Achieving QoS in Underwater Sensor Networks

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Abstract— **Wireless information transmission through the ocean is one of the enabling technologies for the development of future ocean-observation systems and sensor networks. Pervasive Underwater sensor networks (UWSNs) establish the communication in underwater for various applications such as natural exploration, surveillance, resource management etc. The prime factors to achieve effective communication through acoustic channel of these networks are the Energy and Reliability. owing to the long propagation delay and high error rate of acoustic channels, it is very challenging to provide reliable data transfer for UWSN.For throughput and robustness of networks it is proved to be that network coding is an effective coding technique. So this paper proposes a communication model called EERCM that utilizes a Multipath routing with network coding to improve reliability and energy efficiency in UWSN.By adopting the hop by hop transmission method to form multipath, this model reduces the energy consumption of acoustic nodes to achieve energy efficiency and without framing of end-to-end paths, each node maintains the path information for local nodes to the next hop node and during the hop node election neighbor nodes are diverged into groups and then the sensed information is sent to the next hop node that hop to lesser sink node. So from this redundant information provides reliable communication. This model is implemented and its performances are evaluated.**

***Index Terms*— Acoustic Channel, Energy efficiency communication, Multipath communication, Reliable communication, underwater sensor networks.**

I. INTRODUCTION

A wireless sensor network is a type of wireless network. It is small and basically consists of number of sensor nodes and these are working together to detect a region to take data about the environment. A wireless sensor network (WSN) is used to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. Sensor nodes can be deployed inside or in close proximity to a phenomenon of interest, which may be on the ground, in the air, underwater, underground, in vehicles or inside buildings [1].

In wireless sensor network, there are five types:

1. Terrestrial wireless sensor network
2. Underground wireless sensor network
3. Underwater wireless sensor network
4. Multi-media wireless sensor network
5. Mobile wireless sensor network

One third of the earth is covered by water. So the underwater communication is necessary for various applications such as monitoring, surveillance, scheduling, underwater environment control, commercial exploitation, scientific exploration, attack protection and prevention etc. The self-organizing network of Mobile UWSNs supports these applications. Underwater WSNs consist of a number of sensor nodes and vehicles deployed underwater. Unlike terrestrial WSNs, underwater sensor nodes are more costly and less dense. Independent underwater vehicles are used for searching or gathering data from sensor nodes.

Underwater sensor nodes use acoustic communications, since radio does not work well in underwater environments due to low bandwidth, large latency and high error rate. The underwater nodes are mobile due to water currents. The major issues to be considered while implementing the UWSN are Energy efficiency, Memory capacity, Reliability, Data synchronization, Redundancy, Data security, Corrosion of sensors so on.

Underwater monitoring missions can be very expensive due to the high cost involved in underwater devices, it is important that the deployed network be highly reliable, so as to avoid failure of monitoring missions due to failure of single or multiple devices. The network capacity is also influenced by the network topology. Since the capacity of the underwater channel is severely limited, it is very important to organize the network topology such a way that no communication bottlenecks are introduced.

Underwater acoustic communications are mainly influenced by path loss, noise, multi-path, Doppler spread, and high and variable propagation delay. All these factors determine the temporal and spatial variabilityof the acoustic channel, and make the available bandwidth of the Underwater Acoustic channel(UW-A) limited and dramatically dependent on both range and frequency. Long-range systems that operate over several tens of kilometers may have a bandwidth of only a few kHz, while a short-range system operating over several tens of meters may have more than a hundred kHz bandwidth. In both cases these factors lead to low bit rate.

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II. RELATED WORK

Multipath FEC Approach: In underwater sensor network, the major difficulties are propagation delay, high bit error rates, energy consumption and path loss. so for improving energy efficiency and reliability in underwater sensor networks ,a Multiple-path FEC(M-FEC) based on hamming coding was proposed.FEC becomes a suitable way for providing reliable data Communications when retransmissions are relatively costly or impossible. In FEC, redundancy is added for error prevention. Redundant bits are encapsulated with data bits to form encoded information. However this increases the payload for transmission. Addition of redundant bit is known as channel coding. Error Correcting Codes (ECC) (block or convolutional) are used for this purpose. FEC codes have constant throughput which is equal to the code rate. However it has the drawback of using parity bit irrespective of the existence of errors [2].

Forward Error Correction (FEC) or error control coding is a system for achieving reliable message transmission in a communication system by correcting errors in the receiver side (hence the name 'Forward'). Weak reliability and low energy efficiency are the inherent problems in Underwater Sensor Networks (USNs) characterized by the acoustic channels. Multiple-path FEC approach (M-FEC) based on Hamming Coding is proposed for improving reliability and energy efficiency in USNs. Although multiple-path communications coupled by Forward Error Correction (FEC) can achieve high-performance for USNs, the low probability of successful recovery of received packets in the destination node significantly affects the overall Packet Error Rate (PER) and the number of multiple paths required, which in turn becomes a critical factor for reliability and energy consumption[2].

III. PROPOSED SYSTEM

To improve reliability and energy efficiency in UWSN, Our paper proposes a communication model called **EERCM** that utilizes the advantage of Enhanced Network Coding based Energy Efficient and Reliable Multi-path routing.EERCM is designed with model where it has multiple paths to reach the sink node. Node-disjoint paths may be frequently long, due to of using multiple hops in underwater wireless sensor networks, and consequently use significantly more energy. In disjoint multipath, some nodes on main routing paths may be used for many times, which leads to more energy consumption. Multipath increases absolutely the number of paths. All the nodes on main paths may be used equally by turns, which leads to less energy consumption and makes overall network load balancing.

IV. ACOUSTIC CHANNEL

Underwater communication and networking has becoming very important for military and commercial purposes. To communicate in sensor network between sensor nodes, the characterization of underwater acoustic channel is important [3].Acoustic channel means it contains an equipment and physical media for the transmission of signals by the way of audio and ultrasonic phenomena. In an acoustic channel the signals are either passive type or the active type. Passive type means the sound produced by the process under inspection. Passive signal acoustic channel are useful in industry to know the noise uniqueness of manufactured products (for example, to know the quality of assemblies containing gearing), in medicine and to study sound from an organism.

Active type means which are specially generated. Active signals in the audio or ultrasonic range are used to find out the parameters of a medium, and to identify certain undesirable impurities. The underwater acoustic channel is to a certain extent is the most wireless communication medium. Limit the usable bandwidth say, a few kilohertz and several tens of kilohertz, depending on the range due to absorption at high frequency and ship noise at low frequencies. Due to reflection, refraction and scattering the horizontal underwater channels are prone to multipath propagation. Compared with speed of light, the sound speed c~1.5km/sec is low and may result in channel interruption (delay) spreads of hundreds or tens of milliseconds [4].

By three important factors, the acoustic propagation is characterized that is time-varying multipath propagation, attenuation that increases with signal frequency and low speed of sound(1500m/s).the channel capacity is limited and it depends on the distance[5].The fact that the acoustic bandwidth depends on the distance has important implication for the design of underwater networks. It makes a strong case for multihopping, since it enables transmission at a higher bitrates over each (shorter) hop by dividing the total distance between a source and the destination into multiple hops. The same fact helps to compensate for the delay involved in relaying. Since multihopping also helps in lower total power consumption. Its benefits are doubled from the view point of energy per bit consumption on an acoustic channel [5].

V. ENERGY EFFICIENT AND RELIABLE COMMUNICATION MODEL

Energy efficient and reliable communication model [EERCM] is designed as, where it has multiple paths to reach the sink node. In underwater sensor network from using multiple hops, the node disjoint path may be frequently long and from this energy consumption will be more. In disjoint multipath if some nodes on main routing path are used many times, leads to more energy consumption.

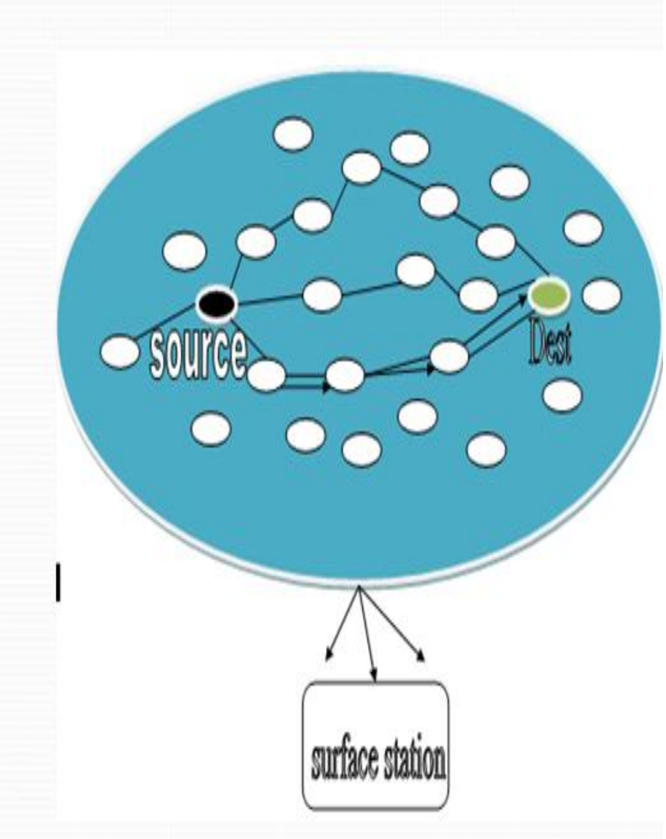

Fig1: System Architecture

The number of paths increases implicitly in multipath. So if all the nodes on main paths used equally by turns leads to less energy consumption and makes overall network load balancing.

Algorithm:

Finding shortest path to reach sink node, path setup and data transmission

Step 1: Algorithm for routing discovery

2. The source node send request to all neighboring nodes
3. Intermediate node update the path information
4. Intermediate node update the hop count to identify shortest path
5. Cluster head record the path information periodically
6. Repeat steps 1, 2, 3 until reaches the destination
7. Sink node replies

Step 8: Algorithm for path setup

9. Source node compute the shortest path hop count

Step 10: Algorithm for data transmission

11. Source node generates the Random Number (RN)
12. Source node encodes the data using RN
13. Sending data to the intermediate nodes until reaches the destination
14. Sink node receive the encoded data
15. Sink node decodes the data using RN
16. End

The algorithm is, first the source node send the request to all neighboring nodes. The neighboring nodes are selected based on some constant distance. The nodes which are within constant distance or equal to constant distance are selected as neighboring nodes. Then neighboring nodes update the hop count to know the shortest path to reach the destination node. Then source node select the shortest path based on minimum number of hops to reach the destination node. After selecting the path, the source node encodes the data using random number and sends the data through number of intermediate nodes (path) selected. After it reaches the destination, the destination node decodes the data using random number.

VI. IMPLEMENTATION

The Energy Efficient and Reliable Communication Model [EERCM] Provides energy consumption methodology, network load balancing and reliable data transfer. The objective function is the total energy consumption of each node involved in the shortest path. The neighboring nodes are selected based on some distance from source node and then after selecting neighboring nodes, the paths were selected based on minimum hop count.

VII. SIMULATION RESULTS

To run the experiment in order to identify the performance of the model in terms of threshold, the NS-2 network simulator is used with the AODV protocol. It uses AQUA-SIM package. For creating underwater network scenarios for simulation purposes the Aqua-sim is used.

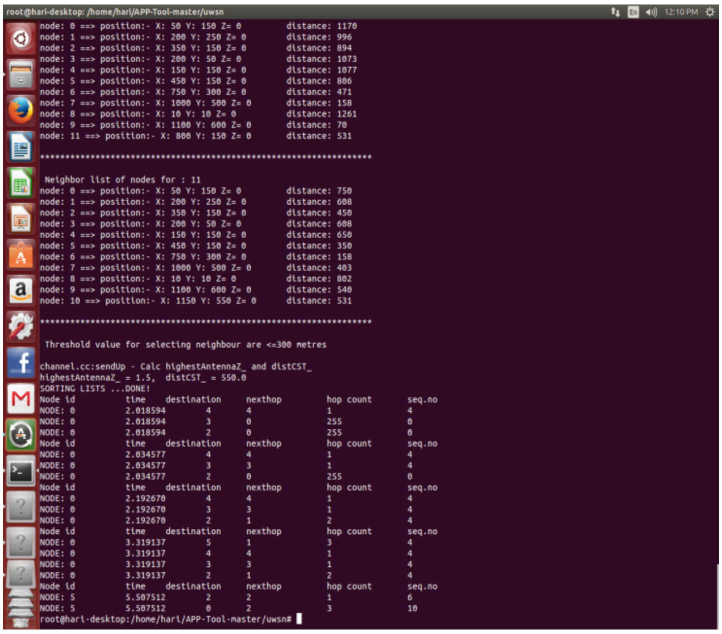

Fig 2: Selecting neighboring nodes

The fig 2 shows the selection of neighboring nodes based on the constant distance.

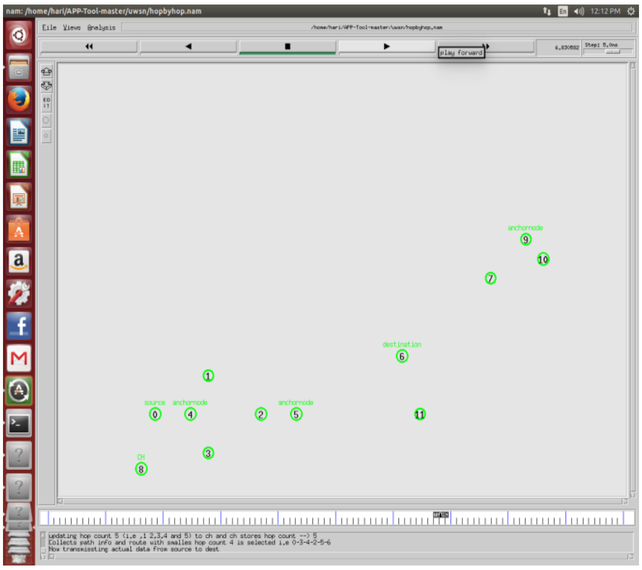

Fig 3: Data transmission

VIII. CONCLUSION

In this paper, EERCM model is implemented. This communication model shows gradual progress in both energy efficiency and reliability of the underwater sensor networks and then network load balancing. This model enhances the reliability of sensor network greatly and reduces the transmission path number. And calculates the each sensor node energy consumption, and then packet delivery ratio and reliability.

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