# ISO/IEC TR 30167

Edition 1.0 2021-06

# TECHNICAL REPORT



colour inside

## Internet of things (IoT) – Underwater communication technologies for IoT

ISO/IEC TR 30167:2021-06(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

**About the IEC**
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

**About IEC publications**
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

**IEC publications search - webstore.iec.ch/advsearchform**
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

**IEC Just Published - webstore.iec.ch/justpublished**
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

**IEC Customer Service Centre - webstore.iec.ch/csc**
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

**IEC online collection - oc.iec.ch**
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

**Electropedia - www.electropedia.org**
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

# ISO/IEC TR 30167

Edition 1.0 2021-06

# TECHNICAL REPORT



colour inside

## Internet of things (IoT) – Underwater communication technologies for IoT

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.020

ISBN 978-2-8322-9865-7

# CONTENTS

# INTERNET OF THINGS (IoT) – UNDERWATER COMMUNICATION TECHNOLOGIES FOR IoT

## FOREWORD

1) ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.
2) The formal decisions or agreements of IEC and ISO on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC and ISO National bodies.
3) IEC and ISO documents have the form of recommendations for international use and are accepted by IEC and ISO National bodies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC and ISO documents is accurate, IEC and ISO cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC and ISO National bodies undertake to apply IEC and ISO documents transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC and ISO document and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC and ISO do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC and ISO marks of conformity. IEC and ISO are not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this document.
7) No liability shall attach to IEC and ISO or their directors, employees, servants or agents including individual experts and members of its technical committees and IEC and ISO National bodies for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this ISO/IEC document or any other IEC and ISO documents.
8) Attention is drawn to the Normative references cited in this document. Use of the referenced publications is indispensable for the correct application of this document.
9) Attention is drawn to the possibility that some of the elements of this ISO/IEC document may be the subject of patent rights. IEC and ISO shall not be held responsible for identifying any or all such patent rights.

ISO/IEC TR 30167 has been prepared by subcommittee 41: Internet of Things and Digital Twin, of IEC joint technical committee 1: Information technology. It is a Technical Report.

The text of this Technical Report is based on the following documents:

| DTR | Report on voting |
|---|---|
| JTC1-SC41/183/DTR | JTC1-SC41/203A/RVDTR |

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

The language used for the development of this Technical Report is English.

This document has been drafted in accordance with the 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.

**IMPORTANT – The "colour inside" logo on the cover page of this document 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

Earth is the aquatic planet as water covers 70 % of its surface. Due to the rapid growth of technology, underwater communication technologies can be used for the development of various smart underwater applications. The underwater communication system is one of the fastest-growing fields since many applications such as monitoring applications, military applications, security applications, new resource exploration, etc. are continuously being developed and used. However, many applications still need to be studied in-depth and underwater resources also need to be explored. Therefore, the research in underwater communication technology plays a vital role in the exploration of undersea resources and the development of various underwater applications.

Using the radio frequency (RF) signal, the communication technology in the underwater environment can be extremely influenced by various factors such as environmental noise, pollution, power, etc. This can cause several issues related to attenuation, frequency fading, Doppler shift, multipath effect, etc. Hence, acoustic communication technology has been used by numerous researchers to solve these issues. In the case of high-speed acoustic communication, problems like limited bandwidth, reliability in data, error rate, multipath, etc. remain to be solved.

Optical communication technology is used for high-speed and short-range communication in the underwater environment. The optical communication uses the laser to carry the information through the water. In the case of long-distance communication in the underwater environment, optical communication is not suitable. The magnetic fusion communication in the underwater environment is only used for near-field communication. Therefore, all communication technologies are essential for underwater communication.

The purpose of this document is to provide a technical overview of the different communication technologies in the underwater environment such as acoustic communication, optical communication, Very Low Frequency (VLF)/Extremely Low Frequency (ELF) communication, and Magnetic Fusion Communication (MFC). Correspondingly, this document also provides the characteristics of each communication technology in the underwater environment, trends of underwater communication technology, layered design of underwater technology, and the application development using different communication technologies.

# INTERNET OF THINGS (IoT) – UNDERWATER COMMUNICATION TECHNOLOGIES FOR IoT



## 1 Scope

This document describes the enabling and driving technologies of underwater communication such as acoustic communication, optical communication, Very Low Frequency (VLF)/Extremely Low Frequency (ELF) communication, and Magnetic Fusion Communication (MFC). This document also highlights:

– technical overview of different communication technologies;
– characteristics of different communication technologies;
– trends of different communication technologies;
– applications of each communication technology;
– benefits and challenges of each communication technology.

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

No terms and definitions are listed in this document.

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 Symbols and abbreviated terms

| | |
|---|---|
| ACPG | a specific graph technique |
| AUV | autonomous underwater vehicle |
| ASK | amplitude shift keying |
| BER | bit error rate |
| BPSK | binary phase-shift keying |
| CBC-MAC | cipher block chaining-message authentication code |
| CCM-UW | counter with CBC-MAC for underwater |
| CRC | cyclic redundancy code |
| DTN | delay/disruption tolerant network |
| ELF | Extremely Low Frequency |
| FSK | frequency-shift keying |
| FSO | free space optics |
| HF | high frequency |
| IM | intensity modulation |