ISSN: 2321-7782 (Online)
Volume 4, Issue 4, April 2016
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Survey Paper / Case Study
Available online at: www.ijarcsms.com

A Study on Building Underwater AD-HOC Networks and Sensor Networks

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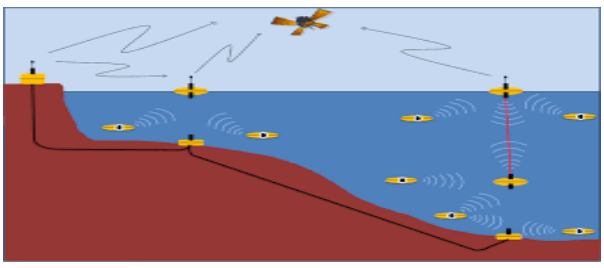
Abstract: ***In this paper there have been significant interests in monitoring aquatic environments for scientific exploration and coastline protection of attention to build large-scale UANET and UWSN for real-time aquatic applications. Present an application scenario to demonstrate the usefulness of the new networking paradigms. Although the application scenario is one of fundamental problem in Underwater Sensor Networks (UWSNs): robust, scalable and energy efficient routing. UWSNs are significantly different from terrestrial sensor networks in the following aspects: low bandwidth, high latency, node float mobility (resulting in high network dynamics), high error probability, and 3-dimensional space. These new features bring many challenges to the network protocol design of UWSNs. We further analyze design challenges of implementing the needed underwater networks. Following a top-down approach study shows that UANET and UWSN are inter-disciplinary challenges requiring integration of acoustic communication, signal processing and mobile network design.***

Keywords: UWSNs Design Challenges, Network Layer Issues and Routing Protocols, Underwater Wireless Security, Attacks and Countermeasures.

I. INTRODUCTION

Unlike traditional wireless networks, UWSN are built to be deployed as an autonomous network without any type of network administration to control data transmission in the common acoustic link. Gathered information, by (Acoustic Frequency Identification sensor networks) ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS sensor nodes, are routed through the network to ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS reader having more powerful units in terms of, energy, acoustic unit range and computational operations. Sink's job is to collect data from ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS sensor nodes and then transmit them to the user, and also can serve as gateway for interconnection to other networks like UWSN. Underwater Wireless Sensor Networks (UWSNs) research has predominantly assumed the use of a portable and limited energy source, viz. batteries, to power sensors [5]. Without energy, an acoustic sensor is essentially useless whole. Consequently, substantial research efforts have been spent on designing energy-efficient networking techniques to maximize the lifetime of UWSNs [6]. However, ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS sensors are required to operate for much longer durations (like years or even decades). This paper surveys related research and discusses the challenges of cross layer designing networking for such ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS.



Recently, underwater sensor networks have emerged as a very powerful technique for many applications for underwater environment, including monitoring, measurement, surveillance and control [24], [22], [21], [2], [8], [5], [15]. Even though underwater sensor networks (UWSNs) share some common properties with sensor networks, such as the large number of nodes and limited power energy, UWSNs are significantly different from sensor networks in many aspects: low bandwidth, high latency, node float mobility.

II. CHALLENGES FOR ESTABLISHING AN ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS NETWORK

Underwater wireless communication is characterized by high level of noise. So, Man-made and natural noises, animal or environmental (waves, rain), can interfere with good acoustic signal. To resume, this section describes the main problems for the establishment of ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS network.

Physical constraints [9][10]:

- The bandwidth of acoustic communications is relatively low (0 400 KHz).
- Low throughput (less than 50 kbps)
- Absorption phenomenon is the fundamental limitation of maximal frequency
- limited, range-dependent bandwidth
- time-varying multipath
- low speed of sound (1500 m/s)
- Long propagation delay
- noise problems

Energy consumption [10][11]:

Waste of energy is the critical parameter for UWSN because of its limited resources in which we cannot profit from energy solar to recharge battery. Energy efficient communication is a key requirement of energy-constrained underwater sensor networks (UWSNs). In this paper, we present a solution which is conventionally used to improve reliability in ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS, it can be employed to reduce energy consumption and preserve a reasonable level of data reliability. The most important sources of energy consumption in the MAC layer are [15][16][17]:

Idle listening: a node does not know exactly when it will receive information from other nodes; it should be ready for reception by listening to the underwater channel. Lost information has to be retransmitted.

Overhearing: when a sensor node is listening to the radio channel it can receive parquets that do not belong to it. Energy is wasted for reception and processing.

Over mitting: when a node transmit a message to another node that it is not ready for reception this message will be lost.

Collisions: they are the first cause of waste of energy and happened when two nodes transmit at the same time. In fact, the retransmission of data demands energy.

Overhead: we don't transmit only user's data in the radio link but also many kinds of data necessary for the control of communication and for network management. These overhead must be relatively shorter than user's data to not affect the throughput.

III. Contribution for Saving Energy in Acoustic Frequency Identification Sensor Networks

Underwater Network lifetime is the important criteria when evaluating ACOUSTIC FREQUENCY IDENTIFICATION SENSOR NETWORKS Network and as we know it depends on the energy consumption of the node unit's. This is related to minimize and optimize energy dissipation in every node of the network. Our approach is based on the cross-layering design in which MAC and physical layers should be investigated together. Figure 4 shows the major levels of energy saving for UWSN [4]. Today our earth is overlay by 75 precent of water either by rivers or by oceans where a large amount of data and resources lies and are needed to discover these hidden information, from the bottom of the underwater seashore surface. These underwater networks are widely utilized in research areas of aquatic applications to investigate the unexplored underwater surface. Some of the underwater aquatic applications are

(i) Pollution monitoring such as oil-leakage in lakes or rivers, Chemical pollutions, Nuclear Pollutions in the environment.

(ii) Surveillance in UAN has more accurate and low signatures can be achieved by using different sensors.

(iii) Mine Reconnaissance or Mine Detection can detect mine like objects efficiently with the help of acoustic sensors and optical sensors.

(iv) Disaster Prevention is used to monitor seismic activity such as Ocean- related disaster, undersea activities etc., can be informed to coastal areas when happen in real time.

(v) Assisted Navigation is used to locate and identify various underwater threats, like Rocks, Submerged Vehicles, Shoals etc. [1, 14]. The fastest way of finding information which is available in Underwater Sensor network. This information is not only helpful for human beings but also responsible for researchers [14].

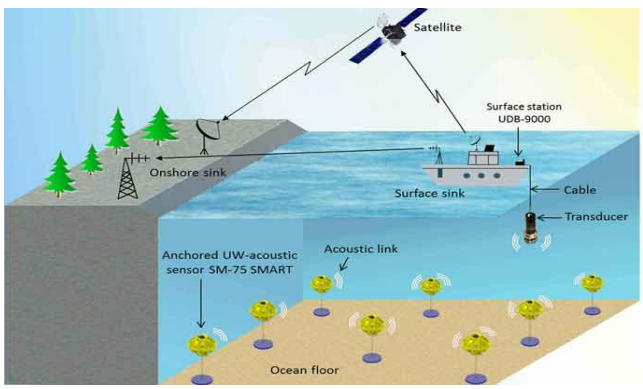
Basically communication in underwater environment is different from terrestrial networks due to its unique features of the networks. Underwater Networks are established by using acoustic signals as communication medium with the help of sensors and autonomous underwater vehicles. Since wireless sensor networks as in behaviour of terrestrial networks, some different fundamental challenges are not suitable for underwater usage, such as

(i) Radio Signals transmits long distances at extra low frequencies, which requires large antennas and high transmission power [1] and

(ii) Due to the continuous movement of sensor nodes with water flow, Global Positioning System (GPS) is inapplicable to the underwater environment [2]. Hence Underwater Wireless Networks are depends on the Acoustic Communication medium. Therefore the major issue in these networks is that how the sensing data are routed and successfully delivered to the sinks.

IV. Thus Research Programmers are being undertaken for Designing Efficient Protocols Considering the unique Characteristic of the Under Water Communication Network

In this section, we discuss about challenging issues of the Underwater Networks, and then proceed to communications and networking layers, followed by a discussion on various security issues of network layer.



Topology: High dynamic due to the continual movement of sensor nodes by the current movement of the water.

Communication Media: Acoustic waves for underwater environment and radio waves for water surface.

Position information: Unavailable by GPS, because GPS uses high frequency waves which are rapidly absorbed in the sea water. Network Components: Underwater ordinary nodes, sinks, AUV, and onshore base station.

Range: Usually used in vast ocean areas.

Speed of Medium: Acoustic Velocity in water is about 1500 m/s.

Price: Too expensive.

Path Loss: High path loss.

Wave movement: Spherical in deep water and Cylindrical in shallow water.

Sink Position: Located on water surface and it usually moves by water current.

Routing: Due to high movement of nodes in water current, greedy hop-by-hop routing is employed.

Prone to error: Links and nodes are highly prone to error due to high propagation delay of acoustic waves and corrosion respectively.

Sensors Size: Large size.

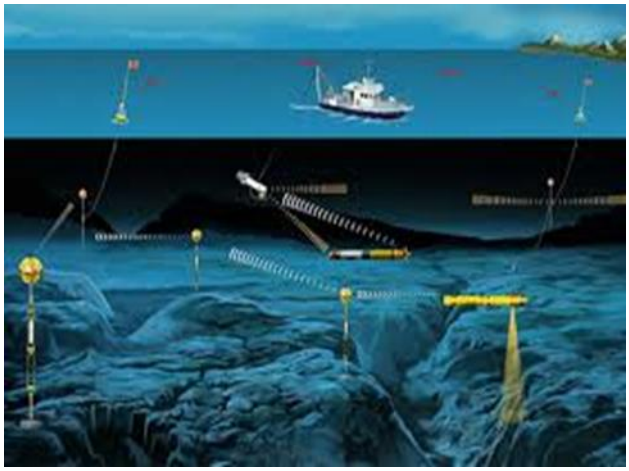
V. RESEARCH ISSUE IN NETWORK LAYER

1. To manage loss of connectivity without provoking immediate transmissions, mechanisms have to be developed for delay-tolerant applications.
2. Due to fading and multipath, the quality of acoustic links is highly unpredictable, with respect to intermittent connectivity of acoustic channels, healthy routing algorithms is required.
3. Protocols and algorithms are required to be developed to address connection failures, unforeseen mobility of nodes and battery depletion.
4. In case of geographical routing protocols development of efficient underwater location discovery techniques are to be developed [24].
5. To understand dynamics of data transmission at the network layers, credible simulation models and tools are required to be developed for accurate modelling.

6. The delay variance of acoustic signals to propagate from one node to another heavily depends on the distance betweentwo nodes. The delay variation in horizontal acoustic links is generally larger than in vertical links which is due to multipath [25].

VI. UNDER WATER WIRELESS SECURITY

The attacks against geographic routing in UWSNs are the same as in terrestrial sensor networks. The same countermeasures cannot be directly applied to UWSNs due to their difference in characteristics such as: the large propagation delays, the low bandwidth, the difficulty of recharging batteries of underwater wireless sensors, and the high mobility of nodes in underwater environment.



Data Confidentiality: Confidentiality is an assurance of authorized access to information. It is the ability of the network to conceal messages from a passive attacker so that any message communicated via the sensor network remains confidential. Thus, it ensures the protection of sensitive information and not revealed to unauthorized third parties. Applications like maritime surveillance communicate highly sensitive data.

Data Integrity: Data integrity is to ensure that information is not modified in transit, either due to malicious intent by an attacker. Thus, integrity is an assurance that packets are not modified in transmission.

Data Authentication: Data authenticity is an assurance of the identities of communicating nodes. WSN communicates sensitive data to help in many important decisions making. Thus, it is very important for every node to know that a received packet comes from a real sender. Otherwise, the receiving node can be cheated into performing some wrong actions. Also, authentication is necessary during exchange of control information in the network.

Data Freshness: Packet replaying is a major threat to the freshness requirement in network communication, so as to prevent a packet from continuing to a destination, and hold it for any amount of time, and then reply it into the network. The obsolete information available in the packet can cause many problems to the applications deployed in the network.

Availability: Sensor nodes may run out of battery power due to excess computation or communication and become unavailable. It may happen that an attacker may block the communication to make sensors unavailable. The requirement of security not only affects the operation of the network, but also important in maintaining the availability of the network node should not break the security of the entire network.

Self-Organization: UWSN is typically an ad hoc network, in which every sensor node in the network be independent and flexible enough to be self-organizing and self-healing according to different conditions and no fixed infrastructure available for the purpose of network management in a sensor network. This inherent feature also brings a big challenge to underwater wireless sensor network security.

Secure localization: The use of an underwater wireless sensor network will depend on its ability to accurately and automatically locate each node in the network. This accurate location information is needed in order to identify the location of a fault in the network.

Robustness and Survivability: The sensor network should be robust against various security attacks, and if an attack targets, then its impact should be minimized.

VII. ATTACKS AND COUNTERMEASURES

In computer networks an attack is any attempt to destroy, expose, alter, disable, steal or gain unauthorized access to or make unauthorized use of an asset.

Jamming attack: It is a type of attack which interfere physical channel that the nodes use in a UWSN for communication by putting noises or meaningless signals. A jamming source may be powerful enough to disrupt the entire network. A jamming attack consists of interpose with the physical channel by putting up carriers on the frequencies neighbor nodes use to communicate. When an attacker intently jammed the communication between a sender and a receiver, and later replays the same message with stale information posing as the sender.

Counter measures: It can be overcome using following two techniques are:

1. Spread spectrum techniques
2. Sensors can switch to sleep mode.

Wormhole Attack: A wormhole is an out-of-band connection created by the antagonist between two physical locations in a network with lower delay and higher bandwidth than ordinary connections. In a wormhole attack the malicious node transfers some selected packets received at one end of the wormhole to the other end using the out-of-band connection, and refill them into the network.

Counter measures: It can be overcome using following two techniques are:

1. Dis- VoW
2. Estimating the direction of arrival.

Sinkhole Attack: In a sinkhole attack, a malicious node attempts to provide a false routing information to other nodes, and produce itself as the intended node to receive the entire network traffic and modifies the secret information available in the packet. For example, the malicious node can produce a better route, by that exchange of routing take place. The sinkhole attack is a particularly violent attack that prevents the base station from obtaining complete and accurate sensing data, thus forming a serious threat to other layers in the network. Geographic routing and authentication of nodes exchanging routing information are possible countermeasures against this attack, but even geographic routing in UWSN is a challenging open research topic.

Counter measures: It can be overcome using following two techniques are:

1. Geographical routing
2. Authentication of nodes exchanging routing information.

Sybil attack: In this an attacker with multiple identities can pretend to be in many places at once. Multiple identities can be occupied within the sensor network either by fabricating or stealing the identities of authorized nodes. Effectiveness of fault-tolerant schemes can be reduced by this attack. Sybil attacks also pose a high threat to geographic routing protocols. Authentication and position verification are methods against this attack, while position verification in UWSNs is difficult owing to mobility.

Counter measures: It can be overcome using following two techniques are:

1. Authentication
2. Position verification

Selective forwarding attack: Malicious nodes drop certain messages instead of forwarding them to delay routing. In UWSNs it should be verified that a receiver is not getting the information due to this attack and not because it is located in a shadow zone. Selective forwarding attacks may corrupt some mission critical applications such as military surveillance and Environmental monitoring.

VIII. CONCLUSION

While research on underwater wireless sensor networks has significantly advanced in recent years, it is clear that a number of challenges still remain to be solved. With the flurry of new approaches to communication, medium access, networking and applications, effective analysis, integration and testing of these ideas is paramount—the field must develop fundamental insights, as well as understand what stands up in practice. This paper explores the significant advantages, disadvantages of design issues of different routing protocols. UWSNs suffer from the vulnerabilities which decreases the reliability. So, this article also have discussed for security in UWSNs, underlining the specific characteristics of these networks, possible attacks, countermeasures and challenges.

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