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Performance Evaluation of AODV Protocol over TCP & CBR Connections in Wireless Ad hoc Network using NS2 Simulator

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Abstract: In this research paper, performance of On-demand routing protocol AODV in wireless Ad hoc network has been analyzed by means of packet delivery ratio, loss packet ratio and throughputs under TCP & CBR traffic connection. The ad hoc network is simulated in NS2 .There is a significant difference between TCP and CBR traffic connections and this difference results in different output parameters. This varied output may be compared for analysis of any protocol in ad hoc wireless networks.

Keywords: Ad hoc Network; AODV; CBR; NS2; Packet delivery ratio; Throughput; UDP.

I. INTRODUCTION

Wireless networking is an emerging technology. An ad hoc network is a wireless network basically where collection of wireless mobile nodes dynamically forming a temporary network takes place without the use of any existing network infrastructure or centralized administration[9]. The wireless network here have two forms one is where the communication links are formed using the access points known as infrastructure based wireless networks and another is where nodes are communicated without having any central access points , known as infrastructure less or independent networks called as wireless Ad hoc networks [10].

In wireless Ad hoc networks each node works as access point or router. Ad hoc networks have different applications like military networks used at battle field, disaster relief operations, mine site operation, robot data acquisition etc[9] . There are many advantages of ad hoc networks including,

a. They provide access to information and services regardless of geographic position.
b. These networks can be setup at any places and at any time.
c. These networks works without any pre existing infrastructure.
d. Some disadvantages of wireless ad hoc networks are.
e. Limited resources
f. Limited physical security
g. They are vulnerable to different attacks
h. Lack of authorization facility
i. Dynamically changing topology as the nodes can move randomly in the topology
j. Security protocols used for wired networks cannot work for wireless ad hoc networks.
k. The nodes in wireless ad hoc networks are mobile in nature therefore they are also known as mobile ad hoc networks (MANET)

II. ROUTING IN WIRELESS AD HOC NETWORK

In ad hoc networks, any pre existing infrastructure is not available. Therefore the protocols used in wired networks can not used in ad hoc networks. Routing protocols in ad hoc wireless network are classified as[4] , Table-Driven Routing or Proactive protocols where consistent and up to date routing information to all nodes is maintained at each node and On-Demand Routing or Reactive Protocols where routes are created as and when required. When a source wants to send data to a destination, it invokes the route discovery mechanism to find the path to the destination.[8]

Ad Hoc On-Demand Distance Vector Routing (AODV) is one of the most promising On-Demand Routing Protocol used in wireless Ad hoc network .Ad-hoc On-Demand Distance Vector (AODV) [1] is an on demand routing protocol which is used to find a route between the source and destination node as needed. It uses control messages such as Route Request (RREQ), and Route Reply (RREP) for establishing a path from the source to the destination.

When the source node wants to make a connection with the destination node, it broadcasts an RREQ message. This RREQ message is propagated from the source, and received by neighbors (intermediate nodes) of the source node. The intermediate nodes broadcast the RREQ message to their neighbors. This process goes on until the packet is received by destination node or an intermediate node that has a fresh enough route entry for the destination in its routing table. Fresh enough means that the intermediate node has a valid route to the destination established earlier than a time period set as a threshold. Use of a reply from an intermediate node rather than the destination reduces the route establishment time and also the control traffic in the network[1],[2].

Sequence numbers are also used in the RREP messages and they serve as time stamps and allow nodes to compare how fresh their information on the other node is. When a node sends any type of routing control message, RREQ, RREP, RERR etc., it increases its own sequence number.

Higher sequence number is assumed to be more accurate information and whichever node sends the highest sequence number, its information is considered most up to date and route is established over this node by the other nodes.

In this paper we are simulated a wireless ad hoc network which uses AODV protocol using NS2 and evaluate the performance of AODV over different traffic sources.

III. NETWORK SIMULATOR NS2

Network Simulator Version-2 widely known as NS2, is a discrete event driven network simulator used in networking research. It is open source software implemented in C++ and Otcl programming languages. The NS2 provides a highly modular platform for simulating wired as well as wireless networks. It supports different network elements, protocols like TCP, UDP, FTP, traffic agents like CBR, different routing algorithms.NS2 provides users with a way of specifying network protocols and simulating their corresponding behavior[7]. The NS2 has a tool NAM (Network Animator) which visualizes the simulated network and the results of simulation are stored in a trace file that contains history of all occurred events. The simulating experiment is carried out using LINUX (Ubuntu 12.4). The detailed simulated network model is based on Network Simulator-2 (Ver 2.35), is used in the evaluation. The NS instructions can be used to define the topology structure of the network, the mobility of the nodes, to configure the service source and the receiver, to create the statistical data trace file and so on. Some important NS2 commands used for the simulation are as follows[6]

a. set ns [new Simulator] - Creates a new simulator object
b. create-god $Par(nn) - Creates the GOD (General Operations Director)
c. set topo [new Topography] - Creates and configure topography
d. $ns node-config – used to specify nodes configuration parameters
e. $node_(0) set X, set Y, set Z – Sets nodes X,Y and Z co ordinates
f. set agent [new Agent/TCP] – Create new TCP source Agent
g. set app [new Application/FTP]- Creates new application Agent (FTP)
h. set sink [new Agent/TCPSink] – Creates new TCP receiving Agent

IV. PERFORMANCE METRICS

There are several performance metrics are available which is used to evaluate the performance of network. The performance of routing protocols can vary with the various parameters such as speed, pause time, node density and traffic scenarios[5] . In this paper we simulate wireless Ad Hoc network having CBR and TCP traffic flow. Constant Bit Rate (CBR) means consistent bits rate in traffic are supplied to the network. In CBR, data packets are sent with fixed size and fixed interval between each data packets. Establishment phase of connection between nodes is not required here, even the receiving node don't send any acknowledgement messages.[3] Connection is one way direction like source to destination. Where, as Transmission Control Protocol (TCP) is a connection oriented and reliable transport protocol. To ensure reliable data transfer TCP uses acknowledgement, time outs and retransmission. Acknowledge means successful transmission of packets from source to destination. If an acknowledgement is not received during a certain period of time which is called time out then TCP transmit the data again. For evaluating the performance of AODV protocol over CBR and TCP traffic flow, we have used following three performance metrics.

A. Packet delivery ratio:

Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources. Mathematically, it can be defined as:

$$PDR = R_{Size} \div S_{Size}$$

Where, R_{Size} is the sum of data packets received by the each destination and S_{Size} is the sum of data packets generated by the each source.

B. Packet Drop (Loss) Ratio:

Packet loss occurs when one or more packets of data traveling across a computer network fail to reach their destination. Packet loss is distinguished as one of the three main error types encountered in digital communications; the other two being bit error and spurious packets caused due to noise. Packet loss can be caused by a number of factors including signal degradation over the network medium due to multi-path fading, packet drop because of channel congestion

C. Throughput:

It is defined as the total number of packets delivered over the total simulation time. Mathematically, it can be defined as:

$$Throughput = N/T$$

Where N is the number of bits received successfully by all destinations and T is simulation time.

V. IMPLEMENTATION AND ANALYSIS OF WIRELESS AD HOC NETWORK

In our simulation, we used topography size 500 m x 500 m, node density 15 nodes with constant maximum speed 8 m/s. We did the Simulation for 150 s with maximum 6 connections at a time following CBR and TCP traffic. The network parameters we have used for our simulation purpose shown in the table I.

Table I. Network Simulator Parameters

Parameters	Value
Number of nodes	15
Simulation Area	500 x 500 m
Simulation Time	150 s
Protocol	AODV
Traffic Type	CBR,TCP
Payload	512(CBR),1440(TCP)
Network Simulator	NS2-2.35

A Tcl script is written in NS2 for simulation of network model. When this Tcl script is executed it creates two files trace file and Nam file. The Nam file is used to visualize

simulated network, where as trace file store different events statistics such as each individual packets arrival time, departs or is dropped , information about protocol agent ,traffic agent , source and destination nodes address etc., which can be used to measure a protocol performance. Different tools [7] are available for the extracting and analysis of required data from trace file such as grep, Awk, sed, Perl. We wrote AWK script to extract the required statistical data of trace file. For this the simulated network is executed using CBR and TCP traffic flow in NS2. Data packet size for CBR is 512 and for TCP using FTP is 1440. Following figures show the output of Nam (Network animator).

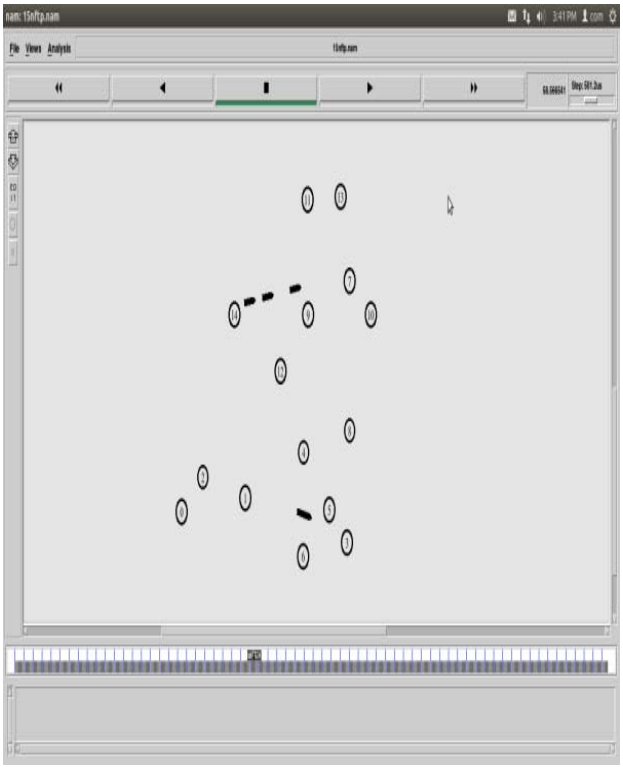

Figure: 1 Nam output of simulated network

The data extracted from the trace file using the AWK is used to measure the packet delivery ratio, dropped packet ration and throughput. Data obtained from Awk script is used find different performance metrics i.e. PDR, DPR and Throughput, which is used for the comparison of AODV protocols performance under CBR and TCP traffic flow. Following table 2 shows the evaluated data of trace file which includes packet sent, packet received, packet dropped, and throughput for CBR and FTP, PDR, DPR and Throughput of Wireless Ad Hoc network simulated using AODV protocol.

Table II. Parameter Evaluation Results

Parameters	Traffic type	
	FTP	CBR
Generated Packets	7884	99925
Received Packets	7592	24953
Dropped Packets	91	74972
Packet Delivery Ratio(PDR)	0.96 %	0.24 %
Throughput	10936 (kbps)	111089 (kbps)

VI. RESULTS AND CONCLUSIONS

We present a systematic comparative performance evaluation of TCP and UDP protocols in Ad hoc networks. The scalability of these protocols is quite good and their performance depend a lot from the network environment .We evaluated the protocols on the basis of data sent, data received and data dropped .The protocol comparison metrics included packet delivery ratio(PDR) , packet dropped ration and throughput. It's concluded that the AODV protocol will perform better in the TCP networks.

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