Performance Evaluation of Some Mobile Adhoc Network Routing Protocols.

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Abstract ---- The introduction of adhoc networks into wireless communication opened up a new dimension because devices can communicate without any centralized system. The nodes on this type of network are responsible for forwarding and receiving packets and are very mobile. This type of network is easily deployable and self-configuring because it adapts to the rapid change in topology. Routing protocols designed for the network differ and they face diverse challenges as a result of the unpredictable change of the topology and link instability. Routing is one of the challenges that adhoc network face and effective routing mechanism helps to improve the successful deployment of the network. This research was carried out to evaluate the performance of some routing protocols in adhoc networks by using simulation approach. The different protocols evaluated are the AODV, TORA, DSR, OLSR, DSDV. The performance of these protocols were evaluated using the throughput, end-to-end delay and packet delivery ratio as the performance evaluation metrics. NS 2.35 was the simulation tool that was used to carry out the simulation for the two different network environments (High and low traffic environments) that were simulated. The result shows that the TORA and the OLSR generally outperforms other protocols evaluated in the reactive and the proactive protocols respectively when the traffic on a network is high whereas, the TORA and the DSDV generally outperforms other protocols evaluated in the reactive and the proactive protocols respectively when the traffic on a network is low.

Keywords: Ad Hoc Network, Topology, Routing, Throughput, Performance, Protocols and Simulation.

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1. INTRODUCTION

The most widespread notion of an ad hoc network is a network formed without any central administration which consists of mobile/movable nodes that use a wireless interface to send data. The nodes in a network of this kind can serve as routers and hosts that can forward packets on behalf of other nodes and run user application [1]. The challenges that exists in ad-hoc network are security, congestion control, routing, power management, topology control, quality of service to mention a few. Some these challenges, more specifically, congestion, results to user experiencing longer delays, more packet loss and other degradation issues that affects the quality of service of the network.

Researchers have proposed a number of solutions to overcome the challenge in ad hoc environment. These solutions are based on packet generation rate, transmit power control, utility function, carrier sense threshold or a combination of them [3].Various research and experiments have shown that routing mechanism in networks with central systems performs poorly in ad hoc network [5] this is due to the high mobility rate of the nodes in ad hoc networks.

The challenges that exists in ad-hoc network include but not limited to security, congestion control, routing, power management, topology control, quality of service to mention a few. This research will be focusing on evaluating routing protocols that are presently deployed on adhoc networks in order to showcase the strengths and weaknesses of these protocols.

2. REVIEW OF LITERATURE

There are currently two variations of mobile wireless networks. The first is known as infrastructured networks, i.e., those networks with fixed and wired gateways. The bridges for these networks are known as base stations. The second type of mobile wireless network is the infrastructureless mobile network, commonly known as an ad-hoc network. Infrastructureless networks have no fixed routers; all nodes are capable of movement and can be connected dynamically in an arbitrary manner. Nodes of these networks function as routers which performs the duty of the router in infrastructure network amidst which include discovery and maintenance of routes to other nodes in the network. Example of the applications of ad-hoc networks are emergency search-and-rescue operations, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrains [9].

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The need for correct routing of packets is important in ad hoc networks because the mobility rate of the nodes is high due to the unfixed/undefined topology and the lack of infrastructural backbone. Messages must be sent from a sender to the intended receiver even without a direct link. This is a major challenge with ad hoc networks because the routers move anyhow and anytime in an unpredictable way thereby making routing challenging. According to [2], adequate routing can be used to improve the performance of adhoc network. The techniques that have been put in place for adequate routing of infrastructural network are not sufficient to solve that of the ad hoc network because of the undefined topology in ad hoc network.

Senthil and Sankaranarayanan in [7] opined that packet loss, long delay, unfair Scenarios and low throughput come to be as a result of congestion due to routing which in turn affects the general performance of the entire network thus there is a need to eradicate/ reduce rate packet loss, long delays and low throughput so as to improve performance, reduce energy consumption, reduce delay, and increase the reliability of the network. There are various mechanisms that have been put in place in order to handle the routing process of Mobile Adhoc network. These mechanisms are referred to as routing protocols.

3. THE ROUTING PROTOCOLS:

The discovery and maintenance of routes between nodes is handled by routing protocol which are generally categorized into 3 which are:

re-active (on demand) routing protocol

pro-active (table driven) routing protocol, and

hybrid routing protocol.

The reactive protocol is also known as on-demand protocol. This protocol finds a route as demanded by the source by flooding the network with route request packets (RREQ). Examples of this protocol include but not limited to the Ad hoc On-Demand Distant Vector Routing (AODV) and Dynamic Source Routing (DSR). This method is prone to high latency time in route finding and excessive flooding [4]. In reactive protocol, the routing overhead is not as high as that of the proactive because it only maintains actively used routes.

The proactive protocol also known as table driven, is a protocol that uses information acquired from neighboring node to decide which route to take. All nodes have tables with routing information which is updated at intervals. Nodes on the network need to have information about the topology of the network. Examples of this protocol amidst others include Optimized Link State Routing Protocol (OLSR) and Destination Sequenced Distant Vector Routing (DSDV). This mechanism is prone to slow reaction on reconstructing and failures as a result of large amount of data needed for maintenance [4].

The hybrid protocol is the protocol that combines the features of both reactive and proactive protocol. It uses both the reactive and proactive approaches during routing. This mechanism depends on number of nodes activated and traffic volume. Example amidst others include the Zone Routing Protocol (ZRP), Hybrid Adaptive Routing Protocol (HARP) [4].

3.1 Routing protocols to be considered

The following routing protocols were simulated, evaluated and analyzed:

3.1.1 Ad-hoc on demand Distance Vector Routing (AODV).

AODV is an on demand routing protocol. When one node is to communicate with another, it broadcasts a route request (RREQ) to all neighbouring nodes. The RREQ is forwarded until it reaches its destination or it finds a node with a fresh route to the destination. AODV ensures all routes are loop-free and contain the most recent routing information. Each node keeps track of its own sequence number and a broadcast ID which is incremented every time a RREQ is sent. The RREQ contains information of the source IP address, the source sequence number, the broadcast ID and the most recent sequence number known for the destination address. If a link between two intermediate nodes is broken, a message of this event is sent back to the source node which then can decide if it wants to send a RREQ to re-establish the route to the destination or not. The error message is known as the route error (RERR).

3.1.2 Temporally Ordered Routing Algorithm (TORA).

TORA is an adaptive on demand routing protocol suitable for every mobile ad-hoc networks [3]. TORA focuses on solving the routing problem where the topology has changed. It does this by letting all nodes hold routing information of the neighbouring nodes. TORA establish the routes quickly and minimize the communication overhead in reaction to topological changes where necessary. Instead of using the concept of shortest path for computing routes which take huge amount of bandwidth TORA algorithm maintains the “direction of the next destination” to forward the packets. Thus the source node maintains one or two “downstream paths” to the destination node through multiple intermediate neighboring nodes.

3.1.3 Dynamic Source Routing (DSR).

In DSR, all nodes keep a route cache which holds routing information of other nodes. Entries in the routing cache hold the entire routing information of a route, not just the next hop node. If a node is not in the routing cache that a source node wants to communicate with, the source node broadcasts a route request, much like in AODV. This route request holds the information of source and destination but also the nodes on the path, called a route record. When an intermediate node receives a route request, it checks if it is in this route record. If it is, the message is discarded; otherwise it adds itself to the route record and sends the route request on to its neighbours. When a route request reaches a node that has a route to the destination in its routing cache, the node adds itself and the routing cache information to the route record and sent back a route reply, containing the route record, to the source. If the route request reaches the destination node, it also adds itself to the route record and sends back a route reply.

3.1.4 Optimized Link State Routing (OLSR).

OLSR is a proactive protocol based on link state routing in which initially nodes have routing tables which they update from time to time. The routes are immediately available whenever needed due to the route tables. It uses the concept of Multipoint Relays (MPR) to reduce the possible overhead in the network. In OLSR only the nodes chosen as MPRs transmit packets to all other nodes thus reducing traffic significantly. Each node selects a MPR which is one hop away from it. Each MPR node maintains the topology information of network and sends this information to other MPRs [1].

3.1.5 Destination Sequenced Distant Vector (DSDV).

DSDV routing is a proactive routing protocol. Every node has a table that holds information about every other reachable node in the network. For every node the information stored is: the next hop node, the hop distance and a sequence number. Every node sends its table to its neighbours at time intervals. When a node receives a table from a neighbouring node it updates its own table. At every new time interval when a node is to broadcast its table, the sequence number is incremented. This way a node receiving a table knows how up-to-date the information is. New information replaces old information, and better information (a quicker route) replaces worse. In order to keep the network traffic due to updating information down, the whole routing table is not sent every time but smaller incremental packages only containing the changed information since the last full dump.

4. EXPERIMENTAL STUDY

This research work adopted a simulation approach. This is due efficiency that has been recorded by simulation when carrying out research on network environments because it is time efficient and less expensive amidst other advantages. The performance metrics that were used for the evaluation were throughput, packet loss ratio and end-to-end packet delay so as to showcase the strengths and weaknesses of each routing protocols. Network Simulator 2 (NS-2) was used for the simulation. The simulation experiment was setup in a way that three (3) parameters were used to evaluate the performance of five (5) routing protocols which are the AODV, DSDV, DSR, OLSR, and TORA. These protocols were used in two (2) different network environments which are; a network with low mobility and low traffic containing twenty (20) nodes which covered a space of 400x400m2 and the one with high mobility and high traffic containing eighty (80) nodes which covered a space of 800x800m2. The simulation was scheduled to run for 180 seconds. The Constant Bit rate traffic type was used in both scenarios. The nodal movement was randomized throughout the whole simulation time.

4.1 Performance Parameters

There are three main performance parameters that were considered during this research for the purpose of evaluation. They are throughput, packet delivery ratio and end-to-end packet delay.

4.1.1 Throughput

This is the number of packets successfully delivered to the destination. It is measured in bytes/second. The higher the throughput, the better the protocol performance.

4.1.2 Packet delivery ratio

This is the number of packets delivered to the destination. The higher the packet delivery ratio, the better the performance of the protocol.

4.1.3 End-to-End packet delay

This is the time it takes the packet to reach the destination after it leaves the source. It is measured in second. The lower the delay, the better the performance of the protocol.

5. DATA ANALYSIS, RESULTS AND DISCUSSION OF FINDINGS

Below are the graphical representations of the results obtained after the simulation

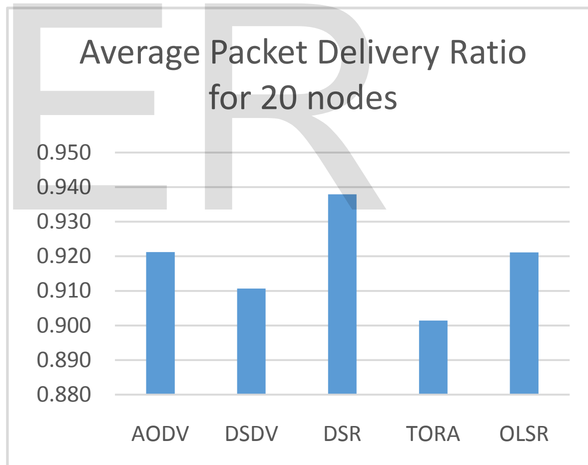

Fig. 1: Graph showing packet delivery ratio between protocols in the network with 20 nodes

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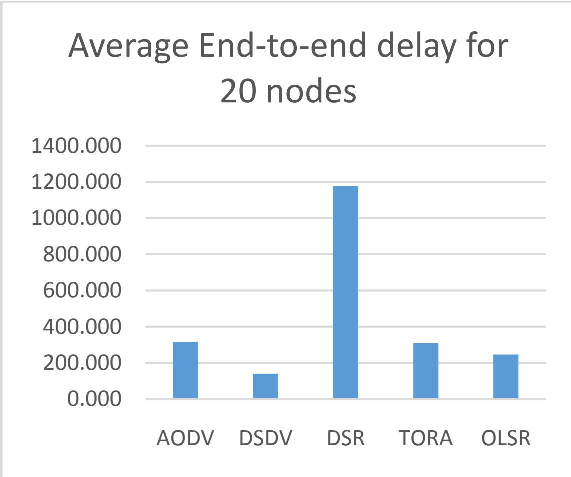


Fig. 2 Graph showing end-to-end delay between protocols in the network with 20 nodes

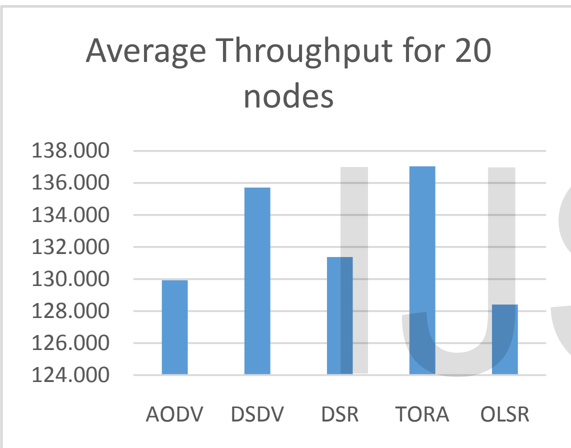
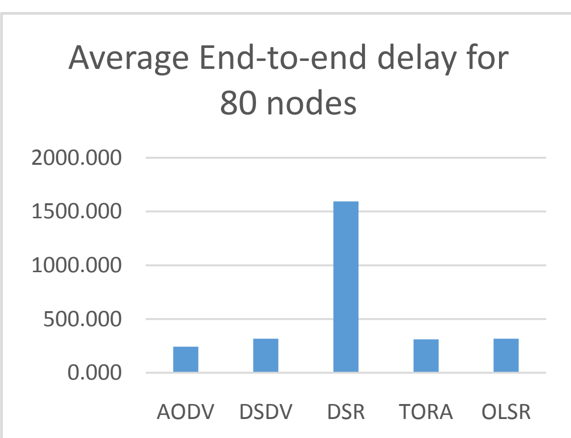


Fig. 3: Graph showing throughput between protocols in the network with 20 nodes



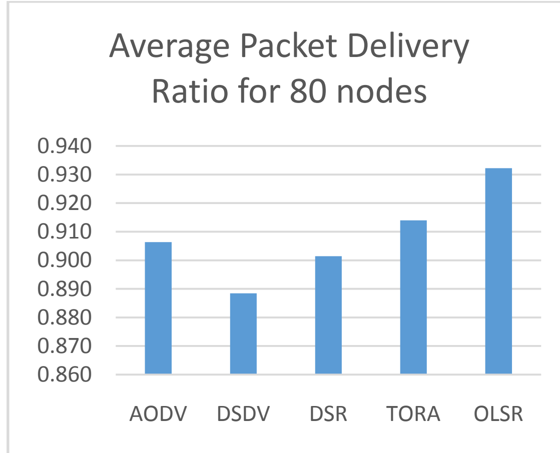


Fig. 4: Graph showing packet delivery ratio between protocols in the network with 80 nodes

Fig. 5: Graph showing end-to-end delay between protocols in the network with 80 nodes

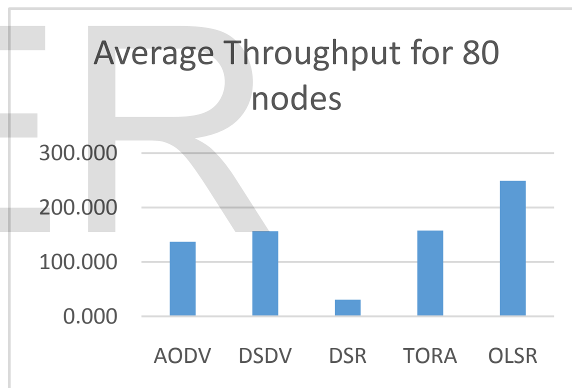


Fig. 6: Graph showing throughput between protocols in the network with 80 nodes

Analyzing the results, it was observed that in the high traffic network, the TORA and the OLSR outperforms other protocols in the Reactive and Proactive categories respectively when it comes to packet delivery while the OLSR and the AODV are the protocols with the lowest delay in the proactive and reactive categories respectively and the protocols with the highest throughput are the TORA for the reactive category and the OLSR for the proactive category.

Moreover, analyzing the network with low traffic, it was observed that the DSR and the OLSR outweighs other protocols in the reactive and proactive categories respectively when it comes to packet delivery ratio. The DSDV and TORA has the lowest delay and highest throughput in the proactive and reactive categories respectively.

6. CONCLUSION:

From the research conducted, it is clear that due to the dynamic properties of the adhoc network, effective routing is a complex issue. Till now, many routing protocols are being used in MANETs and each protocol has its own unique and dynamic features. This research was carried out in two different network environment (High traffic and low traffic) and it was observed that the TORA and the OLSR generally outperforms other protocols in the reactive and the proactive protocols respectively when the traffic on a network is high while the TORA and the DSDV generally outperforms other protocols in the reactive and the proactive protocols respectively when the traffic on a network is low.

7. RECOMMENDATION FOR FUTURE WORKS

In future research, the most effective protocols under the networks environments simulated could be integrated to develop a hybrid protocol that will be suitable for any network either high or low trafficked. And also, more Protocols could also be evaluated and compared with each other so as to identify the most efficient protocol under diverse network conditions.

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