Routing Protocols in Mobile Ad-hoc Networks

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ABSTRACT
A Mobile Ad Hoc Networks (MANETs) is a group of mobile nodes which cooperate in forwarding packets in a multi-hop fashion without any centralized administration. One of its key challenges is routing. Many routing protocols for MANET have been proposed and the protocols can be classified as proactive routing and on demand routing protocols. This paper uses ns-2 as the simulation tool, 802.11 as the wireless MAC protocol, and AODV & DSDV as the routing protocol. We present the traces of communication between different mobile nodes using Routing Protocols in MANETs. To compare the performance of Proactive and Reactive routing protocol, we have to analyze the simulation results by graphical manner and trace file based on QoS metrics such as Throughput, Drop, Delay, Jitter etc. Here, we have analyzed the simulation result by traces files only. The performance differentials have been analyzed based on network load, mobility, and network size.

INDEX TERMS
DSDV, AODV, MANET, QoS, Network Simulator-2 (NS2).

1. INTRODUCTION
An AD-HOC Mobile Network (MANETS) is a collection of mobile nodes that are dynamically and arbitrarily located in such a manner that the interconnections between nodes are capable of changing on a continual basis. In order to facilitate communication within a network, a routing protocol is used to discover routes between nodes. The primary goal of such an ad hoc network routing protocol is correct and efficient route establishment between a pair of nodes so that message may be delivered in a timely manner. Route construction should be done with a minimum of overhead and bandwidth consumption. Since their emergence in the 1970s, wireless networks have become increasingly popular in the computing industry. This is particularly true within the past decade, which has seen wireless networks being adapted to enable mobility.

AODV is perhaps the most well-known routing protocol for MANET [1], which is a hop-by-hop reactive (On demand) source routing protocol, combines DSR and DSDV mechanisms for routing, by using the on-demand mechanism of routing discovery and route maintenance from DSR and the hop-by-hop routing and sequence number from DSDV. For each destination, AODV creates a routing table like DSDV, while DSR uses node cache to maintain routing information [2]. It offers quick adaptation to dynamic link conditions, low processing and memory overhead, low network utilization, and determines unicast routes to destinations within the Ad-hoc network [1].

Destination-Sequenced Distance Vector routing protocol (DSDV) is a typical routing protocol for MANETs, which is based on the Distributed Bellman-Ford algorithm [3]. In DSDV, each route is tagged with a sequence number which is originated by destination, indicating how old the route is [2]. All nodes try to find all paths to possible destinations nodes in a network and the number of hops to each destination and save them in their routing tables. New route broadcasts contain the address of destination, the number of hops to reach the destination, the sequence number of the information receive regarding the destination, as well as a new unique sequence number for the new route broadcast [2].

Wireless networking is an emerging technology that allows users to access information and services electronically, regardless of their geographic position. Wireless networks can be classified in two types:-

1.1. Infrastructure Networks
Infrastructure network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed.

Examples of an infrastructure, a wireless network presented in fig. 1

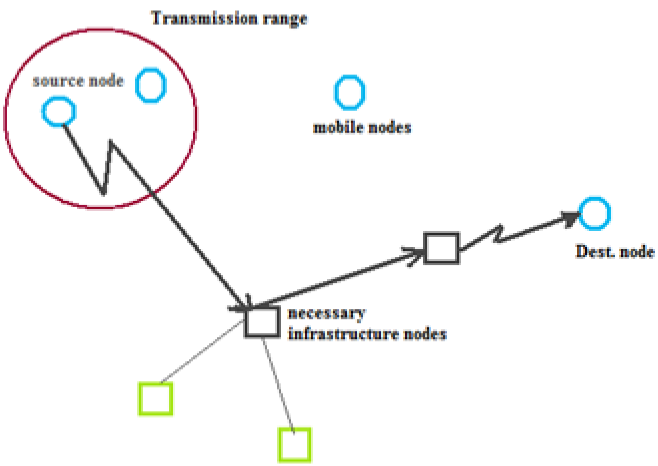

Fig. 1 Example of WAN

1.2. Infrastructure Less (Ad-Hoc) Networks
In contrast to infrastructure based wireless network, in ad-hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner A Mobile Ad-hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network without using any existing infrastructure or any administrative support. The wireless Ad-hoc networks are self-creating, self-organizing and self-administrating. The nodes in an Ad-hoc network can be a laptop, cell phone, PDA or any other device capable of communicating with those nodes located within its transmission range. The nodes can function as routers, which discover and maintain routes to other nodes. The Ad-hoc network may be used in emergency search-and-rescue operations, battlefield operations and data acquisition in inhospitable terrain. In Ad-hoc networks, dynamic routing protocol must be needed to keep the record of high degree of node mobility, which often

changes the network topology dynamically and unpredictably. Ad-hoc network presented on fig 2.

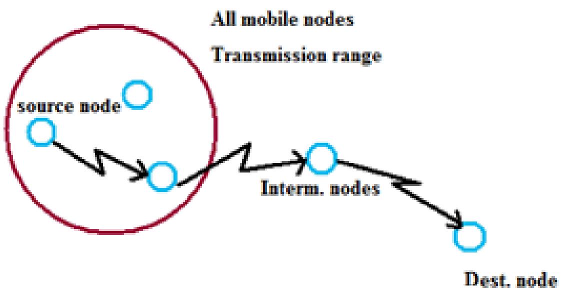

Fig. 2 Example of Ad-hoc Networks

2. ROUTING PROTOCOLS

The existing routing protocols in MANETs can be classified into two categories: (1) Table-driven routing protocols, and (2) on-demand routing protocols. Fig 3 shows the classification along with some examples of existing MANET protocols.

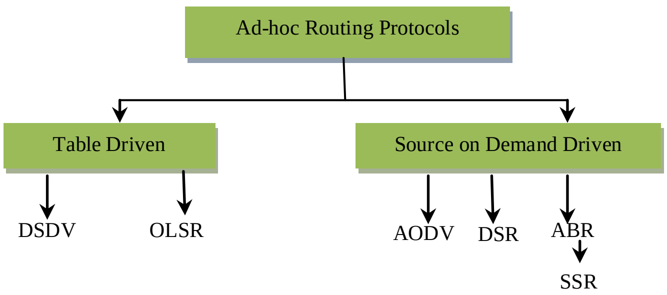

Fig.3 Classification of MANETs Routing Protocols.

2.1. OVERVIEW OF AODV AND DSDV ROUTING PROTOCOL

2.1.1. Destination-Sequenced Distance Vector

DSDV is one of the most well known table-driven routing algorithms for MANETs The Destination-Sequenced Distance-Vector (DSDV) Routing Algorithm is based on the classical Bellman-Ford routing algorithm with certain improvement [3].

Every mobile station maintains a routing table with all available destinations along with information like next hop, the number of hops to reach to the destination, sequence number of the destination originated by the destination node, etc. DSDV uses both periodic and triggered routing updates to maintain table consistency. Triggered routing updates are used when network topology changes are detected, so that routing information is propagated as quickly as possible. Routing table updates can be of two types - "full dump" and “incremental”. “Full dump” packets carry all available routing information and may require multiple network protocol data units (NPDU); “incremental” packets carry only information changed since the last full dump and should fit in one NPDU in order to decrease the amount of traffic generated. Mobile nodes cause broken links when they move from place to place. When a link to the next hop is broken, any route through that next hop is immediately assigned infinity metric and an updated sequence number. This is the only situation when any mobile node other than the destination node assigns the sequence number. Sequence numbers assigned by the origination nodes are even numbers, and sequence numbers assigned to indicate infinity metrics are odd numbers. When a node receives infinity metric, and it has an equal or later sequence number with a finite metric, it triggers a route update broadcast, and the route with infinity metric will be quickly replaced by the new route. When a mobile node receives a new route update packet; it compares it to the information already available in the table and the table is updated based on the following criteria:

- If the received sequence number is greater, then the information in the table is replaced with the information in the update packet
- Otherwise, the table is updated if the sequence numbers are the same and the metric in the update packet is better

The metrics for newly received routes are each incremented by one hop since incoming packets will require one more hop to reach the destination. In an environment where many independent nodes transmit routing tables asynchronously, some fluctuations could develop. DSDV also uses settling time to prevent fluctuations of routing table updates. The settling time is used to decide how long to wait before advertising new routes. The DSDV protocol guarantees loop-free paths to each destination and detects routes very close to optimal. It requires nodes to periodically transmit routing update packets. These update packets are broadcast throughout the network. When the number of nodes in the network grows, the size of the routing tables and the bandwidth required to update them also grows, which could cause excessive communication overhead. This overhead is nearly constant with respect to mobility rate

2.1.2. Ad-hoc On-demand Distance Vector

Reactive protocols discover routes only as needed. When a node wishes to communicate with another node, it checks with its existing information for a valid route to the destination. If one exists, the node uses that route for communication with the destination node. If not, the source node initiates a route request procedure, to which either the destination node or one of the intermediate nodes sends a reply back to the source node with a valid route [5]. A soft state is maintained for each of these routes – if the routes are not used for some period of time, the routes are considered to be no longer needed and are removed from the routing table. Example of this type algorithm is DSR & AODV

AODV stands for Ad-Hoc On-Demand Distance Vector [4] and is, as the name already says, a reactive protocol, even though it still uses characteristics of a proactive protocol. AODV takes the interesting parts of DSR and DSDV, in the sense that it uses the concept of route discovery and route maintenance of DSR and the concept of sequence numbers and sending of periodic hello messages from DSDV.

Routes in AODV are discovered and established and maintained only when and as long as needed. To ensure loop freedom sequence numbers, which are created and updated by each node itself, are used. These allow also the nodes to select the most recent route to a given destination node.

AODV takes advantage of route tables. In these it stores routing information as destination and next hop addresses as well as the sequence number of a destination. Next to that a node also keeps a list of the precursor nodes, which route through it, to make route maintenance easier after link breakage. To prevent storing information and maintenance of routes that are not used anymore each route table entry has a lifetime. If during this time the route has not been used, the entry is discarded.

3. SIMULATION SCENARIO

For the simulation study, we used the ns-2 network simulator version 2.34 that the latest version of simulator. Ns-2 is a discrete-event simulator targeted at networking research [6]. It began as a part of the REAL Network Simulator and is evolving through an ongoing collaboration between the University of California at Berkeley and the VINT project [7].

Simulation environment consists of 20 wireless mobile nodes which are place uniformly and forming a Mobile Ad-hoc Network, moving about over a 900 x 900 meters area for 250 seconds of simulated time. We have used standard two-ray ground propagation model, the IEEE 802.11 MAC, and Omni directional antenna model of NS2. The simulator parameters are listed in Table I. We have used DSDV and AODV routing algorithm and interface queue length 50 at each node. There is a some are source nodes and some are the receiving nodes.

TABLE I Simulation parameters

Parameter	**Value**
Simulator	NS-2 (Version 2.34)
Channel type	Channel/Wireless channel
Radio-propagation model	Propagation/Two ray round wave
Network interface type	Phy/WirelessPhy
MAC Type	Mac /802.11
Interface queue Type	Queue/Drop Tail
Link Layer Type	LL
Antenna	Antenna/Omni Antenna
Maximum packet in ifq	60
Area (MXM)	1000 X 1000
Number of mobile node	12,16
Source Type	UDP, TCP
Simulation Time	300 sec
Routing Protocols	DSDV, AODV

4. SIMULATION MODEL AND RESULT

The objective of thesis is to study and analyze the performance of two routing protocol for mobile ad hoc network. By using an open-source network simulation tool call Network simulator [NS-2]. These two routing protocol are Destination Sequenced Distance Vector Routing (DSDV) & Ad-Hoc on-Demand Distance Vector (AODV). The simulation environment will be conducted with the LINUX operating system. Because NS-2 work with only Linux platform. Fig 4 shows the simulation overview.

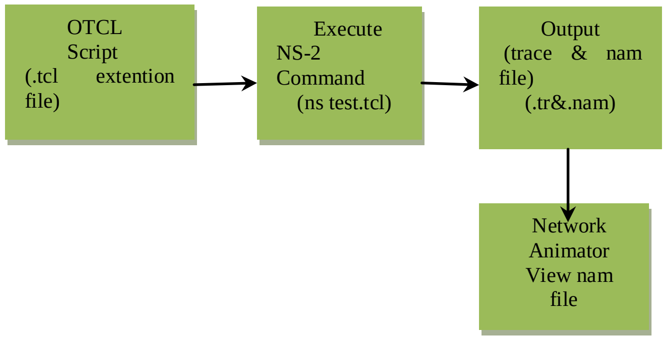

Fig.4 Simulation Overview

Whole simulation study is divided into two part one is create the node (that may be cell phone, internet or any other device) that is a NS-2 output. It's called NAM (Network Animator) output. NAM visualization tool shows the nodes movement and communication occurs between various nodes in various conditions. And another one is graphical analysis of trace file (.tr) and nam file (.nam). Graphical analysis is possible through Xgraph and TraceGraph. That is directly read the trace file and generate graph. To generate trace file and nam file we call tcl script in CYGWIN command shell. By varying the simulation parameter shown in (fig. 4), we can see the graphical variation between various performance metrics like Throughput, Drop, Delay, Jitter etc.

5. RESULT

Generated trace file that is (.tr)

s 10.006348737 _1_ MAC --- 3 ack 118 [13a 0 1 800] ------- [1:0 0:0 32 0] [0 0] 0 0

r 10.007293041 _0_ MAC --- 3 ack 60 [13a 0 1 800] ------- [1:0 0:0 32 0] [0 0] 1 0

s 10.007303041 _0_ MAC --- 0 ACK 38 [0 1 0 0]

r 10.007318041 _0_ AGT --- 3 ack 60 [13a 0 1 800] ------- [1:0 0:0 32 0] [0 0] 1 0

s 10.007318041 _0_ RTR --- 4 tcp 1560 [0 0 0 0] ------- [0:0 1:0 32 1] [1 0] 0 0

s 10.007318041 _0_ AGT --- 5 tcp 1540 [0 0 0 0] ------- [0:0 1:0 32 0] [2 0] 0 0

r 10.007318041 _0_ RTR --- 5 tcp 1540 [0 0 0 0] ------- [0:0 1:0 32 0] [2 0] 0 0

1. First field is event type; it may be r, s, f, d for "received", "sent", "forwarded" and "dropped" respectively.
2. The second field is the time.
3. The third field is the node number.
4. The forth field is MAC to indicate if the packet concerns a MAC layer; it is AGT to indicate the transport layer (e.g. tcp) packet, or RTR if it concerns the route packet. It can be IFQ for drop packets.
5. After the dashes comes the global sequence number of the packet (not tcp sequence number).
6. At the next field comes more information on the packet type (e.g. tcp, ack, or udp).
7. Next is the packet size in byte.

8. The 4 numbers in the first square brackets concern MAC layer information. The first hexadecimal number specifies the expected time in seconds to send this data packets over the wireless channel. The second number stand for the MAC-id of the sending node third is for receiving node. And forth number, 800, specifies that the MAC type is ETHERTYPE_IP.
9. The next number in the second square brackets concern the IP source and destination addresses, then the ttl (time to live) of the packet (in our case 32).
10. The third brackets concern the tcp information: its sequence number and acknowledgement number.

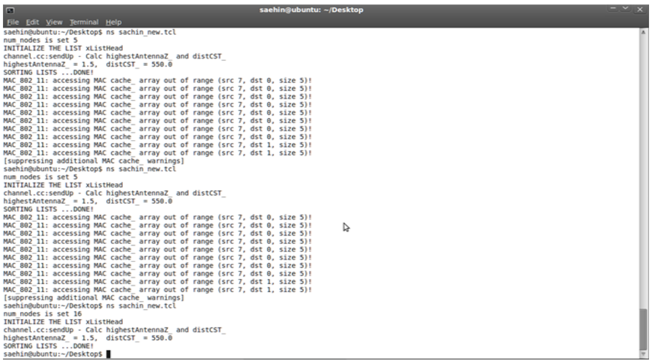

Fig. 5 Running TCL script in cygwin command shell

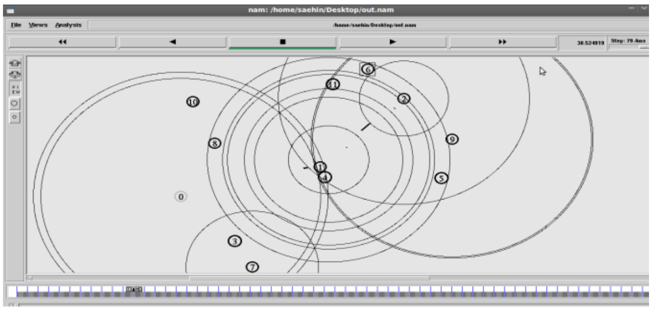

Fig. 6 A snapshot of the simulation topology in NAM for 12 mobile nodes

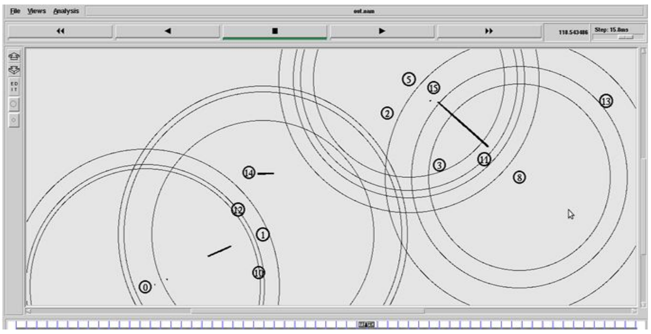

Fig. 7 A snapshot of the simulation topology in NAM for 16 mobile nodes

6. CONCLUSION

Otcl script (.tcl extention file) has been created and NS-2 command (ns test.tcl) using CYGWIN command shell has been executed successfully. After execution, tcl script .tr (trace) file & .nam (NAM) files have been generated and simultaneously packets movement between the nodes in NAM (network animator) has been visualized.

7. REFERENCES

[1] Md. Monzur Morshed, Md. Habibur Rahman, Md. and Analysis of Ad- hoc on demand Distance Vector Routing Protocol," ICIS 2009, vol. II, pp. 610- 614, November 2009.

[2] Valid Nazari Talooki, Jonathan Rodriguez, "Quality of Service for Flat Routing Protocols in Mobile Ad-hoc Network," ICST, September 7-9, 2009.

[3] V. Ramesh, Dr. P. Subbaiah, N. Koteswar Rao and M. Janardhana Raju, "Performance comparison and analysis of DSDV And AODV for MANET," (JJCSE) International Journal on Computer Science and Engineering, vol. 02, pp. 183-188, 2010.

[4] Charles E. Perkins, Elizabeth M. Belding-Royer, Samir R. Das Ad hoc On-Demand Distance Vector Routing, IEFT MANET Draft, Charles E. Perkins, Ad Hoc Networking, ISBN 0-201-30976-9 February 2003.

[5] S H Manjula, C N Abhilash, Shaila K, K R Venugopal, L M Patnaik, "Performance of AODV Routing Protocol using Group and entity Mobility Models in Wireless Sensor Networks," Proceedings of the International Multi Conference of Engineers and Computer Scientists (IMECS 2008), vol. 2, 19-21 March 2008, Hong Kong, pp. 1212-1217.

[6] Network simulator-ns-2 www.isi.edu/nsnam

[7] NS Manual/Documentation-The VINT Project Collaboration between researchers at UC Berkeley, LBL, USC/ISI and Xerox PARC. Kevin Fall_ kfall@ee.lbl.gov Editor Kennan Varadhan_kannan@catarina.usc.edu