SIMULATION COMPARISON AND ANALYSIS OF NETWORK THROUGHPUT IN DSDV AND AODV AND DSR MOBILE ADHOC NETWORK PROTOCOLS

M. Omari, Z. Kebir, H. Soulimani
LDDI Laboratory, Mathematics and Computer Science Department, faculty of Sciences and Technology, University of Adrar, 01000, Algeria
omarialgeria@gmail.com, zohrakebir@hotmail.com, soulimanihasna@gmail.com

Abstract - *Mobile ad hoc network (MANET) is an autonomous system of mobile nodes connected by wireless links. Each node operates not only as an end system, but also as a router to forward packets. The infrastructure less of this networks and frequent topology changes increase the need to routing strategies to be implemented in order to provide efficient end-to-end communication. Several routing protocols are proposed, they are mainly classified as proactive, reactive and hybrid routing protocols.In this paper, we simulate a proactive routing protocol (DSDV) and two reactive routing protocols (AODV and DSR) using the famous simulator NS2. We conducted some tests for each routing protocol focusing on the throughput. This metric was tested versus the node's velocity, the network load and the traffic type.*

Keywords: *Mobile ad hoc, routing, NS-2, AODV, DSR, DSDV.*

INTRODUCTION

Increased use of laptop computers and the increase in people's mobility have fuelled the demand for wireless networks [1]. The term wireless networking refers to a technology that enables two or more computers to communicate using standard network protocols through radio or infrared signals.There are two different approaches for enabling wireless communication between two hosts. The first approach is to form an infrastructure network where each node communicates each other by the aid of an existing infrastructure (base station or access point) carry data as well as voice. One of the major problems posed in this approach is the handoff problem, which tries to handle the situation when the connection should be smoothly handed over from one base station to another base station without noticeable delay and packet loss. The second approach of wireless networking is to form a mobile ad hoc network where each node communicate each other directly without the need of any preexisting infrastructure or base stations, In this approach nodes required to act as routers as well as end systems.One interesting research area in MANET is routing. Routing in the MANETs is a challenging task and has received a tremendous amount of attention from researches [2]. This has led to development of many different routing protocols for MANETs, and each author of each proposed protocol argues that the strategy proposed provides an improvement over a number of different strategies considered in the literature for a given network scenario. Therefore, it is quite difficult to determine which protocols may perform best under a number of different network scenarios. The routing protocol must be able to keep up with the high degree of node mobility that often changes the network topology drastically and unpredictably. The objective of this paper is to understand and evaluate the most widely used protocols which are AODV, DSDV and DSR based on the simulation tool with NS-2 using different scenarios and performance metrics such

as: packet delivery fraction, throughput, average end to end delay, packet loss and normalized overhead.

The rest of the paper is organized as follows. Section 2 presents an introduction of mobile ad hoc networks. Section 3 shows the classification of routing protocols for ad hoc networks and describe some of these protocols. The simulation environment, the results and the results analysis are presented in Section4. Finally, the conclusion of this work is presented in Section 5.

METHODS

MOBILE AD HOC NETWORKS

Wireless networks are collection of mobile devices without using cables; these devices communicate each other through radio frequencies in air.
Wireless networks have many advantages:

- Mobile users are provided with access to real-time information even when they are away from their home or office.
- Setting up a wireless system is easy and fast and it eliminates the need for pulling out the cables through walls and ceilings.
- Network can be extended to places which cannot be wired.
- Wireless networks offer more flexibility and adapt easily to changes in the configuration of the network [1].

Yet, on the other hand, its main disadvantages are:

- Interference due to weather, other radio frequency devices, or obstructions like walls.
- The total Throughput is affected when multiple connections exists [1].

Wireless networks can be either infrastructure where wireless hosts can be connected with the wireless system by the help of specific devices called access points (base stations) when they roam from one place to the other, or infrastructure less (Ad Hoc), in which each mobile node communicates with each other without need of any base station.

Definition

An ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration. Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks, where the structure of the network changes dynamically. This is mainly due to the mobility of nodes. Nodes in these networks cooperate in a friendly manner to engaging themselves in multihop forwarding. The absences of centralized administration oblige nodes to act as hosts and router in the same time in order to route data to/from nodes in network.
A Mobile Ad hoc Network (MANET) is a network architecture that can be rapidly deployed without relying on existing fixed wireless network infrastructure. This means that the network nodes should be able to communicate to each other even if no static infrastructure, such as backbone network, base stations, and centralized network management function are available.
The transmission range of a node is limited to a circular region around the node, whose radius depends on the transmitted power, receiver sensitivity and propagation loss

model. If the destination node is not in the transmission range of the source node, then the mobile ad hoc network works like a multi hop network with one or more node acting as routing node.
All the active nodes of the MANET need to transmit a hello message at regular intervals, to indicate their presence. Other nodes, in the transmission range of a node, can use that node as next hop to forward their packets toward the destination [2].

MANETs Architecture
The architecture of an Ad Hoc network can be divided into two types - peer-to-peer structure and hierarchical structure.

Peer-to-Peer
In this type of architecture, each mobile node has the same status in a peer-to-peer structure. Each node can move randomly and establish point-to-point wireless connection with each other, automatically. Information can be exchanged among the nodes, directly.

Hierarchical
In this type of architecture, the whole network is organized into different clusters. Each cluster is a subnet and includes one cluster head with multiple cluster members. The cluster head and cluster members move randomly and are self-organized, and use the same radio frequency to connect with each other. The cluster head, however, uses another radio frequency to communicate with the other cluster heads. In the hierarchical structure, the status of the cluster head is more important than the cluster members. These cluster heads link among themselves to provide the backbone of an Ad Hoc network. The traffic flow is higher in the backbone than on the other links. Thus, some cluster members that are located far away from the backbone, do not need to participate in some of the routing processes [3].

Routing in MANETs
All communications between devices in a network is based on routing. Routing is the act of moving and forwarding packets of data from a source to a destination by providing the shortest path between them using routing algorithms or protocols. Unlike wired and wireless infrastructure networks routing confine on specific devices (centralized administrator, base stations), routing in MANETs represent a complex task due to the high mobility of nodes, unpredictable topology and every node operate as a router and user at the same time. This means that routing information should be updated more regularly than in wired networks.
Routing based on construction of routing tables which are formed by the adaptive routing protocol. Several protocols and algorithms proposed for MANETs each one try to modify routing table and increase routing performance [4].

Classification of routing Protocols in MANETs
Routing is the essential task of transferring packets form source node to destination, or can be described as the process of path finding. A lot of routing algorithms have been proposed for mobile ad hoc networks and most of them have been implemented as protocols. These protocols are classified into three main categories: proactive, reactive and hybrid [5]. We are dealing here with the proactive protocols.
These protocols are also called as Table-Driven routing protocols since they maintain the routing information even before it is needed [5]. Each and every node in the network

maintains routing information to every other node in the network. Routes information is generally kept in the routing tables and is periodically updated as the network topology changes. Many of these routing protocols come from the link-state routing.
In proactive routing protocols, paths towards all destinations are periodically refreshed even if not used. Normally, these protocols require nodes to broadcast information about their neighbors, and based on this information, each node in the network computes the minimum path to every possible destination. DSDV, OLSR, WRP and CGSR are typical protocols based on proactive routing algorithm in Ad Hoc networks.

On Demand Routing Protocols (Reactive)

On-demand routing protocols create routs only when needed by source node to send a packet of information to destination node. When a node requires a route to destination, it initiates a route discovery process within the network, when a route found or many possible routes discovered then the node choose a specific route with smaller metric (shortest path).
This approach of routing tries to eliminate the routing tables and reduce the need of updating these tables in contrast with the proactive routing protocols which maintain all tables up-to-date at every node. In reactive routing protocols routes is always available with reduce of network traffic and power consumption but on demand routing suffer longer delay while route discovery.
In the following sections are described some of reactive routing protocols such as AODV and DSR.

Ad hoc On Demand Distance Vector Routing (AODV*)*

AODV stands for Ad-Hoc On-Demand Distance Vector and is, as the name already says, routes are discovered, established, and maintained only when needed. It is jointly developed in Nokia Research Centre of University of California, Santa Barbara and University of Cincinnati by C. Perkins and S. Das. It borrows most of the advantageous concepts from DSR and DSDV algorithms. The on demand route discovery and route maintenance from DSR and usage of node sequence numbers from DSDV make the algorithm cope up with topology and routing information. AODV is capable of both unicast and multicast routing [6]. 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 protocol mainly based on two phases: route discovery that is done with route request (RREQ) and route reply (RREP) messages and route maintenance represented by route error (RERR).

Dynamic Source Routing Protocol (DSR)

Dynamic source routing protocol (DSR) is an on-demand, source routing protocol, whereby all the routing information is maintained (continually updated) at mobile nodes.
DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network.
An optimum path for a communication between a source node and target node is determined by Route Discovery process. Route Maintenance ensures that the

communication path remains optimum and loop-free according the change in network conditions, even if this requires altering the route during a transmission [7].

SIMULATION

The three main techniques for analyzing the performance of wired and wireless networks are:

- Analytical Modeling: Numerical calculations with mathematical models using probability, calculus, operation research, queuing networks, etc.
- Computer Simulation: Realization of physical behavior using probability, statistics and queuing theory.
- Real Time Physical Measurement: Real time tests.

Computer Simulations approach is the more used technique for quantitative analysis of networks. They are generally Discrete Event Simulations.
There are several popular network simulators: Network Simulator - 2 (NS-2), Tiny OS Simulator (TOSSIM), National Chao Tung University network simulator (NCTUns), QualNet, NetSim, Java Sim (JSim), GloMoSim, OMNET++ and OPNET. Network Simulator NS-2 is the most popular one.

Simulation environment

Our simulation is based on the NS-2 simulator on an Ubuntu operating system. We choose as mobility model the random waypoint which is very widely used in simulation studies of MANET. We also choose as traffic model the CBR (Constant Bit Rate) traffic over UDP. The simulation is based on the routing protocols AODV, DSR and DSDV.

Performance metrics

There are different kinds of parameters for the performance evaluation of the routing protocols [8]. These have different behaviors of the overall network performance. We will evaluate parameters for the comparison of our study on the overall network performance.
The throughput is defined as the total data packets received divided by the total duration of the simulation; it is expressed in (packet/sec). If a protocol shows high throughput so it is the efficient and best protocol than the routing protocol which have low throughput. This metric extracted from the trace file generated by the simulation script, we use the AWK language to calculate the metrics mentioned above.

Simulation parameters

We have conducted the simulation of the DSDV, AODV and DSR protocols in different situations in order to show the behavior and the performance of each one. The evaluation parameters are: Network load, nodes' speed, traffic type, and topology size.

Simulation scenarios

Based on the parameters mentioned before, these are the selected scenarios:

TABLE 1: SCENARIO1 (NETWORK LOAD)

Network load
20%, 40%, 60%, 80%

TABLE 2: SCENARIO2 (CHANGING SPEED)

Speeds
1000, 2000,3000,4000, 5000

TABLE3: SCENARIO 3 (TRAFFIC TYPES)

Traffic types
CBR, Exponential, Preto

TABLE 4: SCENARIO 4 (TOPOLOGY SIZE)

Topology sizes
1000x1000, 2000x2000, 3000x3000, 4000x4000

RESULTS AND DISCUSSION

The results are obtained from the trace files using AWK, and plotted in graphs using EXCEL.
The next figure shows the throughput versus network load:

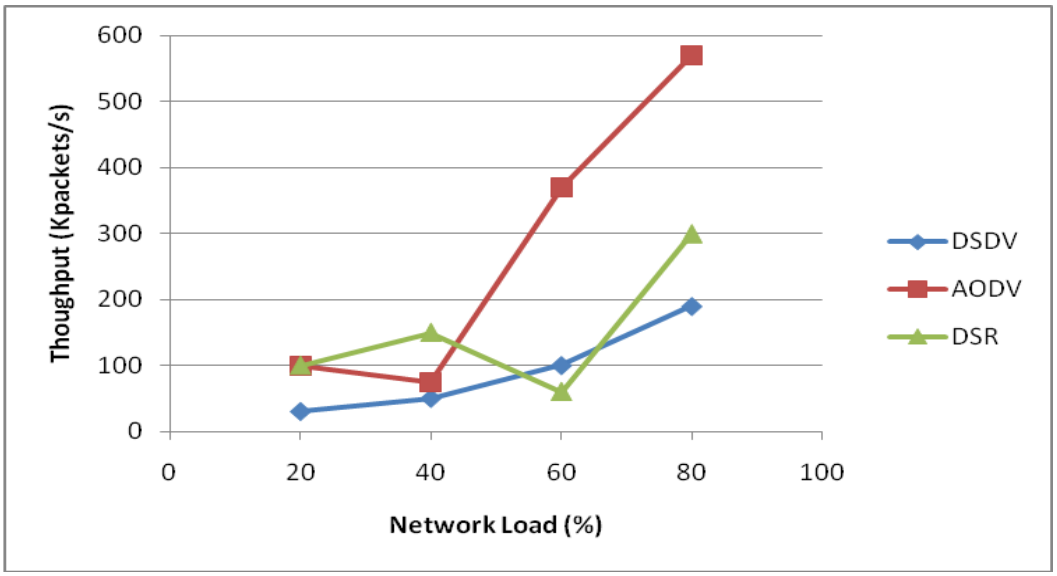

Fig. 1: Throughput vs network load

The above graph shows that:

- For DSDV: As the network load increases the throughput increases slowly, but it still less than AODV and DSR due to its proactive nature.
- For AODV: The network load throughput decreases because of route discovery process, after that it increases.
- For DSR: As the network load increases the throughput increases; yet, we found that the throughput decreases when the load ranges between 40 and 60%.

The next figure shows the throughput versus the velocity

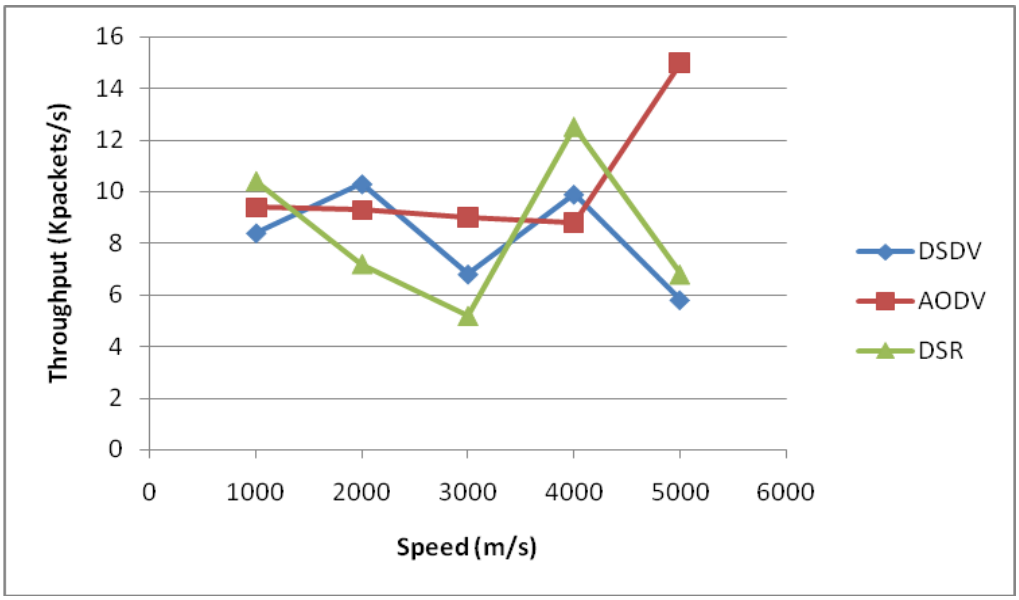

Fig. 2: Throughput vs speed

The throughput of both DSDV and DSR fluctuates when velocity is increased, while AODV throughput generally increases as speed increase.
The next figure shows the throughput versus traffic:

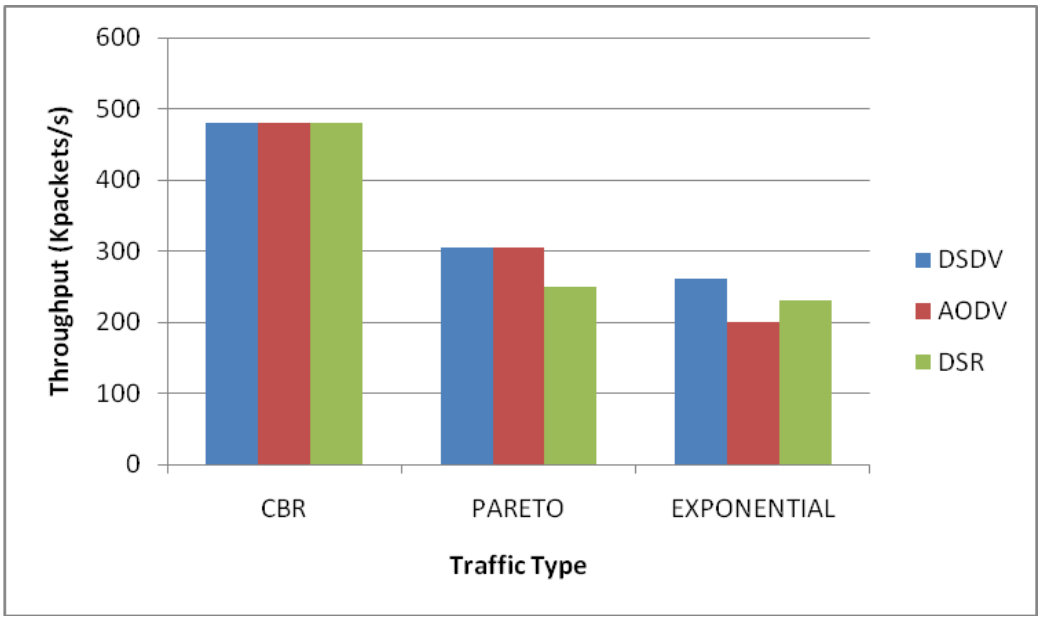

Fig. 3: Throughput vs traffic

For the CBR traffic, the throughput is the same for each protocol, while for the Exponential traffic and pareto throughput is less due to the burst (transmission exist) time and the idle time (no data transmission).

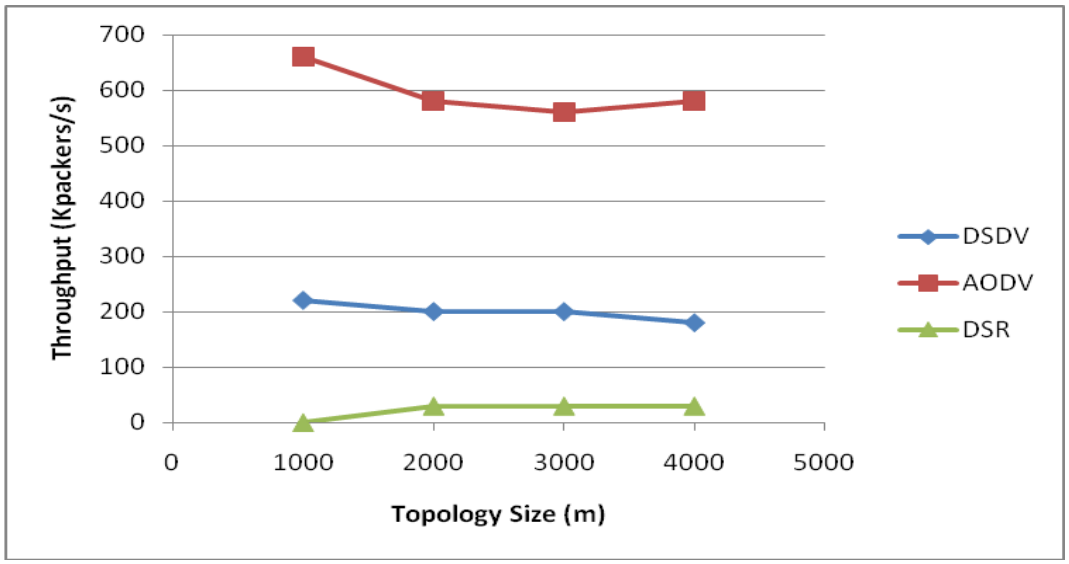

Fig. 4: Throughput vs topology size

For each protocol as the topology size increase, the throughput decreases because as we extend the topology there is the possibility to extend the distance between nodes.

CONCLUSION

In this paper, we aimed to present and simulate some routing protocols for mobile ad hoc networks which take a large portion and attention of computer science networking research. We also try to conduct experimental simulations of the three most popular routing protocols: Destination sequence Distance Vector (DSDV), Dynamic Source Routing (DSR) and Ad hoc On Demand Vector (AODV) based on the famous simulator NS-2.

The performance evaluation of routing protocols must take in consideration a lot of metrics and simulation parameters, which needs on the other hand a lot of time and effort in order to obtain a fair analysis and extract the best protocol. As future work, we suggest the followings: evaluating these protocols using other performance metrics in order to improve the found results, such as energy consumption and end-to-end delay.

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