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Performance Comparison of Transport Layer Protocols for Multimedia Application in MANET Networks

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Abstract: A Mobile Ad hoc Network (MANET) stands for a group of wireless mobile nodes which have communication capability with other mobile nodes without any central base station or fixed wireless hardwires. Routing protocols handle the approach for selecting the finest path from source to destination. Ad hoc On-demand Distance Vector routing protocol (AODV) is one of the extensively used routing protocols in MANET networks. This study presents an investigation for the performance of the transport layer protocol (TCP, UDP) for multimedia application with AODV routing protocol using diverse simulation scenarios on MANET with AODV routing protocol. Execution measurements like throughput, Packet Delivery Fraction (PDF) and Average Delay (AED) are employed to evaluate the TCP and UDP protocols .Network Simulator (NS-2.35) is adopted as network test tool in this study for all investigational parameters.

Key words: TCP, UDP, AODV, NS2 simulations, wireless, hardwires

INTRODUCTION

Ad-hoc system is a network without infrastructures where the nodes are communicated together without fundamental base station. Wireless link is the transmission medium among nodes. Every one of nodes can transmit, receive and forward data to the neighborhood nodes. The chosen system has the capability for managing the network configuration because of the node movement. The movement of node may lead to break communication link between other nodes in this case, nodes merely establishes a new links. Infrastructures less network can be divided into dual categories; Static Ad-Hoc Network (SANET) and Mobile Ad-Hoc Network (MANET) (Ullah and Rehman, 2010).

Mobile Ad hoc Network (MANET) is a network without central base station in view of the fact that each node communicate straightforwardly with other neighbors. Routing protocols are responsible to select the finest path from source to destination dynamically. A lot of routing protocols as in Ad hoc on Demand distance Vector routing protocol (AODV), Dynamic Source Routing protocol (DSR) and others are used for MANET networks to get the most favorable pathway from source to destination (Telang, 2016).

Transport layer protocol represents one of the imperative issues that may influence the QoS of mixed medium applications through the MANET networks transportation. Many transport layer conventions are utilized for end-to-end information transmission. UDP is one of the significant protocols in the transport layer that provides end-to-end contact. It represents the multimedia applications transportation as it offers a smaller amount of delay and multimedia applications are delay bigoted. The foremost negative aspect of UDP is the deficiency in of congestion control mechanisms that might cause a number of packet losses and network congestion. TCP is a different transport layer protocol that offers connection-oriented service and congestion control mechanisms with the reliable transfer of the data onto transportation. These two protocols are the most widespread transport protocols used for wired and wireless networks. The network capability supplies superior service to choose network traffic over a variety of networking technologies called Quality of Service (QoS). The main goals of QoS are to supply priority including dedicated bandwidth, controlled to delay and jitter and loss characteristics. Based on the handling of network traffic, absolutely diverse applications have special needs (Hussein and Lu, 2016).

Ad hoc On Demand Distance Vector (AODV) routing protocol is an algorithm that facilitates active, self-starting, multi-hop routing among joined mobile nodes wishing to set up and sustain an ad hoc network. AODV allocates mobile nodes to acquire routes rapidly for new targets and does not involve nodes to preserve routes to destinations that are not in dynamic communication schemes. Also, AODV tolerates mobile nodes to act in response to link cracks and modifications in network topology in a well-timed approach. An imperative characteristic of AODV is the continuance of time-based states in all nodes; a routing entry not newly employed is terminated. If a route is not working, the neighborhood nodes will be alerted. Route discovery is in

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accordance with query and reply sequences while route information is saved in every transitional nodes by the side of route as route table entries. The subsequent control packets are adopted in this issue; Routing Request message (RREQ) is transmitted by a node that require a route to a new node and Routing Reply message (RREP) is unicast returning to the RREQ source while Route Error message (RERR) is transmitted to inform other nodes about the link loss. HELLO messages are employed for links detection and checking to neighborhood nodes (Perkins *et al*., 2003).

Transmission Control Protocol (TCP) is a transport layer protocol adopted by applications that involve definite delivery (Forouzan, 2007). It is a link oriented byte stream protocol and TCP is a trustworthy stream transport protocol. The stream term here is an indication for connection. TCP is broadly utilized as an oriented connection transport layer protocol that offers consistent data packet delivery over unreliable links. TCP conveys roughly ninety percent of internet activity in the current heterogeneous wireless and wired networks (Salem *et al*., 2014). TCP is utilized to manage segment size, rate of data exchanging, flow control and network congestion. Web browsing, e-mail and file transfer are common applications that make use of TCP. It is preferred where error correction facilities are required at network interface level. TCP is reliable end to end protocol for the reason that TCP is attempting to provide reliable data transmission between two entities (QasMarrogy *et al*., 2014).

User Datagram Protocol (UDP) is a more straightforward, connectionless internet protocol. It is one of the foundation protocol members of the Transmission Control Protocol and Internet Protocol (TCP/IP) other than set of network protocol utilized for the internet. Packets are referred as datagram in case of UDP. UDP sends datagram within internet protocol organized without the need of prior interchanges to set up uncommon transmission channels or information ways. UDP utilizes a vital transmission demonstrated without comprehended handshaking dialogues and without executing any reliability providing, ordering and data integrity (Gosai and Goswami, 2013). Time-sensitive applications often use UDP for the reason that when packet delivery time is within the considerable the interest, dropping packets are ideal as divergent to waiting for delayed packets. For multimedia data transmission, UDP is fundamentally employed by time sensitive applications in addition to servers that respond to undersized queries from enormous clients number. UDP is normally used in Domain Name System (DNS), Voice Over IP (VOIP), trivial file transfer protocol and online games, news websites, etc.

This study focuses on quality of service regarding Packet Delivery Ratio (PDR), throughput and Average End to End Delay (AED). It gives a summary of the TCP and UDP protocols utilized in MANET network with AODV routing protocol and its features are concentrated on the performance analysis of the transport layer protocols. Diverse settings are achieved with the intention of investigating the resultant performance. The QoS metrics like, throughput, delay, packet loss can be employed to evaluate the results of these transport layer protocols. Network Simulator 2 (NS-2.35) has been utilized as a simulation tool for the transport layer protocols in the wireless network in this study.

Literature review: Experiments on transport layer protocol were performed by a several of researchers to analyze and assess the behavior of transport layer protocols.

Taha (2017) TCP and UDP protocols are simulated and their performance were compared. From the simulation results, the performance analysis of TCP and UDP shows that TCP is better than UDP in term of throughput in the three simulation scenario despite of varying number and speed of mobile nodes in the network and change of the size of the simulation area. But in Packet Delivery Ratio (PDR) and Average End to End Delay (AED) of UDP is better than TCP because there is no form of flow control or error correction and TCP suffers from multihop wireless routes because its sent packets acknowledgement is time consuming as compared to UDP.

Selvam and Vimal-Raj (2016) the researchers investigated the performance of TCP, SCTP, DCCP and UDP is assessed using You Tube video traffic over 3G and 4G. With the intention of analyzing the performance of these transport layer protocols, diverse performance metrics have been employed such as packet loss, delay, high speed and throughput. By comparison of TCP, SCTP, DCCP and UDP protocols, it has been seen that DCCP has superior QoS constraints in accordance with speed, delay, throughput and packet loss. It can be adopted for effectual transportation of the You Tube video traffic over 3G and 4G in widows and Ubuntu operating system.

Wheeb (2017), the researcher studied the relation between transport layer protocols which considerably affects the QoS service for the transport layer with wired network. The transport layer supplies end-to-end data communication through a network. Presently, the most shared transport protocols used by internet application are TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). The researcher assessed the results of UDP, DCCP, SCTP and TFRC protocols for diverse traffic flows: data transmission, video traffic and VOIP in wired networks. The used performance standards for this assessment consist of throughput, end to end delay and packet loss rate. Eminent network simulator NS-2 is utilized to achieve the UDP, DCCP, SCTP and TFRC protocols results evaluation.

Kaur and Gill (2012) the researcher compares the performance of UDP and an enhanced version of UDP, called (UDP-lite) based on network delay, retry threshold and network load, for numerous video codecs by changing several network parameters such as nodes, traffic, bandwidth and mobility in Mobile Ad hoc Network (MANET) with various simulated setups.

MATERIALS AND METHODS

Simulation environment and tools: It is extremely tricky to assess the performance of a projected network in real life. As a result, a lot of network simulators are proposed to design and simulate the networks in different scenarios. In this study, TCP and UDP protocols in MANET network with AODV routing protocol have been simulated and their performance was compared. The simulation performance of routing protocols is investigated. Simulation support analyzing the behavior of routing protocols and complex networks performance previous to the factual applications. To accomplish the simulations, a number of simulators are existing that provides outputs in accordance with the input parameters. Accordingly, Network Simulator (NS-2.35) was used with diverse traffic models and AWK script is carried out to evaluate the performance of dynamic nature of communication networks. Linux Mint 10 Julia was used as operating system to support the simulation. The simulation parameters that are employed in the next experiments are explained in Table 1.

Performance metrics: There are a range of performance metrics as in Average End to End Delay (AED), Packet Delivery Ratio (PDR) and throughput are considered as three basic performance metrics.

Throughput: Throughput of the protocols, refers to how much data can be transferred from one location to another in a given amount of time. It is the total data for each time unit that is transferred from one node to another via. a communication link. It is calculated in bits/second. A throughput with a higher value is more frequently an absolute option in every network because it determines the nodes ability to deliver the packets from source to its intended destination.

Table 1: Simulation values

Parameters	Values
Radio model	Two ray ground
Mobility model	Random way point
Protocol	AODV
Traffic source	CBR, FTP
Packet size	1000 bytes
Transmission range	250
Area	500, 1000, 1500, 2000, 2500
Number of nodes	10, 20, 30, 40, 50
Transport protocol	TCP, UDP
Duration	100 sec
Speed	5 m/sec
Pause time	5 sec

Packet Delivery Ratio (PDR): It is characterized as the proportion of data packets delivered to the destinations to those produced from the sources. It can be computed by partitioning the packets number delivered to the destination throughout the packets number prepared by the source application layer. It describes the efficiency and accuracy of ad hoc directing protocols. A huge packet delivery ratio is of course, wanted in at all wireless networks.

Average End-to-End delay (AED): AED is the average time of data packet to be successfully sent via. a MANET from source to destination. It stands for the used time for the entire message to completely arrive at the goal from the source. Evaluation of end-to-end delay for the most part relies on upon transmission time, queuing time and processing delay. For each received packet, the average of end-to-end delay will be the time discrepancy among every packet transmitted and received, divided by the total number of received packets. The lower the average end-to-end delay is the better application performance.

Performance results: Here, the performance of TCP and UDP over AODV based on three parameters like number of nodes, number of connection and size of network area considering packet delivery ratio, throughput and average end to end delay for data packet delivery has been analyzed with different simulation scenario.

RESULTS AND DISCUSSION

The TCP and UDP performances are evaluated using the CBR traffic high data rate (500 kbps) application traffic with large packet size (500 bytes) to simulate multimedia application traffic in the real word like a video stream over MANET networks.

First scenario: In this simulation scenario,varying number of mobile nodes from 50-100, network size (2000*2000) and number of connections between nodes equal to 6 other value are setting according to Table 1.

Throughput: Table 2 shows analysis of throughput for two Transport layer Protocol (TCP, UDP). From the

Table 2: Analysis of throughput for two transport layer protocol (TCP, UDP)

No. of nodes/ Protocol	50	60	70	80	90	100
TCP	1300.82	2033.16	1875.11	1577.3	2314.58	1840.62
UDP	58.2848	60.0768	60.256	59.9872	59.9872	60.2112

Table 3: Analysis of packet delivery ratio for transport layer protocol (TCP, UDP)

No. of nodes/Protocol	50	60	70	80	90	100
TCP	98.7750	99.3078	99.1961	97.6792	99.3004	99.4053
UDP	95.8027	98.7482	99.0427	98.6009	98.6009	98.9691

Table 4: AED of data packet to be successfully sent via. a MANET from source to destination

No. of nodes/Protocol	50	60	70	80	90	100
TCP	0.0949155	0.17820500	0.1782050	0.10914900	0.0747364	0.10044300
UDP	0.0699504	0.00531917	0.0114173	0.00630363	0.0149793	0.00963113

Table 5: Throughput values of 2nd scenario

No. of nodes/ Protocol	1000 m	2000 m	3000 m	4000 m	5000 m
TCP	1300.8200	1300.8200	1300.8200	1300.8200	1300.8200
UDP	58.2848	58.2848	58.2848	58.2848	58.2848

Table 6: PDF values of 2nd scenario

No. of nodes/ Protocol	1000 m	2000 m	3000 m	4000 m	5000 m
TCP	98.7750	98.7750	98.7750	98.7750	98.7750
UDP	95.8027	95.8027	95.8027	95.8027	95.8027

following table, the TCP protocol has better throughput as compared to the UDP protocols when varying number of mobile nodes in the simulation scenario.

PDF: Table 3 illustrates an analysis of packet delivery ratio for two Transport layer Protocol (TCP, UDP). From the following table, we analyzed that the TCP protocol has better packet delivery ratio as compared to the UDP protocols when varying number of mobile nodes in simulation scenario.

AED: Based on Table 4, we can observe that UDP protocol is superior than TCP protocol in term of average end to end delay at what time the mobile nodes number was changed.

Second scenario: In this scenario, network size was changed to 1000-5000 m, mobile node number is 50 and connections number between nodes equal to 6, other value are setting according to Table 1.

Throughput: Table 5 shows that TCP is better than UDP in term of throughput. When the size of network area was changed, it does not reflect any change in both protocol in throughput that can easily in Table 5. It does not reflect any change in delay.

PDF: TCP has higher pdf than UDP as it can be easily recognized from Table 6. When the size of network area was changed. PDF of TCP and UDP protocols wasn't changed when network size changed and give the same result that can easily in Table 6.

Table 7: AED values of 2nd scenario

No. of nodes/ Protocol	1000 m	2000 m	3000 m	4000 m	5000 m
TCP	0.0949155	0.0949155	0.0949155	0.0949155	0.0949155
UDP	0.0699504	0.0699504	0.0699504	0.0699504	0.0699504

Table 8: Throughput values of 3rd scenario

No. of nodes/ Protocol	1	2	3	4	5
TCP	964.238	1048.3835	1132.529	1216.6745	1300.82
UDP	10.1696	19.9808	30.1952	40.4544	50.3104

Table 9: PDF values of 3rd scenario

No. of nodes/ protocol	1	2	3	4	5
TCP	98.0809	98.0809	98.0809	97.6693	98.7750
UDP	97.8448	96.1207	96.8391	97.3060	96.8103

AED: Table 7 shows the AED values when of varying number the size of network area. In this set of the simulation, TCP cover a high Average End-to-End Delay (AED) as compared with UDP protocols.

Third scenario: In this scenario, the number of connections between nodes is changed to 1-6 while the number of mobile nodes is fixed to 50 and simulation area set to 2000 m and nodes speed and other parameter are fit according to Table 1. In this scenario, both TCP and UDP protocol is examined in terms of throughput, packet delivery ratio, the average end-to-end delay and NRL.

Throughput: Table 8 gives you an idea about the impact of varying number of connections between nodes on the throughput of the TCP and UDP protocols. From Table 8, it is observed that UDP produces less throughputs when it's compared with TCP when number of connections between nodes was changed.

PDF: Table 9 demonstrates the effect of changing connections number among nodes on the PDF of the TCP and UDP protocols. From Table 9, it is observed that TCP produces high PDF when it's compared with UDP when number of connections between nodes was changed.

AED: Table 10 explains the effect of variable amount of connections between nodes on the AED of the TCP and UDP protocols. From Table 10, it is observed that TCP

Table 10: AED values of 3rd scenario

No. of nodes/ Protocol	1	2	3	4	5
TCP	0.09434140	0.0943414	0.0943414	0.1032230	0.0949155
UDP	0.00611151	0.0156324	0.0450143	0.0268664	0.0471656

produces high AED when it's compared with UDP when number of connections between nodes was changed.

CONCLUSION

This study evaluates the performance of transport layer protocol TCP and UDP in MANET network by using AODV routing protocol with multimedia applications. From the simulation results, we made TCP is suitable for the investigational scenarios because throughput and PDF is reasonably high as compared with UDP though mobile nodes number, number of connection between nodes and the size of network area was changed. However, in term of AED, UDP has better results over TCP in same simulation scenario. Though the size of the network is increased, it does not reflect any performance change of TCP and UDP transport layer protocol in throughput, PDF and AED terms.

RECOMMENDATIONS

Finally, the research recommends the use of AODV protocol for such emergency and rescue scenario due to its considerable performance in packet delivery ratio, throughput and end to end delay.

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