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INTERNATIONAL STANDARD

Internet of things (IoT) – Base-station based underwater wireless acoustic network (B-UWAN) –
Part 1: Overview and requirements

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INTERNET OF THINGS (IoT) – BASE-STATION BASED UNDERWATER WIRELESS ACOUSTIC NETWORK (B-UWAN) –

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FOREWORD

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

Draft	Report on voting
JTC1-SC41/266/FDIS	JTC1-SC41/278/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1, available at www.iec.ch/members_experts/refdocs and www.iso.org/directives.

A list of all parts in the ISO/IEC 30171 series, published under the general title *Internet of Things (IoT) – Base-station based underwater wireless acoustic network (B-UWAN)*, can be found on the IEC website.

INTRODUCTION

Underwater network can play a major role in the underwater environment because approximately three quarters of the Earth is covered by water. Underwater network is important to deploy various underwater applications and services such as finding underwater pipeline leakage, detecting underwater climatic changes, monitoring water pollution levels, discovering underwater natural resources, monitoring and finding underwater intruders, performing strategic surveillance, and so on. Underwater network faces challenges due to constrained and time varying underwater environment, maintaining both stationary and mobile nodes, limited battery power, and managing a large number of sensors. Novel underwater communication methods are brought by emerging technologies to overcome these challenges. Base-station based underwater wireless acoustic networks (B-UWANs) can provide efficient communication and deployment in constrained underwater environment. B-UWAN follows centralized management to improve communication performance with a large number of sensors, stationary and mobile nodes, and to provide longer battery life.

This document describes the overview and requirements appropriate to the B-UWAN under the constrained underwater environment.

INTERNET OF THINGS (IoT) – BASE-STATION BASED UNDERWATER WIRELESS ACOUSTIC NETWORK (B-UWAN) –

Part 1: Overview and requirements

1 Scope

This document provides the general overview of base-station based underwater wireless acoustic networks (B-UWANs). It gives a detailed description of the main components of B-UWAN and also provides functions of B-UWAN components. It further specifies the requirements of B-UWAN.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 29182-2, *Information technology – Sensor networks: Sensor Network Reference Architecture (SNRA) – Part 2: Vocabulary and terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 29182-2 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

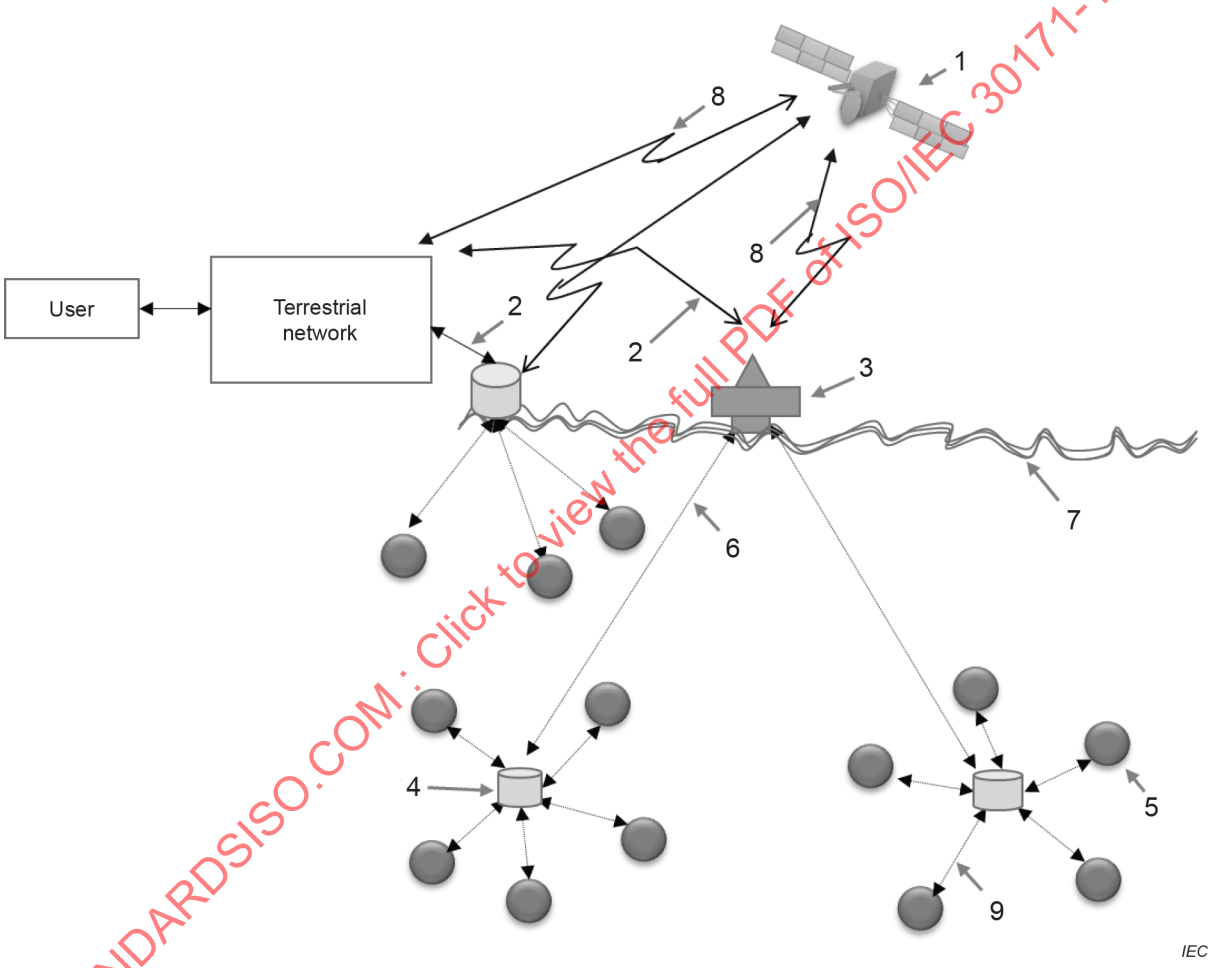
4 Abbreviated terms

B-UWAN	base-station based underwater wireless acoustic network
CDMA	code division multiple access
CSS	chirp spread spectrum
OFDM	orthogonal frequency division multiplexing
UWA-BS	underwater wireless acoustic base-station
UWA-BSC	underwater wireless acoustic base-station controller
UWA-SNode	underwater wireless acoustic sensor node

5 B-UWAN overview

5.1 General

The main motivation for base-station based underwater wireless acoustic network (B-UWAN) is centralized infrastructure of networks with base-stations which can manage and maintain a large number of underwater sensor nodes with mobility. For an efficient and effective underwater communication, selection of the best communication method is important. With the help of B-UWAN, such selection can be achieved in the underwater communication. The overview of B-UWAN shown in Figure 1 depicts the three main components. They are underwater wireless acoustic base-station controller (UWA-BSC), underwater wireless acoustic base-station (UWA-BS), and underwater wireless acoustic sensor node (UWA-SNode). UWA-BSC controls UWA-BSs, and UWA-BS controls UWA-SNodes.



Key

1	Satellite	6	Acoustic/wired link
2	RF/wired link	7	Water surface
3	UWA-BSC	8	Satellite communication
4	UWA-BS	9	Acoustic link
5	UWA-SNode		

Figure 1 – Overview of B-UWAN

B-UWAN has a layered architecture with different functionalities. B-UWAN provides centralized management of power, adaptive link, resource, handover, frequency reuse, multiple access control and inter-cell interference. Because of these functionalities B-UWAN can provide more reliable underwater communication with low power, and low latency.

5.2 Layered architecture of B-UWAN

The layered architecture of B-UWAN is shown in Figure 2. B-UWAN follows the layered architecture with two layers. Layer 1 provides the communication between the UWA-BSC and UWA-BSs. Layer 1 may operate in same or different frequencies between UWA-BSC and UWA-BSs. Frequencies for transmitting and receiving the data within layer 1 may be the same or different. In layer 1, wired or wireless communication is used. Frequencies and time resources are managed by UWA-BSC in layer 1. Within layer 1, the same or different communication wave forms like orthogonal frequency division multiplexing (OFDM), code division multiple access (CDMA) or chirp spread spectrum (CSS) can be used for different UWA-BSs.

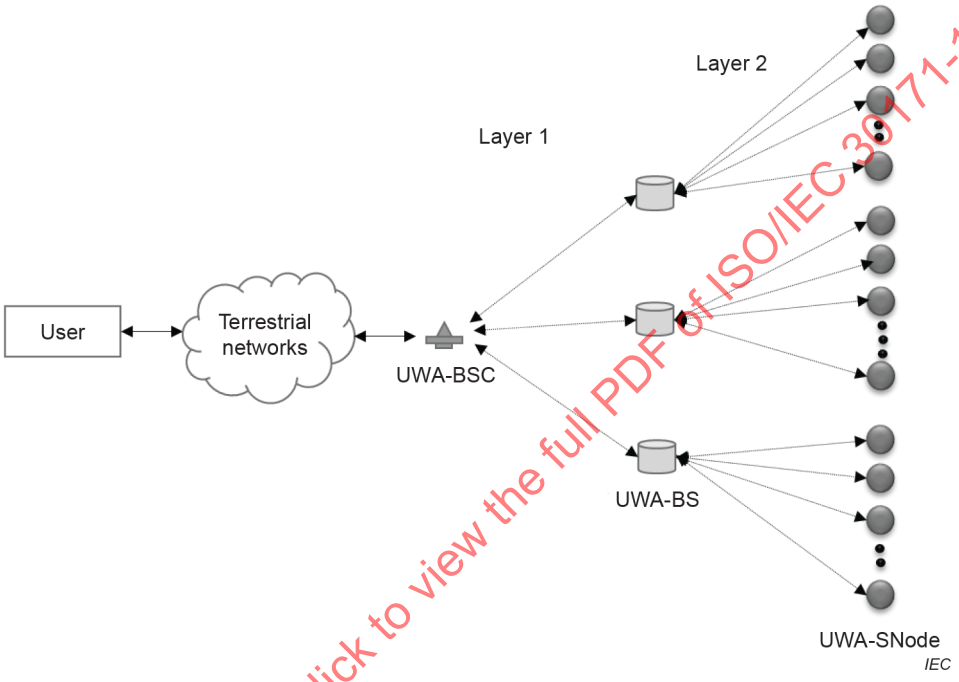
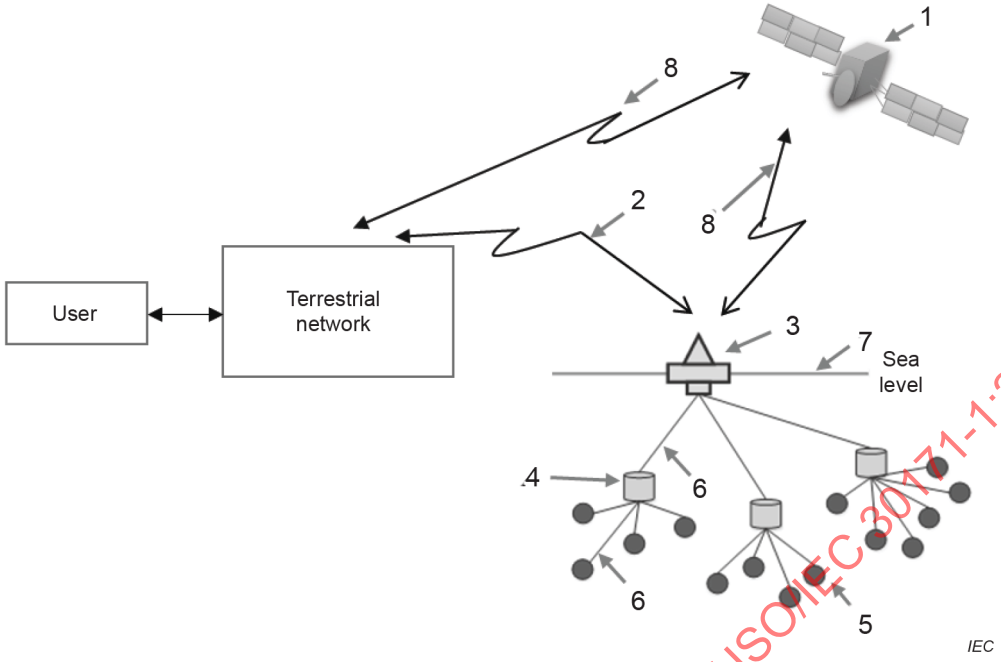


Figure 2 – Layered architecture of B-UWAN

Layer 2 provides communication between the UWA-BS and UWA-SNodes. Layer 2 uses wireless acoustic communication. Layer 2 uses the same frequency or different frequencies for the communication between UWA-BS and UWA-SNodes. Within layer 2, frequencies for transmitting and receiving the data may be the same or different. In layer 2, frequencies and time resources are managed by UWA-BS. Layer 2 uses the same or different communication methods for different UWA-SNodes.

5.3 Installation methods of B-UWAN

The installation of B-UWAN with wireless configuration is shown in Figure 3. Here UWA-BSCs, UWA-BSs and UWA-SNodes use acoustic communication. Here layer 1 and layer 2 operate with wireless acoustic communication.

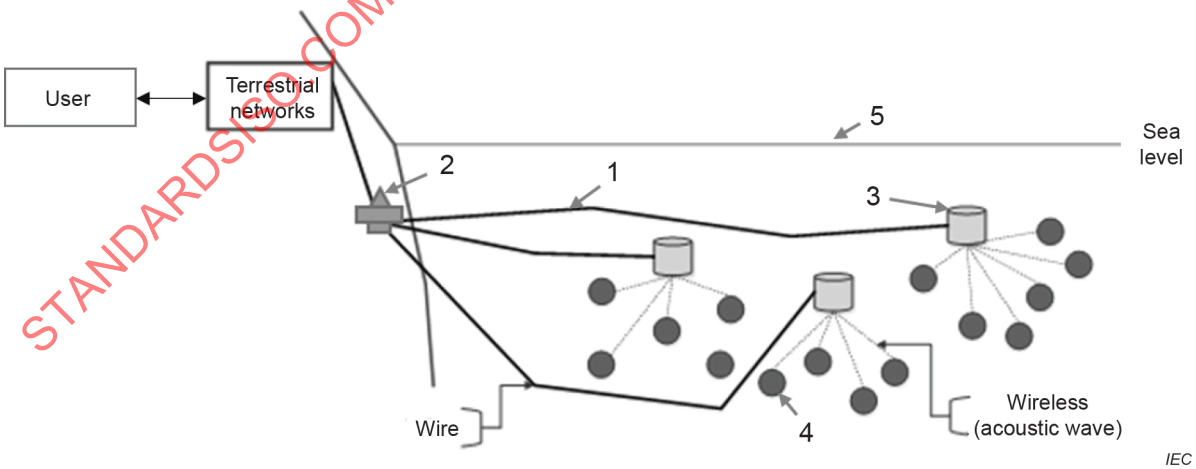


Key

1	Satellite	5	UWA-SNode
2	RF link	6	Acoustic link
3	UWA-BSC	7	Water surface
4	UWA-BS	8	Satellite communication

Figure 3 – B-UWAN installation with acoustic communication

The installation of B-UWAN with wired UWA-BSC configuration is shown in Figure 4. UWA-BS uses wired communication to communicate with UWA-BSC, which is layer 1. In layer 2, between UWA-BS and UWA-SNodes, wireless acoustic communication is used. UWA-BSC uses wired communication to communicate with terrestrial networks.

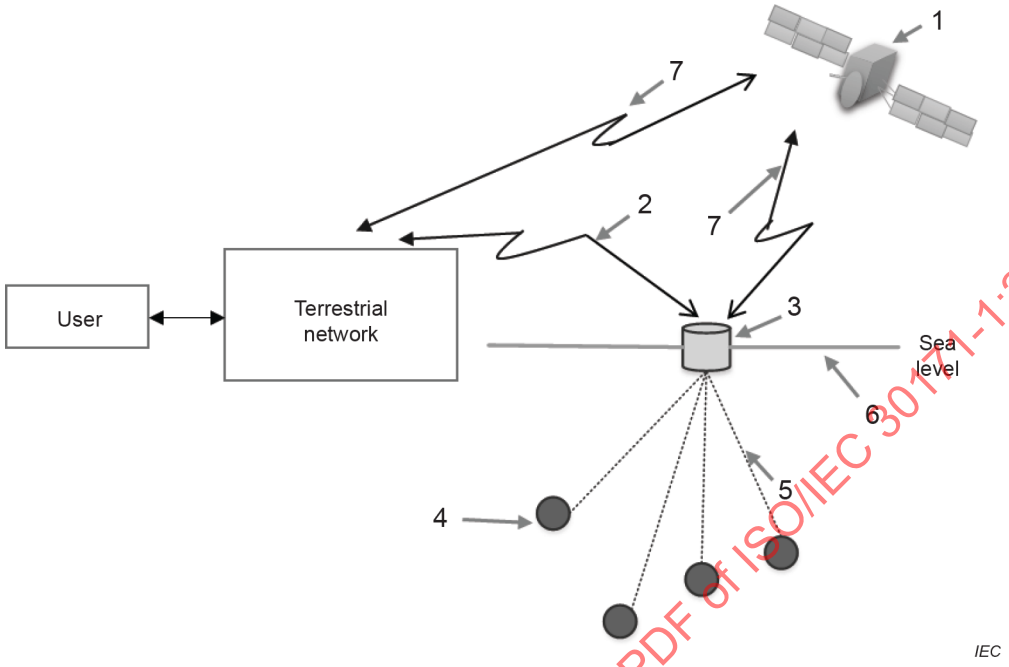


Key

1	Wired link	4	UWA-SNode
2	UWA-BSC	5	Water surface
3	UWA-BS		

Figure 4 – B-UWAN installation with wired and acoustic communication

The installation of B-UWAN without UWA-BSC is shown in Figure 5. In layer 2, UWA-BS uses wireless acoustic communication to communicate with UWA-SNodes. Here layer 1 is optional.



Key

1	Satellite	5	Acoustic link
2	RF/wired link	6	Water surface
3	UWA-BS	7	Satellite communication
4	UWA-SNode		

Figure 5 – B-UWAN installation without UWA-BSC

Figure 5 contains one UWA-BS on the surface and several UWA-SNodes underwater.

5.4 UWA-BSC communication system

The UWA-BSC communication system overview is shown in Figure 6. UWA-BSC provides functionality to control and manage several UWA-BSs. UWA-BSC also provides support for terrestrial communication.

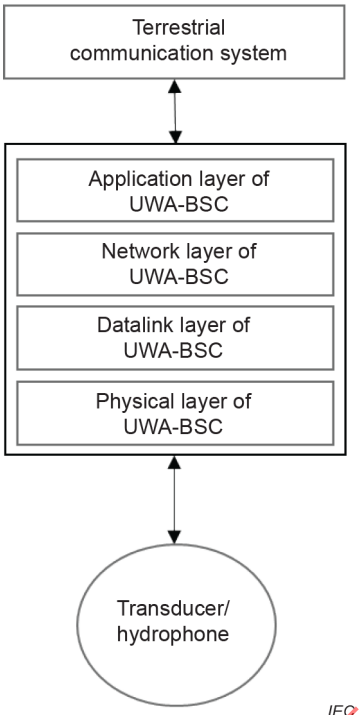


Figure 6 – Overview of UWA-BSC communication system

Figure 6 shows the different layers of the UWA-BSC communication system. Here the transducer transmits or receives acoustic signals. The physical layer of UWA-BSC performs conversion of acoustic signal to digital data, digital data to acoustic signal, channel measurement for adaptive link, and state measurement for handover for UWA-BSs. The datalink layer of UWA-BSC performs link adaptation and medium access control for UWA-BSs. The network layer of UWA-BSC performs operation management of handover for UWA-BSs. The application layer of UWA-BSC manages the sensor information with the help of a sensing module. UWA-BSC's sensing module can detect the water temperature, dissolved oxygen, pH and CO_2 levels.

5.5 UWA-BS communication system

The UWA-BS communication system overview is shown in Figure 7. UWA-BS controls and manages UWA-SNodes and also performs data linkage. Initialization of UWA-SNodes system parameters, management of UWA-SNodes system parameters, power management, multiple access control management, adaptive link management, and resource management of UWA-SNodes are done by UWA-BS.

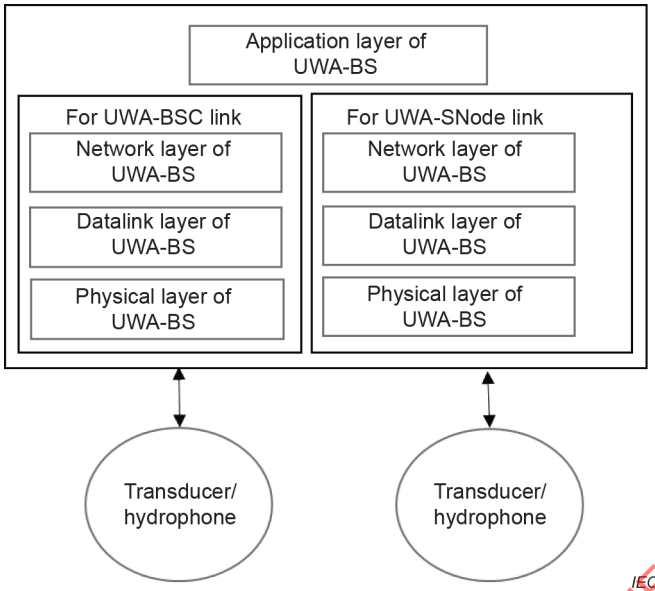


Figure 7 – Overview of UWA-BS communication system

UWA-BS has different links for the UWA-BSC and UWA-SNode. The physical layer of UWA-BSC link performs conversion of acoustic signal from UWA-BSC to digital data and digital data from UWA-BS to acoustic signal for UWA-BSC, supports channel measurement of adaptive link, and supports state measurement of handover for UWA-BSC. The datalink layer of UWA-BSC link supports link adaptation and medium access control for UWA-BSC. The network layer of UWA-BSC link supports operation management of handover for UWA-BSC. The physical layer of UWA-SNode link performs conversion of acoustic signal from UWA-SNode to digital data and digital data from UWA-BS to acoustic signal for UWA-SNode, performs channel measurement of adaptive link, and also performs state measurement of handover for UWA-SNode. The datalink layer of UWA-SNode link performs link adaptation and medium access control for UWA-SNode. The network layer of UWA-SNode link performs operation management of handover for UWA-SNode. The application layer is common for the UWA-BSC link and UWA-SNode link. A sensing module can be attached to the application layer of UWA-BS communication system.

5.6 UWA-SNode communication system

The UWA-SNode communication system overview is shown in Figure 8. UWA-SNode collects underwater sensor information and only communicates with UWA-BS. There is no direct communication between UWA-BSC and UWA-SNode.

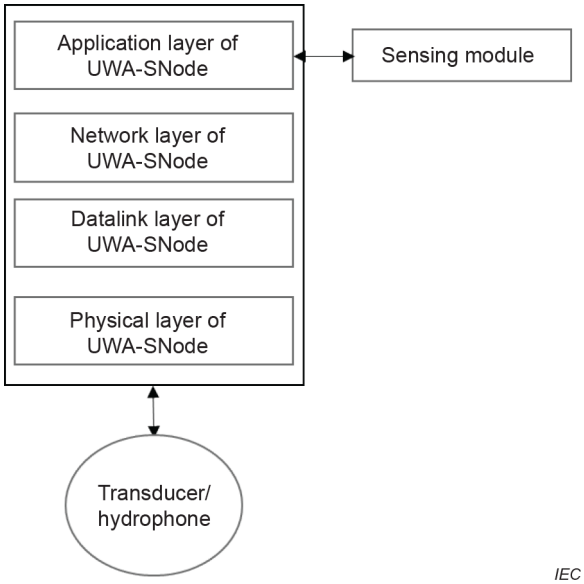


Figure 8 – Overview of UWA-SNode communication system

The physical layer of UWA-SNode performs conversion of acoustic signal to digital data and digital data to acoustic signal, supports channel measurement of adaptive link, and performs state measurement of handover. The datalink layer of UWA-SNode supports link adaptation and medium access control. The network layer of UWA-SNode supports operation management of handover. A sensing module is attached to the application layer of UWA-SNode communication system.

6 Requirements of B-UWAN

6.1 General requirements

6.1.1 General

There are general requirements available for B-UWAN such as scalability, device management, low latency and carrier frequency management, etc.

6.1.2 Scalability

The UWA-BSC shall support scalability in number of UWA-BSs with no compromise in the performance. The UWA-BS shall support scalability in number of UWA-SNodes with no compromise in the performance.

6.1.3 Device management

The UWA-BSC shall manage and maintain number of UWA-BSs. The UWA-BS shall manage and maintain number of UWA-SNodes.

6.1.4 Low latency

The UWA-BSC should support UWA-BSs with low latency by minimizing the UWA-BSC's processing time. The UWA-BS should support UWA-SNodes with low latency by minimizing the UWA-BS's processing time.

6.1.5 Carrier frequency

The UWA-BSC shall support carrier frequencies or available bandwidth for UWA-BSs based on usage. The UWA-BS shall support carrier frequencies or available bandwidth for UWA-SNodes based on usage.

6.1.6 Reliability

The UWA-BSC shall provide reliable communication to UWA-BSs. The UWA-BS shall support reliable communication of UWA-SNodes.

6.1.7 Availability

The UWA-BSC shall be available to number of UWA-BSs. The UWA-BS shall be available to number of UWA-SNodes.

6.1.8 Safety

UWA-BSC, UWA-BS, and UWA-SNode should not be dangerous to underwater life, property, or environment. In particular, the transmit power and frequency of the wireless acoustic transducers should depend on underwater environment.

6.1.9 Security

Communication modules of UWA-BSC, UWA-BS, and UWA-SNode should not be accessible to unauthorized users.

6.1.10 Compatibility

B-UWAN should provide compatibility for other underwater communication networks.

6.1.11 Network monitoring and management

B-UWAN should provide network monitoring and management support for UWA-BSCs, UWA-BSs and UWA-SNodes.

6.1.12 Support for other communication methods

B-UWAN should provide support for various communication methods such as visible light communication, magnetic induction, etc.

6.2 Specific requirements of B-UWAN

6.2.1 General

There are several specific requirements available for B-UWAN such as power management, adaptive link management, resource management, etc.

6.2.2 Communication with terrestrial network

UWA-BSC and UWA-BS shall provide functionalities for communication with terrestrial network via wired or wireless communication.

6.2.3 Centralized power management

UWA-BSC shall have control of UWA-BS's maximum transmission power based on usage. UWA-BS shall have control of UWA-SNode's maximum transmission power based on usage.