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An Efficient and Optimized Method for Underwater WSN

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Abstract

In this research work, Underwater Wireless Sensor Networks (UWSNs) are utilized to monitor the undersea areas where the sensor nodes are compatible with IEEE 802.15.4 protocol operating at the frequency of 2.4 GHz. The performance of UWSNs with static nodes or Reduced Function Devices (RFDs) together with static and mobile sink nodes which are Full Function Devices(FFDs) is analysed and evaluated. To optimize the performance, time synchronization between the sensor nodes to reduce average end to end delay for critical and real time data monitoring can be achieved by cautiously monitoring the mobility of the mobile sink node in underwater wireless sensor networks.

Keywords:— *WSN, FFD, UWSN, Nodes, Sensor*

I. Introduction

Wireless Sensor Network: Wireless Sensor Networks (WSNs) are geographically dispersed self-reliant sensors to monitor environmental or physical conditions, like pressure, sound, temperature, toxicity, vibrations and the rest, and to inter-reliantly send the information to the sink or control room by utilizing wireless network. It comprises of self-reliant and self-configurable sensing devices called as “nodes” connected to at least one other node out of a few oreven thousands deployed in the network [1]. The architecture of the nodes is constituted of constituted of numerous elements: power source,

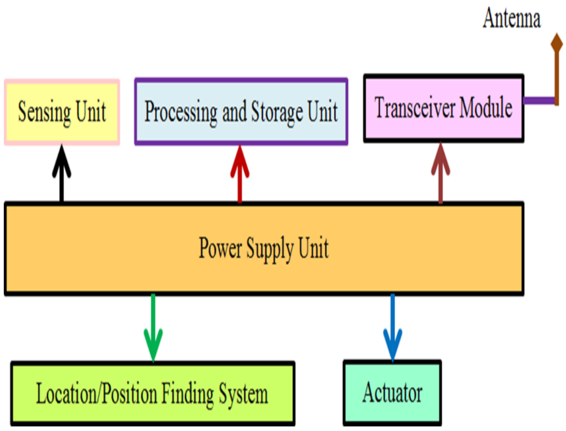

Figure 1: Architecture of WSN node

The three main topologies of WSNs are star, cluster-tree and mesh enabling it to support single-hop as well as multihop communication. There are two types of devices/nodes in WSN such as Full Function Device (FFD) equipped with high computation power and storagecapacity and Reduced Function Device(RFD) with limited computation power and storage capacity. The monitoring of strident environments where human access is very difficult and even not possible can be effectively performed by WSNs. The design parameters of a WSN such as strategies, topology and size depend on the surroundings in which it is deployed [1]. Its composition rely upon the surroundings, the aspiration of applications, hardware, price, and system limitations such as low bandwidth, short range of communication, constrained energy, limited computation ability and small memory storage in every sensor.

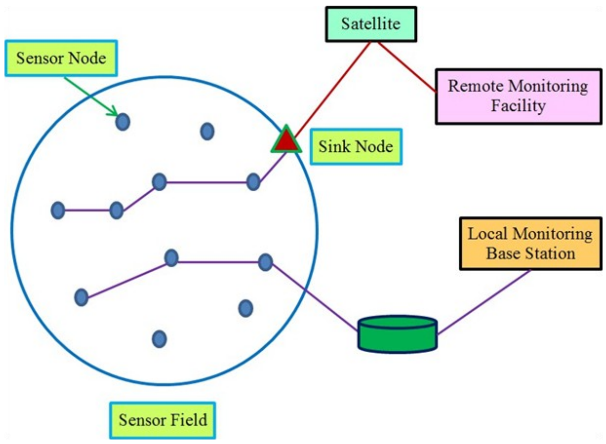

Figure 2: Architecture of WSN

Architecture of UWSN

The architecture of UWSN consisting of different types of sensor nodes and autonomous underwater vehicles used for collaborative monitoring in this research work is shown in Figure 3. The underwater sensors are linked with each other via microwave links. Further, the surface sink nodes are connected to the control center via radio frequency links. The architectures are application dependent, either 3-dimensional or 2-dimensional. The ordinary sensor nodes sense and relay data using direct link or througha multihop path to the coordinators. The coordinators further forward/relay the data sensed as well as received by the sensors to the surface stations.

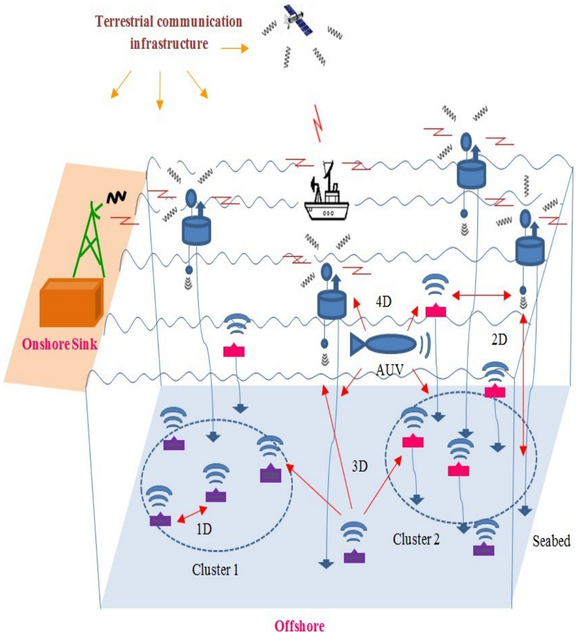

Figure 3: Architecture of under water wireless sensor network

Table 1 : Comparison between different modes of communication in UWSN

Mode	Acoustic	Electromagnetic	Optical
Speed (m/s)	1500	3.3 ×107	3.3 ×107
Band-width	1 kHz	1 MHz	10-150MHz
Range	1 km	10 m	10-100m
Power-Loss	>0.1 dB/ m/Hz	28 dB/1 km/100 MHz	Dependson-turbidity

II. Literature Survey

[1]. I. F. Akyildiz *et al.* [2] recognize research challenges, mainly focusing on protocol issues, hardware issues and a cross -layer design approach for UWSNs. The elemental technology used in the physical layer of underwater acoustic sensor networks is acoustic communication

In 2017, A Tedeschi *et al.* [5] have considered the detrimental events in WSNs inducing packet losses due to either misconducting nodes or intervention on the wireless channels.

In 2015, H. Shao *et al.* [7] have achieved patent regarding the MAC protocol communication method and device for synchronous WSN. The invention constitutes of a MAC protocol and a device for a synchronous WSN.

In 2014, MaLietal.[9] have optimized the performance of wireless sensor networks by prolonging its lifetime. The protocol has implemented different wakeup time tables for the sender and able to predict the wakeup time of the receiving nodes

In 2013, F. Sultan *et al.* [10] have received a patent titled as wireless sensor network with energy efficient protocols. It includes energy efficient protocols, and a network of external sensors in communication with a data sink.

Research Gaps

The study of recent research in the field of underwater wireless sensor networks has few research gaps. These are illustrated as follows:

- The utilization of electromagnetic waves at 2.4 GHz frequency band and the exploitation of the mobility of sink nodes as a benediction for underwater wireless sensor networks need to be analyzed and evaluated.
- The effective deployment of underwater sensors to perform single hop communication with mobile sink to lower the energy dissipation as well as the implementation and evaluation of efficient algorithms to determine the most effective path for the mobile sink need to be developed.

III. METHODOLOGY

In this work, IEEE 802.15.4 protocol is utilized to perform the collaborative

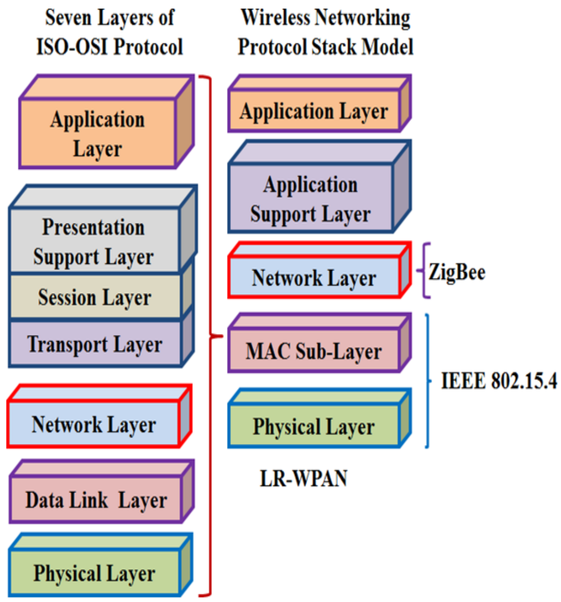

Figure 4: Protocol stack model of ISO- OSI implemented in WSN

Monitoring of smart grids. The thorough study and understanding of the recent research work in the respective field of research is very important to effectively understand and

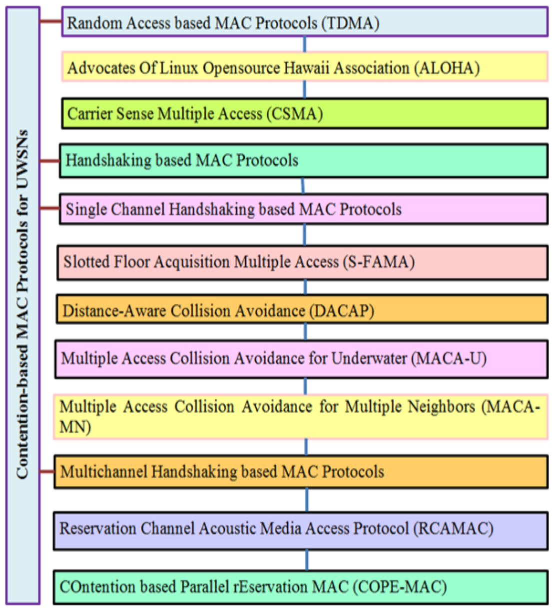

Figure 5: Contention-based MAC protocols for UWSN

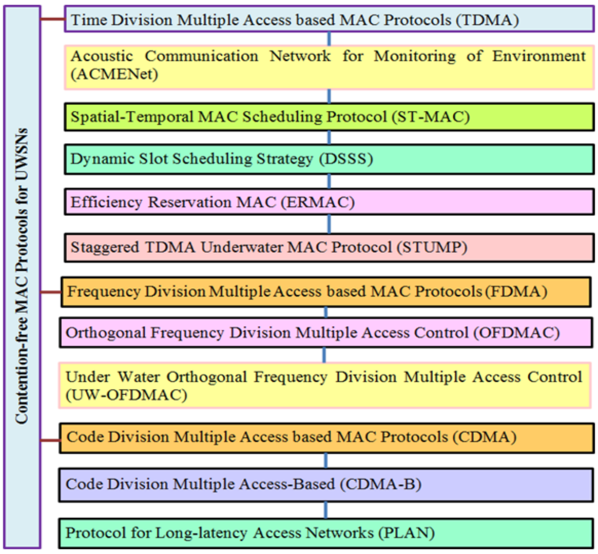

Figure 6: Contention-based MAC protocols for UWSN

IV. SIMULATION AND RESULT

The research problem considered in this chapter is to implement the mutual exclusion of the active/sleep time slots of the sensors (Reduced Function Devices) by the utilization of the concept of cyclic quorum. It is further improved by varying the active/sleep time slots of coordinators (Full Function Devices) to effectively relay the data packets towards the sink node. The goal is to reduce the number of contending nodes providing optimal area coverage to optimize the successful receptions of data packets reducing the number of redundant packets and collisions.

Simulation Results and Analysis

Table 2: Simulation Parameters

S. No.	Parameter	Value
1.	Total Number of Nodes	50, 100
2.	Number of PAN Coordinator	1, 1
3.	Communication Protocols	
	RFDstoPANCoordinator	IEEE802.15.4
	PANto RFDs	IEEE802.15.4
4.	ChannelFrequencies (GHz)	2.4, 2.42, 2.44
5.	PacketSize (bytes)	38
6.	PacketInterval(secs)	1
7.	Simulation Time (secs)	1500
8.	Battery (mAh)	300
9.	Transmission Range(m)	10
10.	TerrainArea(m2)	100´50,100´100
11.	Energy Model	Mica-Motes
12.	Battery Model	Linear
13.	Application	Traffic-Generator
14.	Number of Transceivers	
	PAN Coordinator	3
	RFDs	1

Table 3: Simulation Results

S. No.	Parameter	MC	MCCQ	MCSCQI
1.	**Throughput(bps)**			
	50 nodes	1212	677	715
	100 nodes	1664	1608	1710
2.	**AverageEndtoEndDelay(secs)**			
	50 nodes	0.16065	0.09496	0.10726
	100 nodes	0.5191	0.2876	0.3759
3.	Jitter(secs)			
	50 nodes	0.1926	0.05342	0.05682
	100 nodes	0.7717	0.2719	0.3628
4.	**PacketsDroppeddueto CAF**			
	50 nodes	7	0	0
	100 nodes	159	4	2
5.	**AverageNumberofPacketsDropped**			
	50 nodes	21	20	7
	100 nodes	210.96	20.91	11.22
6.	**NetworkLifetime (hours)**			
	50 nodes	796.43	2206.53	2264.49
	100 nodes	179.77	573.92	595.8

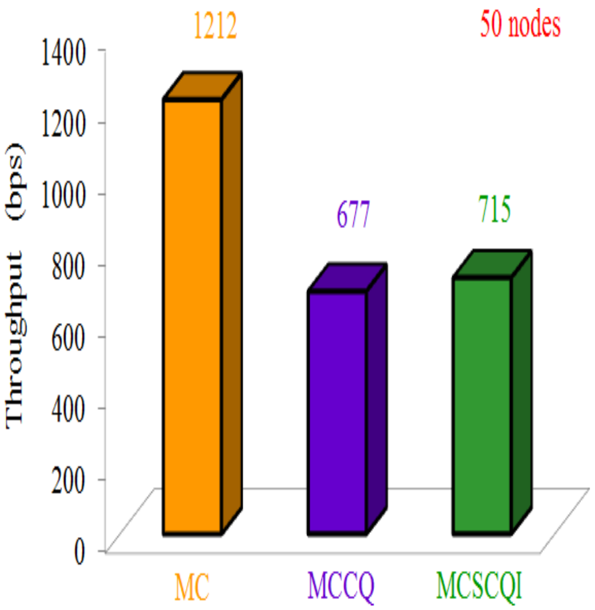

Figure 7: Comparison of throughput (bps) for 50 nodes

V. Conclusion and Future Scope

Conclusion

In the beginning of this research work, a novel energy-efficient and delay-aware AR-MAC protocol is proposed and implemented with Effective Path-Length and Optimum Throughput Path Determination algorithms after the determination of suitable queue size, queue type and scheduler type is for the UWSNs with a mobile sink. The simulations are performed on two underwater networks constituted of 101 and 201 nodes. Electromagnetic waves of 2.4 GHz frequency are utilized for underwater wireless communication. A mobile sink is exploited to attain single hop communication between the sensors and the sink to save battery power of the nodes.

Future Scope

In the future, the intent is to resolve the influence of clock skew and sensor mobility by developing an efficient scheduling algorithm for UWSNs with mobile sinks. The development of suitable routing protocols and security mechanisms may be considered to enhance the network performance in secured underwater communication. The development of cross-layer, adaptive, selective security scheme is of prime importance as layered security schemes cannot protect UWSN against blended attacks. The focus willbe on the development of cross layer security mechanisms to prevent the data form unauthenticated access and attacks.

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