

An Optimized Approach on Link Stability with Load Balancing in MANET using Balanced Reliable Shortest Route AOMDV (BRSR_AOMDV)

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Abstract

Objectives: MANET consistency depends on the robustness of the load balancing and link between the mobile nodes of the network. This paper has been evaluated the reliability for defective nodes (transceivers) to find the average queue length and signal interference noise ratio. In order to increase the load balancing and produce high throughput. **Methods/Analysis:** This paper proposes Balanced Reliable Shortest Route AOMDV (BRSR-AOMDV) a technique which handles both load balancing and link stability based on the average queue length computation and the signal strength of the each reachable links. This proposed approach uses two phases, one for discovering the path with least queue size and in the second phase among the selected paths with short queue size the path with high link stability is considered as optimal path for traversing packet from the selected source to destination nodes. **Findings:** The method is illustrated with an application and some imperative results are also presented. The performance is done based on different metrics for load balancing as well as link stability and the proposed method performs better than the AODV. **Conclusion:** BRSR-AOMDV achieves good packet delivery ratio, more network lifetime while attaining low delay overhead than the existing scheme AODV scheme.

Keywords: Fault Tolerance, Load balancing, Link Stability, MANET, Queue size

1. Introduction

Mobile Ad hoc Network (MANET) is self-organized wireless and mobile networks. Due to mobility the topology of the network changed. Each mobile node in an ad hoc network moves by chance and acts as both a router and a host¹. However, due dynamic topology centralized management security routing in MANET is the challenging task.

Fault-tolerant of a network to deliver the data successfully within the time period when some node or link failure occurs. A network fault-tolerant method can offer reliable Quality of Service (QoS) guarantee.

Since it is difficult to predict and hold various network attacks. Normally the fault-tolerant mechanisms focus on keeping up maintaining the transmission of important information the network cannot completely withstand and eliminate faults. Packet loss due to network faults will cause great damage in urgent situation events. Therefore, it is essential for WMNs to supply fault-tolerant functions to ensure the victorious transmission of significant data in a judicious manner.

AOMDV (Ad Hoc On-demand, multipath distance vector routing protocol) is a routing protocol specially designed for MANET environment. On demand multipath protocols discover multiple paths between the

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source and the destination in a single route discovery. So, a new route discovery is needed only when all these paths fail⁴. AOMDV extends the AODV protocol to discover multiple paths between the source and the destination in every route discovery. Multiple paths so computed are guaranteed to be loop-free and disjoint. AOMDV has three novel aspects compared to other on-demand multipath protocols. First, it does not have high inter-nodal coordination overheads. Second, it ensures disjointness of alternate routes via distributed computation without the use of source routing. Finally, AOMDV computes alternate paths with minimal additional overhead over AODV; it does this by exploiting already available alternate path routing information as much as possible. In BRSR_AOMDV route table entry has a new field AQL. Besides a route list is used in BRSR_AOMDV to store additional information for each alternate path including: Next hop, last hop, hop count, and expiration timeout and AQL. The AQL field is used to find an average queue length of all available paths.

This paper handles two major issues in BRSR_AOMDV they are load balancing and link stability. A critical part of the finest promising network is the load balancing. For illustration, job completion becomes difficult, if massive load is given to the nodes with less processing capabilities and which do not have any means to share the load¹¹. There is a chance of load disproportion due to that the computing power of the systems are non-uniform it means few nodes may be idle and few will be overloaded. The second major issue in MANET is nodes are moving randomly without any centralized administration in case if these nodes are not having reliable stability of neighbor nodes, links, and paths from source to destination, it will suffer more loss in link. This proposed work introduces an innovative technique to handle both these issues.

2. Related Works

In Join-Idle-Queue (JIQ) used for distributed load balancing in high volume system was proposed by²¹. They also introduced another mechanism for random dispatching of packets using Equal-Cost-Multipath. This approach reduces the communication cost considerably. This is applied only for web services and not in mobile ad hoc networks.

In their work¹² on Ad hoc On-demand Trusted-path Distance Vector protocol (AOTDV) which is used to select multiple loop free paths in one route discovery

process, the selection of shortest path based on two approach that is hop count and trust values. Author in¹⁷ projected an algorithm for selection of backup path with high reliability. This algorithm estimate link reliability with the help of link expiration time between two nodes. It also finds the routes simultaneously for node-disjoint and link-disjoint path. Author in³ designed a framework on anonymous multipath routing protocol based on secret sharing, to detect the activate attack using hash function.

Author in⁹ introduced a novel method on Multipath OLSR; multiple paths obtained using Multipath Dijkstra Algorithm. This algorithm aims to create flexibility and extensibility of path by using different link metrics and cost functions. Author in² proposed a novel approach that enhanced the reliability under path failures and load balancing. This approach identified the disjoint-path using mechanism of Stream Control Transmission Protocol and Dynamic Source Routing Protocol.

Author in¹⁶ adapted Markov Model to predict the link connectivity based on link duration and estimate the settling time for node movement. Author in¹⁴ proposed Route Stability based QOS Routing Protocol which computes link stability and route stability based on received signal strengths. The work given in¹⁵ was based on Dynamic Congestion Detection and control Routing (DCDR) method which is proposed to avoid congestion to estimate average queue length at the node level, based on this to identify the congestion level of the node and send warning message to neighbour nodes. Author in⁴ presented a new approach to apply the queue to a power saving in wireless sensor networks and also apply N-Policy of discrete time queue with disasters. The work given in⁵ anticipated a scalable and reactive data replication which increases data availability with the help of frequently used items. SCALAR achieves fault-tolerance and load balancing; it is applied in virtual backbone structure to perform data lookup and replication operation. Author in¹⁹ presented Channel -Aware AOMDV which is used to select the stable link based on a routing metric channel average non-fading duration. Identification of the link stability using multi-objective approach, that is average queuing delay, energy cost and link lifetime is discussed in²⁰.

The work given in¹⁰ path duration is a design parameter, which establishes a relationship between path duration includes node density, velocity of nodes, transmission range and number of hops. Author in¹¹

proposed a fault-tolerant cluster-based QOS, the link failure was evaluated using failure recovery time, packet dropped, throughput and flow bandwidth. Author in⁶ proposed LAER Link-stability and Energy aware Routing Protocols. This approach satisfies bi-objective optimization link stability and minimum drain rate energy consumption⁶.

Author in¹⁸ proposed reliable paths based on the number of links; also introduce prediction base link availability estimation to identify the link reliability. The work given in¹ takes two metrics to find the node lifetime and link lifetime that they represent is energy drain rate and mobility estimation rate of nodes respectively. It was implemented in Dynamic Source Routing (DSR) which used two mechanisms such as lifetime-prediction routing and signal-stability-based adaptive routing. The work given in⁸ improves routing efficiency to select the stable path, which leads to reduced latency and overhead. The work proposed was applied on Random Direction Model through this to selects an optimal path in terms of path availability.

Author in²² proposed to identify the link stability using multi-objective approach, that is average queuing delay, energy cost and link lifetime.

Author in²³ proposed to develop a new multipath load sharing algorithm using channels sensing, node energy level analysis and malicious node detection. The selection of best path based on packet count.

All the existing work discussed above either rely load balancing or link stability. None of them integrated or taken in to the account both the problems. So this proposed work aims dealing with both load balancing and link stability in AOMDV.

3. The Proposed Process

This paper proposes an Optimal Balanced Reliable Shortest Routing technique is for the establishment of effective routing of the packets in case of load balancing and link stability. This technique minimizes the packet drop and delay while increasing the packet delivery ratio. The work¹³ aims at overcoming two critics in AOMDV. They are efficient load balancing and maintaining the link stability. The work consist of two phases, in the first phase load balancing is handled using the computation of average queue length of each reachable neighbour nodes using instantaneous queue length and weight factor of each nodes. The path with minimum queue lengths is

selected as the potential routes for packet traversal to the destination node. In the phase 2 link stability of each selected routes from the phase 1 is computed based on the signal to interference ratio. The route which has the SIR value less than the defined threshold value is considered as the best route for traversing the packets to reach the destination. Here the threshold value is set to 15 to 17 db. The main objective of this work is determining optimized path from source to destination in AOMDV. First finding average queue length of each reachable path from the source to destination node in order to overcome load imbalance is performed which results in the selection of set of paths which have minimized queue length. Next the best stabilized link is determined and finally the path which satisfies both these criteria is chosen as the optimized route for packet transfer in BRSR-AOMDV.

The below Figure 1. From the available routes path with minimum queue lengths are selected and represented using R1, R2 and R3. The selection process is based on the size of AQL and main objective is to determine the minimum load balancing path. The route R1 has the minimum AQL with comparing to R2 and R3. The R2 has one single node as medium Queue length whereas the R3 consist of two medium queue lengths. Finally we opt to proceed with Rout R1 and R2 for finding better link stability. From the selected paths of phase 1 the link stability with minimum threshold is R1 and it is selected as optimal BSSR for packet traversal from the Source S to Destination D.

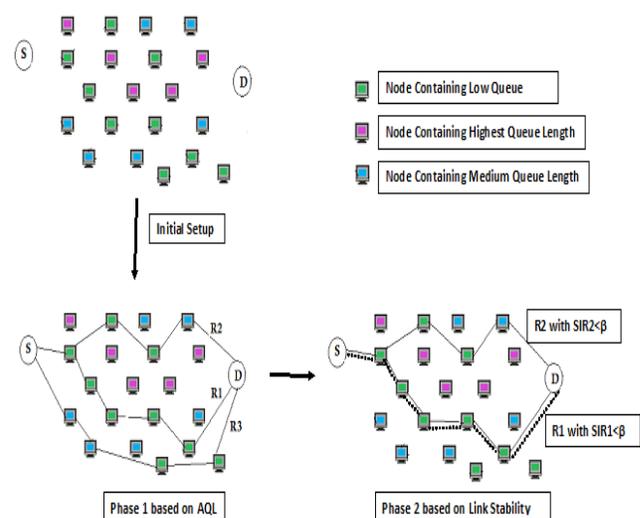


Figure 1. Optimal route selection based on load balancing and link stability.

BRSR_AOMDV Algorithm
Input: Number of Nodes
Output : Optimal Route
/* This algorithm is to find an optimal route using load balancing and link stability .The following parameters are used S β Source _Node D β Destination _Node N _i β Intermediate _Node N β number of nodes */
Begin Step 1: Initiate Route Discovery Process using BRSR_AOMDV , to find all available path between source S to destination D. Total number of available is n_path. Step 2: call load_balance() Step 3: Choose the optimal path (S _{path}) to traverse the packet End
Find Average_Queue_Length of all available path
Input : Number of nodes n, Number of paths n_path
Output : Path with minimum load
/* This procedure is to find the Average_Queue_Length (AQL) for all available path. The following parameters are used Wf β 0.002 Q _{thres} β Constant_Value AQL _(Path_id) β Average_Queue_Length IQL β Intermediate_Queue_Length Path _{no} β 0 Np β number of packets l β packet arrival per unit time S _{path} β Selected_path */
Begin Step 1 IPR β N _p * l Step 2 :set Path _{no} β Path_Id _i Step 3 : While (n_path >0) { AQL _{Pathno} = (1-wf)* AQL _{Pathno} +(IQL * wf); Path _{no} =Path _{no} -1 ; } Step 4: wf β wf * ctf*IPR /* wf used to regulate the load_balance in the node */ Step 5 : Path _{no} βPath _{id} , n_path1 β n_path Step 6: While (n_path1>0)

{ If (AQL _{pathno} < Q _{thres}) { S _{path} β AQL _{pathno} ; Call Link_Stability(); } Else //Remove the Path in the route list n_path1 = n_path1 -1; } End
Find the link stability of each minimum load balancing path
Input : S_{path}, n_path
Output : Stable path
/* This procedure is to find the Signal Interference Ratio (SIR) to identify the link stability for the selected path. The following parameters are used link gain for link (i, j) β h(i,j) thermal noise power β σ ² transmitted power of the ith node β P _i number of codes used for transmission by user k β m _k (m _k = 1 for time multiplexing) the user l spreading factor code β L _i represents the number of transmitting nodes in the neighbourhood link (i, j) β N _t */
Begin Step 1: While(true) { SIR1 β h _(i,j) * P _i ; SIR2 β 1/L _i *sum(h _(k,j) * m _k * P _k)+σ ² ; SIR _{(i,j)-S_{path}} β SIR1 / SIR2 ; $SIR_{(i,j)} = \frac{h_{(i,j)} P_i}{\frac{1}{L_i} \sum_{k=1, k \neq i, j}^{N_t} h_{(k,j)} m_k P_k + \sigma^2}$ } Step 2 : If (SIR _{Spath} < SIR _{thres}) Return(S _{path}); End

3.1 Stability of Neighbour Nodes

There are two parameters taken in to the consideration of neighbour nodes stability. i.e., Mobility, Link loss Path mobility is measured using packets as follows:

Suppose if there are two nodes A and B then the mobility of node PQ

$$PQ_{mob} = \frac{\text{Num of packets measured from P to Q}}{\text{Num of packets measured from Q to P}} \quad (1)$$

The node link loss can be measured by using Signal to Noise Ratio. It can be measured by using⁷ Bit Error Rate (BER) which is related to SNR as follows: Let F be the fading in the channel, given by

$$F = \frac{P_{tr}}{d^{2j}} \quad (2)$$

Fading can be also represented as the difference between transmitted and received power of source and destination mobile nodes.

$$F = P_{tr} - P_{rr} \quad (3)$$

Signal to Noise Ratio (SNR) is given as ratio of transmitted power to the noise power. It is given by

$$SNR = \frac{P_{tr}}{N_0} \quad (4)$$

If channel is fading based, Noise power is also the fading power. So the Signal to Noise Ratio (SNR) in db can be represented as:

$$5NR = 10 \log\left(\frac{P_{tr}}{F}\right) \quad (5)$$

$$SNR = \frac{P_{tr}}{P_{tr} - P_{rr}} \quad (6)$$

If we take it in to non logarithmic scale,

When the noise power N0 or fading is more, Signal to Noise Ratio decreases and Bit Error Rate also decreases. This relationship is represented by following equation. Hence Bit error rate

$$P_b \propto \frac{1}{SNR} \quad (7)$$

$$P_b = \frac{J}{SNR} \quad (8)$$

$$P_b = \frac{1}{SNR} \quad (9)$$

Where, J = 1

From the link loss with signal to noise ratio and mobility of the nodes, the stability of neighbour nodes is

easily measured. The neighbour node stability is estimated by the combination of mobility and link loss of the node.

3.2 Stability of Path in Whole Network

Similarly, if there are ‘n’ numbers of nodes then Mobility of path PS is measured as follows:

$$\text{Mob of path P} = \text{Mob of PQ} * \text{Mob of QR} * \text{Mob of RS}$$

And the link loss of the path AD is measured as follows:

$$\text{Link loss of path PS} = \text{link loss of PQ} + \text{link loss of QR} + \text{link loss of RS}$$

Therefore, by using the two parameters the mobility and link loss, the stability of the path is measured as follows

$$S_p = \frac{M_p - LL_p}{H_c} \quad (10)$$

Where S_p = Stabilitypath,

M_p = mobilitypath,

LL_p = link loss path,

H_c = Number of hop count

We also proposed stability of path from stability of link by following calculations. When the distance between two nodes becomes larger than the transmission range the nodes will be disconnected. For transmission range T_r link stability L_{sb} between any two nodes overtime period t can be calculated by:

$$L_{sb} = \frac{T_r}{\sqrt{\{(p_1 - p_2) + t(n_1 \cos \theta_1 + n_2 \cos \theta_2)\}^2 + \{(q_1 - q_2) + t(n_1 \sin \theta_1 + n_2 \sin \theta_2)\}^2}} \quad (11)$$

Note that L_{sb} is the link stability of individual links between any two nodes and for a path it is a concave parameter and it is same as the minimum link stability along the path. For a path from source to destination path stability P_{sb} is given by,

$$P_{sb} = \text{Min}(L_{sb}(1), L_{sb}(2), L_{sb}(3), \dots, L_{sb}(N))$$

Where 1,2,3...N is the number of links along the path.

4. Experimental Result

4.1 Simulation Setup

In order to evaluate BRSR-AOMDV, we have compared its performance with AODV using several performance metrics. We have used NS-2 as the simulation environment. In our scenario two phases used to find the

balanced reliable shortest route to solve the link failure problem and balance the load of the route. The area in which the nodes are spread is 1000 X 1000 meters and there are 100 nodes which can move in a range of 250 meters in random directions. In this work we adapted CBR traffic model and each node uses the IEEE802.11 protocol in its MAC layer and the total simulation time is 10 minutes and the packet size is which is to be delivered to single destination is 512 bytes.

Table 1. Simulation setup

Parameter	Value
Transmission Range	250m
Topology size	1000m X 1000m
No. of nodes	100
No. of destination	1
Traffic type	CBR
Packet size	512 byte
MAC layer	802.11
Bandwidth	2 Mbps
Node placement	Random
Simulation Time	10 minutes
Routing Protocol	AODV, AOMDV
Queue Size	100

4.2 Performance Metric

4.2.1 Queue Size Vs Delay

The chart above displays the queue size vs. Time delay in dispatching the data to the neighboring nodes. The performance of the proposed system was compared with the AODV and the result shows that the proposed technique better performs by taking less time delay comparing to the existing technique this is possible due

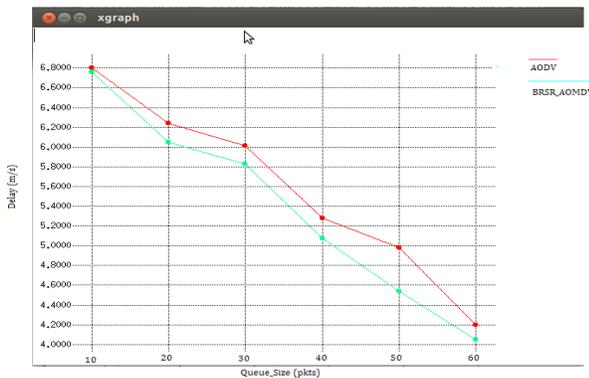


Figure 2. Queue size vs delay.

to the load balancing based on usage of average queue length.

4.2.2 Link Stability Vs Propagation Distance

Determining the life time of the path statistic were performed for several propagation distance in case of AODV and our proposed method BRSR-AOMDV protocols, whose nature of packet variation becomes as in Figure 3. The proposed approach perform better when the propagation distance of data packets increases because the path selected for transferring the data packets is with the path which has less load while lead to more stable link path from source to destination. BRSR-AOMDV is superior to AODV especially when the 80 % node's propagation distance begins to rise.

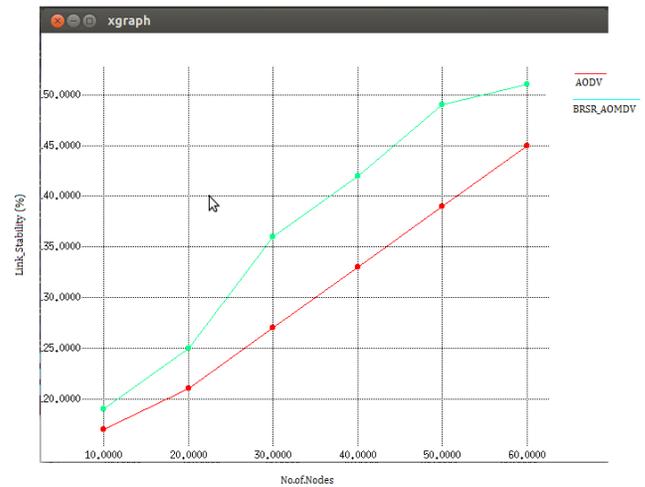


Figure 3. Link stability vs propagation distance.

4.2.3 Number of Nodes Vs Link Stability

The performance comparison shows that when the number of nodes increases the link stability ratio also increase it is because each time a path contains more no of nodes the energy loss can be compensated while finding the best short queue size in the overall network which is reachable for source to destination. In this result the proposed work increase link stability more than 60% compared to AODV.

4.2.4 Queue Size Vs Throughput

Figure 5 show the results of while there is increase in the queue size for the throughput 35, 40, 45, 90 for the nodes ranges from 10, 20, 30...60 scenario. Clearly our Proposed BSSR AOMDV scheme achieves 40% network

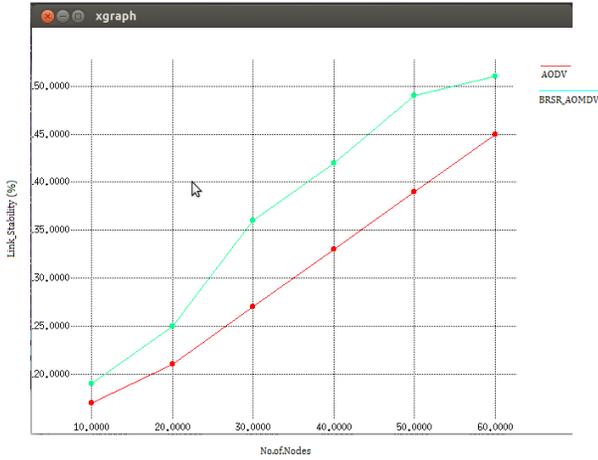


Figure 4. No of nodes vs link stability.

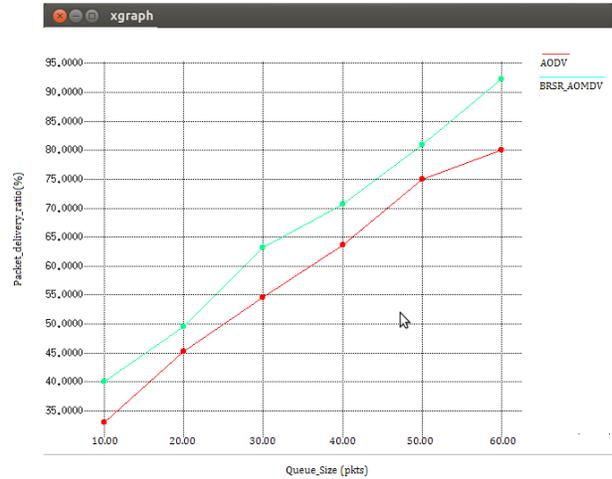


Figure 6. Queue size vs packet_delivery_ratio.

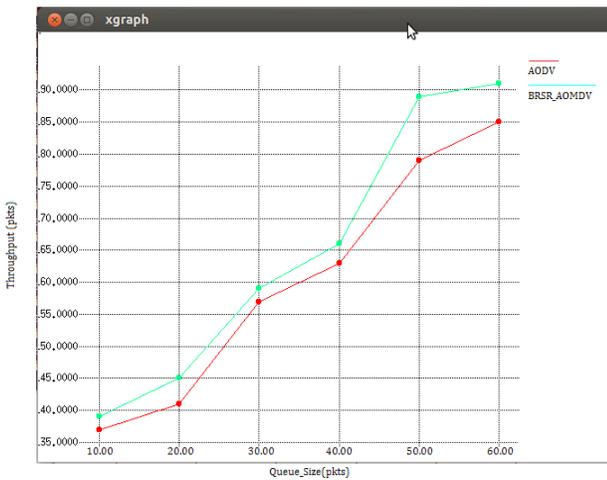


Figure 5. Queue size vs throughput.

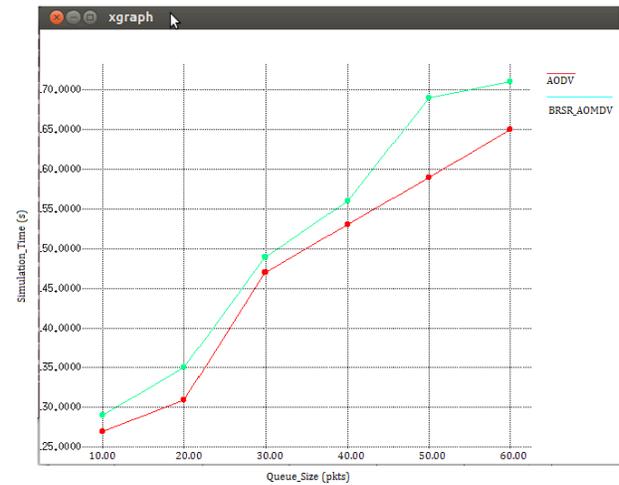


Figure 7. Queue size vs simulation time.

throughput than the AODV scheme since it has both predicting stability features.

4.2.5 Queue Size Vs Packet Delivery Ratio

Figure 6 show the results of packet delivery ratio for the stability queue size 10, 20...60 for the 100 nodes scenario. Clearly our BRSR-AOMDV scheme achieves 80% delivery ratio than the AODV scheme since it has both reliability and stability features.

4.2.6 Queue Size Vs Simulation Time

The performance of the Queue size vs simulation time shows that the proposed method takes more time when the queue size increase because the load balancing and the link stability has to be determined before choosing

the path but in case of the AODV the option of selection optimal path is missing because it holds simple strategy to select the path which leads 50% to packet drops and the link failure.

5. Conclusion

In this paper, we have developed a prediction based stability scheme with stability models which attains stability in link, path and neighbour nodes. In the first phase of the scheme, stability of neighbour nodes is achieved using Load balancing. The load balancing is obtained by determining the average queue size of each reachable neighbour node from source to destination. The path with least queue size is selected for optimal

traversal of data packets. In second phase, stability of path is achieved. It uses two factors called mobility factor and link stability. The stability of total mobile nodes is reached using the threshold signal strength value. In this we predicted the network lifetime of the whole network. By simulation results we have shown that the BRSR-AOMDV achieves good packet delivery ratio, more network lifetime while attaining low delay overhead than the existing scheme AODV scheme while varying the number of nodes, node speed, throughput and stability weight

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