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Performance Evaluation of Wireless Sensor Network Routing Protocols for Real Time Application Support

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Performance Evaluation of Wireless Sensor Network Routing Protocols for Real Time Application Support

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Abstract - This paper evaluates the performance of prominent on demand routing protocols, which are Ad Hoc On –Demand Distance vector Routing(AODV), Destination –Sequenced Distance Vector Routing(DSDV), Dynamic Source Routing(DSR)for wireless sensor networks Results obtained from simulations demonstrates that even though DSDV,AODV and DSR share a similar on demand behavior, the differences in protocol mechanics can lead to significant performance differentials. The performance differentials are analyzed using varying network load and network size using PHENOM ATTRIBUTES & NS-2.26 is used as a platform for simulating DSDV, AODV&DSR under various conditions.PHENOM routing protocol is designed especially for wireless sensor networks. Wireless Sensor Networks (WSNs) are characterized by multi-hop wireless connectivity, frequently changing network topology and need for efficient routing protocols.

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I. Introduction

Wireless sensor networks are defined as an autonomous, adhocsystem consisting of a collection of networked sensor nodes designed to intercommunicate via wireless radio. Theses are of small with sensing, computations, and wireless networking capabilities, and as such these networks represent the convergence of important technologies. Sensor networks have enormous potential for both consumer and military applications. Military mission require sensor and other intelligence gathering mechanisms that can be placed close to their intended targets. the solutions to these constraints lies in large arrays of passive electromagnetic, optical, chemical, and biological sensors[2]. These can be used to identify and track targets, and they serve also as a first line of detection for various types of attacks. Such networks can also support the movement of unmanned robotic vehicles. The design considerations for some industrial applications are quite similar to those for military applications. Most sensors will be deployed with non-rechargeable batteries. The problem of battery life time in such sensors may be surrounded by using ultra small energy-harvesting radios. Research in this area promises radios smaller than one cubic centimeter, weighing less than 100grams, and with a power dissipation level below 100 microwatts [10]. Sensor networks are very different from conventional computer networks.First, because sensors have a limited supply of energy, energy-conserving forms of communication and computation are essential to wireless sensor networks.Second,since sensors have limited computer power, they may not be able to run sophisticated network protocols.Third,since the bandwidth of wireless link connecting Sensor nodes is often limited,inter-sensor communication is further constrained. The goal of this paper is to Carry out a systematic performance study of three dynamic routing protocols for WSN,the Dynamic Source Routing protocol(DSR)[5],the Ad-Hoc On-Demand instance Vector protocol(AODV)[6]&DSDV [1] for wireless sensor networks using NS2.

a) NetworkSimulator2

It is Discrete event simulator developed in C++.NS-2[14] is one of the most popular non-specific network simulators, and supports a wide range of protocols in all layers. It uses OTcl[Y]as configuration and script interface.NS-2 is the paradigm of reusability. It provides the most complete support of communication protocol models, among non-commercial packeges.several projects intend to provide WSN support to NS-2 such as Sensor-Sim[5] and NRL[14].Both are extensions of NS-2 to support WSN modeling.NS-2 can comfortably model wired&wireless network topologies up to 1,000 nodes or above with some optimizations. This experiments size can be kept for wireless using some optimizations [11] .A disadvantage of NS-2 is that it provides poor graphical support, via Nam.This application just reproduces a NS-2[12] trace The key motivation behind the design of on-demand protocols is the reduction of the routing load. High routing load usually has a significant performance impact in low bandwidth wireless links. Including this section, this paper has five sections, Section1shows about importance of wireless sensor network Section2 highlights sensor's simulation model.Section3 describes how protocols mechanisms are simulated and enlists simulation model parameters.Section4 discusses results

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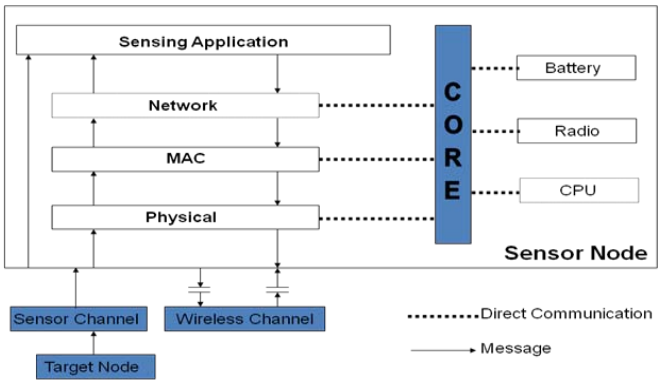
which are obtained from various cases. Finally in section5 analysis on the basis of results is given.

II. Simulation Model

The goal of simulation is to simulate and closely model the sensor network scenario[14]. The broad outline of any sensor network can be represented by high-level representation as shown in Fig.1.The sensor model can be represented by the sensor node model and the power model.



Sensor node representations in a network

Fig1 : Sensor node representations in a networ

III. Performance Evolution

a) Performance Measures

Several simulations were run both with AODV,DSDV and DSR to compare performance metrics of both versions of the protocol.The performance metrics under considerations are:

- Mean end-to-end packet latency/delay: End-to-end packet latency is defind as the time elapsed from the moment a packet is generated by the data agent at the sending node,to the time the packet is received at the corresponding agent at the receiving node[8]
- Packet delivery ratio/Success rate ratio:

Packet delivery ratio is the ratio of total number of data packets that were deliverd successfully to intended destinations to the total number of data packets generated[10].packets may not be deliverd to the destination mainly because of one of the following reasons:packet collisions,routing loop and queue drop[15].

b) Simulation model

Simulation Area	500*500
Model	Energy
Ininatial energy	12.1J
Transmitting Power	0.660
Receiving Power	0.396
Transmission range	250m to 450m
No.of Mobile nodes	100

Table1 : Node configuration parameters

Radio Propagation model	Two Ray Ground Model
Antenna Model	Omni Antenna
Network Interface Type	Phy/Wireless Phy
MAC Type	802.11
Routing Type	AODV,DSDV,DSR
Interface Queue Type	Queue/DropTail/PriQueue
Buffer Size of IFq	6000

Table2 : energy model

c) Received Signal Power in free Space

The free space propagation model assumes the ideal propagation condition that is only one clear line of sight path between the transmitter and receiver[3]. H.T.Friis presented equational to calculate the received signal power in free space at distance from the transmitter

$$\Pr = (Pt * Gt * Gr * \lambda 2) / (4\pi) 2 * d 2 * L$$

Equation .1 : received signal power in free space

Pt is the transmitted signal power,Pr is the received signal power,Gt, Gr are the antenna gains of the transmitter and the receiver respectively and L is the system loss

d) Implemented Algorithm Explanation

This section explains how AODV[8] is simulated; DSR[9]&DSDV[1] algorithms are simulated in the manner except it has a slight difference in maintaining routing information.

In AODV, each node maintains two separate counters:

1. Sequence number, a monotonically increasing counter used to maintain freshness information about the reverse route to the source.
2. broadcast-ID, which is incremented whenever the source issues a new route request (RREQ) message.

Each node also maintains information about its reachable neighbors with bi-directional connectivity. Whenever a node (router) receives a request to send a message, it checks its routing table to see if a route exists. Each routing table entry consists of the following fields:

a) Destination address
b) next hop address
c) Destination sequence number
d) hop count

e) AODV route discovery algorithm

When a node needs to determine a route to a destination node, it floods the network with a route request (RREQ) message as shown in fig.2. if a route exists, the originating node sends data packet to destination[9]. Otherwise, it saves the messages in a message queue, and then it initiates a route request to

the destination (destination node) it replies with RREP (route reply) message, so that path can be determined/ established by source node and communication can take place.

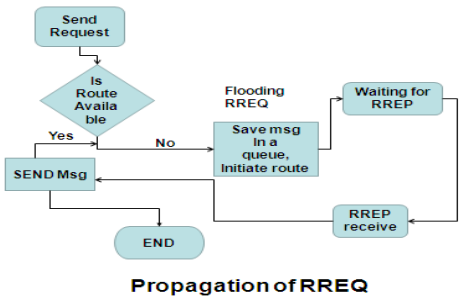


Fig2 : Propagation of RREQ

As these requests spread through the network, intermediate nodes store reverse routes back to the originating node[15]. Since an intermediate node could have many reverse routes, it always picks the route with the smallest hop. Count

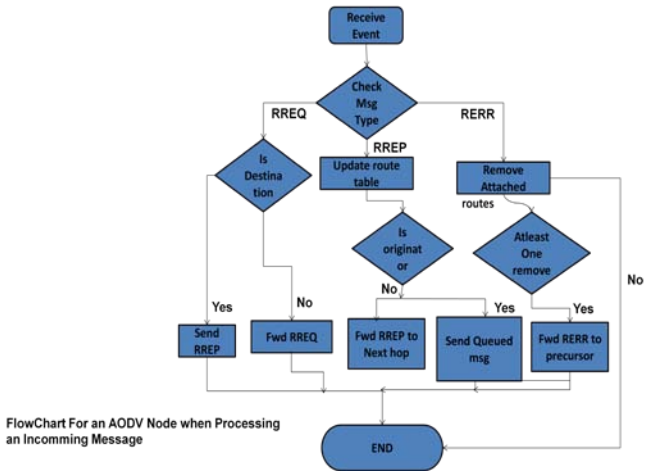


Fig3 : Flowchart for an AODV node when an incoming message

f) Packet Storage

The flow chart in fig.4 explains how packets are serviced inside a node, before node does anything it has to store a packet in a queue[15]. The nodes in simulation stores packets in FIFO manner.

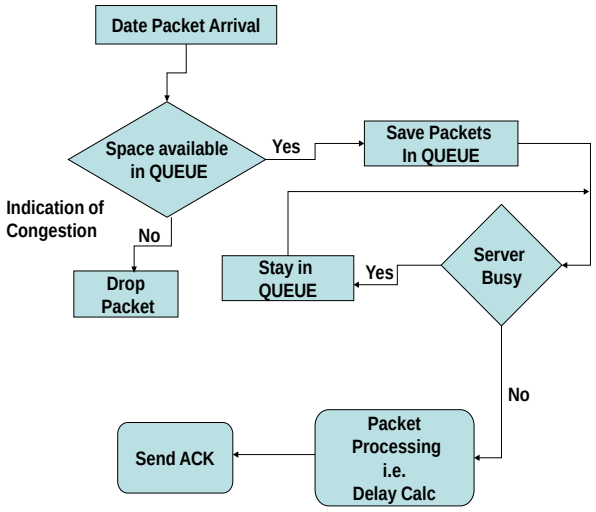


Fig4 : Flow chart of AODV node when storing Packet.

IV. Direct-Secquenced Distance Vector Routing(DSDV)

It is table driven routing protocol based on Bellman-Ford Routing Algorithm with certain improvements. Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node[1]. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in its table from the last update sent.So,the update is both time-driven and event drive[10].

V. Dynamic Source Routing

The Dynamic source routing (DSR) is based on source routing, which means that the originator of nodes through which the packet must pass while travelling to the destination. The DSR protocol consists of two basic mechanisms: Route Discovery and Route Maintenance [5]

a) RouteDiscovery

Route discovery is used only when a source node attempts to send a packet to a destination node and does already know a route to it[10] To initiate the Route Discovery, the source node transmits a "Route Request "with a unique ID as a single local broad cast packet. when some intermediate node receives this Route Request, at first it determines whether it has seen the Route Request or not. If the node has already seen the Route Request earlier, it will discard the packet; otherwise it will check its Route Cache whether there is a route to the destination of the packet [5]. If it has the

route to target in its routing cache ,it returns a "Route Reply "to the initiator of the Route Discovery, giving a copy of the accumulated route record from the Route Request; otherwise it transmits the Route Request until the Route Request is received by the target[9]

b) Route Maintenance

DSR Protocol implements the route maintenance mechanism while communicating the packets from source node to destination node. In this scenario DSR protocols uses the route mechanism, to detect any other possible known route towards the destination to transmit data [8]. If the route maintenance fails to find an alternative known route to establish the communication then it will invoke the route discovery to find the new route to destination.

VI. Results & Conclusion

a) Comparison of Delay

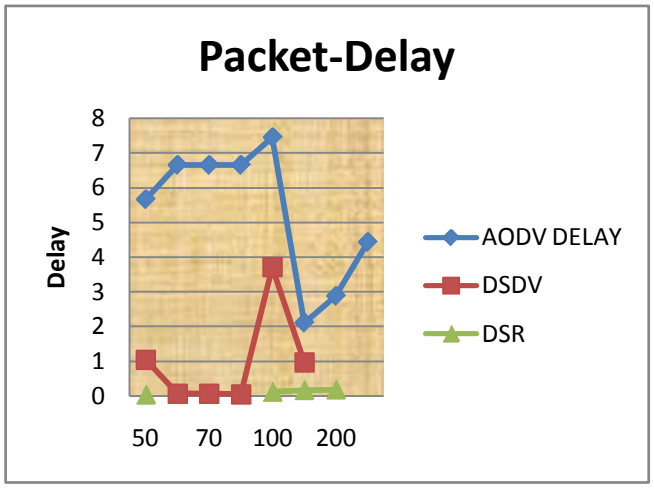


Fig 5 : Packet-Delay Comparisons

Simulations were run for varying number of packets with constant packet size and the result is plotted in fig.5. the result shows that the delay of DSR is slightly less than DSDV& AODV for increasing number of packets, the delay is more for DSDV at lower no. of packets According to above result, it can be said that AODV[outperforms DSR for more number of sources or for more network traffic and DSR performs better even though increasing more number of packets in terms of delay[3].

b) Packet Delivery Ratio (PDR) Comparison with varying no. of packets

The results plotted in fig6 is that delivery ratio is linearly increasing at lesser no. of packets ,PDR decreases at higher no. of packets in the case of DSDV.PDR is constant for all values in the case of AODV.PDR linearly varying at higher no. of loads in DSR[5].AODV outperforms than DSDV&DSR.

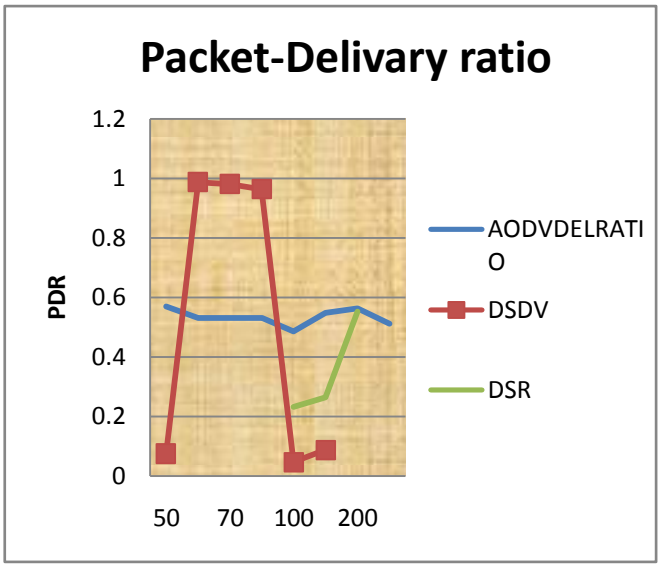


Fig 6 : Packet-Delivary Ratio Comparisons

c) Packet-Drop Comparison with varying no. of Packets

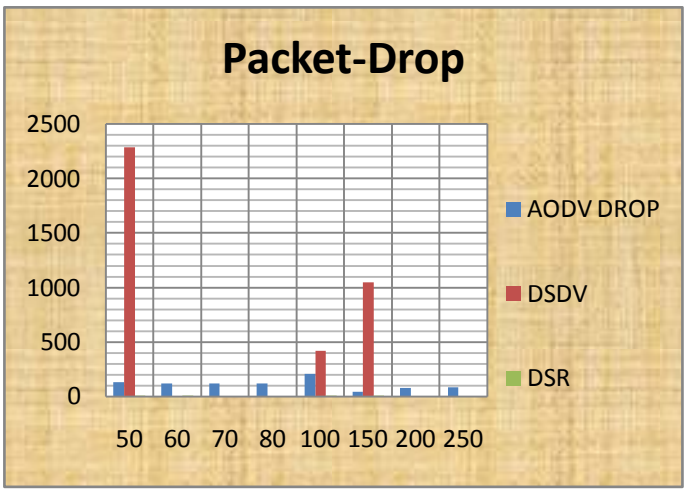


Fig7 : Packet Drop Comparison

DSR packet drop very low when compared to DSDV and AODV.Drop rate is more at less no. of sources in the case of DSDV.Drop rate is almost constant in AODV irrespective of varying load. Hence DSR outperforms DSDV&AODVhere as shown in Fig7.

VII. Analysis

a) Delay Performance

DSR exhibits slower delay than AODV&DSDV. However DSDV's delay performance worsens with large number of sources and gives about twice as much delay than AODV[15].

b) Overall Performance

On the whole shows better performance than DSDV in terms of packet delivery ratio &Drop except Delay performance. DSR, AODV&DSDV use on-demand route discovery, but with different routing

mechanics. In particular, DSR uses source routing and route caches, and does not depend on any periodic or timer-based activities. DSR exploits caching aggressively and maintains multiple routes per destination. AODV, on the other hand, uses routing tables, one route per destination, and destination sequence numbers, a mechanism to prevent loops and to determine freshness of routes.

VIII. Conclusion & Future Work

In this paper we simulated wireless sensor networks routing protocols for DSDV, AODV&DSR using PHENOM attributes and comparing the performance analysis of various parameters like Packet Delivery Ratio(PDR),Delay&Drop usingNS-2.26.

To enhance these protocols by adopting various routing techniques with the help of OTCL linkage with C++ in order to get Energy Efficient Model.

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