International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 5 Issue 6, June-2016

Wireless Sensor Network based AODV and DSDV Routing Protocols using Qualnet

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Abstract: Wireless sensor networks (WSN) have generated tremendous interest among researchers in recent years because of their potential usage in wide variety of applications. Nodes in WSN communicate with each other using different routing protocols. A variety of routing protocols have been proposed for wireless sensor networks in the past. Based on update mechanisms, they are classified into reactive, proactive and hybrid routing protocols. The performance of these protocols varies depending on the simulation environment. Many researchers have been working in this direction to evaluate the performance of these protocols in different simulation environments. The main aim of this paper is to compare the performance of three different protocols- AODV (Ad-hoc on demand distance vector routing) and DSDV (Destination-Sequenced Distance-Vector Routing) which constitutes a good combination of on-demand (reactive), table-driven (proactive) and hybrid protocols respectively. It is taken into account that these protocols are the best protocols in their respective domains due to their low overhead. The performance of these protocols will be analyzed in two ways. Firstly, by keeping no. of CBRs constant and varying nodes from 10 to 50. Another way is by keeping no. of nodes constant and varying no. of CBRs from 1 to 7. The evaluation is done by considering the performance metrics - throughput, jitter and average end to end delay. The simulator used is Qualnet 7.3.

Keywords: WSN, Qualnet 7.3, nodes, CBR, Routing protocols (AODV, DSDV).

INTRODUCTION

The basic task of sensor networks is to sense the events, collect data and send it to their requested destination. The main problem in wireless sensor networking is the efficient transmission of data packets to the mobile nodes. Hence, proper routing in wsn is the challenge to the designers. A Wireless sensor network (WSN) is the collection of homogenous, self-organized nodes called sensor nodes. These nodes have the capabilities of sensing, processing and communication o data with each other wirelessly using radio frequency channel.

Many routing algorithms have been proposed for proactive and reactive approach and as well as for hybrid approach [1]. In proactive routing approach it continuously evaluates the path of the network, so whenever it needs to send the packets in the network the routes is already known and can send immediately. Reactive routing protocol invokes the route only when it is required. So route determination required more time as compared to proactive protocol. Because of larger delay and control traffic it is not applicable to the real-time system.

Hybrid routing is the combination of proactive and reactive approach and it make use of proactive to determine the early routes in its internal zone whereas uses the reactive approach in its intra-zone, that is communicating between inter-zone of the network. ZRP uses the hybrid routing approach. To identify and select best routing protocol for an application, it is required to understand the strict demands of that application first and then to select the appropriate protocol to be implemented and simulated. There are several routing protocols developed for WSNs. All these routing protocols have different competing features and qualities. Therefore, the selection of correct routing protocol is vital. Based on the route selection classification, WSN protocols can be categorized in three parts i.e. proactive, reactive and hybrid.

The performance comparison for all the approaches is presented in this paper. Routing protocol DSDV is for proactive, AODV is for reactive and ZRP for Hybrid are well-known approaches in their respective domains. The parameter throughput, end-to-end delay and jitter are examined for each of the approaches Finally, the simulation results of protocols implemented on Qualnet 7.3 are concluded here.

WSN ROUTING PROTOCOLS CLASSIFICATION

Classification based on Route selection or routing information update mechanism is shown below in figure 1. Routing is a method to choose the best path from source to destination to send data packets in a network. The WSN routing protocols can be classified into large number of routing protocols based on different criteria's. Based on the routing information update mechanism, there are three different types of routing protocols namely- Proactive or table driven routing protocol, Reactive or on-demand routing protocol and Hybrid routing protocol.[2] This classification of protocol is based on how the source node finds a route to a destination node.

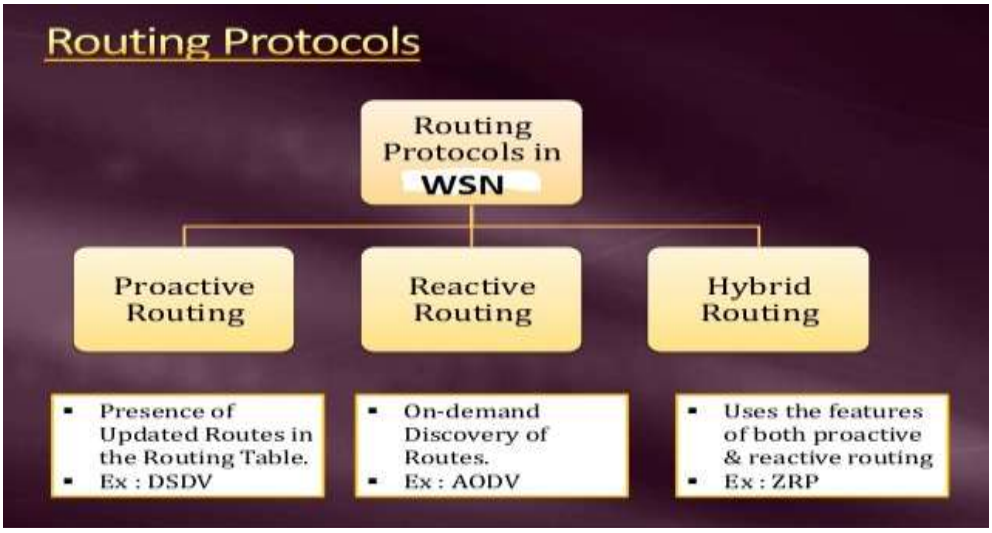


Figure 1 : Classification of Routing Protocols

1) Proactive Protocol: Proactive routing protocols are also known as table driven protocols.Here each node maintains a routing table for keeping the updated route information of others nodes [3]. This routing information is flooded in the whole network. Whenever the network topology changes, the corresponding update needs to be done throughout the network. This category of protocols has large bandwidth and more memory requirements making them more suitable for wired networks only. Destination Sequenced Distance-Vector Routing protocol (DSDV), Optimized Link State Routing Protocol(OLSR), Fisheye State Routing(FSR), and Source- Tree Adaptive Routing protocol (STAR) are some examples of proactive protocols. The chosen protocol in this category is DSDV.

DSDV

DSDV (Destination Sequenced Distance-Vector Routing protocol) is an enhanced version of the distributed Bellman-Ford algorithm, where each node maintains a table that contains the shortest distance and the first node on the shortest path to every other node in the network. It incorporates table updates with increasing sequence number tags to prevent loops, to counter the count-to-infinity problem and for faster convergence. As it is table driven routing protocol, correct route to any node in the network is always maintained and updated. The tables are exchanged between neighbors at regular intervals to keep an up to date view of the network topology. The tables are also forwarded if a node finds a significant change in local topology. This exchange of table imposes a large overhead on the whole network. To reduce this potential traffic, routing updates are classified into two categories.

The first is known as "full dump" which includes all available routing information. This type of updates should be used as infrequently as possible and only in the cases of complete topology change. In the cases of occasional movements, smaller "incremental" updates are sent carrying only information about changes since the last full dump. Each of these updates

should fit in a single Network Protocol Data and thus significantly decreasing the amount of traffic. Table updates are initiated by a destination with a new sequence number which is always greater than the previous one. Upon receiving an updated table a node either updates its tables based on the received or holds it for some time to select the best metric received from multiple versions of the same information update from different neighbors. The availability of routes to all destinations at all times implies that much less delay is involved in the route setup process.[4] The mechanism of incremental updates with sequence number tags makes the exiting wired network protocols adaptable to mobile ad hoc networks. Hence, an existing wired network protocol can be applied to mobile ad hoc networks with fewer modifications. DSDV suffers from excessive control overhead that is proportional to the number of nodes in the network and therefore is not scalable in mobile ad hoc networks. Another disadvantage is stale routing information at nodes.

2) Reactive protocol:

It is also called On Demand routing because it establish a route to destination whenever a node has something to send thus reducing burden on network. In this case protocols do not maintain network topology information. When a source wants to send data to the destination, it invokes the route discovery mechanisms to find a path to the destination. Hence the routes are created on demand and table updating is not required here. [5]This type of protocols is more suitable for ad hoc network as they do not have large memory and bandwidth. In comparison to Table Driven routing protocols the routing delay in this case is quite high since the routes are created when required. Some examples of reactive protocol are Dynamic State Routing protocol (DSR), Ad hoc On-Demand Distance Vector Routing protocol (AODV), associativity-based routing *(*ABR*)* and Location-Aided Routing *(*LAR*)* . The protocol taken into consideration is AODV.

AODV

The AODV (Ad hoc On-Demand Distance Vector Routing protocol) uses on-demand approach. Periodic exchange of routing information does not take place in this protocol. Here neighbour nodes store the route information of its next hop neighbour only. This protocol is based on two mechanisms i.e. route discovery and maintenance. AODV nodes use four types of messages to communicate among each other. Route Request (RREQ) and Route Reply (RREP) messages are used for route discovery. Route Error (RERR) messages and HELLO messages are used for route maintenance. The destination sequence number is used to make this routing protocol loop free and identify the most recent path. When route for destination is not available, the source floods the Route Request packet in the network. It consists of source identifier, destination identifier, source and destination sequence number, broadcast identifier and time to live field.[6] When a node has to send data and wants a path to the destination, it sends Route Request message to the next neighbour node. The node which receives this message either forwards it to the next node or sends a Route Reply message if it has a path to the destination. AODV does not repair the broken links locally. When a link breaks between any two nodes, they send a Route Error message to inform the end nodes about the link break and this link is removed from the table of the end nodes. Once again the source starts the path finding process with a new broadcast ID and old destination number.

The main advantage of AODV protocol is route is discovered and identified on demand. The count- to-infinity and loop problem is solved with sequence numbers. The disadvantage of AODV is poor scalability and unnecessary bandwidth consumption, due to periodic beaconing [7].

SIMULATION RESULTS & ANALYSIS

The analysis and comparison of protocols can be done by testbed, real world experiments or simulation. Since simulation is cheaper and feasible so most research work of Wireless Sensor Networks is conducted using simulation software. It eliminates the need for time consuming and costly real world experiments. The simulator used in my analysis is Qualnet-EDU 7.3 that predicts wireless, wired and mixed platform network and networking device performance. The reason for choosing this software is its accuracy, speed and portability.

The main motive of this paper is to compare the performance of AODV and DSDV in different simulation environments. The comparison was made by varying the node density and the simulation environment one at a time and keeping all the factors to be constant. The simulation was carried on an area of size 1500*1500 sq units. The node density was varied from 10 to 50 nodes. In the scenario UDP (User Datagram Protocol) connection was used and data traffic of Constant bit rate (CBR) was applied between source and destination. The multiple CBR applications were applied varied from 1 to 7 CBR. Each simulation was carried out for 30 seconds. The performance metrics used for comparison were throughput, end- to-end delay, and jitter. Various parameters and their description is summarized below in the table given:

Table 1 : Simulation Parameters

PARAMETERS	DESCRIPTION
Network Simulator	Qualnet 7.3
Protocols Studied	AODV,DSDV,ZRP
Size of region	1500*1500 sq.units
Shape of region	Square
Mobility Model	Random Waypoint
No. of Nodes	10,20,30,40,50
Placement of Nodes	Random
Antenna Model	Omnidirectional
Traffic Source	CBR(Constant Bit Rate)
No. of CBR	1,3,5,7
Packet Size	512 bytes
Simulation Time	30 sec.
Radio Type	802.11b
MAC Protocol	802.11
Channel frequency	2.4 GHz
Data Rate	2 Mbps

The **snapshot of the simulation** keeping 30 nodes and 5 CBR is shown below.

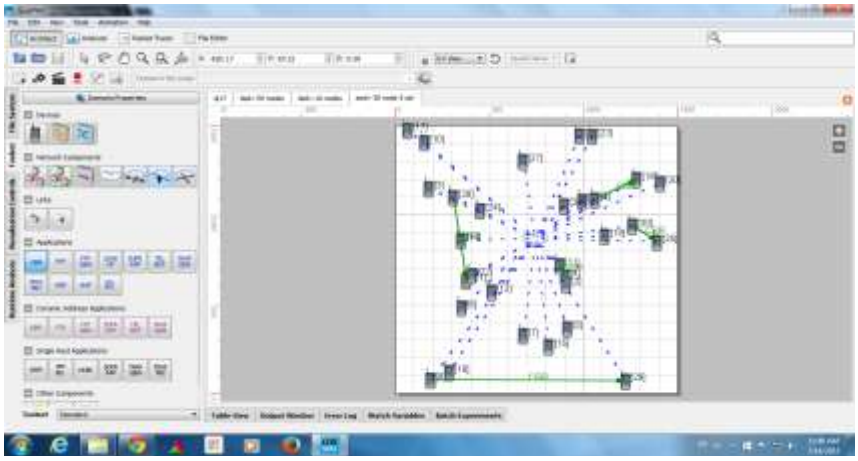


Figure 2 : Simulation Scenario

Expected Results:

The Qualnet 7.3 network simulator is used to analyze the performance of AODV, DSDV, and ZRP. The animation of nodes mobility and transmission of data of one of the scenario is shown in Figure 3.

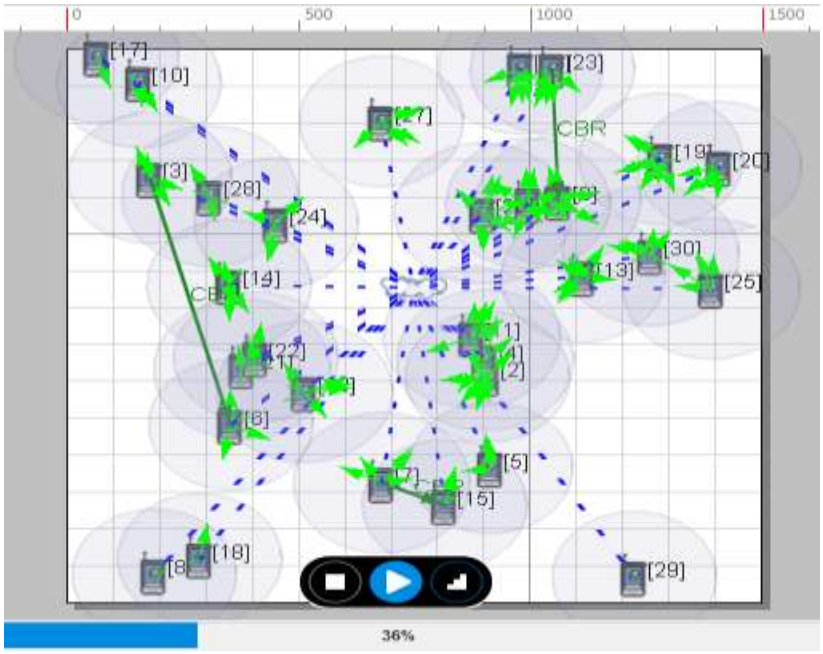


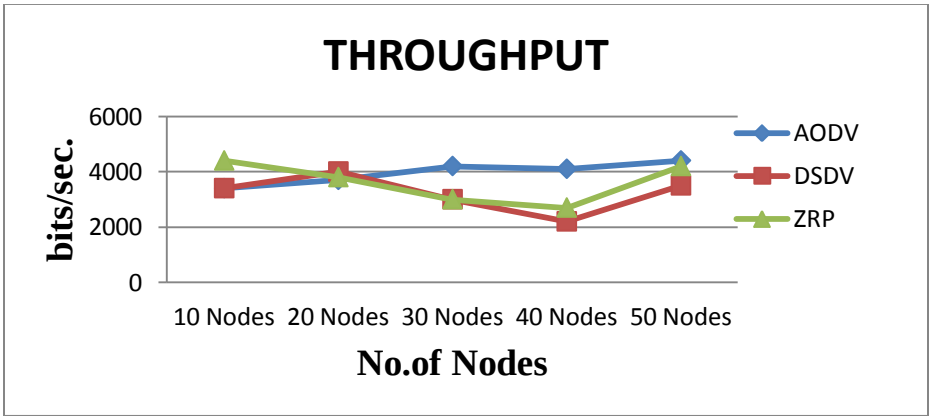
Figure 3. Running Simulation Scenario

Our study is divided in two conditions. Acc. to first condition, no. of nodes are varied keeping CBR constant and in second condition, no. of CBR's are varied keeping nodes constant.

Condition 1 - CBR CONSTANT AND NODES VARIED

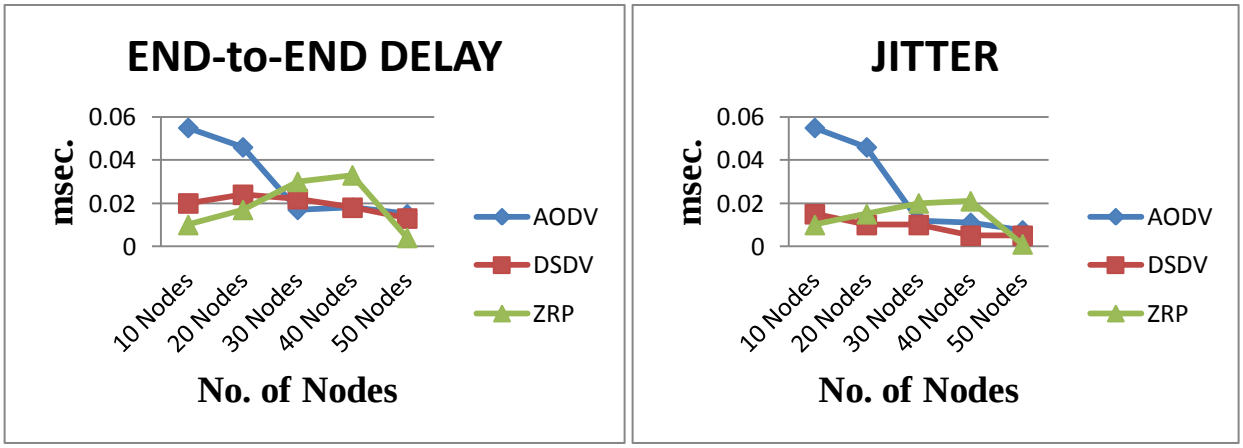
In this experiment, no. of CBR remains constant i.e. 3 CBR but nodes are varied from 10 to 50. Various results are obtained by comparing all the three protocols. Different Scenarios are created by firstly taking 10 nodes then, 20 nodes, then 30 and upto 50 nodes.

After the simulation of all the scenarios which has been created by varying the no. of nodes from 10 to 50 and keeping CBR constant, various results are obtained. All the results are analysed and briefed in the form of graphs given below.



Here, we notice that as the no. of nodes increases, value of throughput for AODV also goes increasing but in case of DSDV and ZRP throughput decreases as the no. of nodes decreases except when nodes are 50. So, overall we can say that AODV is the most preferred routing protocol for larger networks in terms of throughput.

AED and Jitter-



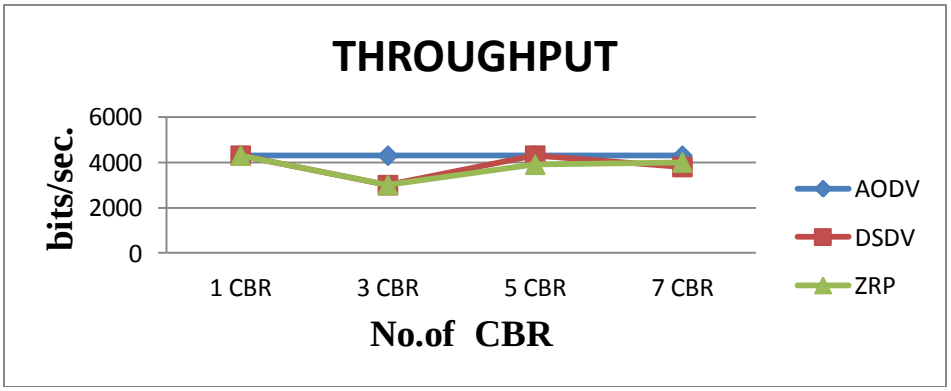
Here, we notice that as the no.of nodes increases, value of AED and Jitter for AODV and DSDV goes decreasing but in case of ZRP, these parameters increases as the no. of nodes increases except when nodes are 50.This behavior of ZRP is due to its hybrid nature because for smaller no. of nodes, it behave as a Proactive Routing Protocol but for larger networks, it distributes the nodes into different zones and hence, due to IERP effect, it behave as a Reactive Routing Protocol. So,overall we can say that AODV is the most preferred routing protocol for larger networks in terms of AED and Jitter because its these parameters decreases more sharply than DSDV.

Condition 2 - NODES CONSTANT AND CBR VARIED

In this experiment, no. of nodes remains constant i.e. 30 nodes but no. of CBR are varied from 1 to 7. Various results are obtained by comparing all the three protocols. Different Scenarios are created by firstly taking 1 CBR then, 3 CBR then, 5 CBR and at last 7 CBR

After the simulation of all the scenarios which has been created by varying the no. of CBR's from 1 to 7 and keeping nodes constant, various results are obtained. All the results are briefed in the form of graphs given below.

Throughput-



Here, we notice that value of throughput for AODV remains constant as the no. of CBR increases but in case of DSDV and ZRP throughput show many variations i.e. sometimes it decreases and sometimes increases but through deep analysis, we can also notice that despite constant behaviour of AODV, its value for throughput always remain on the top in comparison to DSDV and ZRP. Hence we can conclude that AODV is the best protocol in terms of throughput. It does not depend on the no. of CBR's.

CONCLUSIONS

It is analyzed and proved that AODV is more reliable protocol in terms of delay and throughput than DSDV. Network size has no considerable effect on AODV performance with respect to throughput but it does affect ZRP. In some scenarios, Routing protocol DSDV has also performed good even than AODV. However, not all of these protocols are efficient enough to fulfill all desired features of WSNs applications.

From the conducted study on selected protocols, we conclude that no one protocol is superior with respect to overall performance. The performance of one protocol may be far better in terms of delay other may be superior in terms of throughput. Secondly, network type and size of network also matters for protocols performance. Therefore, choice for selecting particular routing protocol will depend on application type (expectation from network) and intended use of network

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