A Comparative Study of Mobile and Vehicular Adhoc Networks

Vandana Jindal

DAV College, Bathinda, Punjab, India.
{jindal_vandana@yahoo.co.in}

Abstract— Increased mobility and collaboration, improved response, better access to information, easier network expansion, enhanced guest access etc. are some of the important features that have motivated researchers to go for work in wireless systems. Direct access to these wireless networks is possible through radio waves. The radio waves are used to carry information, by systematically changing some property of the radiated waves, such as their amplitude, frequency, phase, or pulse width depending upon application. Mobile and Vehicular Ad hoc networks are some of the networks which are gaining advantage through research in wireless systems. A comparative study of these networks has been carried out in the paper.

Index Terms— Adhoc Networks, DGPS, MANET, VANET, V2V, WANET, ZigBee

1 INTRODUCTION

Wireless networking is the cheapest means to connect our homes, office, enterprise installations by avoiding costly process of cables. Wireless networks use radio waves to connect devices such as laptops to the Internet, the business network and other applications. Many types of wireless communication devices exist. These devices include personal dig ital assistants (PDAs), laptops, personal computers (PCs), servers, and printers having a means of interfacing with a particular type of network. Wireless networks may be categorized as:

I. Wireless Personal Area Network (WPAN): Interconnects devices within an area of about 30 feet. The two current technologies for WPAN are- Infra Red (IR) and Bluetooth (IEEE 802.15).

II. Wireless Local Area Network (WLAN): It connects two or more devices using a wireless distribution scheme, providing a connection through access points to the wider Internet. It allows users in a local area, such as a university campus or library, to form a network or gain access to the internet.

III. Wireless Metropolitan Area Networks (WMAN): It connects various wireless LANs. This technology permits the connection of multiple networks in a metropolitan area which may include various buildings in a city.

IV. Wireless Wide Area Network (WWAN): Covers large geographical areas like neighboring towns and cities.

Wireless networks provide freedom of movement and the ability to extend applications to different parts of a building, city, or nearly anywhere in the world. Wireless networks allow people to interact through e-mail or browse the Internet from a location that they prefer without any difference from wired networks. These networks have the flexibility to be constituted on ad hoc basis as setting up the network is easy and economical. MANET and VANET are two such wireless networks which are gaining popularity among users. Research activity is on the rise to make these networks more and more versatile.

The organization of the paper is as under: Sec II gives us a brief introduction about the ad hoc networks; Sec-III and Sec-IV touch the various aspects of MANET and VANET respectively. Finally Sec-V gives us the conclusion.

2 ADHOC NETWORKS

Today, the technology involved in wireless communication, has become an intrinsic part of various communication devices permitting the users in far away areas to communicate. The devices used for wireless communication may be cordless telephones, mobiles etc. which may use GPS units, ZigBee technology, wireless radio and satellite communication, etc. There is continuous evolution in computing and communications.

A wireless ad hoc network (WANET) is a decentralized type of wireless network [1,2], which is not depending upon a pre existing infrastructure like- routers in wired networks or access points in wireless networks. An ad-hoc network is a local area network (LAN) that is built spontaneously as devices connect. Instead of relying on a base station to coordinate the flow of messages to each node in the network, the individual network nodes forward packets to and from each other. In Latin, *ad hoc* literally means "for this," meaning "for this special purpose". Wireless ad hoc networks do not require complexities of infrastructure setup and administration. It is made up of enabling devices to create and join networks "on the fly" – anywhere, anytime.

Wireless networks are permitted to use, unlicensed frequency spectrum specifically assigned for these networks and can serve the *sites that are difficult to connect with a wired network.* Rapid distribution of information to the user(s) is possible. The striking weaknesses associated with the wireless networks are- security, speed, compatibility among heterogeneous devices, dynamic topology etc. Various wireless ad hoc networks are depicted below pictorially-

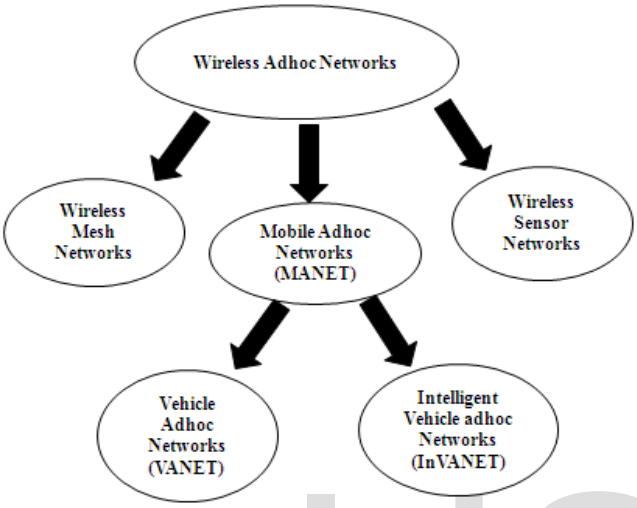


Figure 1: Various Ad hoc Networks

3 MANET

Situations, where the construction and destruction of networks take place on adhoc basis, mobile ad-hoc networking is an excellent choice. The idea of mobile ad-hoc networks was conceived in 70s. It was only in mid-90s that this conception started taking its shape and emerged as an alternative to many costly practices. They can be setup anywhere without requirement of any existing infrastructure i.e. the cables and the base-station. They can be mobile and named as- Mobile Ad hoc NET works popularly called MANET.

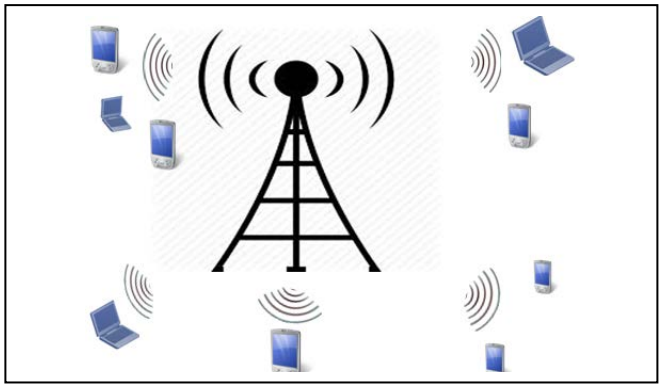
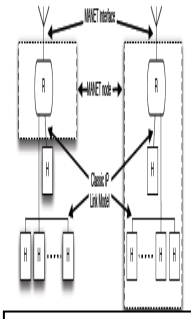


Figure 2: MANET

An Ad hoc network may be a LAN with wireless connections where some of the network devices are a part of the network



f the session (communication). MANET
endent mobile nodes which communi-
rough radio waves. If no direct link ex-
and the sink then multi-hop routing is
rwarded using various techniques. The
a MANET interface, and is connected,
(H) via classic IP links.

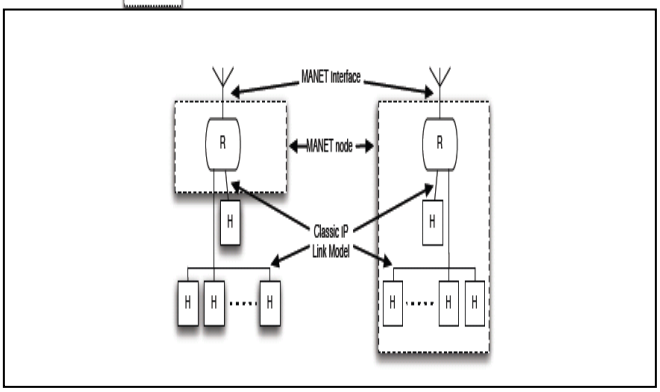
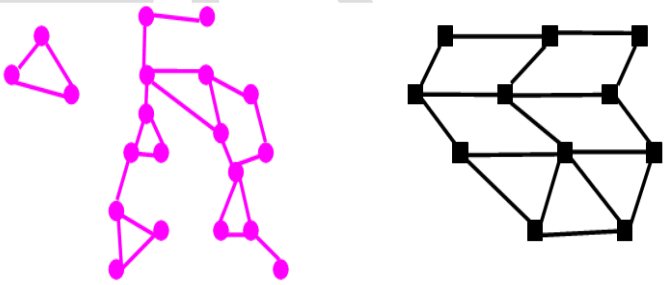


Figure 3: MANET node model

3.1.1 Attributes of MANET

Some of the striking features of MANET:

Rapidly deployable, self-configuring; Wireless links; Multi hop communication (basically nodes communicating to fixed infrastructure); Purpose specific; Autonomous; unlike wired network, no master-slave relationship;



(a)Mobile,ad-hoc network (b) Wireless, Fixed network

Figure 4: Types of Wireless networks

Nodes act both as host and router; No centralized control; Intrinsic mutual trust; Dynamic network topology; Autonomous, no infrastructure required; May be set up anywhere; Limited security; Energy constraints.

3.1.2 Applications of MANET

The areas where MANET can be put into use are:

Military or police exercises; Disaster relief operations; Mine site operations; Urgent business meetings; Robot data acquisi-

tion; Sensor networks; Students on campus; Free Internet connection sharing; Conferences.

3.1.3 FACTORS INFLUENCING MANET

Various factors that influence MANET:

i. Bandwidth-constrained, variable capacity links: A very normal feature in wireless networks is congestion because of multiple access, fading, noise and interference conditions thus leading to application demands (of resources) exceeding the limit of the network capacity. As the mobile network is an extension of the fixed network infrastructure, mobile adhoc users face similar problems.

ii. Energy-constrained operation: Nodes are battery operated with limited life in MANETs. Thus energy conservation is of utmost importance.

iii. Limited physical security: MANETs are more prone to physical security threats like - eavesdropping, spoofing, denial-of-service etc. For relief to some extent, MANETs have been provided with the decentralization of network control.

3.1.4 ROUTING PROTOCOLS IN MANET

Routing protocols present for MANET are:

i. Pro-active: Routes are set up based on continuous control of traffic and all the routes are maintained all the time.

ii. Reactive: Does not take initiative for finding routes but establishes routes "on demand" by flooding a query.

iii. Hybrid: As the name suggests this approach employs the combination of both reactive and pro-active

3.1.5 DATA DELIVERY MODELS

The data in MANET is delivered in any of the below mentioned models:

i. From application point of view- Continuous; Event-driven; Observer-initiated; Hybrid

ii. From implementation point of view - Flooding; Unicast; Multicast.

4 VANET

VANET may be regarded as a subset of MANET. It is a technology which employs moving cars as nodes in a network creating a mobile network. Each car that participates is used as a wireless router or node by the VANET. Cars have limited range of 100 to 300 meters and are moving all the time. 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. VANETs have grown out of the need to support the growing number of wireless products that can now be used in vehicles [13, 14]. The products may be remote keyless entry devices, personal digital assistants (PDAs), laptops and mobile telephones. As mobile wireless devices and networks become increasingly important, the demand for Vehicle-to-Vehicle (V2V) and Vehicle-to-Roadside (VRC) or Vehicle-to-Infrastructure (V2I) Communication is continuously growing [14].

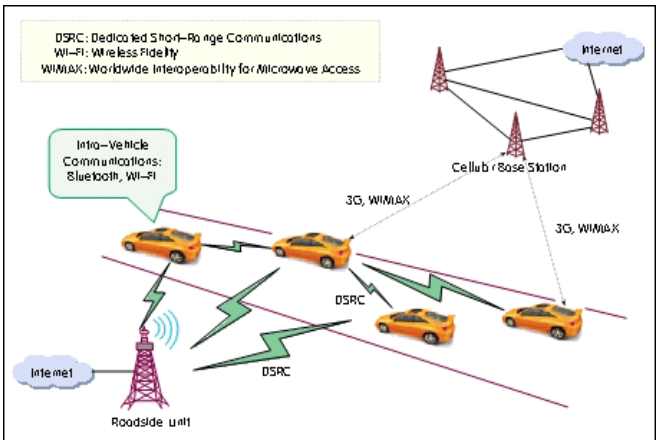


Figure 5: Schematic representation of VANET

VANET is an Intelligent Transportation System (ITS), where each vehicle acts as a sender, receiver and router [15] broadcasts information to a vehicular network, which then uses the information for the safety and free-flow of the traffic.

The protocol that has been standardized for communication in VANET is DSRC, having a communication range between 300 meters to 1 km. The roadside base station provides information to the driver throughout his journey so that he can find a best route to his destination. The information is periodically exchanged.

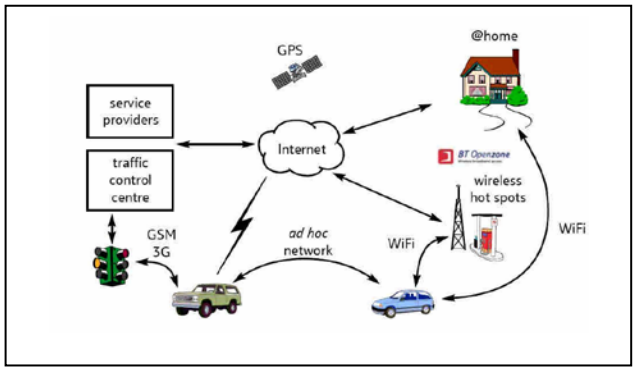


Figure 6: The Connected car scenario

For communication between vehicles and Road Side Units (RSUs), vehicles must be equipped with some sort of radio interface or On Board Unit (OBU) enabling short-range wireless ad hoc networks to be formed [16]. Vehicles must also be fitted with hardware that permits detailed position infor-

mation 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 upon the communication protocol used. Police and Fire vehicles are the most appropriate applications for these networks.

4.1.1 Attributes of VANET

VANET can be considered a subset of MANET; Nodes do not move in any random direction; Nodes are powered (energy is not an issue); Node contact time is limited; Intermittent connectivity might occur; Node speed is bounded; Mostly high speed, but occasionally stop and slow moving.

4.1.2 Applications of VANET

The areas where VANET can be put into use are:
Safety–intersection warning;Vehicle-based; Infrastructure-based; Vehicle probe (travel time estimation, environmental data collection, road surface data collection); Emergency vehicle (pre-emptive traffic control) navigation.

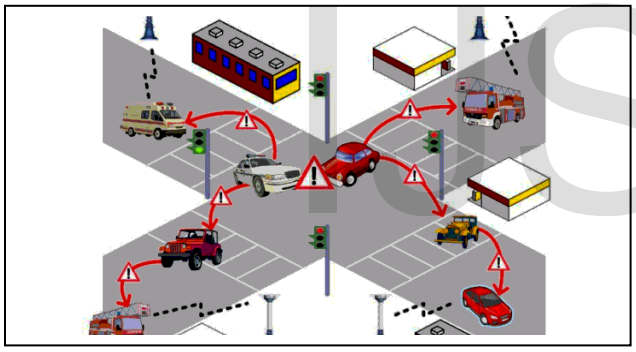


Figure 7: Vehicular Ad hoc Networks

4.1.3 Factors influencing VANET

VANETs get affected by various conditions like: Short radio transmission range; Omni directional broadcast; Limited storage capacity; Dynamic Topologies; Bandwidth-constrained, variable capacity links; Energy-constrained; Limited Physical security; Scalability; No prior control messaging ; Hidden terminal problem; Different traffic volumes; Different environments (Urban or rural).

4.1.4 Routing Protocols in VANET

The routing protocols in VANETs may be classified into various categories: Flat routing protocols, Hierarchical routing protocols, Location-based routing protocols, Hybrid Schemes, Geographical Routing, and Routing with dynamic address.
1. *Flat routing protocols*: The following protocols fall under this category:

a. Pro-active (Table driven): Routes are set up based on continuous control traffic and all the routes are maintained all the time. These types of protocols maintain fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. The drawbacks associated with them are that large amount of data exists for maintenance and the reaction is slow on restructuring and failures. E.g. FSR (Fisheye State Routing), FSLS* (Fuzzy Sighted Link State), OLSR (Optimized Link State Routing), TBRPF (Topology Broadcast Based on Reverse Path Forwarding), etc. The prime characteristics of such protocols are: Large routing table, large flooding of routing information (for large network population), and frequent updating when mobility is high. These types of protocols are most suited for network with small population.
b. Reactive (On-demand): Does not take initiative for finding routes but establish routes "on demand" by flooding a query. e.g., AODV (Ad Hoc On-demand Distance Vector routing), DSR (Dynamic Source Routing), TORA (Temporally-Ordered Routing Algorithm), etc. As the communication takes place between the leaders of the groups, overhead of routing processing is reduced. The problem associated with this is - the overhead of routing between the groups.

2. *Hierarchical routing protocols*: When the size of a network increases, the flat routing schemes become infeasible as the associated link and processing overhead also increases. Therefore, hierarchical routing protocols have been developed. In this the network is partitioned into various groups where each node is assigned different function within and outside the group. E.g. CGSR(Cluster head-Gateway Switch Routing), HSR (Hierarchical State Routing), ZRP (Zone Routing Protocol), LANMAR (Landmark Ad Hoc Routing Protocol), etc.
3. *Location-based routing protocols*: This protocol requires GPS to provide every node with its location information. Universal time is provided by the GPS. It uses geographical forwarding to send packets.
4. *Hybrid Schemes*: It is a combination of reactive and pro-active branches. Routing may be divided into two categories: Inter zone and intra zone routing. In this the former uses the reactive protocols and the latter the pro-active protocols. E.g. Zone routing protocol (ZRP).
5. *Geographical Routing*: The nodes are aware of their geo coordinates (GPS) i.e. the geographic position. A route that moves the packet close to the destination is formed on the basis of this information. The information is propagated through flooding. E.g. DREAM, GPSR, LAR.
6. *Routing with dynamic address*: Use of address-based routing protocols requires that each of the participating nodes be assigned a unique address. This implies that a mechanism for

assigning a unique address to vehicles should be there. These protocols have no safeguard to detect allocation of duplicate addresses in the network [17].

4.1.5 Design of VANET

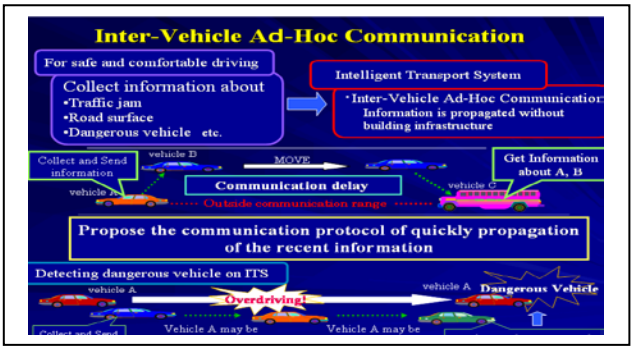


Figure 8: Architecture of VANET

4.1.6 Metrics

Metrics to evaluate performance of these networks are:

i. Receipt rate
ii. Dissemination speed
iii. Redundancy

4.1.7 Standards available

The standards available in VANET are:

i. *Dedicated Short Range Communication (DSRC):* DSRC spectrum is allocated for vehicle-to-vehicle and infrastructure-to-vehicle communication. It can be put to use by traffic control to save lives and improve traffic flow, and also to provide value through private applications. It is an IEEE 802.11 based technology.
ii. *IEEE 1609*: A standard for Wireless Access in Vehicular Environments (WAVE) (IEEE 802.11p). Security Services for applications and management messages, defines secure message formats and processing. It also defines the circumstances for using secure message exchanges and how those messages should be processed based upon the purpose of the exchange.

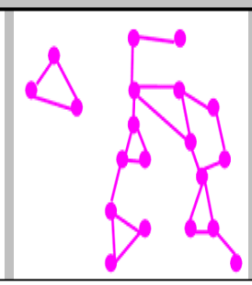
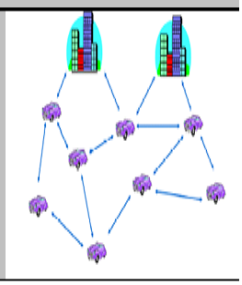
4.1.8. Issues in a mobile environment

The problems associated with the mobile environment are: Variable Bandwidth; Frequent link failures; Limited Power.

5 Conclusion

Ad hoc Wireless Sensor Networks have the capacity to revolutionize the contemporary technical arena. Offering a more convenient means of communication, this idea of infrastructure-less networks can transform many applications, military strategy, home security, information transfer, environment monitoring, traffic and safety services and surveillance. They can initiate wave of wireless interaction that the world has not yet seen.

TABLE 1
MANET vs. VANET

Factors/ Issues	MANET	VANET
Moving pattern	Uncontrolled	Restricted
cost	Not so high	High
Mobility	Slow	High
Bandwidth	Low	High
Node movement	Random	Regular
Range	<100m	>500m
Life span	Power Dependent	Vehicle dependent
Structure		

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