Impact of FTP Application file size and TCP Variants on MANET Protocols Performance

Abdelmuti Ahmed Abbasher Ali, Dr.Amin Babkir A/Nabi Mustafa

***Abstract*— MANET is a peer-to-peer, multi-hop Mobile wireless network where nodes operate as hosts, generating traffic, and Routers, carrying control and data. Packets are transmitted in store and forward manner from source to destination. In this research paper we analyzed the impact of file size on the performance of AODV, DSR and OLSR under TCP traffic. We used different TCP Variant namely Tahoe, New-Reno, CUBIC and Standard TCP. We found that the file size have impact on network performance but the impact of TCP variant is not outstanding and the selection of suitable MANET protocol is more important than the selection of TCP variant.**

***Index Terms*—AODV, DSR, FTP, OLSR, TCP**

I. Introduction

A mobile ad hoc network is an autonomous collection of mobile devices (laptops, smart phones, sensors, etc.) ; that communicate with each other over wireless links and cooperate in a distributed manner; in order to provide the necessary network functionality in the absence of a fixed infrastructure[1]. It is a peer-to-peer network where nodes operate as hosts, generating traffic, and Routers, carrying control and data. Nodes that are located within each other transmission range, can directly communicate, otherwise intermediate nodes will act as a router and relay data packets to their destinations. Many routing protocols have been designed for MANETs. Routing protocols in MANETs are classified as Proactive, Reactive and Hybrid.

Proactive protocols (Table-driven) maintain fresh lists of destinations and their routes by periodically distributing routing tables throughout the network so that a source can find a route immediately when it needs it. Optimized Link -State Routing Protocol (OLSR) is an example of proactive routing protocols in MANET .Reactive or (On-demand) finds the route on-demand by flooding the network with route request packets. AdHoc-On-Demand Vector Routing protocol (AODV) and Dynamic Source Routing (DSR) are examples of Reactive protocols. Hybrid protocol combines the advantages of proactive and reactive routing. Zone Routing Protocol (ZRP) is an example of a hybrid protocols. The protocols studied in this research are AODV, DSR and OLSR.

In this research paper we will study the Impact of application file size, on the performance of the protocols under study. Five different file sizes will be simulated for each protocol and, the performance parameters under study will be evaluated to find out which file(s) size is appropriate for each protocol. FTP is being used as the application where all the nodes in the network run multiple FTP sessions. Data will be transmitted from one source (FTP server) to the destined node. When the application files size increase the volume of traffic do too. This will cause congestion on the nodes that are located near the source; which will degrade the overall performance of the network. The routing protocol should be able to find an alternative route to overcome congestion near the source (FTP Server).this research will also find out which of the protocols under study are able to avoid congestion by finding an alternative route. FTP uses TCP as the transport protocol; and after determining the best file size for the protocols under study; we will study the impact of TCP variants; namely New Reno, CUBIC, and Tahoe on the performance of routing protocols under study; to figure out the best TCP variant for the appropriate file size.

Many researchers have investigated the impact of TCP variant on MANET routing Protocol. In reference [2] a comparison of the performance of TCP-Reno and TCP-Vegas over MANET had been performed. The researchers concluded that the performance difference between TCP-Reno and TCP-Vegas over any selected routing protocol is irrelevant; and the selected routing protocol is more important than the selected TCP variant. In reference [3] a comparison study of TCP-Reno, TCP-New Reno and TCP-SACK has been performed. The results of the comparison is that in a high density network when congestions and packet error rates are very likely, TCP SACK outperforms other variants in terms of retransmission attempts, upload and download response time. With the variations of mobility rates, TCP Reno dominates other congestion control algorithms in most of the cases. In Reference [4] the authors has carried out a comparison of performance of TCP over MANET. The TCP variant implemented were Reno, New-Reno and SACK under different scenarios related to mobility and network size. The study concluded that out of the three, the SACK variant can adapt relatively well to the changing network sizes while the Reno performs most robustly in different mobility scenarios.

II. TCP in MANET

TCP is an end-to-end and reliable transport protocol. It was originally designed for wired networks. There are several factors that influence TCP performance in MANET, such as dynamic topology, shared medium, high Bit Error Rate (BER) and signal fading [6].One of the important aspect of TCP is congestion control[5].TCP interpret a packet loss as an indicator of congestion. In MANET packet loss can occur as a result of a link failure or other errors, but this loss will be interpreted by TCP as congestion, so TCP invokes congestion mechanisms. The invoked congestion mechanisms; will decrease the network throughput; thus degrading MANET performance [7].Many congestion control exists for TCP. A brief discussion of the TCP variants implemented in this research is discussed in the following sections.

Abdelmuti Ahmed Abbasher Ali, Faculty of Engineering-Elneelain University-Khartoum-Sudan
Dr.Amin Babkir Abdelnabi Mustafa, Faculty of Engineering-Elneelain University-Khartoum-Sudan

A. TCP Tahoe

In non-congestion environment the congestion window size, is the same size as the receiver's advertised one.TCP Tahoe upon a loss of a segment decrease the congestion windows size exponentially [5]. If loss continues, TCPTahoe limit transmission to a single datagram and double Time-out; so that routers gain more time to clear their queues. This mechanism is called Multiplicative Decrease Congestion Avoidance [5].Slow start mechanism is used when congestion is over. It starts the congestion window at the size of a single segment and increase the congestion window by one segment each time an acknowledgement arrives. The overall approach is known as Additive Increase Multiplicative Decrease (AIMD) [5].

B. Reno and New- Reno

When TCP Reno receives 3 duplicate ACK's it interprets it as a sign of a segment loss. It reacts by re-transmit the segment without waiting for timeout. This algorithm is called Fast Re-Transmit [8].New Reno acts as Reno when receiving three 3 duplicate ACK's. it differs from RENO in that, Unless all data outstanding is acknowledged ,New Reno will not exit fast-recovery [8]. Thus it overcomes the problem faced by Reno of reducing the CWD multiples times [9].

C. CUBIC

In contrast to existing TCP congestions control standards ,which modify the congestion windows growth function linearly, CUBIC use a cubic function in order to improve the scalability of TCP over fast and long distance networks[10].It make the windows growth to be independent of Round Trip Time (RTT).CUBIC is scalable and fair to TCP flows[10].

III. OVERVIEW OF AODV, DSR AND OLSR

A. AdHoc-On-Demand Vector Routing protocol (AODV)

AODV [11] is an On Demand routing protocol and thus only initiate a route discovery when needed. Neighbor nodes learn about each other's either by broadcast or a HELLO messages. When a node wants to send a packet it first checks for the address of destination in it is routing table; if address exist; it start sending packets otherwise; it will start a route discovery process by broadcasting a route request packet (RREQ). All the nodes that receive the RREQ packets check if they have any packet with the same broadcast identifier and same source IP address if they do, they will discard the packets to avoid duplicate packets. When the destination node receives the RREQ; it sends a route reply packet RREP to the source node by unicast in the reverse path. When an intermediate node discovers an active links disconnection; or change of topology caused by node movement; it sends a route error message (RERR) to the affected nodes. The source node will re-initialize Route discovery process; if it is still need that route. In brief AODV uses three types of control messages RREQ, RREP and RERR to implement route discovery and maintenance processes.

B. Dynamic Source Routing (DSR) Protocol

DSR [12] uses source routing in which the sender knows the complete hop-by-hop route to the destination. These routes are stored in a route cache. The data packets carry the source route in their packet header [13]

DSR protocol composed of two mechanism Route Discovery and Route maintenance.DSR uses flooding to discover a requested route. Route maintenance is the mechanism by which a source node can detect any changes in the network. When change detected the source node; can either attempt to use any route it happens to know about the destination node or invoke a route discovery mechanism to find a new route to destination. Route discovery and Route maintenance are on-demand operations. Implementation of DSR and source routing results in a loop-free packet routing ,eliminate the need for updating routing information in the passed-by nodes and allow caching of information by nodes that forwarding or over hearing packets for their own future use.

C. Optimized Link State Routing Protocol (OLSR)

Optimized link state routing (OLSR) [14] protocol is a modification and optimization of the pure link state routing. Instead of blind flooding the network, OLSR reduces the overhead of network floods through the use of, Multipoint Relay (MPR).MPR are the selected routers (Nodes) that can forward broadcast messages during the flooding process. Each node selects it is MPR set from among it is one – hop symmetric Neighbors; such that it covers, in terms of radio signal, all symmetric two –hop nodes. In OLSR each node maintains a route to every other node in the network. The routes are stored in routing-table at each node. OLSR has three functions: packet forwarding, neighbor sensing, and topology discovery [14]. Packet forwarding and neighbor sensing mechanisms provide routers with information about the neighbors and offer an optimized way to flood messages in the OLSR network using MPRs. The neighbor sensing operation allows nodes to disseminate local information in the entire network. Topology discovery is used to determine the topology of the entire network; and to construct the routing tables

IV. SIMULATION SETUP

In this section we will describe how the case under study has been carried out. A network of 50 stationary node and FTP server has been created. We simulate each protocol using five different file sizes which are ranged between low-load and huge-load. We measured the impact of file size based on the metric proposed. Table (1) below shows the simulation parameters and table (2) shows the color used for each file size.

Table (1) Simulation parameters

Simulation Parameters	
Simulation area size	1000mx1000m
Number of Nodes	50
Simulation Time	600sec
Routing MAC Protocols	
Routing protocol studied	AODV,DSR,OLSR
MAC Protocol	802.11g
Data Rate(bps)	1Mbps
Buffer size(bits)	256000
Mobility Model	
Mobility Type	N/A
Speed	N/A
Pause Time	N/A
Radio Characteristic	
Transmitted Power(w)	0.005
Packet Reception Power threshold	-95
Traffic and FTP Parameters	
Inter request Time	Exponential(720)
Type of Service	Best effort
File Size(constant) in Byte	1000,5000,50000 100000and 200000byte

Table (2) Color Code used for File Sizes

1000 Byte	5000 Byte	50000 Byte	100000 Byte	200000 Byte

Performance Metrics

The performance metrics used to measure the impact of application file size are as follows

A. Average End-to-End delay

The packet End-to-End delay is the amount of time it takes a packet to exit from a source until it reaches it is destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, propagation and transfer times .End-to-End delay is expressed in Seconds. End-to-End delay is important because some applications are delay sensitive.

B. Throughput

Throughput can be defined as the ratio of the total data that reaches a receiver from the sender. It is expressed as bytes or bits per second. Throughput can be affected by many factors such as limited bandwidth, network topology changes, and unreliable communication between nodes

C. Download Response Time(DRS)

Measured from the time a client application send a request to the server to the time it receives response packet, it include every response packet sent from the FTP server to the ftp application client. The download response time is highly influenced by TCP's congestion window size. More especially, the larger the congestion window size, the shorter would be the file response time.

D. Data Packets Dropped

The number of packet dropped at the application layer while transferring data packets

V. Result Analysis and Discussion

In this section we provide results obtained from simulation and discuss them for each protocol.

A. OLSR Analysis

The figures below show simulation results obtained for OLSR

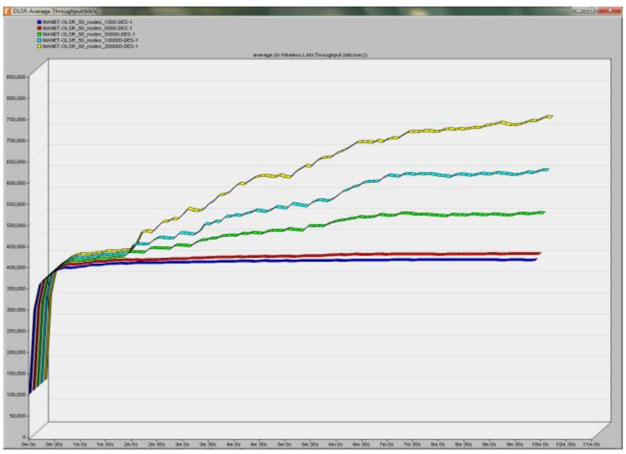

Fig (1) Average Throughput for OLSR for Different File size

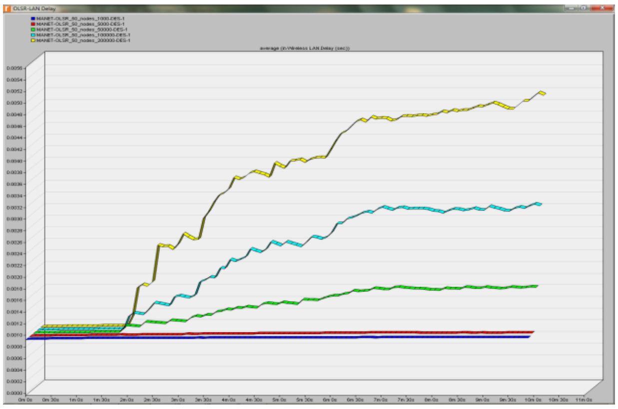

Fig (2) Average End-To-End Delay for OLSR

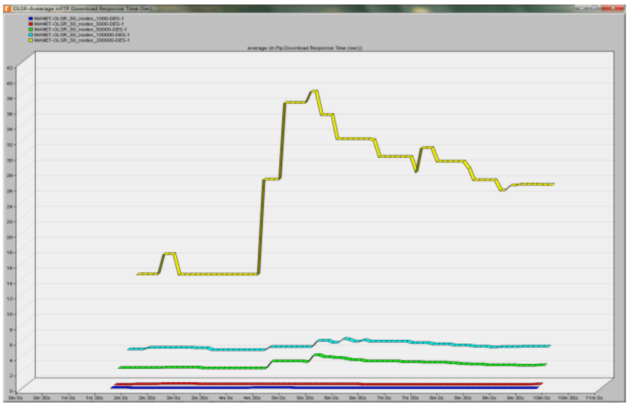

Fig (3) Average in Download Response time

Table [3] below include all results obtained from OLSR simulation .We note that when file size is set to 200000bytes Download response time increase dramatically and it became 5 time the value for 100000 bytes. Also Data Dropped increase 3 times the value for 100000 byte but the Throughput compared to 100000 byte file is not increasing significantly. For the same reasoning 100000 byte file compared to 50000 byte is also not significant so it better to sit the file size in OLSR case to 50000 byte or less

Table3-Data Analysis of different file size of OLSR

File Size (Byte)	Throughput (Byte/sec)	Delay (Msec)	DRS (Sec)	Dropped (byte)
1000	51964	.951	.3	0
5000	52811	.978	.4	.9
50000	63847	1.7	2.5	58
100000	75350	3	4.5	168
200000	89999	4.9	25	517

A. AODV Analysis

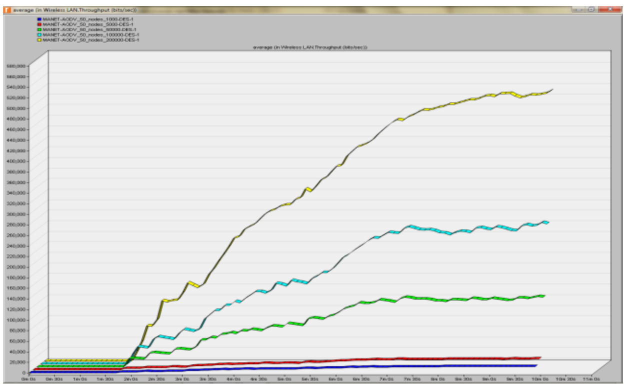

Fig (4) Average Throughput for AODV for Different File size

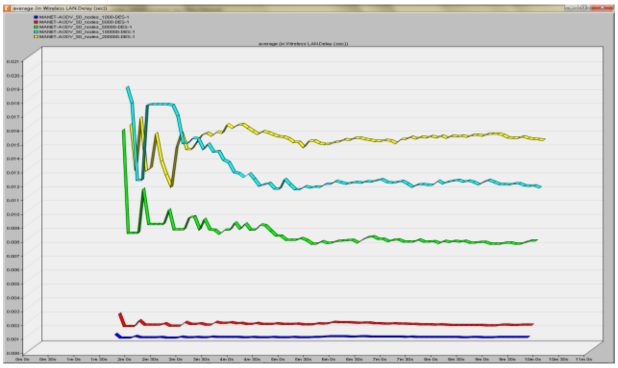

Fig (5) Average End-To-End Delay for AODV

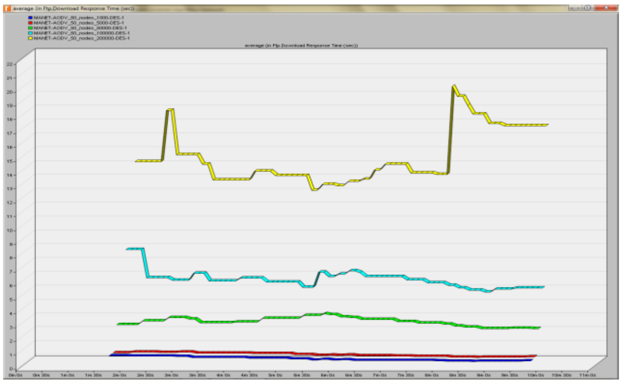

Fig (6) Average in Download Response time in AODV

Table [4] below include all results obtained from AODV simulation .We note that when file size is set to 200000 Download response time increase dramatically and it became 3 time the value for 100000 bytes. Also Data Dropped increase 2 times the value for 100000 byte but the Throughput compared to 100000 byte file is increasing 2times. For the same reasoning 100000 byte file compared to 50000 increased DRS 2 times and data dropped increased 3 times. It is better to set file size to 50,000bytes

Table4-Data Analysis of different file size of AODV

File Size (Byte)	Throughput (Byte/sec)	Delay (Msec)	DRS (Sec)	Dropped (byte)
1000	1377	1.1	.6	0
5000	2543	1.7	.7	.17
50000	17773	7.3	2.4	75
100000	34554	11.6	5.19	236
200000	65578	14.6	16.69	591

A. DSR Analysis

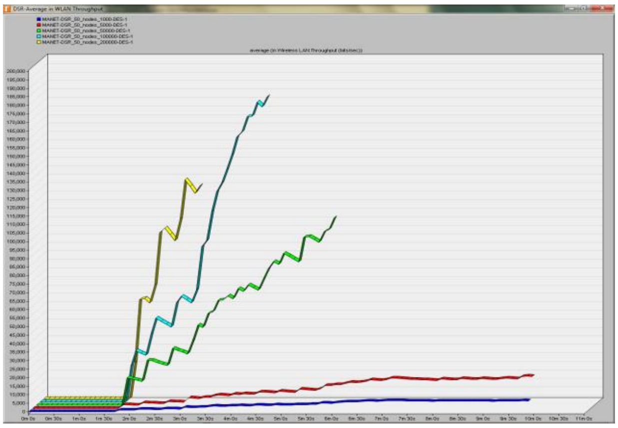

Fig (7) Average Throughput for DSR for Different File size

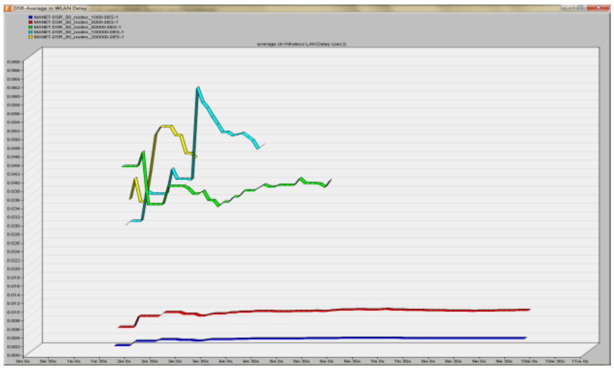

Fig (8) Average End-To-End Delay for DSR

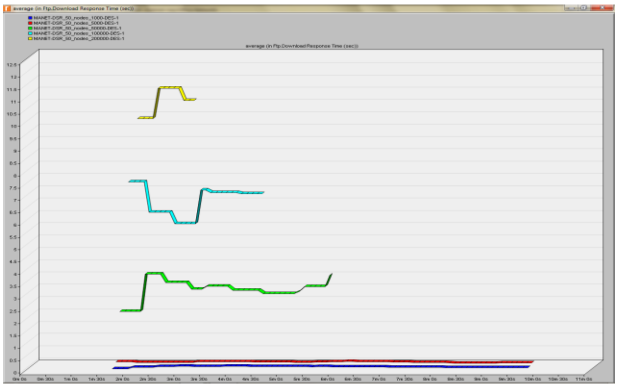

Fig (9) Average in Download Response time in DSR

Table5-Data Analysis of different file size of DSR

File Size (Byte)	Throughput (Byte/sec)	Delay (Msec)	DRS (Sec)	Dropped (byte)
1000	789	3.8	.,3	0
5000	2326	9.7	.,4	0
50000	19270	49	2.8	414
100000	22404	46 (270sec)	7	247 (270sec)
200000	15634	43 (186sec)	10.5	28 (186sec)

Table (4) include all results obtained from DSR simulation .We note that when file size is set to 100000 bytes and 200000 bytes the DSR protocol stopped completely after 270 and 180 sec respectively, this show that due to congestion in nodes near the source of traffic DSR failed to find another route to a void the congested ones and as a result the link will be saturated and no more data packets will be forwarded which will lead to congestion collapse [5]; so it better to sit the file size in DSR case to 50000 byte or less. The poor delay and throughput performances of DSR are mainly attributed to aggressive use of caching, and lack of any mechanism to expire stale routes or determine the freshness of routes when multiple choices are available [13]

And as proved in [13] Stale caches in DSR have a harmful effect on TCP performance. This will answer the research question of which protocols can avoid congestion when nodes near the source (FTP Server) are congested. It is clear that AODV and OLSR can survive congestion near the source but DSR failed to do that for the above-mentioned reasons.

A. TCP Variant Results and Analysis

Here we used the 50,000 byte file size and we used TCP variant, namely CUBIC, NEW-RENO, TAHOE and STANDARD to compare the performance of the routing protocol under study. The results shown below are obtained for each protocol

Table (6) OLSR Results

TCP Variant	Throughput (Byte/sec)	Delay (Msec)	DRS (Sec)	Dropped (byte)
New Reno	63847	1.7	2.5	58
CUBIC	63752	1.7	1.85	72
Tahoe	53965	.9	2.4	78
Standard	49266	.9	2.5	60

From table (6) we note that TCP New-Reno outperformed other variants in term of throughput and minimum data dropped although the difference is not very significant. CUBIC comes next in terms of throughput then Tahoe and Standard with different variation in delay and DRS time. This can be attributed to the different mechanism followed by the variants in response to congestion.

Table (7) AODV Results

TCP Variant	Throughput (Byte/sec)	Delay (Msec)	DRS (Sec)	Dropped (byte)
New Reno	17773	7.3	3.04	75
CUBIC	16807	7.3	2.66	52
Tahoe	16814	8.2	3.67	103
Standard	16827	8.2	3.8	104

From table (7) we note that AODV perform almost equally for all the TCP variants in terms of Delay and Download Response time with minor differences in throughput. Data dropped is more in Tahoe and Standard while CUBIC has minimum data dropped and minimum download response time compared to other protocols. This performance indicate that the latency time or the time required by AODV to find a route is less than the round trip time required by the TCP variants.

Table (8) DSR Results

TCP Variant	Throughput (Byte/sec)	Delay (Msec)	DRS (Sec)	Dropped (byte)
New Reno	19270	49	2.8	414
CUBIC	14581	47.9	3.69	604
Tahoe	13887	56	6.76	1278
Standard	10429(up to 324ec)	41.5(up to 324ec)	4.6(up to 324ec)	270(up to 324ec)

From table (8) we note that DSR is performing poorly in terms of delay and throughput compared to OLSR and AODV. This is mainly attributed to aggressive use of caching, and lack of any mechanism to expire stale routes or determine the freshness of routes when multiple choices are available

VI. Conclusion

In this research paper we have studied the impact of file size and TCP variants on the performance of AODV, DSR and OLSR.OLSR out performed AODV and DSR in term of throughput and Delay and this is due to it is proactive nature. We also find out that AODV and OLSR can avoid congestion routes by finding other routes while DSR failed. New Reno has achieved the best throughput in all the protocols .This achievement is due to the fact that New-Reno always tries to maintain a wide congestion window. AODV performs well under different TCP variant and this proves the flexibility of AODV. We can conclude that the selection of AdHoc routing protocol is important than the selection of TCP variant as the results obtained through simulations prove. In the future we will study the impact of node mobility and network size on the performance of TCP variant and different file size.

REFERENCES

[1] K. Subir, and G, Basavargia AdHoc Mobile Wireless networks Principles, protocols and Applications Taylor & Francis Group .USA 2008 Page

[2] Kim .D et el “A comparison of the performance of TCP-Reno and TCP-Vegas over MANETs” 1-4244-0398-7 2006 IEEE

[3] Md Nazmul Islam Khan & et el “A survey of TCP Reno, New Reno and SACK over Mobile Ad-Hoc Network” International Journal of Distributed and Parallel Systems (IJDPS) Vol.3, No.1, January 2012

[4] K. Natarajan and G. Mahadevan “A Comparative Analysis and performance evaluation of TCP over MANET routing protocols” Journal of Wireless Network and Microsystems Vol. 4 No. 1-2, January-December, 2015

[5] C.Douglas Internetworking with TCP/IP principles, Protocols and Architecture Person Education. New Jersey USA 2014 Page 234-278

[6] O. Bazan, U. Qureshi, M. Jaseemuddin and H.M. El-Sayed, "Performance Evaluation of TCP in mobile ad-hoc networks," in The Second International Conference on Innovations in Information Technology, IIT’05, Toronto, Canada, 2005, pp. 175-185

[7] K. Natarajan, Dr. G. Mahadevan “A Comparative Analysis and Performance Evaluation of TCP over MANET Routing Protocols” Int Jr of Advanced Computer Engineering and Architecture Vol. 1, No. 1, June 2011

[8] V. Jacobson. “Modified TCP congestion avoidance algorithm”, Technical report, 30 Apr. 1990. Email to the end2end-interest Mailing List, URL: ftp://ftp.ee.lbl.gov/email/vanj.90apr30.txt

[9] S. Floyd, T. Henderson “The New- Reno modification to TCP’s fast Recovery algorithm” RFC 2582, Apr 1999

[10] S. Ha, I. Rhee, and L. Xu, “CUBIC: a new TCP-friendly high-speed TCP variant,” SIGOPS Oper. Syst. Rev., vol. 42, pp. 64–74, July 2008. [Online]. Available: http://doi.acm.org/10.1145/1400097.1400105

[11] C. E. Perkins and E. M. Royer Ad hoc on-demand distance vector routing. In Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications, pages 90–100, Feb 1999

[12] D. B. Johnson and D. A. Maltz, “Dynamic Source Routing in Ad-Hoc Networks," Mobile Computing, ed. T. Imielinski and H.Korth, Kluwer Academic Publishers, 1996, pp. 153-181

[13] Perkins, C.E.; Royer, E.M.; Das, S.R.; Marina, M.K., Performance comparison of two on demand routing protocols for ad hoc networks, Personal Communications, IEEE , vol.8, no.1, pp.16,28, Feb 2001

[14] T. Clausen, P. Jacquet, A. Laouiti, P. Muhlethaler; A. Qayyum, and L. Viennot. “Optimized Link State Routing Protocol,” in Proceedings of IEEE INMIC, Lahore, Pakistan, December 200