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Simulation and performance evaluation of AODV Protocol with QoS using Network Simulator 3(NS3)

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Abstract - The Ad hoc mobile networking is a current active research area. It is type of adhoc network in which nodes are mobile and connected with each other via wireless connection. Mobile Adhoc Network in which every node share data with another node without using fixed infrastructure. So it is infrastructure-less and self configuring network. But it is very difficult to maintain all the devices over the Network. There are so many protocols which are being developed for maintaining the devices over the Network. In this research we evaluate performance of one routing protocols AODV(Ad hoc On-Demand Distance Vector Routing).They can be used in agriculture for monitoring and control of environmental parameters in the form of wireless sensor networks. The aim of that paper is achievement evaluation of protocol of these Ad hoc networks that is QoS-enabled AODV protocol. The performance evaluation is completed by means of its distinguish with normal AODV protocol. QoS stands for the Quality of Service. That paper proposed some enhancements to the AODV protocol to through or consist QoS by the adding extensions to Route Discovery messages, related to bandwidth estimation. This paper focused on three of the parameters namely Speed of nodes, Traffic Rate & Pause Time of mobile nodes. For evaluation purpose the performance metrics used are Throughput, Bandwidth, Average end-to end Delay, Packet Delivery Ratio (PDR), Normalized Overhead Load (NOL). The simulation is performed through the simulation tool NS-3(Network Simulator- 3) due to its open source simplicity and free availability.

Keywords: Ad hoc networks, AODV, bandwidth estimation, quality of service,NS3

I. INTRODUCTION

Network technology and it is very reliable technology to enhance efficiency and to perform multiple applications in the area of communication among mobile nodes. Communication is done through wireless links among hosts through their antenna. Wireless sensor network consist of number of tiny sensor nodes, each node can monitor physical as well as environmental conditions like a change in climate, pressure, temperature, earthquake. There is no standard protocol for mobile wireless sensor network so often protocols are adopted from Mobile Ad-hoc Networks. Wireless networks are playing a main role in the area of communication. Wireless Networks enable the users to communicate and transfer data with each other without any wired medium. In these networks routing protocols should be more dynamic so that they quickly respond to topological changes .

If two hosts are not within radio range area, all message communication between them must pass through two or more intermediate hosts that double as routers. The hosts are free to move around randomly, thus changing the network topology dynamically. Thus routing protocols must be adaptive and able to maintain routes in spite of the changing connectivity. Such networks are very useful in military and other tactical applications such as emergency rescue or exploration missions, where cellular infrastructure is unavailable or unreliable. Private applications are also likely where there is a need for ubiquitous communication services without the presence or use of a stable infrastructure.

II. ROUTING PROTOCOL

The main routing protocols are of two types i.e. Protocol operation type and Network structure type. Routing protocol can be classified in to three categories namely, proactive, reactive and hybrid protocol depending on how the source sends a route to the destination. In proactive (table-driven) routing protocol; information broadcast to each neighboring node. Each node keeps information about neighborhood nodes, reachable node and the number of hops in their respective routing table. Each node continuously maintain route between pair of nodes. Reactive (on-demand) this routing protocol called as On-demand protocol because

routes are established on demand as they are needed. Once path established; a route is maintain as long as it is needed.

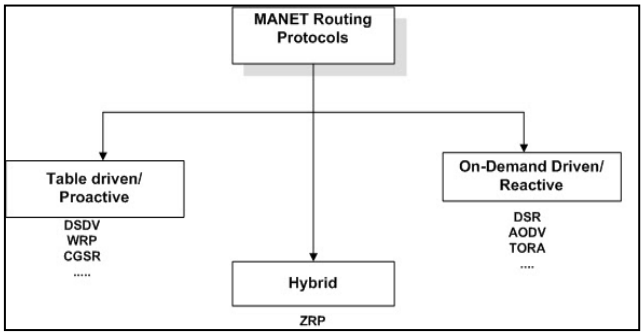

Fig. 1 Represents the types of routing protocol

A) Routing Protocols

Routing protocol should be capable to handle a very large number of nodes with limited resources. The main issue associate with the routing protocol involves being appeared and disappeared of nodes in various locations. It is need to reduce routing message overhead despite the growth number of nodes. Routing protocol needs to have following qualities to be effective: distributed operation, loop freedom, demand based operation, proactive operation, security and unidirectional link support. Distributed operation means that any node can enter or leave whenever they want. Loop-freedom is to prevent overhead created during sending information uselessly. Demand based operation is to decrease traffic and use bandwidth resources more efficiently. Proactive operation is used when they require enough bandwidth and energy resources. Security is the most important factor for any communication. Routing protocol is categorized on the basis of how and when route are discovered, but both select the shortest path to the destination.

A. Proactive Routing Protocols

Proactive routing protocols are also known as Table-driven routing protocol uses link-state routing algorithms which floods link information about its neighbors frequently. This type of protocol keeps and maintains up-to-date routing information between every pair of nodes by sending control message periodically in network. One of the main advantages of this protocol is that routes are ready to use when needed. The major drawback of proactive routing protocols includes the overhead of flooding route. There are various proactive routing protocols present for MANET like DSDV, OLSR, and WRP etc.

B. Reactive Routing Protocols

Reactive or on-demand routing protocols were designed to reduce overheads present in proactive protocols by maintaining information. It uses distance vector routing algorithm and establishes the route to given destination only when a node request it by initiating route discovery process. This protocols work on route discovery and route maintenance mechanism. Reactive routing protocols have drawback of delay in finding routes to new resources or destination. There are number of reactive routing protocols available in MANET like DSR, AODV, TORA and LMR etc.

C. Hybrid Routing

Hybrid routing protocol is a network routing protocol that combines distance vector routing protocol. and link state routing protocol features. HRP is used to determine optimal network destination route and report network topology data modification. Hybrid routing commonly referred to as balanced hybrid routing.

of mobile nodes. For evaluation This paper focuses on three of the parameters namely traffic rate, speed & pause time purpose the performance metrics used are Throughput, Bandwidth, average end -to end delay, packet delivery ratio (PDR), normalized overhead load (NOL). Evaluate the AODV protocol for QoS as well Non Qos is done with thereof the parameters. five performance metrics by means of graphical representation of their interrelations

D) Ad hoc On-Demand Distance Vector Routing (AODV)

AODV offers low network utilization and uses destination sequence number to ensure loop freedom. It is a reactive protocol implying that it requests a route when needed and it does not maintain routes for those nodes that do not actively participate in a communication. An mainly feature of AODV is that it uses a destination sequence number, which corresponds to a destination node that was requested by a routing sender node. The destination itself provides the number along with the route it has to take to reach from the request sender node up to the destination. If there are multiple routes from a request sender to a destination, sender takes the route with a higher sequence number. This ensures that the ad hoc network protocol remains loop-free.

Ad-hoc On-demand Distance Vector (AODV) routing protocol is the one of the most popular routing protocol for mobile ad-hoc networks. This work optimizes AODV protocol by minimizing the sum of load and delay. Enhancements include developing an improved version of AODV protocol which uses load and delay parameters to select a path with minimum weight. This is a weight based algorithm where weight is calculated in terms of load and delay. In this paper we evaluate performance of the proposed scheme based on different performance metrics like Load balancing efficiency, jitter, End-to-end delay, packet delivery ratio, etc. and compare it with some of the recent techniques proposed .The considering more parameters like jitter and load balancing efficiency in the network. The simulation is done using NS3.13 simulator. The results show that the proposed enhancement outperforms many of the existing algorithms and it is expected to achieve efficient resource utilization. AODV is a distance vector routing protocol which comes under the category of proactive routing protocol that is based on conventional Bellman-Ford routing algorithm. This protocol adds a new attribute, sequence number, to each route table entry at each node. Routing table is maintained at one node and with this table, node transmits the packets to other

nodes in the network. This protocol was motivated for the use of data exchange along changing and arbitrary paths of interconnection which may not be close to any base station.

The Ad hoc On-Demand Distance Vector protocol is both an on-demand and a table-driven protocol. AODV supports multicasting and uncasing within a uniform framework. AODV routing protocol is an on-demand reactive routing protocol that uses routing tables with one entry predestination. When a source node needs to find a route to a destination. It starts a route discovery process, based on flooding, to locate the destination node The Ad hoc On-Demand Distance Vector protocol is both an on-demand and a table-driven protocol. AODV supports multicasting and uncasing within a uniform framework. A wireless Ad-hoc network consists of wireless nodes communicating without the need for a centralized administration. A collection of autonomous nodes or terminals that communicate with each other by forming a multichip radio network and maintaining connectivity in a decentralized manner is called an ad hoc network.

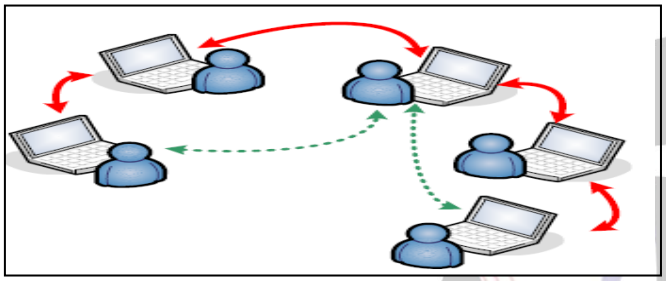

Fig.2 - Ad-hoc Network

There is no static infrastructure for the network, such as a server or a base station. The idea of such networking is to support robust and efficient operation in mobile wireless networks by incorporating routing functionality into mobile nodes. An ad hoc network, where there are numerous combinations of transmission areas for different nodes. From the source node to the destination node, there can be different paths of connection at a given point of time. But each node usually has a limited area of transmission. In an Ad hoc mobile network, every node in the network carries its own router with it, and all nodes cooperate in carrying traffic. The whole philosophy of the Ad hoc networking model is a radical departure from the highly structured and frequently hierarchical models employed for both local area and wide area networking, currently in use.

The range of possible situations in which Ad hoc networking can be exploited is huge. What mature and robust Ad hoc networking offers is virtually universal connectivity, limited only by the link performance and routing delays of the participating nodes, and their connectivity to the established fixed network. Ad hoc networks are well within the bounds of today's technology, provided that suitable Ad hoc routing protocols exist and are implemented A mobile ad hoc network is a dynamically self-organizing network without any central administrator or infrastructure support. If multiple nodes are not within the transmission range of each other, other nodes are needed to serve as intermediate routers for the communication between the multiple nodes. Moreover, mobile devices wander autonomously and communicate via dynamically changing network. Thus, frequent change of network topology is a tough challenge for many main issues, such as routing protocol robustness, and performance degradation resiliency. AODV is the reactive routing protocol that uses some characteristics of proactive routing protocol i.e., hop-to-hop routing methodology. AODV allows for construction of the routes and it is not necessary for other nodes to keep these routes when they are not in active communication. ROUTE REQUEST is used to initiate the route finding process. ROUTE REPLY is used to finalize the routes. When the request reaches a node with route to destination, it creates again a REPLY which contains the number of hops that are requiring the destination. All nodes that participate in forwarding this reply to the source node create a forward route to destination. This route created from each node from source to destination is a hop-by-hop state and not the entire route as in source routing. ROUTE ERROR is used to notify the network of a link breakage in an active route.

E) AODV and QoS-AODV

The Ad hoc On Demand Distance Vector (AODV) protocol is proposed by Perkins. The research focuses on enhancement in performance of normal AODV protocol by improving the QoS. The various QoS parameters can be stated as bandwidth, cost, end-to-end delay, delay variation (jitter), throughput, probability of packet loss, battery charge, processing power etc. Various Performance metrics are to be studied for Performance evaluation of QoS enabled AODV protocol. Research is going on towards Performance Improvement by emphasizing any of these parameters. This research considers the Bandwidth & other parameters so as to improve QoS. AODV offers low network utilization and uses destination sequence number to ensure loop freedom. It is a reactive protocol implying that it requests a route when needed and it does not maintain routes for those nodes that do not actively participate in a communication. An mainly feature of AODV is that it uses a destination sequence number, which corresponds to a destination node that was requested by the routing sender node. The destination itself provides the number along with the route it has to take to reach from the request sender node up to the destination. If there are multiple routes from a request sender to a destination, the sender takes the route with a higher sequence number. This ensures that the ad hoc network protocol remains loop-free.

III. SYSTEM DESIGN

IMPLEMENTATION

The implementation section discusses how AODV protocol was implemented and analyzed for comparison. This includes the platform i.e. Fedora and the tools such as ns3 (Network

Simulator version, NAM Network Animator) and Gnu plot. Then the core implementation is discussed.

A. Need of Fedora

All simulation, implementation and analysis work was done on Linux. The flavor of Linux used for this purpose was Fedora. The reason for choosing this specific operating system for research work is that, it is one of the most stable and robust platforms around. Secondly Linux systems provide more security than others and security is a very essential element in network environments.

Since the platform consists the basis for doing everything, therefore it becomes essential to discuss some core features of this platform.

B. Network Simulator ns3

• NS3 is implemented using C++

• With modern hardware capabilities, compilation time was not an issue like for NS2, NS3 can be developed with C++ entirely. A simulation script can be written as a C++ program, which is not possible in NS2.

• There is a limited support for Python in scripting and visualization Because NS3 is implemented in C++, all normal C++ memory management functions such as new, delete, malloc, and free are still available A packet consists of a single buffer of bytes, and optionally a collection of small tags containing meta-data NS3 performs better than NS2 in terms of memory management.

• The aggregation system prevents unneeded parameters from being stored, and packets don't contain unused reserved header space.NS3 employs a package known as PyViz, which is a python based real-time visualization package NS3 is not backward compatible with NS2; it's built from the scratch to replace NS2.

• NS3 is written in C++, Python Programming Language can be optionally used as an interface.

• NS3 is trying to solve problems present. in ns2

• Automatic de-allocation of objects is supported using reference counting (track number of pointers to an object); this is useful when dealing with Packet objects. The aggregation system prevents unneeded parameters from being stored, and packets don't contain unused reserved header space. NS-3 has been developed to provide an open ,extensible network simulation platform for networking research and education. In brief na3 provide models of how packet data networks work and perform as well as provide a simulation engine for users to conduct simulation experiment .Some of the reason to use ns3 include to perform studies that are more difficult or not possible to perform with real systems to study system behavior in a highly controlled reproducible environment and to learn about how network work.

• NS3 is primarily used on Linux system, although support exists for FreeBSD, Cygwin (for window) and native windows visual studio support is in the process of being developed.NS3 designed as a set of libraries that can be combined together and also with other external software libraries. While some simulation platform provide users with a single integrated graphical user interface environment in which all task are carried out NS3 is more modular in this regard. Several external animators and data analysis and visualization tools can be used with NS3.

C.NAM

NAM is a Tcl/TK based animation tool for viewing network simulation traces and real world packet trace. It supports topology layout, packet level animation, and various data inspection tools. It has a graphical interface, which can provide information such as number of packets drops at each link. The network animator" NAM" began in 1990 as a simple tool for animating packet trace data. am began at LBL. It has evolved substantially over the few years. The NAM developed effort was an ongoing collaboration with VINT project. It is being developed as an open source project hosted at source forge.

Core Implementation

a) Basic Protocol Simulation:

This section discusses how the AODV protocol was simulated and implemented. First the platform i.e. Fedora 8 was set up in a virtual environment. Then ns-3 was set up on the platform on which the above said protocols were implemented. NS-3 requires a script file to be run on it. These script files are written in a language called TCL (Tool Command Language). We have made use of shell scripting & Gnu plot for emulation: plotting of graphs In this research a quality of service (QoS) architecture for supporting real-time data transmission in mobile Ad hoc networks (MANETs) is explored. The QoS architecture includes a QoS transport layer, QoS routing, queue management and a priority MAC protocol. Through simulations, it is found that the QoS architecture reduces packet loss and greatly increase the resource utilization in MANETs.

b) QoS architecture:

The proposed QoS architecture, which includes all networking layers from the application layer to the MAC layer. The bold lines shows the flow of data packets or the narrow lines shows the flow of control packets.

c) Bandwidth Estimation

In a distributed Ad hoc network, a host's available bandwidth is not only decided by the raw channel bandwidth, but also by its neighbor's bandwidth usage and interference caused by other sources, each of which reduces a host's available bandwidth for transmitting data. Therefore, applications cannot properly working their coding rate without knowledge of the status of the entire network. Thus, bandwidth estimation is a fundamental function that is needed to provide QoS in MANETs. Bandwidth estimation can be performed in several various network layers. The improve QoS with major focus on Bandwidth parameter. The shows RREQ message format before and after QoS enabling. in AODV protocol. For enhancing performance of the basic protocol one more field named "Bandwidth Required" is added in the given RREQ format. This RREQ packet is used to store the

information of bandwidth required field & then used to compare it with the current requirement. And, the packet is forwarded to the next intermediate node only when it does have sufficient amount of bandwidth otherwise it is dropped & then it is re-transmitted when favorable condition present.

IV. METHODOLOGY

A) Performance Analysis

The performance analysis has been done on Fedora 8 as operating system. NS3 is installed on the platform for simulating the protocols along with necessary software such as the Gnu Plot, which is software for plotting graphs from the trace files. NS (version 3) is an object oriented, discrete event driven network simulator written in CPP and Otcl.

B) Basic Protocol Simulation

This section discusses how the AODV protocol was simulated as well as implemented. First the platform that is Fedora 8 was set up in a virtual environment. Then NS 3 was set up on the platform on which the above said protocols were implemented. NS3 requires a script file to be run on it. These script files are written in a language called TCL (Tool Command Language). We have make use of shell scripting& Gnu plot for plotting of graphs.

Performance Metrics used for Analysis

The following metrics were used for the comparison of protocols:

a) *Throughput:* This is the effective share of bandwidth that the application is getting from the network.

b) *Bandwidth:* This signifies the portion of the present capacity of an end-to-end network path that is accessible to the application. Consequently, the number of bits that are injected into the network by the various flows of an application have to be adjusted accordingly.

c) *Average Packet Delay:* It is average packet delivery time from a source to the destination. First for each source destination pair, an average delay for packet delivery is computed. Then the whole average delay is computed from the each pair average regularly.

d) *Packet Delivery Ratio:* It is a ratio of number of data packets delivered to the destination and the number of data packets are sent by the source or number of data packets delivered over number of data packets generated and Number of data packets delivered is the total number of received data packets by destinations.

e) *Network Overhead Load*: It is the ratio of total amount of overhead caused due to control routing packets and the amount of wireless bandwidth wasted to transmit the packets that are dropped in other links.

QoS Parameters-

a) Bandwidth

This signifies the portion of the available capacity of an end-to-end network path that is accessible to the application or data flow

b) Cost

Total cost required for packet transmits from source to destination.

c) End to end delay

This is the average time delay for data packets from the source node to the destination node. To find out of the end-to-end delay the difference of the packet sent and received time was stored and then dividing to the total time difference over the total number of packet received gave the average end-to-end delay for the received packets. The performance is better when packet end to-end delay is low

d) Throughput

Throughput is also known as packet delivery fraction. which is number of bits transferred per second from sender to receiver. How much data can be transferred from one location to another in a given amount of time during simulation

e) Packet loss

Pause time is related with degree of mobility. In DSDV packet loss is more instead of AODV when pause time is small but packet loss increases with increase in pause time.

V. CONCLUSION

I presented the QoS (Quality of Service) enabled AODV protocol. Then using Gnu plot, graphs are generated with three varying scenarios for simulation used are 1) Speed of Nodes, 2) Traffic Rate, 3) Pause Time or Mobility & the performance metrics used are 1) Throughput 2) Bandwidth, 3) PDR, 4) Average packet delay 5)NOL. Then, the QoS of basic protocol is improved & again graphs are generated ultimately the comparison of the Non-QoS and QoS-enabled protocol is carried out.

Reduced Average Packet Delay in case of QAODV indicate that this approach is suitable for modern and futuristic networks. Whenever streaming of the multimedia based data such as video, audio and text is performed, traffic will be most and network becomes congested. It is observed that network congestion is the dominant reason for packet loss, longer delay and delay jitter in the streaming video. The primary goal of a protocol is to increase the overall utility of the network by granting priority to higher-value or more performance-sensitive flows. QAODV protocol is found to cope up with this situation better as compared to AODV protocols although there is marginal increase in Network Overhead Load with Average throughput and Packet Delivery Ratio of QAODV are almost same. Goal of reduced Packet Delay of this new QAODV is very significant. This is because; wireless networks of future will need such approach, which will reduce delay in the transmission. This reduced delay will transpire to very important parameter for the networks handling real time traffic like video calling.

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