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INTERNATIONAL STANDARD

colour inside

Internet of things (IoT) – Underwater acoustic sensor network (UWASN) – Network management system overview and requirements

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INTERNET OF THINGS (IoT) – UNDERWATER ACOUSTIC SENSOR NETWORK (UWASN) – NETWORK MANAGEMENT SYSTEM OVERVIEW AND REQUIREMENTS

FOREWORD

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
JTC1-SC41/149/FDIS	JTC1-SC41/160/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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INTRODUCTION

Water covers approximately 70 % of the surface of the Earth. Modern technologies introduce new methods to monitor the body of water, such as pollution monitoring and detection. Underwater data gathering techniques require exploring the water environment, which can be most effectively performed by underwater acoustic sensor networks (UWASNs). Applications developed for the UWASNs can record underwater climate, detect and control water pollution, monitor marine biology, discover natural resources, detect pipeline leakages, monitor and find underwater intruders, perform strategic surveillance, and so on.

In order to build and apply the UWASN technology, most suitable methods for managing the network have been developed based on the ISO/IEC 30140 series. This document describes the network management outline and requirements appropriate to the UWASN under the constraints of underwater physical environment.

The ISO/IEC 30140 series provides general requirements, reference architecture (RA) including the entity models and high-level interface guidelines supporting interoperability among UWASNs in order to provide the essential UWASN construction information to help and guide architects, developers and implementers of UWASNs.

This document provides the information such as requirements of an underwater network management system (U-NMS), functions supporting U-NMS and components required for U-NMS in UWASN.

Various technical standards derived from the R&D results of the technical areas under the UWASN and underwater communication fields not covered by the ISO/IEC 30140 series are continuously proposed and developed.

INTERNET OF THINGS (IoT) – UNDERWATER ACOUSTIC SENSOR NETWORK (UWASN) – NETWORK MANAGEMENT SYSTEM OVERVIEW AND REQUIREMENTS

1 Scope

This document provides the overview and requirements of a network management system in underwater acoustic sensor network (UWASN) environment. It specifies the following:

– functions which support underwater network management system;
– entities required for underwater network management system;
– data about the communication between elements in underwater network management system;
– guidelines to model the underwater network management system;
– general and functional requirements of underwater network management system.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
agent
software program that manages the devices installed in underwater

3.2
u-MIB
collection of managed objects, which acts as the database for the management of each device in the underwater environment

3.3
manager
program installed in the management station, which is used for the management of devices in underwater networks

4 Abbreviated terms

UUV	unmanned underwater vehicle
UWASN	underwater acoustic sensor network
UWA-GW	underwater acoustic gateway
UWA-SNode	underwater acoustic sensor node
U-NMS	underwater network management system
UWA-CH	underwater acoustic cluster head
u-MIB	underwater management information base
OID	object identifier
FCAPS	fault-management, configuration, accounting, performance and security
FCAPSC	fault, configuration, accounting, performance, security and constrained management
MO	managed object
UUV	unmanned underwater vehicle
AUV	autonomous underwater vehicle

5 U-NMS overview

5.1 General

The UWASN operates in a constrained environment as compared to terrestrial network's operating environment. Hence, the UWASN needs an efficient network management system to handle and compensate for phenomenological difficulties encountered in the underwater environments. This system can be termed an "underwater network management system" or "U-NMS".

Figure 1 shows the diagrammatic representation of a U-NMS module residing within the UWA-Application Layer.

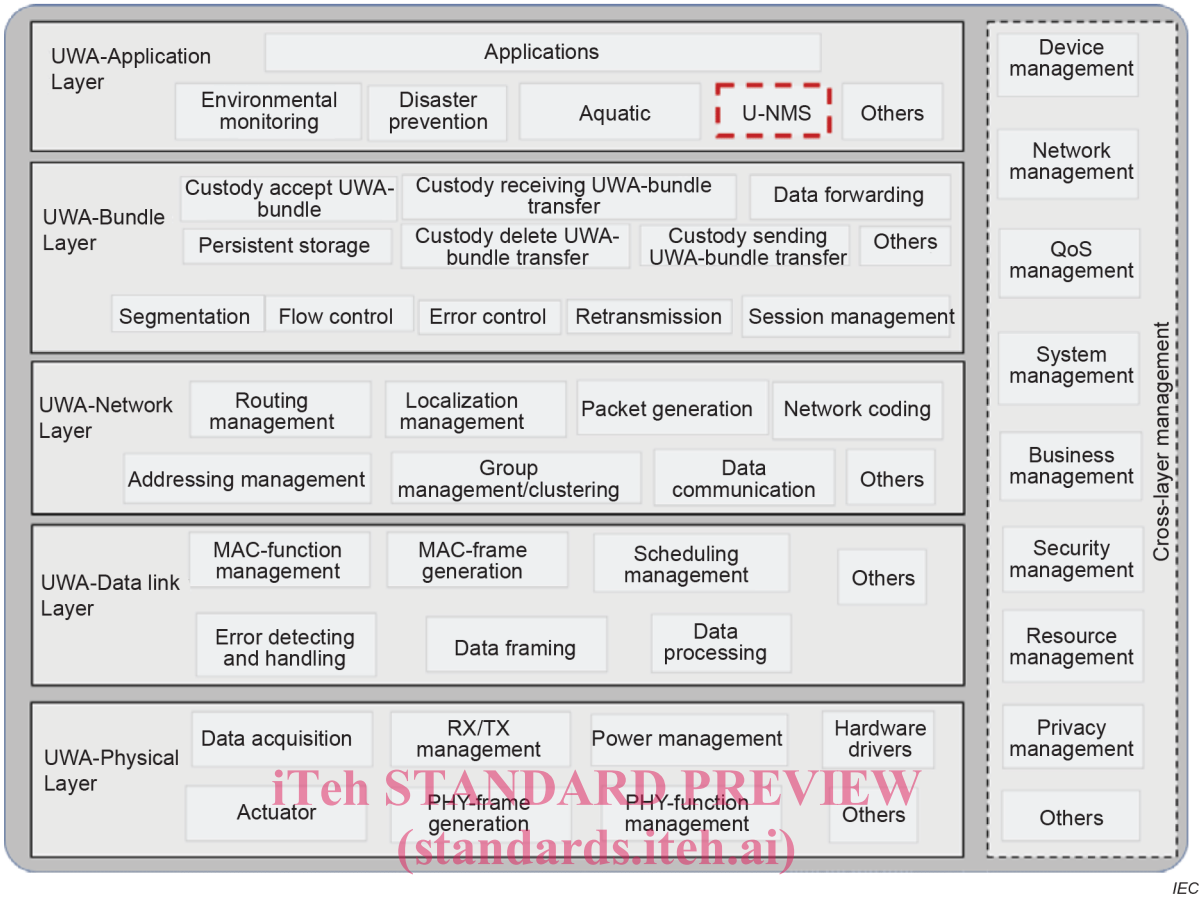

Figure 1 – Stack of layers in a U-NMS

5.2 Problem statements

As the conditions of the underwater environment differ significantly from terrestrial networks, it becomes mandatory to have an appropriate network management system designed uniquely for the underwater environments.

The specific challenges or issues for the UWASNs to operate with the help of U-NMS are given below.

– Low data rate: In UWASN, the total amount of data collected during the monitoring process by each sensor is less, when compared to terrestrial networks. This is because of the limitation in memory, battery power, etc. in underwater devices.

– Transmission range: In UWASN, the nodes can cover only less distance when considering the network coverage and battery power planning. On the other hand, signals are usually transmitted in low frequencies under water, in order to avoid being absorbed by water. This in turn allows longer transmission ranges, but at the same time increases the chances for interference and collision.

– Battery charge level: As battery backup is limited for all devices in the underwater environment, energy efficiency turns out to be a major challenge when considering the cost of battery recharging.

– Attenuation: In UWASN, the transmission loss can occur based on an absorption in the underwater environments.

– Deployment depth: In UWASN, the node deployment and the node management encounter difficulties due to the depth of sea.

– Size of the antenna: In UWASN, the size of the antenna is designed as small for short range communication and bigger for long range communication. So, it faces difficulties during deployment in underwater communication.

– Data delivery rate: In UWASN, the total packets delivered to the receiver can be influenced by various factors such as time, traffic, etc.

– Delay of data transmission: In UWASN, as the underwater environment is heavily congested with acoustic signals, this situation can cause delays during data transmission.

– Bit errors: In UWASN, the increased bit errors at receivers are caused by various factors such as noise, attenuation, interference, etc.

5.3 Description of the U-NMS

The U-NMS is a program or collection of programs that allows the administrators to independently manage and control every component in an underwater network system.

Operations performed by the U-NMS are the following:

– configuring underwater networks;

– monitoring the performance of components;

– identifying and controlling traffic;

– dealing with problems like device failure, attacks, etc.

5.4 Purpose and advantages of the U-NMS

The main purposes of the U-NMS are to

– monitor the network systems and functions of UWASNs, and

– ensure that the generated data can be transmitted and received at the destination efficiently through the network.

The advantages of using the U-NMS include, but are not limited to, the following.

– Cost reduction: In a constrained environment, it is difficult to manage the devices physically at all times. For example, power, memory, deployment, fouling cleaning, etc. require efficient management mechanisms. Also, the cost is very high for direct management. If a proper management system is employed, then the operational cost, installation cost, etc. can be reduced.

– Easy network monitoring: Each device and the network can be used for monitoring the connection between the devices and network in the underwater environments.

– Error handling: In the underwater environment, the errors can occur in both the devices and network sides and this can be easily handled using the U-NMS.

– Automatic software updates: In the U-NMS, the automatic updating of software over the underwater network is essential.

– Network configuration flexibility: The U-NMS provides easy configuration support among the hardware, software, devices, network, etc. In this way, flexible connections can be made between devices and network.

– Service improvement: The U-NMS can provide the high-quality services such as data collection, processing, predicting, communicating, etc.

– Data control over network: The U-NMS can control the status of devices such as memory, power, network range, etc. Also, the U-NMS can control each underwater management device by collecting and processing dynamic data.

– Security solutions: The U-NMS consists of a security module which can protect the underwater devices from authorization and authentication related issues. Also, the U-NMS can manage the security level of the system based on the security rules.

– Log data analysis: In the U-NMS, log data is the set of underwater activity observation data captured by underwater devices, underwater networks, operating system, etc. Log data can be used to analyse user behaviour, security risks, audit, etc.

6 Functions of the U-NMS

6.1 Overview

In UWASN, the network management system utilizes different methods and tools to assist a human operator in order to manage underwater devices, networks or systems. The functions of U-NMS are modelled using Fault, Configuration, Accounting, Performance, Security and Constrained management (FCAPSC).

FCAPSC functions of U-NMS are described in Figure 2.

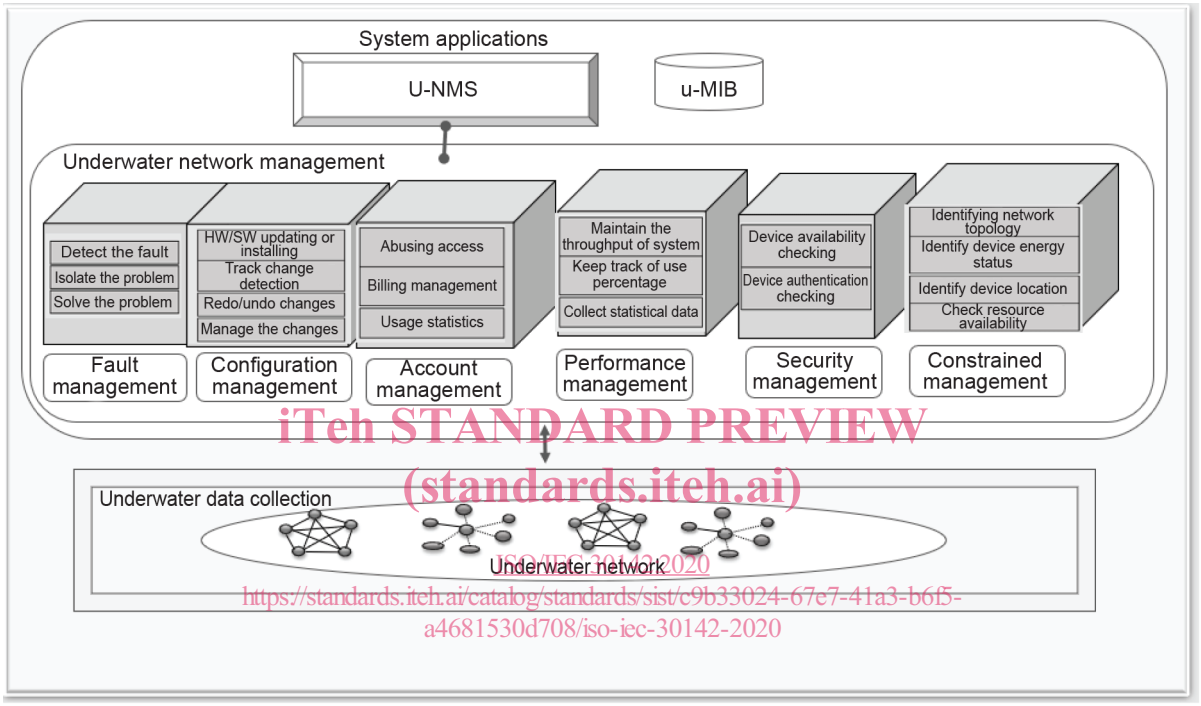

Figure 2 – Functions of the U-NMS

6.2 U-NMS fault management

The main goal of fault management in U-NMS is to notify the faults and abnormal operations in the UWASN. U-NMS fault management functionality includes examining and maintaining the error logs, responding to notifications, finding the faults, performing the diagnostic tests and correcting the faults.

Network problems are detected, isolated and corrected at the fault management level in the U-NMS. As a fault may occur in various components of the system, it is important to identify the relationship between these components. The network always stays operational with the help of the fault management mechanism. The fault management shows how to design and install the services of faults in the U-NMS.

The U-NMS fault management steps are as follows.

– Detect the fault: In U-NMS, the fault detection is indicated by notification messages. The u-MIB has the information related to types of fault that will correlate and find the reasons for the occurrence of faults such as device faults, battery faults, etc.

– Isolate the problem: The source of fault occurring in the U-NMS such as device, battery, network, etc. can be identified.