Comparison of AODV, DSDV and DSR routing protocols in Error Prone Mobile Ad-hoc Networks

M A Raghuram Balchander V R

November 20, 2014

Abstract

A MANET is a type of ad hoc network that can change locations and configure itself on the fly. All nodes in this network are mobile and they use wireless connections to communicate with various networks. In a MANET, the router connectivity usually changes frequently which leads to the multi-hop communication paradigm that can allow communication without the use of access point.A MANET is usually formed by mobile nodes using wireless communications. It uses a peer-to-peer multihop routing instead of a static network infrastructure to provide network connectivity.MANETs can be characterized as having a dynamic, multihop, potentially rapid changing topology.Many routing protocols have been developed for these dynamic nature of MANETs.In this paper we have compared AODV,DSDV and DSR for different error models with varying error rates.

1 Introduction

Routing protocols adapt to the changing network conditions and provide multihop paths. Routing protocols differ in construction, maintenance and update. For MANETs, they are mainly categorized as proactive, reactive and hybrid.

Proactive protocols: Every node in the network has one or more routes to any possible destination in its routing table at any given time.These routing protocols use this information to reduce the latency that occurs during route discovery. But these are not suitable for networks with high mobility rate.

Reactive protocols: Every node in the network obtains a route to a destination only on a demand. These routing protocols never maintain up-to-date routes to any destination in the network and do not generally exchange any periodic control messages.

Hybrid routing protocols:-Every node acts reactively in the region close to its proximity and proactively outside of that region, or zone

2 Description of Routing Protocols

2.1 AODV : Adhoc On-demand Distance Vector

Ad hoc On-Demand Distance Vector (AODV) Routing is a routing protocol for mobile ad hoc networks (MANETs) and other wireless ad hoc networks. It is a reactive protocol. Until a node needs a connection the network will be silent at which the node broadcasts its request for connection. Each node store the next-hop information corresponding to each flow for data packet transmission and hence providing temporary routes to the needy node. Then the needy node uses the route that has least hop count for further exchange of data. When a link fails, a routing error is passed back to the transmitting node and process repeats. In AODV, each request for a route has a sequence number which is used by nodes inorder to avoid repeat request of route that is already done.

Types of messages used for route discovery and route maintenance.

1. RREQ (Route Request) : Broadcast message for route discovery. 2. RREP (Route Reply) : Unicast message sent as a response to the RREQ containing information about path to destination 3. RERR (Route Error) : Unicast message which is sent as response links are broken. 4. HELLO : Broadcast message for route maintenance .

Each RREQ has source identifier (SrcID), the destination identifier (DestID), the source sequence number (SrcSeqNum), the destination sequence number (DestSeqNum), the broadcast identifier (BcastID), and the time to live (TTL) field. TTL number limits the number of retransmissions. If a RREQ fails,then another RREQ is not sent until twice as much time has passed as the timeout of the previous route request. DestSeqNum indicates the freshness of the route that is accepted by the source. If a route request is recieved by an intermediate node then it either forwards it or prepares a RouteReply if it has a valid route to the destination. If a request is received multiple times, its discarded. This can be identified from BcastID-SrcID pair.

Route maintenance is carried out with exchange of HELLO messages. Suppose if any node fails to respond to the HELLO messages then a link error is identified which is propagated through RERR messages.

2.2 DSDV : Destination Sequence Distance Vector

Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven proactive routing protocol based on Bellman–Ford algorithm. In this protocol every node has route to every other node in the network. Each entry in the routing table contains a Destination Specific Sequence Number (DSSN), subsequent hop and hop count to the terminal. It is generated by the destination, and the emitter needs to send out the next update with this number. Full dumps and smaller incremental updates are sent infrequently and frequently respectively to distribute routing information between nodes. Whenever a node receives a new topology information then it uses the latest sequence number and compare the new topology with the current one and updates with one of the above mentioned methods.

2.3 DSR : Dynamic Source Routing

Dynamic Source Routing (DSR) is a reactive routing protocol that uses source routing instead of depending on routing table. It restricts the bandwidth used by control packets since it is on-demand without HELLO commands that are used in AODV. In route discovery the source will check first in route cache and if its not there it initiates a route discovery. Else if that is an unexpired route, it uses that route. Source floods RREQ. It receives RREP if RREQ reaches destination or it reaches node that has unexpired route to destination. RREQ is forwarded to neighbouring nodes if an intermediate node does not have unexpired route and TTL is also not expired. Whenever a link is broken RERR is generated leading source to delete contaminated nodes and source may start a new RREQ.

3 Error models and Performance metric

Errors occur in different patterns and quantities depending on physical media, node speed, obstructions,multi-path, fading etc. Error models are one of the important factors that influence the performance of a routing protocol in a mobile adhoc networks. In wireless errors occur randomly in bursts and order is of 1×10^{-6} and worse. The manner error occurs and quantity of error have direct implication on design and analysis of communication protocols. We have considered the below models for our assignment.

3.1 Uniform model

Uniform error model provides packet losses at a constant rate which consequence an imprecise results during simulation as in wireless environment packet losses are arbitrary, bursty and time diversify in nature.

3.2 Two State Markov model

This model has two states. They are good state (error probability= 0.0) and bad state(error probability= 0.7). The transition from one state to another state depends on a matrix that is given below

$$\mathrm{T} = \begin{array}{c c} & \begin{array}{cc} G & B \end{array} \\ \begin{array}{c} G \\ B \end{array} & \begin{pmatrix} 0.9 & 0.1 \\ 0.7 & 0.3 \end{pmatrix} \end{array}$$

The occurrences of these two states have the same probability and which state comes first that is also random and this process continues for the whole simulation time.

4 Simulation

We used Network Simulator-2[NS-2] for studying the simulation. We used application as Constant Bit Rate(CBR) which uses UDP traffic. We kept the number of nodes constant in the network - Number of nodes = 100 and low mobility (small number of randomly generated node movement events). Different scenarios were generated by varying the error percentage for each error model. Initially UDP traffic was generated with 100 nodes and 30 connections at rate = 4.0 and seed=123.9 . Then simulation was carried for 200s for all scenarios.

For Uniform model we have varied the error from 5% to 15% for AODV, DSDV and DSR in steps of 0.1%. For two state markov model we have varied the error rate in bad state from 50% to 80% in steps of 1%.

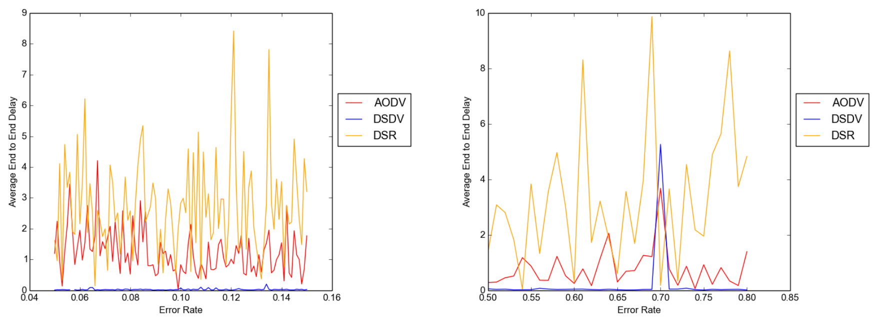
Table 1: NS2 simulation parameters

Simulation Parameters	**Value**
Network Type	Mobile
Number of nodes	100
Connection Pattern	Random
Connection Type	CBR/UDP
Simulation Time	100s
Simulation Area	1400×500
Packet Size	500
Error Models	Uniform, Two State Markov

5 Results

5.1 End to End delay

In both the error models DSDV has the lowest end to end delay parameter because once the routes are established subsequent control packet losses do not affect the routes that have been established due to little mobility. Therefore the only delay is the time taken for the packet to reach the destination while for AODV and DSR the routes have to be established each time. Loss of AODV or DSR control packets during route discovery severely affects their performance and increases the end to end delay as lost control packets need to be requested(retransmitted) again.



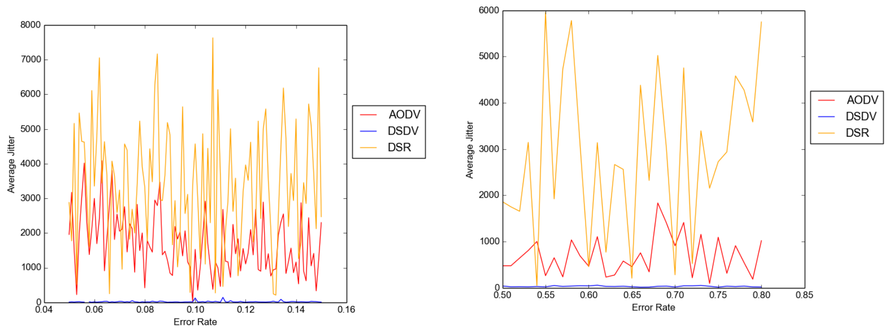
(a) End-to-end delay for Uniform Error Model

(b) End-to-end delay for Two State Markov Error Model

Figure 1: Average End to End Delay with varying error rates

5.2 Jitter

Jitter represents the variation in end to end delay for a packet. Again, this scenario is almost ideal for DSDV - because of little or no mobility. DSDV has the lowest jitter while DSR has the highest jitter. In case of uniform error model, DSR and AODV have higher average jitter but when the errors are more realistic - Two State Markov error model, the average jitter is reduced. DSR has the highest average jitter becaues lost routing packets can induce unpredictable latencies in the network and therefore result in high jitter.



(a) Jitter for Uniform Error Model

(b) Jitter for Two State Markov Error Model

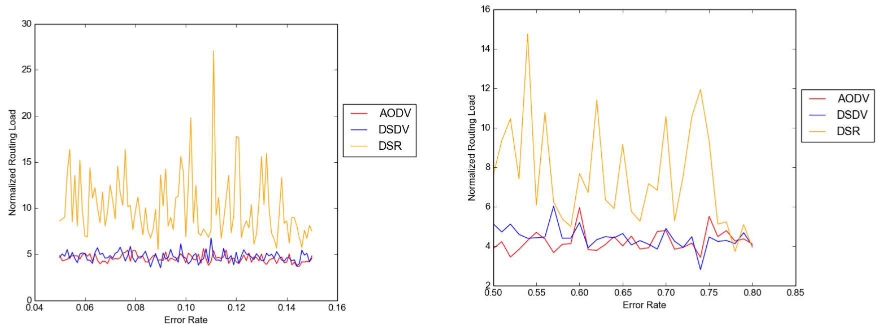
Figure 2: Average Jitter with varying error rates

5.3 Normalized Routing Load(NRL)

NRL represents the routing overhead in the network. It is the ratio of routing packets received to routing packets sent. In case of DSDV once the routes are established initially there is little routing information being exchanged later due to low mobility. This results in lower NRL value for DSDV and AODV has a similar NRL value because routing packets are exchanged only when routes need to be discovered and it is almost equivalent in this case to flooding the network initially by DSDV.DSR has have higher NRL values because of retransmission of lost larger routing packets due to high error rates in the network. The scenario is almost identical in both error models except that DSDV,AODV and DSR have a higher network load in Two State error model because of burst error control packet losses.

5.4 Packet Delivery Ratio(PDR)

Packet delivery ratio represents the ratio of total packets received to toatl packets sent. This can be sometimes greater than 1 because of multicast and broadcast packets. In case of Uniform error model DSDV and AODV perform almost identically with DSDV having a slightly higher PDR but this can be attributed to the fact that DSDV has to flood the network initially to build the routing table and most of its packet losses occur during that period while in AODV the packet losses occur uniformly over the entire simulation time. In case of Two State error model, AODV has the highest packet delivery ratio but this can be attributed to the fact that AODV injects more packets in the network because of broadcasting route request and hello messages more often than DSDV's

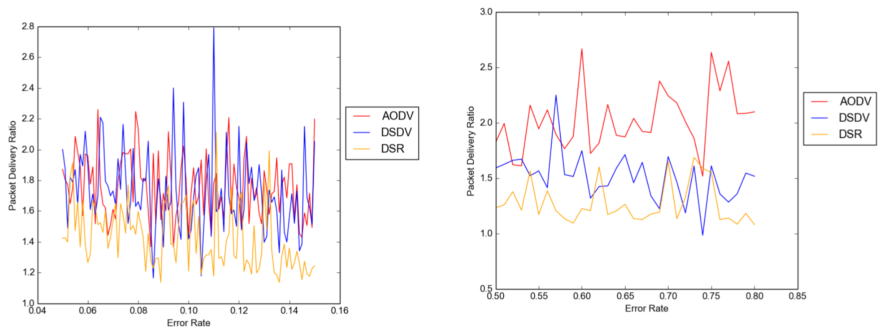


(a) NRL for Uniform Error Model

(b) NRL for Two State Markov Error Model

Figure 3: Normalized Routing Load(NRL) with varying error rates

broadcast messages which are sent only in case of changes in network topology.



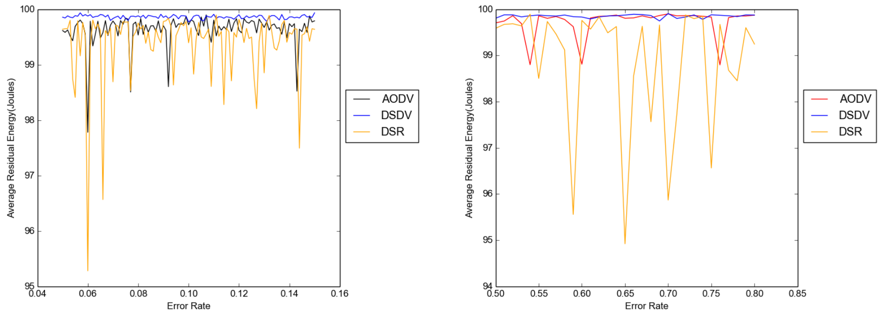
(a) PDR for Uniform Error Model

(b) PDR for Two State Markov Error Model

Figure 4: Packet Delivery Ratio(PDR) with varying error rates

5.5 Average Residual Energy

Although AODV is expected to consume lesser energy because of its on-demand nature, DSDV uses much less energy consumed to both AODV and DSDV. This is because once the routing information is established initially in DSDV, little or no energy is spent in maintaining this information because of low mobility. Thus the only energy spent afterwards is in forwarding user packets wherease in case of AODV, considerable energy is used each time a node wants to transmit data. In case of DSR, which has the highest energy usage, loss of heavy control packets due to burst errors increases the energy usage due to larger retransmissions.



(a) Average Residual Energy for Uniform Error Model

(b) Average Residual Energy for Two State Markov Error Model

Figure 5: Average Residual Energy with varying error rates

6 Conclusion

In this paper we have compared three routing protocols *AODV*, *DSDV* and *DSR* for two different error models *Uniform error model* and *Two State Markov error model* based on the performance metrics *End to End delay,* . It is observed that when the network has little or no mobility DSDV clearly outperforms the other two protocols irrespective of the error rate in the network. Similary DSR performs the worst in case of increasing error rates because of loss of its heavy control packets. AODV performs better than its reactive counterpart DSR because of AODV incurrs lesser control packet data loss compared to DSR.

7 References

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