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Internet of Things (IoT) – Underwater acoustic sensor network (UWASN) – Application profiles

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International Standard ISO/IEC 30143 was prepared by subcommittee 41: Internet of Things and related technologies, of ISO/IEC joint technical committee 1: Information technology.

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

FDIS	Report on voting
JTC1-SC41/150/FDIS	JTC1-SC41/161/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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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, the most suitable methods for managing the network have been developed based on the already proposed ISO/IEC 30140 series. This document describes the application profiles 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 guidelines for designing and developing the UWASN application. It also provides other information such as the components required for developing UWASN application, modelling techniques for UWASN application and UWASN application profiles example.

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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.

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INTERNET OF THINGS (IoT) – UNDERWATER ACOUSTIC SENSOR NETWORK (UWASN) – APPLICATION PROFILES

1 Scope

This document provides the guidelines for designing and developing new applications in the underwater environment such as fish farming, environment monitoring, harbour security, etc. This document also:

- provides the components required for developing the application;
- provides instructions for modelling the application with examples;
- helps the user to understand the communication between the elements in the application for modelling the communication between elements;
- guides the user with the design process of underwater applications.

2 Normative references

There are no normative references in this document.

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3 Terms and definitions

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

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

3.1
application profile
set of documents which provides the effective guidance to develop a particular application

3.2
component
representation of an actor in a UWASN application profile

3.3
element
<of use case model> object used to connect the devices and networks in the underwater environment

EXAMPLE actors, use cases, relationships

3.4
element
<of sequence diagram model> essential part used to connect the devices and networks in the underwater environment

EXAMPLE class, execution place, lifeline

3.5
element
<of class diagram model> class, object or method used for the communication between the devices and networks in the underwater environment

4 Abbreviated terms

RF	radio frequency
UUV	unmanned underwater vehicle
UWASN	underwater acoustic sensor network
UWA-GW	underwater acoustic gateway
UWA-SNode	underwater acoustic sensor node
UWA-CH	underwater acoustic cluster head
UWA-CH-id	underwater acoustic cluster head identity
UWA-SNode-id	underwater acoustic sensor node identity
UWA-DTN-GW	underwater DTN gateway
UWA-FN	underwater acoustic fundamental network

5 Overview of UWASN application profiles

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5.1 Introduction to application profiles

In UWASN, the application profiles comprise of a group of components, approaches and guidelines for a specific application.

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5.2 Benefits of application profiles

An application profile is a layout or outline for users. Application profiles can help users as suggested below:

– utilizing them to depict how applications are deployed, arranged and managed in submerged conditions;
– providing required components for building up new UWASN applications effectively;
– providing the basic information for planning;
– reducing the learning curve;
– standardizing the development work; and
– providing the general requirements and functional requirements for developing the application.

6 Design process of UWASN application profiles

6.1 General

The primary goal of the design process is to give guidance for developing underwater applications (See Annex A). The design process of UWASN application profiles provides the following information:

– purpose of UWASN application;
– overview of UWASN application;
– user requirements for the design process of UWASN application;
– general requirements for the design process of UWASN application;

– functional requirements for the design process UWASN application;
– constrained requirements for the design process of UWASN application;
– consideration for the design process of UWASN application.

6.2 Criteria for the design process of UWASN application profiles

The criteria considered for the design process of the UWASN application profiles include but are not limited to the following:

– limitation in bandwidth;
– localization;
– limited battery power;
– deployment of devices;
– reliability;
– scalability;
– quality of service;
– distance of transmission;
– propagation delay;
– device configuration;
– device maintenance;
– self-management.

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6.3 Design process steps for UWASN application profiles

Table 1 shows the steps for the design process of UWASN application profiles.

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Table 1 – Steps for the design process of UWASN application profiles

Design process steps	Description
Step 1: User requirements analysis	The user requirements for a particular UWASN application are collected.
Step 2: General requirements analysis	The general requirements for particular UWASN application are collected.
Step 3: Functional requirements analysis	The functional requirements for a particular UWASN application are collected.
Step 4: Constrained requirements analysis	The constrained requirements for a particular UWASN application are collected.
Step 5: Design process	The design process of UWASN application profile needs the modelling techniques for designing the application such as case modelling, sequence diagram modelling and class diagram modelling.
Step 6: Implementation guideline process	The implementation process consists of installation, deployment, configuration, performing operation and testing.
Step 7: Specialized maintenance	The specialized maintenance for underwater applications is considered. For example, node reclamation (change battery/recharging), fouling cleaner, housing case, etc.

7 Requirements for the design process of UWASN application profiles

7.1 General

Clause 7 discusses the various requirements such as user requirements, general requirements, functional requirements and constrained requirements for the design process of UWASN application profiles (See Annex A).

7.2 User requirements of UWASN application profiles

Table 2 shows the user requirements for UWASN application profiles.

Table 2 – User requirements of UWASN application profiles

User requirements	Description
Durability	Durability refers to the time period for which a product or system can meet its service and performance requirements.
System performance	System performance refers to the effectiveness of a system, which includes response time, throughput, latency, availability, etc.
Low cost	Low cost includes the total cost of the system, which includes the cost of procurement, installation, usage and disposal.
Efficiency	Efficiency of a system can be identified using various factors such as response time, number of tasks completed in a stipulated time, etc.
Adaptability	Adaptability refers to the extent to which a system adapts to the change in its working environment.
Reliability	Reliability refers to the hardware or software or other application related items; its performance is consistently monitored by the users. It can be considered while buying or using the product.
Usability	Usability can be defined as the ease of use with respect to the system. This includes measures such as learnability, efficiency, memorability, etc.
Availability	Availability refers to the percentage of time that the system is available and working according to the requirements.
Maintainability	Maintainability refers to the ability to make variations in the system quickly and cost effectively.
Security	Security refers to the ability of the system (1) to resist unauthorized usage and (2) to continue providing services to the legitimate users in case of attacks.
Portability	Portability can be defined as the ability of a system to run under different computing environments such as hardware, software, operating systems, etc.
Reusability	Reusability refers to the ability of a system to make reuse of existing components in new applications.

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7.3 General requirements of UWASN application profiles

Table 3 shows the general requirements for UWASN application profiles.

Table 3 – General requirements for UWASN application profiles

General requirements	Description
Capability of discovery	The UWA-SNode shall use discovery capability mechanism to identify other nodes connected inside the UWASN system.
Connectivity support to different network	Integration shall be supported by different networks for avoiding complexity.
Routing techniques	The best routing algorithm is performed by the device known as router, used for passing the message from source to destination. This technique can also reduce the cost in UWASN.
Security	A standard security system shall be used to prevent attacks from illegal users.
Service quality	Service quality refers to a network capability to attain maximum bandwidth and deals with the various performance elements of network, which include latency, error rate, etc.
Scalability	If the number of devices increases, the UWASN system shall use the scalability support.
Dynamic adaptation	Due to the mobility of UUV and UWA-SNode, the UWASN shall use dynamic adaptation techniques.

General requirements	Description
Deployment	Easy deployment techniques shall be used for the deployment of UWA-SNodes in the underwater environment.
Battery life time management	In UWASN, the battery life time management shall be used to increase the battery life time of underwater devices.
Localization	Localization techniques shall be used to find the location of UWA-SNodes, UUVs, etc.
Time synchronization	Time synchronization shall be used to synchronize the time of all sensor nodes used in UWASN.
Network management	Network management shall be used to manage the whole applications such as fish farming, environment monitoring, etc.
Wired/wireless communication	Wired or wireless communication shall be established based on the requirements.
Privacy	Any information cannot be provided for all. So, this function shall be used for maintaining privacy.
Packet loss reducing	Various techniques shall be used to minimize the packet loss in UWASN.

7.4 Functional requirements of UWASN application profiles

Table 4 shows the functional requirements for UWASN application profiles.

Table 4 – Functional requirements for UWASN application profiles

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Functional requirements	Description
Data processing	Data processing is used for performing the operations such as classifying, retrieving, transforming, etc.
Device management	Device management is used for the management of components such as UWA-SNode, UWA-GW, etc.
Data acquisition	The data acquisition function is used for measuring the physical characteristics of water such as temperature, dissolved oxygen, pH value, etc.
Validation process	The validation process is used for application quality management, such as whether the application meets its requirements or services.
Integration	This is used to integrate different components to perform the required functions.
Data communication	Communication module and efficient protocols are required for long-range and short-range communication.
Data storage	The amount and type of data stored in UWA-SNode, UWA-CH, etc.
Identification	The UWA-SNode needs a unique identifiable address.
Self-localization	The UWA-SNode, UWA-CH and UUV needs the ability to identify their location.
Data security	In UWASN the functions like key distribution, data integrity and authentication are used to increase the security level.
Key distribution	The shared key mechanism can be used between the nodes such as UUV, UWA-SNode, UWA-CH, etc. to increase the reliability of communication.
Integrity	The integrity mechanism is used to increase the confidentiality while sending and receiving data.
Authentication	The authentication mechanism is used to ensure whether the messages are generated from the authenticated user or not.
Network recovery	The network recovery functions are used to reconnect the network when the connection is broken.
Device recovery	The devices such as UWA-SNodes, UUVs, etc. consist of all the information related to environment. If some failures occur in the device, the device recovery function shall be used.
Battery capacity	To identify the maximum amount of power availability in underwater devices such as UWA-SNodes, UUVs, etc. the battery capacity function is needed.