TCP ANALYSIS UNDER VARIOUS MOBILE ADHOC NETWORKS

Ajay Dahiya*

Dr.Parvinder Singh**

Abstract:

A Mobile Ad-hoc Network (MANET) is a temporary wireless network composed of mobile nodes without any permanent infrastructure. Each node not only operates as an end system, it also acts as a router to forward packets on behalf of other nodes [1]. One of the best features of MANET is its flexibility and can configure itself in the fly and thus very suitable for the emergency situation. So in this paper we are trying to evaluate the performance of the ADHOC protocols and performing simulation on NCTUNs simulator and changing the properties of mobile nodes like number of nodes,obsatcles etc. We will consider AODV and ADV.

* Dept. of Computer Science ofEngg. "DCRUST Murthal"

** Dept. of Computer Science ofEngg. "DCRUST Murthal"

INTRODUCTION:

A Mobile Ad-hoc Network (MANET) is a temporary wireless network composed of mobile nodes without any permanent infrastructure. Each node not only operates as an end system, italso acts as a router to forward packets on behalf of other nodes [1]. One of the best features of MANET is its flexibility and can configure itself in the fly and thus very suitable for the emergency situation.

The IEEE 802.11 MAC protocol [2] is a best choice for providing Ad-hoc network facilities. Mobile ad hoc network can be a standalone network or it is also possible to connect it to the infrastructure network. Thus it provides the facility to connect to the internet from anywhere. According to [1] typical applications of MANET are

(1) Military use

(2) Search and rescue.

(3) Vehicle-to-vehicle communication in intelligent transportation.

(4) Temporary networks in meeting rooms, airports, etc.

(5) Personal Area Networks connecting cell phones, laptops, smart watches, and other wearable computers.

Ad hoc networks are a new paradigm of wireless communication for mobile hosts which are also called nodes. In an ad hoc network, there is no fixed infrastructure such as base stations or mobile switching centers i.e. it is decentralized. Mobile nodes that are within each other's radio range communicate directly via wireless links, while those that are far apart rely on other nodes to relay messages as routers. Node mobility in an ad hoc network causes frequent changes of the network topology. Ad hoc is more to do with transmission of wireless signals from node to node dynamically rather than systematically. From this it comes out to be that Ad hoc network protocols act according to network situations. We can also suggest that an Ad hoc network is a computer-to computer temporary internet connection. It is often used to share files between two computers wirelessly. It is actually a communication mode.

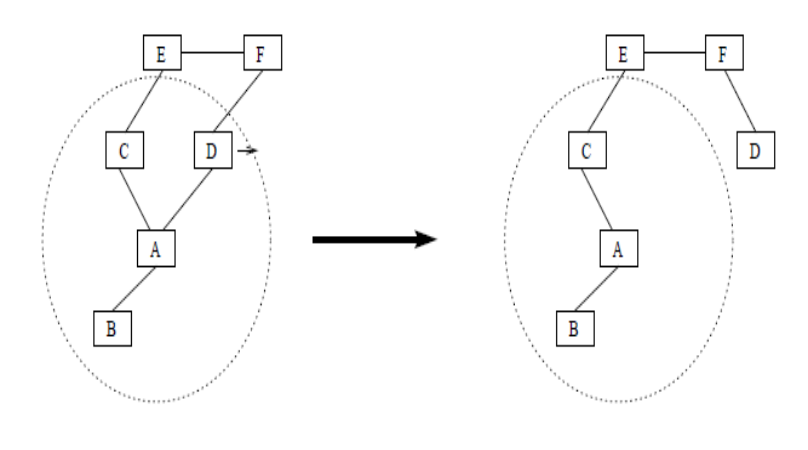

Figure 1 : Ad hoc Network

Figure 1 shows such an example: initially, nodes A and D have a direct link between them. When D moves out of A's radio range, the link is broken. However, the network is still connected, because A can reach D through C, E, and F. Military tactical operations are still the main application of ad hoc networks today. For example, military units (e.g., soldiers, tanks, or planes), equipped with wireless communication devices, could form an ad hoc network when they roam in a battlefield.

Ad hoc networks can also be used for emergency, law enforcement, and rescue missions. Since an ad hoc network can be deployed rapidly with relatively low cost, it becomes an attractive option for commercial uses such as sensor networks or virtual classrooms.

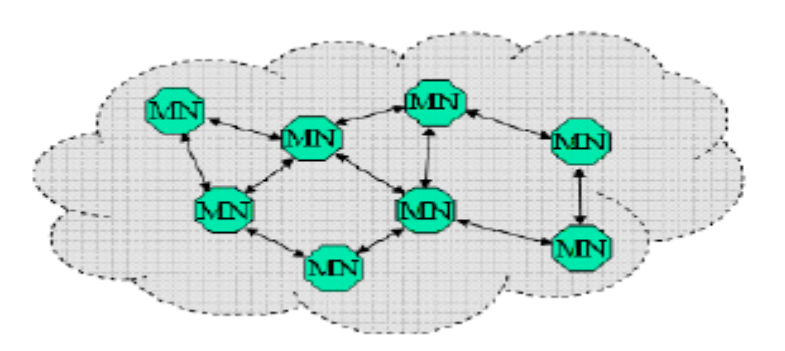

Figure 2: Infrastructure less

Features:

- Nodes
  - ✓ Limited Resources: Battery Backup, Limited Range etc.
  - ✓ Dynamic Topology: Number of nodes keeps on changing on the fly.
  - ✓ Address Assignment: Allocating Address to different nodes successfully
- Wireless Channels
  - ✓ Relatively High Error Rate: High bit error rate is caused due to multipath fading, Doppler shift and signal attenuation.
  - ✓ High variability in the quality: Qos keep on changing as per the variability of network topology.
  - ✓ Low bandwidth.
  - ✓ Broadcast Nature: Every node has the ability to transmit info for path and information to all other adjacent nodes (e.g. FLOODYING).
  - ✓ Security Aspects: Authentication, Integrity, Availability.
- Ad hoc networks are basically peer-to-peer, multihop mobile wireless networks in which information packets are transmitted in a store-and –forward manner from a source to an arbitrary destination, via intermediate nodes.

Issues related to Ad hoc:

Ad hoc networks nodes or access points have power problems. Also, there might be interference between a single ways of one node to another. Node-networks should be able to keep- pace with the connect –disconnect dynamic mechanism of ad hoc networks. This means that ad hoc networks might need more technology to support their reliability. To get our device to go the Ad hoc network way, we need to configure our wireless network adaptor in Ad hoc mode. All said and done, Ad hoc networks don't have the capability to get onto mainstream wired local area

networks. To do this a network gateway has to be implemented. Ad hoc networks are only building Ad hoc wireless local area networks that are temporary. However, as more devices in this Ad hoc LAN increases, connectivity speed slows down considerably. This is another drawback of Ad hoc networks.

REVIEW OF ROUTING PROTOCOLS:

The commonly used ad hoc routing protocols initially implemented for MANETs have been tested and evaluated for TCP. Use of these address-based and topology-based routing protocols requires that each of the participating nodes be assigned a unique address. This implies that we need a mechanism that can be used to assign unique addresses to nodes but these protocols do not guarantee the avoidance of allocation of duplicate addresses in the network [7]. Thus, existing distributed addressing algorithms used in mobile ad-hoc networks are much less suitable in movable nodes. Several MANET routing protocols have used topology based routing approach. Topology based routing protocols use links information within the network to send the data packets from source to destination [6].All of these protocol strategies can also be used in Mobile Nodes networks, where each node is required to have a unique address in order to send and receive messages.

Topology based routing approach can be further categorized into three groups as shown:

1) Proactive routing 2) Reactive routing 3) Hybrid routing

Proactive Routing Protocols:

Proactive routing protocols are mostly based on shortest path algorithms. Proactive routing protocols employ standard distance-vector routing strategies (e.g., Destination-Sequenced Distance-Vector (DSDV) routing) or link-state routing strategies (e.g., Optimized Link State Routing protocol (OLSR) and Source-Tree Adaptive Routing (STAR)).They keep information of all connected nodes in form of tables because these protocols are table based [8]. Furthermore, these tables are also shared with their neighbors.

Whenever any change occurs in network topology, every node updates its routing table. Thus they maintain and update information on routing among all nodes of a given network at all times even if the paths are not currently being used. Route updates are periodically performed regardless of network load, bandwidth constraints, and network size.

The main drawback of such approaches is that the maintenance of unused paths may occupy a significant part of the available bandwidth if the topology of the network changes frequently. Since a network between cars is extremely dynamic proactive routing algorithms are often inefficient because distance vector routing takes much bandwidth to share routing information with neighbors.

Reactive Routing Protocols:

On demand or reactive routing protocols were designed in such a manner to overcome the overhead that was created by proactive routing protocols. This is overcome by maintaining only those routes that are currently active [8]. Routes are discovered and maintained for only those nodes that are currently being used to send data packets from source to destination. Reactive routing protocols such as Dynamic Source Routing (DSR), and Ad hoc On-demand Distance Vector (AODV) routing implement route determination on a demand or need basis and maintain only the routes that are currently in use, thereby reducing the burden on the network when only a subset of available routes is in use at any time. Communication among mobile nodes will only use a very limited number of routes, and therefore reactive routing is particularly suitable for this application scenario.Route discovery in reactive routing can be done by sending RREQ (Route Request) from a node when it requires a route to send the data to a particular destination.After sending RREQ, node then waits for the RREP (Route Reply) and if it does not receive any RREP within a given time period, source node assumes that either route is not available or route expired [9]. When RREQ reaches the particular destination and if source node receives RREP then by using unicasting, information is forwarded to the source node in order to ensure that route is available for communication.

Hybrid Routing:

Hybrid routing combines characteristics of both reactive and proactive routing protocols to make routing more scalable and efficient [8]. Thus it has an advantage over both reactive and proactive protocols. Mostly hybrid routing protocols are zone based; it means the number of nodes is divided into different zones to make route discovery and maintenance more reliable for MANET.

NCTUns TOOL:

The NCTUns is a high-fidelity and extensible network simulator and emulator capable of simulating various protocols used in both wired and wireless IP networks. Its core technology is based on the novel kernel re-entering methodology invented by Prof. S.Y. Wang [14] when he was pursuing his Ph.D. degree at HarvardUniversity. Due to this novel methodology, NCTUns provides many unique advantages that cannot be easily achieved by traditional network simulators such as ns-2 and OPNET.

NCTUns directly uses the real-life Linux's TCP/IP protocol stack to generate high-fidelity simulation results. By using the novel kernel re-entering simulation methodology, a real life UNIX (e.g., FreeBSD or Linux) kernel's protocol stack is directly used to generate high-fidelity simulation results.

NationalChiaoTungUniversity Network Simulator (NCTUns) NCTUns is written in C++ with a powerful GUI support. NCTUns can simulate 802.11a, 802.11b, 802.11g and 802.11p technologies. NCTUns can simulate multiple wireless interfaces inside one node including 802.11.p interface. After the release of version 5 [14], NCTUns enhanced its usability for ITS. NCTUns includes free space with a shadowing path loss model, Rayleigh and Ricean fading models. NCTUns implements directional, bidirectional and rotating antenna types. The Signal to Noise Ratio calculation is cumulative and the signal strength is determined from the sender's and receiver's perspective point. NCTUns implements block objects to introduce the hindering object between wireless signals.

The Wall object can completely block the wireless signal or can attenuate the signal with a specified value. During the simulation, each node is allowed to send either a UDP or TCP packet. However, there is a limitation in NCTUns. Most of the Network simulators allow

multiple TCP/IP versions (Tahoe and New Reno) inside single simulators whereas NCTUns allows only a single instance of TCP/IP version. Unlike TraNs, NCTUns which integrate traffic and network simulators within a single module with a powerful feedback to support vehicular network simulations. The feedback between the traffic and the network simulators in a timely manner is needed for efficient VANET simulations. Thus, NCTUns is the only simulator that overcomes the limitations of other simulators discussed earlier namely MOVE, TraNS, and VANET Mobiles. However, NCTUns can support a maximum of only 4096 nodes inside a single simulation.

Thus it can be summarized that NCTUns is a powerful research tool. It has two unique features that are difficult to be achieved by traditional network simulators such as ns-2 [15] and OPNET modeler [16].

Network participants and deployment:

Network design consists of wireless ad hoc network for the generation of simulation results. The network consists of mobile nodes, path setting and obstacles and in this section all these network participants and how these participants can be configured and deployed for simulation setup, are discussed.

Nodes network construction:

Node network construction plays an important role to study mobile nodes behavior in specific area. To observe a nodes behavior path construction should be more realistic i.e. more nodes can move at gateway paths as compared to city. Nodes speed, movement and breaking etc are proportional to road conditions. For this simulation study we construct paths according to the real situation to observe the behavior of mobile nodes that is provided by NCTUns GUI environment.

Mobile Nodes (Vehicles)

Mobile Nodes are the network participants that are used to communicate among themselves in case of any critical situation on the roads. The request from a source to destination is sent by gathering the geographical data with help of other intermediate nodes. In this study we have make the following settings for nodes profile configuration:

- Each node is assigned a unique IP address and maximum high speed.

City obstacles

Most of the city area consists of huge buildings that are obstacles for radio signals. Some buildings just attenuate them and some completely block them. To simulate this situation "obstacles" are used in simulation. To simulate more realistic environment the properties of obstacles are set accordingly.

Performance metrics

Different performance metrics are used to check the performance of routing protocols in various network environments. In this study throughput and packet drop are selected to check the performance of Mobile Nodes routing protocols against each other. The reason for the selection of these performance metrics is to check the performance of routing protocols in highly mobile environment of city. Moreover, these performance metrics are used to check the effectiveness of Mobile Ad hoc routing protocols i.e. how well the protocol deliver packets and how well the algorithm for a routing protocol performs in order to discover the route towards destination. The selected metrics for routing protocols evaluation are as follows:

Throughput

Throughput is the average number of successfully delivered data packets on a communication network or network node. In other words throughput describes as the total number of received packets at the destination out of total transmitted packets [20]. Throughput is calculated in

bytes/sec or data packets per second. The simulation result for throughput in NCTUns shows the total received packets at destination in KB/Sec, mathematically throughput is shown as follows:

Throughput (bytes/sec) = Total number of received packets at destination packet size/ Total simulation time*

Packet Drop

Packet drop shows total number of data packets that could not reach destination successfully. The reason for packet drop may arise due to congestion, faulty hardware and queue overflow etc. Packet drop affects the network performance by consuming time and more bandwidth to resend a packet. Lower packet drop rate shows higher protocol performance.

Total Simulation Time Taken

This is the total time taken by NCTUns-6.0 to simulate the given network. This time varies according to network complexity and routing protocols used. Thus it actsas important criteria to select a more efficient routing protocol.

Result and Analysis

Throughput

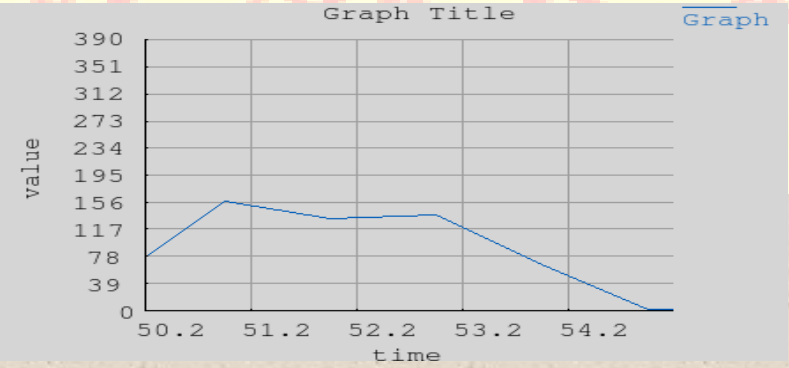

Figure 3: AODV Throughput performance in Obstacle free environment

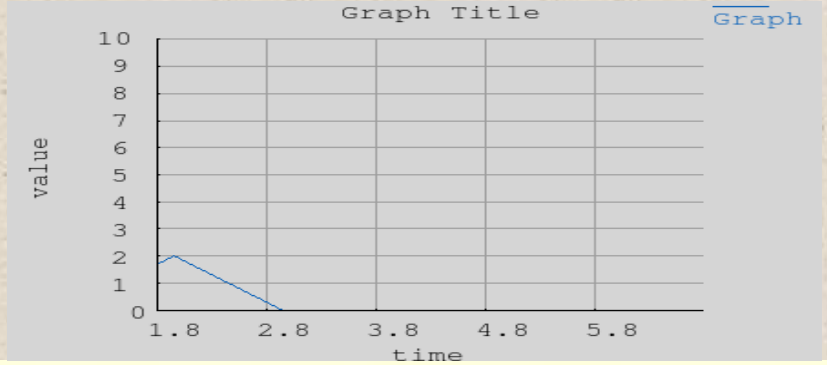

Figure 4: Throughput performance of Obstacle free scenario ADV

Figure3, 4depicts the network throughput of AODV in which no Obstacle is present and the speed of node is 20m/s. And the no of drop packets do not shot up in the starting but increases with the delay of time. In this case we can see that AODV throughput rate starts with the above 50 Kbytes/ sec and within matter of seconds the throughput rate fall to the lowest level i.e. approximately 1 KB/ sec. Although AODV is one of the best examples of reactive routing methods but in the highly mobile environment its performance decreases suddenly to the lowest level in terms of throughput. The reason behind the sudden decrease in throughput rate is that AODV reacts on demand basis, thus when the source node send the RREQ to its neighbors for forwarding the packet towards destination the neighboring nodes move with high speed. So, source node could not receive any RREP from its neighboring nodes and it considers the destination is out of range, this factor suddenly reduce its throughput rate. As it is shown in Figure 8 that AODV throughput rate become higher after some time and maintain its throughput rate for some time this is due to the feature of AODV in which it repeatedly sent the request for forwarding packets towards destination but its disadvantage is that it uses more network resources to resend the route request.As compared to AODV, ADV shows stable throughput rate in entire simulation time. ADV throughput rate in the highly mobile environment of constant for a short period of time. The on-demand character in ADV is implemented by two key aspects: only routes to *active receivers* are maintained and by varying the frequency and the size of the routing updates in response to the network load and mobility conditions. Thus the average throughput of ADV is more as compared to AODV.So overall in this scenario ADV performed well as compared to AODV.

Packets Drop

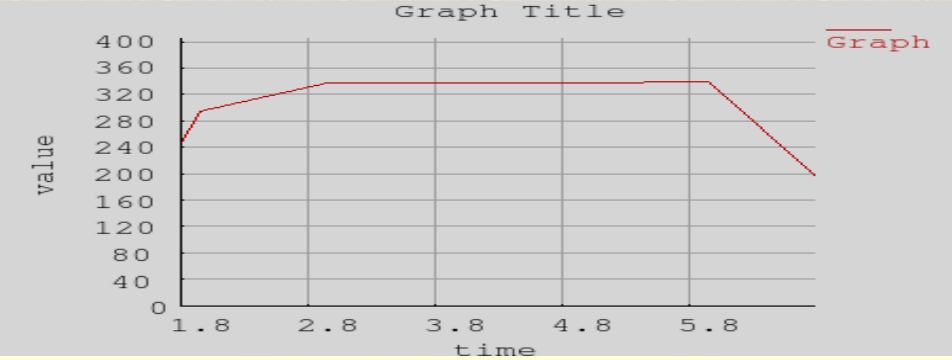

Figure 5: ADV Drop packets in Obstacle free environment.

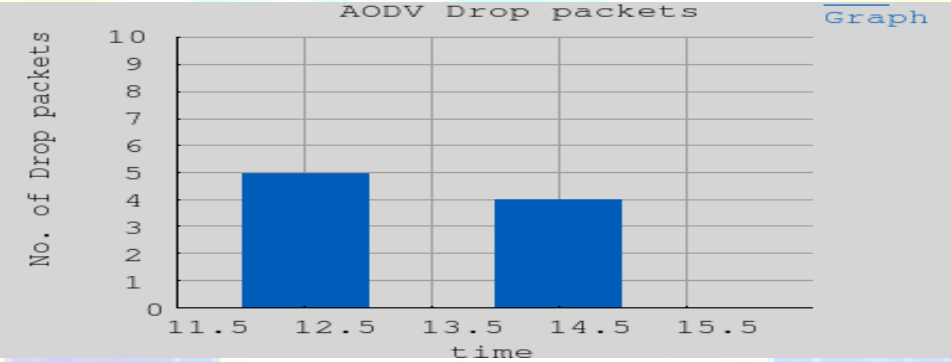

Figure 6: packet drop performance for AODV in Obstacle Free environment

Figure 5, 6 shows behavior of AODV and ADV in terms of packet drop at maximum node speed of 20 m/s. But this decrease in packets is only for a single second and in no time the packet drop ratio of AODV becomes higher. The reason for the higher packet drop in AODV is due to the multi-hop nature of the network.

On the other hand the packet drop ratio of ADV ratio gradually increases with the time but Figure 5, 6 shows that there is a slight increment in the packet drop ratio but this ratio remained constant for the rest of time and decrease to again the level where it was before. The slight changes in the packet drop ratio in ADV may be due to the longer beaconing interval.

Thus in mobility scenario with the nodes maximum speed of 20 m/s there is a tremendous difference in AODV and ADV in term of packet drop ratio. On the whole in this scenario ADV has dropped much lower number of packets as compared to AODV. Furthermore, in this scenario we calculated only those drop packets that lost between the last intermediate nodes to

destination. Therefore, in this situation a throughput and drop packets do not have any direct relation.

ADV performed well in terms of packet drop as it is illustrated from the above figures that the packet drop rate of ADV is less than AODV in complete simulation time. Also there is a reduction in the total number of packets drop in ADV when nodes moving with the maximum speed. While AODV packet drop rate increased when nodes movement was more compared to previous case. ADV drop packets rate is lower than AODV in both situations. AODV drop packets rate was higher when nodes speed increased. Furthermore, it can be concluded that ADV outperformed AODV in terms of throughput. However, tremendous difference in drop packet of both these protocols when nodes movement was 20 m/s or more. Moreover, packet drop and throughput graphs are not the exact mirror of each other in our results. Packets can be lost at intermediate nodes while throughput shows the total number of received packets at the destination

CONCLUSIONS:

The main goal of this thesis is to identify different issues in ad hoc routing protocols and to evaluate these routing protocols against each other using TCP. In this study focus was on reactive and hybrid routing strategies.

We have examined how different routing protocol suffers from the highly mobile nature of nodes.

In this study, by literature surveying we found reactive routing protocols of traditional ad hoc networks are applicable for mobile nodes. From the results of our study we realized that the traditional ad hoc reactive routing protocols have unstable performance in MANET. We examined reactive ad hoc routing protocol AODV against hybrid routing protocols i.e. ADV and found that the performance of AODV suffers from the high speed of nodes, obstacles and sudden change in position of nodes. So high speed of nodes and involvement of obstacles are major challenges for traditional ad hoc routing protocols that make them unsuitable for mobile Nodes. We found that hybrid routing protocols shows better results than traditional ad hoc routing protocols in Mobility. We evaluated routing protocols that are ADV and AODV in two different

scenarios of Mobility. ADV outperforms AODV completely in both Obstacle free and Obstacle environments of Mobile Nodes.

For both environments of Mobile nodes where numbers of nodes are higher and obstacles involved, ADV is reliable for direct communication among nodes. Furthermore, hybrid routing protocols cannot deal with all various environments of Mobile nodes.

From the conducted study, we suggest that hybrid routing protocols are more promising than traditional ad hoc routing protocols for Mobility. Although hybrid routing is scalable for Mobile but it is hard to suggest any single routing protocol that can deal with different scenarios of mobility. The selection of a single routing protocol is hard because the protocol performance depends on vehicle speed, driving environment etc. that may vary from one environment of network to another.

Future work:

In wireless network community mobile nodes received attention of many researchers due to its unique nature. Although amount of research has been devoted to the various routing issues in mobility but still there are some areas that need more attention. Due to time constraint, we only focused on traditional ad hoc and position based routing protocols but still there are some areas in these routing protocols that need more attentions.

- Other performance metrics such as end-to-end delay, average routing overhead and packet delivery ratio etc. should be measure for both topologies based and position based routing methods.
- Secure routing is one of the challenging areas. Due to the unsecure and ad hoc nature of MANET, there is prone to several security attacks that may lead to devastating consequences. So security attacks should be investigated with respect to different attacks in Mobile Nodes.
- Several other routing methods such as broadcast, geocast and cluster based routing methods can be considered for the evaluation of routing protocols.

- New algorithms should be proposed to provide reliable QoS for safety and comfort applications in Nodes.

Different position based routing protocols should be evaluated in real environment of mobile nodes to check their efficiencies in real situation.

REFERENCES:

- Xiang Chen, HongqiangZhai, Jianfeng Wang, and Yuguang Fang," TCP performance over mobile ad hoc networks", CAN. J. ELECT. COMPUT. ENG., VOL. 29, NO. 1/2, JANUARY/APRIL 2004.
- StylianosPapanastasiou, Mohamed Ould-Khaoua, Lewis M. Mackenzie," On the evaluation of TCP in MANETs", Department of Computing Science University of Glasgow Glasgow, UK G128QQ.
- Yuvaraju B N and Dr. Niranjan N Chiplunkar," Scenario Based Performance Analysis of Variants of TCP Using NS2 - Simulator", *International Journal of Computer Applications (0975 – 8887) Volume 4– No.9, August 2010.*
- Jennifer.S.Raj, S.Smys, G.JoseminBala," Performance Improvement in MANETs: A Cross Layer Approach via TCP", International Journal of Recent Trends in Engineering, Vol 2, No. 1, November 2009.
- Sridhar K N and MunChoon Chan," Stability and Hop-Count based Approach for Route Computation in MANET", School of Computing, National University of Singapore, Singapore 117543 ©2005 IEEE
- M. Mauve, A. Widmer, and H. Hartenstein, "A survey on position-based routing in mobile ad hoc networks," *Network, IEEE,* vol. 15, no. 6, pp. 30 - 39, Nov/Dec 2001.
- Mohandas, B. &Liscano, R., "IP address configuration in VANET using centralized DHCP", in Proceedings of 33rd IEEE Conference on Local Computer Networks, Montreal, Canada, October 2008
- M. Abolhasan, T. Wysocki and E. Dutkiewicz, "A review of routing protocols for mobile ad hoc networks", Ad Hoc Networks 2 , 2004 , pp. 1–22

- N. H; Tony Larsson, " Routing Protocols in Wireless Ad Hoc Networks- A Simulation Study," Department Of Computer Science and Electrical Engineering, Luleå University of Technology, Stockholm, 1998.
- C. Perkins and E. Royer, "Ad-hoc on-demand Distance Vector Routing," Proc. 2nd IEEE Wksp. Mobile Comp. Sys. App., Feb. 1999, pp. 90–100.