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Analysis of Power, Security and Routing Factors In Underwater Wireless Sensor Network (UWSN)

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ABSTRACT: - Underwater wireless sensor network (UWSN) is currently a hot research field. However, UWSNs suffer from various limitations and challenges: high ocean interference and noise, high propagation delay, narrow bandwidth, dynamic network topology, and limited battery energy of sensor nodes. The design of routing protocols is one of the solutions to address these issues. A routing protocol can efficiently transfer the data from the source node to the destination node in the network. The Proposed Study Analyzed the different factors of Underwater Wireless Sensor Networks are visualized as little power unnatural devices, which might be scattered over a vicinity of interest, to modify observation of that region for associate extended amount of your time. The device devices are visualized to be capable of forming associate autonomous wireless network, over that perceived information will be delivered to such as set of destinations. This work considers a Underwater Wireless Sensor Network and addresses the matter of minimizing power consumption in every device node domestically whereas guaranteeing two international (i.e., network wide) properties: (i) communication property, and (ii) sensing coverage. A Sensor node saves energy by suspending its sensing and communication activities in keeping with a weighted honest programming model. The study presents a model and its resolution for steady state distributions to work out the capability of various researches. Given the steady state chances, we have a tendency to construct a non-linear optimization downside to reduce the ability consumption. Simulation studies to look at the collective behavior of huge variety of device nodes manufacture results that are expected by the analytical model.

Keywords: - [Wireless Network Under Water Sensor Network (UWSN), Security, Routing Protocols, and Energy.]

1. INTRODUCTION

Underwater wireless sensor network (UWSN) is a newly emerging wireless sensor technology which is used to provide the most promising mechanism and methods that are used for discovering aqueous environment. It is used in various key applications in underwater environment. It works very efficiently in many situations like commercial, military, emergency monitoring, data collection, and environmental monitoring purposes. In this kind of networks, small sensors node are deployed in sea water. These nodes are equipped with central processing unit, antenna, and battery. Batteries in these sensor nodes are non-rechargeable and non-replaceable. These sensors collect the required data and send it to sinks which are installed offshore. The Underwater Wireless Sensor Network (UWSN) platform, you easily can monitor your assets or environment with reliable, battery-powered measurement nodes that offer industrial ratings and local analysis and control capabilities. Each wireless network can scale from tens to hundreds of nodes and seamlessly integrate with existing wired measurement and control systems.

Autonomous underwater and unmanned vehicles which are equipped with sensors that are specially designed for underwater communication, which are mostly used in areas where humans are unable to explore underwater resources directly. Information about natural resources lying underwater is obtained by unmanned vehicles and forwarded to sinks

Understanding the UWSN Architecture

An Underwater Wireless Sensor Network consists of three main components: nodes, gateways, and software. The spatially distributed measurement nodes interface with sensors to monitor assets or their environment.

The acquired data wirelessly transmits to the gateway, which can operate independently or connect to a host system where you can collect, process, analyze, and present your measurement data using software. Routers are a special type of measurement node that you can use to extend UWSN distance and reliability. Learn more about each of these components

UWSN Architectures

Combine different types of nodes and gateways to meet the unique needs of your application. Create a simple, PC-based Underwater Wireless Sensor Network (UWSN) monitoring system with the UWSN Ethernet gateway, or a headless, embedded monitoring system with the UWSN programmable gateway, which can run deployed LabVIEW Real-Time applications. For applications that require the combination of high-speed I/O (or control) and distributed wireless monitoring, take advantage of the UWSN C Series UWSN gateway.

About UWSN an Underwater Wireless Sensor Network (UWSN) (sometimes called a wireless sensor and actor network (UWSAN)) are spatially distributed autonomous sensors 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. The more modern networks are bi-directional, also enabling control of sensor activity. The development of Underwater Wireless Sensor Networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

The UWSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. Sensor Networks also utilize minimal capacity devices which places a further strain on the ability to use past solutions.

1.1. Routing of UWSN

Routing Multihop routing is a critical service required for UWSN. Because of this, there has been a large amount of work on this topic. Internet and MANET routing techniques do not perform well in UWSN. Internet routing assumes highly reliable wired connections so packet errors are rare; this is not true in UWSN. Many MANET routing solutions depend on symmetric links (i.e., if node A can reliably reach node B, then B can reach A) between neighbors; this is too often not true for UWSN. These differences have necessitated the invention and deployment of new solutions. For UWSN, which are often deployed in an ad hoc fashion, routing typically begins with neighbor discovery. Nodes send rounds of messages (packets) and build local neighbor tables. These tables include the minimum information of each neighbor's ID and location. This means that nodes must know their geographic location prior to neighbor discovery. Characteristics of UWSN

The main characteristics of a UWSN include:

Power consumption constraints for nodes using batteries or energy harvesting

- Ability to cope with node failures (resilience)
- Mobility of nodes
- Heterogeneity of nodes
- Scalability to large scale of deployment
- Ability to withstand harsh environmental conditions
- Ease of use
- Cross-layer design

Cross-layer is becoming an important studying area for wireless communications. In addition, the traditional layered approach presents three main problems:

1. Traditional layered approach cannot share different information among different layers, which leads to each layer not having complete information. The traditional layered approach cannot guarantee the optimization of the entire network.
2. The traditional layered approach does not have the ability to adapt to the environmental change.

2. ENVIRONMENT OF UWSN

The environment of UWSNs is very dissimilar from terrestrial wireless sensor networks (WSNs) in many ways. The electromagnetic signals cannot travel for long distance in UWSNs due to the high attenuation, scattering and the absorption effect. In order to address this issue acoustic waves are used in UWSNs environment. The propagation speed while using the acoustic waves in UWSNs environment is 1500m/sec which is much slower as compared to the radio waves based communication. In acoustic communication the end-to-end delay is high along with long propagation latency. The available bandwidth is very limited in acoustic communication (less than 100kHz). The sensor nodes in UWSNs environment are mostly considered static but due to the underwater activities these sensor nodes can move from 1 to 3m/sec. The sensor nodes in UWSNs environment are large in size and they consume more power due to which efficient utilization of energy is a critical factor in UWSNs communication. Charging and replacing of batteries in UWSNs environment is a challenging task. The basic security requirements in UWSNs are authentication, confidentiality, integrity and availability. There are different attacks possible in UWSNs which can abrupt the normal operation of the networks.

2.1. Hardware

One major challenge in a UWSN is to produce low cost and tiny sensor nodes. There are an increasing number of small companies producing UWSN hardware and the commercial situation can be compared to home computing in the 1970s. Many of the nodes are still in the research and development stage, particularly their software. Also inherent to sensor network adoption is the use of very low power methods for radio communication and data acquisition.

In many applications, a UWSN communicates with a Local Area Network or Wide Area Network through a gateway. The Gateway acts as a bridge between the UWSN and the other network. This enables data to be stored and processed by devices with more resources, for example, in a remotely located server.

2.2. Software

Energy is the scarcest resource of UWSN nodes, and it determines the lifetime of UWSNs. UWSNs may be deployed in large numbers in various environments, including remote and hostile regions, where ad hoc communications are a key component. For this reason, algorithms and protocols need to address the following issues:

- Increased lifespan
- Robustness and fault tolerance
- Self-configuration

Lifetime maximization: Energy/Power Consumption of the sensing device should be minimized and sensor nodes should be energy efficient since their limited energy resource determines their lifetime. To conserve power, wireless sensor nodes normally power off both the radio transmitter and the radio receiver when not in use.

2.3. Operating System

Operating systems for Underwater Wireless Sensor Network nodes are typically less complex than general-purpose operating systems. They more strongly resemble embedded systems, for two reasons. First, Underwater Wireless Sensor Networks are typically deployed with a particular application in mind, rather than as a general platform. Second, a need for low costs and low power leads most wireless sensor nodes to have low-power microcontrollers ensuring that mechanisms such as virtual memory are either unnecessary or too expensive to implement.It is therefore possible to use embedded operating systems such as eCos or uC/OS for sensor networks. However, such operating systems are often designed with real-time properties.

TinyOS is perhaps the first operating system specifically designed for Underwater Wireless Sensor Networks. TinyOS is based on an event-driven programming model instead of multithreading. TinyOS programs are composed of event handlers and tasks with run-to-completion semantics. When an external event occurs, such as an incoming data packet or a sensor reading, TinyOS signals the appropriate event handler to handle the event. Event handlers can post tasks that are scheduled by the TinyOS kernel some time later.

2.4. Online collaborative sensor data management platforms

Online collaborative sensor data management platforms are on-line database services that allow sensor owners to register and connect their devices to feed data into an online database for storage and also allow developers to connect to the database and build their own applications based on that data. Examples include Xively and the Wiki sensing platform. Such platforms simplify online collaboration between users over diverse data sets ranging from energy and environment data to that collected from transport services. Other services include allowing developers to embed real-time graphs & widgets in websites; analyse and process historical data pulled from the data feeds; send real-time alerts from any datastream to control scripts, devices and environments.

2.5. Application of UWSN

- **Process Management -** It not working for cables or wires only sensors in management.
- **Area monitoring -** Area monitoring is a common application of UWSNs. In area monitoring, the UWSN is deployed over a region where some phenomenon is to be monitored. A military example is the use of sensors detects enemy intrusion; a civilian example is the geo-fencing of gas or oil pipelines.
- **Health care monitoring -** The medical applications can be of two types: wearable and implanted. Wearable devices are used on the body surface of a human or just at close proximity of the user. The implantable medical devices are those that are inserted inside human body. There are many other applications too e.g. body position measurement and location of the person, overall monitoring of ill patients in hospitals and at homes. Body-area networks can collect information about an individual's health, fitness, and energy expenditure.
- **Water quality monitoring -** Water quality monitoring involves analyzing water properties in dams, rivers, lakes & oceans, as well as underground water reserves. The use of many wireless distributed sensors enables the creation of a more accurate map of the water status, and allows the permanent deployment of monitoring stations in locations of difficult access, without the need of manual data retrieval.
- **Natural disaster prevention -** Underwater Wireless Sensor Networks can effectively act to prevent the consequences of natural disasters, like floods. Wireless nodes have successfully been deployed in rivers where changes of the water levels have to be monitored in real time.
- **Chemical agent detection -** The U.S. Department of Homeland Security has sponsored the integration of chemical agent sensor systems into city infrastructures as part of its counterterrorism efforts. In addition, DHS is supporting the development of crowd sourced sensing systems that will draw upon chemical agent detectors embedded in mobile phones.

3. LITERATURE SURVEY

UWSN is a wireless technology which has gained worldwide attention these days. It provides the most promising mechanism used for discovering aqueous environment very efficiently for many scenarios like military, emergency, and commercial purposes. Autonomous underwater and unmanned vehicles are equipped with sensors that are specially designed for underwater communication, which are mostly used in those areas where exploration for natural resources which lie underwater is needed. These unmanned vehicles gather data of resources lying underwater and send is back to offshore sinks which is forwarded to other stations for further processing. Till date many protocols have been proposed for underwater sensor networks. These are mainly divided into two types which are localization based and localization-free protocols, where the term localization means knowledge of nodes and sink in network. Those routing protocols which need prior geographic information of other nodes and sinks are localization based routing protocols, while those routing protocols which do not need any earlier geographic information for routing can be categorized as localization-free routing protocols.

Khasawneh, A., Latiff, M. S. B. A., Kaiwartya, O., & Chizari, H. (2018), proposes a location-free Reliable and Energy efficient Pressure-Based Routing (RE-PBR) protocol for UWSNs. RE-PBR considers three parameters including link quality, depth and residual energy for balancing energy consumption and reliable data delivery. Specifically, link quality is estimated using triangle metric method. A light weight information acquisition algorithm is developed for efficient knowledge discovery of the network. Multi-metric data forwarding algorithm is designed based on route cost calculation which utilizes residual energy and link quality. Simulations are carried out in NS-2 with Aqua-Sim package to evaluate the performance of RE-PBR. The performance of the proposed protocol is compared with the stat-of-the-art techniques: DBR and EEDBR. The comprehensive performance evaluation attests the benefit of RE-PBR as compared to the state-of-the-art techniques in terms of network lifetime, energy consumption, end-to-end delay and packet delivery ratio.

Saeed, K., et al, (2020), proposes SEECR: Secure Energy Efficient and Cooperative Routing protocol for UWSNs. SEECR comprised of energy efficient and strong defense mechanism for combatting attacks in underwater environment. SEECR exploits cooperative routing for enhancing the performance of network. Considering the resource constrained UWSNs environment minimum computation is employed for implementing security so that SEECR remains suitable for underwater environment. In order to evaluate the performance of SEECR, this research compares the performance of SEECR with AMCTD: Adaptive Mobility of Courier Nodes in Threshold-optimized DBR - a well-known routing protocol for UWSNs environment. The performance of SEECR and AMCTD protocols are evaluated using different performance evaluation parameters such as number of alive nodes, transmission loss, throughput, energy tax and end-to-end delay. The results suggest an improved performance of SEECR over AMCTD. SEECR shows an improvement of 9% in terms of number of alive nodes, over 50% reduction in terms of transmission loss, up to 9% increase in throughput, up to 23% reduction in energy tax, and 25% reduction in end-to-end delay.

Rani, S., et al, (2017), proposes energy efficient chain based routing protocol for underwater wireless sensor networks (E-CBCCP). While keeping in view the complex features of underwater dynamics, dynamic network topology and node mobility, energy of the cluster heads (CHs), relay nodes (RNs) and cluster coordinators (CCOs) has been considered during the transmission of data and role of the CHs, CCOs and RNs is changed after some time duration to maintain the load on the nodes. Distance based communication is based on the location aware nodes and can be used in monitoring domains during steady state but in dynamic state, location free communication is required therefore RN communication is based on hop to hop. Confidence level of the sensor nodes is computed to select the optimal RN and to improve the reliability. New prototype has shown the improvement over CARP a routing protocol in terms of data packets transmission and energy.

Ahmad, I., et al, (2021), Underwater Wireless Sensor Networks (UWSN) have gained more attention from researchers in recent years due to their advancement in marine monitoring, deployment of various applications, and ocean surveillance. The UWSN is an attractive field for both researchers and the industrial side. Due to the harsh underwater environment, own capabilities, and open acoustic channel, it is also vulnerable to malicious attacks and threats. Attackers can easily take advantage of these characteristics to steal the data between the source and destination. Many review articles are addressed some of the security attacks and taxonomy of the Underwater Wireless Sensor Networks. In this study, we have briefly addressed the taxonomy of the UWSNs from the most recent research articles related to the well-known research databases. This study will help the researcher's design the routing protocols to cover the known security threats and help industries manufacture the devices to observe these threats and security issues.

Al Guqhaiman, A., et al, (2020), deals, Underwater Wireless Sensor Networks (UWSNs) are liable to malicious attacks due to limited bandwidth, limited power, high propagation delay, path loss, and variable speed. The major differences between UWSNs and Terrestrial Wireless Sensor Networks (TWSNs) necessitate a new mechanism to secure UWSNs. The existing Media Access Control (MAC) and routing protocols have addressed the network performance of UWSNs, but are vulnerable to several attacks. The secure MAC and routing protocols must exist to detect Sybil, Blackhole, Wormhole, Hello Flooding, Acknowledgment Spoofing, Selective Forwarding, Sinkhole, and Exhaustion attacks. These attacks can disrupt or disable the network connection. Hence, these attacks can degrade the network performance and total loss can be catastrophic in some applications, like monitoring oil/gas spills. Several researchers have studied the security of UWSNs, but most of the works detect malicious attacks solely based on a certain predefined threshold. It is not optimal to detect malicious attacks after the threshold value is met. In this paper, we propose a multi-factor authentication model that is based on zero-knowledge proof to detect malicious activities and secure UWSNs from several attacks.

However, the proposed scheme has a few limitations which include redundant transmission, that is, transmission of a same packet multiple times.

CONCLUSION

The Proposed Study Concludes that the performance of Underwater Wireless Sensor Network is influenced by different factors such as routing, power consumption and security, these factors are studied in different papers individually, or have planned the employment of directional antennas or localization infrastructure. on condition that sensors area unit unreal to be light-weight energy forced devices, it should not be fascinating to equip them with such additions. This work considers a theme that ensures coverage and property in a very sensing element network, whiles not the dependence on external infrastructure or advanced hardware. Additionally, taking advantage of the redundancy of nodes, the theme can give energy savings by turning off nodes which will not be needed to take care of coverage. it's terribly obvious that important energy is saved beside uniform decay of battery life at the most of the nodes.

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