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REVIEW

Performance Evaluation of Reactive Routing Protocols in MANETs in Association with TCP Newreno

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ABSTRACT

We inspect the performance of TCP NewReno protocol for data transfer in Mobile Ad hoc networks (MANETs). Dynamic Source Routing (DSR) protocols and AdHoc On-demand Distance Vector (AODV) are standard reactive routing protocols widely used in MANETs. In addition we also have to consider Transmission Control Protocol (TCP) as essential for MANETs since it is one of the widely used internet protocol for dependable data transmission. TCP has its variants namely TCP Reno, TCP NewReno , TCP Vegas and TCP SACK. In this paper we are evaluating the performance of DSR and AODV in association with TCP Newreno with respect to various parameters such as Average throughput, instant throughput, residual energy, packet delivery ratio. The ns-2 network simulator was used for simulation.

1. Introduction

Mobile Ad-Hoc network (MANET) is a punch of mobile nodes which collaborate with each other for multi-hop communication in a infrastructure less environment. In MANET routing is challenging task due to various characteristic of a network such as dynamic topology, multipath, link quality, performance metrics, and load balancing parameters between the nodes. . In this dynamic environment updating the routing table of every node during the communication is playing a very important role in terms of providing an optimum path according to the current change of topology [1]. In recent days many routing algorithms were developed like ABR, AODV, DSR, FSDSR, ZRP, ADV, CBRP, FSR, OONP, and ZHLS etc. These protocols divided into different categories such as reactive, proactive and hybrid routing protocols. Also Nature –inspired routing algorithms-swarm Intelligence such as Ant Colony Optimization (ACO) has been provided a appropriate technique for developing new routing algorithms for MANET. So it is very important to make efficient routing in high unpredictable network. The essential concept of any network is trust worthy delivery of data. Initially for the wired network Transmission Control Protocol (TCP) was designed. Then the TCP is used for wireless network due to its mobility it's affected largely [2]. TCP works based on sliding window protocol is responsible for reliable data communication. The congestion control mechanism plays a major role in sliding window protocol. TCP always tries to detect the congestion before hand by assuming the packet loss rate and tries to reduce or increase the load in the network as needed. However, in wireless networks, packet loss may not be only due to

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congestion in the network. Hand-offs, link failures, collisions are possible reasons for a packet loss in wireless networks. TCP is unable to distinguish packet losses due to reasons such as link failures, collisions, etc or congestion and thus, results in overall performance degradation.

Our simulations results demonstrate that the reactive protocols AODV performs well under a various conditions in association with TCP Newreno.

2. Literature Review

Jose Aex Pontes Martines et al., proposed bio-inspired algorithm called Ant Dynamic MANET on-demand (Ant-DYMO) routing protocol [5]. The Ant-DYMO is a hybrid and multi-hop algorithm which has two types of ants for exploring routes for a specific destination. In this algorithm the EANTs carries the information of source node address and all the intermediate nodes passed to reach the source node from the destination node and also it impose pheromone signs along its way. Then EANTs keep updates the path details in the last node pheromone table and broadcast EANT to neighboring nodes. Since Ant-DYMO is a proactive approach the EANTs Keep on updating the routes in a regular interval , so that it has growing the probabilities of finding an alternative route in case route failure [3]. The ns-2 simulator was used to evaluate the performance of Ant-DYMO with 50 nodes and 20 nodes. Here various configurable parameters were used in Ant-DYMO for the simulation like eants_percentage, eants-history, evaporation factor, eants_route_expiration _time, eants_interval. The basis of DYMO is used in Ant-DYMO implementation. The discussed algorithm was compared with DYMO with respect to different parameters like delivery rate, end-to-end delay, routing overhead and loss rate, and the result says, it comprises the network delay with high probability of quickly finding the optimum route in very less time, high data delivery rate and the data loss rate with less number of node is same as DYMO but with more number of nodes the data loss rate is high because of traffic control over head. The routing overhead is more due to transmission and retransmission of information by the (updating routing table)EANTs. It may also gives outmoded paths information, due to the dynamic change in the network topology. A final analysis of Ant-DYMO states that, Ant-DYMO reduces time in data delivery and shows significant improvement in terms of packet loss.

Mamoun Hussein Mamoun proposed a new proactive routing algorithm called NPR with basis of modified Ant Colony optimization (MACO) [6]. In this algorithm single hop HELLO message packet is used to build a neighbor list, Which is used to initialize the routing table node. NPR algorithm uses FANT to reach a specific destination either using broadcast or unicast depending on the availability of a route to the destination. Here the FANT are a light weight packets consist of , Packet ID, source IP address, Destination IP address and the keep rising stack which consist of the intermediate Node ID and the Node_ Traversal_Time. All these information's are collected by FANTs while going to the destination. The FANT after reaches its destination, it passes all the information regarding the route to the Backward Ant (BANT) created by the destination node and it dies. Then the BANT choose the next hop by popping the stack and updates the traffic model, routing table. The node elapsed trip time and the reinforcement signal of BANT indicates that the good selection of route. The every discovered path by the FANT by the BANT and update the routing table [4]. The data are transmitted through the route that has the leading pheromone concentration, which is going to be a primary path. The ns-2 simulation environment was used to evaluate the result with 100 nodes. The evaluation was compared with reactive protocol AODV with in terms of average end-to-end delay, packet delivery ratio, routing overhead. The final analysis says at high mobility, high packet delivery ratio because of proactive path maintenance of the routing table whereas in AODV reinitiate the path discovery process again. Low end-to-end delay due to maintenance of all the leading paths. Due to heavy traffic of route maintenance it leads to more overhead, which is not handled.

Huva Wang et al., proposed a tree growth based Ant colony algorithm (TGBACA), which is mainly concentrating on QoS in multicast routing [7]. TGBACA aim to trace a tree consists of all the target nodes. In this approach Ant does not select only the target node. The TGBACA has three basic process the first one, Tree Growth - The ant is used to grow a current tree and here the basis principle of Ant Colony Algorithm is used. The multicast tree grows constantly by adding the next node according to the probability and its stop growing when it covers all the multicast members. The second one, Tree Pruning- the grown multicast tree contains some leaf nodes of non multicast member nodes, which will be pruned. Now the final multicast tree is obtained. The final one, Updating Pheromones- the pheromones intensity of the multicast path is keep updates and this will help to increase the process speed. Here the ant number(antnum) enables the cost factor of the algorithm. When the number of ants increases mean while the convergence time also increases. But when the antnum increases certain extent multicast path search will be done randomly. When the network size increases it will lead to slow process, increased process

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time, average cost value. The parameters were chosen for the experiment via orthogonal experiment like with different ant number, different scales of topology, and different proportions of group members and compared. Here the final analysis says that the TGBACA acquire the better cost of multicast tree but there is more overhead in terms of growing a tree.

Quality of service enabled ant colony-based multipath routing (QAMR) algorithm is proposed by P. Venkata Krishna et al.,[8]. This algorithm has two ant agents (FANT,BANT) to evaluate the diverse parameters such as next hop availability(NHA), delay and bandwidth to fulfill the QoS constraints. The QAMR algorithm core concept is constancy of the link for the route discovery to match the requirement of QoS. The FANTs (reactive) are generated by the source which carries the stack of source address, destination address, all the intermediate nodes addresses along with path, bandwidth and hop count, start time to the destination. Here when first time FANT is received by a intermediate node verify about the address of its own incase if the address is not their it adds to FANT and broadcast to all its stable neighbors by its NHA values. The FANT also collects the transmission delay and processing delay of each node. By using all these QoS metrics path preference value will be calculated as soon as the FANT reaches the destination. Only the path which meets the user defined QoS threshold will generate the BANT. By popping the node present in the stack the BANT reaches the destination an unicast manner. For each BANT when it reaches the next hop it will see the probability of preference path by calculating the delay, bandwidth and the hop count. Here the BANT is providing several paths to the destination but for the data transmission the higher pheromone value path is chosen. When the higher pheromone path is overloaded it causes, less available bandwidth, more delay, reduction of nodes energy. Even due to mobility of the node, the NHA of a node goes below the threshold. The QAMR evaluation is done in ns-2 and compared with AODV and ARMAN. The final analysis says that, Due to the mobility of the node frequent route updating is require which is high routing overhead. In QAMR stability of the link is considered as a main parameters, the packet delivery ratio is high. As well as because of route mobility the the link failure will increase gradually.

D Karthikeyan et al., proposed an Ant based Intelligent Routing Protocol(ABIRP) to minimize energy utilization of the nodes and prolong the entire network lifetime [9]. The ABIRP is mainly focused on maximizing the span of network with minimum overhead. In ABIRP Approach in terms of expanding the span of network there are three operations done wisely coordinator election- The node which has more energy capacity and the more number of neighboring node is elected as coordinator node. Secondly coordinator announcement- The node which cannot reach the coordinator node should become a coordinator node by end of this operation a minimum number of coordinator nodes maintained in the entire network. Since the data are routed through the coordinator node , this topology duty is to give good capacity. The last operation is coordinator withdrawal- Here if the neighboring node can reach the other coordinator neighboring node either directly or indirectly the corresponding coordinator node should withdraw, regarding this periodic monitoring will take place. So here most of the time the non coordinator nodes can sleep and this way energy can be saved. Periodically the non coordinator node will communicate with the coordinator node. In ABIRP algorithm three different types of packets are used like, the information- data packet, Control packet like the neighbour control packets and FANT –to maintain the collection of available nodes to which the transmission take place. The BANT is used to update the pheromone table. The ns-2 network simulator is used to evaluate the ABIRP performance with 50nodes and compared with unmodified AODV. A final analysis of ABIRP state low energy utilization and that high packet delivery ratio when was compared to AODV protocol.

An Improved Location- Aware Ant colony Optimization based routing for MANETs was proposed by AJIT R. Bandgar et al.,. AntHocNet-LS is a extended version of AntHocNet protocol [10]. The AntHocNet protocol, whenever the changes in network topology rapidly it should restore the link detail and this is lead to the new route discovery process. Here the proposed algorithm introduced the concept of location server, which is consist of updated topology and routing path of a entire network. It will serve the information to the requested node in terms of selecting the optimum nearest to the destination. In the proposed algorithm there are two levels of location server is maintained. That the lowest level of location server maintains the information of the nodes in the region, the higher level of location server maintain the information of the nodes outside the region. Depending on the requirement the location information is received from either lowest or highest level location server and then data is send to the appropriate neighbor. The performance of proposed algorithm was evaluated using network simulator-2 with 500nodes and compared with basis AntHocNet algorithm [5]. This analysis state that control overhead, great packet delivery ratio, and routing overhead remains constant as the number of nodes increases whereas in AntHocNet approach routing overhead keep increases as the number of node increases.

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Gurpreet Singh et al., proposed An Innovative ACO based routing algorithm for MANETs(ANTALG). This algorithm mainly concentrating on selection of source and destination, which is done randomly and exchange Ant Agent between them [11]. While the ants moves along its path, The pheromone table and the data structures are created to store the trip time of the node. The ANTALG algorithm creates the community of artificial Ant which is updating the pheromone table. Every ant memory is consist of routing information. The data structure of memory is type of packet used by Ants, Source address and target address Packet length, sequence no, start time of the ant etc.The proposed algorithm consist of, Route setup phase- Here the FANT created in source node and it is send towards the destination, then the source and destination nodes are selected randomly to identify the overall topology. The BANT is created at the destination end and it traverse reverse towards the source in same path of FANT to updates the routing table. Then Route maintenance phase- The FANTs are periodically dispatched by the source node in a proactive manner in order to maintain all the better availability paths. Route discovery phase is the last one – Due to mobility of the node the path can be broken and it broadcast the link failure message and it has to be solved with local repair process in order to find the better path to the destination. The evaluation of the proposed algorithm is done in ns-2. The results are compared with ADSR, HOPNET, AODV with respect to different performance metrics. The results are increased throughput, less packet drop, high packet delivery ratio, more data packet sent, better End-to-End delay, less jitter, large window size.

Gurpreet Singh et al.,[12] proposed an orientation based ant algorithm(OANTALG) with the basis of ANTALG. The ANTALG process is explained in the same section along with this the orientation factor of ants also included. This orientation factor is used to flood the search node in the proper direction. In the proposed algorithm all the nodes are participating in the path finding process (bi-direction). An OANTALG is orientation based distributed learning algorithm. This way the better path can be found fro the destination from source.The evaluation of the proposed algorithm is done in ns-2. The results are compared with ADSR, HOPNET, AODV with respect to different performance metrics. The results are increased throughput, less packet drop, high packet delivery ratio, more data packet sent, better End-to-End delay, less jitter, large window size.

Saptarshi Banerjee et al., proposed a new on-demand power balanced routing algorithm for MANET which is Modified Ant Colony Optimization (ACO) Based Routing protocol . The major task of this protocol is to reduce the overhead for routing [13]. This algorithm uses the remaining battery charge of a mobile node as a factor to direct the other nodes, with this can find this algorithm is as power balanced and increasing the process of packet delivery ratio. In the proposed algorithm routing follows the three phases such as Route discovery phase-The sources node creates the FANT which has pheromone value, next hop, destination address is broadcasted to all the neighboring nodes. The information's are collected when the FANT reaches the destination and it dies at the same time BANT is created by the destination ,which come back to the source in the same path of FANT. The BANT when it reaches the source the path is established and it dies. Route maintenance phase- the data packet itself maintain the route. Route failure handling phase- based on the missing acknowledgement the path failure is identified and finds the alternative path. The proposed algorithm was evaluated using OMNET++ 4.5. Here was observed decreased packet delivery ratio due to faster process and quick rescaling factor reduces the time duration of reach ability metric in Modified Ant Colony Optimization algorithm.

Shubhajeet Chatterjee et al., proposed Enhanced Dynamic Source Routing algorithm based on Ant colony Optimization which is called as E-Ant-DSR In this routing algorithm, the path is chosen based on the number of nodes present along the path and congestion between nodes [14]. Here from source to destination the feasible path is chosen with higher pheromone value and less congestion value. The Evaluation of the proposed algorithm is done in Microsoft visual C++ and MATLAB and compared with other ACO algorithms. The final result obtained better results in terms of data delivery ratio, broken route, routing overhead, and energy consumption.

Hajoui Younes et al., proposed a new structure for load balancing based on mobile agent and ant-colony optimization technique [15]. The main focus of this algorithm is constructing a multi-agent system to share out tasks on a cluster of heterogeneous nodes. In this algorithm a dispatcher agent is dedicated to distribute the received task to the worker agent in order to select the right path with minimum execution time. The proposed framework system has 3 main layers: user procedure, Task Distribution –Load Balancing, and workers. These layers can be distributed of Procedure agent-allows user to create a task, and the work agents are assigned the received task by dispatcher agent. Tester agent-evaluate the complication of the task, Controller agent- control and collect the states of the worker agent, Worker agent-execute the assigned task. The pheromone table is updated while each task assigned

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by the dispatcher. So all the distributed nodes allows, the dispatcher to accumulate the information's to prepare scheduling decisions. Hence the proposed algorithm minimizes the overall execution time and maximizes system performance.

Hyun-Ho Choi et al., proposed a new routing protocol encouraged by a pheromone diffusion and rerouting behavior of ants in real life called regional route maintenance algorithm for mobile adhoc networks. The proposed protocol contains two process as follows, local pheromone diffusion – the pheromones (the routing information)are diffused in the region of the shortest path between the source and the destination by overhearing the one hop neighbors and sharing information about overheard pheromone. The other side the regional route maintenance process- has two types of ants wisely, Exploitation ant- is used to utilize the present shortest path by overheard one hop neighbor and Exploration ant- is used to explore all other alternative paths between source and destination based on the diffused local pheromones information's. Further the pheromone information's can also be classified into two types like Indirect pheromone- it provides indirect probability to reach destination by local pheromone information and Direct pheromone- it provides direct regional route to the destination by using exploitation ants pheromone updates. The proposed algorithm consist of series of operation like routing table structure- is consist of basic multipath information for one hop and additionally the relevant routing table updated time, the value of the pheromone and the type of pheromone whether direct or indirect. Local pheromone diffusion and Regional route maintenance–as we discussed earlier. Link failure and rerouting- since the proposed algorithm has maintained all the possible routes, the link failure can be rectified. Here OPNET simulator is used to evaluate the performance of the proposed algorithm and compared with AODV, MDSDV, AntHocNet algorithms. The result states Smaller amount disruption, gradually decreasing end-to-end delay due to availability of alternative paths so maximum data delivery ratio. According to the performance of network scale the performance decreases as the number of node decreases due to increased propagation time delay and collision of control packets.

Mohit P. Tahiliani: The high-speed TCP variants evaluated in multi-hop wireless networks to analyse the network excepted throughput and network throughput, which used for comparison of throughput at the time nodes are mobile. Through simulations we have studied the behavior of high-speed TCP variants in multi-hop wireless networks by varying the routing protocols such as Destination Sequenced Distance Vector (DSDV), Ad hoc On demand Distance Vector (AODV) and Dynamic Source Routing (DSR) routing protocols.

Manish DevendraChawhan: The effects of simplex and duplex networks on various TCP variants. The effect of application of SNOOP and ECN on the performance enhancement of TCP along with TCP variants is assessed, improving the performance of TCP over wireless network by implementing cross layer design protocol (Snoop). ECN is used to avoid congestion and Snoop aims at retransmitting the lost packets from base station, avoiding retransmission from the transmitter. The performance of different TCP variants such as TCP Tahoe, Vegas, Reno, New Reno, Sack are analyzed on Wi-Fi scenario. MATLAB is used for simulation. The analysis result shows progress in throughput of Vegas and E-Vegas with and without snoop with respect to other TCP Variants such as Newreno, Reno, Tahoe, Sack.

Shenoy et al., proposed modified transmission control protocol TCP Reno to improve the performance in mobile ad hoc networks. The main focus of this algorithm is resizing the congestion window by various factors of 60%, 70%, 80% and 90%, such a way that the time path connectivity can be regained due to temporary problems in the wireless medium like path break, signal fading etc. Hence the proposed algorithm shows increased throughput and reduction in jitter and end to end delay.

Broadly clustering methods is used in wireless mobile ad hoc networks for the efficient and accurate routing procedures. Here cluster head, cluster member, cluster gateway are plays different roles. The gate way device acts as a conceptual bridge between clusters. Among all the available cluster heads a cluster head may be elected as gateway. For gateway node election Aayushi Jain et al., proposed a novel approach wireless mobile ad hoc networks. The main focus of this approach is electing the gateway on the basis of high rank of devices which determined use of maximum cluster belongings, maximum remaining battery and devices neighbors. This method is analysed using ns2 simulator and various performance metrics that results in good performance.

Samita Rout et al., presented the work on impact of multiple TCP connections in MANET considering different network size. The performance analysis was done DSR, AODV, DSDV for different network sizes creating multiple TCP connections for different mobile nodes considering random way point (RWP) mobility model. Result shows that AODV protocol achieves higher throughput and packet delivery ratio (PDR) at the cost of more packet loss and routing overhead and DSR achieves lower delay as compared to others.

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3. Simulation Methods

Our simulation was implemented by using ns-2 network simulator [16]. We used wireless LAN standard an IEEE 802.11 [17]. We also used CMUuPriQueue for functioning of DSR. The simulated network consisted of 30 nodes randomly placed on a 1637m x 600m field at the beginning of a simulation. We utilized a mobility prototype based on the random waypoint model. To mimic high node mobility, node speeds were randomly distributed between 0 m/s and 30/ms to two nodes, yielding a mean node speed of 15 m/s. These two nodes are moving with a interference of 550 metres and transmission range of 250metres.In this setup energy also considered as one of the factor like initial energy, transaction energy, receiving energy, ideal energy, sleeping energy.

The steady-state conditions of a network was simulated with various background traffic loads generated FTP connections. The TCP packet size was 1500 bytes, and the maximum size of both the send and receives windows was 8.

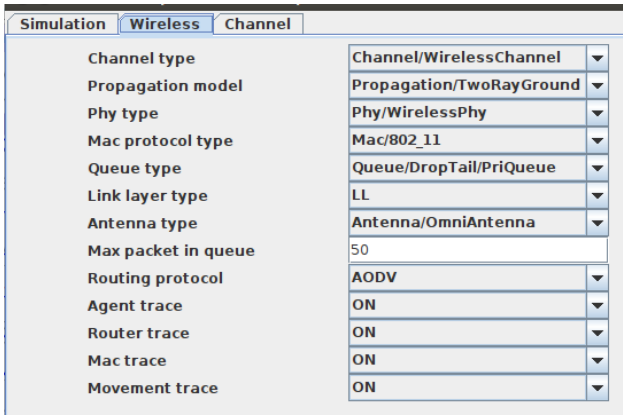

Figure 1. Simulation setup

Figure 1 shows the simulation setup of interaction between TCP-Newreno and reactive protocols AODV and DSR. TCP-Newreno is the most widely used TCP variant with the functions of slow start, Congestion Avoidance and Fast Recovery. The performance of TCP Newreno was evaluated in association with AODV and DSR. The evaluation was experimented with various parameters like instant throughput, Average throughput, packet delivery radio. Our simulation used TwoRayGround Propagation, Mac/802_11 Mac protocol type, Drop Tail Queue for AODV and CMUuPriQueue for DSR, Omni /Antenna and the maximum packets in queue is 50.

4. Performance Metrics and Results Analysis

4.1 Average Throughput

Throughput is the ratio of the total amount of data that reaches a receiver from a sender to the time it takes for the receiver to get the last packet. It is measured in bits/sec or packets per second . A raised throughput network is desirable. It is evaluated as follows:

Throughput= No of received Packet / (Time packet received – Time packet sent)

Table 1. Throughput

TCP Varient	Roting Protocol	Average Throughput (kbps)
TCP Newreno	AODV	0.127463
TCP Newreno	DSR	0.124746

Table 1 shows that AODV has maximum average throughput over DSR.

4.2 Instant Throughput

Instant throughput is valuable information for assessing the network performance. It says about the channel utilization and protocol efficiency. A high instant throughput wireless network is desirable. It is calculated as follows:

Instant Throughput= Received Packet Size / Current Time

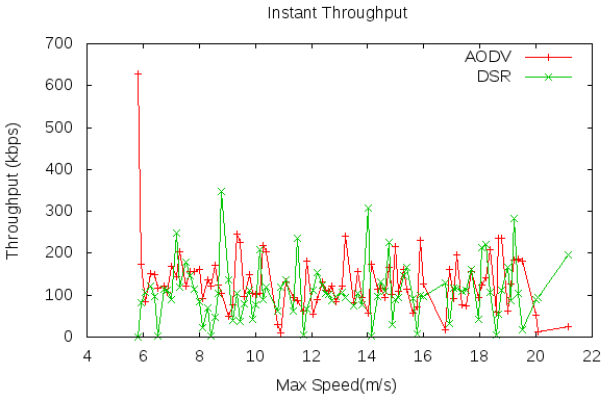

Figure 2. Instant Throughput

Figure 2 shows the performance metrics of two protocols when speed increases the simulation movement changes. Here, can conclude that in AODV protocol the instant throughput is decreased at maximum speed of simulation time, while DSR maintains the constant level.

4.3 Packet Delivery Ratio

The packet delivery ratio is also called as Packet delivery Fraction (PDF). It presents the ratio between the number of packets sent from the application layer and the number of packets actually received at the destination nodes. The metrics used to calculate as

Packet Delivery Ratio = (Received Packets / Packets Sent) *100

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It is desirable that a routing protocol keep this rate at a high level since efficient bandwidth utilization is important in wireless networks where available bandwidth is a limiting factor. This is an important metric because it reveals the loss rate by the transport protocols and also characterizes the completeness and correctness of routing protocols.

Table 2. Statistics of packet delivery ratio

Routing Protocol	Sent Packets	Received Packets	Forwarded Packets	Packet Delivery Ratio
AODV	370	321	1707	0.867568
DSR	316	302	2236	0.955696

Table 2 shows the statistics of packet delivery ratio. We can conclude that in association with TCP Newreno the AODV protocol shows low packet delivery ratio while DSR protocol shows high packet delivery ratio.

4.4 Residual Energy

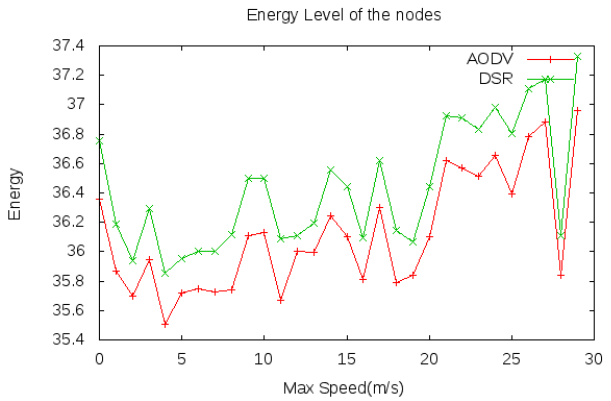

Figure 3. Energy level of the nodes

The energy availability of the nodes is a main limitation of ad hoc systems. The energy efficiency in MANET can be addressed at different layers. The intend of energy-aware routing protocols is to reduce energy consumption in transmission of packets between a source and a destination, to avoid routing of packets through nodes with low residual energy, to optimize flooding of routing information over the network and to avoid interference and medium collisions as told by Parma N and & Sharma (2011).

The residual energy statistics of AODV and DSR showed in the diagram. For our simulation energy level of the node is balanced.

5. Conclusion

IETF MANET working group has standardized AODV and DSR as its reactive routing protocols. In addition, from the perspective of transport layer , TCP protocol play essential role. As TCP has its variant TCP Newreno, we evaluated AODV and DSR in association with TCP Newreno protocols.

In summary, from the various parameters such as average throughput, instant throughput, packet delivery ratio, residual energy the AODV protocol is giving the maximum throughput in association with TCP Newreno.

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