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PERFORMANCE ANALYSIS OF VBF PROTOCOL IN UNDERWATER COMMUNICATION FOR ANCHORING NODES AND MOVING NODES

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ABSTRACT

Underwater communication is a process of sending and receiving messages in water medium. Underwater acoustics sensor networks are used to monitor various ocean parameters with help of autonomous underwater vehicles. It uses acoustics waves to transmit data packets between the nodes. These data transmission gets interrupted by several problems like Fading, Multipath propagation, Absorptions etc. This paper explains the concept of vector based forwarding protocol for anchoring nodes and moving nodes. The simulation output is explained with graph plotted for time vs BER, Data Throughput, Delay and PDR. On analyzing the output performance obtained from graph we can conclude that VBF is an effectual protocol and it is more advantageous. The MATLAB has been not implemented since it has some drawbacks like I) It does not provide information related to topologies, power model or other factors like packet transmission, losses, and collision between the nodes. II) It does not support Routing protocols. II) It is used for specific application and applied at lower layers only. Hence we have analyzed the VBF using AQUASIM tool to make it a veritable protocol.

Keywords: AQUASIM, VBF-vector based forward BER-bit error rate, packet delivery ratio, anchoring nodes, central control nodes.

INTRODUCTION

The underwater sensor uses acoustic waves instead electromagnetic waves to transmit data packets between the nodes. High speed communications in underwater communication in underwater has been challenging because of several factors like noises, Doppler shift, fading etc. Energy management is usually done by batteries, but that is not sufficient to the entire maintenance. Hence it requires an efficient routing algorithm to handle the node mobility. In this paper we discuss about VBF routing protocol assuming two kinds of nodes namely Anchoring nodes (source) and moving nodes(to link source and destination), central control node(target). The moving nodes include slow and fast moving nodes. The information is obtained from the anchoring nodes which are designed in a way and the information may be an image or sound.

The various applications are
- **Ocean sampling networks: A**dvanced ocean models are used to improve the ability to observe and predict the oceanic environment with Networks of sensors and AUVs.
- **Environmental monitoring:** ocean currents and winds, improved weather forecasts, detecting climatic changes, understanding and predicting the effect of human activities on marine eco-system.
- **Undersea exploration:** Used to detect the underwater oil fields, reservoirs and also to determine the roots of the lying undersea cables and also assisting in exploring the most valuable minerals in the sea.
- **Disaster prevention and warning:** Sensors are used to measure the seismic activities from remote location to predict the tsunami warnings.
- **Navigation assistant:** Underwater Sensors identify hazards on sea beds by locating rocks or other submerged wrecks.

Unique features of underwater communication channel

a) Low bandwidth & high latency

Acoustics channels are used since radio frequency doesn't function well in underwater. The propagation speed of Acoustic signal in water is five times lesser than the speed of radio frequency signal. $(3 * 10 \text{ m/s})$.

b) Highly dynamic & BER

In majority most of the nodes are fixed, only few are moving with either low or medium speed. Usually UWV covers 3.6 km/h which is denoted as 2-3 knots. Hence this factor also affects the neighborhood nodes and protocol design. The channels are also affected by many factors such as Path Loss, Noise & Doppler Spread resulting in high bit error and delay variance.

c) Highly error prone

UWA communication channels are affected by many factors such as Path Loss, Noise & Doppler Spread. These problems result in high bit error and delay variance.

d) UW sensor networks are 3D

Usually acoustics outputs are deployed in 3 Dimensional spaces, terrestrial images are obtained in 2 Dimensional.

RELATED WORKS

Many research work have been done based on VBF, especially the BER, Data throughput have been analyzed with respect to number of nodes and graph have been obtained. [1]. in some research papers as one of the routing protocol and its types are discussed [2]. In few papers the VBF's best feature self-adaptation has been discussed. From the above studies, in this paper we deliver that VBF is a constructive protocol. [3-4].

Author has discussed about the good performance of metric protocol design with recovery mode in

underwater communication. And the entire test is done for Durbin Watson using ns2 simulation [5].

Author has evaluated many applications in which low cost, short range optical feature can be used to improve underwater sensor networks [6]. Research has been made on depth based routing protocol and various reports are obtained to support greater lifetime of Underwater sensor network [7-10].

Using WENZ model, a mobile network model is designed and simulated with addition underwater channel and network performance is analyzed [11]. This paper gives a fundamental aspects of underwater communication are researched. Main challenges and suggestion to integrate all communication functionalities are discussed in this paper [12].

The problems and challenges faced by researchers are discussed here. It also focuses on the developments of techniques for underwater networking protocols on basis of point to point communication [13].

VBF PROTOCOL

VBF is a location based routing protocol. In VBF, each packet carries the position of the sender, the target and the forwarder. It also carries two fields to maintain the node mobility. The RADIUS field is responsible for checking the presence of the forwarder node within a particular distance and the RANGE field is used to control the flooded packets at specific area.

The forwarding path in VBF is specified by the routing vector from the sender to the destination target. When packet is received, the relative position to the forwarder is computed by the node by measuring its distance and also by the angle of arrival.

Architecture

In this architecture, the number of anchoring nodes is three, and two central controlling node and the remaining nodes are slow and fast moving node. According to the notion VBF construct a pipe utilizing the nodes between the source (anchoring nodes) and destination (central control node).
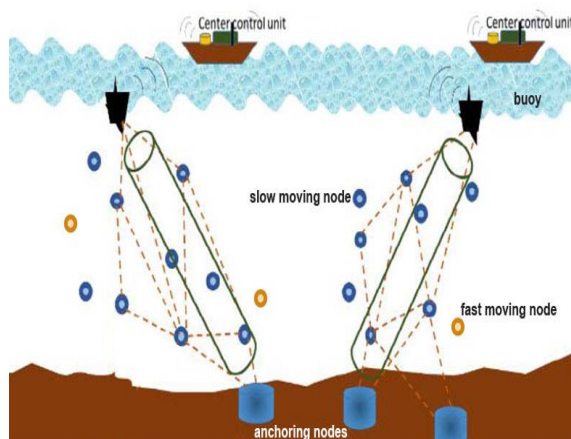

Figure-1. Architecture of VBF.

All the other nodes receive the packets and compute their position and form a routing pipe. If the forwarder finds itself near the routing vector, before finding the successive forwarder, it keeps the packet for small period of time, in which this specified time is referred as Tadaption and such characteristics of VBF is defined self-adaptation.

The Equation.(1) gives the mathematical expression for T Adaptation

$$\textbf{T adaptation} = \sqrt{\alpha} \ \ \textbf{x} \ \ \textbf{Tdelay} + \textbf{(R-d) / V} \quad (1)$$

where,
- V - propagation of acoustic waves ie$(1.5*10^3$ m/s)
- T delay – Time taken to delay the forwarding packets
- α-Desirableness factor
- d - distance between the existing node and forwarder.
- R - range

WORK METHODOLOGY

The work methodology defines the algorithmic steps to create and execute the VBF process. The nodes are created and forwarder is computed regressively to complete the data transmission.

Network performance

Aquasim is a tool independent of the wireless communication simulation package. The detailed overview is explained below and as shown in Figure-2.

It consists of 4 folders.
1. UW – Common: It includes codes to simulate sensor nodes and traffic.
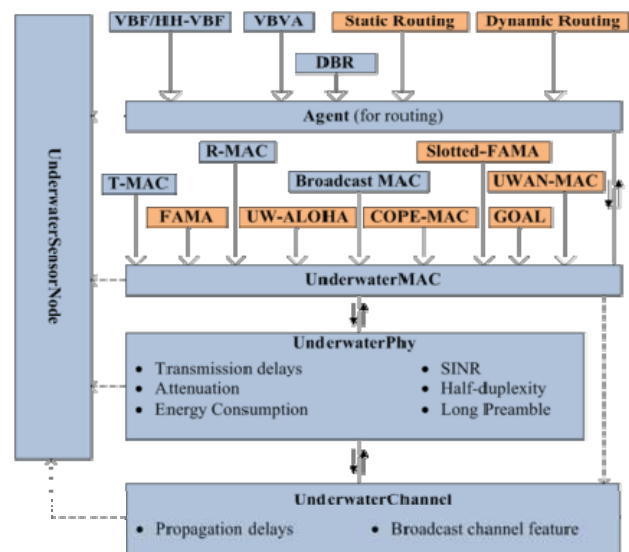2. UW – MAC
3. UW – Routing
4. UW-Tcl.

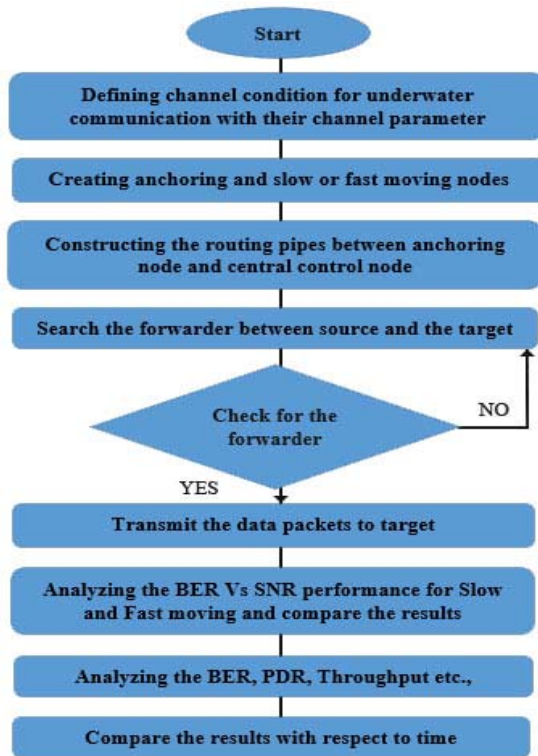**Figure-2.** Architecture of underwtaer aquasim.

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Figure-3. Flowchart of VBF.

Existing protocols

MAC: All classes of MAC are grouped in a single folder uw_mac .Public interfaces which are common to all MAC protocols are specified in underwater MAC.

ALOHA: It does not sense the channel, directly sends the data packets. It uses timer to get Acknowledgement from receiver, if not retransmit the data packet.

1. Broadcast MAC: It sense the channel for free avail   ability and then start sending data packets.
2. GO   AL – Geo routing aware MAC integrating VBF and handshake scheme

Slotted FAMA

1. TU-MAC: It uses CTS/RTS method in which the sender sends the CTS throughout the entire transmission range.
2. COPE-MAC: It uses two modules in parallel to handle long delays, 1) concurrent transmission 2) contention based. It avoids collision and improves efficiency.
3. R-MAC: It used for long delay and to achieve high energy efficiency. This schedules transmission of control packets and also avoids the collision.

Routing

The classes related to the routing layer are grouped under a single folder called uw_routing. The flowchart of VBF function is shown in the Figure-3. This follows the standards structure and can be adjusted using Tcl script Existing three protocol which are often used are

- VBF: Each node computes the position with respect to the neighboring node based on distance. Thus forming forwarding virtual pipe between target and source and complete the transmission.
- HH-VBF (Hop by Hop VBF): It utilizes a multihop to accomplish the objective.
- Depth based Routing: It is protocol based on greedy forwarding algorithm. It utilizes the depth information of sensor node to the forwarding nodes and transmits the data packet. It computes the depth of previous hop to the node with respect to the current node recursively.
- QELAR Routing: This is an adaptive, energy-effective and lifetime-aware routing protocol. It gets the knowledge from the sensors and designs the routing path with low hopping count thus saving energy.
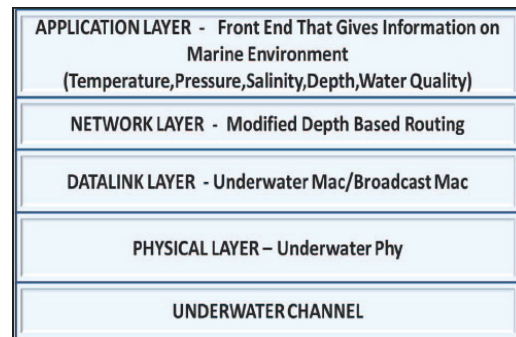

Figure-4. Layers of underwater channel.

Advantages of aquasim
- Discrete
- 3D networks and Mobile networks
- Simulate acoustic channels with high fidelity
- Implement a complete protocol stack

THEORITICAL ANALYSIS

The process is accomplished using NS2 Aquasim tool. The total numbers of nodes chosen are 50. Each node is separated from each other at a distance of 100m. The dimension of the topology is 1000*10*11. And the simulation time taken is for 50 sec. The size of each packet is about 50 bytes. It contains the details of the residual energy and depth of the individual node. As the VBF routing is initiated, each node starts computing its distance and position between the source and forwarder and it involves only the nodes available in the path between the source and target. It takes only single Hop. The usage of Broadcast MAC such as discovery of neighboring nodes, flooding, establishing route path, and self-localization was discussed here. The detailed

characteristic feature of underwater topology as shown in the Table-1.

Table-1. Characteristic feature of underwater topology.

S. No	Characteristic feature
1.	Dimension: 1000*10*11
2.	Number of nodes: 50
3.	Transmission range: 100m
4.	Width: 100
5.	Packet size: 50 bytes
6.	UW-MAC: Broadcast MAC
7.	Simulation time: 50 sec
8.	Initial energy: 10,000
9.	Idle power: 0.008

The energy level, PDR, BER, Throughput are calculated for smaller time intervals. Graphs are plotted between time vs parameters. Result Analysis. The different layer of underwater channel is shown in the Figure-4.
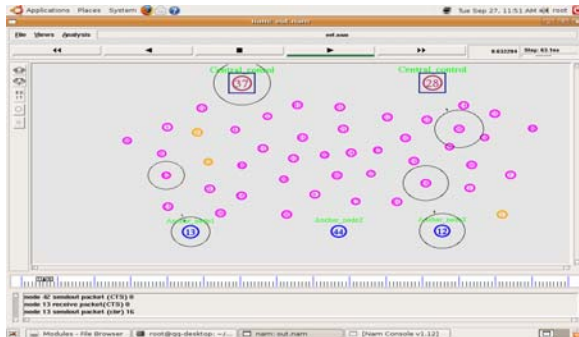

Figure-5. Simulation analysis.

a) Bit error rate vs time

The bit error rate is defined as the number of bit errors per unit time.
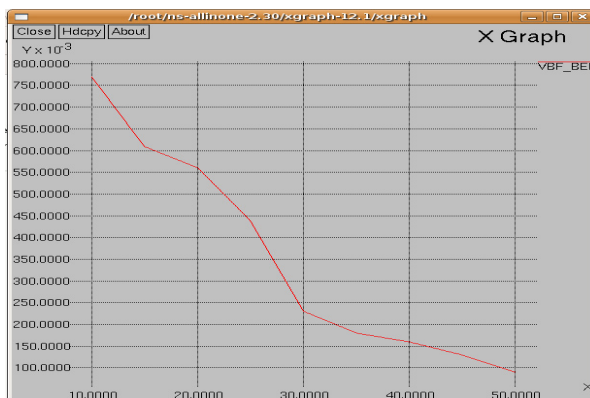

Figure-6. Bit error rate vs time.

Graphical analysis as shown in Figure-6 concludes that BER decreases with increase in time. Thus it improves the quality of the data transmission.
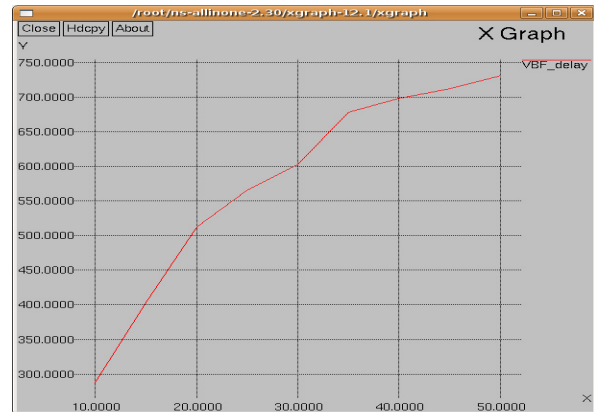
b) Delay vs time

Figure-7. Delay vs time.

The graphical result shows that the packet delay increases with the increase in time interval as shown in Figure-7.

c) PDR vs time & energy consumption vs time

PDR is the ratio of the number of packets transmitted by source to the number of data packets received at the target. We can analyze from the Figure-8 that PDR increases at particular time and gradually slows down, it increases with time interval finally.
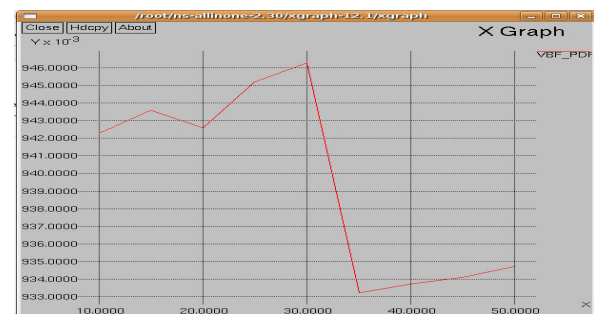

Figure-8. PDR vs time.

The amount of energy utilized by the nodes to transmit the data packets to the forwarder is the energy consumption. The analysis shows that system consumes more energy with increasing number of nodes.
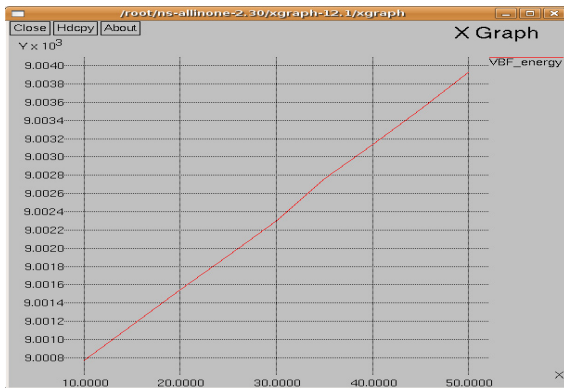
Figure-9. Energy consumption vs time.

From the Figure-9 the graphical analysis implies that energy also increases linearly with the time interval. This is one of the factors used to determine the efficiency in any routing protocol in UW sensor networks.

d) Throughput vs time

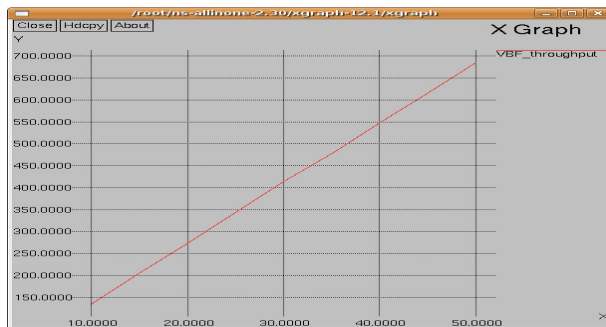This also varies proportionally with time interval as illustrated in the figure-10.

Figure-10. Throughput vs time.

FUTURE WORK

The result analysis is done on the basis of number of nodes and here we have discussed the performance of VBF with respect to time interval from 10 secs to 50 secs. The future work is planned to carry out on link quality between the nodes which adds more value to select VBF as the successful routing protocol in UW Acoustic communication and also planned to modify the existing VBF protocol with some feature to make it more efficient.

CONCLUSIONS

From the various result analysis of VBF protocol, we can conclude that this doesn't require individual state of information at every single node. This is also scalable with respect to the size of network. Only the nodes along the forwarding path are involved in packet routing thus saving the energy of the network using VBF protocol resulting in as an efficient routing protocol.

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