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Ships and marine technology — Standard data for shipboard machinery and equipment

Navires et technologie maritime — Données normalisées pour les machines et équipements à bord des navires

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation and ship operations*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

On-board computer applications for safety and energy-efficient operations have become popular. These applications require access to data of shipboard machinery and equipment.

To access data of navigational equipment, a data exchange standard, the IEC 61162 series can be used. However, access of data from other on-board components and systems (e.g. machinery, safety equipment and hull) have not yet been standardised.

Exchanging non-standardised data between and/or among applications requires name-based aggregation and format mapping. However, this requires a large amount of labour, which hinders the use of such data.

To improve these situations, this document defines unified rules for developing machine and human-readable identifiers and data structures for shipboard machinery and equipment, with the objective to facilitate exchange and processing of sensor data from ships.

This document defines two concepts and their models for data exchange: one is Data Channel, and the other is Time Series Data. This document thus defines two distinct data structures and file formats: A Data Channel List, which contains the necessary meta-data, and a Time Series Data format for measurements. The time-series format is designed to be lightweight and it therefore contains minimal meta-data information only in the form of a reference to the channel list.

Data Channel is a concept that represents virtual data transmission channels, and defines time-invariant properties. Data Channel can be viewed as a static description for the different sensor data streams.

Data Channel is composed of Data Channel ID and Data Channel Property.

Data Channel ID uniquely identifies the logical data channels. Data Channel Property defines attributes of Data Channel.

There are three types of Data Channel ID. One is Local ID, which is a unique identifier used on-board a ship, and another is Universal ID, which is a universal identifier, composed of Name Entity, Ship ID (e.g., IMO numbers) and Local ID. The other ID is Short ID, a short alternative ID of Local ID.

The purpose of this document is for exchanging data on-board a ship; however, in the future, shipboard machinery and equipment may be connected directly to the Internet.

Therefore, considering the compatibility between Data Channel ID and URLs, which are used to identify data on the Internet, Data Channel ID has a hierarchical structure with slashes as delimiters. To represent a hierarchy, Data Channel is categorised in accordance with the standardised categorising rule and named by concatenating these category names with slashes.

In Annexes B and C, two types of categorising rules and example of codebook, lists of standardised category names given in accordance with the rules, are defined for reference.

They are not designed to unify Data Channel ID, but it is assumed that some entities will develop, maintain and manage codebook and that they will be disclosed widely.

Data Channel Property is assumed to be used to automate data processing and help understanding of data. Data Channel Property shall be used because it is considered to be essential to both computer applications and humans for the reasons mentioned above.

Time Series Data is a concept that represents collection of time-stamped data. Time Series Data is assumed to be used for sharing latest data and for analysing trends made over time-stamped data.

For reliable data exchange, this document mandates the use of XML (Extensible Markup Language) and XML Schema for data encoding and data structure definition. Using XML and XML schemas makes it possible to define data structures precisely and validate data in accordance with such definitions.

As a result, it is believed that data can be exchanged more reliably between and/or among computer applications.

Further, for convenience and efficiency, this document also defines data-structures in JSON and CSV format.

It is assumed that data from shipboard machinery and equipment will be collected by shipboard data servers, which are defined in ISO 19847. Then, the data encoded in accordance with this document, in some cases, could be encrypted for security reasons, will be shared between and/or among computer applications in a wide variety of means, such as in Hyper Text Transfer Protocol (HTTP), in Message Queue Telemetry Transport (MQTT) or by e-mail through the servers. As described above, external computer applications can retrieve on-board data uniformly by accessing the servers.

Ships and marine technology — Standard data for shipboard machinery and equipment

1 Scope

This document applies to the structure of the ship and to shipboard machinery and equipment, and is intended for implementers of software used for the capture and processing of sensor data from the objects mentioned above.

For those purposes, this document describes the way to name the sensor, required data item, and the way to describe the data above.

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 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC 80000 series, *Quantities and units*

W3C XML: Extensible Markup Language (XML) 1.0, W3C Recommendation

W3C XML Schema Part 1: XML Schema Part 1: Structures, W3C Recommendation

W3C XML Schema Part 2: XML Schema Part 2: Datatypes, W3C Recommendation

RFC 3339, *Date and Time on the Internet: Timestamps*

RFC 4180, *Common Format and MIME Type for Comma-Separated Values (CSV) Files*

RFC 5234, *Augmented BNF for Syntax Specifications: ABNF*

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 https://www.iso.org/obp

3.1
alert data
information that represents abnormal conditions of shipboard machinery and equipment

3.2
analogue data
numerical information obtained from sensors such as temperature sensors and pressure sensors

Note 1 to entry: Analogue data is a physical value converted from raw electric signals, such as 4-20 mA or 0-5 V.

3.3
codebook
list of standardised names

3.4
data
measurement value from shipboard machinery and equipment to which a timestamp is added

3.5
Data Channel
virtual channel for data transmission from shipboard machinery and equipment to shipboard data server, defining static properties of data

3.6
Data Channel ID
identifier for Data Channel that identifies Data Channel universally and on-board a ship

Note 1 to entry: There are three types of Data Channel ID: Universal ID, Local ID and Short ID.

3.7
Data Channel List
list of definitions for Data Channel that define Data Channel ID and Data Channel Property, and is shared through the shipboard data server

3.8
Data Channel Property
attributes of Data Channel, such as units and ranges

3.9
Data Set
set of Data having the same timestamp

3.10
Extensible Markup Language
XML
text-based data description language used for exchanging data on the Internet

3.11
Hyper Text Transfer Protocol
HTTP
communication protocol used to exchange HTML (Hyper Text Markup Language) or other content on the Internet

3.12
IMO Number
unique reference number for ships that is given by the International Maritime Organisation (IMO)

3.13
logical structure
structure of data that is independent of physical implementation

3.14
measurement value
numeric value or a status symbol, produced as a result of measuring, calculating or estimating the state of various objects

3.15
metadata
data that describes information about other data

3.16
Name Object
building block of Data Channel ID used to define the hierarchical structure of Data Channel ID

3.17
Namespace
set of names that is used in order to avoid conflicts of names

3.18
Shipboard Data Server
ship's "information hub" that stores data from shipboard machinery and equipment, shares data at sea including machine data, and sends stored data outboard

Note 1 to entry: See ISO 19847 for details.

3.19
shipboard machinery and equipment
various systems located in ships machinery space, such as main engine, generator, pumps, fans, valves, pipelines and electric control systems

3.20
status data
information that represents the condition of shipboard machinery and equipment

3.21
Time Series Data
collection of a Data Set

3.22
XML Schema
data definition language used for XML

4 Abbreviated terms

ABNF	Augmented Backus Naur Form
AMS	Alarm Monitoring System
BNF	Backus Naur Form
IAS	Integrated Automation System
IMO	International Maritime Organisation
HIN	Hull Identification Number
HTML	Hyper Text Markup Language
HTTP	Hypertext Transfer Protocol
RFC	Request for Comments
SI	The International Systems of Units
URI	Uniform Resource Identifier

UTC	Universal Time Coordinated
UTF-8	UCS Transformation Format 8
XML	Extensible Markup Language

5 Data Channel

5.1 General

Data Channel is composed of Data Channel ID and Data Channel Property.

Data Channel ID is an identifier for Data Channel, and Data Channel Property represents attributes of Data Channel.

5.2 Data Channel ID

There are three types of Data Channel ID:

— Universal ID;

— Local ID;

— Short ID.

Universal ID is for identifying on-board Data Channel universally.

Local ID, meanwhile, is for identifying on-board Data Channel locally. For instance, on-board computer systems, such as the Integrated Automation System (IAS) and the Alarm Monitoring System (AMS), have their own Data Channel List, which is composed of unique Channel ID. This Channel ID can correspond to Local ID.

Short ID is an optional short alternative identifier of Local ID for usability and data compression. This short identifier, for instance, can be used as Data Channel identifier in the Time Series Data format.

Local ID and Short ID shall be unique for a ship.

These IDs shall be case-insensitive to avoid unexpected mistyping.

NOTE Data Channel of the same kind of sensors on different ships is expected to have a same Local ID. Conversely, even if Data Channel has a same meaning, Short ID may be different for each ship.

5.2.1 Universal ID

Universal ID is an URI conforming to the requirements below, in addition to those of the URI definition. The URI definition allows for many different compositions, but the Universal ID will be a subset of these and shall be in the following format.

Universal ID composition is defined by using Augmented BNF(ABNF), which is defined in RFC 5234, as follows.

UniversalID	= [protocol] "//" NamingEntity ShipID LocalID
NamingEntity	= authority
ShipID	= path-element
path-element	= "/" unreserved
path-elements	= path-element | path-element path-elements

Definition of the “Local ID” element is mentioned in 5.2.2.

The “authority” and “unreserved” element is defined in the URI definition. The “protocol” element is optional.

NOTE 1 Though path element of URI that is defined in RFC 3986 accepts much more characters, such as RFC 3986 “sub-delimiters”, “:”, “@”, etc., this document only accepts RFC 3986 “unreserved” characters since these characters may be used as control character in ISO 19847. (Definition of sub-delimiters and unreserved are defined in RFC 3986).

The slash (“/”) is a reserved character for describing hierarchies.

a) Naming Entity

Naming Entity element shall be a domain owned or controlled by the entity producing Local ID.

EXAMPLE

— data.shipdatacenter.jp

— data.dnvgl.com

b) Ship ID

Ship ID is for identifying ships universally.

Usually, an IMO number or HIN should be used for Ship ID.

If ships have no IMO number or HIN, an identifier provided by countries or regions, or other means may be used instead.

EXAMPLE

— /IMO1234567

— /JP-HXAB7A33G293

5.2.2 Local ID

Local ID consists of Naming Rule and Local Data Name.

Local ID composition is defined by using ABNF as follows

LocalID	= NamingRule LocalDataName
NamingRule	= path-element
LocalDataName	= path-elements
path-element	= "/" unreserved
path-elements	= path-element | path-element path-elements

a) Naming Rule

Naming Rule shall be the designated name for the rule used to name Data Channel.

This name can be set freely under the supervision of Naming Entity, and shall have a symbol that represents Naming Entity in front to eliminate duplications.

A Naming Rule is a set of requirements that define a naming scheme (or an identification scheme) for components and systems on-board the ship. A Naming Rule shall define how identification strings are composed, and the method of developing an identification string.

EXAMPLE

— /jsmea_mac

— /dnvgl-vis

b) Local Data Name

Local Data Name is an identifier for Data Channel that is named in accordance with Naming Rule.

The syntax of the identification string shall be disclosed and precisely defined using ABNF.

EXAMPLE

— /MainEngine/Cylinder1/ExhaustGas/Temp

— /411.1/C101.31+1/ExhGas+t(C)

5.2.3 Short ID

Short ID is an optional short alternative to Local ID. There must be a one-to-one correspondence between Data Channel and Short ID; Short ID shall therefore be unique for a ship.

Definition of Short ID is as follows.

ShortID	= unreserved

Short ID shall be as short as practical and represented as machine-friendly symbols, human-friendly short word, or a combination of those symbols and short word.

EXAMPLE

— 0001

— TAH001

— ME_RPM

5.2.4 Example of Data Channel ID

In the following example, Ship ID, Naming Rule and Local Data Name will be understood as the above definition, but without the leading slash.

Universal ID	http://data.shipdatacenter.jp/imo1234567/jsmea_mac/MainEngine/Cylinder1/ExhaustGas/Outlet/Temp
Local ID	/jsmea_mac/MainEngine/Cylinder1/ExhaustGas/Outlet/Temp
Short ID	0001
Ship ID	imo1234567
Naming Entity	data.shipdatacenter.jp
Naming Rule	jsmea_mac
Local Data Name	MainEngine/Cylinder1/ExhaustGas/Outlet/Temp

Universal ID	http://data.dnvgl.com/imo1234567/dnvgl-vis/411.1/C101.31+1/ExhGas+t(C)
Local ID	/dnvgl-vis/411.1/C101.31+1/ExhGas+t(C)
Short ID	0001
Ship ID	imo1234567
Naming Entity	data.dnvgl.com
Naming Rule	dnvgl-vis
Local Data Name	411.1/C101.31+1/ExhGas+t(C)

NOTE 1 It is not a requirement that the Universal ID be a resolvable URI, i.e., the URI is not necessarily a valid URL.

5.3 Data Channel Property

Data Channel Property shall be defined to provide the attributes of Data Channel.

The reserved property types are as follows.

— Data Channel Type

— Format

— Range

— Unit

— Quality Coding

— Name

— Remarks

The properties above shall be described in accordance with the rules in this Clause.

Properties that are not listed above may be used if these are clearly distinguished from the properties defined in the standard.

Details of each property are as follows.

a) Data Channel Type

Data Channel Type is used to identify the types of Data Channel, such as row numeric value, average value, alarms and status. Data Channel Type is composed of the following sub-properties.

— Type

— Update Cycle

— Calculation Period

Type sub-property defines type of Data Channel and the value of the property follows the definitions mentioned in Table 1.

Table 1 — Type name of Data Channel Type

Type	Description
Inst	Measuring value at a certain point in time.
Average	Average of the value within a certain time period. "Average" does not mean average of values from multiple sensors at the same time but average of time-series values from single sensor.
Max	Maximum value within a certain time period. "Maximum" does not mean maximum of values from multiple sensors at the same time but maximum of time-series values from single sensor.
Min	Minimum value within a certain time period. "Minimum" does not mean minimum of values from multiple sensors at the same time but minimum of time-series values from single sensor.
StandardDeviation	Standard deviation of the value within a certain time period. "StandardDeviation" does not mean standard deviation of values from multiple sensors at the same time but standard deviation of time-series values from single sensor.
Calculated	Value obtained from calculation instead of measurement.
SetPoint	Target value for automatic control.
ControlOutput	Manipulated value of automatic control.
Alert	Alarm values that can be obtained are also described.
Status	Status values that can be obtained are also described.
ManuallyInput	Value input by crew. Value assumed here is reading of indicator.

Update Cycle represents the cycle of updating measurement value. This sub-property shall be used when measurement value is updated periodically.

When a value of Data Channel is a result of calculation that uses measurement value of specific time periods, Calculation Period shall be used to describe the said period.

Update Cycle and Calculation Period shall be described with a decimal number that is larger than zero. The unit of Update Cycle and Calculation Period shall be the “second”.

Type sub-property is mandatory and the others are optional.

EXAMPLES

— Type Average

— Calculation Period 60

— Update Cycle 1

b) Format

Format is used for describing data formats and defined by the following sub-properties.

— Type

— Restriction

Type sub-property is mandatory and Restriction sub-property is optional. More than one Restriction sub-property may exist under the Format property.

Available Types are as follows. Definitions of these data types comply with W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatype.

Table 2 — Available Datatype for Format property

Type	Description
Decimal	Decimal represents a subset of the real numbers, which can be represented by decimal numerals. The value space of decimal is the set of numbers that can be obtained by dividing an integer by a non-negative power of ten, i.e., expressible as i / 10^n where i and n are integers and $n \geq 0$. Precision is not reflected in this value space; the number 2.0 is not distinct from the number 2.00. The order relation on decimal is the order relation on real numbers, restricted to this subset.
Integer	Integer is·derived·from decimal by fixing the value of fraction digits to be 0 and disallowing the trailing decimal point. This results in the standard mathematical concept of the integer numbers. The value space of integer is the infinite set {...,-2,-1,0,1,2,...}. The base type of integer is decimal.
Boolean	Boolean represents the values of two-valued logic.
String	The string datatype represents character strings in XML.
DateTime	Date and time data types are used for values that contain date and time. Format shall follow ISO 8601 "YYYY-MM-DDThh:mm:ssZ" where: YYYY indicates the year MM indicates the month DD indicates the day T indicates the start of the required time section hh indicates the hour mm indicates the minute ss indicates the second Z indicates UTC

Following restrictions defined in W3C XML Schema are available to define acceptable values. Validation rules and available constraint for each data types shall follow W3C XML Schema.

Table 3 — Restrictions for Format property

Restriction	Description	Data Type
Enumeration	Defines a list of acceptable values.	string
FractionDigits	Specifies the maximum number of decimal places allowed. Must be equal to or greater than zero.	nonNegativeInteger
Length	Specifies the exact number of characters or list items allowed. Must be equal to or greater than zero.	nonNegativeInteger
MaxExclusive	Specifies the upper bounds for numeric values (the value must be less than this value).	A value from the ·value space· of the {base type definition}.
MaxInclusive	Specifies the upper bounds for numeric values (the value must be less than or equal to this value).	A value from the ·value space· of the {base type definition}.
MaxLength	Specifies the maximum number of characters or list items allowed. Must be equal to or greater than zero.	nonNegativeInteger
MinExclusive	Specifies the lower bounds for numeric values (the value must be greater than this value).	A value from the ·value space· of the {base type definition}.
MinInclusive	Specifies the lower bounds for numeric values (the value must be greater than or equal to this value).	A value from the ·value space· of the {base type definition}.