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Survey on Dynamic Source Routing / Ad Hoc on Demand Distance Vector Protocol's Energy Efficiency in Wireless Network

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Abstract: Wireless networks have recently received tremendous attention from both academia and industry because of their promise of numerous potential applications in both civilian and military areas. A wireless network consists of a large number of small sensor nodes with sensing, data processing, and communication capabilities, which are deployed in a region of interest and collaborate to accomplish a common task, a sensor network has many unique characteristics, such as denser node deployment, higher unreliability of sensor nodes, asymmetric data transmission, and severe power, computation, and memory constraints, which present many new challenges for the development and eventual application of wireless sensor networks. In particular, sensor nodes are usually battery-powered and should operate without attendance for a relatively long period of time. In most cases, it is very difficult and even impossible to change or recharge batteries for these sensor nodes. Thus, energy-saving routing protocol in wireless networks is necessary for increasing the network lifetime. In this paper we present a comparative study of different routing algorithms and analysis of same is presented in the paper

Keywords: MANET, Routing protocols, AODV, DSR, OLSR, Proactive, Reactive

Introduction

Recent advances in wireless communications and electronics have enabled the development of low cost, low-power, multifunctional sensor nodes that are small in size and communicate untethered in short distances. These tiny sensor nodes, which consist of sensing, data processing, and communicating components, leverage the idea of sensor networks. Sensor networks represent a significant improvement over traditional sensors. A sensor network is composed of a large number of sensor nodes that are densely deployed either inside the phenomenon or very close to it. The position of sensor nodes need not be engineered or predetermined. This allows random deployment in inaccessible terrains or disaster relief operations. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities. Another unique feature of sensor networks is the cooperative effort of sensor nodes. Sensor nodes are fitted with an onboard Processor. Instead of sending the raw data to the nodes Responsible for the fusion, they use their processing abilities to locally carry out simple computations and transmit only the required and partially processed data.

Materials

The following are the various materials to increase the energy efficiency.

Routing

It is the process of establishing path and forwarding packets from source node to destination node. It consists of two steps, route selection for various source-sink pairs and delivery of data packets

to the correct destination. Various protocols and data structures (routing tables) are used to meet these two steps. This survey paper is focused on finding and selecting energy efficient routes. We are going to discuss the four approaches in the routing. These are proactive, reactive, hybrid and location based routing.

Classification

Routing protocols can be classified according to various approaches which are as follows:

A. Proactive Routing

Proactive protocols continuously evaluates the routes within the network so that when we are required to forward the packet route is already known and immediately ready for use. There is no time delay (time spend in route discovery process) takes place. Examples of the proactive protocols are – DSDV (Destination-Sequenced Distance-Vector), Wireless Routing Protocol, and Optimized Link State Routing, TBRPF.

B. Reactive routing

It is also called on demand routing. it is more efficient than proactive routing and most of the current work and modifications have been done in this type of routing for making it more and more better. The main idea behind this type of routing is to find a route between a source and destination whenever that route is needed whereas in proactive protocols we were maintaining all routes without regarding its state of use. So in reactive protocols we don't need to bother about the routes which are not being used currently. Time delay in reactive protocols is greater comparative to proactive types since routes are calculated when it is required. e.g. Ad-hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR).

C. Hybrid Routing

Both of the proactive and reactive routing methods have some advantages and shortcomings. In hybrid routing a combination of proactive and reactive routing methods are used which are better than the both used in isolation. It includes the advantages of both protocols. Examples of hybrid protocols are Zone Routing Protocol, Hazy Sighted Link State.

D. Location based routing

All of the above approaches share a common feature of discovering topology information with the help of routing messages and the further discovery of any other route uses this information with the help of routing tables. Location based routing is completely different from above these methods. It acquires a completely different approach that utilizes the global information of the nodes. e.g. Location Aided Routing, Distance Routing Effect Algorithm for Mobility (DREAM).

Energy Efficient Routing

Energy is a limiting factor in case of WSN. Routing in WSN has some unique characteristics.

First- Energy of nodes is crucial and depends upon battery which has limited power supply.

Second- Nodes can move in an uncontrolled manner so frequent route failures are possible.

Third-Wireless channels have lower and more variable bandwidth *compare* to wired network

Here Table: 1 and Table: 2[1347] gives the summary about performances of three routing protocols in which "1" denotes the best performance and "3" denotes the worst performance

Table - 1 Nodes = 100, Packet length = 50,000 bytes.

Protocols	Packet Delivery Ratio (PDR)	End to End Delay	Routing Load	Throug hput
BATMAN	2	3	3	3
OLSR	1	1	1	2
DSR	3	2	2	1

Table - 2 Nodes = 100, Mobility = 30 (m/s).

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DSR	3	3	1	3

Methods

Energy Efficient Routing Protocols

In this section we have studied following energy efficient routing protocols.

Ad Hoc On Demand Distance Vector (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 both unicast and multicast routing. It is an on demand algorithm, meaning that it builds routes between nodes only as desired by source nodes. It maintains these routes as long as they are needed by the sources. Additionally, AODV forms trees which connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. AODV uses sequence numbers to ensure the freshness of routes. It is loop-free, self-starting, and scales to large numbers of mobile nodes.

Advantages and Disadvantages:

The main advantage of AODV protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is less. The HELLO messages supporting the routes maintenance are range limited, so they do not cause unnecessary overhead in the network. One of the disadvantages of this protocol is that intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. Also multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead Another disadvantage of AODV is that the periodic beaconing leads to unnecessary bandwidth consumption.

Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks and is based on a method known as source routing. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one.

Advantages and Disadvantages: DSR uses a reactive approach which eliminates the need to periodically flood the network with table update messages which are required in a table-driven approach. The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead. The disadvantage of DSR is that the route maintenance mechanism does not locally repair a broken down link. The connection setup delay is higher than in table-driven protocols. Even though the protocol performs well in static and low-mobility environments, the performance degrades rapidly with increasing mobility. Also, considerable routing overhead is involved due to the source-routing mechanism employed in DSR. This routing overhead is directly proportional to the path length

Energy Dependent DSR (EDDSR)

EDDSR [8] is energy dependent DSR algorithm which helps node from sharp and sudden drop of battery power. EDDSR provides better power utilization compare to LEAR (least energy aware routing) and MDR (minimum drain rate). EDDSR avoids use of node with less power supply and residual energy information of node is useful in discovery of route. EDDSR has further advantage over MDR because it can use route cache used by DSR

Location Aided Routing (LAR)

LAR [14] (Location Aided Routing) protocol is one of the most important and popular geographical based routing protocol for wireless mobile Ad-hoc networks. LAR is based on sensible flooding. In flooding source node broadcasts the route request to its neighbours.

Localized Energy Aware Restricted Neighborhood Routing (LEARN)

LEARN [16] is an energy efficient routing protocol proposed by Y. Wang, W. Song, X. Li, T. Dahlberg. This routing algorithm theoretically guarantees the power efficiency of its route asymptotically almost sure. If destination node is t, any intermediate node u will only choose a particular neighboring node v if $\angle vut \leq \alpha$ for a parameter $\alpha < \pi/3$ in learn method.

Temporally Ordered Routing Algorithm (TORA)

TORA is a distributed routing protocol for mobile, multi-hop wireless networks. Its intended use is for the routing of IP datagram's within an autonomous system. TORA's design is predicated on the notion that a routing algorithm that is well suited for operation in this environment should possess the following properties are Executes distributedly, Provides loop-free routes, Provides multiple routes (i.e., to reduce the frequency of reactions to topological changes, and potentially to alleviate congestion), Establishes routes quickly (i.e., so they may be used before the topology changes), Minimizes communication overhead by localizing algorithmic reaction to topological changes when possible (i.e., to conserve available bandwidth and increase scalability).

Flat-Based Routing

- Each node typically plays the same role
- Sensor nodes collaborate to perform the sensing task
- Data-centric routing
- The BS sends queries to certain regions and waits for data from the sensors located in the selected regions
- Sensor Protocols for Information via Negotiation (SPIN)
- Nodes assign a high-level name to completely describe their collected data
- Perform metadata negotiation before data transmission

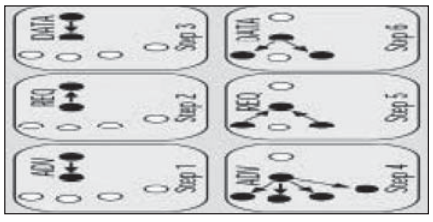


Figure 1:Works well in time-driven fashion

- SPIN provides more energy savings than flooding.
- Metadata negotiation almost halves the redundant data.
- However, SPIN cannot guarantee delivery of data.

Directed Diffusion

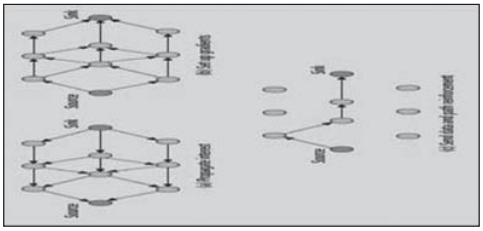


Figure 2: Directed Diffusion

Directed diffusion achieve energy saving by:

a. Selecting empirically good paths

b. By cashing and processing data in the network

c. Directed diffusion can spontaneously propagate an important event to some section of the sensor networks

d. It is not worth setting up gradients for queries that use the path only once.

e. Flooding the query message by BS to the entire network may decrease the system lifetime of WSNs.

Minimum Cost Forwarding Algorithm:

Maintain the least cost estimate from the nodes to the BS. The BS broadcasts a message with the cost set to zero. When each node receives the broadcast message originated at the BS, checks to see if the estimate in the message plus the link cost on which it is received is less than the current estimate. If yes, the node updates the broadcast message; and resends it. Every node will check if itself is on the least cost path when receiving the forwarding message sent to BS.

Energy-Aware Routing

Maintain a set of paths instead of only one optimal path. These path are chosen by means of a certain probability. By having paths chosen at different times, the energy of any single path will not deplete quickly.

Hierarchical-based routing

Nodes will play different roles in the network. Higher energy nodes can be used to process and send the information. Low energy nodes can be used to

perform the sensing job. Hierarchical-based routing is an efficient way to lower energy consumption within a cluster.

LEACH protocol

Randomly selects a few sensor nodes as cluster heads and rotates this role to evenly distribute the energy load of sensor nodes. LEACH is separated into two phases, Setup phase, Select the CHs and organize the clusters, Steady state phase. Actual data transfer to the BS according to the TDMA scheduling

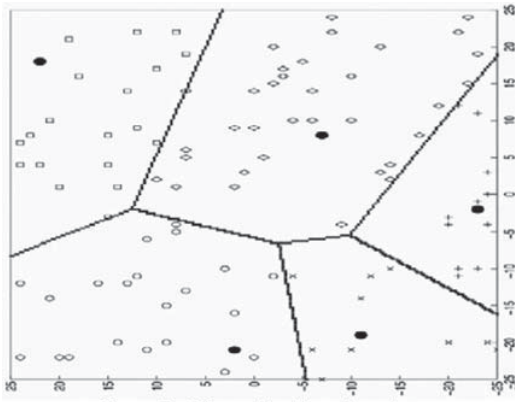


Figure 3: Hierarchical-based routing

TDMA scheduling is an energy-efficient way for nodes to send data. The unreasonable assumption of LEACH All nodes can transmit with enough power to reach the BS. All nodes always have data to send. Threshold-Sensitive Energy Efficient Network Protocols. Sensor nodes sense the medium continuously, but data transmission is done less frequency. The node will transmit data only when, The current value of the sensed attribute is greater than the hard threshold. The current value of the sensed attribute differs from sensed value by an amount equal to or greater than the soft threshold.

Location-Based Routing

Sensor nodes are addressed by means of their locations. Sensor nodes'positions are exploited to route data in the network. The location information can be obtain by GPS or by exchanging relative coordinates of neighbors for estimation.

Geographic Adaptive Fidelity (GAF)

The network area is first divided into fixed zones and form a virtual grid. The cluster size is dependent on the required transmitting power and communication direction. Inside each zone, nodes will elect one sensor node to stay awake for a certain period of time, and then the rest go to sleep. A CH can ask the sensor nodes in its cluster to switch on and start gathering data if it senses an object.

Classifying by the protocol operation

- Multipath based
- Query-based
- Negotiation-based
- QoS-based
- Coherent-based

Multipath based- Maintain multiple path from sink to source. Enhance the system life time and fault tolerance, Query-based, Sink node propagate a query for data. Nodes with this data sends the data that matches the query back to the node that initiated the query.

Negotiation-based- Use high-level data descriptors in order to eliminate redundant data transmissions through negotiation.

QoS-based The network has to satisfy certain QoS metrics (delay, energy, bandwidth, etc.) when delivering data to the BS.

Coherent and Noncoherent based- In coherent routing, the data is forwarded to aggregators after minimum processing. In noncoherent data processing routing, nodes will locally process the raw data before it is sent to other nodes for further processing.

Recently, energy-efficient system design has been received much attention in both industrial and academic fields. In the industrial area, both vendors and operators are expecting more energy-saving devices to reduce manufacturing or operating cost. Several projects and organizations, e.g. Energy Aware Radio and neTwork tecHnologies (EARTH), have been set up to develop more energy-efficient architectures and techniques.

OFDMA Networks:

OFDMA has been extensively studied for next generation wireless communication systems, such as Worldwide Interoperability for Microwave Access (WiMAX) and the Third Generation Partnership Project (3GPP) Long Term Evolution (LTE).Energy-efficient orthogonal frequency division multiplexing (OFDM) systems, a special case of OFDMA, have been first addressed with consideration of circuit consumption for frequency-selective fading channels [14]. It is demonstrated that there is at least a 15% reduction in energy consumption when frequency diversity is exploited.

Energy-efficient design has been also extended to general OFDMA networks [19].In [20], energy-efficient design in multi-cell scenarios with inter-cell interference is studied. As shown there, energy-efficient power distribution not only boosts system EE but also refines the EE-SE tradeoff due to the conservative nature of power allocation, which sufficiently restricts interference from other cells and improves network throughput.

The existing research on energy-efficient OFDMA has mainly focused on uplink scenarios or mobile terminal sides. More effort should be put on the downlink or BS sides for the green design target. In addition, the impact of knowledge of traffic statistics has not been investigated. Moreover, the general EE-SE tradeoff is not addressed yet.

Further research on the following aspects is desired.

- **Energy-Efficient Transmission in Downlink**: In many situations, downlink EE is also very important.
- **Role of Traffic Statistics:** It is crucial in energy-efficient broadband communications.
- **Tradeoff between EE and SE:** Since EE and SE are two important system performance indicators, the tradeoff between EE and SE for general OFDMA networks should be exploited to guide system design. The bounds and achievable EE-SE regions for downlink OFDMA networks are important for system designer.

MIMO Techniques:

MIMO techniques have been widely adopted in wireless networks nowadays. As shown in Fig. 3, single input single-output (SISO), single-input multiple-output (SIMO), and multiple-input single-output (MISO) can be regarded as special cases of multiple-input multiple-output (MIMO). MIMO can also be used with single user or multiple users to form single-user MIMO (SU-MIMO), multi-user MIMO (MU-MIMO), and coordinated multipoint transmission (CoMP).Existing research on the EE of MIMO techniques mainly focuses on the open-loop SU-MIMO schemes. A lot of potential research can be developed in other aspects of MIMO schemes to further improve EE.

Some possible topics are as follows.

- **Closed-Loop MIMO Schemes:** Closed-loop MIMO schemes, such as beam forming and proceeding, are shown to enhance SE efficiently. However, the overhead for CSI feedback will consume additional radio resources, including time, bandwidth, and power. Whether or when closed-loop MIMO schemes are more helpful than open-loop ones to save energy is still an open issue.
- **Energy-Efficient MIMO Schemes in Multi-User and Multi-Cell Scenarios:** In multi-user and multi-cell environments, the existence of inter-user and inter-cell interference complicates the design of energy efficient MIMO systems. How to utilize the spatial resource to maximize EE while suppressing the interference is well worth investigating.
- **Energy-Efficient MIMO-OFDMA Systems:** MIMO schemes are usually incorporated into OFDMA systems. The spatial and frequency resource can be jointly allocated to improve EE. However, the complexity of the joint design may be prohibitive. Effective but simple algorithms need to be developed to obtain a tradeoff between complexity and performance.

Results and Discussions

We use the two types of protocols to find the path from source to destination. These two types of protocol are reactive and proactive protocol. We have to make the comparison between BATMAN, DSR and OLSR. In this the performance is checked by the packet delivery ratio, end to end delay, routing load, throughput parameter. Different protocols have the different performance on different parameter. Different type of variations is done with nodes is number of nodes, packet length and mobility.

Table- 3 Overall Performanes of Protocols

Maximum Number of nodes with Maximum Packet length	OISR>	DSR>BATMAN
Maximum number of nodes With Maximum Mobility	OLSR>	BATMAN>DSR

Further research issues QoS problem posed by video and imaging sensors and real-time application The mobility of nodes. BS or source or sensor nodes mobility. How to handle the overhead of the position update and topology change. The integration of sensor networks with wired networks. Some directions for designing the routing protocol. Main objective is prolonging network lifetime. Exploit redundancy, Tiered architectures. Achieve desired global behavior with adaptive localized algorithms. Leverage data processing and exploit computation near data sources to reduce communication, Time and location synchronization, Self-configuration and reconfiguration, Secure routing.

The table summarizes the classification of the protocols covered in this survey. We also included in the table whether the protocol is utilizing data aggregation or not, since it is an important consideration for routing protocols in terms of energy saving and traffic optimization.

Table 4: Classification of routing protocols in sensor networks

Routing protocol	Data-Centric	Hierarchical	Location-based	QoS	Network-flow	Data Aggregation
SPIN	✓					✓
Directed Diffusion	✓					✓
Rumor Routing	✓					✓
GBR	✓		✓			
CADR	✓					
COUGAR			✓			
ACQUIRE	✓					✓
LEACH	✓	✓		✓		
GAF		✓	✓	✓		
GEAR						
SAR		✓	✓	✓		✓

Employing ADHOC Routing Protocols

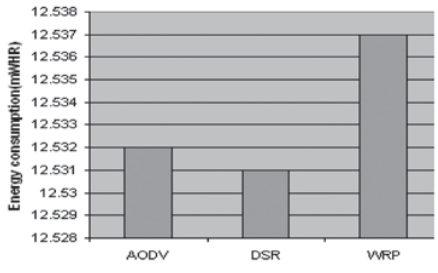


Figure 5.(a): Energy consumption by the nodes (100 nodes, 40 sources)

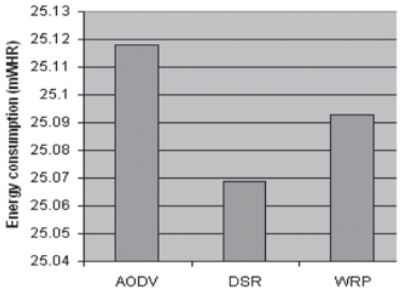
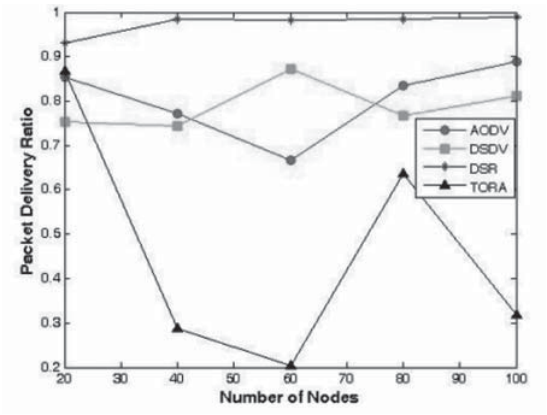


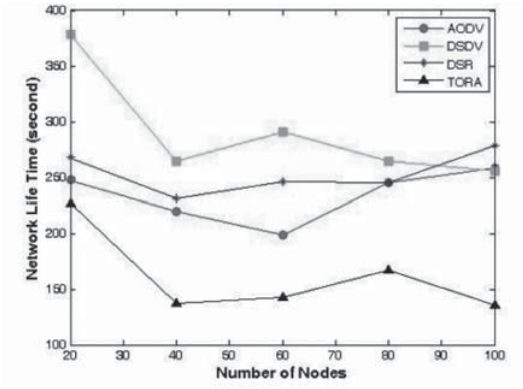
Figure 5.(b): Energy consumption by the nodes (50 nodes, 10 sources)

From Figure-5(a) and Figure 5(b) we find that DSR outperformed both the WRP and AODV routing protocol in case of energy consumption too. As it was expected, in case of energy consumption, for low traffic network WRP performs worst because of maintaining set of tables to setup routes in advance without necessity. But as it can be seen from Figure-5(a), surprisingly WRP outperforms AODV in case of energy consumption for high traffic network. One thing that might be responsible for that is the inconsistent paths (when AODV is used) constructed by the intermediate nodes in the network.

We simulated this network under each of routing protocols and outputs shown in Figs. 6-9. Figs. 6-9 show a comparison between the routing protocols as a function of number of nodes. From these graphs it is clear that routing overhead increase with increase in number of nodes. DSR has better packet delivery ratio and in overall DSDV has better performance. TORA



has low performance because in our simulation



network has middle dynamic. AODV and DSR have middle performance.

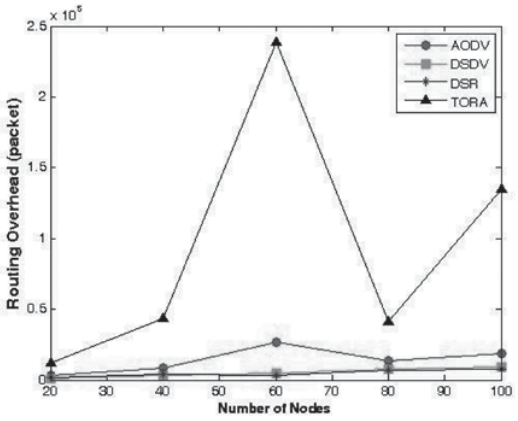
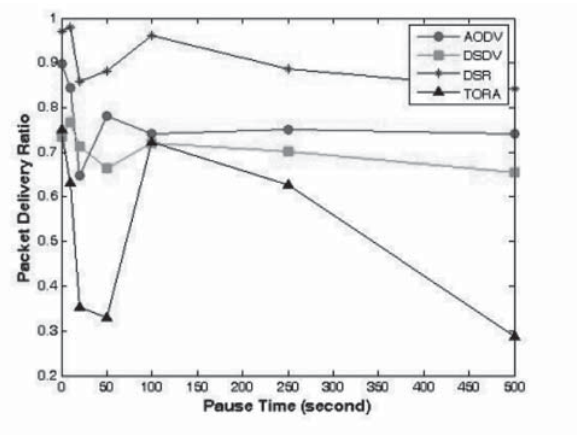


Figure 6 : Packet Delivery Ratio versus



Number of Nodes

Figure 7: Network Life Time versus Number of Nodes

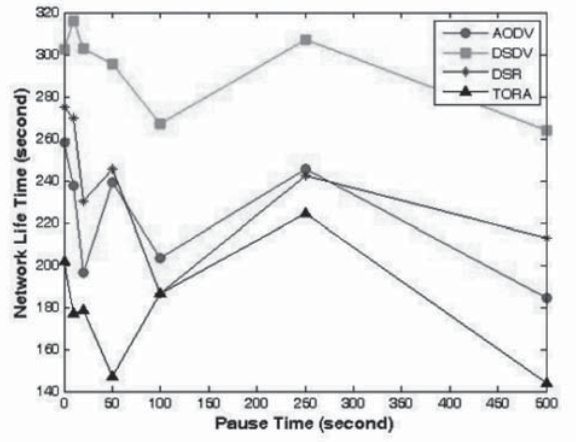


Figure 8: System Life Time versus Number of Nodes

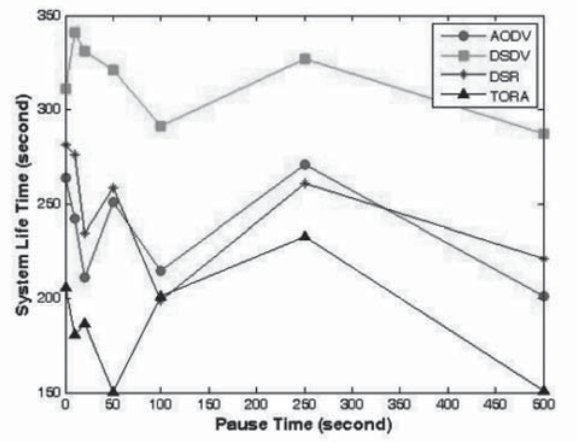
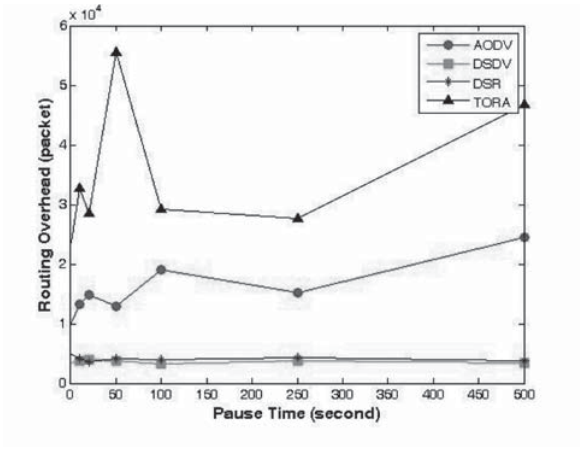
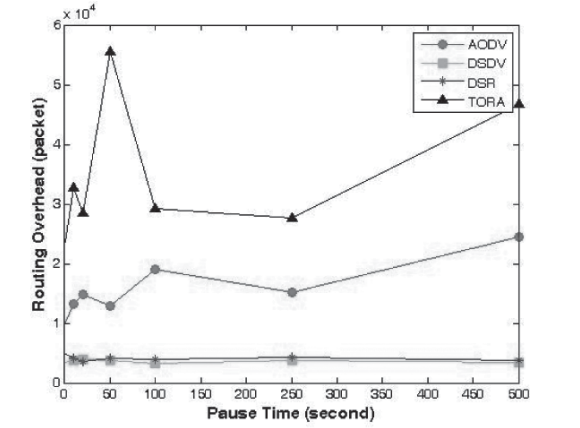


Figure 9: Routing Overhead versus Number of





Nodes

We simulated this network under various routing protocols and outputs are shown in Figs. 12-16.

Figure 10: Packet Delivery Ratio versus Pause Time

Figure 11: Network Life Time versus Pause Time

Figure 12: System Life Time versus Pause Time

Figure 13: Routing Overhead versus Pause Time

Figures 12-16 show a comparison between the routing protocols as a function of pause time. We can conclude from simulations results as follow. In case of Packet Delivery Ratio, DSR has better performance. In cases of Network Life Time and System Life time DSDV has better performance. In case of End-to-End Delay AODV, DSDV and DSR have relative performance. In case of Routing Overhead, DSDV has better performance.

Conclusion and Future Work

Among these conclusions some are of general types while rest varies from one scheme to the other. In general most of the schemes lack with practical implementation. On the basis of result, it was concluded that as the packet size is increased the end-to-end delay of AODV is lesser than that of DSR for larger number of nodes; average throughput of generating packets for DSR is larger than that of AODV for larger number of Nodes and traffic sources. However the average throughput of generating packets for AODV is greater when the numbers of nodes are 40 and 80. Delay is an important metric which decides the efficiency of the routing protocol. DSR (Dynamic source routing) protocol is not a winner when it comes to the large size of the network. So AODV gave the best performance overall, making it suitable for medium as well as larger networks.

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