# Simulation of Enhanced MAC servies in UNET simulator

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***Abstract*— From the last few years Underwater, wireless sensor networking(UWSN) becomes one of the important research areas for the researchers for developing new applications in Underwater monitoring, Assisted navigation, etc.… In Underwater monitoring sensor nodes are placed to form a network. To observe the behavior and results of those nodes simulations are used. Of many different platforms, UNET simulator have been recently developed and released open source allowing to seamlessly for simulation and emulation. In this project, Extension of MAC layer functionality is done. By incorporating the TDMA protocol, Slot time synchronization and the dynamic behavior to it were added. Experimental results in an underwater network (monitoring sensor nodes) revealed that Synchronization and the Dynamic behavior has increased the Throughput in the given network when compared over the existing protocol***

***Keywords -Underwater Wireless Sensor Networking, UNET simulator, Synchronization, Dynamic TDMA, Throughput***

## I. Introduction

Underwater wireless sensor networks(UWSN) are becoming more popular everyday due to their important role in different applications, such as offshore search and underwater monitoring. The traditional approach for the ocean column monitoring is to deploy underwater sensors that record data during the monitoring and then to collect the results. Due to the disadvantages (Occurrences of misconfigurations, Limitations to the storage of data such as the capacity of onboard storage devices, Real Time monitoring is not possible) there is need to deploy underwater networks that will enable real time monitoring.

This is fulfilled by connecting underwater instruments by means of wireless links based on the acoustic communications. This has been usually inspected by means of simulations and a very few of them are tested at sea. Simulations, only capture a small amount of the total environmental, resulting in an approximate and simplified model of the underwater channels and its dynamics. The field experiments involve a huge cost and complexity and they usually require to reimplement and modify the simulated solutions to support the use of real hardware. Recently a novel solution has been proposed in Underwater Acoustic Sensor Networks(UASN) simulation i.e. UNET. The features that make UNET a novel solution is…Integrated development environment (IDE), and out-of-the-box support for Windows OS. The additional features that make UNET superior to the other simulators are…

- Simulator fully supports the Baseband service
- Added MAC tutorial to documentation
- Web based Shell Access
- Usage of Fjage Agent based Framework
- Uses the Groovy Language

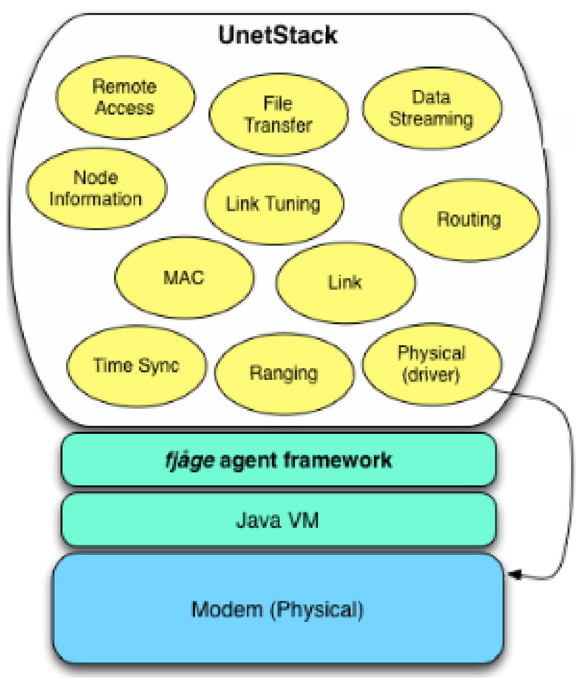


**Fig. 1. The UnetStack architecture.**

To avoid being constrained by the traditional layered network stack architecture that has cross layer interaction at its core. This enables to add functionality that is typically not provided by tradition network.

**A.** CONTRIBUTION OF THIS PAPER…

Throughput**:**

For every network that is formed, Throughput is one of the major factor by which the efficiency is measured. To increase the efficiency of the networks
in underwater monitoring enhancement of MAC services is done.

- Default use of TDMA in simulators lead to low throughput
- By incorporating the existing, adding the Synchronization feature leads to increased throughput.
- By enabling the preamble bits in TDMA frame structure, the Nodes can be traced, if they are mobile.
- Slots can be assigned on demand in Dynamic TDMA

## II. RELATED WORK

### 2.1 UNDER WATER SENSOR NETWORKS:

Underwater wireless sensor networks consist of nodes both deployed at underwater as well as surface and are aiming in performing collaborative tasks over a prescribed area. To achieve this purpose the nodes should exchange and share information among themselves and base stations, while at the same time self-organize the characteristics of communication channel to adapt to the current applications [1] needs, as posed by the surrounding environment.

### 2.2 UWSN SIMULATORS:

Several simulators such as SUNSET [2], OMNET++ [3], DESERT [4], AQUA SIM [5], AUV NETSIM [6], NS3 [7] & UNET [8]. UNET has lot of advantages and functionalities compared to the above simulators. It has cross layered communication. It uses Groovy language. Added shell closures for baseband service access. UNET fully supports the Baseband services. It contains of Web-based shell access. Uses fjage agent based architecture. With these functionalities the UNET and advantages over other simulators, this project is lead under the UNET simulator

### 2.3 TDMA in UNET Simulator:

Several protocols were simulated in UNET. Aloha, OFDM, TDMA etc.… The implementation of TDMA described in UNET as…

### 2.4 THE NODE CREATION

Creation of the nodes basing on the requirement. The address of the node basing on a certain id or number for the recognition. Specifying the location through co-ordinates [x,y,z]. we can either state the mobility of the created nodes as True or false, which makes it as mobile or static

### 2.5 SCHEDULE CREATION

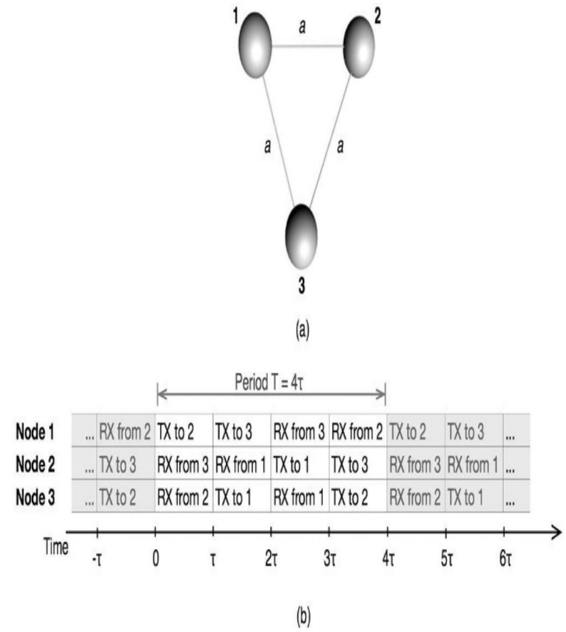


**Fig. 2. A three-node equilateral triangle network and its transmission schedule. (a) Geometry for a three-node equilateral triangle network (b) Periodic schedule.**

The schedule node is derived basing on a respective time period. Schedule of each node is the number of transmissions and receiving of data from another node in a respective period of time.

The network created for this protocol has been around three nodes forming like a equilateral triangle [9].

## III.PROBLEM STATEMENT

In Underwater monitoring applications large number of sensor nodes are required to form a network. Simulation basing on the large created network of these deployed sensor nodes is one of the major issue. The network created between the nodes deployed for sensing may be mobile or static. For the mobile sensor nodes, tracking the sensor nodes is another issue to be dealt. Comparing to the terrestrial network communication, Underwater communication has very low performance. To better the performance apart from the limitations, increasing the throughput (for a given network) is a partial solution. Selection of simulator is one of the major issue, as the analysis of the results play a major part

## IV. METHADOLOGY

This section defines the solution for the issues stated in the problem statement. Tracking the mobile sensor nodes is done through AUV locator in UNET simulator and through preamble bits 4.1. Increasing of throughput in UWSN communication is done through implementation of Synchronous TDMA and Dynamic TDMA 4.2. Betterment in analysis of results is shown 5.

### 4.1 TRACING THE SENSOR NODES

In underwater monitoring a large network is created. To trace the sensor nodes, we use the package of Track AUV Locator. Ticker behavior [10] is activated for every 100 seconds. A ticker behavior is run repeated with specified delay between invocations.

trace.moved()

This method uses the NodeId and the initial location of nodes as parameters. This delivers the location of all the nodes in the network.

### 4.2SLOT TIME SYNCHRONIZATION-TDMA

Time Synchronization in wireless networks is extremely important for basic communication, but it also provides the ability to detect movement, location, and proximity.

To avoid transmission collision, all nodes in a TDMA-based network must be synchronized to the same time slot reference. To achieve this, we can use two methods. The first is by receiving time from a Global Position System (GPS) [11], which can provide a high precision. The other method is decentralized synchronization, by which each node mutually adapts its time slots to a time-base by obtaining time slot differences from other nodes [12] [13] [14]. Based on the above work, this paper will focus on the implementation of time synchronization protocol in TDMA-based ad hoc networks.

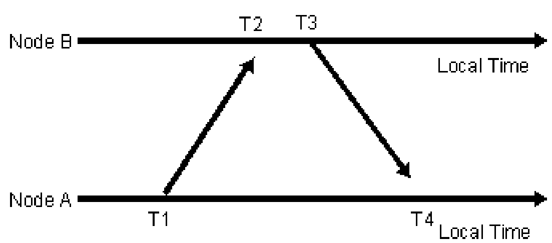


**Figure 3: Synchronization between two nodes**

In TDMA networks, all nodes maintain a consistent global time to get a same time slot reference. An internal hardware oscillator in any node, say X, which provides local clock Tx continuously running, can synchronize to the Coordinated Universal Time (UTC)

Through our experiments, we can find the relationships between X's clock Tx and the UTC T matches the following function:

Tx = Axt + T0x + Driftx(t) --- Eq(1)

- Ax- clock skew
- T0x-intitial time offset
- Drift- variations due to oscillator & envi conditions

#### 4.2.1 Parameters Used for the Algorithm

SENDER'S:

Send Time: The delay used to assemble a packet and delivery the send request to the MAC layer in the sender side. It relies on the system call overhead of the operation system and on the load of processor. It is nondeterministic.

Access Time: The time from the packet waiting for access to the transmit channel till the transmission starts. The access time is the least deterministic part of the message delivery process.

Transmission Time: the delay it takes for sender to transmit the packet at the physical layer. This time is deterministic and the time depends on the length of the packet and the baud rate of the transmission.

Propagation time: The delay it takes for one binary bit in packet to travel the wireless link from sender to receiver once it has left the sender. The propagation time is highly deterministic in wireless network and it depends on the distance between the sender and the receiver

RECIEVER'S:

Reception Time: The time for the receiver to receive the packet. It is the same as transmission time but partly overlaps with transmission time.

The overlap part can be found out in figure 4.

Receive time: The delay incurred processing the incoming packet up to the point when delivering it to the application layer in receiver. Its character is analogical to that of send time.

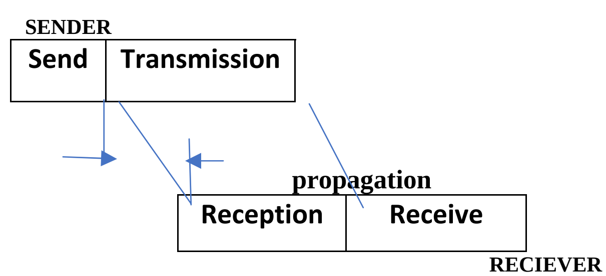


**Figure 4: Message Content for Delivery**

#### 4.2.2 ALGORITHM

The basic concept of the synchronization phase is two-way communications between two nodes. As mentioned before this is a sender to receiver communication. Figure 3 illustrates the two-way messaging between a pair of nodes. This messaging can synchronize a pair of nodes by following this method. The times T1, T2, T3, and T4 are all measured times.

- NodeA will send synchronization-pulse to Node B. This packet will contain Node A's level and the time T1 when it was sent.
- Node B will receive the packet at time T2. Time T3 is when NodeB sends acknowledgement packet to Node A.That packet will contain the level number of Node B as well as times T1, T2, and T3.
- By knowing the drift, Node A can correct its clock and successfully synchronize to Node B. This is the basic communication for TPSN.

The synchronization process is again initiated by the root node. It broadcasts a *time_sync* packet to the level one nodes. These nodes will wait a random amount of time before initiating the two-way messaging. The root node will send the acknowledgment and the level one nodes will adjust their clocks to be synchronized with the root nodes.
Any synchronization packet has the four delays discussed earlier:

- send time
- access time
- propagation time
- receive time

Eliminating any of these would-be a plus. Although TPSN does not eliminate the uncertainty of the sender it does, however, minimize it.

TPSN gives the Synchronized slot time between the sender and receiver (Communicating nodes in a network).

### 4.3 DYNAMIC TDMA SLOT SCHEDULING (DTDMA)

A scheduling algorithm dynamically reserves a variable number of time slots in each frame to variable bit-rate data streams, based on the traffic demand of each data stream.

To implement Dynamic TDMA, Slot based Time Synchronization is used. From the above algorithm we derive the Slot time (Sync slot time) in frame.

## V. PERFORMANCE EVALUATION

Evaluation of the results is done in this section. Performance of Slot Time Synchronization and Dynamic TDMA are picturized in terms of graphs.

Table 1: Parameters for simulation

| Parameter | Value |
|---|---|
| Network Size | 10 |
| MAC Protocols | TDMA |
| Area | 600x600 |
| Simulation Time | 900s |
| Range | 50mts |
| Slot | 1 sec |
| Sync Time | 2 secs |

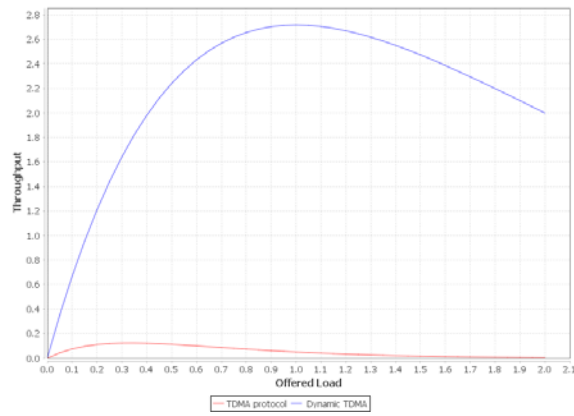


Figure 5: The ranges computed over the Super TDMA Protocol and TDMA Protocol

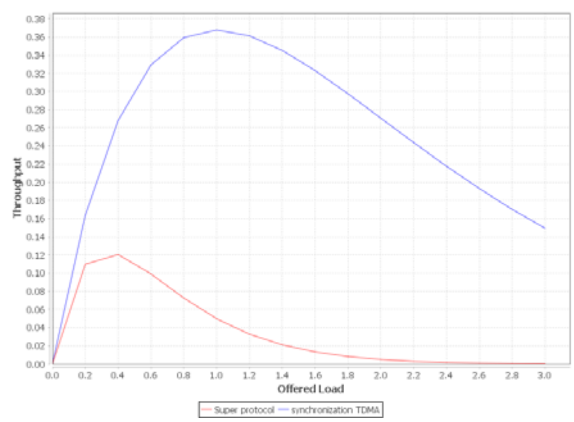


Figure 6: The ranges computed over the Super TDMA Protocol and Synchronize TDMA Protocol.

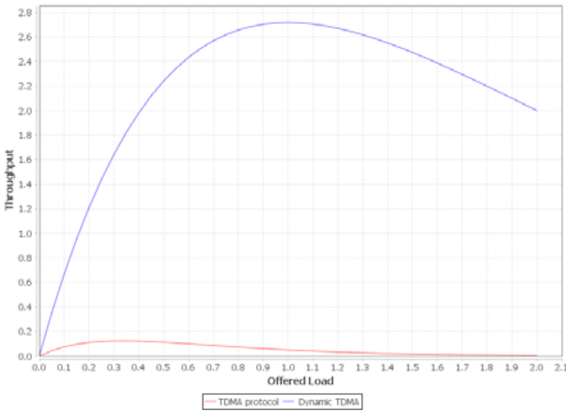


Figure 7: The ranges computed over the TDMA Protocol and Dynamic TDMA Protocol**.**

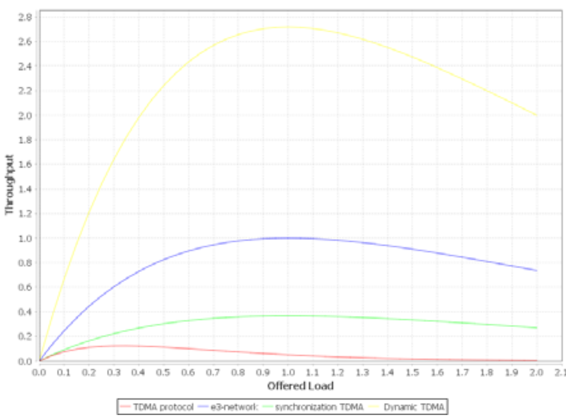


Figure 8: The ranges computed over the Super TDMA Protocol, Dynamic TDMA Protocol, TDMA &Super TDMA protocol

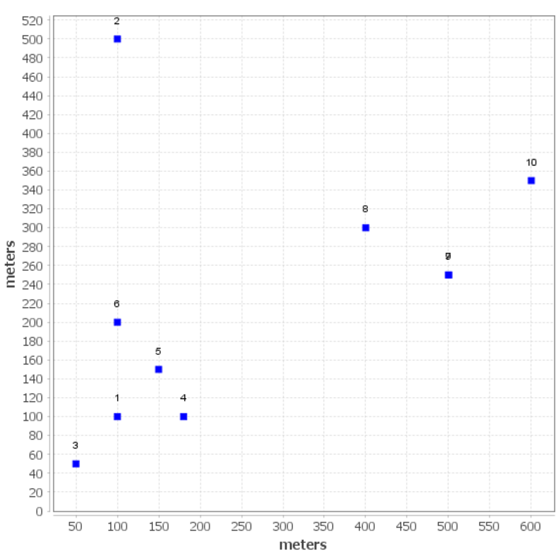


Figure 9: Location of Nodes

The Figure 1 results are drawn over the schedule of

[2, 3, 0, 0]
[0, 0, 1, 3]
[0, 1, 0, 2]
[0, 1, 1, 2]

over a given period of time. Here these are only depicted between the 4 nodes.

The Figure 2,3,4 results are drawn over the schedule that is formed over the 10 nodes that are created. The Node creation has been increased to 10 nodes because to show the robustness of the algorithms that are implemented. The ranges in X-Axis are varied as 2.0,3.0,5.0 basing on the values obtained from the implemented algorithm. The ranges in the Y-Axis are varied as 0.05,0.20,0.50 basing on the values obtained from the implemented algorithm.

Above results clearly state the increased throughput under the network formed. Nodes have been traced even in mobility.

## VI. CONCLUSION

In this simulation, our protocol defines many uses like determining location, proximity, or speed, it is also needed because hardware clocks are not perfect. Dynamic TDMA improves the Throughput in underwater monitoring communication.

## FUTURE WORK

For future work, the protocols should be tested in larger networks over a longer period of time to get more accurate data. A larger scale network is more realistic than having a sensor network with only few nodes.

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