# A VARIABLE BIT-RATE ON- DEMAND ROUTING PROTOCOL FOR MOBILE AD HOC NETWORKS

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***ABSTRACT***

*Mobile ad hoc networks are facing new challenges including routing, quality of service and reliability. Quality of service can be achieved through the use of bit rate transmission. A modified variable bit rate on demand routing protocol for mobile adhoc network is presented in this paper. We designed, implemented and studied the performance of a Variable Bit-rate On demand Routing (VBOR) protocol which is based on the Adhoc On-demand Distance Vector (AODV) protocol. Here, the mode of transmission used for simulation purpose is variable bit rate. We calculate the residual power information of the node to select the best and stable route in between source and destination. Various QoS parameters such as average energy consumption, control overhead, data transmission delay, packet delivery ratio and throughput are studied and analyzed. The results are compared with the existing AODV protocol and the results are encouraging.*

**Keywords:** MANET, AODV, DSR, VBOR, QoS, throughput, packet delivery ratio, transmission delay and control overhead

## 1. Introduction

A mobile ad hoc network is a collection of nodes connected by wireless links. Although it offers the advantage of being easy to deploy, the wireless ad hoc network paradigm, characterized by the absence of any control at the routing operation or data forwarding, introduced truths problems of security making thus less powerful the operation of such network. In mobile ad hoc networks, there are two classifications in routing protocols namely, table-driven routing protocols and on-demand routing protocols. Table-driven routing protocols can be compared with the distance-vector routing protocol of wired networks. In wired networks, these routing protocols are functioning in same manner but little difference. Since there are wireline connections between the nodes, the routing protocols need not find difficulty in finding the path between one node and another. But in wireless networks, the path between one node and another should be established whenever needed since there are no wireline connections among nodes. Table-driven routing protocols are working based on the principle of distance or hop count between one node (sender) and another node (receiver). DSDV, WRP, CGSR and STAR are the popular table-driven routing protocols. Destination

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Sequenced Distance-Vector (DSDV) [1] routing protocol is working on distance or hop count. DSDV finds the distance between one node and another node but there is no path finding mechanism since these protocols don't have capability to find the path whenever needed. On-demand routing protocols [2] and [3] are finding the path dynamically whenever the source node wants to communicate with destination node. Most of the on-demand routing protocols are having two phases namely, route discovery and route maintenance. These protocols find the route when the source node wants to send some data to a particular destination but it doesn't have the route to that destination. At first it initiates the route discovery process by flooding the route request packets. These route request packets are flooded by neighbor nodes till it reaches the destination. Then, the destination finds a best path among many paths. Route reply packets are sent by destination back to the source node through that selected path. After finding the path, the route maintenance process is performed by listening the topology whether any path breaks occur or not. If any path break occurs, the route repair message is sent to their neighboring nodes and it is forwarded till it reaches source and destination or either (it depends on the protocols). By listening to this route repair message either of the side will initiate process to find the alternate path. If the alternate path is available at neighboring nodes, these nodes will send the reply to either sender or receiver. There are many popular on-demand routing protocols such as AODV, DSR, TORA, ABR and so on. In this paper, we are introduced the variable bit rate for the Adhoc On demand Distance Vector routing protocol.

## Ad-Hoc On-demand Distance-Vector (AODV) routing protocol:

AODV protocol is an improvement of DSDV protocol of table-driven routing protocols. It reduces the number of broadcast packets by creating routes on demand basis but against DSDV that maintains routes to each destination [4]-[6]. It finds the route when the source node wants to send some data to a particular destination but it doesn't have the route to that destination. At first it initiates the route discovery process by flooding the route request packets. These route request packets are flooded by neighbor nodes till it reaches the destination. Then the destination finds a best path among many paths. Then route reply packets are sent by destination back to the source node through that selected path. AODV [7] allows nodes to respond to link breaks and changes in topology. The routes which are not in use for longer time are deleted from the routing table. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets. So these nodes are notified with RERR packets when the next hop link breaks in the path. With the use of these RERR packets, each predecessor node will erase that particular broken entry.

In this paper, we develop a new protocol, Variable Bit-rate On-demand Routing (VBOR) protocol. This protocol has to be implemented in variable bit rate scenarios. Most of the previous works have been focused on constant bit rate (CBR) transmissions. We have measured performance parameters such as average energy consumption, control overhead, data transmission delay, packet delivery ratio and throughput.

The paper has been organized as follows. Section 2 presents the related works. In section 3, the new protocol Variable Bit rate On demand routing protocol and its functions are presented. Performance analysis and the results are presented in section 4 and the conclusion is presented in section 5.

## 2. **Related work**

M.L.Sharma, Noor Fatima Rizvi, Nipun Sharma, Anu Malhan, Swati Sharma [8] have did their analysis on MANET routing protocols under CBR and FTP traffic classes. This scheme has shown that AODV performs better than DSR and WRP for CBR traffic also DSR performs better than AODV and WRP for FTP traffic in pause time scenarios. Node speed and offered load scenarios have shown that AODV performs better than DSR and WRP for packet delivery ratio except that packet delivery ratio of DSR is less than WRP in offered load under CBR traffic class.

Lajos Hanzo ll, Rahim Tafazoil [9] developed the solutions for QoS aware Routing (QAR) and admission control (AC) protocols. This solution improving the performance of QAR and AC protocols in the face of mobility, shadowing and varying link SINR. It is found that in low link SINR can improve the reliability of throughput services. The authors proposed the StAC-multirate protocol that adds multiple link transmission rate awareness to the AC and routing process, as well as features to route around temporarily low-quality links. Here backup routes are encouraged with end-to-end redundancy and produces the most reliable StAC-multirate- backup protocol.

George Adam et al [10] evaluates the performance of routing protocols for multimedia transmission over mobile ad hoc networks. The authors have chosen three protocols AODV, DSR and OLSR for their analysis. The analysis has shown that among these three protocols, DSR performs better than AODV and OLSR in terms of end-to-end delay and packet delay variation and states that DSR is the most efficient routing protocol when multimedia traffic especially video traffic is considered. Packet delivery ratio shows that AODV is better than DSR and OLSR. In addition, the authors planned to evaluate the performance of MANET routing protocols in conjunction with congestion controls mechanisms and variable bit rate traffic.

Kunagorn Kunavut and Teerapat Sanguankotchakorn [11] evaluate the performance of ad hoc routing protocols to deliver MPEG-4 traffic. MPEG-4 encoding scheme seems to be suitable for ad hoc networks since they offer high video quality with higher compression ratio than other MPEG standards. This evaluation has taken both proactive (OLSR) and reactive routing (AODV,DSR) protocols for analysis. This analysis proved that DSR is not fit for both high load and high mobility scenarios. Among other two protocols, AODV performs better than OLSR in high mobility situation due to its ability to maintain the broken route. OLSR performs better than AODV in high load situations because of its ability to update the best route at regular predefined interval.

Hasana Moustafa and Houda Laboid in [12] developed a Multicast On-demand Mesh-based Routing Protocol for multihop mobile wireless networks. It proposed a on-demand multicast routing protocol, named Source Routing based Multicast Protocol (SRMP). SRMP constructs a mesh to connect the group members, providing robustness against mobility. It also provides stable paths based on links availability according to future prediction of link state, higher battery life paths to conserve the power. The authors motivate to implement the protocol with different group mobility models that are suitable for multicast applications.

# 3. **Proposed Work**

In this paper, we develop a new protocol, Variable Bit-rate On-demand Routing (VBOR) protocol. This protocol has to be implemented in variable bit rate scenarios. Most of the previous works have been focused on constant bit rate (CBR) transmissions. We have measured performance parameters such as average energy consumption, control overhead, data transmission delay, packet delivery ratio and throughput.

## A) Variable Bit-rate On-demand Routing (VBOR) protocol

VBOR protocol is designed based on AODV. Like AODV this protocol is also having two phases: Route Discovery and Route Maintenance. It makes route whenever there is no route in the source node's cache and it wants to communicate with the destination. Existing AODV protocol has been applied in the variable bit rate transmission. By varying the transmission rate we have shown that the new protocol VBOR experiences better improvement in terms of energy consumption, packet delivery ratio, throughput, delay and overhead. In the following sections two phases of VBOR viz. route discovery and route maintenance are explained.

### a) Route Discovery

Like other on-demand routing protocols, VBOR also floods the route request packets unless the source has particular route to the destination in its table and it wants to communicate. Unlike other protocols, VBOR takes power information from the lower layers. Then the routing decision is made based on the power information of the nodes. This information includes residual power of the nodes. Residual power can be calculated after any communication that means transmission, reception. Transmission consumes more power than reception. Thus after any communication, the residual power of the node is calculated. Here, the route request packet is flooded to their neighbors by the source node if it doesn't have the route to the destination. After receiving the route request packets, the neighbors check their table whether it has the route. If it doesn't have the route, it will forward the packets to its neighbors. The duplication of route request packets is avoided using the sequence numbers. The sequence number of the received packet is checked with the existing one for the same packet. If the received sequence number is greater than the existing one, it will be replaced. Otherwise the existing entry will be maintained. Here, the transmission of route request packets happened after getting the information about power of the node. This power information is taken from the MAC layer after transmitting the RTS/CTS signals. Since RTS transmission consumes more power than CTS and DATA, the information about power of the node is very important to make decision for routing.

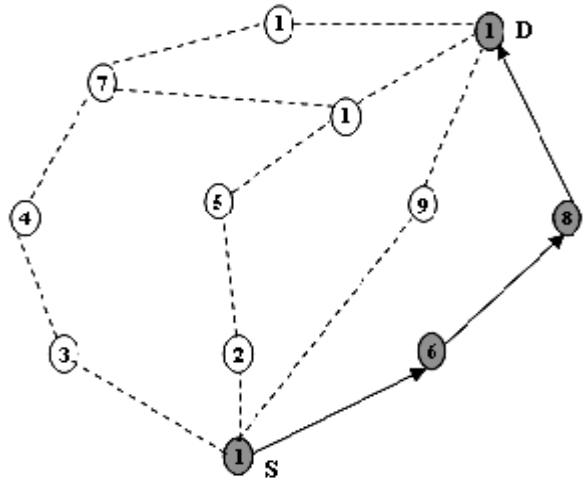


Figure 1a Route Maintenance

After the route is discovered, the route has to be maintained. Since there is high mobility in ad hoc networks, the node movements are very high. In this work, we have taken the random waypoint mobility model for the node movement. Suppose any node movement is there in existing topology, the connection between two nodes can be broken. In AODV protocol, the end node of the broken link has to decide about the new route to the source or destination. The end node of the broken link can intimate the route error message to its neighbors up to the source or destination. In this work, the uplink node of the broken link has to search for the next high power node from its neighbors table. If any neighbor is having high residual power, that node will be selected as a downlink node towards destination.

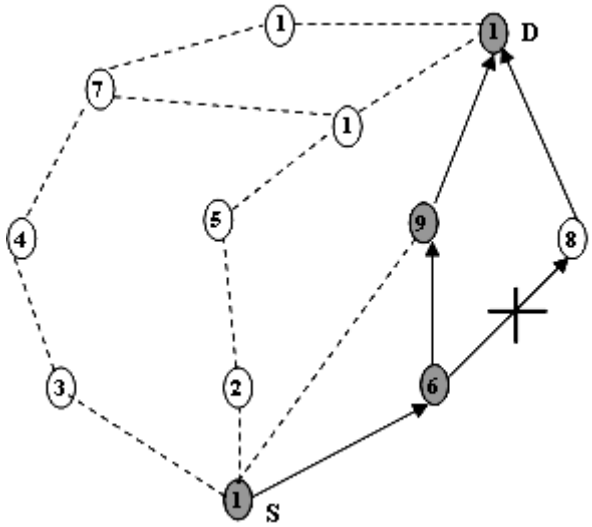


Figure 1b Route Maintenance process

## 4. Performance Analysis

Simulation study has been carried out to show the performance of the proposed VBOR protocol. Simulation used here is NS2 (Network Simulator). Simulation results of VBOR have been compared with AODV in terms of quality of service (QoS) parameters such as average energy consumption, control overhead, data transmission delay, packet delivery ratio and throughput.

TABLE I SIMULATION PARAMETERS

| Parameter | Value |
|---|---|
| Test Area | 1500m x 1500m |
| Channel type | Wireless channel |
| Radio Propagation | Two Ray Ground |
| Antenna type | Omni antenna |
| Interface Queue type | Drop tail with priority queue |
| Interface Queue length | 50 |
| Transmission Range | 250m |
| Number of Nodes | 100 |
| Transmission Bandwidth | 1Mbps |
| MAC | IEEE 802.11 |
| Mobility Model | RandomWaypoint |
| Traffic type | VBR, UDP |
| Packet Size | 512 bytes |
| Initial Energy | 100 Joules |

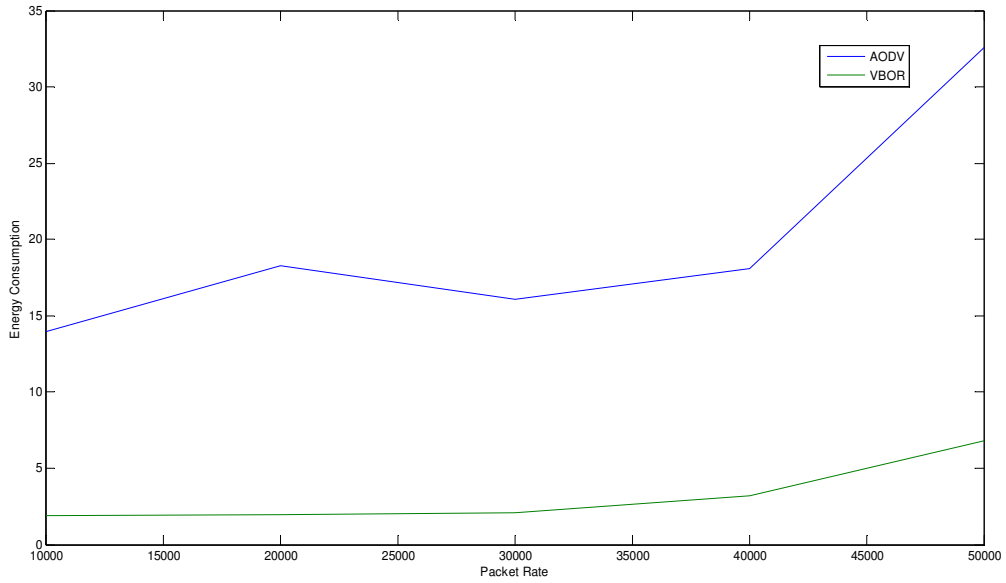


Figure 2: variation of average energy consumption with the number of nodes

Average energy consumption with the number of nodes is depicted in Figure 2. It is the ratio of the total energy consumed with the number of nodes. In the simulation, AODV routing protocol consumes energy of 453 joules when compared to that of VBOR protocol 95 joules. The energy consumption is reduced due to controlled usage of RTS/CTS signals in MAC layer in route discovery, reduction in routing overheads and control overheads in route maintenance procedure. The average energy consumed by each node is 1.9 joules when compared to AODV protocol of 9.2 joules. As the times goes, the average energy consumption is maintained in a linear fashion. The reduction in average energy consumption leads to increased life of routes and also of the nodes. RTS/CTS retransmission is avoided in route selection.

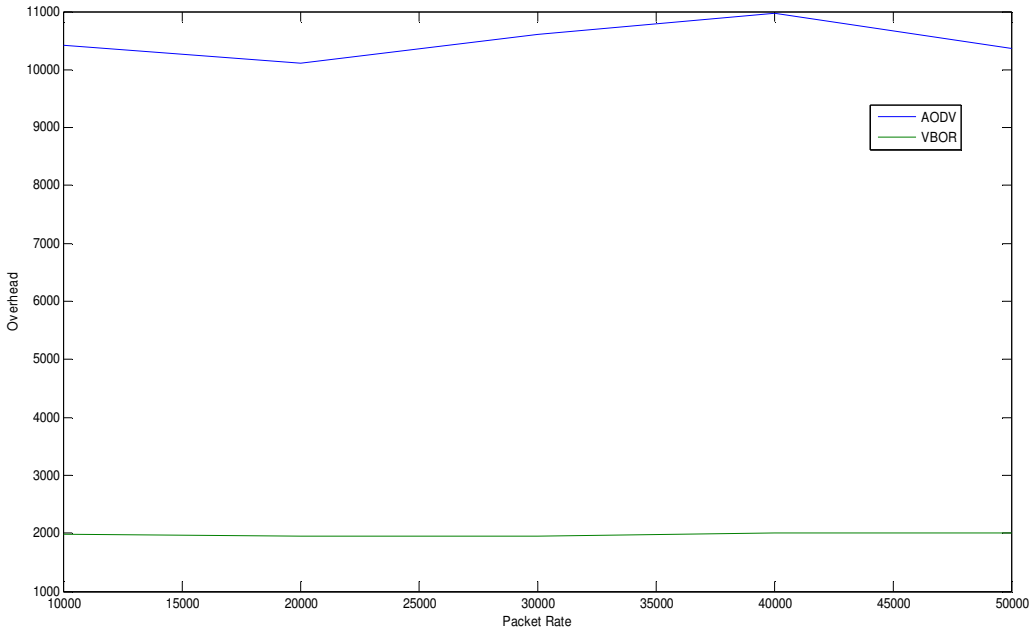


Figure 3 Variation of control overhead with packet rate

Figure 3 shows the variation of control overhead with packet rate during the route maintenance phase. In AODV routing protocol, the control messages where high due to frequent path breaks during mobility and energy depletion of nodes. In the VBOR protocol, energy efficient paths are selected by considering its residual energy. During the route discovery, each node is compared with a threshold value in order to select the route. So the route breakup due to energy depletion is avoided. The control overhead is reduced by five times compared to AODV routing protocol. The local repair mechanism in route maintenance also help in reducing control overheads, since no breakups occur during data transmission.

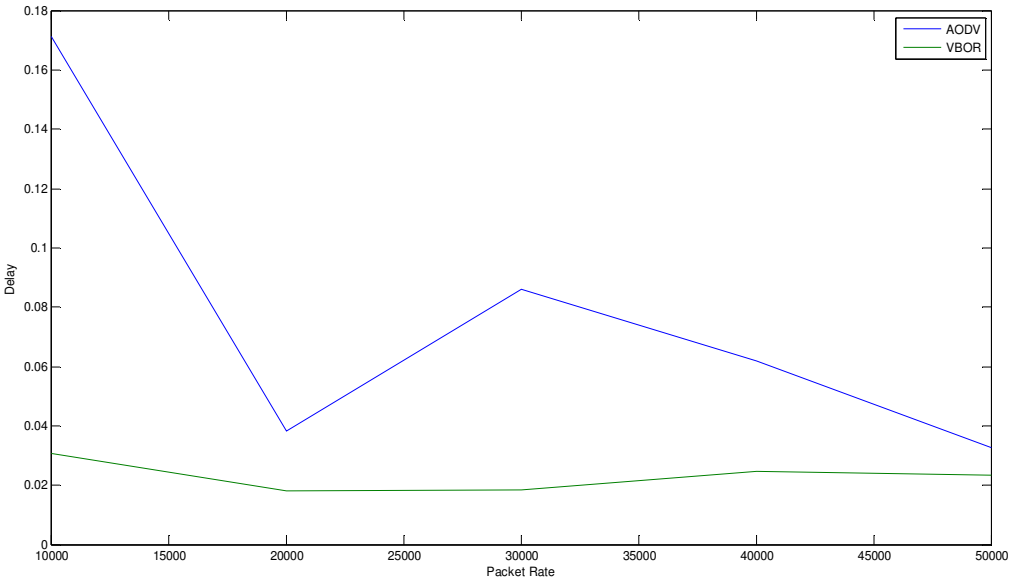


Figure 4 variation of data transmission delay with packet rate

Variation of data transmission delay with packet rate is depicted in Figure 4. Packet transmission delay of VBOR is very low compared to AODV routing protocol. It is in linear fashion as the time goes. There is a fluctuation in the delay of AODV. VBOR gets high delay but lower than AODV. The data transmission delay for the VBOR is minimal when compared to the AODV protocol. For a packet rate of 25000, the data transmission delay is 0.02, but in the case of AODV, the delay is 0.06. The delay in the case of VBOR is mostly linear in fashion when compared to the AODV.

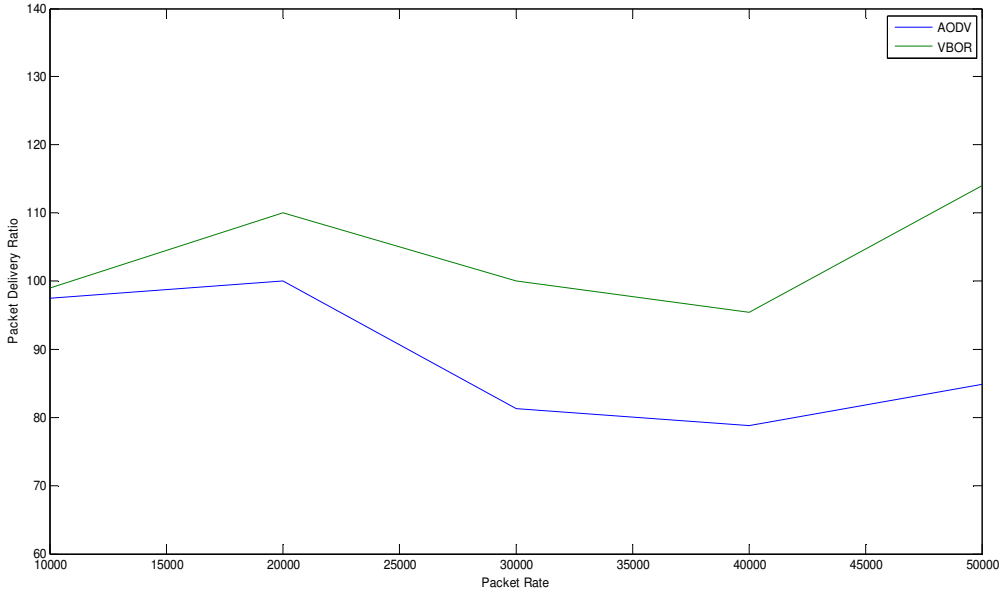


Figure 5 Packet delivery ratio with packet rate

Variation of packet delivery ratio with the packet transmission rate is shown in Figure 5. Data delivery ratio can be calculated as the ratio between the number of data packets that are sent by the source and the number of data packets that are received by the destination. Packet delivery ratio is 99 percent in VBOR routing protocol. The route is maintained by local repair mechanism without any path breaks. The paths are selected based on the SINR and residual energy, which leads to energy efficient and stable path.

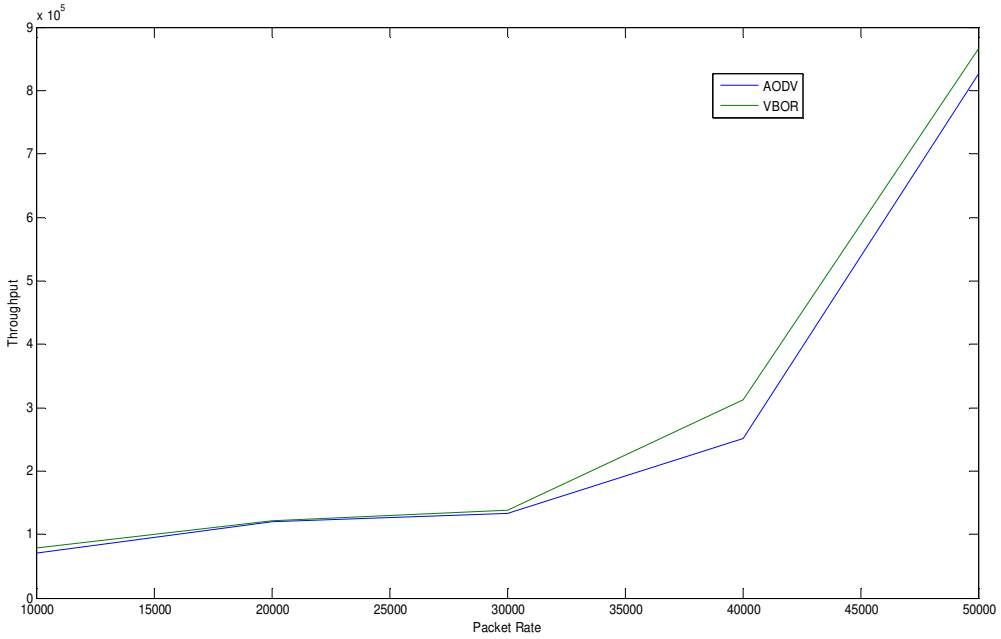


Figure 6 Variation of throughput with packet rate

Variation of throughput with packet arrival rate is shown in Figure 6. The route selected is stable and energy efficient so less breakups occurs. There is successful delivery of packets due to stable paths. Throughput also increases, since the SINR values of the nodes are calculated at the physical layer for path selection. All these factors leads successful delivery of packets, hence increase the throughput.

## 5. Conclusion

In MANET, there were no such power conscious algorithm using the variable bit rate mechanism for evaluating the performance of the unicast routing protocols like AODV and DSR. In our proposed algorithm, we showed that the remaining energy of the node is used to calculate the stable path. The residual energy is calculated from initial energy and spent energy at each stage. The MAC layer and physical layer information are crucial to make dynamic routing protocols and perform QoS parameters comparison. In this work, we have analyzed the performance parameters like average energy consumption, control overhead, data transmission delay, packet delivery ratio and throughput and VBOR outperform AODV for the above QoS parameters.

In future, these parameters are to be addressed against high mobility using many mobility models and these protocols can be applied in various other application traffics like File Transfer protocol (FTP), Trivial FTP(TFTP) etc. Also these protocols woule be including Signal to Noise ratio (SNR) information and Bit Error Rate (BER) from the physical and MAC layers.Various security measures are also considered and implemented for the variable bit rate based protocol.

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