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Evaluation of MANET Routing Protocols using OMNeT++

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Abstract: ***The work presented here is a summary of the results obtained when routing protocols viz. AODV, DSR, DYMO were simulated using virtual hosts on a discrete-event simulator: OMNeT++ v4.4.1. The three protocols run on a simulation setup of 50 nodes. We describe and compare the three routing protocols on available parameters like throughput, SNIR, radio state and more. We conclude by stating the DYMO emerges as the better protocol of the three examined here.***

Keywords: MANET, DSR, AODV, DYMO, OMNeT++

1. Introduction

A network is a frame in which we can communicate. A computer network is a telecommunications network that allows computers to exchange data. Initially the wired networks played a major role in networking. They were faster, more secured, more reliable and generally had less faults. But because of difficulties faced while installing the setup, wireless network came into existence. Moreover, wired networks were expensive to install and the entire installation was very time consuming procedure. It was not flexible either.

Wireless networks use radio waves/microwaves to sustain the network between the computers. It is a neat and clean network, no tidy cables are required. It is very flexible in the space around. But on the other head it is less reliable than the wired network. Wireless networks were also divided into two broad categories namely: infrastructure-based networks and infrastructure less networks. Infrastructure-based networks are collection of wireless devices attached to an intermediate piece of network infrastructure, typically an access point, router, or PC running access point software. In other words nodes connect to an external network like Internet or Intranet with the help of an access point [1].

Ad Hoc or infrastructure less networks is peer-to-peer connections between two wireless devices capable of operating in Ad Hoc mode. The two devices have a direct wireless connection to each other, with no intervening wireless devices (or “infrastructure”) such as wireless access points or routers. The Latin expression “ad hoc” translates into English as “for this,” a translation that loosely suggests what ad hoc networks are: networks set up for a single simple purpose. Additionally, multiple Ad Hoc devices sharing the same SSID (“Service Set Identifier”) can be on the same Ad Hoc network, extending the concept from a one-to-one network to a multi-node system of connections. Ad Hoc networks can be set up simply and easily with no need for a pre-existing wireless network, or for additional network hardware beyond the nodes in the network itself. Ad Hoc networks offer low cost networking as well.

An Ad-hoc network can be further classified as MANET, WSN (Wireless Sensor Network), WMN (Wireless Mesh Network). MANET is a temporary network in which mobile nodes communicate without any aid of centralized administration and may operate in either standalone fashion or connected to the Internet [9, 10]. In simple words, a MANET is a self-configuring infrastructure less network of mobile devices connected by wireless. In MANETs, routing is needed to find path from source to destination which is done with the help of routing protocols [1].

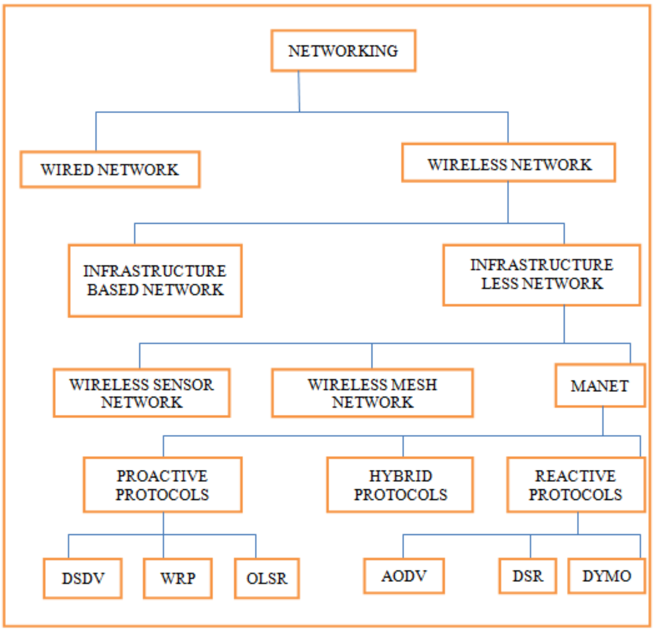

Figure 1: Classification of Routing Protocols

2. MANET Routing Protocols

MANET routing protocols can be classified into three categories as shown in figure 1: Reactive (On-demand), Proactive (Table-driven) or Hybrid.

2.1 Proactive or Table-Driven Routing Protocol

Proactive routing protocols [2, 3] maintain fresh lists of destination and their routes by periodically distributing routing tables throughout the network. Proactive routing protocols perform route discoveries automatically and periodically without any requests from nodes. It builds up a routing table for each node which contains information on how to reach every other node and to maintain the consistency the algorithm tries to keep updating its routing table periodically. Each node shares this table with its neighbour nodes. Therefore, routes are discovered for every mobile node of the network, without any requests from the nodes. Each node has to maintain one or more tables to store routing information, and response to changes in network topology by broadcasting &and propagating. Examples: DSDV (Destination-Sequenced Distance-Vector Routing), WRP (Wireless Routing Protocol) and OLSR (The Optimized Link State Routing Protocol) [4, 5].

2.2 Reactive or On-Demand Routing Protocols

Reactive routing protocols [2, 3] have been introduced to prevent the periodic routing information exchange as in Proactive routing protocols. In reactive routing protocols, when a node requires a route to a destination, it initiates a route discovery process. Reactive protocols perform route discovery and path establishment by using specialized sets of control packets such as RREQ (Route Request), RREP (Route Reply) and RERR (Route Error). When a node wants to communicate with any other node in the network it sends a RREQ packet to its neighbouring nodes and if the neighbouring node is the required destination it replies with a RREP packet to the source thus acknowledging the RREQ packet from source. If there is an error in a link it sends a RERR to its source. Examples: AODV (Ad-hoc On Demand Distance Vector Routing), DSR (Dynamic Source Routing) [6], and DYMO (Dynamic MANET On Demand).

2.3 Hybrid Routing Protocols

Hybrid protocols [2, 3] combine the features of reactive and proactive protocols. These protocols have the advantage of both proactive and reactive routing protocols to balance the delay which was the disadvantage of Table driven protocols and control overhead (in terms of control packages). Main feature of Hybrid Routing protocol is that the routing is proactive for short distances and reactive for long distances. Examples: ZRP (Zone Routing Protocol), CEDAR (Core Extraction Distributed Ad Hoc Routing).

3. Overview of DSR, AODV and DYMO Routing Protocols

Dynamic Source Routing: As the name a state, DSR is based on source routing where the source specifies the complete path to the destination in the packet header [11]. The intermediate nodes simply forwards the packet to the next node as specified in the packet header, which means that intermediate nodes only need to keep track of their neighbouring nodes to forward data packets. In DSR, all nodes in a network cache the latest routing information. When more than one route to the destination is found, the nodes cache all the route information so that in case of a route failure, the source node can look up their cache for other possible routes to the destination. If an alternative route is found, the source node uses that route; else the source node will initiate route discovery operations to determine possible routes to the destination. During route discovery operation, the source node floods the network with query packets. Only the destination or a node which already knows the route to destination can reply to it, hence avoiding the further propagation of query packets from it. If a broken link is detected by a node, it sends route error messages to the source node. The source node on receiving error messages will initiate route discovery operations.

Ad Hoc On-Demand Distance Vector: AODV is essentially a combination of both DSR [7] and DSDV [6, 8]. It borrows the basic Route Discovery and Route Maintenance steps from DSR [6], and the use of hop-by-hop routing it borrows from DSDV. It is a reactive/on-demand routing protocol means route discovery process is started only when source node raises the demand for it. AODV avoids the counting-to infinity problem unlike other distance vector protocols by using sequence number for each RREQ route and this sequence number feature is most distinguishing feature of AODV compared to the other routing protocols. In AODV, all nodes maintain a routing table containing the entry for each destination node [14]. Each entry includes the next hop, sequence number and number of hops requires for reaching destination node. Using the destination sequence number ensures loop freedom. AODV makes sure the route to the destination does not contain a loop and is the shortest path. Route Requests (RREQs), Route Replay (RREPs), Route Errors (RERRs) are control messages used for establishing a path from source to the destination.

Dynamic MANET On-Demand: The DYMO routing protocol is a successor to AODV routing protocol and shares many of its features, so it is also called as AODVv2 [12, 13]. DYMO inherits features of AODV like sequence numbers, route discovery methodology, RERR messages and it also inherits features from DSR [6] protocol like Path Accumulation function. DYMO can work both as a proactive and reactive routing protocol, i.e. routes can be discovered just when they are needed. These entire features make DYMO makes it useful in MANET scenarios. The DYMO route discovery is very similar to that of AODV except for the path accumulation feature. While broadcasting the RREQ message, the intermediate node will attach its address to the message. Every intermediate node that disseminates the RREQ message makes a note of the backward path. A similar path accumulation process takes place along the backward path. This makes sure that the forward path is built and every intermediate node knows a route to every other node along the path. DYMO is an energy efficient routing protocol.

4. OMNeT++

OMNeT++ is an extensible, modular, component-based C++ simulation library and framework, primarily for building network simulators. Reusable modules are written in C++. Modules' relationships and communication links are stored as plain-text Network Description (NED) files and can be modelled graphically. Simulations are either run interactively in a graphical environment or are executed as command-line applications.

The INET Framework extension is a set of simulation modules released under the GPL. It provides OMNeT++ MODULES THAT REPRESENT VARIOUS LAYERS OF THE Internet protocol suite, e.g. the TCP, UDP, IPv4, and ARP protocols [17.].

INETMANET [18] is based on INET Framework and is continuously developed. Generally it provides the same functionality as the INET Framework, but contains additional protocols and components that are especially useful while modelling wireless communication. In conclusion, OMNeT++ and the INET Framework provide all the necessary components for simulating Internet protocols in general and MANET protocols in particular. Because of its modular architecture and its ability to directly access, monitor and alter all modules' internal states, OMNeT++ is very well suited for the implementation of complex protocols [15].

5. Simulation Setup

The hardware/software setup is shown in table 1.

Table 1: Hardware/Software Setup

Operating System	Windows 7
Processor	Intel Core i3
Memory	3GB
Compiler	gcc
Simulation Environment	OMNeT++ 4.4.1
Simulated using	Cmdenv, Tcl/Tlenv

The simulation setup is shown in table 2.

Table 2: Simulation Setup

Dimensions	2000m X 1000m
No. of Wireless Hosts	50
Mobility Model	Mass Mobility
Radio Tx Power	2.0mW
Radio Bitrate	54Mbps
Simulation Time	3000s
Message Length	512B
Carrier Frequency	2.4GHz
Routing Protocols	DSR, AODV, DYMO
Simulation Style	Cmdenv-express-mode

6. Results

A few of the analysed parameters are presented here:

Signal-to-Noise plus Interference Ratio(SNIR): It is defined as the ratio of signal power to the combined noise and interference power. A high SNIR value means a better routing protocol [15].

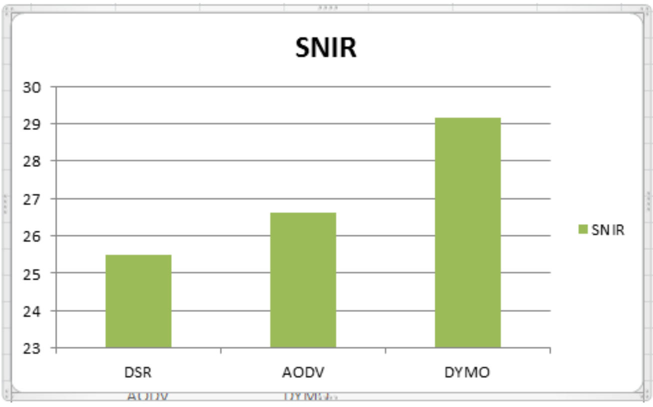

Figure 2: A time average measure of SNIR

Radio State: It is the instantaneous transmitter (tx) power consumed at a certain wireless radio host. The lesser the power consumed the better the routing protocol [15].

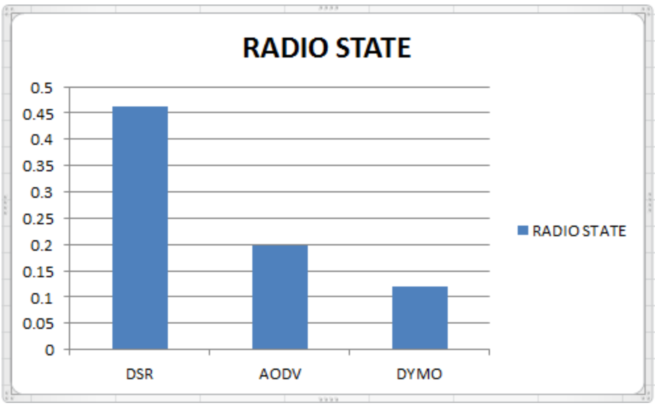

Figure 3: A time average measure of Radio State

Throughput: It is the amount of data that is delivered from one node to another via a communication link per unit time. It is measured in bits per second (bits/s or bps). It should be as high as possible [16].

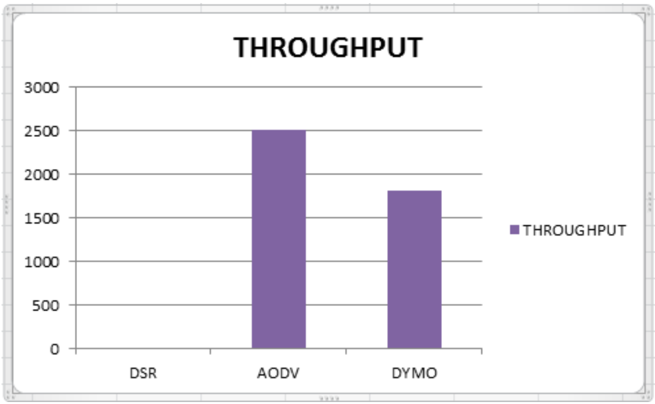

Figure 4: A time average measure of Throughput

Delay: It is the latency caused by a data packet to get from one node to another. It should be low [16].

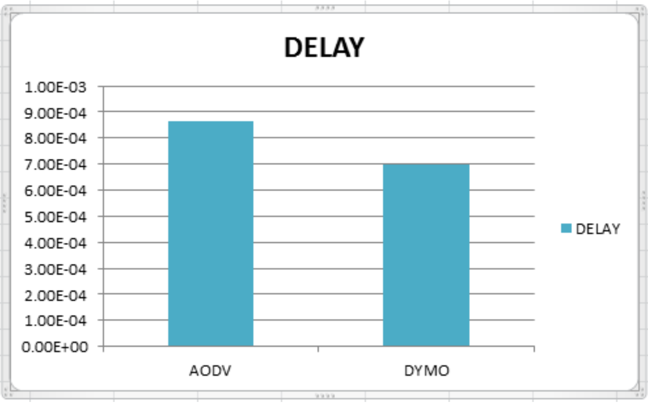

Figure 5: A time average measure of Delay

7. Conclusion and Future Scope

In the previous section, we have compared and evaluated the three routing protocols: DSR, AODV and DYMO over a range of parameters. In conclusion, we believe that DYMO has proved as a better routing protocol. Our overall study shows that DYMO is a better protocol when it comes to networks with high mobility and changing topology. Future enhancement to the DYMO routing protocol can be made by using swarm intelligence based ACO technique.

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