Review of DSDV routing protocol for Ad Hoc Underwater Acoustic Networks

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Abstract

Ad hoc underwater acoustic networks represent a very challenging field in digital communications due to the extreme nature of the underwater acoustic channel and also the requirement to meet critical needs in order to establish long range propagation, decentralisation and reliability.
As a fact the underwater acoustic communications speed is five times less than the magnitude of the radio waves, and this makes the underwater acoustic suffer from high propagation delay and minimum throughput.
This paper discusses the influence of the backoff windows on the ad hoc on demand Destination Sequenced Distance Vector (DSDV) protocol. Underwater Acoustic Media Access Control (UAMAC) is implemented in a NS2 simulator to adopt the Multiple Access Collision Avoidance and Acknowledgment (MACAW) scheme. The simulation results for the developed system are presented.

i. Introduction

Underwater Acoustic (UWA) networks are different from radio networks which suffer from low bandwidth and long propagation delay due to the low speed of sound underwater [1][3]. Energy costs in underwater acoustic networks are also different due to high consumption and the fact that they are battery powered.
MAC protocol with collision avoidance (listen then send) has been considered despite the hand shake procedure increasing the delay and lowering the throughput. However, it is used here because half duplex transmission mechanism is needed [4]. DSDV routing protocol is used to present the influence of the backoff contention windows.

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In Ad hoc networks, the main problem is to obtain the most recent state of each individual link in the network, so as to decide on the best route for the packets. However, if the communication media is highly variable as in the shallow-water acoustic channel, the number of routing updates can be very high. In this paper will give summary of DSDV ad hoc routing protocol which is used in this underwater acoustic network [6].

The Destination-Sequenced Distance-Vector (DSDV) Routing Algorithm is based on the idea of the Bellman Ford routing algorithm with certain modifications. Every node maintains a routing table that list all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node . The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The nodes periodically transmit their routing tables to their neighbours. A node transmits its routing table if a significant change has occurred in its table from the last update sent. So, the update is both time driven and event driven.

If a node detects that a route to a destination has broken, then its hop number is set to infinity and its sequence number increased but assigned an odd number and the even number correspond to sequence numbers of connected paths [5].

ii. Modified parameters in NS2 simulator

In this section we will discuss the modification made to the propagation and wireless physical layer in the NS-2 simulator to represent the underwater acoustic channel.

The path loss in the underwater channel is defined by Thorp's expression:

$$g(f) = \left[\frac{0.11 f^2}{1+f^2}\right] + \left[\frac{44 f^2}{4100+f^2}\right] + 2.75\times10^{-4} f^2 + 0.003 \quad (1)$$

where $g(f)$ in dB/Km and f is in KHz

$$\text{loss} = d^{\gamma} 10^{dg(f)/10} \quad (2)$$

Where d is the propagation distance, γ is the path loss exponent, which is set to two, and f is the centre frequency of the transmission, which is set at 20 KHz.

The propagation speed of the acoustic signals underwater is 1500 m/sec, where the standard propagation speed in the NS2 is changed by replacing the speed of light with the speed of the sound [2].
The implemented
Underwater Acoustic Media Access Control (UAMAC) is used as the MAC layer protocol. An unslotted Carrier Sense Multiple Access (CSMA) technique with Collision Avoidance (CSMA/CA) is used to transmit the packets.

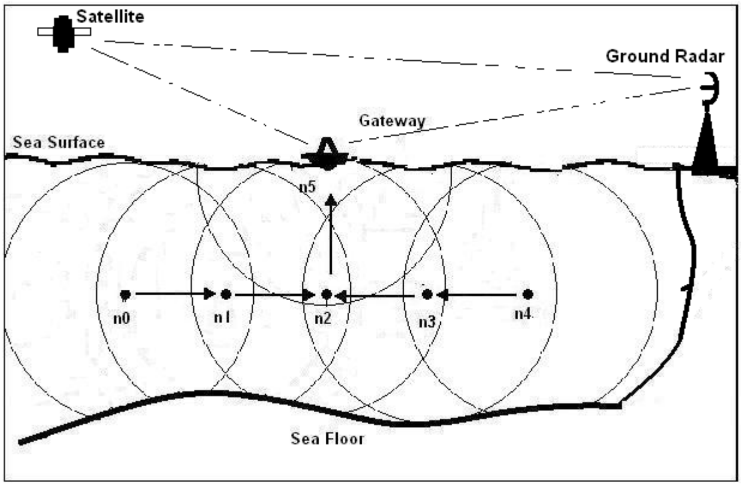

Fig. 1. Six nodes underwater acoustic network and the gateway receiving data from nodes 0 and 4

iii. Simulation and traffic model

The scenario which is used in this paper consists of six nodes. All nodes are stationary, placed in the sea at a depth of about 500 metres. The distance between each node is about 500 metres. Node 5 is the gateway. Nodes 0 and 4 send data to the gateway which is on the surface of the sea. The gateway forwards the data from the underwater acoustic network to the RF networks as shown in fig. 1.

iv. Network parameters

Simulate a virtual environment of 7000 x 2000 metres for 2000 sec of simulation time. Continuous Bit Rate (CBR) traffic source is used and the channel packet rate and packet size are set at 16 kbps and 1000 byte, respectively. The maximum transmission for each node is 600 m, so each node can only transmit to its adjacent nodes where transmission power is 192 dB re 1μ pa. The Short Inter Frame Space (SIFS) and the time slot of the backoff window algorithm are 50 and 100 msec respectively to match the underwater acoustic channel.

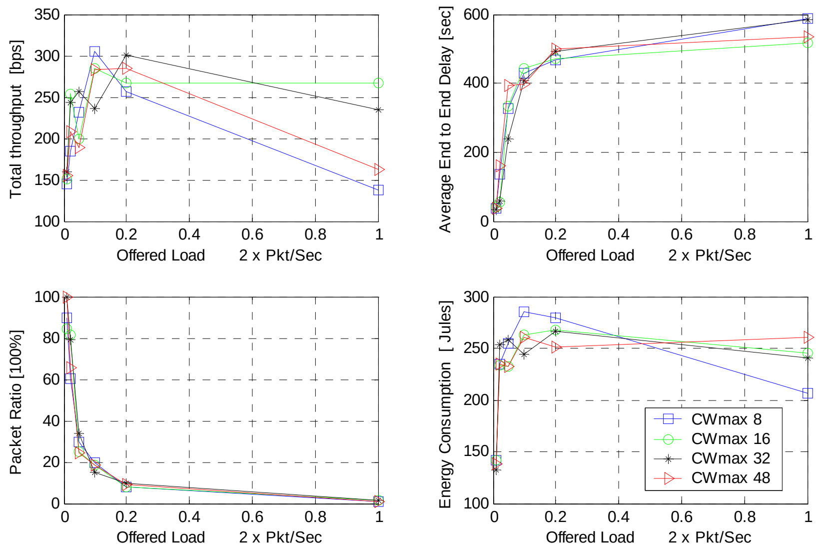

Fig. 2. The influence of different backoff windows on DSDV routing protocol.

v. Results and discussion

In this section we discuss the influence of the backoff Contention Windows (CW) to the DSDV routing, with respect to the following metrics:
- Total throughput is the total packets successfully received per unit time [bps]
- Total packets delivered ratio is the ratio between the number of packets sent out by the sender application and the number of packets correctly received by the corresponding application [100%].
- Average end-to-end delay is the delay calculated by averaging time passed from the time a data packet is generated and when the packet arrives at the final destination [sec].

From fig. 2, all graphs for different CWs show the total throughput achieved about 300 bps at offered load 0.2 pkt/sec. After this the throughput reaches a steady state, because the network reaches its maximum effort. Even if the offered load is increased the packets will drop.

The second box of graphs shows that the average end-to-end delay starts to increase as the offered load increases until the 0.4 pkt/sec offered load. Then the delay becomes constant at around 500 sec, even when the offered load is increased.

The packet delivery ratio figure has a steady state like others, when the offered is very small all packets received successfully and they start decreasing as soon as the offered load increases until 0.4 pkt/sec, the packet ratio reaches a steady state and gives constant packet ratio, even when the offered load is increased.

The influence of the backoff contention windows are not much different when the offered load is less than 0.4 pkt/sec. However, after this, when the CWmin8 and CWmax16 it gives the best performance in the throughput and less end-to-end delay when compared with other CWs.

In the energy consumption figure the changing CW did not change significantly. Therefore, all are of the same characteristic

Conclusions and Future work

The implemented network is formed by acoustically connected ocean-bottom sensors and the surface station woks as the gateway. The gateway provides a link to an on shore control centre.

Due to the fact it is battery powered the lifetime of the underwater acoustic network is limited.

The implemented Underwater Acoustic Media Access Control (UAMAC) on NS2 simulator now works well for underwater acoustic networks, after the modifications made to the propagation, physical and MAC layers in the NS2 simulator.

From the results it can be concluded that the influence of the different contention windows is not too much, but in certain levels of the offered load there is some changing, and so this is a good point to be researched now.

We will focus on the UAMAC which is implemented in the NS-2 and develop an adaptive packet scheduling it to improve the total throughput of ad hoc underwater acoustic networks, minimizing both total end to delay and power consumption.

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