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Design and Simulation of Wireless Ad Hoc Network Using NS2 Simulator

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Abstract:- Networks that support the ad hoc architecture are typically called wireless ad hoc networks or mobile ad hoc networks (MANET) these two terms are used interchangeably. Such networks are typically assumed to be self-forming and self healing. This research paper aims to simulate the wireless ad hoc network using NS2 simulator. We simulate the network which uses AODV as routing protocol and finds the network parameter values and the performance of the AODV protocol is measured.

Keywords:- AODV, Ad Hoc network, NS2 simulator,AWK,Throughput

I. INTRODUCTION

In the recent years, wireless technology has got popularity and usage, thus opening new fields of applications in the domain of networking. The wireless networks may categorize as infrastructure based and infrastructure less network. In infrastructure based networks the mobile nodes are communicated with the help of common access point. Where as in infrastructure less network the mobile nodes are communicated cooperatively with each other, where the participating nodes do not rely on any existing network infrastructure such networks are known as wireless ad hoc networks. In wireless ad hoc networks each node is functions as node as well as router.

Ad hoc networks have a wide array of military and commercial applications. They are ideal in situations where installing an infrastructure network is not possible or when the purpose of the network is too transient or even for the reason that the previous infrastructure network was destroyed.

II. WIRELESS AD HOC NETWORKS

In the past few years, a new wireless architecture has been introduced that does not rely on any fixed infrastructure. In this architecture, all nodes may be mobile and no nodes play any special role. One example of this architecture is the “ad hoc” mode architecture of 802.11, in this architecture, 802.11 nodes do not rely on access points to communicate with each other. In fact, nodes reach other nodes they need to communicate with using their neighbors. Nodes that are close to each other discover their neighbors. When a node needs to communicate with another node, it sends the traffic to its neighbors and the neighbors pass it along to wards their neighbors and soon. This repeats until the destination of the traffic is reached. Such architecture requires that every node in the network play the role of a router by being able to determine the paths that packets need to take in order to reach their destinations.

Networks that support the ad hoc architecture are typically called wireless ad hoc networks or mobile ad hoc networks (MANET) these two terms are used interchangeably [1]. Such networks are typically assumed to be self-forming and self healing. This is because the typical applications of such networks require nodes to form networks quickly without any human intervention. Given the wireless links and mobility of nodes, it is possible that nodes may lose connectivity to some other nodes. This can happen if the nodes move out of each other’s transmission range. As a result, it is possible for portions of the network to split from other portions of the network. In some applications it is also possible that some nodes may get completely disconnected from the other nodes, run out of battery, or be destroyed. For these reasons, nodes in a ad hoc networks cannot be congaed to play any special role either in the way nodes communicate or in the way of providing communication services. This leads to a symmetric architecture where each node shares all the responsibilities. The network needs to be able to reconfigure itself quickly to deal with the disappearance or reappearance of any node and continue operating efficiently without any human intervention [2]. Routing in such networks is particularly challenging because typical routing protocols do not operate efficiently in the presence of frequent movements, intermittent connectivity, network splits and joins. In typical routing protocols such events generate a large amount of overhead and require a significant amount of time to reach stability after some of those events.

III. APPLICATIONS OF AD HOC NETWORKS

Ad hoc networks are very well suited for many situations, in which an infrastructure network can't be built or it is impossible to build an infrastructure. The interest of ad hoc networks increases rapidly in recent year, because ad hoc supports mobility and freedom in the networks. Data can be exchanged without cable, access point, or portable memory space. This section briefly explains some of applications of ad hoc networks. Nowadays computers and phones manufacturers implement ad hoc technology to their products.
Tactical Networks: -Military communication automated system.
Entertainment:- Multi users games, Robotics pets.
Emergency Services: - Disaster recovery, Earth quakes.
Sensor Network: -Earth activities, Remote weather for sensors.

IV. NS2 SIMULATOR

Network Simulator version 2 widely known as NS-2 is a discrete event driven network simulation tool for simulation of network to study the dynamic nature of network [3]. It is an open source solution implemented in C++ and Otcl programming languages at UCB (University Of Carolina Berkley).NS-2 provides highly modular platform for simulation of wired as well as wireless networks. NS-2 supports different network components, protocols like TCP,UDP,FTP and traffic sources like CBR etc. Results of the simulations are provided with in a trace files that contains the entire occurred event during the simulation. The output of simulation is visualized through Nam (Network Animator).

Otcl/Tcl is a scripting language with very simple syntaxes which allows fast development. Otcl in NS-2 is used to specify the parameters for simulated networks like node, links, protocols, topography and so on. C++ objects oriented language is used for byte manipulation, packet processing and implementation of new algorithm or protocol in NS-2. Otcl and C++ interact with each other through TCL/C++ interface called as TclCl

V. AODV PROTOCOL

Ad-hoc On Demand Distance Vector: AODV is a distance vector type routing. It does not require nodes to maintain routes to destinations that are not actively used. As long as the endpoints of a communication connection have valid routes to each other, AODV does not play a role. The protocol uses different messages to discover and maintain links: Route Requests (RREQs), Route Replies (RREPs), and Route Errors(RERRs). These message types are received via UDP, and normal IP header processing applies. AODV uses a destination sequence number for each route entry[4]. The destination sequence number is created by the destination for any information it sends to request nodes. Using destination sequence numbers ensures loop freedom and allows knowing which of several routes is fresher. Given the choice between two routes to a destination, a requesting node always selects the one with the greatest sequence number.

When a node wants to find a route to another one, it broadcasts a RREQ to all the network till either the destination is reached or another node is found with a fresh enough route to the destination (a fresh enough route is a valid route entry for destination whose associated sequence number is at least as great as that contained in the RREQs). Then a RREQ is sent back to the source and the discovered route is made available. Nodes that are part of an active route may offer connectivity information by broadcasting periodically local Hello messages (special RREQ messages) to its immediate neighbors. If Hello messages stop arriving from a neighbor beyond some given time threshold, the connection is assumed to be lost. When a node detects that a route to a neighbor node is not valid it removes the routing entry and send a REER message to neighbors that are active and use the route; this is possible by maintaining active neighbor lists. This procedure is repeated at nodes that receive REER messages. A source that receives an REER can re initiate a RREQ message. AODV does not allow handling unidirectional links [4].

VI. SIMULATION SCENARIO

We simulate the wireless ad hoc network using NS2 simulator version 2.35 having following parameters. Simulation process and results analysis first of all, to set the topology and the configuration of nodes properties, and also properties of MAC layer for some address type, protocol type, channel type, simulation time and transmission way of wireless.

In our simulation, we used topography size 1000 m x 800 m, number of wireless nodes 15 nodes with maximum moving speed 8 m/s. We did the Simulation for 1000 sec. with maximum 6 connections at a time allowing UDP traffic. The network simulation parameters we have used for our simulation purpose shown in the following table I.

Table I : Simulation Parameters

NETWORK PARAMETERS	VALUES
No. of nodes	15
Topography area	1000 m X 800 m
Connection Type	UDP
Source Traffic	CBR
Pay Load	512
Routing protocol	AODV
Simulation Time	1000 Sec.
No.of active connections	6
Network Simulator	NS2- 2.35

Some important NS2 commands used for the simulation are as follows[5]

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/UDP] - Create new TCP source Agent
g. set app [new Application/Traffic/CBR] - Creates new application Agent (CBR)

The paper analyzes the simulation result of AODV protocol in Ad hoc network. 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 [5] 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. Following figure 1 show the output of Nam (Network animator).

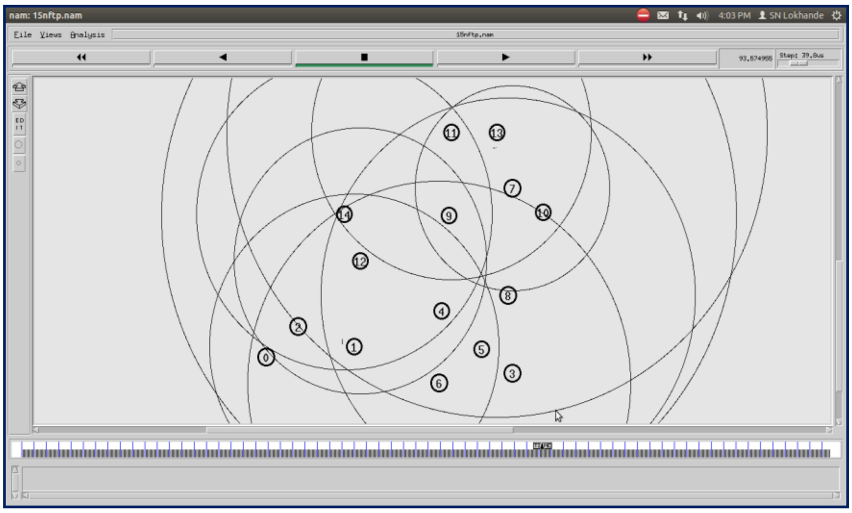

Fig. 1: Snapshot of Simulated Network

VII. PERFORMANCE METRICS

The performance of the protocols depends on various inter-relating metrics [6]. Which plays important role in analytical observation of the protocol. Following are the some important parameters which we are selected to study the performance of AODV protocols in this simulation study.

1]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:

$$PDR= R_{Size}/S_{Size}$$

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.

2] Packet Drop (Loss) Ratio: Packet loss occurs when one or more packets of data traveling across a computer network fail to reach their destination.

3] 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.

VIII. EXPERIMENTAL RESULTS

When the simulation setup is completed, we run the network simulator, which creates two files one is Nam, which visualizes and animates the network. Other file is a trace file, which captures all the events that happened in the simulated network. To extract the data from the trace file we write the AWK script. Data obtained from AWK script is used to find different parameters which includes packet sent, packet received, packet dropped, for CBR traffic flow. This is used to find PDR, DPR and Throughput, which are used to measure the performance of AODV protocol. Following table II shows the evaluated data of trace file which includes packet sent, packet received, packet dropped for CBR .

Table II : Values of Performance Metrics

Node Link	Sent Packets	Received Packets	Total no.of Dropped Packets
N0 - N1	87391	63910	23231
N2 - N3	97344	71204	25640
N6 - N8	76563	55558	20655
N10- N11	102266	69553	31713
N12- N13	94063	68380	24683
N14 - N7	76563	55658	20655
Total	534190	384263	146577

The above values of parameters are used to evaluate the performance of network

PDR = Total received packets / Total Sent packets

=384263/534190 = 0.71

Throughput = 534190/1000 = 534.19 kbps

IX. CONCLUSION

As the objective of this research paper is to simulate the wireless network using network simulator NS2 and to measure the performance of this network using AODV as routing protocol. To measure the performance of AODV we select different performance matrix. The values are obtained from the trace file generated by NS2. Using the AWK script the data is processed and is used to measure the performance of AODV protocol. As above results shows that packet delivery ration of AODV protocol is 0.71 and throughput is about 534.19 kbps.

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