Simulation based Analysis of AODV, BABEL and PUMA Protocols for Adhoc Network

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ABSTRACT
There are many routing protocols in Mobile Ad Hoc Networks, the popular ones being DSDV, AODV, PUMA and Babel. Although a lot of research work is done on individual protocols but not enough research is done on comparing these protocols under environment of NS-2. This is essential considering the fact that these protocols behave differently or perform differently in different environments. By analyzing how a protocol performs under a certain environment, the shortcomings of the protocol can be found out and more research could be done on removing those shortcomings. Further, this paper also helps in choosing a protocol best suited to particular conditions .In order to fulfill the objective a comparative analysis between these three protocols has to be carried out in the simulated environment created in the NS-2.34 simulator comprising of 25 mobile nodes based on the different parameters and examining their values based on the time scenarios.

General Terms
This paper exposes the simulation and performance analysis of AODV, BABEL and PUMA over the 25 mobile nodes using NS2.34 simulator.

Keywords
AODV, MANET, NS-2, NAM, PUMA, TCL

1. INTRODUCTION
MANET represents a system of wireless mobile nodes that can freely and dynamically self-organize in to arbitrary and temporary network topologies, allowing people and devices to communicate without any pre-existing communication architecture. Each node in the network also acts as a router, forwarding data packets for other nodes. The absence of fixed infrastructure in a MANET poses several types of challenges. The biggest challenge among them is routing. Routing is the process of selecting paths in a network along which to send data packets. An adhoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a mobile ad-hoc network. In adhoc networks, nodes do not start out familiar with the topology of their networks instead, they have to discover it. The basic idea is that a new node may announce its presence and should listen for announcements broadcast by its neighbors. Each node learns about nearby nodes and how to reach them, and may announce that it can reach them too [2].

Different protocols are then evaluated based on the packet drop rate, average routing load, average end-to-end-delay, and other measures.

The proposed solutions for routing protocols could be grouped in three categories: proactive (or table-driven), reactive (or on-demand), and hybrid protocols. Even the reactive protocols have become the main stream for MANET routing protocols

2. AODV
The Ad-hoc On-Demand Distance Vector (AODV) routing protocol is designed for use in ad-hoc mobile networks. AODV is a reactive protocol. The routes are created only when they are needed. It uses traditional routing tables, one entry per destination, and sequence numbers to determine whether routing information is up-to-date and maintain the route.The protocol consists of two phases:

i) Route Discovery

ii) Route Maintenance

A node wishing to communicate with another node first seeks for a route in its routing table. If it finds path, the communication starts immediately, otherwise the node initiates a route discovery phase. The route discovery process consists of a route-request message (RREQ) which is broadcasted. If a node has a valid route to the destination, it replies to the route-request with a route-reply (RREP) message [5][8].

Additionally, the replying node creates a message so called reverse route entry in its routing table, which contains the address of the source node, the number of hops to the source, and the next hop's address, i.e. the address of the node from which the message was received. A lifetime is associated with each reverse route entry, i.e. if the route entry is not used within the lifetime it will be removed. The second phase of the protocol is called route maintenance. It is performed by the source node and can be subdivided into:

i) source node moves: source node initiates a new route discovery process
ii) Destination or an intermediate node moves: a route error message (RERR) is sent to the source node.

Intermediate nodes receiving a RERR update their routing table by setting the distance of the destination to infinity. If the source node receives a RERR it will initiate a new route discovery. To prevent global broadcast messages AODV introduces a local connectivity management. This is done by periodical exchanges of so called HELLO messages, which are small RREP packets containing a node's address and additional information.

AODV nodes use four types of messages to communicate among each other. Route Request (RREQ) and Route Reply (RREP) messages are used for route discovery. Route Error (RERR) messages and HELLO messages are used for route maintenance.

3. BABEL

Babel is a sequenced distance vector routing protocol, inspired by DSDV that is designed to be robust and efficient both in networks using prefix-based routing and in networks using flat routing, and both in relatively stable wired networks and in highly dynamic wireless networks.Babel was designed to be robust and efficient on both wireless mesh networks and classical wired networks [3].

Every Babel speaker is assigned a router-id, which is an arbitrary string of 8 octets that is assumed unique across the routing domain. We suggest that router-ids should be assigned in modified EUI-64 form.

3.1 Message Transmission and Reception

Babel protocol packets are sent in the body of a UDP datagram. Each Babel packet consists of one or more TLVs. The source address of a Babel packet is always a unicast address, link-local in the case of IPv6. Babel packets may be sent to a well-known multicast address or to a unicast address. In normal operation, a Babel speaker sends both multicast and unicast packets to its neighbors.

With the exception of Hello TLVs and acknowledgements, all Babel TLVs can be sent to either unicast or multicast addresses, and their semantics does not depend on whether the destination was a unicast or multicast address. Hence, a Babel speaker does not need to determine the destination address of a packet that it receives in order to interpret it.

3.1.1 Acknowledged Packets

A Babel speaker may request that any neighbour receiving a given packet reply with an explicit acknowledgement within a given time. While the use of acknowledgement request is optional, every Babel speaker MUST be able to reply to such a request.

An acknowledgement MUST be sent to a unicast destination. On the other hand, acknowledgement requests may be sent to either unicast or multicast destinations, in which case they request an acknowledgement from all of the receiving nodes.

3.1.2 Neighbour Acquisition

Neighbour acquisition is the process by which a Babel node discovers the set of neighbours heard over each of its interfaces and ascertains bidirectional reach ability. On unreliable media, neighbour acquisition additionally provides some statistics that MAY be used in link quality computation.

3.1.3 Cost Computation

A neighbourship association's link cost is computed from the values maintained in the neighbour table, namely the statistics kept in the neighbour table about the reception of Hellos, and the txcost computed from received IHU packets.

For every neighbour, a Babel node computes a value known as this neighbour's reception cost, written rxcost. This value is usually derived from the hello history, which may be combined with other data, such as statistics maintained by the link layer. The rxcost is sent to a neighbour in each IHU.

How a the txcost and rxcost are combined in order to compute a link's cost is a matter of local policy, as far as Babel's correctness is concerned, only the following conditions MUST be satisfied:

- the cost is strictly positive
- if no hellos were received recently, then the cost is infinite
- if the txcost is infinite, then the cost is infinite

3.1.4 Route Acquisition

When a Babel node receives an update (id, prefix, seqno, metric) from a neighbour with a link cost value equal to cost, it checks whether it already has a routing table entry indexed by (neigh, id, prefix).

If no such entry exists:

- if the update is unfeasible, it is ignored
- if the metric is infinite (the update is a retraction), the update is ignored
- Otherwise, a new route table entry is created, indexed by (neigh, id, prefix), with seqno. seqno and an advertised metric equal to the metric carried by the update.

When a route's expiry timer triggers, the behavior depends on whether the route's metric is finite. If the metric is finite, it is set to infinity and the expiry timer is reset. If the metric is already infinite, the route is flushed from the route table.

3.1.5 Route Selection

Route selection is the process by which a single route for a given prefix is selected to be used for forwarding packets and to be readvertised to a node's neighbours.

Babel is designed to allow flexible route selection policies. As far as the protocol's correctness is concerned, the route selection policy MUST only satisfy the following properties:

- a route with infinite metric (a retracted route) is never selected
- an unfeasible route is never selected

Note, however, that Babel does not naturally guarantee the stability of routing, and configuring conflicting route selection policies on different routers may lead to persistent route oscillation.

Defining a good route selection policy for Babel is an open research problem. Route selection can take into account multiple mutually contradictory criteria, in roughly decreasing order of importance, these are:

- routes with a small metric should be preferred over routes with a large metric
- switching router-ids should be avoided
- routes through stable neighbours should be preferred over routes through unstable ones
- stable routes should be preferred over unstable ones
- switching next hops should be avoided

A simple strategy is to choose the feasible route with the smallest metric, with a small amount of hysteresis applied to avoid switching router-ids.

4. PUMA

PUMA-Protocol for Unified Multicasting through Announcements is another mesh-based multicast protocol. The protocol uses a single control message, a multicast announcement that is exchanged periodically by each network node. One of the purposes of multicast announcements is to elect a core member for the group and to ensure that all nodes in the network have a path to the core. Additionally, all nodes on the shortest paths between any receiver and the core become members of the mesh. Multicast messages are routed to the core until they meet a mesh member; from this point on the messages are footed in the mesh to reach all multicast receivers [9].

Each multicast announcement species a sequence number, the address of the group (group ID), the address of the core (core ID), the distance to the core, a mesh member as that is set when the sending node belongs to the mesh, and a parent that states the preferred neighbor to reach the core. With the information contained in such announcements nodes elect cores, determine the routes for sources outside a multicast group to forward data packets towards the group, notify others about joining or leaving the mesh of a group, and maintain the mesh of the group[1].

5. EXPERIMENTAL SETUP

The simulated environment consists of 25 wireless mobile nodes for 10 seconds of simulated time. The scenario containing all movement behavior of the ad-hoc network nodes is generated in advance so that it can be replaced identically for both the protocols. Similar mobility and traffic scenarios are used for all the protocols. Hence the workload is identical for all the protocols.
A multicast member node joins the multicast group at the beginning of the simulation and remains as a member throughout the entire simulation.

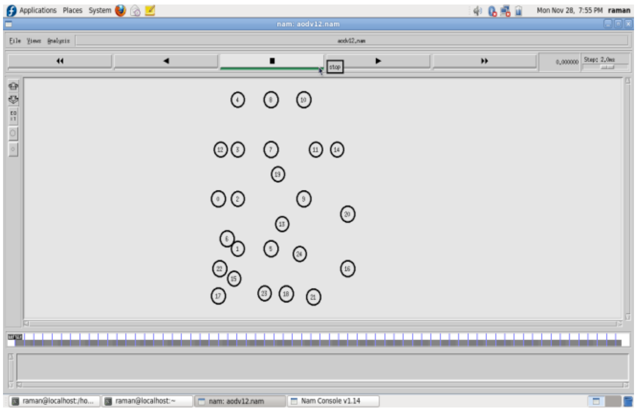

Figure 1 Simulated environments of 25 mobile nodes

6. PERFORMANCE METRICS

AODV, BABEL and PUMA's performance was compared on the basis of the following metrics:

1. Average Delivery Ratio: The ratio between the amount of incoming data packets and actually received data packets. This ratio presents the effectiveness of the protocol in delivering data packets to intended receivers [6].

2. Throughput: This metric represents the total number of bits forwarded to higher layers per second. It is measured in bps. It can also be defined as the total amount of data a receiver actually receives from sender divided by the time taken by the receiver to obtain the last packet.

In this paper, researchers have considered several metrics in analyzing the performance of routing protocols. These metrics are as follows.

6.1 Average delivery ratio:

Total number of delivered data packets divided by total number of data packets transmitted by all nodes. This performance metric will give an idea of how well the protocol is performing in terms of packet delivery at different speeds using different traffic models

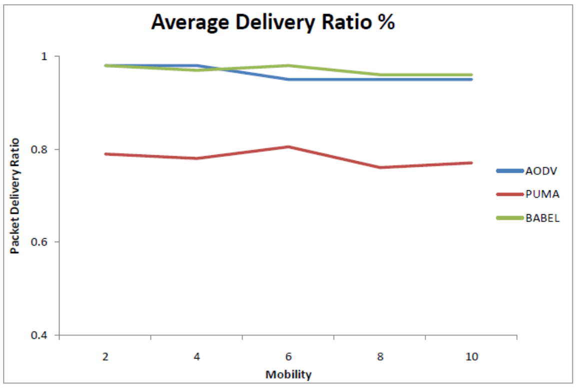

Figure 2 Average Delivery Ratios

Researchers observed that source based routing protocols scale well for packet delivery ratio than mesh based multicast routing protocols in data delivery ratio and access channel efficiency.This is that reason that delivery ratio of BABEL is high than AODV and PUMA.

6.2 Throughput:

This metric represent the total number of bits forwarded to higher layers per second. It is measured in bps. It can also be defined as the total number of data received from sender divided by the time taken by the receiver to obtain the last packet.

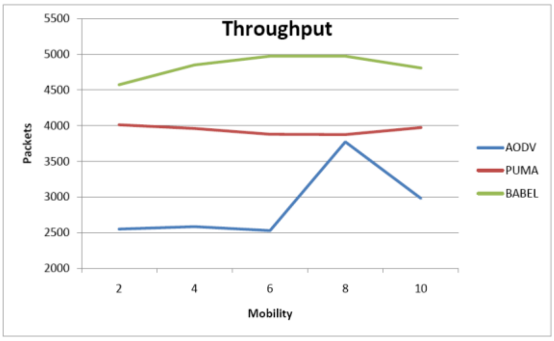

Figure3 Throughput

BABEL having high throughput than PUMA and AODV. Performance of AODV is too less.PUMA have average throughput.

7. CONCLUSION

Researchers investigated that the performance of AODV, BABEL and PUMA over throughput and the delivery ratio of packets .The BABEL has a better packet delivery ratio (PDR) than PUMA and AODV for all the metrics employed above. But in the mesh based multicasting PUMA approach, more data packet transmissions fail to reach the destination and hence need re-transmissions. Researchers have analyzed the performance of AODV, BABEL and PUMA routing protocols by simulation using NS-2, with nodes moving at speeds ranging from 0 to 10 m/s.

The BABEL routing protocol has exhibited superior performance in terms of data packet delivery ratio and throughput as compared to AODV and PUMA.. Whereas AODV routing protocols having good delivery ratio and average throughput .The results show an average performance of AODV, yet a notably stable and low throughput was observed. Puma has low performance but throughput of Puma is average .So Babel is best protocol from these three protocols.

8. FUTURE WORK

Multicasting is the key technology for future wireless networks. As discussed above the mesh based multicasting protocols (PUMA), BABEL and source based multicasting(AODV).

Future work can be done on developing a multicasting protocol which would be a hybrid of these methodologies. One which would be efficient for different network sizes and node speeds, yet have minimum overload. Also protecting these multicast sessions is an important issue in wireless mesh networks. There is further scope of research on a resilient forwarding mesh to protect the multicast sessions.

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