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Energy Models with Different Routing Protocols in BMS Using Qualnet Simulator

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Abstract— Energy efficiency is vital challenge in Sensor networks. Such networks are comprised of sensor nodes which operate with batteries. The main constraint in regard to battery powered devices is sensors will be deployed unattended and in large numbers, so that it will be difficult to change or recharge batteries in the sensors. Therefore, all systems, processes and communication protocols for sensors and sensor networks must consume energy as less as possible. The energy consumption rate for sensors in a wireless sensor network depends on the routing protocols used for communications and the energy motes used for the same. In this context, this paper presents an approach for evaluating the best energy motes for energy consumption in Battlefield Monitoring System using simulation in Qualnet along with three modes i.e. transmit mode, receive mode and idle mode.Also it evaluates the best routing protocol among AODV,DYMO,OLSR,Bellman Ford[1] and RIP[2] which performs best in that energy motes.

Keywords— Battlefield monitoring, energy consumption modes, comparison of modes,protocols,energy motes.

I. INTRODUCTION

In Battlefield Monitoring System[3], Ground sensors and moving vehicles communicate with each other and the moving vehicles pass the message to fusion center. The ground sensors and moving vehicles are battery powered devices.This monitoring System is simulated on QualNet .Three energy motes are compared .These motes are Generic, MicaZ and Micamotes.All the three behave differently in transmit ,receive and idle mode.Five routing Protocols against these motes are compared.They are AODV,BELLMAN-FORD,DYMO,OLSR,RIP.

II. OPERATIONAL MODES

During the communication,[4]the motes are in one of three modes :transmit,receive or Idle.A description of each mode is given below.

A. *Transmit Mode*
B. *Receive Mode*
C. *Idle Mode*

III. ENERGY MOTES

Motes are building blocks of sensor networks.There are basically three energy[5] motes: GENERIC,MICAZ and MICAMOTES[6].

A. GENERIC

The generic model is estimation of energy consumption for the radios with common modulation schemes (analogue and digital) and common classes of amplifiers (class-A, B, C, D). Furthermore, the model can estimate energy consumption in transmitter for the case of continuous transmits power level. The parameters which are optionally required for generic model to be able to more accurately estimate the power or the amount of current loaded on battery are :

- Transmit power consumption
- Receive power consumption
- Idle power consumption
- Sleep power consumption

B. MICAZ

The MICAZ is a 2.4 GHz Mote module used for facilitating low-power, wireless sensor networks.
Its features are:

- IEEE 802.15.4, Tiny Wireless Measurement System
- Designed particularly for Deeply Embedded Sensor Networks
- 250 kbps, High Data Rate Radio
- Wireless Communications with Every Node as Router Capability

- Expansion Connector for Light, Temperature, RH, Barometric Pressure, Acceleration/Seismic, Acoustic, Magnetic and other MEMSIC Sensor Boards
- Applications are:Indoor Building Monitoring system and Security,Acoustic, Video, Vibration and Other High Speed Sensor Data, Large Scale Sensor Networks (1000+ Points)

C. MICAMOTES

The Mica Motes is a radio-specific energy model which is pre-configured with the specification of power consumption. A MICA mote is a commercially available product that has been used extensively by researchers and developers. MICA motes are accessible to the general public through a company called Crossbow.
Its features are :

- an Atmel at mega 128L processor running at 4 megahertz
- CPU is about as powerful as the 8088 CPU found in the original IBM PC
- 8 milliamps consumption while it is running and 15 micro amps in sleep mode.
- 512 kilobytes of flash memory to hold data.
- 10-bit A/D converter so that sensor data can be digitized.
- Radio has a range of several hundred feet and can transmit approximately 40,000 bits per second.

IV. ROUTING PROTOCOLS

The following protocols are compared:

A. AODV

The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile networks. AODV is capable of equally unicast and multicast routing. It is in category of On demand algorithm, meaning that it builds routes between nodes only as desired by source nodes. It keeps these routes as long as they are needed by the sources. Furthermore, AODV forms trees which connect multicast group members. The trees consists of the group members and the nodes needed to bond the members. AODV uses sequence numbers to ensure the originality of routes. It is self-starting,loop-free and scales to large numbers of mobile nodes.

AODV builds routes using a route request / route reply query cycle. When a source node requests a route to a destination for which it does not already have a route, it broadcasts a route request (RREQ) packet across the network. Nodes getting this packet update their information for the source node and set up backwards pointers to the source node in the route tables. A node which is receiving the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that enclosed in the RREQ. If this is the case, it unicasts a RREP back to the source. As the RREP transmits back to the source, nodes place forward pointers to the destination. Once the source node receives the RREP, it may commence to forward data packets to the destination.

B. Bellman Ford

The Bellman-Ford algorithm uses relaxation to find single source shortest paths on directed graphs. And it is also contain negative edges. The algorithm will also detect if there are any negative weight cycles (such that there is no solution). If talking about distances on a map, there is no any negative distance. The basic structure of bellman-ford algorithm is similar to dijkstra algorithm. It relaxes all the edges, and does this |V| - 1 time, where |V| is the number of vertices . The cost of a path is the sum of edge weights in the path.This algorithm finds shortest path .

C. DYMO

Reactive and multihop routing can be achieved between the participating nodes that wish to communicate with help of a protocol called Dynamic MANET On-demand (DYMO) routing. This protocol has two basic operations - route discovery and route management [7]. The core of the route maintenance and route maintenance is based on IETF Internet-Draft DYMO specification.

Route Discovery - In this operation, the originating node initiates flooding of Route Requests (RREQ) throughout the network to find the target node, where each intermediate node records the route to the originating node.

Route Maintenance - In order to respond to the changes in network topology, nodes preserve their routes and monitor the links over which the network traffic flows. When a received packet is to be forwarded to some other node where the route is unknown or broken, the source of the packet is notified by sending Route Error (RERR) that indicates the current route is broken.

D. OLSR

OLSR is a proactive routing protocol for mobile ad-hoc networks (MANETs). It is well suited to large and dense mobile networks, as the optimization is attained using the MPRs works well in this context. The bigger and more dense a network, the more optimization can be attained as compared to the classic link state algorithm. OLSR uses hop-by-hop routing, in which each node uses its local information to route packets.OLSR is well suited for networks, where the traffic is random and irregular between a larger set of nodes rather than being almost exclusively between a small specific set of nodes.

E. RIP

Routing Information Protocol is a standardized vector distance routing protocol and uses a form of distance as hop count metric. It is a distance vector. Through limiting the number of hop counts allowed in paths between sources and destinations, RIP averts routing loops. Typically, the maximum number of hops allowed for RIP is 15. However, by achieving this routing loop prevention, the size of supporting networks is sacrificed. Since the maximum number of hop counts allowed for RIP is 15, as long as the number goes beyond 15, the route will be declared as unreachable.
When first developed, RIP only transmitted full updates every 30 seconds. In the early distributions, traffic was not important because the routing tables were small enough. As networks become larger, massive traffic burst becomes more likely during the 30 seconds period, even if the routers had been initialized at different times. Due to this random initialization, it is commonly understood that the routing updates would spread out in time, but that is not the case in actual practice.

V. SIMULATION SCENARIO

Simulation is performed on QualNet simulator.Features of QualNet are :

- Commercial Derivative of GloMoSim
- Java Based Graphical Interface
- C based implementation for protocols
- Event Based Simulator
- Modular Design

It supports for various networks like MANET,QoS,Wired Networks,Cellular Networks.Advantages of QualNet are:

- Rapid Prototyping
- relative performance of alternative protocols at each layer
- Built-in Measurements at each Layer
- Modular
- Scalable
- A Graphical tool to allow fast system and protocol prototyping/modeling

The basic simulation scenario for our research is as follow:

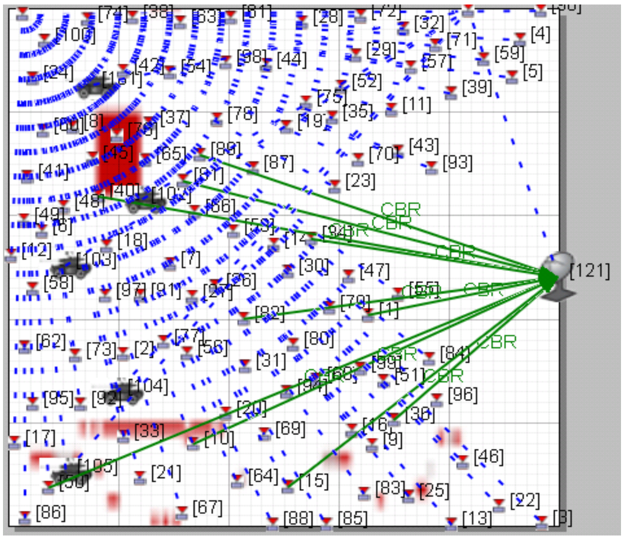

Fig. 1 Battlefield Scenario

Tools provided by QualNet are Animator(Graphical Experiment Setup and Animation),Designer(Finite State Machine (FSM) based custom protocol designer),Analyzer (Statistical graphical analysis tool for custom statistics),Tracer (Packet Level Tracing and Visualization).Satellite NetworksThe protocols which are compared, they are AODV,BELLMAN FORD,DYMO,OLSR & RIP.

Table 1. Simulation Scenario

Scenario	Battlefield Monitoring
Simulation network space	500m X 500m
No. of Nodes	20,40,60,80,100
Node placement	Randomly Deployment
MAC protocol	IEEE 802.15.4

User mobility	Random way point
User speed	10 m/s
Simulation time	1200 s
Energy models	Generic,Micaz ,Micamotes
Performance metrics	Energy consumption in transmit mode,receive mode ,idle mode.
Routing protocol	AODV,BELLMAN FORD,DYMO,OLSR,RIP

VI. RESULTS

The various results for MicaZ ,Generic and Micamotes are given below.

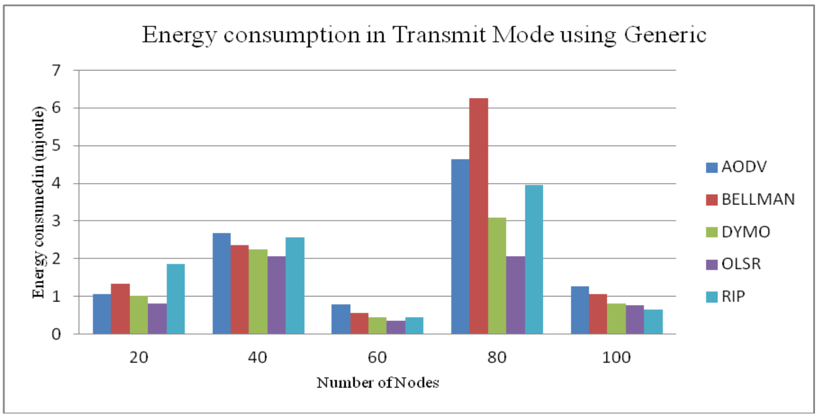

Fig 2. Energy Consumed in Transmit mode using Generic

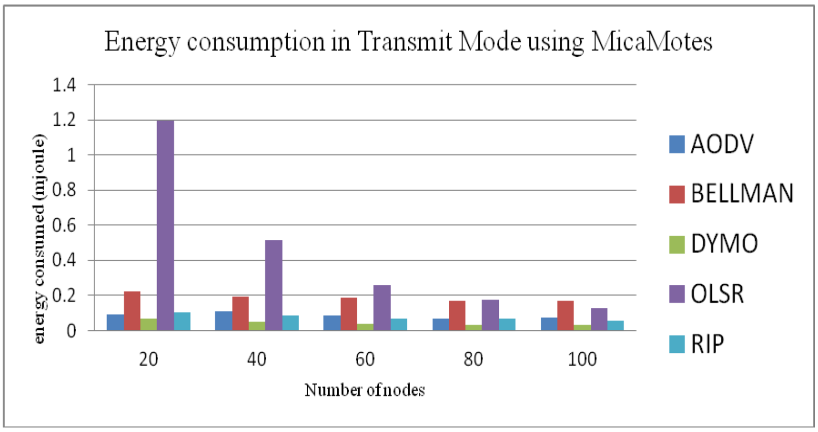

Fig. 3. Energy Consumed in Transmit mode using MicaMotes

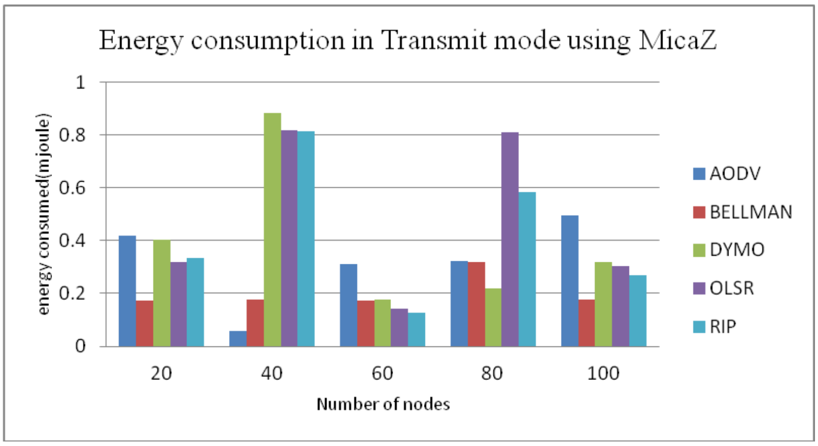

Fig 4. Energy Consumed in Transmit mode using MicaZ

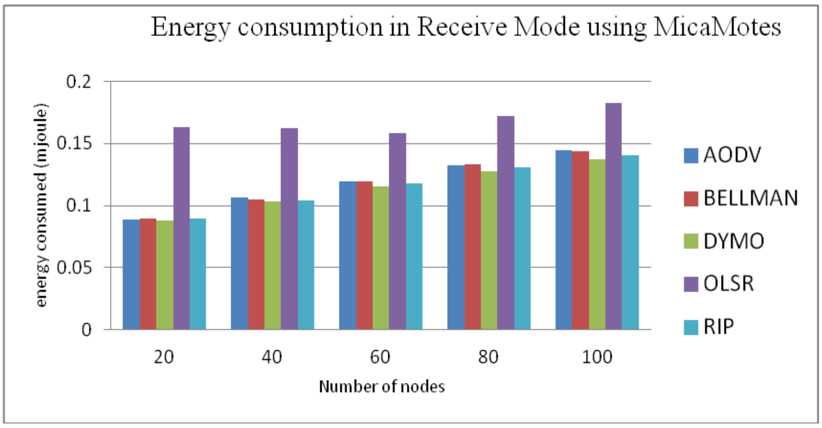

Fig 5. Energy Consumed in Receive mode using MicaMotes

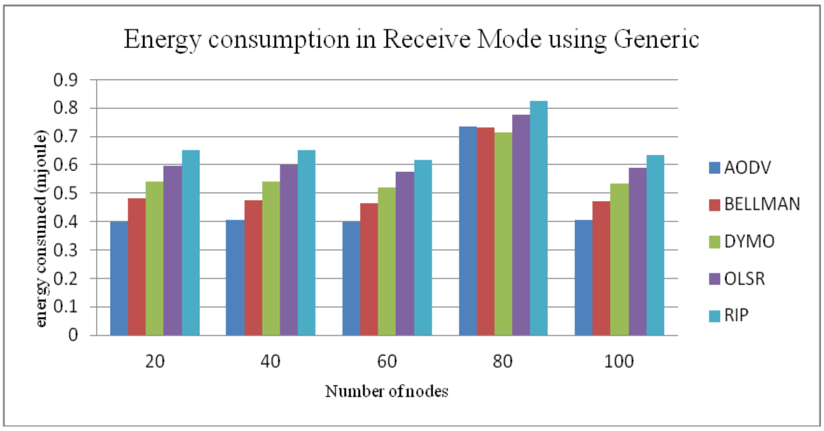

Fig 6. Energy Consumed in Receive mode using Generic

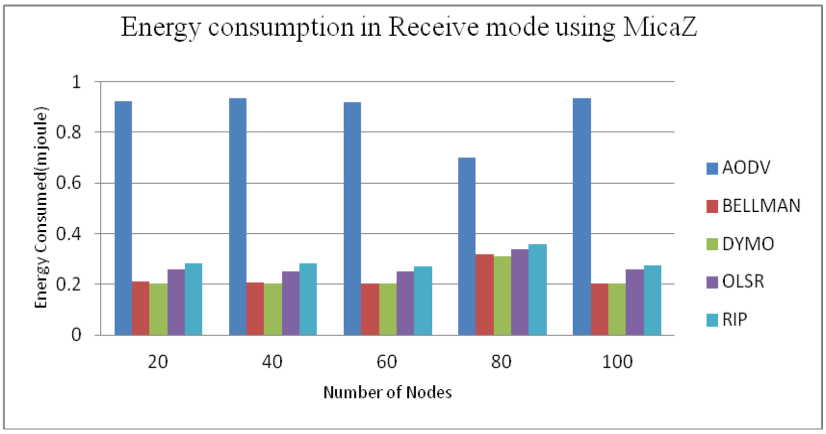

Fig 7. Energy Consumed in Receive mode using MicaZ

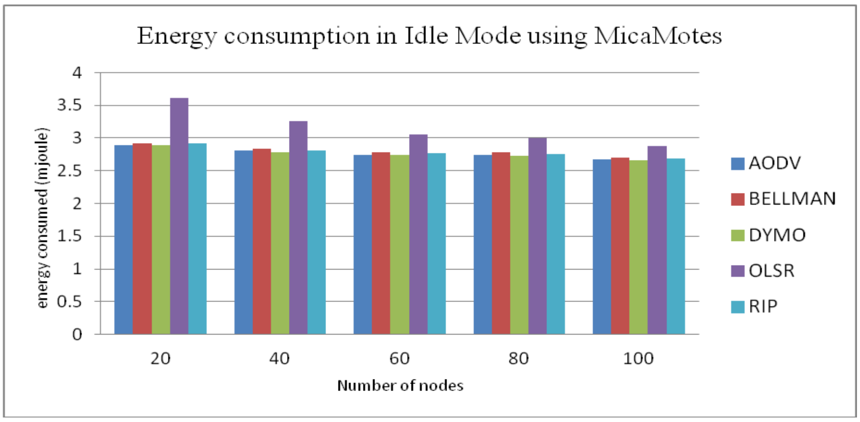

Fig 8. Energy Consumed in Idle mode using MicaMotes

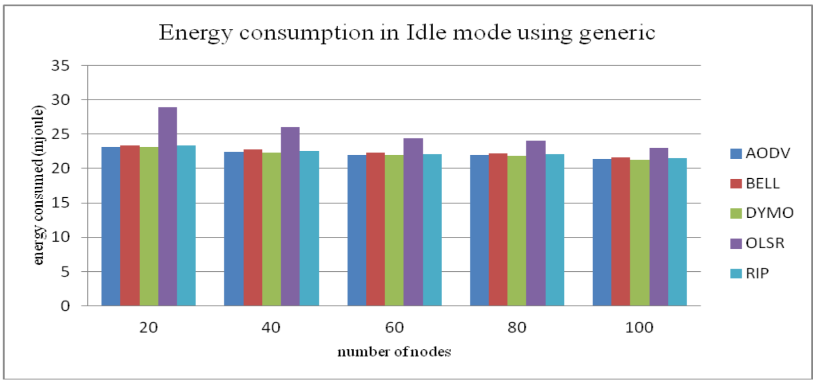

Fig 9. Energy Consumed in Idle mode using Generic

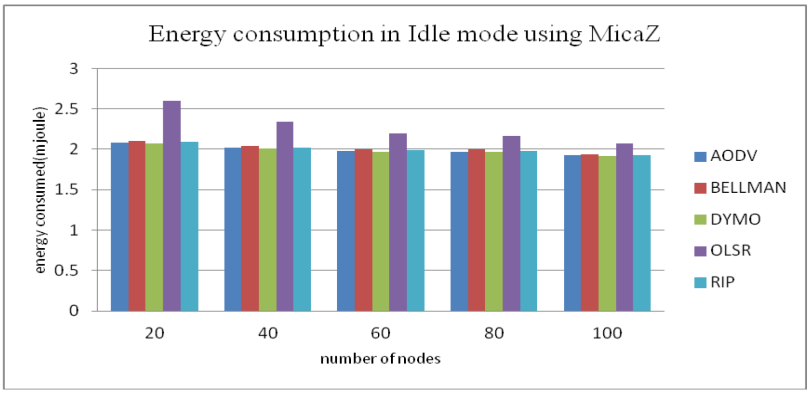

Fig 10. Energy Consumed in Idle mode using MicaZ

While studying about the Battlefield Monitoring system and its requirements for long range communication, there is need to find the best energy model which consumes least energy and best protocol.MicaMotes is consuming least energy as compared to generic and Micaz.

In transmit mode, energy consumed is least in case of Micamotes as compared to generic and micaZ.it is analysed that from all the protocols ,DYMO and AODV[7] is consuming less energy when using Micamotes.Micamotes is consuming less energy in case of receive mode too. AODV,DYMO[8][9] and bellman Ford giving almost same results .As for as Idle mode is concerned, generic is consuming too much energy.there is slight difference in consumption rates of micaz and mica motes.

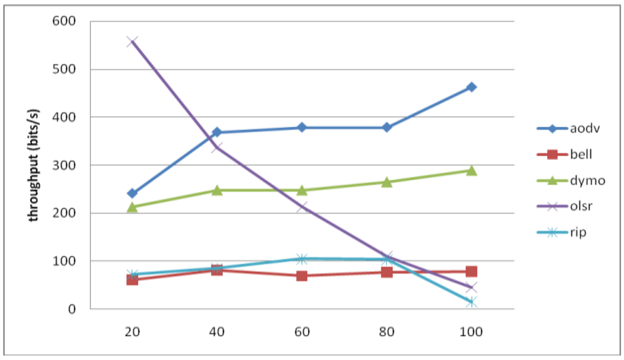

Fig. 11 Throughput versus number of nodes

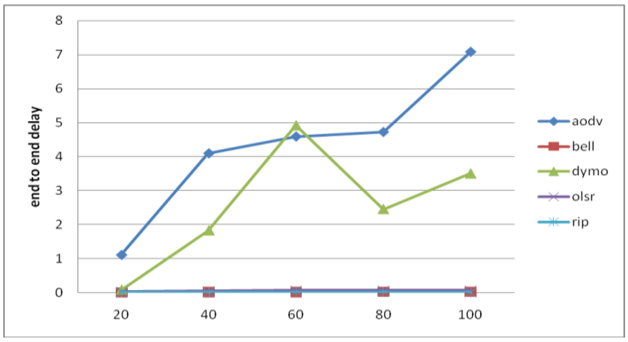

Fig. 12 End to End Delay versus number of nodes

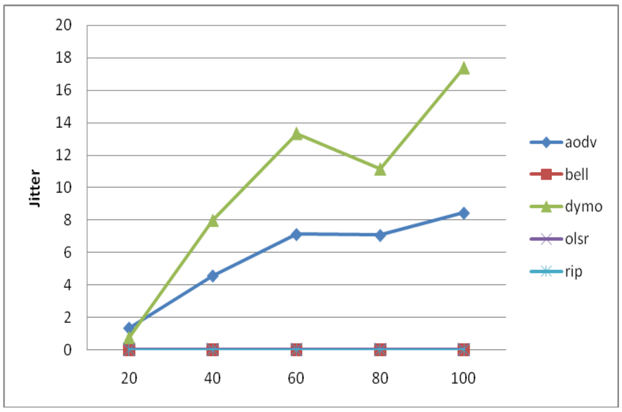

Fig. 13 Jitter versus number of nodes

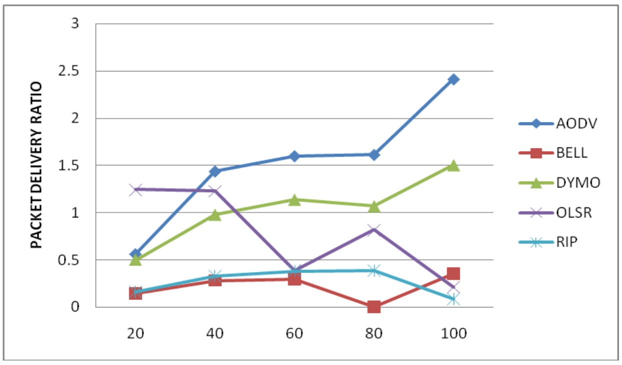

Fig. 14 Packet delivery ratio versus number of nodes

By comparing all the protocols following results, it has been observed that the Throughput increases as the number of nodes increases in battlefield monitoring system.The results for OlSR is declining as the number of nodes decreases. Bellman ford and RIP has almost same throughput.

As the number of nodes increases, end to end delay and jitter increases in case of AODV. In the battlefield Scenario, these two factors should be significantly low. While in case of Packet Delivery Ratio, AODV and DYMO are giving very good results.packet delivery is decreasing as the number of nodes are increasing in case of OLSR.

VII. CONCLUSION

It can be concluded from the results that AODV and DYMO performs well for BattleField Monitoring system.As other protocols are also giving good results in various parameters but these two are best for implementing Battlefield Monitoring System.

ENERGY MOTE	MODE	PROTOCOL
MICAMOTES	TRANSMIT	DYMO
MICAMOTES	RECEIVE	DYMO
MICAMOTES	IDLE	DYMO
GENERIC	TRANSMIT	OLSR
GENERIC	RECEIVE	AODV
GENERIC	IDLE	DYMO
MICAZ	TRANSMIT	DYMO
MICAZ	RECEIVE	DYMO
MICAZ	IDLE	DYMO

Table 2. comparison between various protocols using three energy motes.

VIII. FUTURE WORK

Sensor Networks hold a lot of promise in applications where gathering sensing information in remote locations is essential. It is an evolving field, which offers scope for a lot of research. Hence,designing efficient routing protocols for sensor networks that suits sensor networks serving various applications is important.Along with that several possible attacks on battlefield monitoring system can be studied and the cloud computing can be integrated into the whole system. In future work we will explore the possible attacks & will propose the security model for protection against attacks.

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