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ENERGY CONSUMPTION OF NODES UNDER VARIABLE NODE DENSITY IN MOBILE AD-HOC NETWORK UNDER DIFFERENT ROUTING PROTOCOLS

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Abstract: In Mobile Ad-hoc Network (MANET) , node density plays a vital role in a particular network. Energy consumption of node is a major issue of Mobile Adhoc Network as it decides the lifetime of the network. In MANET powerful battery with less discharge rate is an essential criterion. There are several mechanisms are investigated to conserve the energy of the battery by which nodes are operated. In this paper , we have investigated the effect of energy consumption by varying node density . In simulation work, we have taken an area of 1500mX1500m arranging nodes in grid pattern with 16, 25 and 36 nodes respectively in different Routing protocols. We have used QUALNET as simulation software in our experiments.

Index terms: Mobile Adhoc Network, Node density, Energy Consumption, Routing Protocols.

I. INTRODUCTION

Energy consumption of nodes is very sensitive factor for mobile adhoc network(MANET). Mobile adhoc network is an infrastructureless network which is used in remote or devastated places in an urgent basis as in battlefield or in an area after severe earth quake or cyclone. There is no facility for infrastructure based mobile communication or internet facility in this area where MANET is implemented. Nodes are totally battery operated and there is no facility to recharge the battery in this place as electric supply is unavailable here. Hence, any node can communicate with other nodes till the battery power exists. Operator can replace the battery by keeping a stock of batteries for replacement. Batteries which are finished can be sent to places in distance where recharging facility is available for reusing if it is economical. Battery with long life time is an essential criteria for such adhoc networking. Researchers are finding different ways to keep the energy of the battery with minimal discharge. There are four mode of operation for each node: Transmit, Receive, Idle and Sleep. Energy consumption is maximum in transmit mode followed by receive mode. In Idle mode, trans-receiver is kept in off condition. In sleep mode, nodes takes minimum energy which is ideally zero from battery power supply.

Energy consumption can be reduced by selecting proper routing protocol. Using proper Radio Energy Model we can save energy[1]. Depending on battery discharge characteristics, battery life time can be increased[2]. There are some other characteristics of communication as over-hearing[3], topology control[4], collision avoidance[5] can save the power. Removing Broadcast storm[6] can also save power. If node density is high, number of neighbouring nodes becomes more. In this case transmit power can be reduced for a node as the distance between nodes are less here. By reducing transmit power, we can save energy of a node. But to reach destination node, number of hops may be increased. Intermediate nodes behave as relay nodes. If number of relay nodes are increased, overall energy consumption to deliver a packet of data may be increased. Routing protocol depending on node density is also proposed by researchers[7]. A group of node produces a cluster . In a cluster, one node behaves as a cluster-head which remains in active state whereas other nodes remain in sleep state. Role of cluster-head can be changed rotationally and periodically in a group. In section II, routing protocols are briefly discussed. Review of literature is discussed in section III. Simulation results are presented in section IV. Conclusion and future work are mentioned in section V.

Routing Protocols

The purpose of routing is to find out a suitable path by which data from sending node can reach the destination node. To communicate between any two nodes, path discovery is the initial work to be done in adhoc network. If destination node is a neighbouring node of

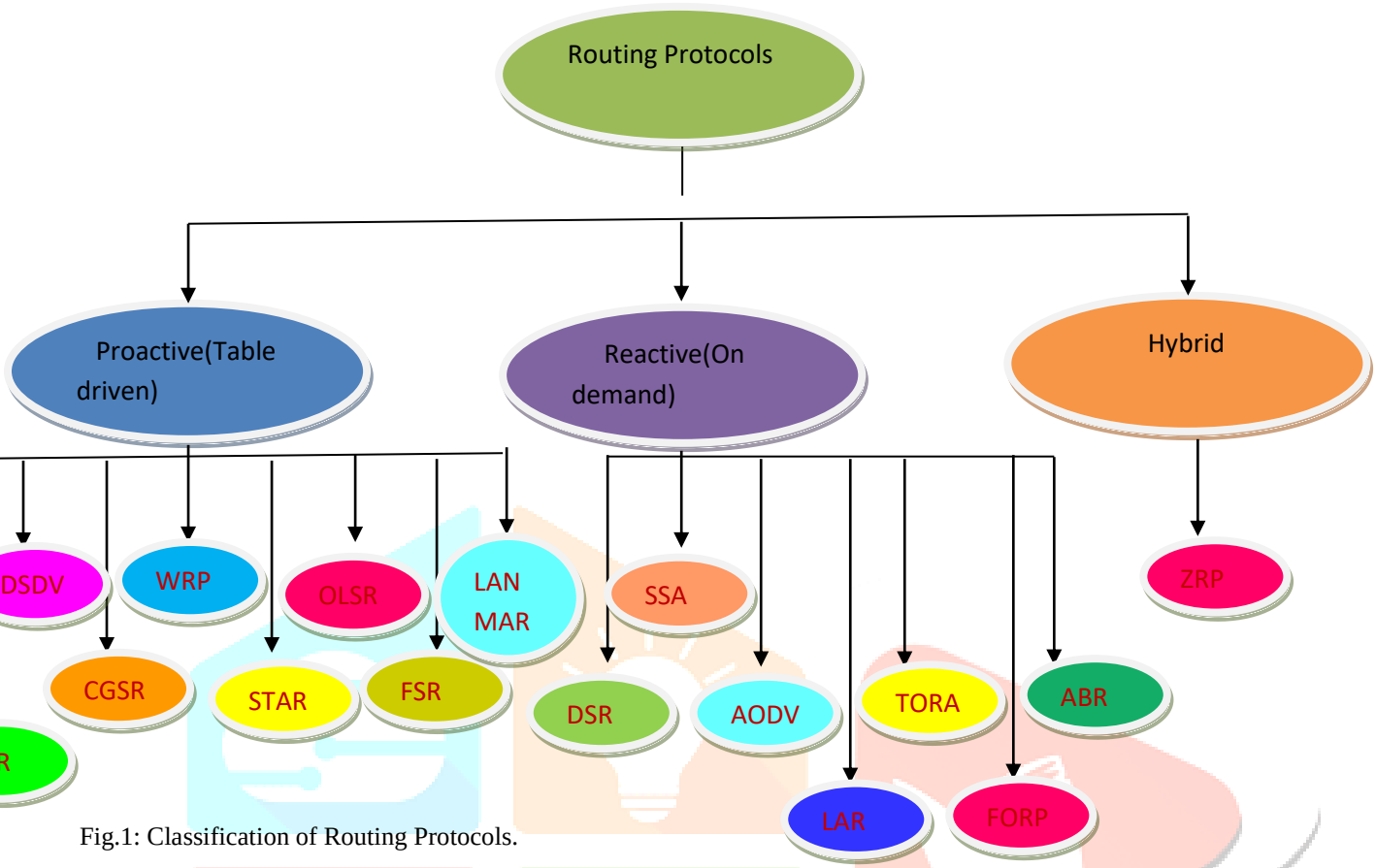

Fig.1: Classification of Routing Protocols.

sending node, data can be sent in single hop. As there is no certainty that destination node is in the neighbourhood of sending node, hence generally communication in adhoc network is made in multi-hop communication where other nodes behave as relay nodes.

The transmission power of nodes in adhoc network is very less to save the energy of the node as nodes are battery operated and lifetime of network depends on battery lifetime. From time to time, researchers have proposed different routing protocols for adhoc networks. Broadly, routing protocols are divided into three categories: Proactive(Table driven), Reactive(On demand) and Hybrid. Under each category, a number of protocols have been made as shown in fig.1 above.

In Proactive routing protocol, nodes keep the information about the paths to reach other nodes. Whether any communication is made or not, nodes regularly search other nodes to correct the path if any changes occur in the network as nodes are mobile in nature. These path information to reach other nodes are kept in a table. In this table, each node keeps shortest path to reach the destination node and the most recent information are kept. Hence , if any node wants to communicate with other node, it can communicate easily as the path to be followed to reach destination node is already available in the routing table kept in the cache of each node. No routing delay is occurred in proactive routing. As routing table plays a major role in this protocol , it is also known as Table driven protocol. As shown in fig.1, examples of this protocols are DSDV(Destination Sequenced Distance Vector), OLSR(Optimized Link State Routing),HSR(Hierarchical State Routing) ,WRP(Wireless Routing Protocol),LANMAR(Land Mark Routing),FSR (Fisheye State Routing), CGSR (Cluster head Gateway Switch Routing), GSR(Global State Routing) and STAR(Source Tree Adaptive Routing).

In Reactive routing protocol, no regular updating of node information is required. Nodes remain indifferent about the path and position of other nodes till there is a demand of communication between nodes. For this reason, this protocol is also known as On-demand routing protocol. There are two primary mechanisms are made in this protocol: Route Discovery and Route Maintenance. In Route Discovery, source node broadcasts a Route Request(RREQ) towards its neighbouring node in search of the destination node if no path information about previous communication is available in cache of source node. Neighbouring nodes repeats the same mechanism as source node and this process goes on till the destination node is searched out. Route Request contains Source IP address, Request identity number and Destination IP address so that same request should not be entertained by a node twice. Hence , receiving any Route Request(RREQ) each nodes checks whether this Route Request is already received by this node to avoid broadcast storm. After receiving Route Request in different paths i.e. through different relay nodes, the shortest path is selected by the destination node and Route Reply(RREP) is sent to the source node by reverse

path. Now data communication is started between source node and destination node. During communication of data packets, if any communicating relay node or destination node does not receive data for a certain interval, the node sends Route Error (RERR) message to its neighbouring nodes to inform the source node about Route Maintenance. Route Maintenance can be done by local repair otherwise communication will be started again from initial condition of Route Request. Examples of Reactive Protocols as shown in fig.1 are DSR(Dynamic Source Routing), AODV(Adhoc On-demand Distance Vector), SSA(Signal Stability based Adaptive Routing Protocol), ABR (Associativity Based Routing), TORA(Temporally Ordered Routing Algorithm), FORP(Flow Oriented Routing Protocol) and LAR(Location Aided Routing).

In Proactive routing , there is no routing delay but a lot of energy is lost for routing update . In Reactive routing, delay is more as source node has no information about location of destination node and searching out of routing path by Route Request and Route Reply mechanism takes some time before communication is started between two nodes. In Hybrid protocol, network area is divided in some zones. For Intra zone communication, Proactive protocol is used and Reactive Protocol is used for inter zone communication. ZRP(Zone Routing Protocol) is an example of Hybrid routing. For small area networking, Proactive routing is preferred, for medium area networking Reactive routing is used and large area networking Hybrid routing is used.

II. Review of Literature

In the year of 2017 ,**Venkatachalapathy & Sundaranarayana**[8] have made a survey on different issues which have effect in energy efficiency of nodes in mobile adhoc network. In this paper they have pointed out issues like malicious nodes which can be solved by Intrusion Detection System(IDS) as tool to remove security problem. Secondly if energy of node is less, it can overhear the route request and only respond as a destination node. Problems in network ,due to overhearing of nodes can be solved by PAMAS(Power Aware Multi-Access protocol with Signalling[9].Collision of data from different nodes in a dense network can produce packet drop and network failure. For Collision free networking, EC-MAC (Energy conserving medium access control) and CSMA/CA[10] may be solution. In this paper several methods as load distribution approach using LEAR(Localized energy aware routing)[11] or CMMBCR(Conditional max-min battery capacity routing)[12]. Topology Control [13], HEED(Hybrid, Energy-efficient, Distributed) Clustering approach[14] and Synchronous Scheme [15] of active and sleep state of nodes can be solution for Energy Efficient Ad-hoc Network.

In the year of 2004,**Anders Nilsson** in the paper[16] investigated about two resources used in adhoc network which are battery life and channel capacity under variation of transmission power, variation of node density , traffic load and mobility. It is shown that higher packet delivery ratio can be achieved with higher energy cost due to more collision in radio layer in a denser network if traffic load is under saturation level.

In the year of 2010 , **Essam Natsheh and Khalid Buragga** have studied [17] the operation of MANET in an environment with varying network node densities, called heterogeneous density environment. Redundant broadcasts which produces broad cast storm[18] is also considered in this paper. The problems identified in this study are low packet delivery ratio, low throughput, high end to end delay and broadcast storm due to unmanaged routing overhead in highly dense network[19]. To solve the problems density based routing protocol is proposed.

III. Simulation Results

In this paper, we have done experiment using Qualnet software. Number of nodes are 16,25 and 36 arranged in grid pattern connected with wireless network in CBR mode. Number of traffic loads is kept at 10. There are two proactive routing protocols(DSDV,STAR), two reactive protocols(AODV,DSR) and one hybrid protocol(ZRP) are used for simulation. Simulation characteristics are given below. Scenario of 16nodes,25 nodes and 36 nodes are shown in fig.2,fig.4 and fig.6 respectively. Snapshots of simulation for 16 nodes,25 nodes and 36 nodes are shown in fig.3,fig.5 and fig.7 respectively. Measurement of Transmit energy, Receive energy , Idle energy and Total energy are shown in fig.8, fig.9,fig.10 and fig.11 below. Simulation time is 30 seconds.

Table1: Simulation Characteristics

Serial No.	Parameters	Values
1	Simulator	QualNet Version 5.0.2
2	Terrain Size	1500 x 1500 sq. Meter
3	Antenna model	Omnidirectional
4	No of nodes	16,25,36
5	Radio Type	802.11b
6	Propagation Model	Two Ray Ground
7	Channel Frequency	2.4 GHz
8	Traffic Source	CBR
9	Pattern of arrangement	Grid
10	Antenna Height(meters)	1.5
11	Data size	512 bytes
12	Data Rate	2Mbps
13	Antenna Gain(dB)	0.0
14	Performance Metrics in Physical Layer	Energy consumed in Transmit mode, Energy consumed in Received mode, Energy Consumed in Idle mode
15	Battery Model	Generic
16	Mobility Model	Random Way Point
17	Routing Protocols	Proactive: DSDV,STAR Reactive: AODV,DSR Hybrid : ZRP
18	Transmit circuitry power consumption(mW)	100.0
19	Receive circuitry power consumption(mW)	130.0
20	Idle circuitry power consumption(mW)	120.0
21	Sleep circuitry power consumption(mW)	0.0
22	Supply voltage(volt)	6.5

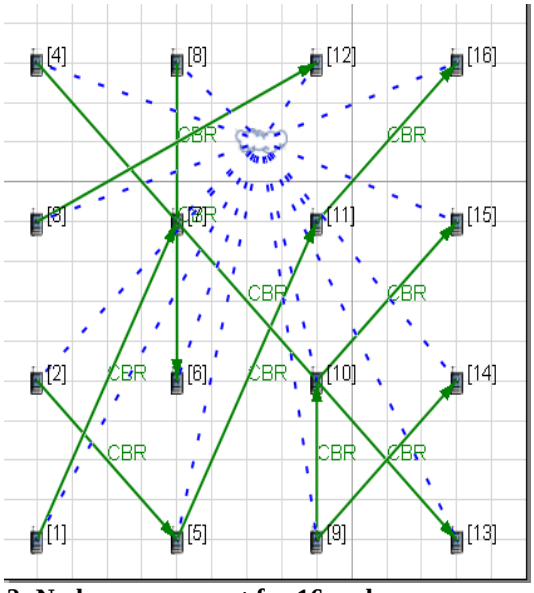

Fig.2: Node arrangement for 16 nodes.

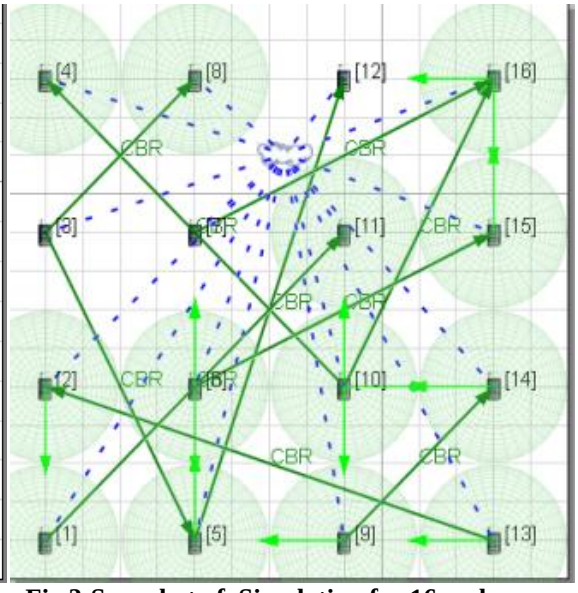

Fig.3:Snapshot of Simulation for 16 nodes

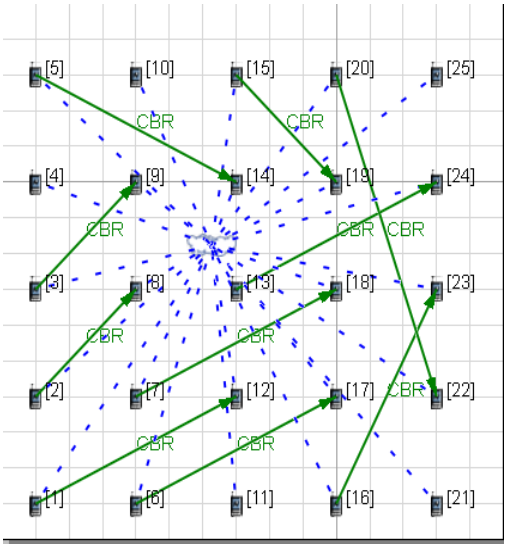

Fig.4: Node arrangement for 25 nodes

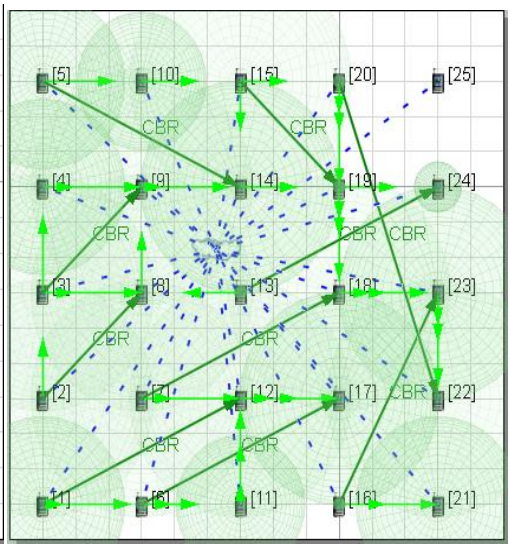

Fig.5: Snapshot of simulation for 25 nodes

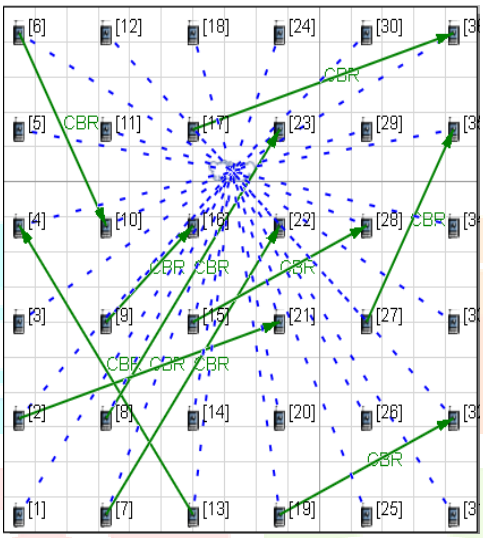

Fig.6: Node arrangement for 36 nodes.

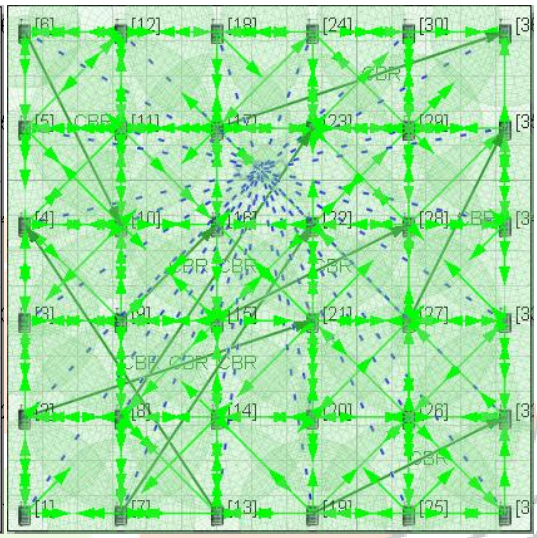

Fig.7: Snapshot of simulation for 36nodes.

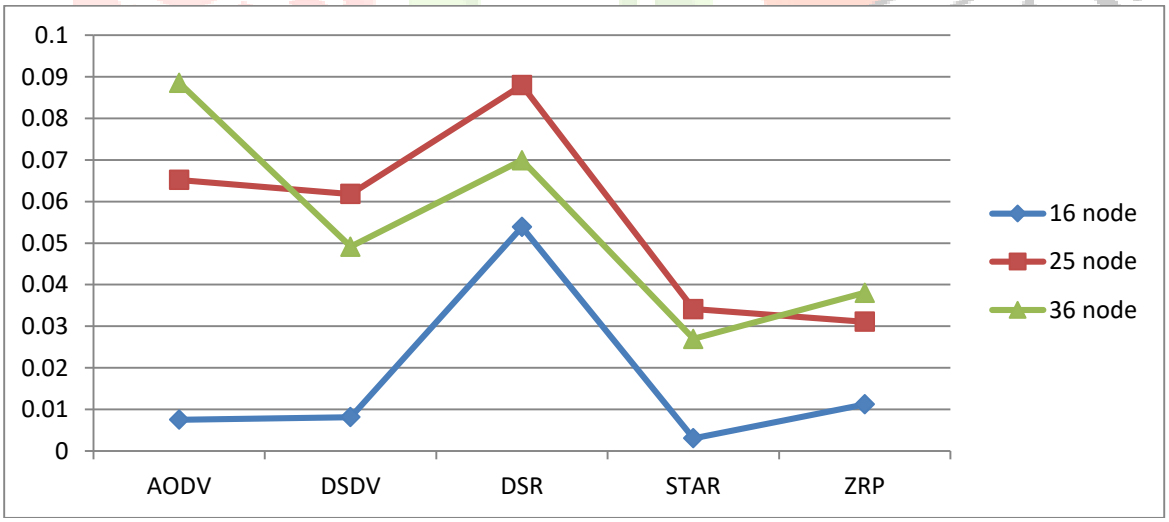

Fig.8:Graph of TX Energy in mJoule for variable node density in different routing protocol.

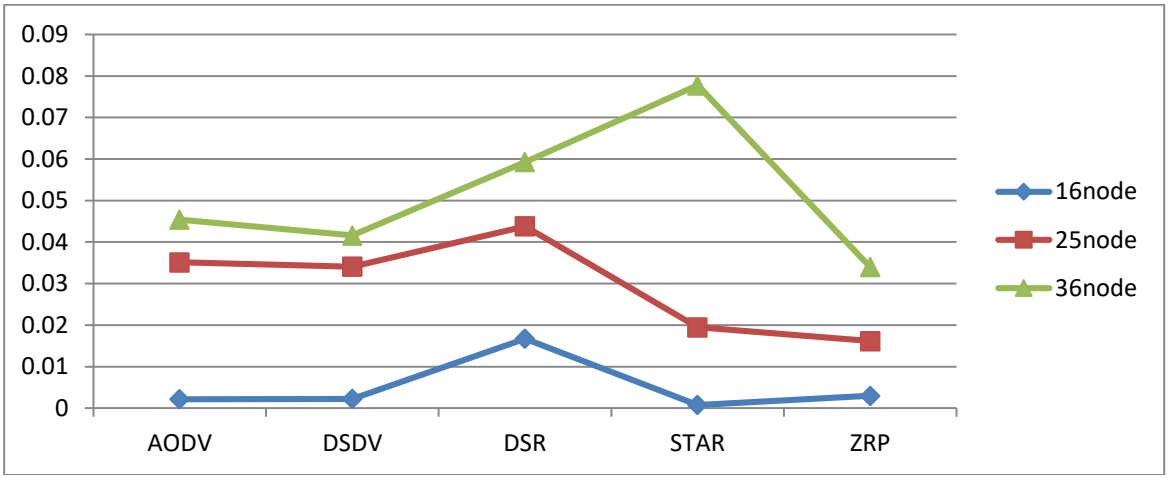

Fig.9:Graph of RX Energy in mJoule for variable node density in different routing protocol.

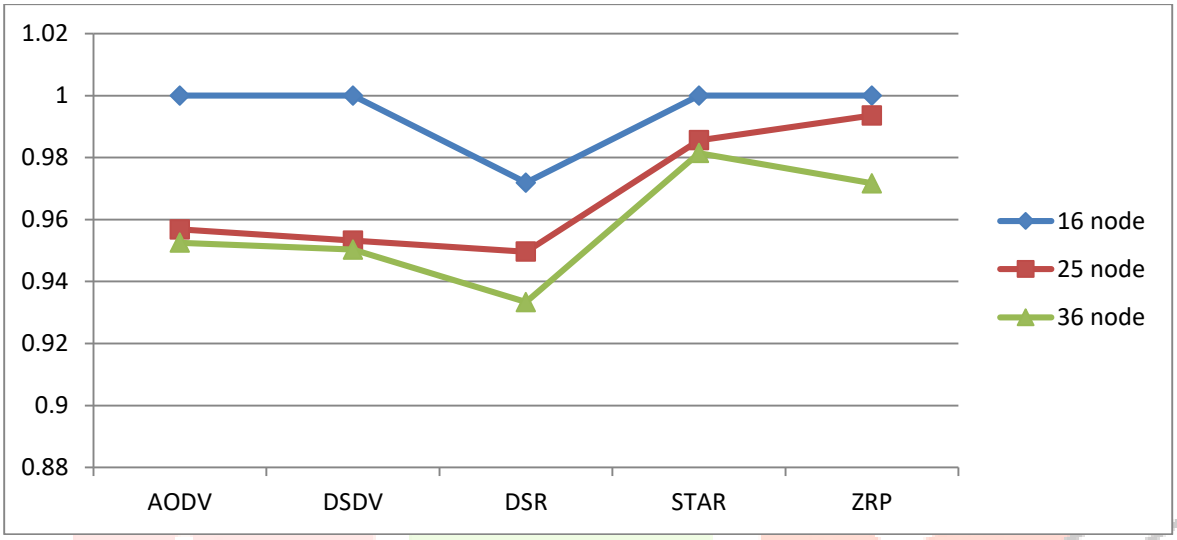

Fig.10:Graph of Idle Energy in mJoule for variable node density in different routing protocol.

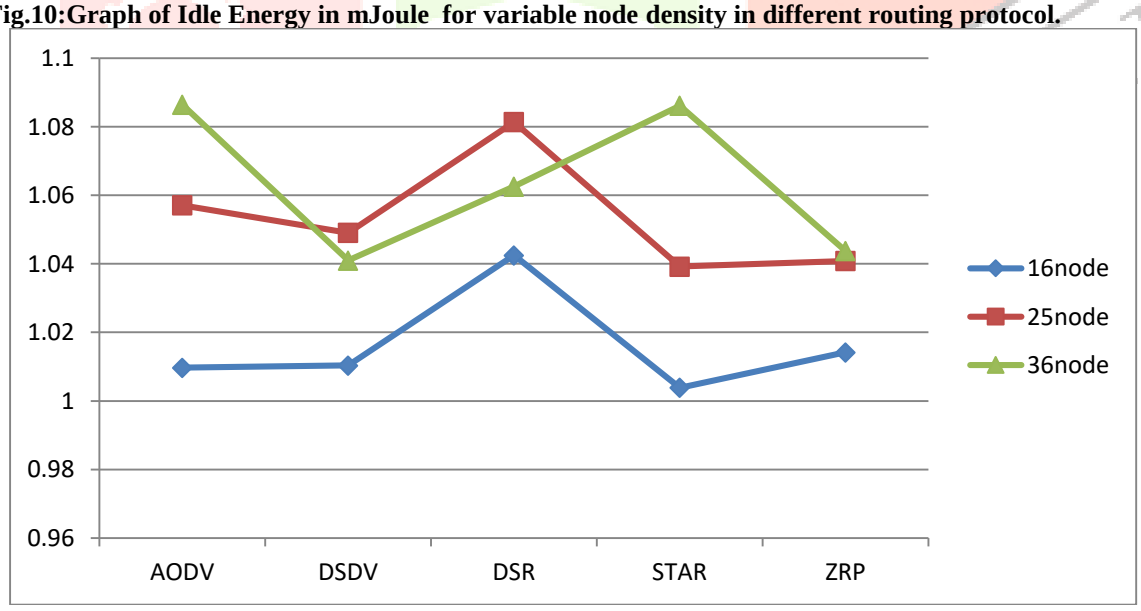

Fig.11:Graph of total Energy in mJoule for variable node density in different routing protocol.

IV. Conclusion & Future work

Analyzing above graphs, one point is clear much of the energy is consumed in idle mode as nodes are maximum time in idle mode though power for idle mode circuitry is less than power consumption of transmit and receive circuitry. Total energy consumption increases with node density for AODV and STAR but after a certain node density total power consumption either decreases or remain unchanged in DSDV,DSR and ZRP. Idle energy decreases with increase of node density for all routing protocols. Received Energy consumption increases with node density. Transmit energy consumption increases with node density only for AODV and ZRP but decreases for DSDV,DSR and STAR after a certain value. Only AODV has shown better results than other protocols. To save power in idle mode we can increase lifetime of the nodes by proposing new routing protocol.

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