, at Acharya Narendra Dev College, University of Delhi. It is further certified that we have not submitted this report to any other organization for any other degree.

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ABSTRACT

A Vehicular Ad-Hoc Network, or VANET, is a form of mobile ad-hoc network, to provide communications among nearby vehicles and between vehicles and nearby fixed equipment, usually described as roadside unit. It is a technology that uses moving cars as nodes in a network to create a mobile network. VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other to connect and, in turn, create a network with a wide range.

Considering the constant growth of automotive market and the increasing demand for the car safety and security, the potential of car-to-car connectivity is immense. The classes of applications for vehicular networks range from time critical safety applications to delay tolerant internet connectivity applications.

In this paper, we take the position that VANETs would indeed turn out to be the networking platform that would support the future vehicular applications. The security of VANET has mostly directed the attention of today research efforts, while comprehensive solutions to protect the network from adversary and attacks still need to be improved, trying to reach a satisfactory level, for the driver and manufacturer to achieve safety of life. The need for a robust VANET networks is strongly dependent on their security and privacy features, which will be discussed in this paper. VANET is attracting considerable attention from the research community and the automotive industry to improve the services of Intelligent Transportation System (ITS). As today's transportation system faces serious challenges in terms of road safety, efficiency, and environmental friendliness, the idea of so called "ITS" has emerged. Due to the expensive cost of deployment and complexity of implementing such a system in real world, research in VANET relies on simulation. This paper attempts to evaluate the performance of VANET in a realistic environment.

VANETs are facing many challenges that have been addressed in this research paper, besides we also discuss a set of solutions presented for these challenges; and propose suitable solutions for some of these problems.

Keywords:

ITS, VANET, GIS, Mobility Model Generator for Vehicular Networks.

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1. INTRODUCTION

1.1Wireless Networks

Wireless network refers to any type of computer network that uses wireless (usually, but not always radio waves) for network connections. Wireless networks are playing a major role in the area of communication. The main difference between wireless and wired networks is only in communication channel. There exist physical medium in wired networks, while on the other side, physical medium doesn't exist on the wireless networks.
Wireless network is a type of computer network that is not connected by cables of any kind.Most wireless networks are based on the IEEE® 802.11 standards. A wireless network is operated by a network of cellular towers and satellites. The media used for communication in wireless networks is air.Wireless telecommunications networks are generally implemented and administered using radio communication. This implementation takes place at the physical level (layer) of the OSI model network structure. The wireless communication revolution is bringing fundamental changes to data networking, telecommunication, and is making integrated networks a reality [1].

It is a method by which homes, telecommunications networks and enterprise (business) installations avoid the costly process of introducing cables into a building, or as a connection between various equipment locations. The most admiring fact in these networks is that it eliminates the need for laying out expensive cables and maintenance costs. Wireless networks allow multiple users to access large amounts of information without the hassle of running wires to and from each computer.This can be extremely helpful if there are a number of users that need to move around and/or access the network. Using a wireless network allows an individual to access the Internet when he is not connected to a computer with an Ethernet cable. Wireless Networks can be used by devices such as cell phones, laptops, and hand-held computers.

Wireless networks have become very popular in different applications considering the following factors: ease of installation, reliability, cost, bandwidth, total required power, security and performance of network.

1.1.1 How Wireless Networks Work

Radio waves are used in a wireless network just as they are used in televisions, mobile phones, and radios. Communication in a wireless network is very similar to two way radio communication. Basically, first a computers wireless adapter changes the data into radio signals and then transmits these signals through the use of an antenna. Then a wireless router receives the signal and decodes it. It then sends the information through a wired Ethernet connection to the internet. This procedure also works backwards in which the router receives information from the internet and sends it to the computer.

Wireless networks operate using radio frequency (RF) technology, a frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. The cornerstone of a wireless network is a device known as an access point (AP). The primary job of an access point is to broadcast a wireless signal that computers can detect and "tune" into. Since wireless networks are usually connected to wired ones, an access point also often serves as a link to the resources available on the a wired network, such as an Internet connection [6].

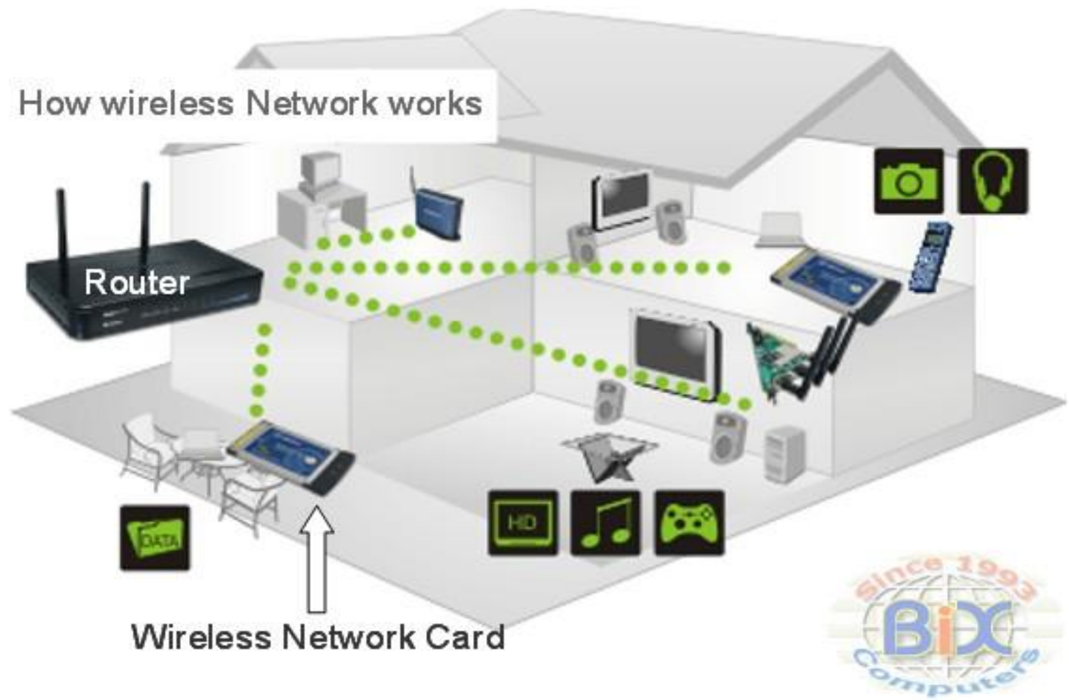

Fig: How Wireless networks works

In order to connect to an access point and join a wireless network, computers must be equipped with wireless network adapters. These are often built right into the computer, but if not, just about any computer or notebook can be made wireless-capable through the use of an add-on adapter plugged into an empty expansion slot, USB port, or in the case of notebooks, a PC Card slot.

Moving data through a wireless network involves three separate elements: the radio signals, the data format, and the network structure. Each of these elements is independent of the other two so one must define all three when one invents a new network. In terms of the OSI reference model, the radio signal operates at the physical layer, and the data format controls several of the higher layers. The network structure includes the wireless network interface adapters and base stations that send and receive the radio signals [6]. In a wireless network, the network interface adapters in each computer and base station convert digital data to radio signals, which they transmit to other devices on the same network, and they receive and convert incoming radio signals from other network elements back to digital data. Each of the broadband wireless data services use a different combination of radio signals, data formats, and network structure.

1.1.2 Types of Wireless Networks

Although we use the term wireless network loosely, there are in fact three different types of network [7].

- Wide area networks that the cellular carriers create,
- Wireless local area networks, that you create, and
- Personal area networks, that creates themselves.

They all have a part to play in developing wireless solutions, separately or in various combinations. This article describes these different types of network, and explains where each can add value.

Wide Area Networks

A Wide Area Network (WAN) is a network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports. Business and government entities utilize WANs to relay data among employees, clients, buyers, and suppliers from various geographical locations. In essence, this mode of telecommunication allows a business to effectively carry out its daily function regardless of location.The Internet can be considered a WAN as well, and is used by businesses, governments, organizations, and individuals for almost any purpose imaginable.

WANs are used to connect LANs and other types of networks together, so that users and computers in one location can communicate with users and computers in other locations. Many WANs are built for one particular organization and are private. Others, built by Internet service providers, provide connections from an organization's LAN to the Internet. WANs are often built using leased lines. At each end of the leased line, a router connects the LAN on one side with a second router within the LAN on the other. Leased lines can be very expensive. Instead of using leased lines, WANs can also be built using less costly circuit switching or packet switching methods. Network protocols including TCP/IP deliver transport and addressing functions. Protocols including Packet over SONET/SDH, MPLS, ATM and Frame relay are often used by service providers to deliver the links that are used in WANs. X.25 was an important early WAN protocol, and is often considered to be the "grandfather" of Frame Relay as many of the underlying protocols and functions of X.25 are still in use today (with upgrades) by Frame Relay [7].

Wireless Local Area Networks

Wireless LANs are networks are set up to provide wireless connectivity within a finite coverage area. Typical coverage areas might be a hospital (for patient care systems), a university, the airport, or a gas plant. They usually have a well-known audience in mind, for example health care providers, students, or field maintenance staff. WLANS are used when high data-transfer rate is the most important aspect of solution, and reach is restricted. For example, in a hospital setting, a high data rate is required to send patient X-rays wirelessly to a doctor, provided he is on the hospital premises.

Wireless LANS work in an unregulated part of the spectrum, so anyone can create their own wireless LAN, say in their home or office. The use of wireless local area networks (WLAN) has increased rapidly, offering flexibility and mobility to the users. This has made the technology popular amongst a wide range of users, including the education sector. Through the use of this technology devices and computers are connected to the local area network (LAN) wirelessly, eliminating or reducing the need for wired Ethernet. In such set-ups all devices must be equipped with antennas that transmit and receive radio signals in order to allow wireless connection.

Wireless LANs have their own share of terminology, including:

- 802.11 - this is the network technology used in wireless LANs. In fact, it is a family of technologies such as 802.11a. 802.11b, etc., differing in speed and other attributes.
- WiFi - a common name for the early 802.11b standard.

In addition to creating own private WLAN, some organizations (Starbucks) and some carriers (Telus Mobility) are providing high speed WLAN internet access to the public at certain locations. These locations are called hotspots, and for a price one can browse the internet at speeds about 20 times greater than one could get over the cell phone.

Personal Area Networks

A personal area network (PAN) is a computer network used for communication among computerized devices, including telephones and personal digital assistants. PANs can be used for communication among the personal devices themselves (intrapersonal communication), or for connecting to a higher level network and the Internet. A wireless personal area network (WPAN) is a personal area network - a network for interconnecting devices centered around an individual person's workspace - in which the connections are wireless. Wireless PAN is based on the standard IEEE 802.15. The two kinds of wireless technologies used for WPAN are Bluetooth and Infrared Data Association [7].

These are networks that provide wireless connectivity over distances of up to 10m or so. At first this seems ridiculously small, but this range allows a computer to be connected wirelessly to a nearby printer, or a cell phone's hands-free headset to be connected wirelessly to the cell phone. The most talked about (and most hyped) technology is called Bluetooth. Personal Area Networks are a bit different than WANs and WLANs in one important respect. In the WAN and WLAN cases, networks are set up first, which devices then use. In the Personal Area Network case, there is no independent pre-existing network. The participating devices establish an ad-hoc network when they are within range, and the network is dissolved when the devices pass out of range. If you ever use Infrared (IR) to exchange data between laptops, you will be doing something similar. This idea of wireless devices discovering each other is a very important one, and appears in many guises in the evolving wireless world. PAN technologies add value to other wireless technologies, although they wouldn't be the primary driver for a wireless business solution. For example, a wireless LAN in a hospital may allow a doctor to see a patient's chart on a handheld device. If the doctor's handheld was also Bluetooth enabled, he could walk to within range of the nearest Bluetooth enabled printer and print the chart.

An important classification of network is based on the infrastructure:

- **Infrastructured wireless Network**
- **Infrastructureless wireless network**

The scope of this project needs the coverage of a special type of wireless network i.e. Infrastructureless wireless network.

Infrastructureless wireless network

Infrastructure-less wireless networks are an important class of wireless networks that is best suited for scenarios where there is temporary and localized telecommunication demand. Such networks consist of wireless devices that can form a network autonomously without the need for pre-deployed telecommunication infrastructures such as base-stations and access points. Thus the network is ad hoc because it does not rely on a pre-existing infrastructure. No access point is involved in this configuration. This form of network is also termed an IBSS.

A wireless ad hoc network is an autonomous system consisting of nodes, which may or may not be mobile, connected with wireless links and without using pre-existing communication infrastructure or central control. Ad hoc networking is expected to play an important role in future wireless mobile network due to the widespread use of mobile and hand-held devices.

In Infrastructure less or Ad Hoc wireless network, the mobile node can move while communicating, there are no fixed base stations and all the nodes in the network act as routers for forwarding or receiving packets to /from other nodes. So the determination of which nodes forward data is made dynamically based on the network connectivity. Thus, mobile nodes in the Ad Hoc network dynamically establish routing among themselves to form their own network. In these networks there is no fixed topology due to the mobility of nodes, interference, multi-path propagation and path loss. Hence a dynamic routing protocol is needed for these networks to function properly.

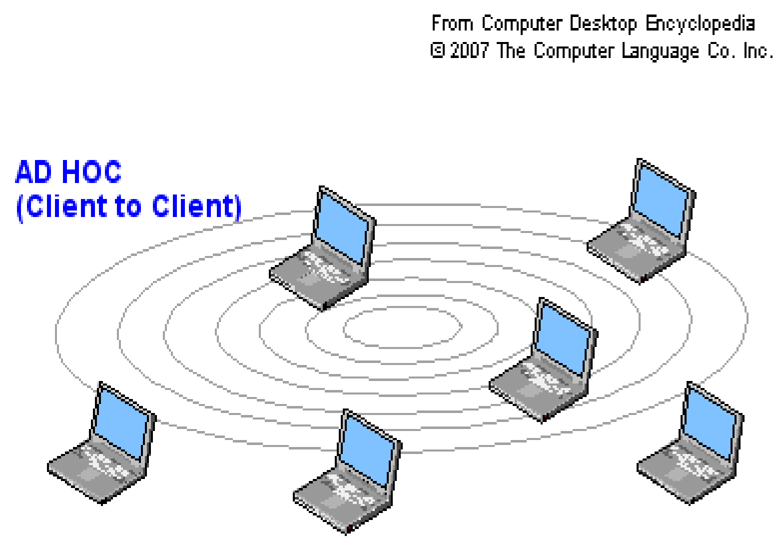

Fig: A mobile ad-hoc network.

Ad-hoc networks can be further classified in three categories based on applications as:

1. Mobile Ad-hoc Networks (MANETs) - A mobile ad hoc network (MANET) is a self forming network of mobile devices connected wirelessly.MANETs consists of mobile nodes, which can communicate with each other and nodes can enter and leave the network anytime. Nodes provide connectivity by forwarding packets between them since they communicate without an infrastructure.

2. Wireless Sensor Networks (WSN) - A wireless sensor network (WSN) employs sensor based devices to jointly observe physical or environmental settings such as sound, pressure, climatic changes, and so on. Wireless sensor networks are used in a wide range of areas: traffic control, vehicle detection, greenhouse monitoring and so on.

1.1.3 Advantages of Wireless Networks [4]

The popularity of wireless LANs is a testament primarily to their convenience, cost efficiency, and ease of integration with other networks and network components. The majority of computers sold to consumers today come pre-equipped with all necessary wireless LAN technology.

- **Mobility** – With the emergence of public wireless networks, users can access the internet even outside their normal work environment. Most chain coffee shops, for example, offer their customers a wireless connection to the internet at little or no cost.

- **Convenience** – The wireless nature of such networks allows users to access network resources from nearly any convenient location within their primary networking environment (a home or office). With the increasing saturation of laptop-style computers, this is particularly relevant.

- **Productivity** – Users connected to a wireless network can maintain a nearly constant affiliation with their desired network as they move from place to place. For a business, this implies that an employee can potentially be more productive as his or her work can be accomplished from any convenient location.

- **Deployment** – Initial setup of an infrastructure-based wireless network requires little more than a single access point. Wired networks, on the other hand, have the additional cost and complexity of actual physical cables being run to numerous locations (which can even be impossible for hard-to-reach locations within a building).

- **Expandability** – Wireless networks can serve a suddenly-increased number of clients with the existing equipment. In a wired network, additional clients would require additional wiring.
- **Cost** – Wireless networking hardware is at worst a modest increase from wired counterparts. This potentially increased cost is almost always more than outweighed by the savings in cost and labor associated to running physical cables.

1.1.4 Disadvantages of Wireless Networks

Disadvantages – For a given networking situation, wireless LANs may not be desirable for a number of reasons. Most of these have to do with the inherent limitations of the technology.

- **Security** – To combat this consideration, wireless networks may choose to utilize some of the various encryption technologies available. Some of the more commonly utilized encryption methods, however, are known to have weaknesses that a dedicated adversary can compromise.

- **Range** – The typical range of a common 802.11g network with standard equipment is on the order of tens of meters. While sufficient for a typical home, it will be insufficient in a larger structure. To obtain additional range, repeaters or additional access points will have to be purchased. Costs for these items can add up quickly.

- **Reliability** – Like any radio frequency transmission, wireless networking signals are subject to a wide variety of interference, as well as complex propagation effects that are beyond the control of the network administrator.

- **Speed** – The speed on most wireless networks (typically 1-54 Mbps) is far slower than even the slowest common wired networks (100Mbps up to several Gbps). However, in specialized environments, the throughput of a wired network might be necessary.

1.2 Vehicular Ad hoc Networks

A **Vehicular Ad-Hoc Network** or **VANET** is a technology that uses moving cars as nodes in a network to create a mobile network. VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 metres of each other to connect and, in turn, create a network with a wide range. As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile Internet is created. It is estimated that the first systems that will integrate this technology are police and fire vehicles to communicate with each other for safety purposes.

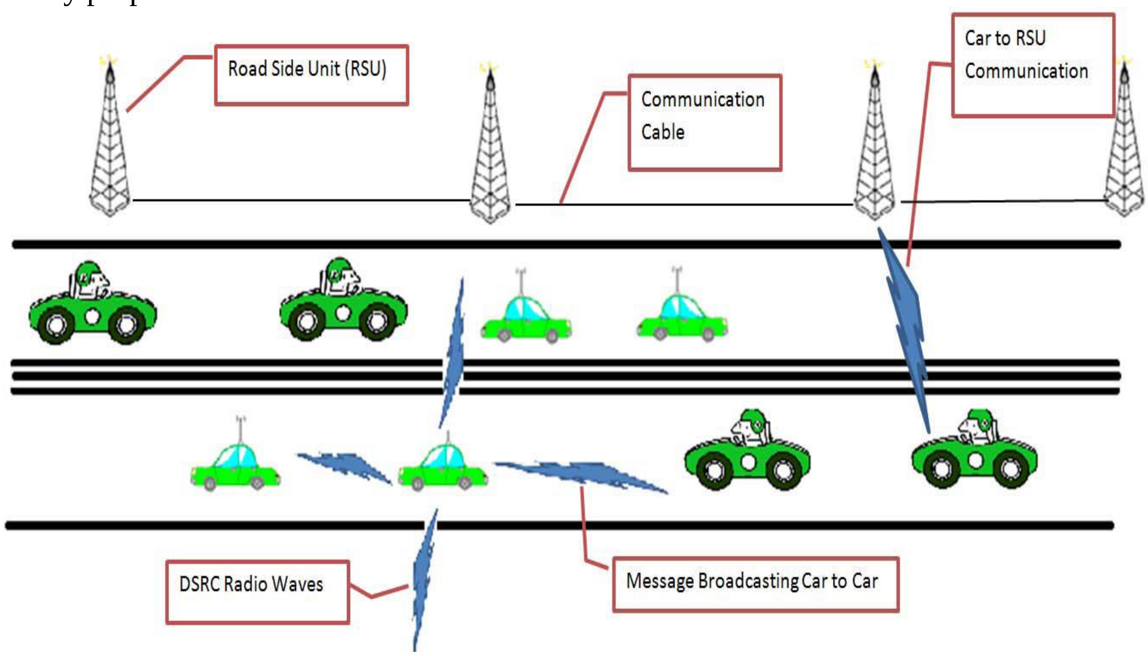

Fig: VANET Structure

Vehicular Ad-Hoc Networks (VANET) are becoming an integral technology for connecting daily life to computer networks. They could greatly improve the driving experience both in terms of safety and efficiency. As shown in Figure, when multi-hop communication is implemented, VANET enables a vehicle to communicate with other vehicles which are out of sight or even out of radio transmission range. It also enables vehicles to communicate with roadside infrastructure. VANET will likely be an essential part of future Intelligent Transportation Systems (ITS).

Fig: VANET communication

Vehicular ad hoc networks (VANETs) are a subgroup of mobile ad hoc networks (MANETs) with the distinguished property that the nodes are vehicles like cars, trucks, buses and motorcycles. This implies that node movement is restricted by factors like road course, encompassing traffic and traffic regulations. Because of the restricted node movement it is a feasible assumption that the VANET will be supported by some fixed infrastructure that assists with some services and can provide access to stationary networks.

The fixed infrastructure will be deployed at critical locations like slip roads, service stations, dangerous intersections or places well-known for hazardous weather conditions. Nodes are expected to communicate by means of North American DSRC standard that employs the IEEE 802.11p standard for wireless communication. To allow communication with participants out of radio range, messages have to be forwarded by other nodes (multi-hop communication). Vehicles are not subject to the strict energy, space and computing capabilities restrictions normally adopted for MANETs. More challenging is the potentially very high speed of the nodes (up to 250 km/h) and the large dimensions of the VANET [8].

Intelligent transportation systems (ITSs)

In intelligent transportation systems, each vehicle takes on the role of sender, receiver, and router to broadcast information to the vehicular network or transportation agency, which then uses the information to ensure safe, free-flow of traffic. For communication to occur between vehicles and Road Side Units (RSUs), vehicles must be equipped with some sort of radio interface or On Board Unit (OBU) that enables short-range wireless ad hoc networks to be formed. Vehicles must also be fitted with hardware that permits detailed position information such as Global Positioning System (GPS) or a Differential Global Positioning System (DGPS) receiver. Fixed RSUs, which are connected to the backbone network, must be in place to facilitate communication. The number and distribution of roadside units is dependent on the communication protocol is to be used.

For example, some protocols require roadside units to be distributed evenly throughout the whole road network, some require roadside units only at intersections, while others require roadside units only at region borders. Though it is safe to assume that infrastructure exists to some extent and vehicles have access to it intermittently, it is unrealistic to require that vehicles always have wireless access to roadside units. Possible communication configurations in intelligent transportation systems include inter-vehicle, vehicle-to road side, and routing-based communications. Inter-vehicle, vehicle-to-roadside, and routing-based communications rely on very accurate and up-to-date information about the surrounding environment, which, in turn, requires the use of accurate positioning systems and smart communication protocols for exchanging information. In a network environment in which the communication medium is shared, highly unreliable, and with limited bandwidth, smart communication protocols must guarantee fast and reliable delivery of information to all vehicles in the vicinity. It is worth mentioning that Intra-vehicle communication uses technologies such as IEEE 802.15.1 (Bluetooth), IEEE 802.15.3 (Ultra-wide Band) and IEEE 802.15.4 (Zigbee) that can be used to support wireless communication inside a vehicle but this is outside the scope of this paper and will not be discussed further.

1.2.1 Features of VANET

Typically, VANET has the following features:

1. Autonomous terminal: In VANET, each mobile terminal is an autonomous node, which may function as both a host and a router. In other words, besides the basic processing ability as a host, the mobile nodes can also perform switching functions as a router. So usually endpoints and switches are indistinguishable in VANET.

2. Dynamic network topology: Since the nodes are mobile, the network topology may change rapidly and unpredictably and the connectivity among the terminals may vary with time. VANET should adapt to the traffic and propagation conditions as well as the mobility patterns of the mobile network nodes. The mobile nodes in the network dynamically establish routing among themselves as they move about, forming their own network on the fly.

3. Light-weight terminals: In most cases, the VANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage. Such devices need optimized algorithms and mechanisms that implement the computing and communicating functions.

4. Distributed operation: Since there is no background network for the central control of the network operations, the control and management of the network is distributed among the terminals. The nodes involved in a VANET should collaborate amongst themselves and each node acts as a relay as needed, to implement functions like security and routing.

1.2.2 Advantages of Vehicular Ad Hoc Network

1. The decentralized nature of wireless ad hoc networks makes them suitable for a variety of applications where central nodes can't be relied on, and may improve the scalability of wireless ad hoc networks compared to wireless managed networks, though theoretical and practical limits to the overall capacity of such networks have been identified.
2. Minimal configuration and quick deployment make mobile ad hoc networks suitable for emergency situations like natural disasters or military conflicts.
3. The presence of dynamic and adaptive routing protocols enables ad hoc networks to be formed quickly.
4. A mobile ad hoc network is made up of multiple nodes connected by links. They provide access to information and services regardless of geographic position. These networks can be set up at any place and time.
5. VANET technologies allow a force of mobile nodes to more easily share data and attain greater situational awareness than a non-networked force. These networks work without any preexisting infrastructure.

1.2.3 Requirements of VANET Applications

Future VANET applications will have four fundamental demands: scalability, availability, context-awareness, and security and privacy [11].

1. Scalability: Because of the number of vehicles that could be incorporated into vehicular networks, VANET may become the largest ad hoc network in history. Undoubtedly, scalability will be a critical factor. The advantages of hybrid architecture, together with in-network aggregation techniques and P2P technologies, make information exchange more scalable.

2. Availability: Due to the real-time interaction between vehicular networks and the physical world, availability is an important factor in system design. This may have a major impact on the safety and efficiency of future highway systems. The architecture should be robust enough to withstand unexpected system failures or deliberate attacks.

3. Context-Awareness: As a cyber-physical system, VANET collects information from the physical world and may conversely impact the physical world. On the one hand, protocols should be adaptable to real-time environmental changes, including vehicle density and movement, traffic flow, and road topology changes. On the other hand, protocol designers should also consider the possible consequences the protocol may have on the physical world.

4. Security and Privacy: There is a recent trend of making vehicular on-board computer systems inter-connectable to other systems. The Ford Sync, for example, connects the vehicle's entertainment system to the driver's cell phone via blue-tooth technology. In the future, vehicular on-board computers could even be open to software developers. These trends may have serious implications for security and privacy due to the cyber physical nature of VANET. Governments and consumers will have very high expectations of VANET safety and security.

1.2.4 Applications of VANET

VANET communications can be used for number of potential applications with highly diverse requirements. The three major classes of applications possible in VANET are safety oriented, convenience oriented and commercial oriented. Safety applications will monitor the surrounding road, approaching vehicles, surface and curves of the road. Convenience application will be mainly of traffic management type. Commercial applications will provide the driver with the entertainment and services as web access, streaming audio and video.

Below we identify the most representative VANET applications and analyze their requirements through use-cases [9].

1. Traffic Signal: Communication from the traffic light can be created with the technologies of VANET. Safety applications would be Slow/Stop Vehicle Advisor (SVA) in which a slow or motionless vehicle will broadcast alert message to its neighborhood. Congested Road Notification (CRN) detects and notifies about road congestions which can be used for route and journey planning. The toll collection is yet another application for vehicle toll collection at the toll booths without stopping the vehicles. Vehicular networks have been shown to particularly useful for traffic management. For instance, Vehicle to infrastructure solution for road tolling is widely deployed.

2. Vision Enhancement: In vision enhancement, drivers are given a clear view of vehicles and obstacles in heavy fog conditions and can learn about the existence of vehicles hidden by obstacles, buildings, and by other vehicles.

3. Weather Conditions: Either vehicle sensors (wipers movement, grip control, outside thermometer, etc.); if not available/reliable, weather information can be updated/requested by an application via DSRC. In post-crash notification, a vehicle involved in an accident would broadcast warning messages about its position to trailing vehicles so that it can take decision with time in hand as well as pass information to the highway patrol for support. Parking Availability Notification (PAN) helps to find the availability of space in parking lot in a certain geographical area as per the weather conditions. For the convenience of the vehicle, highway and urban area maps are available which avoid the traffic jam and accident conditions and also provide shortest path in critical situation which saves the time.

4. Driver Assistance: Vehicular networks can also be used to support driving military exercises, by providing drivers with information that they might have missed or might not yet be able to see. By having vehicles exhibiting abnormal driving patterns, such as a dramatic change of direction, send messages to inform cars in their locality, drivers can be warned earlier of potential hazards, and therefore get more time to react and avoid accidents. Other applications of vehicular networks to driver assistance include supporting decision making.

5. Automatic Parking: Automatic Parking is an application through which a vehicle can park itself without the need for driver intervention. In order to be able to perform an automatic parking, a vehicle needs accurate distance estimators and/or a localization system with sub-meter precision.

6. Safety: Safety applications include immediate collision warning, forward obstacle detection and avoidance, emergency message dissemination, highway/rail collision avoidance, left/right turn assistant, lane changing warning, stop sign movement assistant and road-condition warning, intersection decision support, cooperative driving (e.g. collision warning, lane merging, etc.).

7. Searching Roadside Locations and vehicle's Direction: For unknown passenger help to find the shopping center, hotels, gas stations, etc., in the nearby area along the road. GPS, sensors and database from the nearest roadside base station are capable of calculating information.

1.2.5 Challenges Faced By VANET

There are some challenges associated with VANET that protocol designers and network developers are faced with:

Mobility: The basic idea from Ad Hoc Networks is that each node in the network is mobile, and can move from one place to another within the coverage area, but still the mobility is limited, in Vehicular Ad Hoc Networks nodes moving in high mobility, vehicles make connection throw their way with another vehicles that maybe never faced before, and this connection lasts for only few seconds as each vehicle goes in its direction, and these two vehicles may never meet again. So securing mobility challenge is hard problem [5].

Volatility: The connectivity among nodes can be highly ephemeral, and maybe will not happen again, vehicles traveling throw coverage area and making connection with other vehicles, these connections will be lost as each car has a high mobility, and maybe will travel in opposite direction [5]. Vehicular networks lack the relatively long life context, so personal contact of user's device to a hot spot will require long life password and this will be impractical for securing VC.

Interference: This is the major problem with mobile ad-hoc networks as links come and go depending on the transmission characteristics, one transmission might interfere with another one and node might overhear transmissions of other nodes and can corrupt the total transmission.

Dynamic Topology: This is also the major problem with ad-hoc routing since the topology is not constant. The mobile node might move or medium characteristics might change. In adhoc networks, routing tables must somehow reflect these changes in topology and routing algorithms have to be adapted. For example in a fixed network routing table updating takes place for every 30sec. This updating frequency might be very low for ad-hoc networks [2].

Connectivity: Connectivity is a problem in adhoc networks as networks are created spontaneously and nodes are mobile. Therefore connectivity between the nodes is sporadic.

Asymmetric links: Most of the wired networks rely on the symmetric links which are always fixed. But this is not a case with ad-hoc networks as the nodes are mobile and constantly changing their position within network. For example consider a VANET (Vehicular Ad-hoc Network) where node B sends a signal to node A but this does not tell anything about the quality of the connection in the reverse direction.

Routing Overhead: In wireless adhoc networks, nodes often change their location within network. So, some stale routes are generated in the routing table which leads to unnecessary routing overhead [9].

Lack of Resources: Lack of Resources is a problem with a network which has no central administrator to perform network and security tasks, and rather relies upon nodes to accomplish such services. There is also limited battery power and low bandwidth available in each node.

Cooperativeness: Routing algorithm for VANETs usually assumes that nodes are cooperative and non-malicious. As a result a malicious attacker can easily become an important routing agent and disrupt network operation by disobeying the protocol specifications.

Bandwidth constraint: Variable low capacity links exists as compared to wireless network which are more susceptible to external noise, interference and signal attenuation effects.

Privacy VS Authentication: The importance of authentication in Vehicular Ad Hoc Networks is to prevent Sybil Attack. To avoid this problem we can give a specific identity for every vehicle, but this solution will not be appropriate for the most of the drivers who wish to keep their information protected and private[2],[5].

Fluctuating link capacity: The nature of high bit-error rates of wireless connection might be more profound in a MANET. One end-to-end path can be shared by several sessions. The channel over which the terminals communicate is subject to noise, fading, and interference, and has less bandwidth than a wired network.

Scalability: Scalability can be broadly defined as whether the network is able to provide an acceptable level of service even in the presence of a large number of nodes. Due to mobility of nodes, scale of ad-hoc network changing all the time.
So due to link instability, node mobility and frequently changing topologies routing becomes one of the core issues in VANETs [2]. We should choose an efficient routing protocol to makes the VANET reliable. Also routing discovery and maintenance are critical issues in these networks. A suitable and effective routing mechanism helps to extend the successful deployment of mobile ad-hoc networks [5].

1.2.6 Our Problem

Since the performance of existing VANET technology is not optimal and is facing many challenges, taking into consideration the statistics of the paper [3], the performance of the network has been evaluated by taking delivery ratio, packet loss and router drop as statistical measures. The average delivery ratio for various scenarios such as varying number of vehicles with constant power transmission range of 250m and frequency of 2.4GHz was observed to be 68.38% whereas packet loss was 40.18%. With reference to paper [3], packet transmission over V2V radio wave communication using AODV routing protocol and IEEE 802.11 standard is not much effective & is difficult to implement in a real world scenario.

Radio spectrum is congested but the demand for wireless data doubles each year. Everything, it seems, wants to use wireless data but the capacity is drying up. Wireless radio frequencies are getting higher, complexities are growing and RF interference continues to grow. So what can carry this excess demand in the future?

The solution is Li-Fi. Direct modulation of LED devices is a low cost, secure, and safe way to transmit data, and there is an abundance of free visible light spectrum. High intensity LEDs used in light bulbs, flash lights and cameras can transmit very high data rates, faster than Wi-Fi!!

Also, traffic light scenario has been an important measure to regulate the traffic flow in a round robin fashion. But for data transmission, it has become an obstacle since the packet forwarding nodes at the intersection drops the packets, due to the high number of transmission at the same time. Therefore, it is concluded from the results that packet drops may be reduced by using RSU's that can forward the packets even if the intermediate vehicles drops the packets at the intersections [3]. Therefore, simulation of vehicular networks using Li-Fi & RSU will be our future direction of research.

2. RELATED WORKS

Research is being carried out in the field of VANET such as Analyzing data dissemination in VANETs, identifying and studying routing protocols in VANET in terms of highest delivery ratio and lowest end-to-end delay etc. The issues of Security and Privacy also demands great attention. The study of Mobility Models and their realistic vehicular model deployment is a challenging task. Random way Point (RWP) is an earlier mobility model widely used in MANET in which nodes move freely in a predefined area but without considering any obstacle in that area. However, in a VANET environment vehicles are typically restricted by streets, traffic light and obstacles. The routing track is then chosen considering the social relation between the vehicles and also the destination point. This means that vehicles move only between the initial and final point on path chosen by the social relation strength between the vehicles. GrooveSim [10] was the first tool for forecasting vehicular traffic flow and evaluating vehicular performance. It gives a traffic simulator environment which is easy to use for generating real traffic scenario for evaluation. But it fails to include network simulator as it was unable to create traces for network. David R. Choffnes et al. proposed a mobility model named STRAW (Street RAndom Waypoint). This model has taken real map data of US cities and considered the node (vehicle) movement on streets based on this map. This model also has the functionality to simplify the traffic congestion by controlling the vehicular mobility. But still it lacks overtaking criteria that cause convey effect in street as it considered random method which is not realistic.

In the VANET data dissemination framework several solutions have been proposed. The work is based on a simple but quite effective way for reducing the redundant rebroadcasts and the consequent medium contention and collisions. The Distance Defer Transmission (DDT) protocol in consists in relaying messages only by the receiver that is the farthest from the sender. To do that, each vehicle that receives a message waits for a defer timer which is inversely proportional to the sender-receiver distance before retransmitting it. In this way, the farthest vehicle retransmits the message first. A problem that can arise in this kind of solution is that a vehicle that is quite close to the initial transmitter but is the only vehicle in an intersection point different from the farthest vehicle does not transmit and its intersection direction is not covered. To overcome this kind of problem different protocols have been proposed. The Road Oriented Dissemination (ROD) protocol disseminates data separately in each direction, optimizes data dissemination in the intersection, and does not abandon dissemination if no relay is found. To fulfill the first two points ROD, as in DDT, uses the GPS position of the vehicle that is encoded in the header of the broadcast message. In addition, ROD encodes extra information: the outgoing intersection position and the ingoing intersection position. The work on the basis of some geometrical rules classifies vehicles according to the way they move and by this classification the propagation effect to vehicles in same roads is limited. The protocol assumes that all vehicles will be equipped with GPS devices and digital maps. Multi-hop data delivery through vehicular ad hoc networks is complicated by the fact that vehicular networks are highly mobile and sometimes sparse. Mobility prediction is used where neighbors of the broadcasting vehicle are divided into several sets according to the movement direction. With respect to these works, in this paper we propose set of solutions for improving the overall efficiency of VANET.

2.1 Approaches of vanet performance evaluation

There are three main approaches of evaluating Vanet performance.

A. Approaches Based on Varying Pause Time and Traffic Load

The first attempt to analyze the performance of ad hoc routing protocols was made by Samir et al. in which DSDV, AODV, DSR and TORA were evaluated over a network of 30 nodes in an area of 1;000m_1;000 m, considering varying number of conversations per node (traffic flow) and speed in two different scenarios. In lower speed scenario, the speed was uniformly distributed between 0.4 and 0.6m/s. At higher speed scenario, speed was uniformly distributed between 3.0 and 4.5 m/s. The evaluation was based on packet delivery ratio, end-to end delay and routing load. The mobility model adopted was based on a discrete-event framework. Each node chooses a direction, speed and distance of move based on a predefined distribution and then computes its next position accordingly.

B. Approaches Based on Varying Mobility and/or Traffic Flow

In the second group of work, evaluator focus on the evaluation of delay, throughput and routing overheads of DSDV, AODV and DSR in a network of 50 nodes, varying speed from 0 to 3.5 m/s and varying traffic flow from 5 to 20 pkts/s, in an area of 1;000m_1;000m and a constant pause time of 1 s. The mobility model used in this case was proposed by the authors. Both AODV and DSR perform quite well in almost all scenarios, but DSDV performance degrades with the increase in mobility. However, DSR performs better than AODV at low traffic flow; at higher traffic flow, AODV was better . In almost all the work mentioned in this group, overall DSR, LAR and AODV outperform than others. DREAM performance was contradictory in different papers, but overall it was considered a reliable one. FSR comes next, performing better than WRP.

C. Approaches Based on Varying Number of Nodes
In the third group, Layuan et al. evaluate packet delivery ratio, end-to-end delay, data throughput, routing load, jitter and number of broken links in DSDV, AODV and TORA, by varying the number of nodes . The nodes were randomly placed in a 1;000m ;000m area with constant speed of 40 m/s and pause time of 0 s. The throughput for AODV and DSR was higher and it was increasing with the number of nodes. Then comes DSDV which performed better than TORA, which was unaffected by changing number of nodes, but lower among all. The routing load for all protocols was increasing with the increase in number of nodes except for TORA. Delay produced by DSR was much higher with more nodes than any other protocol. However , the delay introduced by AODV and DSDV was very low than TORA. The study shows that the performance of LAR was promising in almost all scenarios, but with a high end-to-end delay varying between 10 and 100 s. AODV was the second best performing protocol, but resulted to be more sensitive than the others to network size and traffic load. AODV performance is better than DSR for dynamic changing conditions.

3. METHODOLOGY

3.1 Observation
Road traffic injuries are a significant public health problem. Injuries incurred across the road network are the leading cause of injury mortality and morbidity globally and by 2030, are predicted to be the 5th leading cause of mortality in the world.
Road accidents are a human tragedy. It is heartening to note that there has been a marginal decline in road accidents during 2011. However, the problem of road safety remains acute in India. During the year 2011, there were around 4.98 lakh road accidents, which killed 1.42 lakh people and injured more than 5 lakh persons, many of whom are disabled for rest of their lives. These numbers translate into one road accident every minute, and one road accident death in less than four minutes. Sadly, many of these victims are young people, those who are economically active. However several advancements have been made which has resulted in decline in road casualties. Australia, for example, has seen dramatic reduction in road deaths and serious injuries since the 1970's and holds an international reputation for road traffic injury prevention due, in part, to its success in pioneering the multidisciplinary and inter-sectoral approach needed to address this significant issue and by applying an evidence-led approach by utilizing the concept of Road Side Units (RSUs). Australia's early success in road traffic injury prevention (road safety), was achieved by implementing strategic speed enforcement programs through VANET. Considerable emphasis over the past decade has also been placed on a Safe Systems approach to road safety which continues to focus on the road users behavior but importantly, focuses prevention efforts across the entire road system and therefore places renewed emphasis on the road infrastructure and the vehicles in order to minimize the likelihood of injury in the event of a crash and importantly, early post-crash intervention.

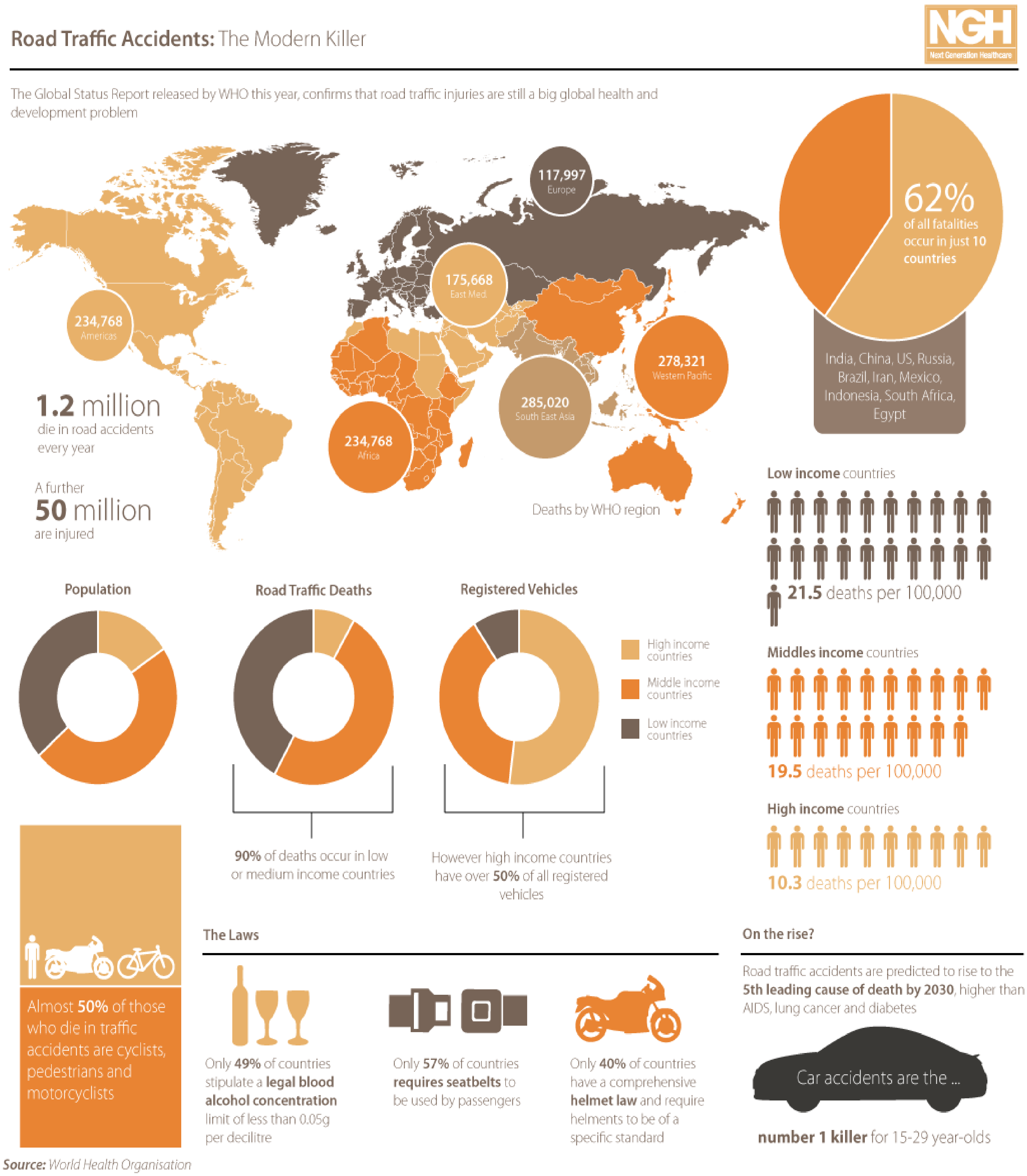

Fig: A Survey of Road Traffic Accidents

3.2 Introducing Solution

3.2.1 Visible Light Communication

With preparations well under way for a societal shift to solid-state lighting based on high-output LEDs, a proverbial light bulb has appeared above the heads of some forward-looking engineers. Their proposal: Why not switch the LEDs on and off so fast the eye cannot tell, in order to use them to transmit data too?

With enough advance work, every new LED light fixture could also be wired into the network backbone, accomplishing ubiquitous wireless communications to any device in a room without burdening the already crowded radio-frequency bands. Visible light communications (VLC) is being refined by industry, standards groups and well-funded government initiatives. And the stakes are enormous, since the traditional lighting market is measured in trillions of dollars and the transition to solid-state has already begun.

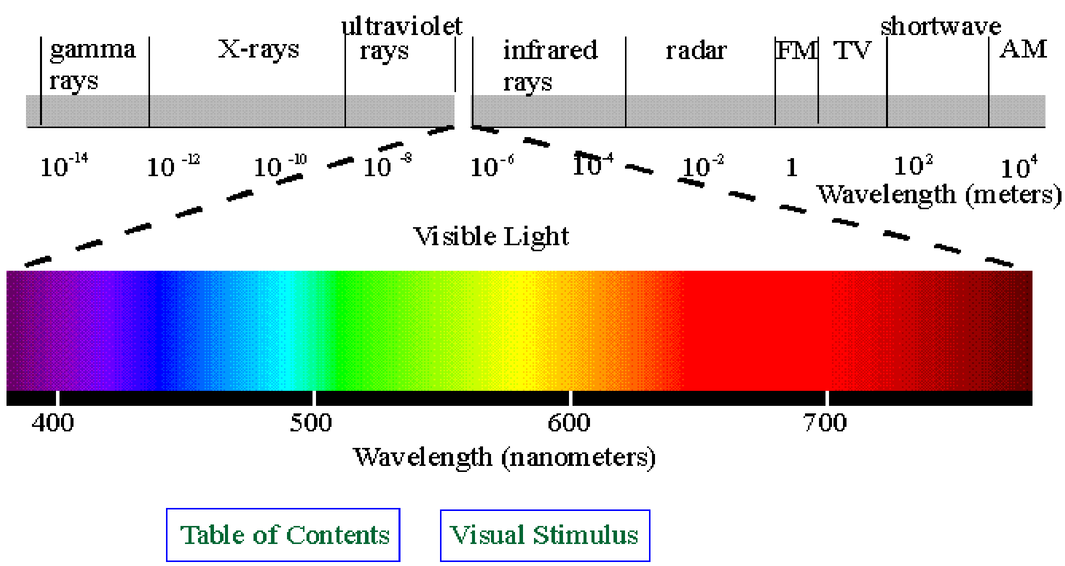

Fig: Visible Light Spectrum

Visible Light Communication uses light emitting diodes (LEDs), for the dual role of illumination and data transmission. Using the visible light spectrum, which is free and less crowded than other frequencies, wireless services can be piggy-backed over existing lighting installations. With this leading edge technology, data including video and audio, internet traffic, etc., can be transmitted at high speeds using LED light.

VLC technology has the potential to deliver data transfer rates in excess of hundreds of megabits per second. Light radiation neither constitutes nor suffers from electromagnetic interference (EMI) making VLC a very attractive technology in places/environments where electromagnetic interference (EMI) is an issue, such as in hospitals and in aircraft. In addition, where security of local communication is important e.g. defence and finance applications, D-Light technology offer a secure medium for communication in an office/building environment.

VLC Applications:

A wide range of applications would benefit from using novel visible light communications:

- **WiFi Spectrum Relief** - Providing additional bandwidth in environments where licensed and/or unlicensed communication bands are congested
- **Smart Home Network** – Enabling smart domestic/industrial lighting; home wireless communication including media streaming and internet access
- **Commercial Aviation** – Enabling wireless data communications such as in-flight entertainment and personal communications
- **Hazardous Environments**- Enabling data communications in environments where RF is potentially dangerous, such as oil & gas, petrochemicals and mining
- **Hospital and Healthcare** – Enabling mobility and data communications in hospitals
- **Defence and Military Applications** – Enabling high data rate wireless communications within military vehicles and aircraft
- **Corporate and Organizational Security** – Enabling the use of wireless networks in applications where (WiFi) presents a security risk
- **Underwater Communications** – Enabling communications between divers and/or remote operated vehicles
- **Location-Based Services** – Enabling navigation and tracking inside buildings.

3.2.1.1 Li Fi

Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication. The technology was demonstrated at the “2012 Consumer Electronics Show in Las Vegas” using a pair of Casio smart phones to exchange data using light of varying intensity given off from their screens, detectable at a distance of up to ten metres.

In October 2011 a number of companies and industry groups formed the Li-Fi Consortium, to promote high-speed optical wireless systems and to overcome the limited amount of radio-based wireless spectrum available by exploiting a completely different part of the electromagnetic spectrum. The consortium believes it is possible to achieve more than 10 Gbps, theoretically allowing a high-definition film to be downloaded in 30 seconds. Li-Fi has the advantage of being able to be used in sensitive areas such as in aircraft without causing interference. However, the light waves used cannot penetrate walls.

Existing VANET uses radio wave technology to communicate with neighbour vechiles which is slow & frequent data loss is encountered. According to our proposed LiFi can improve communication among neighboring vechiles. In our solution every vehicle will be enabled with a sender (LEDs) and receiver (sensor). LEDs flicker on and off imperceptibly thousands of times a second. By altering the length of the flickers, digital information can be sent to specially adapted vehicles [14].

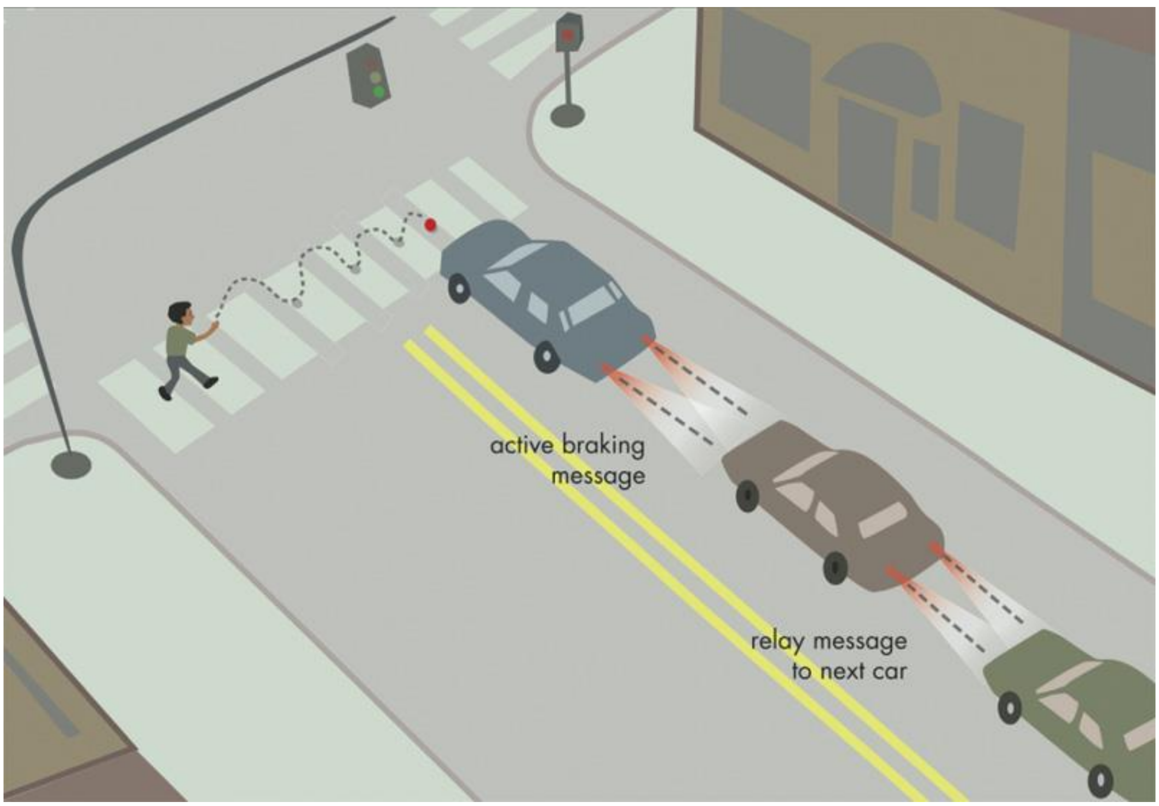

Fig: LiFi environment

The LEDs are made from gallium nitride and can flicker on and off 1000 times quicker and transmit data faster than conventional white LEDs. Their tiny size also means that 1000 can fit into the same space as a single conventional bulb, enabling bandwidth to be increased by a total factor of 1 million over a similar area. Besides providing an alternative to wireless Internet access, visible light communication also could be used to transmit data to vehicles. “Imagine an LED array beside a motorway helping to light the road, displaying the latest traffic updates and transmitting Internet information wirelessly to passenger's vehicles" said lead researcher Martin Dawson, a professor at the University of Strathclyde. "This is the kind of extraordinary, energy-saving parallelism that we believe our pioneering technology could deliver. This is the technology that could start to touch every aspect of human life within a decade" [14].

3.2.2 RSU (Road side Units)

Roadside units (RSUs) are a critical component of Vehicular ad hoc network (VANET). Ideally, RSUs should be deployed pervasively to provide continuous coverage or connectivity. However, during the initial stages of VANET, it will not be possible to ensure such a pervasive RSU deployment due to the huge cost and/or the lack of market penetration of VANET enabled vehicles. Given a limited number of RSUs, in this paper, we address the issue of optimal placement of these RSUs along highways with the goal of minimizing the average time taken for a vehicle to report an event of interest to a nearby RSU. We present a so-called balloon optimization method - the optimal solution is found by using a dynamic process similar to the natural expansion of multiple balloons in a two-dimensional space where each balloon corresponds to the coverage area of one RSU. Our preliminary evaluation shows that the balloon method performs optimal or near optimal compared with the exhaustive method and it can be used for the optimal placement of RSUs along highways.
In our proposed solution, the RSUs will be enabled with LiFi technology to achieve optimization in data communication and improve the overall performance of VANET.

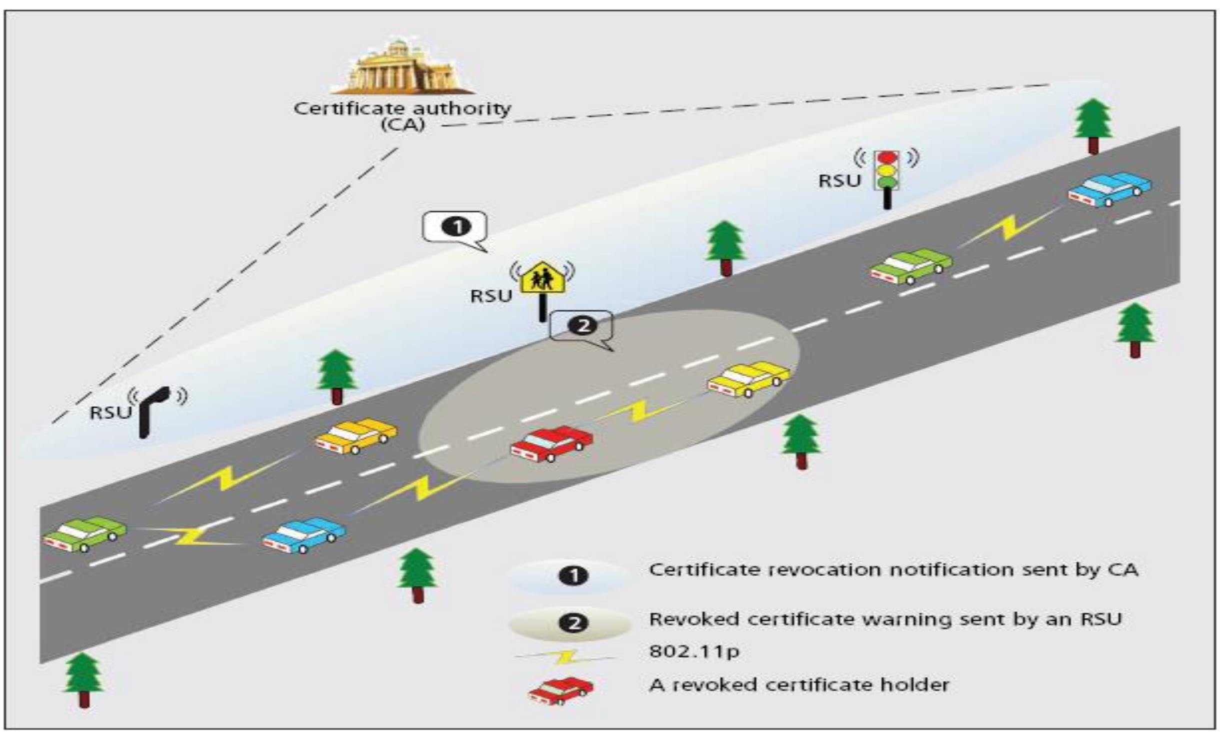

Fig: Road Side Unit Structure

Data dissemination is a key component of Infotainment and safety services in Vehicular Ad Hoc Networks. For infotainment services data dissemination starts from a Road Side Unit (RSU) and propagates to a multiplicity of On Board Units (OBU). A RSU typically can reach with a single hop only a fraction of the interested vehicles. Multi-hop, inter-vehicle communications is necessary to reach vehicles in the whole area that could be interested in the service. For an efficient data dissemination both the number of forwarding vehicles and the number of not covered ones shall be kept down. In this work we study the extension of the RSU coverage area via a simple data dissemination defined for urban scenarios. The proposed forwarding algorithm relies only on information local to the forwarding OBU. We show that in our case studies representing urban structures the protocol guarantees a good RSU coverage extension (in the order of 20 times the transmission area of the RSU) with a very low percentage of vehicles not reached by the disseminated data.

Efficient data dissemination in VANETs is of particular interest for both safety and infotainment services. In case of infotainment services the data dissemination is used to extend the radio coverage area of a Road Side Unit to reach all users that can be interested in a given service area. In this paper we propose three algorithms to extend the RSU coverage area in VANETs.
All the algorithms apply simple geometrical rules based on the position of the sending nodes that are used to allow the data to cross intersection of roads and to propagate toward multiple directions. In some specific case studies we have shown that the proposed solutions are able to increase the number of nodes reached by a broadcast message. Future work will be dedicated to apply the proposed protocols in dynamic scenarios where both the number and the positions of vehicles vary.

4. SIMULATION

Simulation has become an indispensable tool because it makes possible to build a dedicated VANET for its evaluation. Simulators also gather statistical data about the network usage during the simulation that allows measuring the protocols performance. Moreover, it is possible to visualize the VANET in order to easily specify the scenarios for the protocol evaluation using Li-Fi.

The different data like initial point of impact, direction of motions of colliding bodies before and after the collision, point of rest of the colliding bodies, positions of debris, skid marks etc. are used to obtain the approximate initial velocities and directions of the colliding vehicles. Apart from this, the make and model of the vehicles, the surface conditions of the road, coefficient of friction of the road etc. are also necessary for the simulation and analysis. All these parameters are initially estimated but the simulation of the event does not necessarily agree with the crash data known. These parameters in simulations are then iterated so as to get a reasonable match of the known crash data.

VANET simulators can be classified as microscopic or macroscopic. Microscopic traffic simulators emphasize local behavior of individual vehicles by representing the velocity and position of each vehicle at a given moment. This type of simulation is especially helpful for studying localized traffic interactions, but it comes with the price of reduced scalability. Macroscopic simulators capture traffic conditions in a global manner and may use concepts from wave theory. Usually, the traffic is represented in terms of flows (vehicle/hour), density (vehicles/km) or average speed. Similarly, microscopic network simulators take into account the transmission of each individual packet (or message), while the macroscopic network simulators consider transmission statistical properties. Most authors agree that a macroscopic mobility model is not sufficient to allow the study of a vehicular network, therefore microscopic simulation, although more complex, is required. The evaluation of vehicular applications for online traffic control (that produce real time feedback to the driver), such as safety applications, also requires a model of driver behavior. Models for lane changing or car-following are some of the features that a microscopic VANET simulator has to implement to allow the analysis of such applications [13].

4.1 Comparison between Li-Fi & Wireless Radio Transmission

LI-FI is a term of one used to describe visible light communication technology applied to high speed wireless communication. It acquired this name due to the similarity to WI-FI, only using light instead of radio. Radio wave communication is great for general wireless coverage within buildings, and Li-Fi is ideal for high density wireless data coverage in confined area and for relieving radio interference issues, so the two technologies can be considered complimentary.

Table I

TECHNOLOGY	SPEED	DENSITY
Wireless (current)		
Wi-Fi – IEEE 802.11n	**150 Mbps**	*
Bluetooth	**3 Mbps**	*
IrDA	**4 Mbps**	***
Wireless (future)		
WiGig	**2 Gbps**	**
Giga-IR	**1 Gbps**	***
Li-Fi	**>1Gbps**	****

VLC technology, one of the advanced optical wireless communication technologies, in which light in the visible region (375nm-780nm) is used as a medium for data transmission is more secure and achieves high data rates as compared to conventional wireless technologies like Wi-Fi, Bluetooth, Wimax etc., which use radio waves for communication. Till late 1990s infrared spectrum is used for the communication. But in the early 2000s, researches started using visible light from LEDs as the medium for communication. Initially they were able to achieve network speed about 100Kbps. With continuous developments, VLC systems can now achieve about 800Mbps data rate for short range communications.

Many companies and research institutes are conducting research to develop and commercialize Gigabit networks for long range communications [15]. Free space optics (FSO) is based on the same principle as VLC but it uses light in the IR spectrum for communication. Invention RONJA device in 2001, which can achieve 10Mbps network speed over 0.87 miles boosted the research activities in the FSO technology. FSO was initially used for outdoor communication applications. But in the recent times, indoor applications like enterprise connectivity. FSO is expected to play a major role in vehicle connectivity especially in emerging nations like India and Brazil where the reach of ICT and fiber connectivity is still low.

Reliability and network coverage are the major issues to be considered by the companies while providing VLC services. Interferences from external light sources like sun light, normal bulbs; and opaque materials in the path of transmission will cause interruption in the communication. High installation cost of the VLC systems can be complemented by large-scale implementation of VLC. Adopting VLC technology will reduce further operating costs like electricity charges, maintenance charges etc.

Visible light communication technology is still in the introductory phase. Indoor networking and location based services are the only applications that are quite penetrated in the market. Products for other applications (intelligent traffic management system, in-flight entertainment, and underwater communication) are expected to hit the market by the end of 2013. VLC may be implemented as a complementary technology to the existing wireless networks. VLC is expected to penetrate M2M communication, smart cities, power over Ethernet (PoE), wireless sensor networks, ubiquitous networks, augmented reality etc. after five years [15].

Unlike VLC technology, FSO technology is commercialized in the market for quite some time. FSO technology is majorly used in military & aerospace applications due its secure and high speed data transmission rates. FSO is expected to be deployed in MAN (Metropolitan Area Network), service acceleration, last mile connectivity etc. in the field of vehicular applications in the near future.

4.2 Traffic Simulation

Strictly speaking, for the most realistic simulation of moving nodes, their mobility would need to be deduced from trace files obtained in real-world measurements. However, even if such trace files could be readily created for a specific scenario, simulations could still only be performed for exactly the scenario one was able to gather movement traces for. Varying only a single parameter, e.g. traffic density, and keeping all other parameters unchanged, would be infeasible with this approach. Full control over all aspects of the scenario can, however, be readily achieved if movement traces are generated by traffic simulation tools. This also opens up the possibility to generate movement traces on the fly, a prerequisite for closing the loop and allowing network simulations to influence traffic simulations, as is commonly desirable in settings where information relevant to the traffic situation is being exchanged between nodes. Transportation and traffic science classifies traffic models into Macroscopic, Mesoscopic, and Microscopic models, according to the granularity with which traffic flows are examined. Macroscopic models, like METACOR, model traffic at a large scale, treating traffic like a liquid and often applying hydrodynamic flow theory to vehicle behavior.

Mesoscopic models like CONTRAM are concerned with the movement of whole platoons, using e.g. aggregated speed density functions to model their behavior. Simulations of VANET scenarios, however, are concerned with the accurate modeling of single radio wave transmissions between nodes and, therefore, require exact positions of simulated nodes. Both Macroscopic and Mesoscopic models cannot offer this level of detail, so only microscopic simulations, which model the behavior of single vehicles and interactions between them, will be considered as mobility models for simulated VANET nodes. Transportation and traffic science has developed a number of micro-simulation models, each taking a different approach and thus each resulting in simulations of different complexity.

Models that are in widespread use within the traffic science community include the Cellular Automaton (CA) model, the SK model, and the IDM/MOBIL model. When doing traffic simulation, each approach has its particular advantages and particular drawbacks. However, the accuracy of many of these models was evaluated in, which concluded with the recommendation to just “take the simplest model for a particular application, because complex models likely will not produce better results”. Essentially this means that, as far as network simulation is concerned, all common micro-simulation approaches are of equal value as a mobility model. Today, several simulation environments exist which can generate trace files of vehicles moving according to these micro-simulation models. Common tools include Daimler-Chrysler’s FARSI or VISSIM by PTV AG. In the interest of comparability of research results, however, it is evidently more beneficial to use readily available simulation environments like MOVE or VanetMobiSim, as using the same mobility model is the easiest and sometimes the only way of accurately reproducing results obtained in related work. MOVE uses the SUMO environment for the simulation of roads, which in turn uses the aforementioned SK traffic model. VanetMobiSim extends the CANU Mobility Simulation Environment. It implements the adaptations IDM with Intersection Management (IDM IM) and IDM with Lane Changing (IDM LC), the latter of which also includes the MOBIL lane change

model. In this work, only nodes moving on a single road were examined, so simulation of a whole network of roads was not necessary and a plain micro-simulation model could be employed. As it was desirable to keep the underlying traffic model as simple and comprehensible as possible, so that plausible results could be obtained, we chose to perform micro-simulation of road traffic by an adaptation of TrafficApplet1, an open source simulation tool that implements IDM and MOBIL to calculate longitudinal and lateral movement of vehicles, respectively [16].

$$s^* = s_0 + s_1\sqrt{(v/v_0)} + vT + v\Delta v/2\sqrt{(ab)} \qquad (1)$$

$$\dot{v} = a(1 - (v/v_0)^\delta - ((s^*)/s)^2)) \qquad (2)$$

Values s and Δv denote the gap to a vehicle in front and the difference in speed, respectively. In the MOBIL lane change model, for a vehicle to change lanes, two criteria have to be fulfilled: The lane change has to be safe, i.e. after the lane change, the acceleration calculated for the vehicle following the vehicle in question has to be within bsave. The second criterion is fulfilled if the acceleration of the vehicle in question would increase 'a' more than the acceleration of its following vehicle would decrease, weighted by the politeness factor p and a general bias to the right lane Δb.

Table I lists all values used to parameterize the traffic simulations in order to model two different classes of vehicles.

• Nodes representing trucks traveled at a maximum speed of 22.2m/s (approx. 80km/h, 50 mph) and made up 20% of the vehicles simulated.

• The remaining 80% of vehicles represented cars and traveled at speeds of up to 33.0m/s (approx. 120km/h, 75 mph).

The only parameters altered from their default values supplied with the simulation tool were "comfortable acceleration" and "comfortable deceleration", which were reset to more relaxed values, so as not to provoke traffic jams.

TABLE II
ROAD TRAFFIC MICROSIMULATION PARAMETERS

		Car	**Truck**
Desired velocity	v0	33.0m/s	22.2m/s
Time headway	T	1.5 s	1.7 s
Comfortable acceleration	a	0.73m/s	20.73m/s2
Comfortable deceleration	b	1.67m/s2	1.67m/s2
Acceleration exponent	δ	4	4
Minimum gap (jam)	s0	2m	2m
Additional gap (driving)	s1	0m	0m
Vehicle length	l	6m	10m
Politeness factor	p	20%	20%
Maximum safe deceleration	bsave	4m/s2	4m/s2
Lane change threshold	athr	0.3m/s2	0.2m/s2
Bias to the right lane	Δb	0.1m/s2	0.3m/s2

In order to evaluate the impact of using a sophisticated traffic model, simulations were performed not only with nodes moving according to the IDM/MOBIL mobility model, but also according to a simple random waypoint mobility model. Nodes were placed on random points in a rectangular area, corresponding to the simulated road. During the simulation, they each picked a random destination on the road and moved there at their set speed v0, then immediately picked a new destination and started moving again [17].

5. CONCLUSION

Vehicular Ad Hoc Networks is an emerging and promising technology of the future.
In this paper, we argued that VANETs would turn out to be the networking infrastructure for supporting future vehicular applications. We started with describing the factors that would be critical in making VANETs a reality followed by a discussion on the research challenges. Active research efforts are being undertaken to bridge the gaps required to make VANETs using Li-Fi a reality.

The convergence of computing, telecommunications (fixed and mobile), and various kinds of services are enabling the deployment of different kinds of VANET technologies. In the past decade, many VANET projects around the world have been undertaken and several VANET standards have been developed to improve vehicle-to-vehicle or vehicle-to infrastructure communications.

VANET is not a new research field in network communication. MANET and VANET both share some common features of network. However, the performance of VANETs depends heavily on the mobility model, routing protocol, vehicular density, driving environment and many other factors. There are still quite a few parameters that have not been carefully investigated yet like network fragmentation, delay-constrained routing, efficient resource utilization, and delay-tolerant network. These are the points that can be further explored in the future. We will try to explore deeper in this research area.

5.1 Future Applications

Factors Influencing the Adoption Of Vanet In Future

In this section, we highlight the reasons that would drive the adoption of VANETs for future vehicular applications:

A.Low latency requirements for safety applications
Safety applications like collision alert, merge assistance, road condition warning, etc requires messages to be propaged from the point of occurrence to the target vehicles with very low latency (a few nano-seconds). Infostation based Infrastructure access networks have intermittent connectivity and does not provide any delay guarantees .while the 3G based cellular data access networks which can provide continuous connectivity have low bandwidths which could induce a delay of few ms to a few seconds. The natural approach is to leverage the V2V infrastructure that is cheap and can sustain the latency requirements for safety applications and VANETs are the natural candidates for this application.

B. Extensive growth of interactive and multimedia applications
The recent years have witnessed a tremendous increase in the number of multimedia applications, interactive games, and location based services and most of these applications require either intermittent or continuous internet connectivity. A pure V2V based solutions cannot address these application domains and there is a definite need for V2I infrastructure and VANETs have this V2I support as well.

C. Increasing concerns about privacy and security

The biggest threats to VANETs are privacy and security. With a pure V2V architecture, authentication and key management becomes extremely cumbersome and requires a prior knowledge of all the available public keys for the participating vehicular entities in order to verify user’s identity. However, having a fixed identity can in turn raise a lot of privacy concerns and the proposed solution involves the use of disposable temporary identities that can be assigned by a centralized key distribution agency. This centralized agency can in turn selectively geocast these temporary identities with their corresponding public keys in the most relevant geographical area to be picked up by vehicles for authentication or the vehicles can query the key distribution authority to retrieve the public key for the vehicle it needs to authenticate. Thus, to effectively verify the identities of the peers, and dynamically download the keys to address the privacy and security concerns, presence of V2I infrastructure is critical.

During the past five years, the vehicular network (VANET) has emerged as the true commercial heir of the PRNET. Peer to peer, ad hoc communications are made possible in VANETs by the ample supply of power on board of the vehicle. Moreover, VANET applications like content distribution and crash avoidance require P2P exchanges. However, as we have amply illustrated in this paper, the VANET is not a stand alone network. Rather, it is intimately dependent on the wired infrastructure for its applications (e.g. content) and its services (e.g. security, mobility management, routing among remote vehicles, etc.).

Let us take another look at the applications we have studied in this paper:
(a) Navigation safety applications (e.g., crash prevention, road problem warnings, conditions of the driver, etc.);
(b) Navigation efficiency (e.g., Intelligent Transport System, road congestion avoidance, personalized navigator, pollution mitigation);
(c) Entertainment: download multimedia; multi-user games (some also educational);
(d) Vehicle monitoring (OBD, low Carbon emission, green hybrid vehicle management);
(e) Urban sensing (congestion, pollution, forensic); also participatory sensing, involving P2P exchanges with other vehicles (e.g., monitoring the ‘‘density’’ of road segments);
(f) Social networking; proximity and correlated motion driven acquisition of friends/peers; blog uploading (e.g., places we have seen recently);
(g) Emergency (e.g., evacuation for Katrina type disasters);

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