SCENARIO-BASED PERFORMANCES ANALYSIS OF DBR PROTOCOL OF UNDERWATER SENSOR NETWORKS

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Abstract: This research paper provides overview over underwater sensor network protocols and put light over various categories of UWSN's routing protocols. After that this elaborate one flat based protocol named as DBR (Depth Based Routing) protocol and provides its functionality and working environment. As in mentioned title of this paper, scenario of DBR protocol taken as increasing number of nodes in six sets and execute such experiments to obtain parameters values like energy consumption, average throughput, average delay, average residual energy and residual energy sink and source node to communicate. This paper elaborates such simulation techniques to obtain results in graphical output beyond textual results using such tools like aquasim, NAM and tools of trace file. At end compare results of DBR protocols over increasing nodes and provide performance of DBR protocol.

Index Terms **- UWSN, DBR, Aqua-sim, AWK Files, Network Animator (NAM), Energy Consumption, and Throughput.**

I. INTRODUCTION

Earth is about to 70% of its surface is covered with liquid. It is a largely unknown region and has recently absorbed people to find out the reasons behind deserters. Natural disasters and man-made disasters that have occurred in recent years have aroused considerable interest in monitoring the marine environment for scientific, environmental, commercial, security and military purposes. Naval and offshore industries are increasingly interested in technologies such as wireless sensor networks as an economic alternative to modern and costly seismic monitoring methods, structural monitoring, and installation and anchoring. The most important technological advances in related fields have covered the way for many new network projects.

Sensor networks have giving its benefits in all areas of technology: science, industry and government to improve communication. The revolution is associated with the miniaturization and promotion of technology, namely, the availability of low-power processing units, storage units and micro electrical and mechanical systems (MEMS) for the construction of recognition units.

II. UNDERWATER SENSOR NETWORKS AND ITS PROTOCOLS

In UWSN underwater sensor nodes run on the batteries. So, if once node is installed, it's very difficult exchange or charge. By this efficiency of energy plays main role in UWSN. The possibility of having small devices physically distributed near the objects detected opens up new opportunities for monitoring and action in the world, for example, in the monitoring of micro-installations, structural monitoring and industrial applications. While sensor network systems begin to be used in current applications in the field, underwater operations are still quite limited in comparison.

A wireless submarine network is a technology that allows the use of oceanic applications. The water sensor network contains such variable quantity of sensors and vehicles used for joint monitoring actions in a sea. For this purpose, sensors and vehicles are organized in an autonomous network that can be adapted to the characteristics of the marine environment. Networks of submarines can be distinguished from spatial analysis and node density. In the networks of submarine sensors, the means used to transmit information are mainly used. Somatic waves include sound, radio and light.

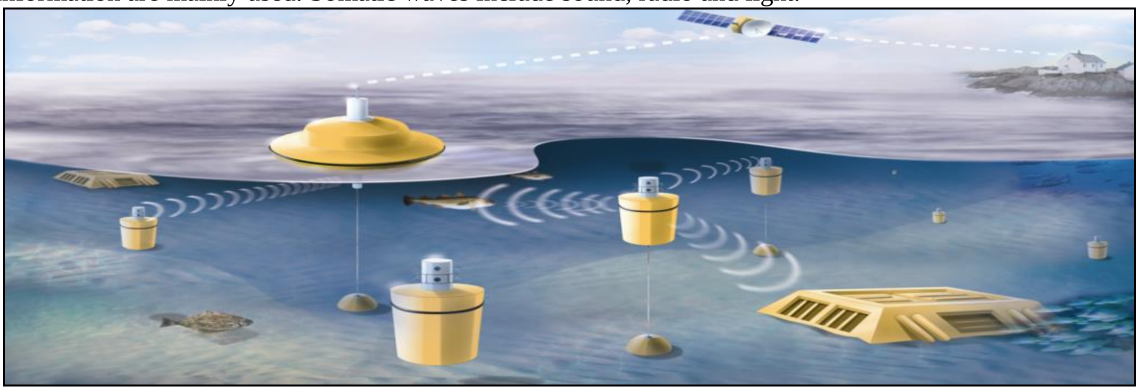

Fig.1 Layout of Underwater Sensor Network

Based on a comparative study, vectors can be selected for submarine sensor networks, which increase the efficiency of communication in a particular submarine environment. Because of the complex underwater environment, however, it is a very difficult research problem the way the collected data can be transmitted quickly and effectively to the nodes sinking on the surface of the sea.

III. UWSN'S PROTOCOLS CLASSIFICATIONS

A. **Location based routing protocols or Geographic based routing protocols:**

This deals in order to handle the problem of node mobility with known locations and geographic coordinates of all nodes.

B. **Flat based routing protocols:**

This kind of protocols is location free, so they have no need to manage table for locations of various nodes.

C. **Energy based routing protocols:**

In this, a layered architecture is constructed based on the different energy levels of sensor nodes.

D. **Hybrid routing protocols:**

This type of protocol works with identifiers registered in the node table after the sensor node, whereby the communication lines can be adjusted symmetrically or asymmetrically, playing a fundamental role in the path forming process.

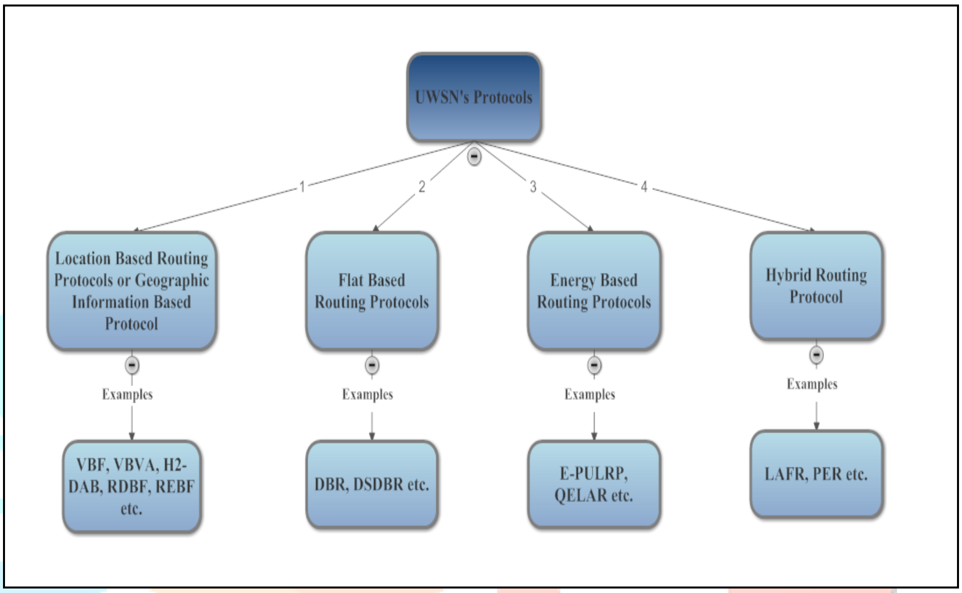

Fig. 2 ***Underwater protocols classifications and its examples***

IV. BACKGROUND: THE DEPTH BASED ROUTING (DBR) PROTOCOL DESCRIPTION

DBR make effective use of underwater framework: data sinks are normally settled at the surface of seawater. DBR greedily controls the data blocks on the surface of the water as a result of the depth data of each sensor. In the DBR, the data block has a field that records the depth data of its current provider and is updated with each hop. The fundamental thought of DBR is as per the following. At the moment when a node obtains a data unit, the packet advances if its depth is less than that implanted in the data unit. He has the data unit. Clearly, if there are many data receivers sent to the surface of the water, as in many submerged sensor designs under water, DBR can usually exploit them. In all the wells, it is assumed that the data units are transported efficiently to the final destination, since these wells can talk to each other by radio means, which have significantly higher transfer rates and much more propagation delays fast inferior.

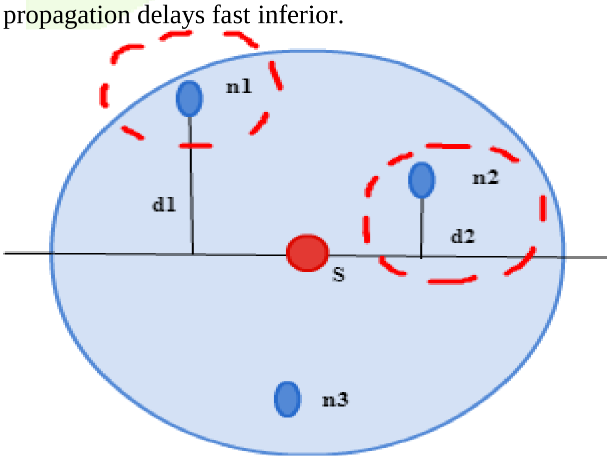

Fig. 3 Depth Based Routing (DBR) Protocol

In a DBR (Depth-Based Routing) protocol, each sensor node is determined by its choice on sending packets in the light of its depth and the depth of the sender passed. As shown in Figure 2, node S is a sender and all neighbor nodes, e.g. n1, n2 and n3, will receive his packages. Still, only n1 and n2 are nominated as candidates that send nodes because they are near to the destination node on the sea surface. Furthermore, node n1 is preferred for forwarding packets when it is in contrast to node n2. The advancement of node n2 is neutralized if the package is picked up from n1 before its own reserved sending time specific to the data unit.

As outline, the principle points of interest about DBR are as per the following.

- Full-dimensional location information does not require for it.
- It can deal with dynamic systems with great vitality effectiveness.
- This protocol works on node near to the sea surface.
- It exploits numerous sink arrange designing without presenting additional cost.

V. Experimental Analysis Setup

The experiment is implemented using the NS2 Aqua-sim, which is a level pack simulator. In Aqua-sim we implement the above with nodes and receivers. In this architecture, the DBR protocol is analyzed in a network of underwater sensors of up to 60 nodes. As a result, it produces the trace file. The trace file contains the information about the communication in a record format as text file. Using an AWK language that accepts a text file as input and processes the sequence of information on the record, we can set Energy Consumption, Average Throughout, Average Delay, Average Residual Energy (ARE), and Residual Energy of Sink and source nodes etc. Here we place the nodes uniformly in the scenario with an area of 100 cubic meters. The following table shows the simulation parameter.

TABLE I
Simulation Parameters

NS2 version	2.35(Aqua-sim)
Topology size	1000m x 10m x 10
Number of nodes	10,20,30,40,50,60
Transmission range	100 meters
Width	100
Packet size	50 bytes
Simulation time	350 Seconds
Initial Energy	10000
Idle power	0.008

Related to the Simulation we use the following concepts to reach our goals:

A. **NS2 Aqua-Sim Overview:** Aqua-Sim simulator is specialized for UWSNs, Which is developed on the basis of NS-2. Aqua-Sim can effectively simulate acoustic signal attenuation and packet level in underwater sensor networks. Furthermore, in Aqua-Sim the 3-D placement can be done. It can easily be combined with the present codes in NS-2. It is in parallel with the CMU wireless simulation platform. The Aqua-Sim can develop separately. It is a powerful regeneration tool, with high reliability and flexibility for Underwater Sensor Network (UWSN) research.

B. **Tcl Files:** TCL files are text files containing TCL scripts. TCL is a dynamic open source language used for building web and desktop applications.

C. **AWK Programming**: The NS2 text files can be processed using AWK language. The AWK program is a continuous instructions statement, in which every statement is a record. Each record is broken up into a sequence of fields. So we can consider the first word in a line as the first field, the second word as the second field, and so on. In actual fact, AWK is a stylish and simple language. AWK example shown in upcoming section in figure 4.

D. **Network Animator (NAM):** NAM is a Tcl/Tr (Trace) based animation tool for viewing network simulation traces and real world packet traces. It supports topology layout, packet level animation, and various data inspection tools. Nam began at LBL. It has evolved substantially over the past few years. The NAM improvement work was an on-going teamwork with the VINT project. Nam output example shown in upcoming section in figure 6.

VI. Scenario, Performance and Evaluations

Aqua-Sim (also called underwater sensor network simulation package) are being used for all simulations with Network Simulator (ns2). The Ns2 platform is an accessible source of great impact and is widely used. It provides a competent and reasonable technique to organize networks and nodes. In our simulation sensor, the nodes are arbitrarily in the range of 1000 × 10 × 10. Sensor nodes are stationary initially and after some time the sensor nodes move haphazardly in the X-Y-Z plane. Nodes speed is set to 0 to 3 m/s. We utilized following metrics for comparison.

A. **Energy Consumption:** Size of nodes in a network defines how much energy will be required. As the nodes in UWSN are big in size more energy is needed for its process, so analysing this parameter is very useful in each communication. The transmitting, receiving and ideal energy consumption of a node is represented by this. Energy consumption of a node at time of the simulation can be determined by finding the difference between the current energy value and the initial energy in the node. In Figure 7 shows total power consumption in the form of bar graph for all number of nodes. It shows that as the simulation time increases the total packet power consumption increases. The x-axis is Number of Nodes and y-axis is power (watts). These parameters show the consumed energy of each node to share date between and transmitting signal for communication.

$$\text{Energy Consumption} = \frac{\sum_{k=1}^{N} (E\,ik - E\,rk)}{\text{Total number of data packets received}}$$

where, *E ik* is initial energy of node k
Erk is residual energy level of node k
N is the number of nodes in the network

B. **Average Throughput:** This can be defined by the amount of data packets delivered in a communication. In the simulation, we are counting all packets that are received by the network. Formula to calculate throughput is given as (received data × 8/ Data transmission period). The code simply prints the observed throughput during the time interval during the simulation time. Figure 5 shows the yield. Show that as the simulation time increases, the throughput increases. The x-axis is the time (seconds) and the y-axis is the throughput (Kbit).

Throughput (Kbits) = (Received data × 8/ Data transmission period)

C. **Average Delay:** The long-term average number of customers in a stable system is equal to: the long-term average arrival rate multiplied by the long-term average time a customer spends in the system.

Delay= Arrival Rate* Time a customer spends

D. **Average Residual Energy:** A residual is generally a quantity left over at the end of a process. A residual is the difference between the observed y-value (from scatter plot) and the predicted y-value (from regression equation line). It is the vertical distance from the actual plotted point to the point on the regression line.

Residual Energy= Energy Supplied-Energy Consumed

E. **Energy Efficiency of source and sink node:** Energy is limited in both terrestrial and underwater sensor networks. Energy efficiency has been a top priority in MAC protocols for terrestrial sensor networks.

VII. SIMULATION SETUP

To performed simulation we use the steps as mentioned in the process chart as below:

- Basic needs for simulation setup we need such tools like ns-aqua, nam.
- Then first we make tcl files of our protocols DBR as per the required no of nodes. We deployed our nodes randomly with some moving positions.
- Than we execute commands “$ns-aqua-el6 file_name.tcl” under the directories installed of ns-aquasim.
- This produces results in form of data , trace, nam files. A parameters awk script to evaluate parameters of our protocols as mentioned above in section VI.
- Than we execute awk code as sample shown in figure with our commands of awk language like :
  $ awk -f Avg_Tput.awk DBR_m10.tr
  $ awk -f Avg_Del.awk DBR_m10.tr
  $ awk -f Av_res_en.awk DBR_m10.tr
- Above commands should be execute with all number of nodes computed in trace files from tcl files.
- We can watch the network animation with nam with commands as follows:
  $nam file_name.nam
- So by this setup we got results which are discussed in next section.

```
Awk for Residual Energy
BEGIN {
energy_left[size] = initenergy;
i=0;
total_energy_consumed = 0.000000;
total=0;
n=0;
}{
state       =     $1;
time        =     $3;
# For energy consumption statistics see trace file
node_num    =     $5;
energy_level     =     $7;
node_id     =     $9;
level            =     $19;
pkt_type    =     $35;
packet_id   =     $41;
no_of_forwards   =     $49;
# To Calculate Average Energy Consumption
if(state == "N") {
      for(i=0;i<50;i++) {
            if(i == node_num) {
                        energy_left[i] = energy_left[i] -
(energy_left[i] - energy_level);
}
            }
}
 }
END {
for(i=0;i<50;i++) {
total=total+energy_left[i];
if(energy_left[i]!=0)
n++;
}
```

Fig. 4 Sample of AWK script for residual energy

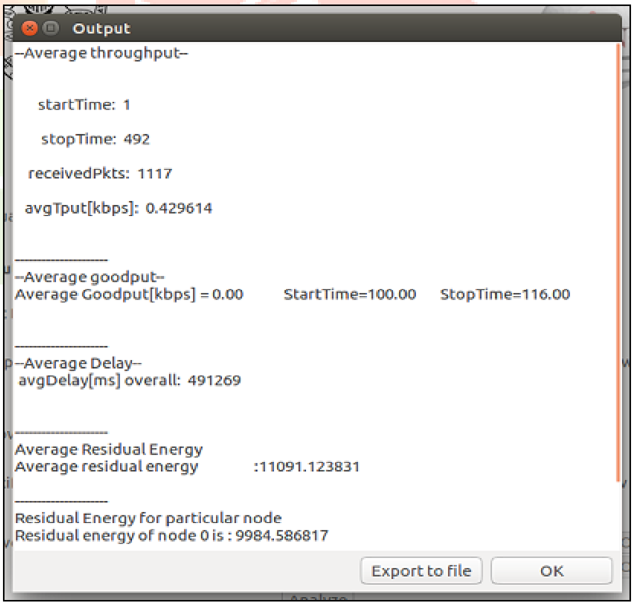

Fig. 5 Sample of AWK scripts output for DBR_10 Nodes

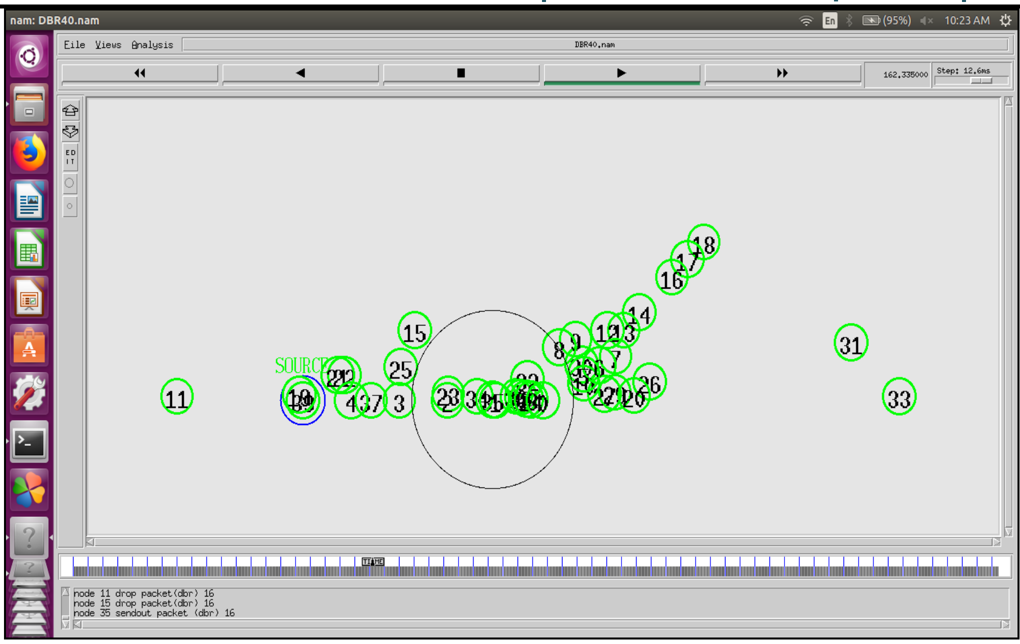

Fig. 6 Sample of NAM (Network Simulator) output

VIII. Simulation Results

Results of all parameters in the form of table and bar graphs are shown as below:

TABLE III
VALUES OF PARAMETERS FOR DBR PROTOCOL WITH VARIOUS NUMBER OF NODES

	No of Nodes→	10	20	30	40	50	60
Parameters	**Energy Consumption**	179.885519	443.175328	670.617622	947.209953	1178.580521	1434.083012
	Average Throughput[kbps]	0.429614	0.67256	1.38259	2.31322	2.86957	3.60106
	Average Delay[ms]	491269	491376	491563	491571	492112	492238
	Average residual energy	11091.12383	10502.99077	10321.70284	10232.12282	10180.02897	10180.14587
	Residual Energy of Sink	9984.586817	9979.183542	9978.937843	9977.21589	9978.065055	9977.307085
	Residual Energy of Source	9978.376564	9971.38581	9970.373459	9967.400394	9968.152319	9968.681782

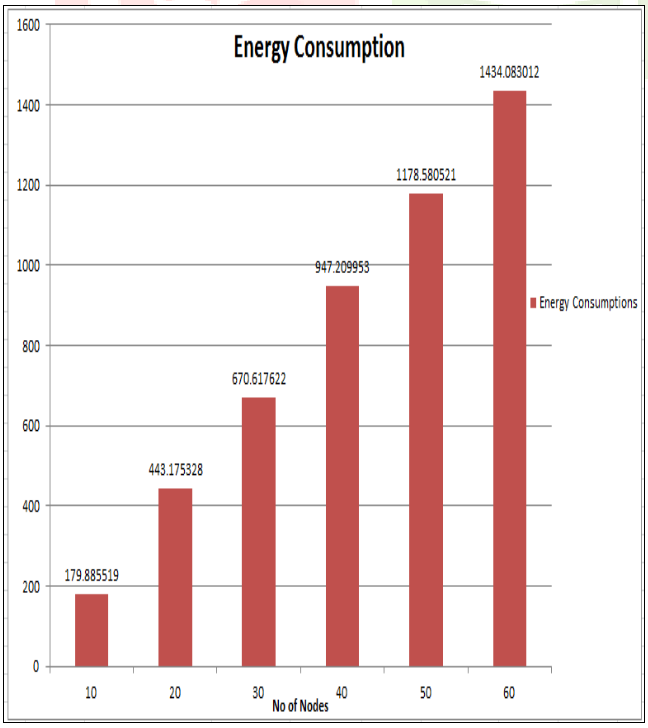

Fig. 7 Energy Consumption

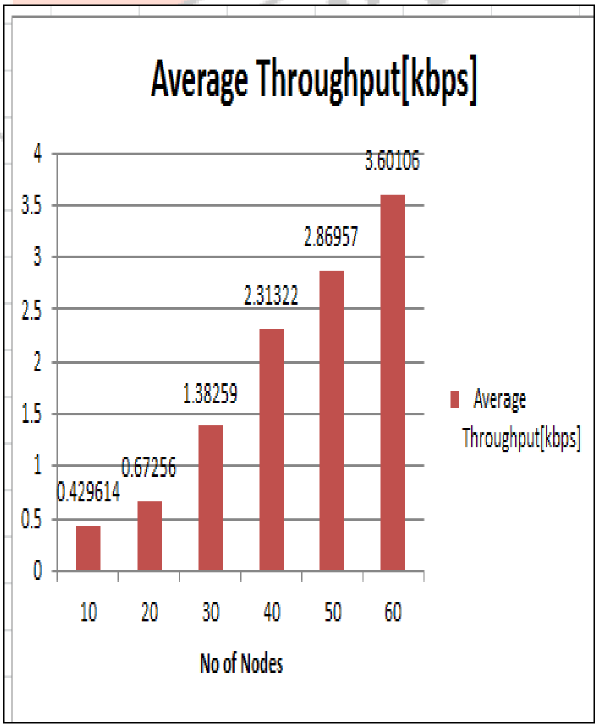

Fig. 8 Average Throughput

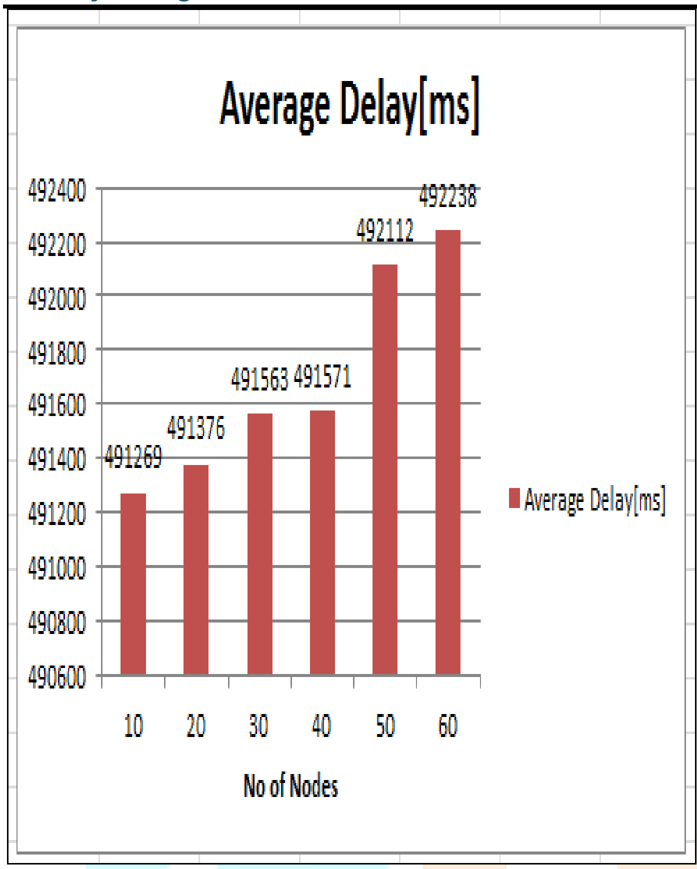

Fig. 9 Average Delay

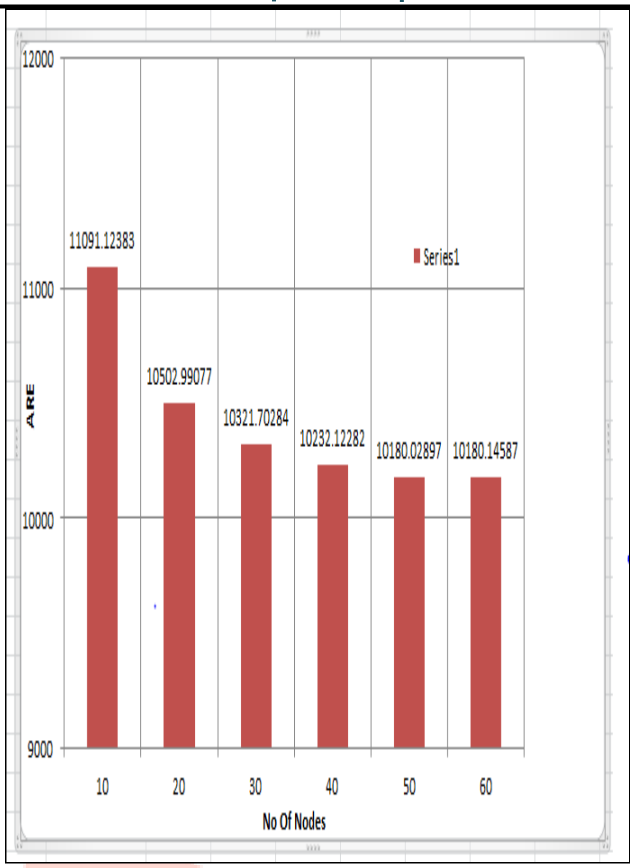

Fig. 10 Average Residual Energy

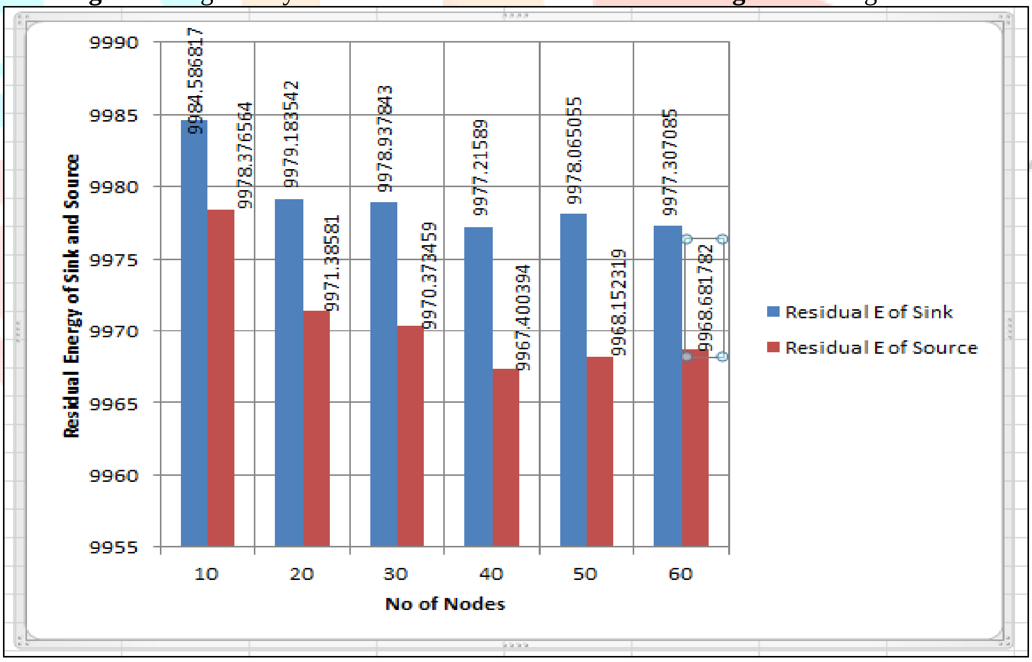

Fig. 11 Residual Energy Sink Node and Source Node

IX. CONCLUSIONS AND FUTURE WORK

In this whole scenario we conclude results as per the values observe from the simulations perform over the DBR protocol under the aqua medium. At 1st iteration we calculate the energy consumption that whenever number of nodes will increase than energy consumption will increase. In 2nd step we obtain throughput shows as no of nodes increase average throughput will also increase. After this 3rd point we obtain average delay will also directly proportional to the number of nodes, So Delay in packets delivery will also raise as number of nodes increases. Then in calculation of residual energy of nodes also affect the results that the overall energy remains with the nodes also high with increasing no of nodes. At last parameters we got that residual energy of sink will always greater than the source so that sink always consumes less energy than source node. The overall performance of DBR shows the proportional results and also motivates to do comparison with other parameters and also provides such base of calculation with various attacks over this.

One of the major goal can also be the comparison of moving and static nodes in DBR protocol can be accomplish and provides such another way to categorized and differentiate from other protocols.

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