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Performance Evaluation of Routing Algorithms for Ad Hoc Wireless Sensor Network and Enhancing the Parameters for Good Throughput

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ABSTRACT
Sensor Network are emerging as a new tool for important application in diverse fields like military surveillance, habitat monitoring, weather, home electrical appliances and others. Technically, sensor network nodes are limited in respect to energy supply, computational capacity and communication bandwidth. In order to prolong the lifetime of the sensor nodes, designing efficient routing protocol is very critical. In this paper, we are optimizing how information can effectively disseminate to the destination is one of the most important tasks in sensor networks. Problem arises when intermediate nodes fail to forward incoming packets. Due to limited power and slow processor in each node, algorithms of sensor networks must be designed carefully. AODV is a typical algorithm which has been used to provide efficient data transmission. We aims to show analysis performance of routing protocol in wireless sensor network using AODV. This paper examines the performance of routing protocols which improve the network efficiency and maximize the network lifetime and optimizing the parameters. This analysis reveals that the PDR and Throughput is important features which need to be taken into consideration while designing routing for wireless sensor network, so optimizing the packet-size and mobility factor. However the AODV perform well when mobility is high.

General Terms
Throughput improvement, WSN

Keywords
WSN, AODV, DSR, Throughput, Packet size

1. INTRODUCTION
DUE to the recent technology advances, the manufacturing of small and low-cost sensors has become technically and economically feasible. A large number of sensors can be networked in many applications that require unattended operations, hence producing a wireless sensor network (WSN). Although sensor maybe mobile, they can be considered to be unchanging after deployment. A sensor network is composed of a large number of tiny autonomous devices, called sensor nodes. A sensor node has limited sensing and computational capabilities and can communicate only in short distances. A typical network configuration consists of sensors working unattended and transmitting their observation values to some processing or control centre, the so called sink node which serve as user interface to the transportation media. Most application scenarios for sensor network involve battery-powered nodes with limited energy resources. Recharging or replacing the sensor battery may be inconvenient, or even impossible in harsh working environments. Thus, when a node exhausted its energy, it cannot help but cease sensing and routing data, possibly degrading the coverage and connectivity level of the entire network. This implies that making good use of energy resources with good throughput and PDR is a must in sensor networks. Routing protocol is a set of rules defining the way router machines find the way that packets containing information have to follow to reach the intended destination. But now we want to explore and simulate the use of AODV for a simple wireless sensor network using network simulator. Using the NS-2 Simulator, we can execute the routing protocols. Using NAM Output window, we can see how the routing protocols work on each sensor nodes. From which we would give the parameters of the AODV protocol for good throughput, from which we can get better output in a wireless sensor networks.

2. WHAT IS WIRELESS SENSOR NETWORK?
A wireless sensor network (WSN) is a wireless network consisting of distributed self-organized autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as vibration, motion, temperature, sound and in medical field etc.
A WSN node mainly consists of four main parts:
- Processing unit.
- Sensor.
- Transceiver
- Energy Source Unit

Depending on usage purpose there may be additional components such as localization unit, energy producer, position changer etc. In the figure below, general architecture of WSN node and a real example is represented.

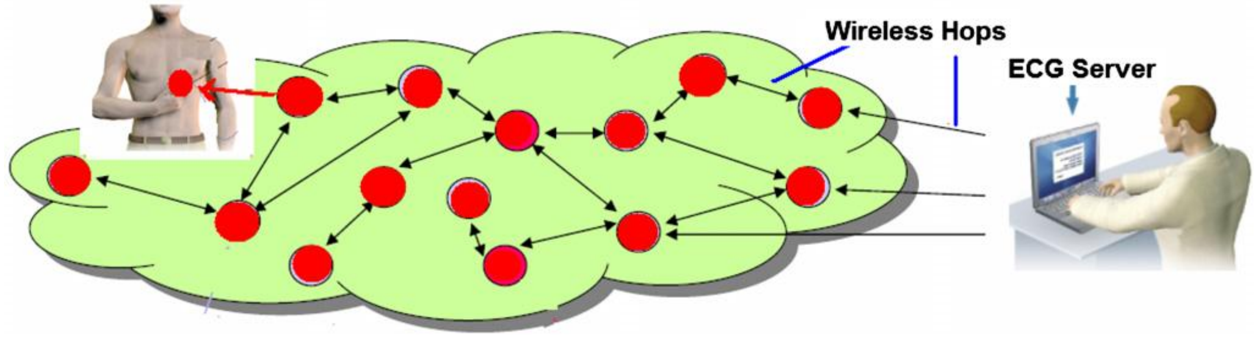

Fig 1: WSN Node architecture and a real example

WSN nodes generally have small sizes up to the size of a coin. However, the sizes of WSN nodes may be further decreased with future advances in micro-electromechanical systems (MEMS). Due to low bandwidth and low energy sources, transmission range of nodes is restricted with about approximately 30 meters. Thus, dense deployment of nodes is required for more reliable data transmission. The processing capacity of WSN nodes is also low both because of data processed by WSN nodes are too small and energy is limited. WSN nodes use less complex operating systems and event-driven programming models. In contrast to modern operating systems, which consist of millions of lines of code, WSN operating systems codes consists of just a few thousands of lines. Some examples of WSN node operating systems are:

- TinyOS
- Contiki
- MANTIS
- BTnut
- SOS
- Nano-RK

Also it should be considered that, since WSN node hardware is similar to embedded systems, it is possible to use some embedded operating systems such as eCos, uC/OS for sensor networks.

3. GOOD SENSOR DEPLOYEMENT

Sensors have size, weight, and cost restrictions, which impact resource availability. For maximizing the network lifetime is an important network design objective. Using a minimum number of sensors is another clear objective, especially in a deterministic node deployment approach. The coverage algorithms proposed are either centralized or distributed. In Distributed algorithms, the decision process is decentralized. The WSN has a dynamic topology and needs to accommodate a large number of sensors, the algorithms and protocols designed should be distributed and localized, in order to better accommodate a scalable architecture. The most discussed coverage problems in literature can be classified in the following types: area coverage, point coverage and barrier coverage based on the subject to be covered (area versus discrete points), different problems can be formulated considering the following design choices:

a) Sensor deployment method: deterministic versus random. A deterministic sensor placement may be feasible in friendly and accessible environments. Random sensor distribution is generally considered in remote areas.

b) Sensing and communication ranges: WSN scenarios consider sensor nodes with same or different sensing ranges. Another factor that relates to connectivity is communication range that can be equal or not equal to the sensing range.

c) Additional critical requirements: Energy-efficiency and connectivity also referred to as energy-efficient coverage and connected coverage.

4. PROTOCOLS FOR THE WIRELESS SENSOR NETWORK

4.1 DSR PROTOCOL

The *Dynamic Source Routing* protocol (DSR) is a simple and efficient reactive Ad hoc unicast routing protocol. It has been designed specifically for use in multi-hop wireless Ad hoc networks of mobile node. By using DSR, the network does not need any network infrastructure or administration and it is completely self-organizing and self-configuring. This routing protocol consists of two mechanisms: the *Route Discovery* and *Route Maintenance* that permit to completely maintain and automatically determine routes. These mechanisms are described in the following subsections:

a) Route Discovery

Route Discovery mechanism is in charge of finding routes between the nodes in the network. DSR is a reactive protocol, a source node S starts searching routes only if it needs to send a packet to a destination D and if no routes are enclosed in its cache. To find routes, DSR employs the Route Discovery mechanism by broadcasting Route Request (RReq) Any intermediate node that receives a non-duplicate RReq appends its address to the source route list in the RReq packet and rebroadcast it as shown in Figure 4. When the destination node receives the packet, it sends a Route Reply (RRep) back to the source node. Further, in the network, the nodes may cache routing information obtained from Route Discovery and data packets. Moreover, if an intermediate node has some requested information, that is the route to destination, in its cache, it may send an RRep back to the source node.

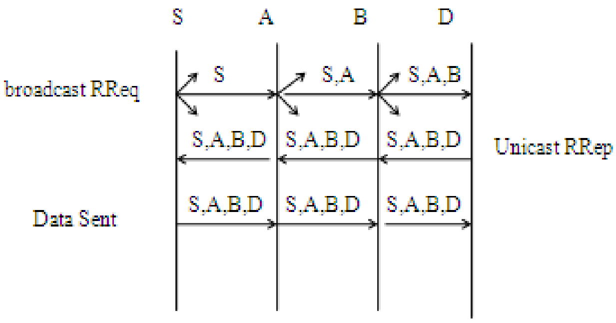

Fig 2: Route Discovery mechanism of DSR protocol.

4.2 AODV and RE-AODV PROTOCOL

4.2.1 AODV Protocol

An Ad-hoc On-Demand Distance Vector (AODV) is one of the reactive routing protocols. It is very simple, efficient, and effective routing protocol for ad-hoc networks. In route discovery phase, source S broadcasts RREQ (Route Request) where destination number of RREQ is the last known number. The destination replies by unicasting RREP (Route Reply). The intermediate nodes which are called as neighbors discard duplicate requests, and reply if they have an active route with higher sequence number. Otherwise, they broadcast the request on all interfaces. There is a two path setup in this process: the first one is reverse path setup where a node records the address of the neighbor sending RREQ, the second is a forward path setup that unicasts RREP back to the reverse path, each node along the path setting up a forward pointer to the node from which the RREP came, and updating its routing table entry. The node propagates the first RREP or the RREP that contains a greater destination sequence number or the same sequence number with a smaller hop count. The neighboring nodes with active routes periodically exchange hello messages. If a next hop link in the routing table fails, the active neighbours are informed. The source performs a new route request when it receives a RERR (Route Error). AODV maintains a time-based state in each node if node routing entry not recently used is expired. If a route is broken the neighbours can be notified. HELLO messages are used for detecting and monitoring links to neighbours. Although AODV is a reactive protocol, it uses these periodic HELLO messages to inform the neighbours that the link is still alive. When a node receives a HELLO message, it refreshes the corresponding lifetime of the neighbour information in the routing table. Due to hello messages, the control overhead increases linearly with the network size. It is possible that a valid route is expired in AODV and determining the reasonable expiry time is also difficult. The AODV has an evident weakness: its end-to-end delay. The route discovering delay can be a crucial factor in wireless sensor networks. For AODV, the number of control packets steeply increase when traffic load is increased from low to high at perpetual mobility. The standard AODV protocol forms routes using random channels rather than selecting optimal channels.

4.2.2 RE-AODV Protocol

Though AODV is suited for Wireless Sensor Network over DSDV, AODV's high delay from source to destination routing and the 'valid route expiry' are the major disadvantages. A protocol called RE-AODV is presented based on the model for reducing the delay by using hello packets to exchange the local routes using *Local Discovery Algorithm (LDA)*.

Local Route Discovery Algorithm:

Step 1: Discover the neighbor node by sending hello packets along with route information.

Step 2: If no route is available, send the hello packet alone.

Step 3: When RREQ is received, check the local route table to know whether any neighbor with route to destination exists.

Step 4: If so, send RREP. If not, broadcast RREQ.

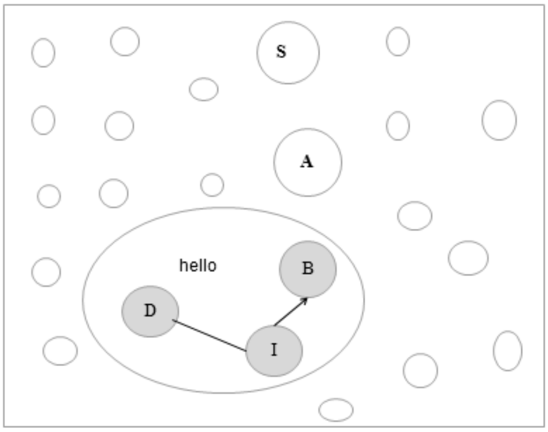

Fig 3: Exchange of hello Packets

The algorithm is better understood with the help of a scenario where n nodes are present in the network in which S is the source and D is the destination. In Figure 5, node I acts as an intermediate node which has route to the destination D. It sends and receives hello packets to their nearby nodes. After node I sends the hello packet to node B, node B updates the information to source S through the return of RREP shown in Figure below. If route information is not available, the control packets are exchanged as in AODV.

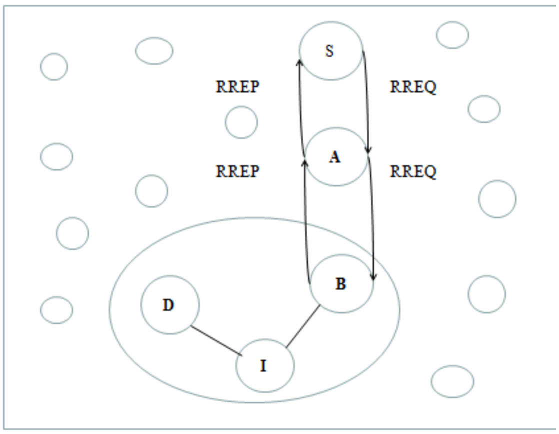

Fig 4: RREQ & RREP Messages

RREQ message is initially sent from source node S to node A, and then to B, since node B has already got hello message from D by using Figure 5. RREQ is only sent up to B. Node B simply sends the RREP message to node A. Finally, the node A sends the RREP message to source node S.

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5. PERFORMANCE EVALUTION

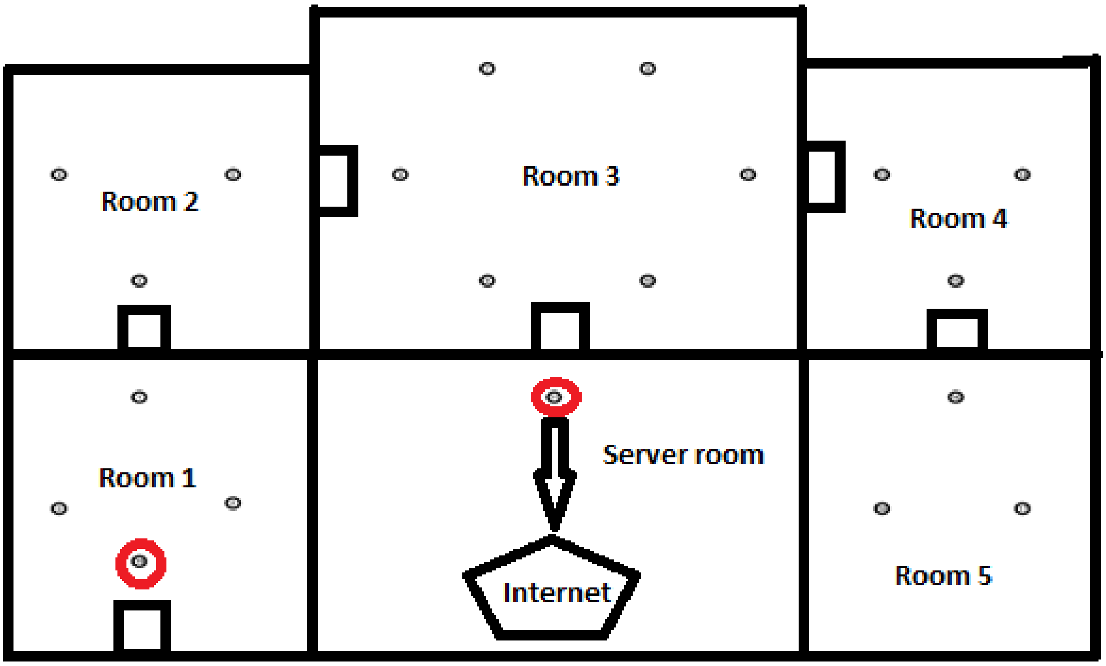

Fig 5: WSN Node Deployment in real example.

In this section, we compare our proposed algorithm AODV. We implement algorithm in NS-2 simulator and use the following model for our simulation study.

− The number of nodes which are distributed randomly over a rectangular area of 1800m×1300m is 20.

− The radio transmission rang R is 240 m.

−A sensor node’s transmitting, receiving and idle listening power consumption rate are 30 joules and 30 joules respectively.

− Initial power is 250 joules.

− The size of data packet is 64 byte.

Three PDR and Throughput are chosen for evaluating and comparing the performance of our algorithm with different mobility, queue’s and packet size. Packet delivery Ratio is defined as the ratio of the number of data packets successfully received by the sink to the number of data packets send by the data source.

6. PERFORMANCE ANALYSIS

6.1 Simulation Analysis of AODV and DSR for mobility

Simulation was carried out on using NAM simulator in a physical topology area of 1800m x 1300m using a random way point mobility model. At start of the simulation, each node waits for a pause time, and then moves towards a destination with a speed between 0 and 20 meter per seconds. On reaching the destination it pauses again and repeats the above procedure till the end of the simulation time. Mobility models were created for the simulations using 19 nodes with pause times of 100, 200, 400,600, 800, and 900 seconds respectively with maximum speed of 10 meter per second.

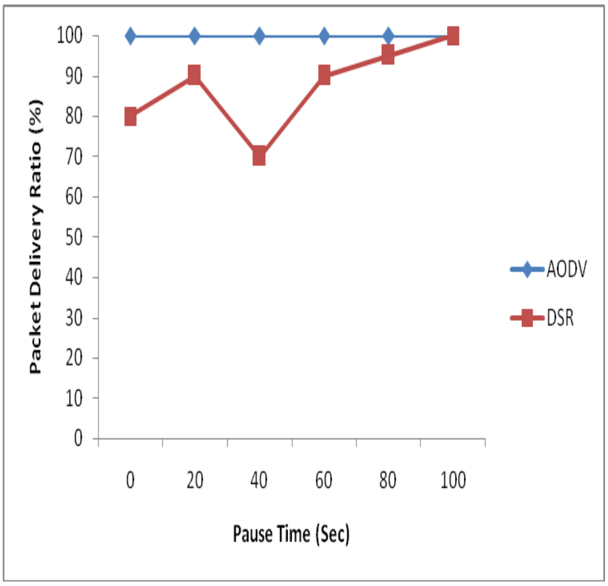

Fig 6: Throughput comparison between DSR & AODV

Constant Bit Rate (CBR) agents and packets size of 1000 bytes are used respectively to generate traffic in the network. Both protocols deliver a greater percentage of the originated data packet at low node mobility, with AODV routing protocol delivering 99% confidence interval while DSR routing protocol delivers at 98% confidence interval. This shows that AODV routing protocol was very good at all mobility rate and movement speed.

Table1. Simulation Parameters of DSR & AODV

Parameters	Values
Channel Type	Wireless Channel
Physical characteristics	Direct Sequence
Mac type	802.11b
Data rate	11 Mbs
Topology	1800m X 1300m
Routing Protocol	AODV, DSR
Number of Nodes	20
Transmit Power	0.005
Packet Size	1000 bytes
Mobility Model	Random Way Point
Simulation Time	900 sec
Traffic Source	CBR
Speed	0-20 m/sec

7. CONCLUSION:

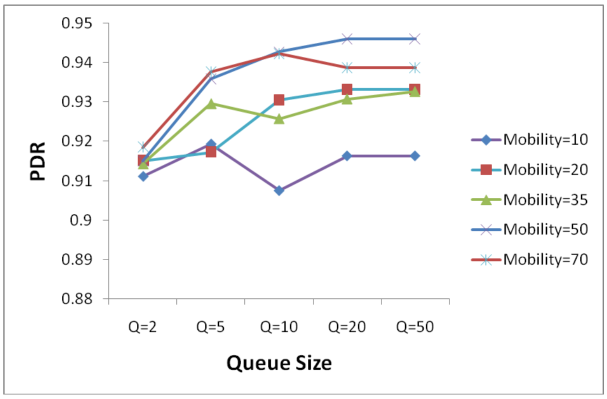

Fig 7: PDR Vs Queue for various Mobility's for AODV

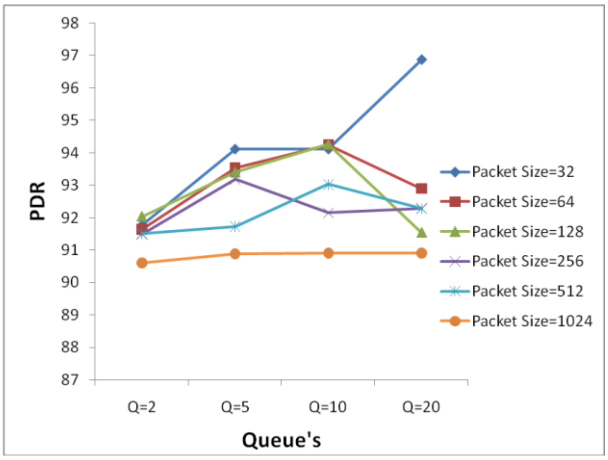

Fig 8: PDR Vs Queue for various Packet Size For AODV

From above graphs we can conclude that PDR increases with increae in queue size, mobility and decreaes with the increase in packetsize.

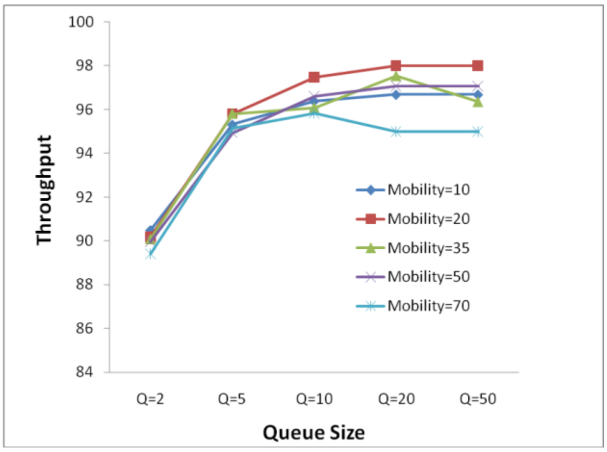

Fig 9: Throughput Vs Queue Size for various Mobility's for AODV

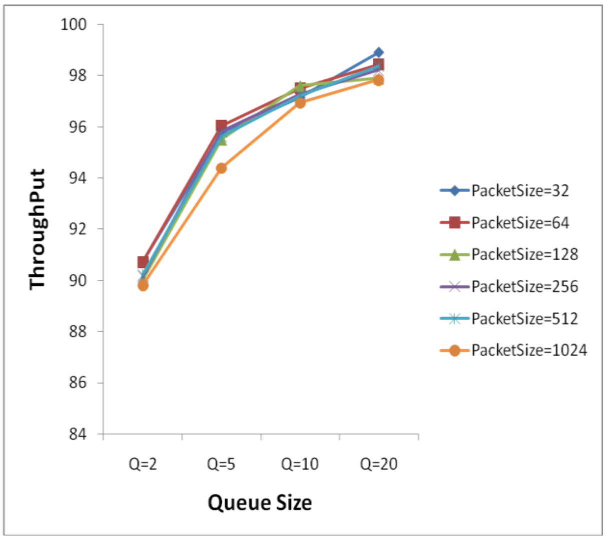

Fig 10: Throughput Vs Queue Size for various Packet Size for AODV

From above graph we conclude that throughput increases with increase in queue size, packet -size and decreases as increase in mobility.

So we optimize the values for the parameter as follows, which would give good throughput and packet delivery ratio.

Queue Size = 20.

Packet Size = 32.

Mobility = 20.

In this project, we have presented a given detail process & technique of AODV protocol and Advantage of AODV protocol for achieving the optimum throughput in the network. The results showed that AODV and DSR routing protocols were optimized to obtain a higher throughput. Simulation results agree with expected theoretical analysis, hence, AODV performs best considering its ability to maintain connection by periodic exchange of hello messages which is required for CBR traffic source. Throughput showed that DSR performs predictably well delivering all it packets at low mobility but decreases slightly as mobility increases, AODV performs well at both low and high mobility. Interference, high mobility, and high noise level degrades the performance of MANET but this effects can be overcome by adaptively setting the received signal threshold from range of levels in accordance with speed of nodes and topology of its network operating environment.

8. FUTURE SCOPE

Future work includes the proper modeling of terrain effect prior to implementation to mitigate the effect of noise on received signal strength of the packet in a multi-hop network & to reduce the energy consumption of nodes within the ad Hoc Network.

9. ACKNOWLEDGEMENTS

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