GOVERNMENT POLYTECHNIC COLLEGE

MATTANNUR-670702

(Department of Technical Education, Kerala)

SEMINAR REPORT ON

UNDERWATER WIRELESS COMMUNICATION

SUBMITTED BY

SIDHARTH O M

(Reg.No:19041679)

DEPARTMENT OF ELECTRONICS ENGINEERING

2021-22

GOVERNMENT POLYTECHNIC COLLEGE
MATTANNUR-670702

(Department of Technical Education, Kerala)

CERTIFICATE

*Certified that seminar work entitled "**UNDER WATER WIRELESS COMMUNICATION**"is a bonafide work carried out by "**SIDHARTH O M** " in partial fulfilment for the award of Diploma in Electronics Engineering from Government Polytechnic College Mattannur during the academic year* 2021-2022.

Seminar Co-ordinator **Head of Section**

Internal Examiner **External Examiner**

DECLARATION

I hereby declare that the report of *the* ***UNDER WATER WIRELESS COMMUNICATION*** work entitled which is being submitted to the Govt. Polytechnic College Mattannur, in partial fulfilment of the requirement for the award **of *Diploma in Electronics Engineering*** *i*s a confide report of the work carried out by me. The material in this report has not been submitted to any institute for the award of any degree.

Place:Mattannur **SIDHARTH O M**

ACKNOWLEDGMENT

I would like to take this opportunity to extend my sincere thanks to people who helped me to make this seminar possible. This seminar will be incomplete without mentioning all the people who helped me to make itreal.

Firstly, I would like to thank GOD, almighty, our supreme guide, for bestowing his blessings upon me in my entire endeavor.

I would like to express my deepest gratitude **Mr. M C PRAKASHAN** (Principal GPTC, Mattannur), **Mr. GEORGE KUTTY (**Head of Department of Electronics Engg.), for the help rendered by him to prepare and present this Seminar in proper way. Moreover I am very much indebted to **Mr. SREEJITH A** (Lecturer, Electronics Engg, seminar co-ordinator), for their advice.

I am also indebted to all my friends and classmates who have given valuable suggestion and encouragement.

SIDHARTH O M

ABSTRACT

Underwater wireless communication network are particularly vulnerable to malicious attacks due to the high bit error rates, large and variable propagation delays , and low bandwidth of acoustic channels. The unique characteristics of the underwater acoustic communication channel, and the differences between underwater sensors networks and their ground – based counterparts require the development of efficient and reliable security mechanisms. In this seminar , a complete survey of security for UMCNs is presented , and then environment are outlined .

Hence the motivation, and our interest in UMCN. Together with sensor technology and vehicular technology, wireless communication will enable new application ranging from environmental monitoring to gathering of oceanographic data , marine archaeology , and search and rescue missions .

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Underwater wireless communication network are constituted by sensors and autonomous underwater vehicles (AUVs) that interact to perform specific application such as underwater monitoring. Co-ordination and sharing of information between sensors and AUVs make the provision of security challenging. The aquatic environment is particularly vulnerable to malicious attacks due to the high bit error rates, large and variable propagation delays, and low bandwidth of acoustic channels. Achieving reliable inter vehicle and sensors –AUV Communication is especially difficult due to the mobility of AUVs and the movement of sensors with water currents

The unique characteristics of the underwater acoustic channel, and the difference between underwater sensors network and their ground based counterparts require the development of efficient and reliable security mechanisms.

CHAPTER 2

FUNDAMENTALS OF WAVES

Understanding the first principal of each physical wave used in UMSN wireless communication is critically important. In this section we layout the fundamental physical properties and critical issues for each of the acoustic and optical wave propagation in underwater environments .We discuss each physical carriers advantages and dis-advantages towards efficient underwater wireless communication.

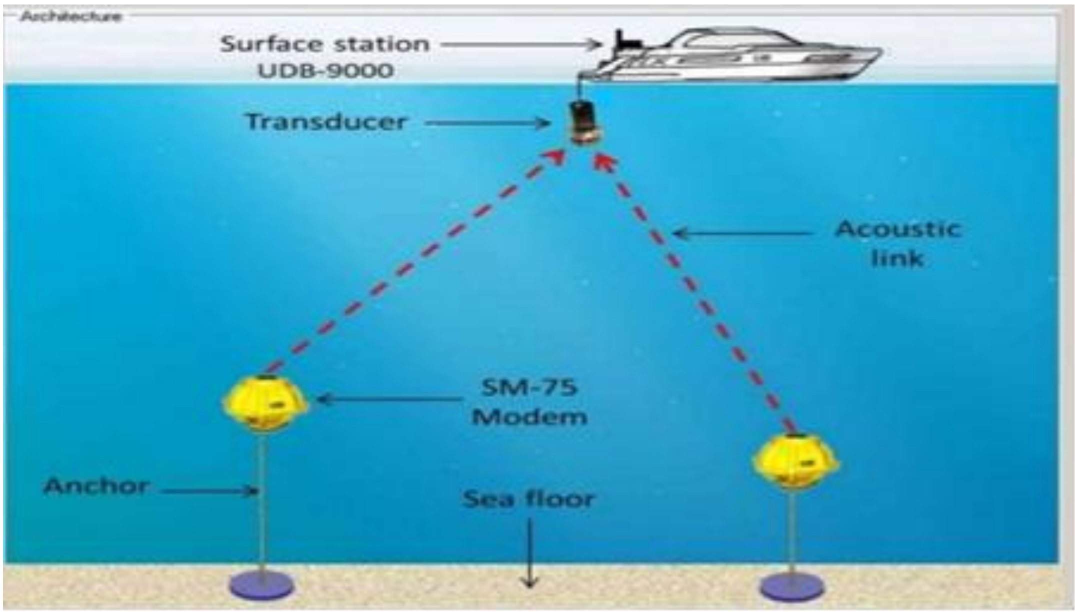

Fig 2.1 Fundamentals of waves

2.1 Acoustic wave

Among the type of waves , acoustic waves are used are the primary carrier of underwater wireless communication system due to the relatively low absorption in underwater environments . We start the discussion with the physical fundamentals and the applications of using acoustic waves as the wireless communication carrier in underwater environments.

2.2 Physical properties

Acoustic waves are mechanical and longitudinal waves (same direction of vibration as the direction of propagation) that result from an oscillation of pressure that travels through a solid, liquid or gas in a wave pattern. These waves show numerous characteristics including wavelength, frequency, period and amplitude. Acoustic waves are perceived by the ear as sound. An acoustic wave has a number of propagation characteristics that are unique from other waves. two of which are highligted below.

2.3 Propagation velocity

The extremely slow propagation speed of sound through water is an important factors that differentiates it from elcctromagnetic propagation . The speed of sound in water depends on the water properties of temperature, and pressure (directely related to depth). A typical sound in water near the ocean surface is about 150m/s. Which is more than 4 times faster than the speed of sound in air, but 5 orders of magnitude smaller than the speed of light. The speed of sound in water increases with increasing water temperature and depth. Near shore and in estuaries, where the salinity varies greatly, salinity can have more significant effect on the speed of sound in water. As depth increases the pressure of water has the largest effect on the speed of sound . Under most conditions the speed of sound in water is simple to understand. Sound will travel faster in warmer water and slower in colder water. As the depth of water increases 1km, the sound speed increase roughly 17m/s.

2.4 Absorption

During propagation, wave energy may be converted to other forms and absorbed by the medium. The absorption energy loss is directely controlled by the material imperfection is the inelasticity, which converts the wave energy into heat.

2.5 Optical communication

The present technology of acoustic underwater communication is a legacy technology that provides low –data –rate transmission for medium – range communication. Data rates of acoustic communication are restricted to around tens of thousands.of kilo bits per second for ranges upto 100km, due to servere, frequency – dependent attenuation and surface indicated pulse speed. In addition, the speed of acoustic waves in ocean is appromately 1500m/s, so that long-range communication involves high latency which poses a problem for real- time response, synchronization and multiple –access protocols. In addition , acoustic waves could distress marine mammals such as dolphins and whales. As a result , acoustic technology cannot satisfy emerging applications that require around the clock, high data rate communication network in real time. Examples of such applications are network of sensors for the investigation of climate change;monitoring biological, biogechannel, evolutionary; and ecological processes in sea, ocean and like environments; and unmanned underwater vehicles used to control and maintain oil production facilities and harbors.

An alternative means of underwater communication is based optics, wherein high data rates are possible. However, the distance between the transmitter and the receiver must be short, due to the extremely , challenging underwater environment, which is characterized by high multi scattering and absorption.

CHAPTER 3

ACOUSTIC MODEM

Acoustic modems offer the possibility of wireless communication underwater. For those who have deal with cables in unfavourable ocean environments, this is an elegant solution for communication. Typical applications for acoustic modems are real time system or previously deployed. Despite the aiiure of wireless communication,acoustic modems are not withou their limitation and challenges. To help you decide whether an acoustic modem is suitable for your particular communication needs, we explain these limitation and how they affect your communication here.

3.1 Parts of acoustic modem

- DSP band
- AFE [Analog Front End] band

3.2 Merits of acoustic modem

They can be used to provide the pre-warnings and for rescue missions.It can be used for collections data for predictions natural disturbances. It reduses the pollution very significantly. They can be used to discover old antiques lost at sea.

3.3 Demerits of acoustic modem

Range and communication over short distances is quite dependable . this is particularly true for vertical communication in deep waer with few boundaries . Horizontal communication in shallow water is increasingly more challenging as the depth/range aspect ratio becomes smaller. An example of a challenging scenario is 5 meter depth over a range of 3000 meters.

Clear Line of sight if you do not have a cler line of sight between the modems, it is very unlikely that there will be communication between them.Right boundary can be used to reflect energy in order to achieve an indirect transmission path.

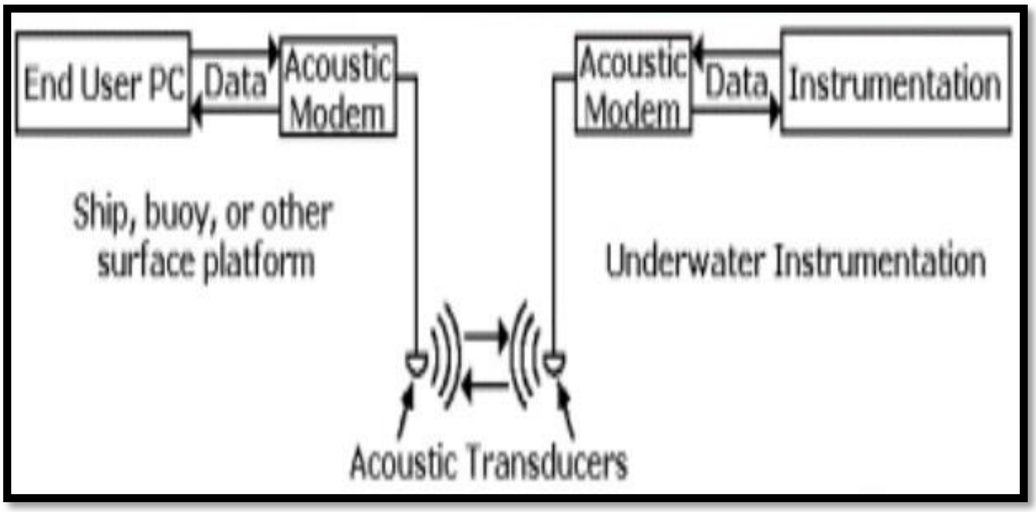

Fig 3.1 Basic acoustic communication model

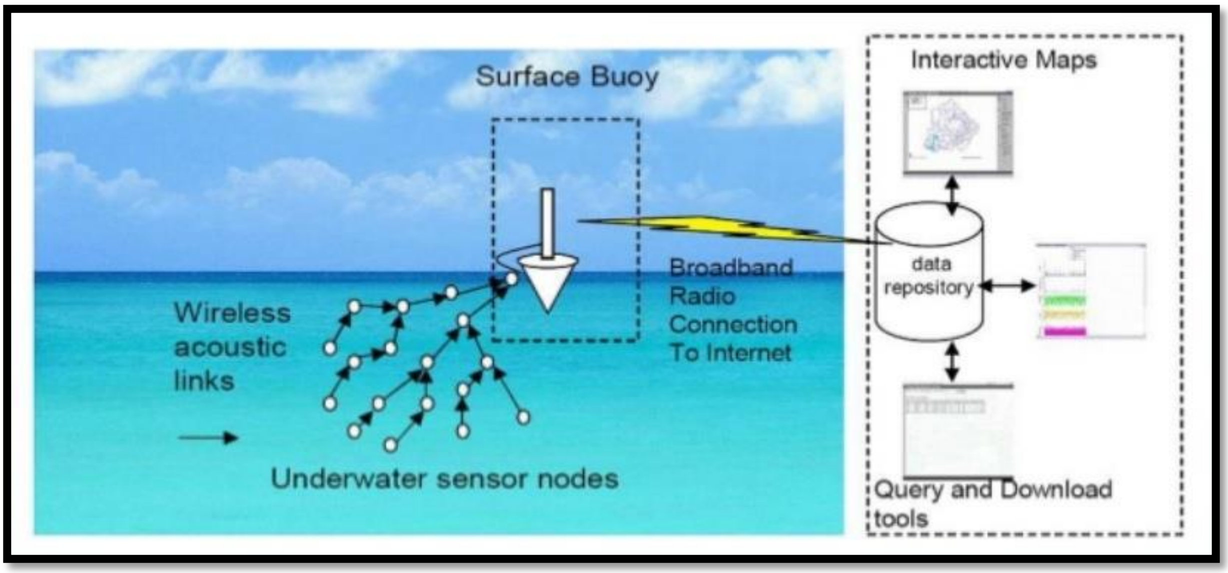

Fig 3.2 Underwater acoustic

CHAPTER 4

AUTONOMOUS UNDERWATER VEHICLES

An autonomous underwater vehicle (AUVs)is a robot which travels underwater without requiring input from an operator. AUVs constitute part of a higher group of under sea system known as unmanned under water vehicles, a classification that includes non – autonomous remotely operated underwater vehicles (ROVs)- controlled and powered from the surface by an operational pilot via an umbilical or using remote control. In military applications AUVs are more often referred to simply as unmanned undersea vehicles (UUVs).

Fig 4.1 Autonomous underwater vehicle

The first AUV was developed at the applied physical laboratory at the univesity of Washington as early as 1957 by Stan Murphy ,Bob Francois and later on, Terry Ewart.

CHAPTER 5

UNDERWATER NETWORK

Integrated network of instruments , sensors , roborts and vehicle will operate in a variety of underwater environment.

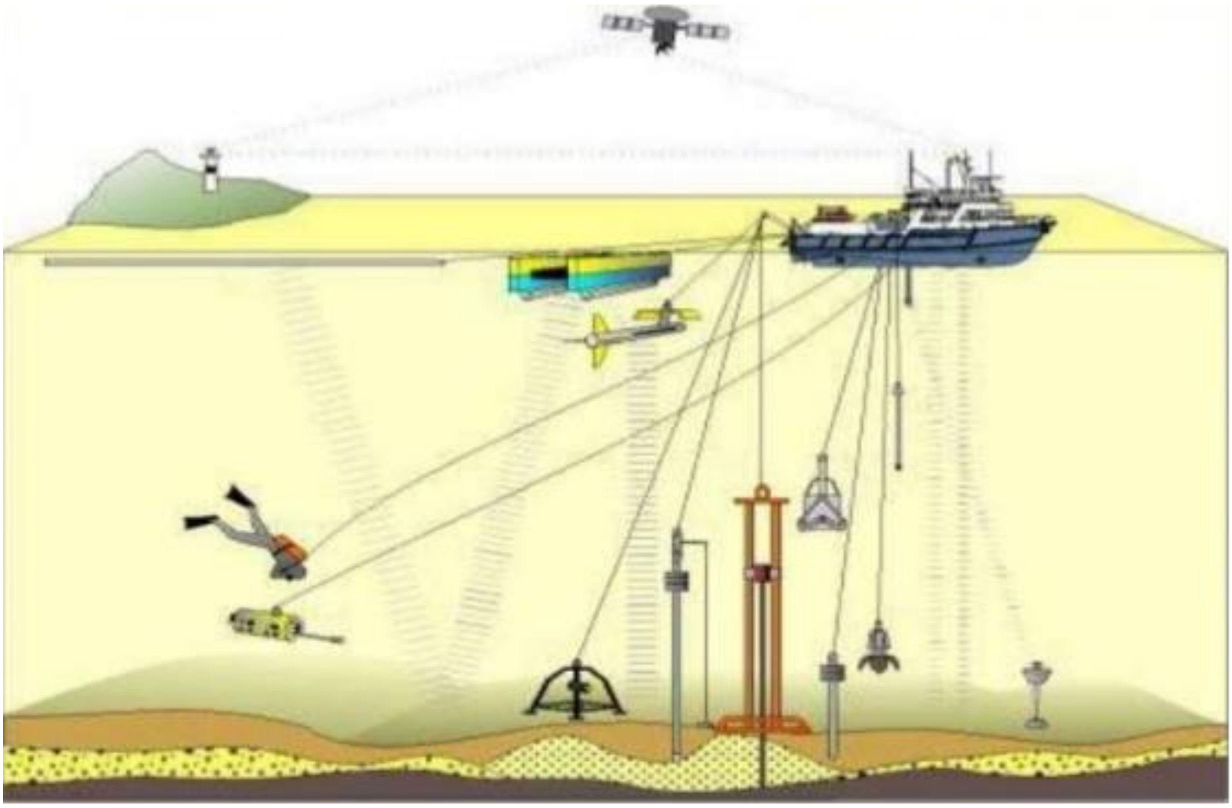

Fig 5.1 Underwater network system

Acoustic network , navigation and sensing for multiple autonomous underwater robotic vehicle. The underwater wireless sensor network (UWSN) is a network used to perform monitoring of tasks over a specific region; it is equipped with smart sensors and vehicles that are adapted to communicate cooperatively through wireless connections . The surface sink retrieves the data from sensor nodes. The sink node has a transceiver that can control acoustic signals received from underwater nodes. The transceiver also can transmit and receive long-range radio frequency signals for communication with the onshore station. The collected data are used locally or connected to another network for a particular purpose

CHAPTER 6

UNDERWATER ACOUSTIC SENSOR NETWORK (UW-ASN)

Underwater Wireless Sensor Networks (UWSNs) contain several components such as vehicles and sensors that are deployed in a specific acoustic area to perform collaborative monitoring and data collection tasks. These networks are used interactively between different nodes and ground-based stations. Presently, UWSNs face issues and challenges regarding limited bandwidth, high propagation delay, 3D topology, media access control, routing, resource utilization, and power constraints. In the last few decades, research community provided different methodologies to overcome these issues and challenges; however, some of them are still open for research due to variable characteristics of underwater environment. In this paper, a survey of UWSN regarding underwater communication channel, environmental factors, localization, media access control, routing protocols, and effect of packet size on communication is conducted. We compared presently available methodologies and discussed their pros and cons to highlight new directions of research for further improvement in underwater sensor networks.

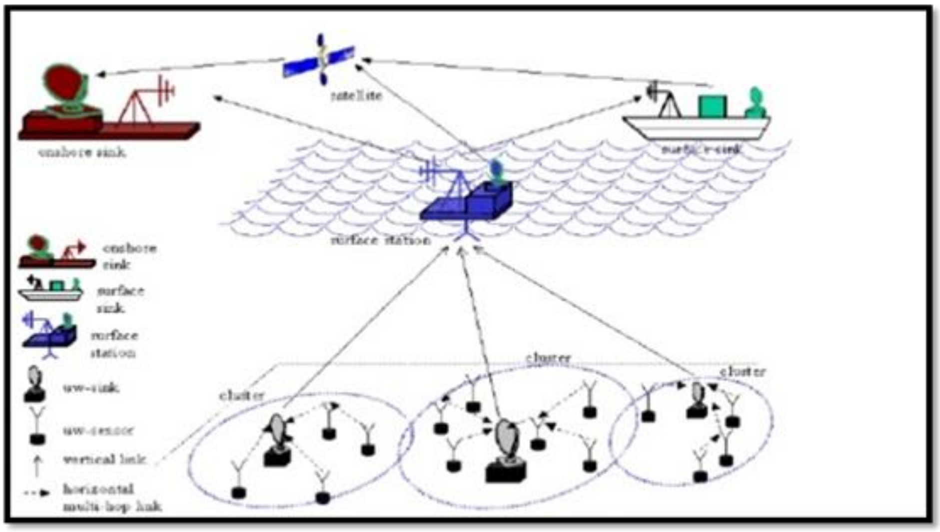

Fig 6.1 2-D architechture of UW-ASN

CHAPTER 7

DATA ACQUIRING AND CONTROLLING

An acoustic data acquisition system for shipboard use is disclosed that permits underwater acoustic data measurements at preselected submerged marine structural coordinates using a free swimming, quiet dynamically positionable remotely operated vehicle ROV. The disclosure also provides a method of performing acoustic data acquisition with an ROV by first inputting the marine structural features by use of a computer aided design subsystem, determining the required trajectory path and hovering coordinates for data measurements, next, establishing the acoustic telemetry system for the ROVs control system to operate within and make an absolute positional fix to the marine structures coordinates then, establish the ambient acoustic conditions of the worksite. The system, monitored and controlled from a computer based system, includes an ROV subsystem that operates in conjunction with a computer based long baseline underwater telemetry and positioning control subsystem, an acoustic transducer array attached to the ROV and a real-time data-coordinate storage subsystem. A particular type of transducer suitable for use with this vehicle is a passive acoustic transducer array hydrophones that measures low level sound pressures and phase data that provides a detailed description of the sound power field emitted over the surface of the underwater structure. Applications include oilgas pipeline leak detection and location of malfunctioning underwater marine equipment.

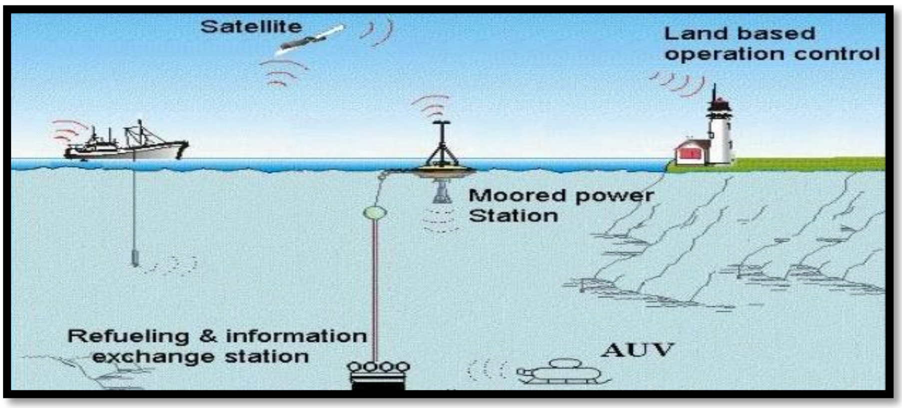

Fig 7.1 Data acquiring and controlling by under water instruments

CHAPTER 8

ATTACKS & COUNTER MEASURES

The coordination and sharing of knowledge between sensors and AUVs build the supply of security difficult. The aquatic atmosphere is especially susceptible to malicious attacks because of the high bit error rates, massive and variable propagation delays, and low information measure of acoustic channels. Achieving reliable entomb vehicle and sensor-AUV communication is very tough because of the quality of AUVs and therefore the movement of sensors with water currents. This paper discusses security in UWCNs. it's structured as follows. the subsequent section explains the particular characteristics of UWCNs compared with their ground based counterparts. Next, the doable attacks and countermeasures square measure introduced. later on, security necessities for UWCNs square measure delineated. Later, the analysis challengesinvolving secure time synchronization, localization, and routing square measure summarized. Finally, the paper is
all over

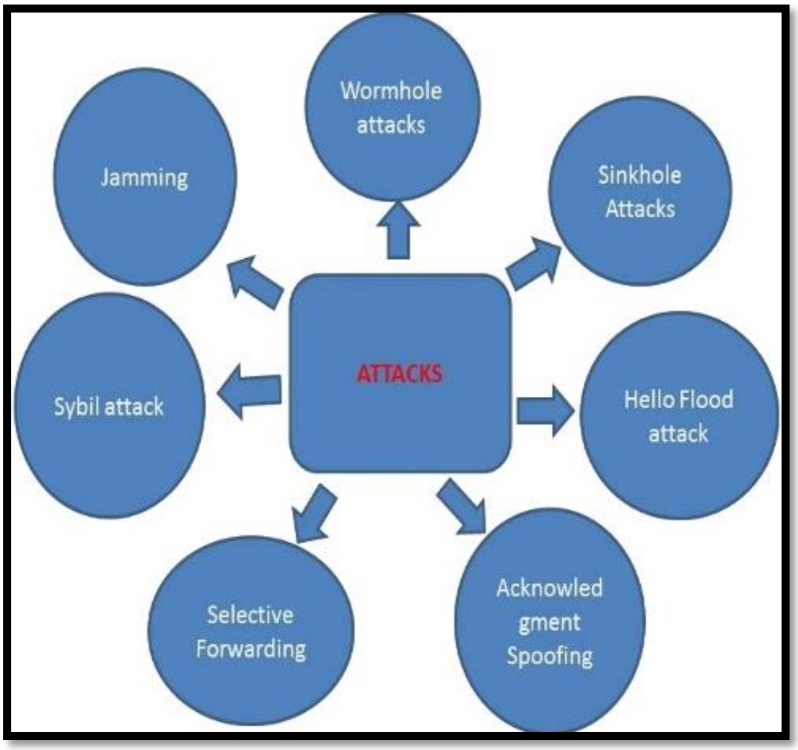

Fig 8.1 Sources of attacks

CHAPTER 9

ADVANTAGES

The massive growth in communication technology in recent years birthed seamless terrestrial wireless communication. Owing to this success, a quest to establish underwater communication systems emerged. There has been a great advancement in this field, particularly with underwater sensor networks; which have been deployed more frequently. An example of this is the operations of Autonomous Underwater Vehicles (AUV). AUVs are robots which travel underwater without needing an operator. AUVs represents the rapid advancements in underwater communication systems as they are increasingly being deployed in various capacities for underwater operations.

Autonomous underwater vehicles have also been deployed in finding crashed aircrafts; and investigation into the causes of their crash. The emergence of communication systems have resulted in the discoveries of the remains of the Titanic, and also the discovery of hydrothermal vents in the deep ocean. These systems are used in detecting objects which aid mapping, and discoveries underwater. They are also very reliable for rescue missions.

Underwater Communication systems are instrumental in ensuring the security of a nation. It is used by the military, to conduct underwater surveillance, as well as to detect intrusion. As rival states might plan a sabotage through the water; having a communication system in the body of waters will alert the nation to the danger. Also, as drug traffickers now deploy autonomous submarines for their operations; having strong communication systems will help to detect and keep them off.

CHAPTER 10

DISADVANTAGES

UWOC has security vulnerabilities and potential risks. Monte Carlo simulation is first adopted to study the security weaknesses of UWOC. With the increased link distance or the deteriorated water quality, the effect of scattering turns more and more severe, which will offer attackers vast opportunities to eavesdrop on the information from the light path. To preliminarily investigate the probability of information leakage, a high-sensitivity MPPC placed aside the light beam is employed to successfully tap a 5-MHz square wave signal at 1-m, 3-m, and 5-m underwater transmission distances.

Further experimentally demonstrate an UWOC system with potential eavesdropping using a single-mode pigtailed green-emitting LD. 2.5-Gb/s OFDM signals transmitting through a 15-m underwater channel are intercepted by an eavesdropping mirror at 7.8 m. When the amplitude of the received signal at 15 m is 161.2 mV, the BERs at 15 m and 7.8 m are 2.3173×10^{-3} and 1.9417×10^{-3}, respectively. When the amplitude of the received signal at 15 m is 129.5 mV, the BERs at 15 m and 7.8 m are 1.6570×10^{-3} and 2.3301×10^{-3}, respectively. In the above two situations, both the eavesdropping receiver at 7.8 m and the normal receiver at 15 m can achieve BERs below the FEC limit of 3.8×10^{-3}, which proves that UWOC suffers hidden dangers of information leakage.

The battery power is limited and usually batteries can not be recharged easily. Highly affected by environmental and natural factors such as heterogeneities of the water column , variations of sound velocity versus depth , temperature and salinity , multiple and random sea reflections and significant scattering by fish bubble clouds and plankton.

CHAPTER 10

FUTURISTIC ASPECTS

More than 75% of the Earth surface is covered by water in the form of oceans. The oceans are unexplored and very far-fetched to investigate due to distinct phenomenal activities in the underwater environment. Underwater wireless communication (UWC) plays a significant role in observation of marine life, water pollution, oil and gas rig exploration, surveillance of natural disasters, naval tactical operations for coastal securities and to observe the changes in the underwater environment. In this regard, the widespread adoption of UWC has become a vital field of study to envisage various military and commercial applications that have been growing interest to explore the underwater environment for numerous applications. Acoustic, Optical and RF wireless carriers have been chosen to be used for data transmission in an underwater environment. The internet of underwater things (IoUT) and next-generation (5G)

networks have a great impact on UWC as they support the improvement of the data rate, connectivity, and energy efficiency. In addition to the potential emerging UWC techniques, assisted by 5G network and improve existing work is also focusing in this study. This survey presents a comprehensive overview of existing UWC techniques, with possible future directions and recommendations to enable the next generation wireless networking systems in the underwater environment. The current project schemes, applications and deployment of latest amended UWC techniques are also discussed. The main initiatives and contributions of current wireless communication schemes in underwater for improving quality of service and quality of energy of the system over long distances are also mentioned.

CHAPTER 11

CONCLUSION

In this article we have discussed about underwater wireless communication . Despite much development in this area of the UWCN, there is still an immense scope so more research as major part of the ocean bottom yet remains unexploded . The main objective is to overcome the present limitation. These research issues remain wide open for future investigation.

CHAPTER 12

REFERNCE

[1] “Underwater Acoustic Sensor Networks: Research Challenges,” *Ad Hoc Net.*, vol. 3, no. 3, I. F. Akyildiz, D. Pompili, and T. Melodia, Mar.2005 .

[2] “Visualization of Wormholes in Underwater Sensor Networks: A Distributed Approach,” *Int’l. J. Security Net.*, vol. 3, no. 1,

[3] A Taxonomy for Denial-of-Service Attacks in Wireless Sensor Networks