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Research Article

An Implementation Of Eavarp And Eavar-Nca In Underwater Sensor Network

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Abstract: Under Water Sensor Network (UWSN) is developed to look at the unidentified underwater atmosphere by gathering the information about obstruction in the underwater, oceanographic and water properties. The exploration process in the underwater is a complicated method. Hence, sensor network is established in the ocean to identify the unexplored portions of the sea. Deployed network faces the traffic and routing problem and it is eliminated with the integration of node categorization procedure. The data loss or any other alterations in the diffusion of packet across the network is minimized with the tree generation and classification of nodes. The proposed scheme avoids the traffic, drop and modification of data packets. In this research work, Energy-Aware and Void Avoidable Routing Protocol (EAVARP) is modified by the scheme called classification of nodes.Concentric shell eventually minimizes the traffic problem in the node classification approach. Analysis of performance metrics results that the proposed algorithm EAVAR – Node Categorization Algorithm (NCA) performs well when compared with the other UWSN algorithms.

Keywords: Low power, packet dropping, node categorization, packet modification, sensor network.

I. INTRODUCTION

In order to satisfy the requirements of today's word, wireless technology has introduced and the key factors of wireless technology made popular among the world. The data transmission and communication is accomplished via wired channel in earlier days and ease of transmission is initiated with the wireless channel in later days. Radio channels are the medium of transmission in wireless communication. Every node in the network shares the common channel to exchange the data among the node. Establishment of the network is done through Ad-Hoc network [1]. UWSN is an eminent paradigm to uncover the sources in the ocean. UWSN met the challenges like broadcast delay, fragile link and mobility of node. Deployment of UWSN is extensively different from the terrestrial network. UWSN is involved in many of the calamity management applications, communication establishment among the submarines and to study about sources of the deep oceans [2,3].

UWSN has gained popularity among the researchers and wireless network development community. Design space of the UWSN is analysed using several experimental setups. UWSN integrates acoustic channel for the transmission and application development. Several emergency situations of the ocean are handled using UWNS and researchers also addressed the shortcomings of the UWSN such as localization, mobility, data collection [5], routing and synchronization [4]. Movement pattern of the nodes are the main concerns in UWSN. Diffusion of sensor nodes is influenced by the oceanographic creatures, water pressure and other factors of ocean [6]. Mobility models plays significant role in simulating the movement of node. Due to the varied conditions of the ocean, an efficient approach is needed to tolerate the shortcomings. The broadcasting of data and the communication establishment is attained via the acoustic channel and it is an attenuation of electromagnetic signals that achieves transmission quickly. Most of the terrestrial protocol designs are not applicable to the deep sea applications. Sink nodes are placed on the surface region which is assigned as an initial point and the remaining nodes are placed at several position of the ocean. The transmission channel is also established at the various depth levels of the sea. Frequent data transmission is at the surface level creates the hot zone which further leads to greater energy utilization, load, and latency. An excess load may lead to a scenario called flooding and traffic [7,8].

Mobility models mimic the mobility behavior of sensor nodes and it is used for simulation experiments in terrestrial sensor networks including a random way point model and a random walk. The effects of these mobility models on the performance of routing protocols have been investigated by a number of researchers. Movable patterns of the nodes may lead the routing problem. To address this issue UWSN is developed using the Node Categorization Algorithm (NCA) which uses tree structure to analyze the nature of the node and to identify the mischievous node. Excess flow of data is prevented using the strategy called NCA. Traffic issue and data loss is achieved effectively using the proposed algorithm and the computational complexity is also reduced.

The rest of the paper is organized as Section II gives the related works of UWSN, Section III explains NCA establishment method, Section IV shows the NCA working procedure, section V shows the analysis of simulation and Section VI concludes the paper.

II. RELATED WORKS

Kong, J., Cui, J. H., et al [12] studied theUWSN's novel framework to investigate the oceanographic atmosphere. Deployment of network under the ocean was faced by numerous challenges namely pollution, pressure and flow of the water. Despite the challenges, performance of the sensor node was also influenced by the acoustic link capability, schema less deployment and mobility of the nodes. Author has addressed the issues using the top-down approach. A practical application was taken into the account for addressing the challenges encountered by UWSN. Extensive study on UWSN protocol stack was carried to elucidate the design challenges of UWSN. In the ocean, the process of maintenance of node synchronization and coordination exploitation was complicated. Distributed Global Positioning System (GPS) was instilled to observe and regulate the behaviours of the node. The author had reported about various findings through this study paper.

Yan, H., Shi, Z. J., et al [13] had proposed a Depth Based Routing (DBR) protocol for UWSN. Acoustic signal showed better outcome over radio signal in the deep water surface. The performance of bandwidths and propagation delay magnitude of UWSN was considered against the radio signals. Another foremost dilemma in UWSN was localization and DBR method had solved the localization issue. DBR uses the data about the location of the sensor node. Dynamic character of the network has handled and reliable localization service was attained are main benefits of DBR protocol. PDR ratio was improved with effective cost management in DBR protocol.

Han, G., Zhang, C., et al [14] explained the impacts of network development and node assessment in the deep sea. The process of maintaining the network link and minimizing the fault rate was summarized. Establishment of underwater network in the ocean encounters abundant challenges namely nature of the sea and water they are pressure and flow of the water. Performance of the sensor node was subjective to the ability of the acoustic link, structure less and mobility of the nodes. From the study report, tetrahedron outperforms the cube and arbitrary node deployment schemes.

Pervaiz, K., Wahid, A., et al [15] developed Depth and Energy Aware Cooperative Routing Protocol (DEAC). DEAC incorporated the data propagation nature that uses the supportive routing scheme and it used the threshold valueD^{th} for every depth. Source nodes D^{th}value is optimized and it dependent on the count of the nodes in the network. The active node in the network decided the varied nature of the D^{th}value. The data transfer is accomplished using two mechanisms which eventually increase the performance of the network. Through the comparison of the available depth based protocols with DEAC, it wasfound that DEAC has better competence power.

Sajid, M., Wahid, A., et al [16] proposed the Sink Mobility with Incremental Cooperative Routing Protocol (SMIC). Several impairments influenced the behaviour of nodes in the network. Multiple transmissions result in higher energy consumption. SMIC used the mobile sink which has minimised the utilization of the energy usage. Transmission was improved using the Amplify and Forward (AF) method. AF was an incremental cooperating transmitting scheme. Every sensor was instilled with a depth sensor to estimate the data about the depth. Based on the data about the depth transmission was adjusted and better results were obtained. SMIC was depth sensor based scheme for the UWSN.

Umar, A., Akbar, M., et al [17]established a co-operating routing scheme. Various demands of UWSN, several new approaches were developed. In this scheme the data transmission was initiated with the assist of the partner node that the data was relayed from the initial to final node. Partner node was assigned with the help of several parameters namely threshold based on depth, prospective node, level of remaining energy and Signal Noise Ratio (SNR). The partner node elected based on the SNR values has showed best result than the other nodes. Stability and PDR value was improved with the assist of cooperating routing scheme.

III. NODE CATEGORIZATION ALGORITHM

In the proposed methodology, the best routing scheme and reduced packet dropping is achieved with effective node categorization approach. A tree is initially generated from the sink to the further data transmission occurred nodes. Every transmitted packet holds an extra data called packet marks. Through the packet marks sink obtains the data loss ratio. Dynamically changing structure of the tree effectively monitors the varied scenario of sensors.

3.1. Initial Deployment Strategy

In the distinctive environment, huge sensor nodes are arbitrarily distributed in the network. Periodical data generation is accomplished at every sensor node which is carried at the two dimensional space. In the initial state, network topology is formulated using the tree that lies on the Direct Acyclic Graph (DAG). Data transmission is carried through the routing tree. Every sending or forwarding packet in the network adds small portion of data mark which is if further utilized by the node categorization algorithm. During every transmission of the restructuring of the routing tree is done.

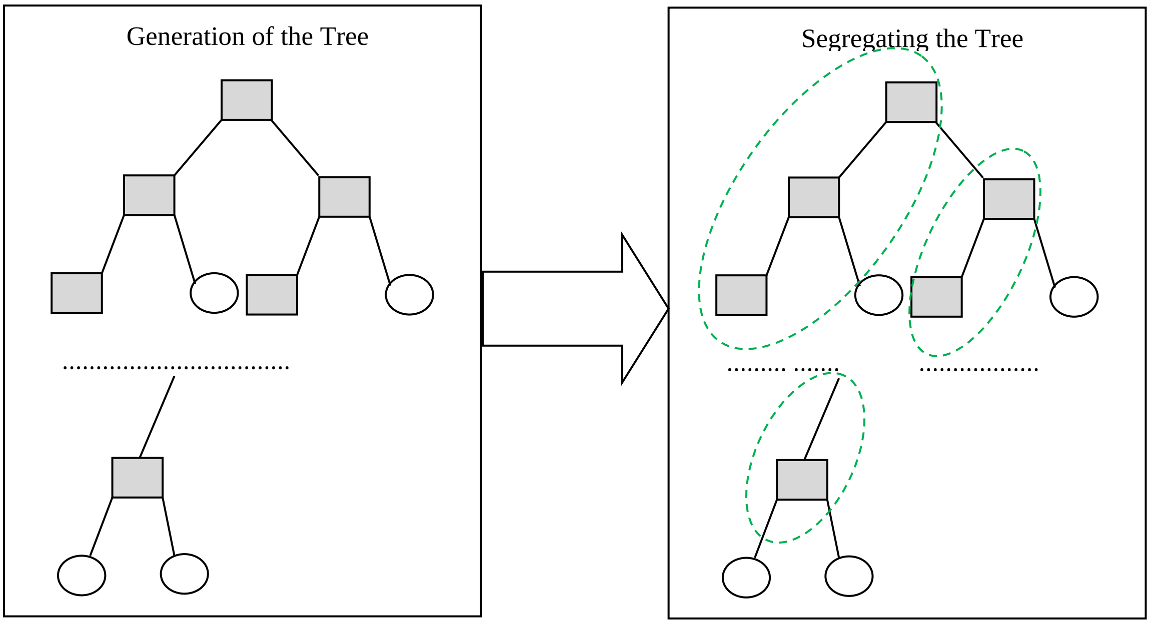


Figure 1. Generation tree using sensor node

Assume that set of nodes N and the set of categories $T_N = \{T_1, T_2, \ldots. T_n\}$. It is a multiclass classification and intent is to identify the varied categories of the nodes. The categorization of the node N that is used in identifying the type of a node.

Categorization of path: Computational complexity of a tree is signified as $Com_c(N_{l,i})$, F_i is the features of the node and $N_{l,i}$ is the parent node from the path N_r. Categorization of the path is give as

$$\boldsymbol{com_c(N_{l,i}) = Com_d + \sum_{l=1}^{h} com_f(F_{i,l}) + \sum_{q=1}^{j} \quad com_f(N_{i,q})} \text{ --------- } \mathbf{(1)}$$

The probability of the node p_i is expressed using the probability of the functions density F(X) is signified as

$$\boldsymbol{p_i = \int_D F(\chi)\mathrm{d}\chi,}$$

where

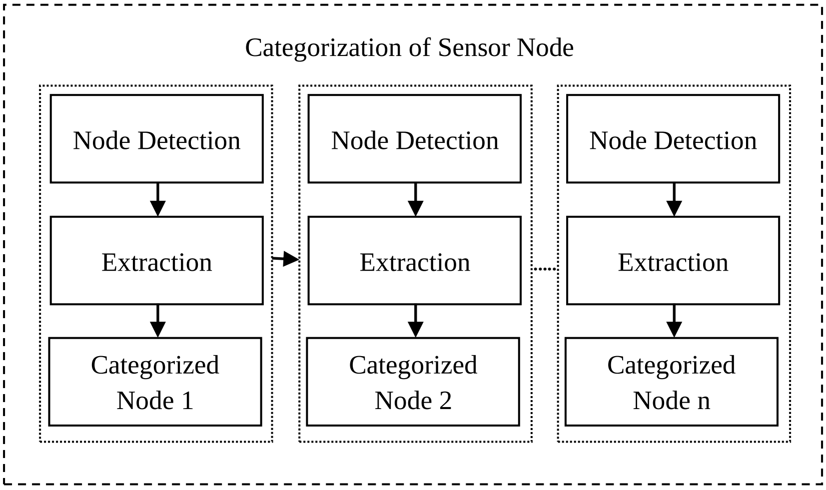
$$\boldsymbol{D = \begin{cases} D_{i,1,} ifT_j usesacousticinformation; \\ D_{i,2,} ifT_j usesnodeinformation; \\ D_{i,3}, ifT_j usesacousticandnodeinformation; \end{cases}} \text{ --------- } \mathbf{(2)}$$

3.2. Categorization of Node

In every transmission of the data, sensor node *u* and sink node *s* that tracks the forwarding data by the data forwarders. Based on the packet mark, nodes are categorized. At the end state of data transmission, sink node estimates the dropping rate of the data. Node involved in the transmission is categorized as bad (packet dropper), suspected to be a bad(suspected to be a dropper), and good(not a dropper). Generally, transmitted data is N_f and received packet is N_r. Dropping rate in every transmission DR is,

$$\boldsymbol{DR = \frac{(N_f - N_r * N_f)}{N_f + N_r + (N_f * N_f - N_r)}} \text{ --------- } \mathbf{(3)}$$

Main principle behid node categorization is nodes placed at the adjacent position has the low stretch which shows early aggregation. Source nodes location and the type of aggregation determines the routing process.



Every node has a unique key and a sequence number that are all used during data transmission. Once the intermediary node obtain a packet, it adds few bits to determine the transmitted path. The sink node tracks the transmitted path to determine path and the data drop. Misbehaving node is dropped and identified by the sink node and it decrypts the sequence number of the data.

Figure 2. Sensor node categorization

IV. PROPOSED ALGORITHM

In the data transmission environment, vast sensor nodes are arbitrarily distributed in the network. The type of the node is characterized with the node categorization and tree generation algorithms. Here, follows the procedure of the proposed algorithm.

Data Deployment: Initially needed nodes are deployed and the source as well as the sink nodes is assigned. Data is transmitted to check the traffic across the transmission area.

Tree Generation: Set of nodes N and the set of categories $T_N = \{T_1,T_2,....T_n\}$. It is a multiclass classification and intent is to identify the varied categories of the nodes. The categorization of the node N that is used in identifying the type of a node.

```
Input Tree T, with each node u, dropping ratio dr, threshold value ϴ, Sink node s, M minimum distance value, Md Set routing path find distance value
    Initialize the minimum distance value and initialize source node
    min = M
    for every sensor node in T do
    find dropping ratio dr
    if dr< ϴ then
    if dis<min && T<Md
    Set u as good or suspected to be bad;
    if dr = 0 then
    Set u as good
    else if dr> 0
    set u as suspected to be bad
    else
```

Pseudo code for EAVAR-NCA

A widely used simulation tool for networks is NS2. The programs in NS2 are written TCL is a front end and C++ is the backend. Once the program is compiled, automatically trace and nam files are generated through the program. Further, these files are used in defining the pattern of the mobility of nodes and the transmission is also tracked entirely. [18, 19]. In this section, EAVAR-NCA is tested using the activity of the network and evaluated using four different performance metrics such as death rate, energy consumption, end to end delay and PDR. Parameters involved in the simulation are represented using table 1.

TABLE 1. Simulation Parameters

S.NO	Metrics	Without IDS
1	No of nodes	100
2	Routing Protocol	DSR
3	Routing Protocol Queue Type	CMUPriQueue
4	Initial Energy	100(J)
5	Packet Size	500 bytes
6	MAC Type	Mac/802_11
7	Simulation Area	1300 * 1300
8	Sink Node	1
9	Monitoring Center	1
10	Sink Node Location	(468,990)
11	Monitoring Center Location	(559,990)
12	Relay node selection distance	250
13	Simulation Ending Time	60ms

Death Rate

Every node in the transmission area needs certain range of energy to accomplish the task assigned to the node. When the level of energy is below the needed energy level, then the node remains the same and doesn’t carry out any process which is a dead node. Death rate of the transmission is estimated using difference among the remaining energy possessed by the node and the entire network. Death rate is also increased due to the factors like uneven energy utilization, transmission delay and other network issues. Optimized energy usage and network maintenance reduces the death rate.

$$\boldsymbol{D_{rt} = A\_Erg - R\_Erg}$$

whereR_Erg **-** Residual energy of some nodes and A_Erg **-** Average residual energy of the network.

Table 2. The death rate of sensor nodes

Performance Metric	**Death rate (Death rate of sensor node/s)**	
Time (S)	EAVARP	EAVAR-NCA
600	0.78	1.04
700	0.81231	1.09
1000	0.846	1.40427
1500	0.92837	1.40522
1900	0.962	1.60517
2000	0.982	2.031

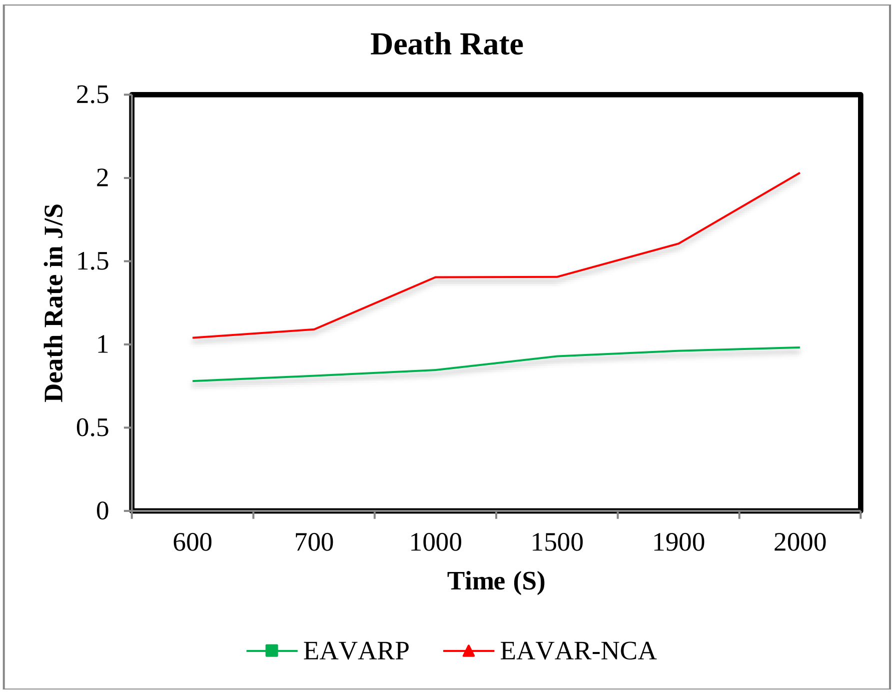


Figure 3. Comparison of Death rate for EAVARP and EAVAR-NCA and the death rate is increased in EAVARP when the simulation time initiated. EAVAR-NCA outperforms the EAVARP.

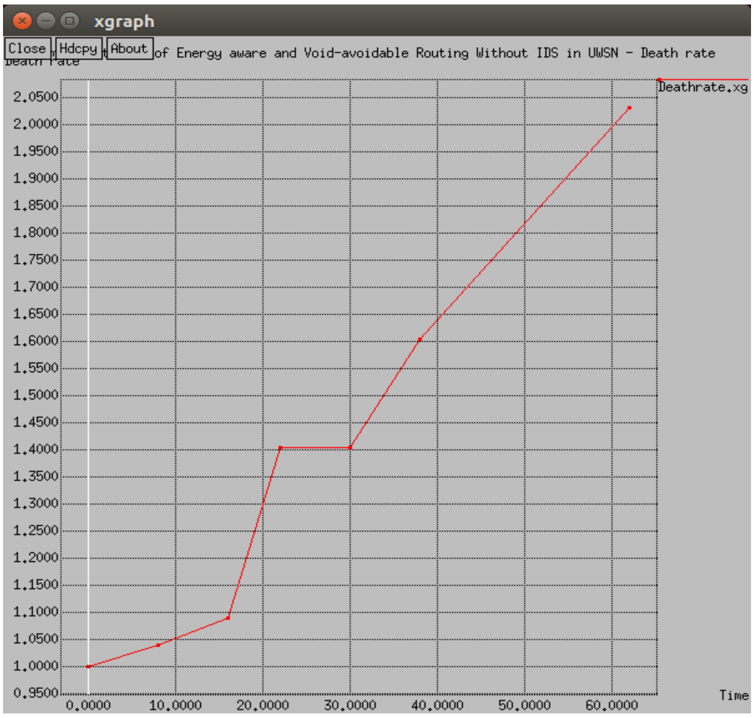


Figure 4. X graph for EAVAR-NCA

Packet Delivery Ratio (PDR)

PDR is a success rate of data transmission and it is used for maintaining the efficiency of the network. During data transmission sender transmits the data to the recipient node and the transmission may influenced by several factors which causes the transmission failure. The node successfully reaches the recipient by overcoming the influencing factors is estimated with total population of the node is PDR.

$$PDR = \frac{R_p}{S_p}$$

whereRp - Received Packets by sink node and Sp - Sent Packets by sensor nodes.

Table 3.PDR of sensor nodes

Performance Metric	**Packet Delivery Ratio (Pdr/s)**	
No of nodes	EAVARP	EAVAR - NCA
10	1.234	1.4
50	1.453	1.7
90	1.46	1.70177
130	1.4845	1.70465
170	1.675	1.95521
210	1.754	1.95538
250	1.786	2.03184

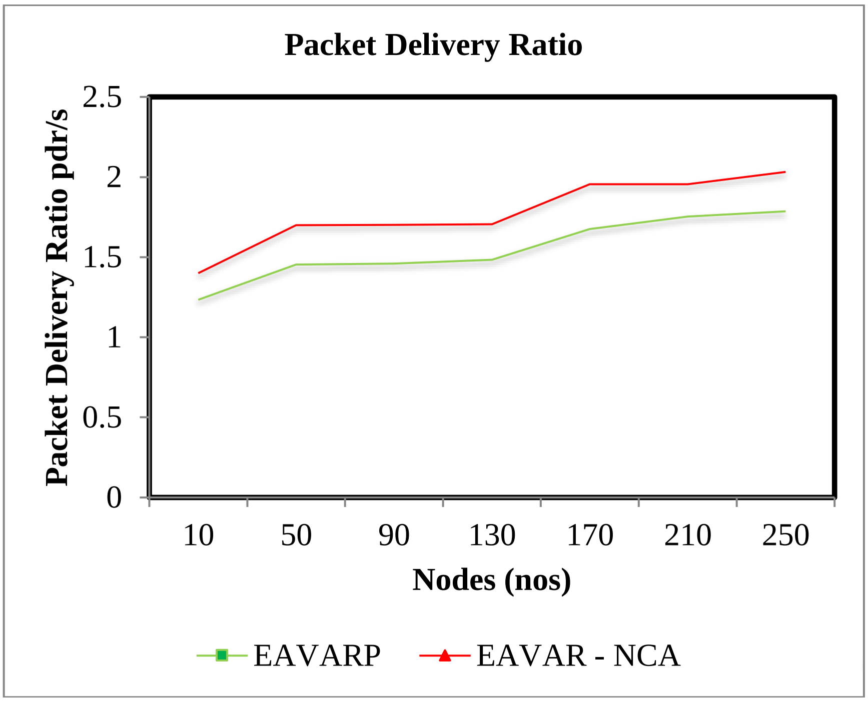


Figure 5. Comparison of PDR for EAVARP and EAVAR-NCA and the PDR is increased in EAVARP when the simulation time initiated. EAVAR-NCA outperforms the EAVARP

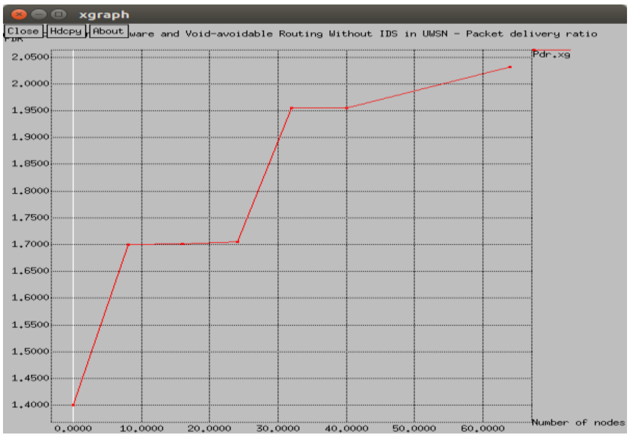


Figure 6. X graph for EAVAR-NCA

Average End to End Delay

Time utilized by the sending sensor node to the receiving node is termed as delay time. The total time T_i of sensor node sending a packet to sink node can be approximated by the sum of the transmission delay, the propagation delay and the additional delay.

$$T_i = \sum_{i=n}^{1} \frac{L_{packet}}{B} + \frac{d_i - d_{i-1}}{\vartheta} + \varphi$$

whereT_i - delay, L_{packet} - length of the data packet, i - the layer of a sensor node that sends a data packet, B - Bandwidth of channel, $d_i - d_{i-1}$ - distance from layer i to layer i – 1, ϑ - Speed of sound is (≈1500m/s) and φ - additional delay.

Table 4. End to End delay of sensor nodes

Performance Metric	**Average End-to-End delay (Delay/s)**	
No of nodes	EAVARP	EAVAR-NCA
50	3.675	2.55333
90	3.451	2.54551
130	3.401	2.5382
170	3.298	2.08912
210	3.209	2.08900
250	3.129	1.93515

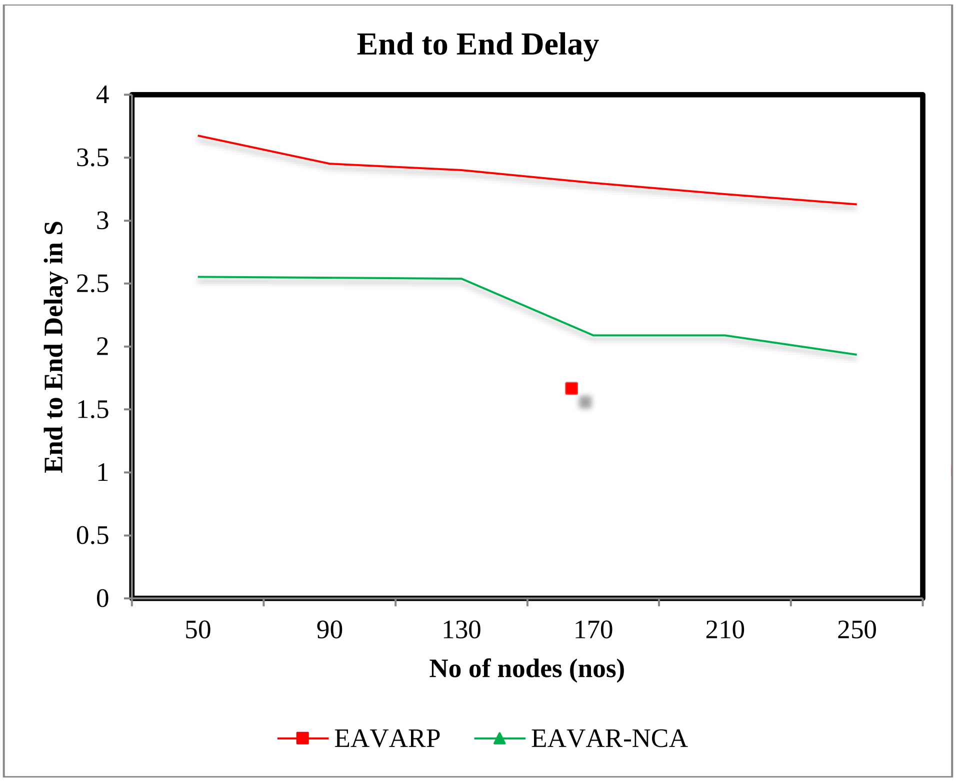


Figure 7. Comparison of end to end delay for EAVARP and EAVAR-NCA and the end to end delay is decreased in EAVARP when the simulation time initiated. EAVAR-NCA outperforms the EAVARP.

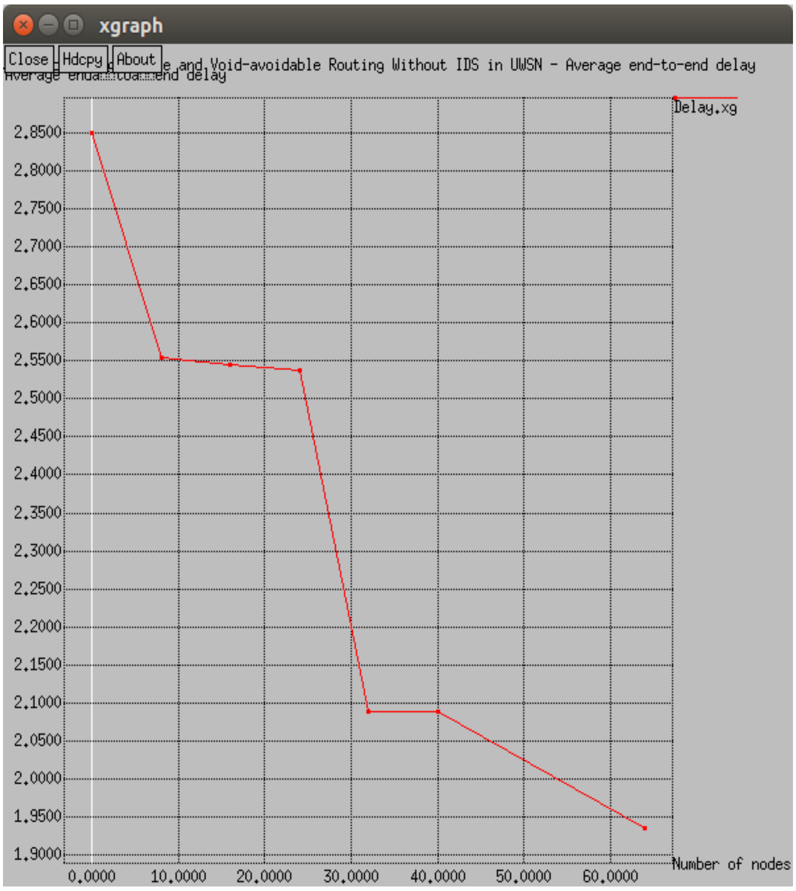


Figure 8. X graph for EAVAR-NCA

Energy Consumption

Energy is utilized by the entire packets in the whole network and maintaining the routing table in the categorization also influences the energy consumption. The total energy consumption energy utilized by the routing table is far minimum than the total energy consumption consumed by data transmission.

$$E_{total} = \sum_{j=p}^{0} \times \sum_{i=n}^{1} \mathbf{E_j} \ (\mathbf{h_i} - \mathbf{h_i} - \mathbf{1})\text{--------}\mathbf{(16)}$$

where $h_i - h_i - 1$ - Represents the distance between node $i - 1$ and node i and j - Last packet.

Table 5. Energy Consumption of sensor nodes

Performance Metric	**Energy Consumption (J/s)**	
No of nodes	EAVARP	EAVAR-NCA
50	1078.87	798.957
90	1090.65	801.412
130	1159.9	803.72
170	1198	954.949
210	1265.87	954.990
250	1298.01	1129.11

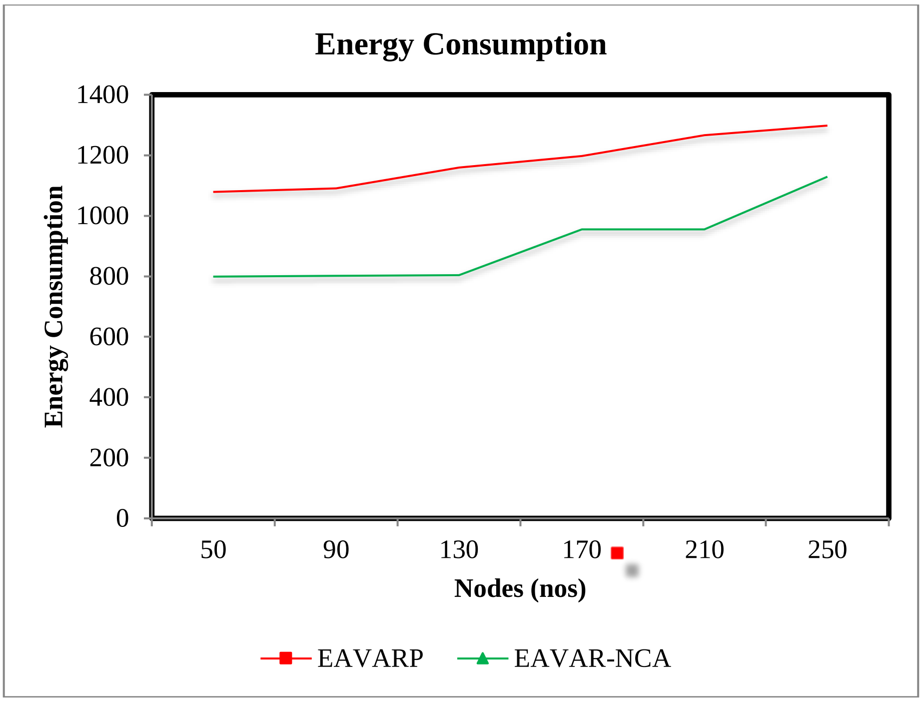


Figure 9. Comparison of Energy Consumption for EAVARP and EAVAR-NCA and Energy Consumption is decreased in EAVARP when the simulation time initiated. EAVAR-NCA outperforms the EAVARP.

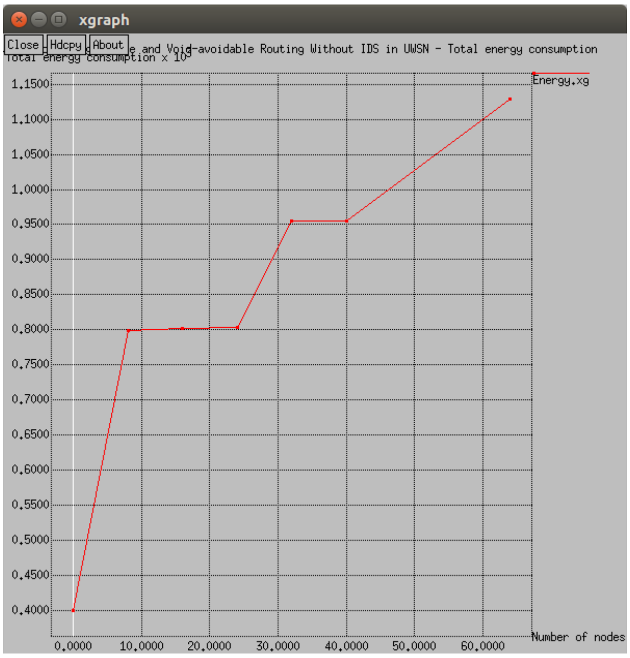


Figure 10. X graph for EAVAR-NCA

V. CONCLUSION

UWSN is an eminent paradigm to uncover the sources in the ocean. In the proposed scheme forwarders which posse flaws are identified using the NCA algorithm and the rate of packet drop is also reduced considerably. Every packet in the network is enciphered and attached with unique number to hide the data and to further tracking of data. Packet marks plays significant role in recovering the dropping data and to identify the data drop rate. Finally, tree based categorization approach shows effectiveness and the extensive test report on simulation also shows that the NCA has shown the better results than other UWSN algorithms. In NCA best path is chosen to handle energy related issues and removed the traffic problem.In future detection accuracy and security issues are rectified by the modification of the algorithms.

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