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A Simulation-Based Performance Evaluation of AODV and DSR in Mobile Ad-Hoc Networks (MANETs)

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***Abstract*– This work evaluates and compares the performance of two reactive routing protocols for mobile ad-hoc networks: Ad hoc On-demand Distance Vector (AODV) and Dynamic Source Routing (DSR). The study focuses on the design and evaluation of routing protocols in mobile ad-hoc networks. Study and implementation of these protocols are been carried out using network simulator (ns2) and metrics such as Packet Delivery Fraction, Average end-to-end Delay, Routing overhead and Normalized Routing are used for performance analysis. Results are presented as a function of these metrics and the graphs generated show that DSR performs better than AODV when fewer nodes are been used.**

***Index Terms*– Performance Evaluation, Routing Protocols, Mobile Ad-Hoc Networks, AODV, DSR and NS2**

I. INTRODUCTION

MANET (Mobile Ad hoc Network) is a self-configuring network of mobile devices connected together by wireless links. It is a collection of different mobile nodes communicating with no fixed infrastructure or predetermined topology of wireless links (Frenlien, 2011). In this case, each node is free to move freely in any way and can connect to other nodes at any time. Because of the limited transmission range of each nodes, all nodes cannot communicate directly with one another and thus use nearby nodes to forward packets to its destination. Since there is no base station for this network, each node serves as a router and forward unrelated traffic to others. Hence, a routing protocol is required to run on every host and functions according to the resources available at each nodes.

Since there is no fixed infrastructure in a MANET, routing is the biggest problem in selecting the best paths in a mobile network. Routing is the process of choosing the best paths to send packet across the network. A good routing protocol should minimize the computing load on the host as well as the traffic overhead on the network (Azzedine, 2004).

II. LITERATURE REVIEW

A) Performance evaluation of routing protocols for ad hoc wireless network

This work described a mobile ad hoc network as nodes that communicate together over a wireless links. Importance of this network in providing communication support where no fixed infrastructure is required (for example in future civilian and military settings) was highlighted. Different routing protocols; AODV, PAODV, CBRP, DSR and DSDV were studied and their performance were compared using different scenarios and work load. The result indicated that CBRP has a higher overhead than DSR because of its periodic hello messages while AODV’s end-to-end packet delay is the shortest when compared to DSR and CBRP (Azzedine, 2004). PAODV has shown little improvements over AODV (Azzedine, 2004).

B) Scenario-based performance analysis of routing protocols for mobile ad-hoc networks

Destination Sequenced Distance Vector (DSDV), Ad-hoc On-demand Distance Vector (AODV) and Dynamic Source Routing (DSR) were studied using simulations scenario where nodes move randomly. The results reflected the relative speed of each node in the scenario. In addition, three realistic scenarios were performed to test the protocols further and the result showed that reactive protocols (AODV and DSR) performed significantly better than DSDV (Per et al, 1999). With an average traffic load, DSR performed better than AODV when tested with mobility values while AODV performance is better than DSR with higher traffic load.

C) Simulation-based performance evaluation of routing protocols for mobile ad-hoc networks

The performance evaluation of many routing protocols was carried out using packet-level simulations. The protocols include those designed specifically for the ad hoc routing and the traditional protocols such as link state and distance vector used for dynamic networks. 30 and 60 nodes for small and medium size networks respectively were used and the performance is recorded in respect to fraction of packets delivered, routing load, end-to-end delay and mobility model (Samir et al., 2011). The results showed that the on-demand routing protocols used lower routing load while the traditional distance vectors and link state protocols produced better packet delivery and end-to-end delay performance.

II. DESCRIPTION OF ROUTING PROTOCOLS

Routing protocol can be divided into proactive, reactive and hybrid routing protocols base on how the information is acquired and maintained by mobile nodes.

Proactive routing protocol is also known as “table driven” routing protocol, because nodes in a mobile ad-hoc network evaluate routes continuously to all reachable nodes and consistently maintain up-to-date information. If a change occurs in the network topology, a respective updates must be propagated across all the nodes to notify the change. Hence, a source node can get routing path immediately. However, a lot of overhead (load) is required, lots of unnecessary traffic is generated and the battery of mobile devices drains in time.

Reactive routing protocols are also known as “on-demand” routing protocols because routing paths are searched only when needed. They use a discovery procedure to terminate either when a route has been found or when no route is available after examination for all route combinations. Less control overhead, better scalability, and longer battery power are advantages of reactive routing over proactive routing protocols. However, in reactive routing, source nodes may suffer from long delays for route searching before they can forward data packets (Changling and Jorg, 2005).

Hybrid routing protocols combine the advantages of both reactive and proactive routing protocols to overcome their shortcomings. They exploit different hierarchical architectures at each level using proper proactive routing approach and reactive routing approach.

Table 1: Routing protocols type and example

MANET Routing protocols	Proactive Routing	Destination Sequence Distance Vector (DSDV)
		Wireless Routing Protocol (WRP)
		Fisheye State Routing (FSR)
		Distance Routing Effect Algorithm for Mobility (DREAM)
	Reactive Routing	Dynamic Source Routing (DSR)
		Ad hoc On-demand Distance Vector Routing (AODV)
		Temporally Ordered Routing Algorithm (TORA)
		Location Aided Routing ((LAR)
		Associativity Based Routing (ABR)
		Signal Stability-base adaptive Routing protocol (SSR)
	Hybrid Routing	Zone Routing Protocol (ZRP)
		Hybrid Ad hoc Routing Protocol (HARP)

The two reactive protocols studied in this work are described as follows:

A) The Ad hoc On-demand distance Vector Routing (AODV) Protocol

The Ad hoc on-demand Distance Vector Routing (AODV) protocol is a reactive unicast routing protocol for mobile ad hoc networks. It functions by maintaining the routing information about the active paths and routing tables at nodes. Each node contains the next-hop routing information and the destinations to which it presently has a route. The routing table expires if it is not used or reactivated for a specified period. It initiates a route discovery operation to send packets from a source node to the destination node if no route is available. The route discovery operation consists of broadcasts route request ((PREQ) packets which includes the source and destination address, the broadcast ID (an identifier), last sequence number of the destination and source node’s sequence number. A node in AODV sends hello messages to notify its existence to its neighbours and monitors the link status to the next hop in active route. When there is a link disconnection, a node broadcasts a route error (RERR) packet to its neighbours, which then propagates the PERR packet towards other nodes whose route may be affected. The route discovery operation can then be re-initiated if the route is still needed.

B) Dynamic Source Routing (DSR) Protocol

Dynamic Source Routing (DSR) protocol is a reactive unicast routing protocol that uses source routing algorithm. In DSR, each data packet contains whole routing information to reach its destination and caching technology is used by each node to maintain learnt route information. DSR uses route discovery phase and route maintenance phase for sending and receiving information or packets between nodes. When a link disconnection is been detected by the data link layer, a ROUTE_ERROR packet is sent backward to the source and the source node initiates a route discovery operation. When the ROUTE_ERROR packet is transmitted to the source, the broken link route is removed from the route caches of the immediate nodes. Since each data packet has complete routing information, increased traffic overhead degrades DSR routing performance.

III. PERFORMANCE ANALYSIS

A) Simulation Setup

Network Simulator 2 (NS2) used is a discrete event driven simulator developed by UC Berkeley and it is written in C++. The parameters used and their values are shown in the Table 2:

Table 2: Simulation Parameters

Parameters	Value
Routing Protocols	AODV, DSR
MAC Layer	802.11
Packet Size	1440 bytes
Terrain Size	1000m * 1000m
Nodes	10 and 40
Data Traffic	Tcl
Max. Packet	50
Simulation Time	60 sec.

The following metrics were used to evaluate the performance of routing protocols discussed above and Figure 1 to Figure 4 show the graph generated.

Packet Delivery Fraction (PDF)

This is the ratio of packets delivered to the destination to the packet generated by the sources.

PDF = (Pd/Ps)*100

Where Pd is total packet delivered to the destination and Ps is total packet sent.

Average End-to-End delay (second)

This is time taken for a data packet to move across the MANET from source to destination. It is total delay experience by the data packet.

D = (Tr - Ts)

Note: Tr is receive Time, Ts is sent Time.

Routing Overhead

This is the total number of control of routing (RTR) packets produced by routing protocol during simulation.

Overhead = number of RTR packets

Normalized Routing Load

This is the total control packet sent by all nodes in the network to discover and maintain route. Number of routing packets transmitted to the packet delivered at destination.

NRL = Routing packet/Received packet

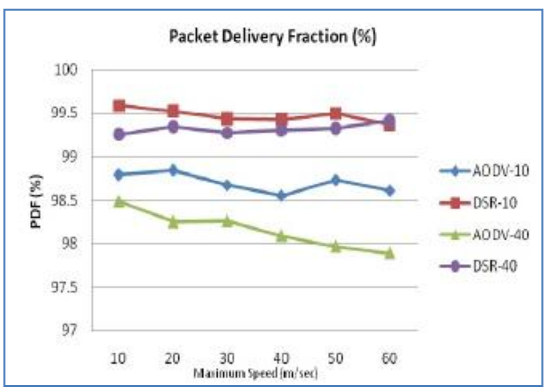

Figure 1: Packet Delivery Fraction vs. Speed

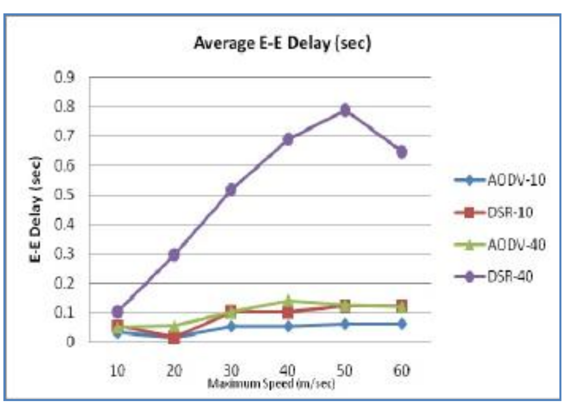

Figure 2: Average end-to-end delay vs. speed

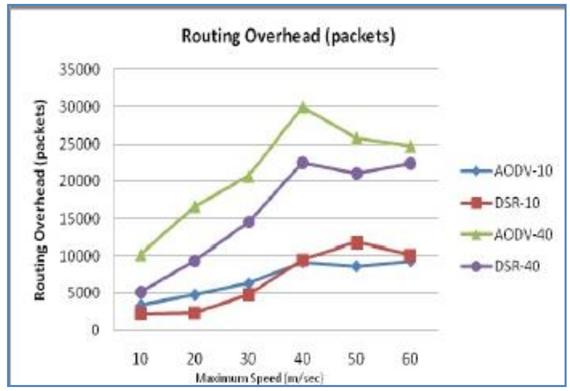

Figure 3: Routing overhead vs. speed

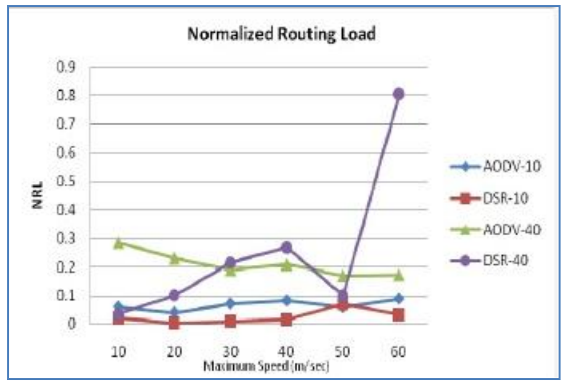

Figure 4: Normalized Routing Load vs. speed

IV. RESULT AND DISCUSSION

The result of this work is based on the performance of the two protocols used during the simulation. The same number of simulation parameters were used under the same simulation environment and a number of random traffic were generated using Microsoft excel.

The Figure 1 to Figure 4 display the result and highlight the relative performance of the two routing protocols AODV and DSR. In packet delivery, DSR performs better irrespective of speed and load as shown in Figure 1. In average end-to-end delay, AODV perform better in all conditions. Delay in DSR is much in Figure 2 due to route caching property of DSR. In terms of routing overhead, DSR also performs better because it has a lower routing overhead than AODV as shown in Figure 3. At low network load in Figure 4, both AODV and DSR performance are similar but AODV performs better at higher load.

IV. CONCLUSION

This work determines the performance of AODV and DSR routing protocols for a MANET using ns-2 simulations. Both AODV and DSR use the reactive on-demand routing strategy. While AODV uses routing tables, each per destination and sequence number to avoid loops and to find fresh route, DSR uses source routing and route caches and do not rely on any periodic or timing activities. It maintains multiple routes for each destination. It is observed from the simulation that DSR performs better than AODV under fewer nodes. This is because aggressive caching help DSR at low loads and then keep its routing load down. However, AODV will perform better if higher number of nodes is use.

A more complex simulation could be carried out in the future using a varying number of nodes to determine and compare the performance of DSR and AODV further. Other new protocols for MANET could also be studied.

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