BS ISO 19848:2024

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of ISO 19848:2024. It supersedes BS ISO 19848:2018, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/80, Maritime navigation and radiocommunication equipment and systems.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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

This second edition cancels and replaces the first edition (ISO 19848:2018), which has been technically revised.

The main changes are as follows:

— Annex A has been updated to define JSON as an equivalent implementation alternative to XML for DataChannelLists and TimeSeriesData. JSON schemas have been introduced to ensure precise definition and validation.

— The example of the codebook in B.2 has been extended to include navigational information, voyage information, weather information around the ship, oil property information and ship motion information.

— In B.3, a full set of standard data names has been added as references, to improve usability.

— In Annex C, the naming scheme has been changed from from “dnvgl-vis” to “dnv-v2”, as well as various updates to the rules for constructing the LocalID.

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.

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Introduction

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

To access data of navigational equipment, the IEC 61162 series, which covers data exchange, can be used. However, there are no existing standards covering the access of data from other on-board components and systems (e.g. machinery, safety equipment, and hull).

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

To improve such situations, this document defines unified requirements and guidelines for developing machine and human-readable identifiers and data structures for shipboard machinery and equipment, with the objective of facilitating the 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 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.

The purpose of this document is to provide guidance and requirements on exchanging data on board a ship. However, in the future, it is possible that shipboard machinery and equipment will 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 categorized in accordance with the standardized naming scheme, called Naming Rule, and named by concatenating these category names with slashes.

Annexes B and C provide two types of naming scheme, an example of a codebook and lists of standardized category names given according to these schemes.

These naming schemes provided in Annexes B and C are not designed to unify Data Channel ID, but it is assumed that some entities will develop, maintain and manage codebooks and that these codebooks will be disclosed widely.

Data Channel Property is assumed to be used to automate data processing and help understanding of data. Data Channel Property should 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 recommends the use of Extensible Markup Language (XML) 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 according to such definitions. As a result, data can be exchanged more reliably between and/or among computer applications.

Furthermore, for convenience and efficiency, this document also defines data structures in JavaScript Object Notation (JSON) and Comma Separated Values (CSV) format.

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1 Scope

This document provides requirements and guidance on the capture and processing of data from sensors monitoring:

— the structure of the ship;

— shipboard machinery and equipment on board the ship;

— ship operational information.

It is intended for implementers of software used to capture and process such data.

This document describes how to name the sensor and required data item, as well as how to describe the data for shipboard machinery and equipment.

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 8601-1, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO 80000 (all parts), *Quantities and units*

IEC 80000 (all parts), *Quantities and units*

IEC 62923-1:2018, *Maritime navigation and radiocommunication equipment and systems — Bridge alert management — Part 1: Operational and performance requirements, methods of testing and required test results*

W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes, W3C Recommendation

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

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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

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

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

3.3
codebook
list of standardized names

3.4
data
measurement value from shipboard machinery and equipment to which a time stamp 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 a *Data Channel* (3.5) 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* (3.5) that define *Data Channel ID* (3.6) and *Data Channel Property* (3.8), and is shared through the shipboard data server

3.8
Data Channel Property
attributes of *Data Channel* (3.5), such as units and ranges

3.9
Data Set
set of *data* (3.4) having the same time stamp

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 Hyper Text Markup Language (HTML) or other content on the Internet

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

3.13
logical structure
structure of *data* (3.4) 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

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3.15
metadata
data that describes information about other data

3.16
Name Object
building block of *Data Channel ID* (3.6) used to define the hierarchical structure of Data Channel ID

3.17
namespace
set of names that is used in order to avoid conflicting names

3.18
shipboard data server
information hub of the ship that stores data from *shipboard machinery and equipment* (3.19), 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, such as main engine, generator, pumps, fans, valves, pipelines and electric control systems

3.20
Time Series Data
collection of a *Data Set* (3.9)

3.21
XML Schema
data definition language used for *Extensible Markup Language (XML)* (3.10)

4 Abbreviated terms

ABNF	augmented Backus-Naur form
AMS	alarm monitoring system
BNF	Backus-Naur form
CSV	Comma Separated Values
IAS	integrated automation system
IMO	International Maritime Organization
HIN	hull identification number
HTML	Hyper Text Markup Language
HTTP	Hypertext Transfer Protocol
JSON	JavaScript Object Notation
RDBMS	Relatinal Data Base Management System
RFC	Request for Comments
SI	the International System of Units

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URI	Uniform Resource Identifier
UTC	Coordinated Universal Time
UTF-8	UCS Transformation Format 8
XML	Extensible Markup Language

5 Data Channel

5.1 Data Channel ID

5.1.1 General

There are three types of Data Channel ID:

— Universal ID

— Local ID

— Short ID

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

Local ID, meanwhile, is intended for identifying an 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 a unique Channel ID. This Channel ID can correspond to a 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 a Data Channel identifier in the Time Series Data format.

Universal ID shall be universally unique, while Local ID and Short ID shall be unique for a ship.

These IDs shall be case-insensitive to avoid mistyping.

NOTE Data channels representing the same type of sensor data on different ships are expected to have the same Local ID. Conversely, even if the Data Channel has the same meaning, the Short ID can be different for each ship.

5.1.2 Universal ID

Universal ID is an URI conforming to the requirements in this subclause, in addition to the requirement of the URI specified in RFC 3986. The URI definition allows for many different compositions, but the Universal ID is a subset of these and shall be in the following format.

The format 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

The definition of the “Local ID” element is mentioned in 5.1.3.

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The “authority” and “unreserved” element is defined in the URI definition specified in RFC 3986. The “protocol” element is optional.

NOTE Although the path element of URI that is defined in RFC 3986 accepts many more characters, such as RFC 3986 “sub-delimiters”, “:”, “@”, etc., this document only accepts RFC 3986 “unreserved” characters since these characters can be used as control character in ISO 19847. The terms sub-delimiters and unreserved are defined in RFC 3986.

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

The definition of each element of the Universal ID is as follows.

a) Naming Entity

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

EXAMPLE 1

— data.shipdatacenter.jp

— data.dnv.com

b) Ship ID

Ship ID is for identifying ships universally.

Usually, an IMO number or HIN should be used for the 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 2

— /IMO1234567

— /JP-HXAB7A33G293

5.1.3 Local ID

Local ID consists of the 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
```

The definition of each element of the Local ID is as follows.

a) Naming Rule

The Naming Rule shall be the designated name for a naming scheme used to name the Data Channel.

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

The naming scheme is a set of requirements that define an identification scheme for components and systems on board the ship. The naming scheme shall define how identification strings are composed, and the method of developing an identification string.

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EXAMPLE 1

— /jsmea_mac

— /dnv-v2

The Naming Entity is responsible for defining a methodology for changing the naming scheme and its codebooks.

Impacts on existing users such as backwards compatibility shall be considered.

Therefore, the Naming Entity shall provide version information and change histories of the naming scheme and its codebook for each version, e.g. in a Naming Rule or on a website.

b) Local Data Name

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

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

EXAMPLE 2

— /MainEngine/Cylinder1/ExhaustGas/Temp

— /vis-3–4a/ 511.11-3/C101/meta/qty-rotational.frequency

5.1.4 Short ID

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

The 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 words, or a combination of those symbols and short words.

EXAMPLE

— 0001

— TAH001

— ME_RPM

5.1.5 Example of Data Channel ID

In the following example, Ship ID, Naming Rule and Local Data Name are understood as the definitions in 5.1.2(b), 5.1.3(a) and 5.1.3(b), respectively, 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

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Naming Rule	jsmea_mac
Local Data Name	MainEngine/Cylinder1/ExhaustGas/Outlet/Temp
Universal ID	http://data.dnv.com/imo1234567/dnv-v2/vis-3-4a/ 511.11-3/C101/meta/qty-rotational.frequency
Local ID	/dnv-v2/vis-3–4a/411.1/ 511.11-3/C101/meta/qty-rotational.frequency
Short ID	0001
Ship ID	imo1234567
Naming Entity	data.dnv.com
Naming Rule	dnv-v2
Local Data Name (coded)	vis-3–4a/511.11–3/C101/meta/qty-rotational.frequency
Local Data Name (verbose)	vis-3–4a/511.11–3/C101/~main.generator.engine.3/meta/qty-rotational.frequency

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

A detailed description of the above two naming schemes are described in Annexes B and C.

5.2 Data Channel Property

Data Channel Property shall be defined to provide the attributes of the 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 requirements in this subclause.

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

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 raw numeric value, average value, alarms and status. Data Channel Type is composed of the following sub-properties.

— Type

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— Update Cycle

— Calculation Period

Type sub-property defines the type of Data Channel and the value of the sub-property shall follow 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 a 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 a 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 a single sensor.
Median	Median value within a certain time period; "Median" does not mean median of values from multiple sensors at the same time but median of time-series values from a single sensor.
Mode	Mode value (a value that appears most often in a set of data values) within a certain time period; "Mode" does not mean mode of values from multiple sensors at the same time but mode of time-series values from a 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 a single sensor.
Calculated	Value obtained from calculation or estimation instead of measurement
SetPoint	Target value for automatic control
Command	Control order to equipment; e.g. slowdown signal to the engine, run/stop order to the pump, opening to the position valve
Alert	Alarm values that can be obtained are also described.
Status	Status values that can be obtained are also described.
ManualInput	Value input by crew. Value assumed here is a reading of the indicator.

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

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

The 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.

EXAMPLE 1

— Type Average

— Calculation Period 60

— Update Cycle 1

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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 can exist under the Format property.

Available Types are as shown in Table 2. Definitions of these data types shall 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 10, 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 the 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 8601-1 “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

Table 3 shows restrictions defined in W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes. These restrictions are available to define acceptable values. Validation requirements and available constraint for each data types shall follow W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes.

EXAMPLE 2

— Type Decimal

— Restriction TotalDigits 8, FractionDigits 3

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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. Shall be equal to or greater than zero.	nonNegativeInteger
Length	Specifies the exact number of characters or list items allowed. Shall be equal to or greater than zero.	nonNegativeInteger
MaxExclusive	Specifies the upper bounds for numeric values (the value shall 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 shall 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. Shall be equal to or greater than zero.	nonNegativeInteger
MinExclusive	Specifies the lower bounds for numeric values (the value shall 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 shall be greater than or equal to this value).	A value from the ·value space· of the {base type definition}.
MinLength	Specifies the minimum number of characters or list items allowed. Shall be equal to or greater than zero.	nonNegativeInteger
Pattern	Defines the exact sequence of characters that are acceptable.	string
TotalDigits	Specifies the exact number of digits allowed. Shall be greater than zero.	positiveInteger
WhiteSpace	Specifies how white space (line feeds, tabs, spaces, and carriage returns) is handled.	

c) Range

Range is intended for describing Data Range. Range property is composed of the following sub-properties.

— Low

— High

Low sub-property represents the lower limit of the analogue data, and High sub-property represents its upper limit.

The value type of these sub-properties is a decimal value or empty. The value of these sub-properties can be empty only if the lower and/or upper limit cannot be specified.

Furthermore, the high value shall be greater than and not equal to the low value.

Range property is mandatory only with the analogue data.

NOTE Range does not mean upper and lower boundary of the value. The value can exceed the range in case of sensor failure or other abnormal condition.

EXAMPLE 3

— Low 0

— High 120

d) Unit

Unit defines the unit and quantity applied to the measurement value. Unit property is composed of the following sub-properties.

— Unit Symbol

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— Quantity Name

Unit symbols and quantity names defined in the ISO 80000 series , the IEC 80000 series or Table 4 shall be used for the Unit Symbol and Quantity Name sub-properties.

The Unit Symbol sub-property represents the unit symbol of the measurement value (e.g. “m” for length and “kg” for mass). The value of the Unit Symbol sub-property can be empty only for non-dimensional quantities.

The Quantity Name sub-property may be used to identify the variable that is measured or computed for the physical item defined by the Data Channel.

The measurement value shall be described in accordance with the unit defined in this property.

NOTE On-board computer applications (Data consumer) can convert units according to the ISO 80000 series and the IEC 80000 series.

EXAMPLE 4

— Unit Symbol kW

— Quantity Name active power

— Unit Symbol Pa

— Quantity Name pressure

Table 4 — Additional units and quantities of measurement value

Quantity name	Unit symbol	Remarks
Cargo capacity	TEU	Twenty-foot equivalent unit
	FEU	Forty-foot equivalent unit
Number of pieces	pcs	pieces
Total revolution count	rev	Total number of rotations

e) Quality Coding

Quality Coding represents a name of data quality evaluation scheme and the scheme shall be able to distinguish at least between valid and invalid measurement values of the Data Channel.

EXAMPLE 5

— “OPC-QUALITY”

— “IEC 61162-STATUS”

In the case of “IEC 61162-STATUS”, “A” (Data valid) and “V” (Data invalid) are used for the data quality.

Channel state, such as “alert acknowledged”, “alert activated”, ”alert temporarily disabled”, and “sensor disconnected”, may be included in the quality coding scheme.

f) Alert Priority

In the case in which Data Channel Type is “Alert”, Alert Priority shall be provided. Priority level and criteria for classification shall be in accordance with IEC 62923-1:2018, 6.2.2.1

g) Name

Name can be used to describe names assigned for on-board control systems and other instruments.

EXAMPLE 6

— “Main Engine Revolution”

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h) Remarks

In Remarks, arbitrary complementary information on Data Channel is described.

Remarks should include locations, manufacturers and types of equipment.

EXAMPLE 7

— "Location: ECR, Manufacturer: AAA Company, Type: TYPE-AAA"

6 Time Series Data

6.1 General

Time Series Data are a collection of measurement values in which all the values have a corresponding time of measurement. Usually such data are arranged and recorded in chronological order.

6.2 Type of Time Series Data

6.2.1 General

For practical purposes (efficient data transport), two distinct representations of Time Series Data are defined:

— Tabular Data

— Event Data

These representations are used depending on update interval of measurement values.

6.2.2 Tabular Data

Tabular Data is a vector of a fixed number of values expected to be reported at regular intervals. Data Channel List defines the interval.

Some examples of Tabular Data are:

— multiple raw numeric values from sensors/transmitters sampled at the same time;

— the result of the calculation (e.g. time average, standard deviation, etc.) to be performed regularly.

Measurement values are grouped per time stamp, as shown in Table 5.

Table 5 — Example of Tabular Data

Time stamp	Data channel 1	Data channel 2	Data channel 3	Data channel 4
2017–01–01T00:00:00Z	101	3	10	CLOSE
2017–01–01T00:00:01Z	0	3	10	CLOSE
2017–01–01T00:00:02Z	110	2	10	OPEN

6.2.3 Event Data

Event Data is a collection of data for which the number of values at a specific time is not fixed.

Some examples of Event Data include:

— alarm information

— status information

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— manually input data

Event Data typically appears in tabular form like Table 6.

Table 6 — Example of Event Data in tabular form

Time Stamp	Data Channel 1	Data Channel 2	Data Channel 3	Data Channel 4
2017–01–01T00:00:00Z	101	—	—	—
2017–01–01T00:00:01Z	—	—	—	—
2017–01–01T00:00:02Z	110	2	—	OPEN

The tabular form shown in Table 6 is not efficient for Event Data, thus measurement values are grouped per both time stamp and Data Channel ID, as shown in Table 7:

Table 7 — Example of Event Data

Time Stamp	Data Channel ID	Value
2017–01–01T00:00:00Z	Data Channel 1	101
2017–01–01T00:00:02Z	Data Channel 1	110
2017–01–01T00:00:02Z	Data Channel 2	2
2017–01–01T00:00:02Z	Data Channel 4	OPEN

6.3 Time Series Data Composition

Each row of Tabular/Event Data is called a Data Set.

Tabular Data are composed of a collection of a Data Set without Data Channel IDs, since value can be identified by its order.

Tabular Data of Table 5 is described as follows.

DataSet(“2017-01-01T00:00:00Z”,”101”,”3”,”10”,”CLOSE”)
DataSet(“2017-01-01T00:00:01Z”,”0”,”3”,”10”,”CLOSE”)
DataSet(“2017-01-01T00:00:02Z”,”110”,”2”, “10”,”OPEN”)

Event Data are composed of a collection of Data Set with Data Channel ID, since a number of values at a specific time cannot be fixed.

Event Data of Table 7 is described as follows.

DataSet(“2017-01-01T00:00:00Z “, “DataChannel1”, “101”)
DataSet(“2017-01-01T00:00:02Z “, “DataChannel1”, “110”)
DataSet(“2017-01-01T00:00:02Z “, “DataChannel2”, “2”)
DataSet(“2017-01-01T00:00:02Z “, “DataChannel4”, “OPEN”)

7 Data structure

7.1 General

Data structure is the definition of logical structures that are independent from data implementation languages, such as XML, JSON and others.

This clause defines two types of data structure. One type is for Data Channel List, the list of Data Channel definitions in Clause 5. The other type is for serialisation and transport of Time Series Data in Clause 6.

These structures can be described by using XML and JSON.

CSV can be used only for DataSet element defined in 7.5 f) without the Quality element.

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In addition, standard data type, which is used to define the data structure and also independent of implementation languages, is defined.

Standard data type can be replaced with the data types defined in the implementation language.

Data implemented in accordance with the data structure can be shared between and/or among computer applications.

7.2 Implementation language

The data structure defined in this Clause shall be implemented in XML or JSON in accordance with Annex A.

7.3 Standard data types

To define the data structure, the following standard data types derived from UML primitive types listed in Table 8 shall be used.

Table 8 — Standard data types

Standard data type	Primitive type	Restriction	Remarks
Integer	Integer		
NonNegativeInteger	Integer	larger than −1	
PositiveInteger	Integer	larger than 0	
Real	Real		
Boolean	Boolean		
String	String		
DateTime	String	formatted by ISO 8601-1	Refer to RFC 3339 for ABNF expression.
Null			Null specifies the lack of a value (can be used for any data types).

7.4 Structure of Data Channel List

7.4.1 Data model

The Data Channel List shall consist of the following five elements.

a) Package

Package is a data package that is made up of Header, which is a set of metadata, and DataChannel, which is a main data body.

b) Header

Header indicates when a Data Channel List is created and who creates it.

c) DataChannel

DataChannel consists of Property and DataChannelID, which indicates Data Channel definitions.

d) DataChannelID

DataChannelID is an identifier of Data Channel defined in 5.1.

e) Property

Property defines the attributes of Data Channel defined in 5.2.

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These elements are represented in a hierarchical structure as shown in Figure 1 using UML. For more information on UML notation, refer to ISO/IEC 19505-1 and ISO/IEC 19505-2.

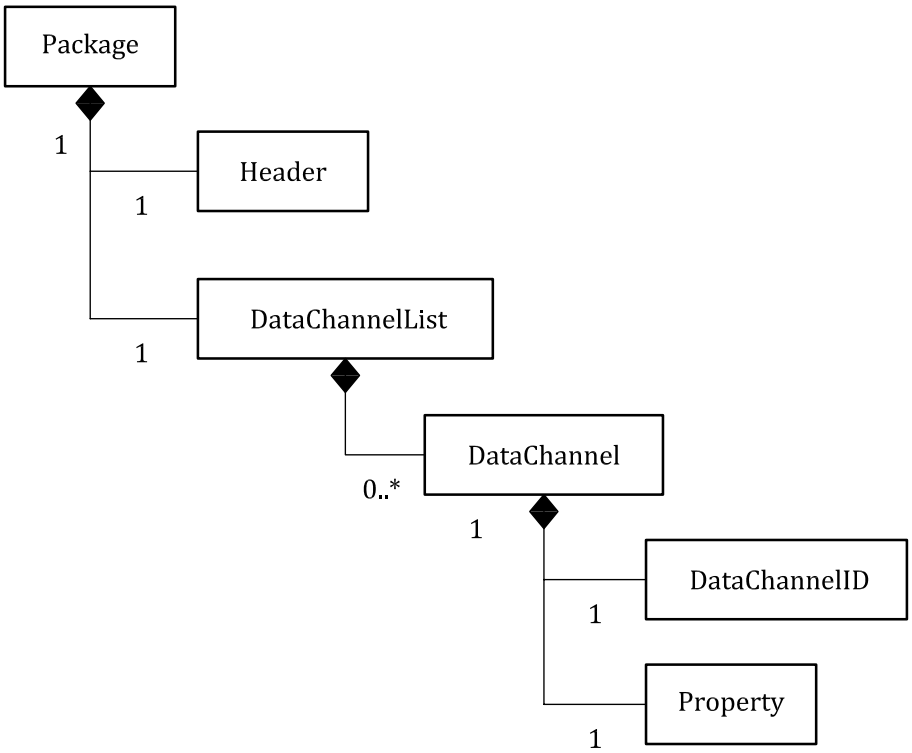

Figure 1 — Model of Data Channel List

7.4.2 Logical structure

The Data Channel List shall have the logical structure shown in Figure 2, using UML. For more information on UML notation (i.e. [1], [0..*] shown in Figure 2), refer to ISO/IEC 19505-1 and ISO/IEC 19505-2.

The Data Channel List has a Package element. The Package element is composed of a Header and a DataChannelList element. The DataChannelList element includes one or more DataChannel elements with its IDs and properties.

Furthermore, the NameObject element can be added to define the structure of the Local ID.

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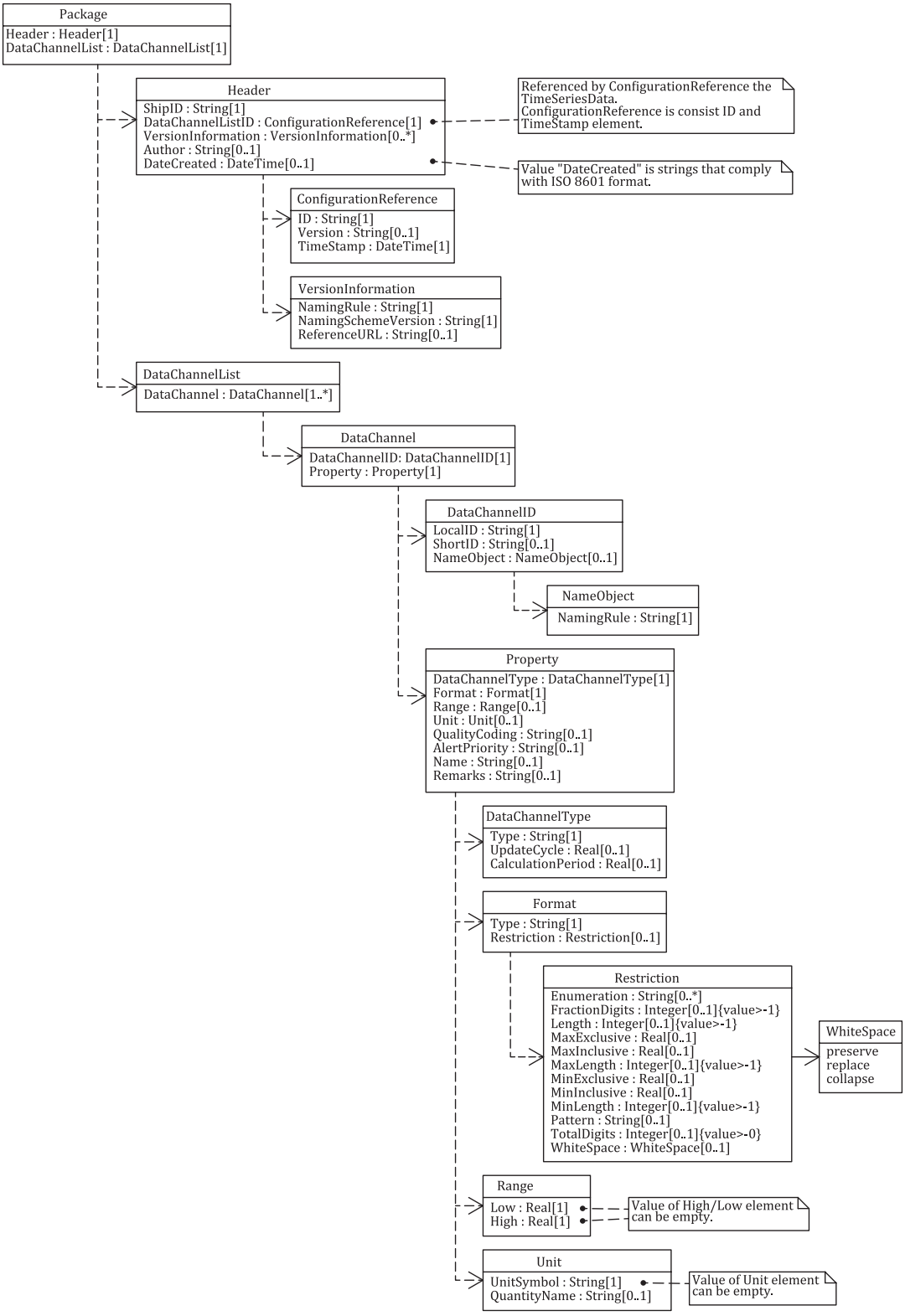

Figure 2 — Logical structure of Data Channel List

Details of each element are described in Tables 9 to 22.

a) Package structure

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Table 9 — Package structure

Name	Data type	Note	Mandatory/ Option	Max count
Header	b) Header	See Table 10	Mandatory	1
DataChannelList	e) DataChannelList	See Table 13	Mandatory	1

b) Header structure

Table 10 — Header structure

Name	Data type	Note	Mandatory/ Option	Max count
ShipID	String	See 5.1.2	Mandatory	1
DataChannelListID	c) ConfigurationReference	See Table 11	Mandatory	1
VersionInformation	d) VersionInformation	Version information of referenced standard for making DataChannelID; See Table 12	Optional	unlimited
Author	String	Author of Data Channel List	Optional	1
DateCreated	DateTime	Date when Package is created	Optional	1

c) ConfigurationReference structure

Table 11 — ConfigurationReference structure

Name	Data type	Note	Mandatory/ Option	Max count
ID	String	Identifier of Data Channel List itself	Mandatory	1
Version	String	Version of DataChannelList	Optional	1
TimeStamp	DateTime	Modified Date and Time	Mandatory	1

d) VersionInformation structure

Table 12 — VersionInformation structure

Name	Data type	Note	Mandatory/ Option	Max count
NamingRule	String	Name of naming scheme	Mandatory	1
NamingSchemeVersion	String	Version of naming scheme corresponding to the Naming Rule; When a DataChannelID string is changed, this shall be changed. Adding/removing DataChannel shall keep the version.	Mandatory	1
ReferenceURL	String	Definition of Local Data Name structure	Optional	1

e) DataChannelList structure

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Table 13 — DataChannelList structure

Name	Data type	Note	Mandatory/ Option	Max count
DataChannel	f) DataChannel	See Table 14	Mandatory	unlimited

f) DataChannel structure

Table 14 — DataChannel structure

Name	Data type	Note	Mandatory/ Option	Max count
DataChannelID	g) DataChannelID	See Table 15	Mandatory	1
Property	h) Property	See Table 16	Mandatory	1

g) DataChannelID structure

Table 15 — DataChannelID structure

Name	Data type	Note	Mandatory/ Option	Max count
LocalID	String	See 5.1.3	Mandatory	1
ShortID	String	See 5.1.4	Optional	1
NameObject	n) NameObject	Definition of Local Data Name structure, see Table 22	Optional	1

h) Property structure

Table 16 — Property structure

Name	Data type	Note	Mandatory/ Option	Max count
DataChannelType	i) DataChannelType	See Table 17 and 5.2 a)	Mandatory	1
Format	j) Format	See Table 18 and 5.2 b)	Mandatory	1
Range	l) Range	See Table 20 and 5.2 c)	Mandatory[a]	1
Unit	m) Unit	See Table 21 and 5.2 d)	Mandatory [a]	1
QualityCoding	String	See 5.2 e)	Optional	1
AlertPriority	String	See 5.2 f)	Optional	1
Name	String	See 5.2 g)	Optional	1
Remarks	String	See 5.2 h)	Optional	1

[a] Range and Unit are required only when Data Channel Type is “decimal”.

i) DataChannelType structure

Table 17 — DataChannelType structure

Name	Data type	Note	Mandatory/ Option	Max count
Type	String	Described in accordance with Data Channel Type format shown in 5.2 a)	Mandatory	1
UpdateCycle	Real		Optional	1
CalculationPeriod	Real		Optional	1

j) Format structure

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Table 18 — Format structure

Name	Data type	Note	Mandatory/ Option	Max count
Type	String	Described in accordance with Data Channel Type format shown in 5.2 b).	Mandatory	1
Restriction	j) Restriction		Optional	1

k) Restriction structure

Table 19 — Restriction structure

Name	Data type	Note	Mandatory/ Option	Max count
Enumeration	String	Described in accordance with Data Channel Type format shown in 5.2 b) Table 3	Optional	unlimited
FractionDigits	NonNegativeInteger		Optional	1
Length	NonNegativeInteger		Optional	1
MaxExclusive	Real		Optional	1
MaxInclusive	Real		Optional	1
MaxLength	NonNegativeInteger		Optional	1
MinExclusive	Real		Optional	1
MinInclusive	Real		Optional	1
MinLength	NonNegativeInteger		Optional	1
Pattern	String		Optional	1
TotalDigits	PositiveInteger		Optional	1
WhiteSpace	One of the following: “Preserve” “Replace” “Collapse”		Optional	1

l) Range structure

Table 20 — Range structure

Name	Data type	Note	Mandatory/ Option	Max count
Low	Real	Lower limit of measuring range	Mandatory	1
High	Real	Upper limit of measuring range	Mandatory	1

m) Unit structure

Table 21 — Unit structure

Name	Data type	Note	Mandatory /Option	Max count
UnitSymbol	String	Unit symbol defined in the ISO 80000 series, the IEC 80000 series or Table 4	Mandatory	1
QuantityName	String	Quantity name defined in the ISO 80000 series, the IEC 80000 series or Table 4	Optional	1

n) NameObject structure

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Table 22 — NameObject structure

Name	Data type	Note	Mandatory/ Option	Max count
NamingRule	String	See 5.1.3	Mandatory	1

7.5 Structure of Time Series Data

7.5.1 Data model

Time Series Data shall consist of the following elements.

a) Package

The Package element is data made up of a Header, which is a metadata, and TimeSeriesData, which is a main data body.

b) Header

The Header element contains the necessary metadata to link the Data in the Package to the right channels in the Data Channel List and the time in the real world.

This can be achieved by indicating when Time Series Data are created, who creates Time Series Data, an explicit reference to a specific Data Channel List, what Data Channels are included, the number of data and the measurement period of theTime Series Data.

If such kind of metadata are shared in advance by any means, the Header element itself may be omitted or just formed by a list of Short IDs.

c) TimeSeriesData

The TimeSeriesData element is a main body of the Package and contains the Time Series Data defined in Clause 6.

The TimeSeriesData element also represents a group of DataSet and is grouped by Data Channel List editions. Once the Data Channel List is updated and the updates affect the value of Time Series Data, this element shall be newly generated.

d) TabularData

The TabularData element contains a list of values defined in 6.2.

Tabular means an ordered list of measurement values that is reported with the same time stamp and the same update interval.

TabularData shall be grouped by the update interval.

e) EventData

The EventData element contains a list of (typically) irregularly updated values where a reference to the Data Channel List (LocalID or ShortID) is given for each data point (see 6.2 for details).

f) DataSet

The DataSet is a set of measurement values having the same time stamp. There are two types of DataSet, one is for TabularData, and the other is for EventData.

These elements are arranged in the hierarchical structure shown in Figure 3, using UML. For more information on UML notation, refer to ISO/IEC 19505-1 and ISO/IEC 19505-2.

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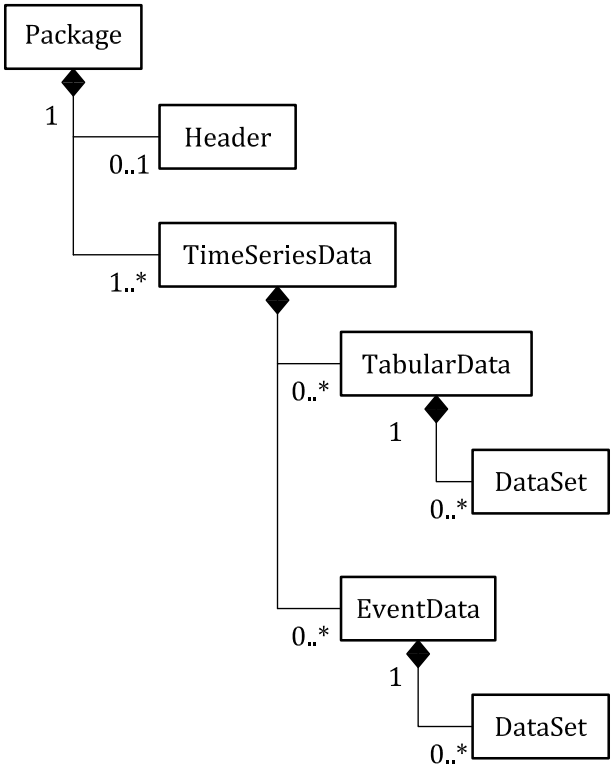

Figure 3 — Model of Time Series Data

7.5.2 Logical structure

The Time Series Data shall have the logical structure shown in Figure 4, using UML. For more information on UML notation, refer to ISO/IEC 19505-1 and ISO/IEC 19505-2.

Time Series Data has Package. Package has Header and TimeSeriesData. TimeSeriesData includes one or more DataSet. DataSet has one TimeStamp and one or more Data.

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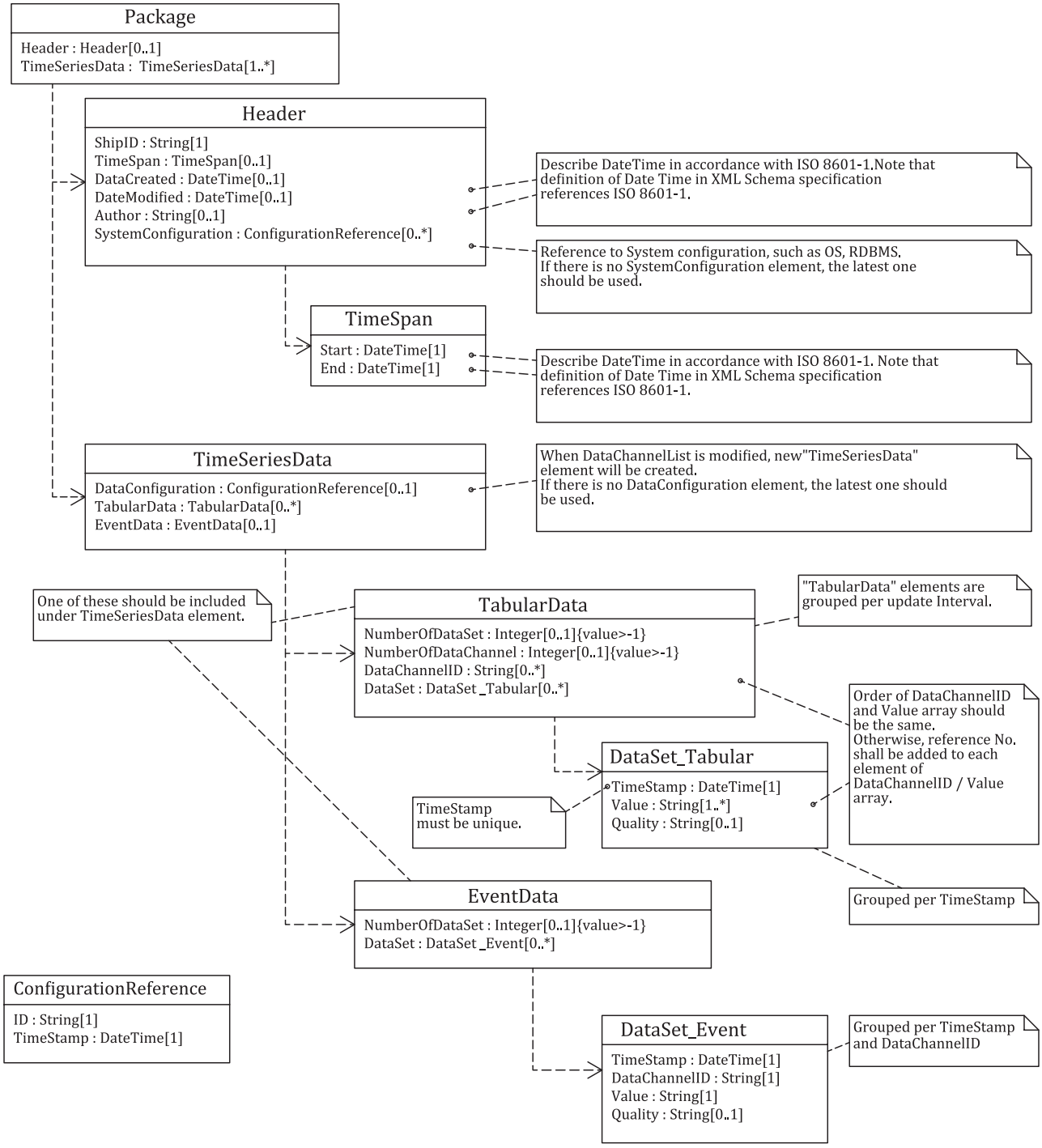

Figure 4 — Logical structure of Time Series Data

Details of each element are as described in Tables 23 to 31.

a) Package structure

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Table 23 — Package structure

Name	Data type	Note	Mandatory/ Option	Max count
Header	b) Header	See Table 24. For periodic data exchange, this element can be omitted to reduce data size.	Optional	1
TimeSeriesData	e) TimeSeriesData	See Table 27. TimeSeriesData are grouped by DataChannelList editions.	Mandatory	unlimited

b) Header structure

Table 24 — Header structure

Name	Data type	Note	Mandatory/ Option	Max count
ShipID	String	IMO number, HIN, etc.	Mandatory	1
TimeSpan	c) TimeSpan	See Table 25	Optional	1
DateCreated	DateTime	Date when Package is created	Optional	1
DateModified	DateTime	Date when Package is modified	Optional	1
Author	String	Author of data	Optional	1
SystemConfiguration	d) ConfigurationReference	See Table 26 Reference to the configuration of systems, such as OS, RDBMS, etc.	Optional	unlimited

c) TimeSpan structure

Table 25 — TimeSpan structure

Name	Data type	Note	Mandatory/ Option	Max count
Start	DateTime	Time stamp of the oldest Data Set	Mandatory	1
End	DateTime	Time stamp of the newest Data Set	Mandatory	1

d) ConfigurationReference structure

Table 26 — ConfigurationReference structure

Name	Data type	Note	Mandatory/ Option	Max count
ID	String	Identifier of the configuration	Mandatory	1
TimeStamp	DateTime	Modified date and time of the configuration	Mandatory	1

e) TimeSeriesData structure

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Table 27 — TimeSeriesData structure

Name	Data type	Note	Mandatory/ Option	Max count
DataConfiguration	d) ConfigurationReference	See Table 26 Reference to the DataChannel-List If there is a no reference, the latest DataChannelList shall be used.	Optional	1
TabularData	f) TabularData	See Table 28 and Clause 6	Optional	unlimited
EventData	g) EventData	See Table 29 and Clause 6	Optional	1

f) TabularData structure

Table 28 — TabularData structure

Name	Data type	Note	Mandatory/ Option	Max count
NumberOfDataSet	NonNegativeInteger	Number of DataSet in the Tabu-larData element	Optional	1
NumberOfDataChannel	NonNegativeInteger	Number of DataChannel in the TabularData element	Optional	1
DataChannelID	String	Array of one of the Data Chan-nel ID in 5.1. Order of DataChannelID ele-ments shall be same as Table 28 TabularData/Value. If the order of DataChannelID elements cannot be specified, reference number shall be added. Further, if the order of Data-ChannelID elements can be fixed and never changed, these elements may be omitted.	Optional	unlimited
DataSet	h) DataSet_Tabular	See Clause 6	Optional	* unlun-limited

g) EventData structure

Table 29 — EventData structure

Name	Data type	Note	Mandatory/ Option	Max count
NumberOfDataSet	NonNegativeInteger	Number of DataSet in the EventData element	Optional	1
DataSet	i) DataSet_Event	See 6.3 b)	Optional	unlimited

h) DataSet_Tabular structure

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Table 30 — DataSet_Tabular structure

Name	Data type	Note	Mandatory/ Option	Max count
TimeStamp	DateTime	Time of measurement	Mandatory	1
Value	String	Array of measurement value of each data channel at TimeS-tamp. Order of Value elements shall be same as Table 28. TabularData/DataChannelID. If the order of Value elements cannot be specified, reference number shall be added.	Mandatory	unlimited
Quality	String	Data quality of the Value above	Optional	1

i) DataSet_Event structure

Table 31 — DataSet_Event structure

Name	Data type	Note	Mandatory/ Option	Max count
TimeStamp	DateTime	Time of measurement	Mandatory	1
DataChannelID	String	One of the Data Channel ID in 5.1	Mandatory	1
Value	String	Measurement value	Mandatory	1
Quality	String	Data quality of the Value above	Optional	1

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Annex A
(normative)

General requirement of data implementation

A.1 General

A.1.1 Exchanging Data

Data which have a structure as written in Clause 7, will be implemented by XML, JSON or CSV.

Regardless of the implementation language, data shall comply as follows.

— Data shall be written by text and encoded by UTF-8 WITHOUT Byte Order Mark (BOM).

XML/JSON is recommended to exchange a snapshot of Time Series Data containing a single or a small number of Data Set(s), or a Data Channel List.

When using XML/JSON, since there is no schema validation mechanism, it is recommended that applications are developed with an environment that can communicate with the actual shipboard data server. CSV is recommended for especially large Time Series Data. In this case, the Data Channel List shall be shared in advance. XML/JSON is recommended for exchanging the Data Channel List.

A.1.2 Exchanging data as a file

The data file shall be designed to allow processing in various file systems.

To do this, the file shall comply with the following requirements.

— The name of the file shall be case-insensitive.

— The name of the file shall not start with "." (period).

— The name of the file shall not contain [\ ] [/] [:] [*] [?] ["] [<] [>] [|] and any white space characters.

— The length of the name of the file shall be less than or equal to 255 characters.

A.2 XML implementation

A.2.1 General

In this clause, requirements are shown of cases in which the data formats discussed in Clause 7 are implemented using XML and XML Schemas.

XML implementation is not mandatory but when it is implemented, it shall be implemented in accordance with the requirements in A.2.

XML Schema is formulated in accordance with the requirements and guidance described below.

— The minimum and maximum numbers of occurrences shall be defined.

— XML Schema shall be created to command XML to add Namespace to all elements and attributes. The following example shows the use of Namespace "nr".

EXAMPLE < nr:NamingRule nr:ID = "Naming_Scheme_ID"/ >

— The naming scheme's specific elements and attributes should belong to its own Namespace.

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— Any newline or indent characters in the file shall not be treated as significant information.

A.2.2 Standard and XML schema data type

Standard data type in 7.3 is replaced with XML Schema data type in Table A.1.

Table A.1 — Correspondences between standard data type and XML schema data type

Standard data type	XML schema data type	Note
Integer	Integer	Integer number
PositiveInteger	PositiveInteger	Integer number that is 1 or larger
NonNegativeInteger	NonNegativeInteger	Integer number that is 0 or larger
Real	Decimal	Decimal number
DateTime	DateTime	ISO 8601-1 time and date
CharacterString	String	Random string of characters
Boolean	Boolean	Truth value
Null	XML Schema < element name = ”example” type = ”float” nillable = ”true”/ > XML Document < example nil = ”true”/ >	When designating Null, designate Attribute nillable = ”true” in the Element definition of XML Schema, and Attribute nillable = ”true” in the corresponding Element in XML Document.

A.2.3 Data Channel List

a) Namespace

The following Namespace (sdd) shall be added to all the elements and attributes in Data Channel List.

XMLNamespace:sdd = urn:ISO19848:Ship_Data_Definition

In case of using naming scheme specific elements/attributes, namespace shall be used to avoid duplication.

The following example shows the use of Namespace “nr”.

EXAMPLE XMLNamespace:nr = urn:ISO19848:Ship_Data_Definition:Naming_Scheme

b) XML Schema

When using XML, data structures in 7.4 shall be defined and validated by using the following XML Schema.

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:sdd="urn:ISO19848:SHIP_DATA_DEFINITION"
           attributeFormDefault="unqualified" elementFormDefault="qualified"
           targetNamespace="urn:ISO19848:SHIP_DATA_DEFINITION"
           xmlns:xs="https://www.w3.org/2001/XMLSchema">

  <!--7.4.2 a) Package structure-->
  <xs:element name="Package" type="sdd:Package"/>

  <!--7.4.2 a) Package structure-->
  <xs:complexType name="Package">
    <xs:sequence>
      <!--7.4.2 b) Header structure-->
      <xs:element name="Header" type="sdd:Header" minOccurs="1" maxOccurs="1"/>
      <!--7.4.2 e) DataChannelList structure-->
      <xs:element name="DataChannelList" type="sdd:DataChannelList" minOccurs="1"
maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>
```

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```
  <!--7.4.2 b) Header structure-->
  <xs:complexType name="Header">
    <xs:sequence>
      <!--IMO Number, HIN or other ship's identification number-->
      <xs:element name="ShipID" type="xs:string"  minOccurs="1" maxOccurs="1"/>
      <!--Identifier of this list, see 7.4.2 c)-->
      <xs:element name="DataChannelListID" type="sdd:ConfigurationReference"
            minOccurs="1" maxOccurs="1"/>
      <!--Version information of this list, see 7.4.2 d)-->
      <xs:element name=" VersionInformation" type="sdd:VersionInformation"
            minOccurs="0" maxOccurs="unbounded"/>
      <!--Author of data-->
      <xs:element name="Author" type="xs:string"  minOccurs="0" maxOccurs="1"/>
      <!--Date when data are created-->
      <xs:element name="DateCreated" type="xs:dateTime"  minOccurs="0" maxOccurs="1"/>
      <!--Extension point for custom headers-->
      <xs:any processContents="lax" namespace="##other" minOccurs="0"  maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 c) ConfigurationReference structure-->
  <xs:complexType name="ConfigurationReference">
    <xs:sequence>
      <xs:element name="ID" type="xs:string"  minOccurs="1" maxOccurs="1"/>
      <xs:element name="Version" type="xs:string"  minOccurs="0" maxOccurs="1"/>
      <xs:element name="TimeStamp" type="xs:dateTime"  minOccurs="1" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 d) VersionInformation structure-->
  <xs:complexType name="VersionInformation">
    <xs:sequence>
      <xs:element name="NamingRule" type="xs:string"  minOccurs="1" maxOccurs="1"/>
      <xs:element name="NamingSchemeVersion" type="xs:string"  minOccurs="1" maxOccurs="1"/>
      <xs:element name="ReferenceURL" type="xs:string"  minOccurs="0" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 e) DataChannelList structure-->
  <xs:complexType name="DataChannelList">
    <xs:sequence>
      <!--7.4.2 f) DataChannel structure-->
      <xs:element name="DataChannel" type="sdd:DataChannel"  minOccurs="1"
maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 f) DataChannel structure-->
  <xs:complexType name="DataChannel">
    <xs:sequence>
      <!--7.4.2 g) DataChannelID structure-->
      <xs:element name="DataChannelID" type="sdd:DataChannelID" minOccurs="1" maxOccurs="1"/>
      <!--7.4.2 h) Property structure-->
      <xs:element name="Property" type="sdd:Property" minOccurs="1" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 g) DataChannelID structure-->
  <xs:complexType name="DataChannelID">
    <xs:sequence>
      <xs:element name="LocalID" type="xs:string" minOccurs="1" maxOccurs="1"/>
      <xs:element name="ShortID" type="xs:string" minOccurs="0" maxOccurs="1"/>
      <!--7.4.2 n) NameObject structure-->
      <xs:element name="NameObject" type="sdd:NameObject" minOccurs="0" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 h) Property structure-->
  <xs:complexType name="Property">
    <xs:sequence>
      <!--5.3 a) Identifier of Data Channel Type, such as raw numeric value,
                                 average value, alarm and status, etc.-->
```

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```
      <xs:element name="DataChannelType" type="sdd:DataChannelType" minOccurs="1"
maxOccurs="1"/>
      <!--5.3 b) Formats are for describing data formats-->
      <!--Assumed data types are "Float","Integer","Boolean","Text" and "Symbol"-->
      <xs:element name="Format" type="sdd:Format"  minOccurs="1" maxOccurs="1"/>
      <!--5.3 c) Range of measurement value-->
      <xs:element name="Range" type="sdd:Range" minOccurs="0" maxOccurs="1"/>
      <!--5.3 d) Unit and quantity of measurement value-->
      <xs:element name="Unit" type="sdd:Unit"  minOccurs="0" maxOccurs="1" />
      <!--5.3 e) Name of data quality evaluation scheme-->
      <xs:element name="QualityCoding" type="xs:string"  minOccurs="0" maxOccurs="1"/>
      <!--5.3 f) Priority of the alert if the DataChannel represents an alert-->
      <xs:element name="AlertPriority" type="xs:string"  minOccurs="0" maxOccurs="1"/>

      <!--5.3 g) Names assigned in on-board control systems and other instruments-->
      <xs:element name="Name" type="xs:string"  minOccurs="0" maxOccurs="1"/>
      <!--5.3 h) Remarks shall contains location, manufacturer and type of equipment-->
      <xs:element name="Remarks" type="xs:string"  minOccurs="0" maxOccurs="1"/>
      <!--Extension point for custom properties-->
      <xs:any processContents="lax" namespace="##other" minOccurs="0"  maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 i) DataChannelType structure-->
  <!--5.3 a) Identifier of Data Channel Type, such as raw numeric value,
                                 average value, alarm and status, etc.-->
  <xs:complexType name="DataChannelType">
    <xs:sequence>
      <xs:element name="Type" minOccurs="1" maxOccurs="1">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Inst"/>
            <xs:enumeration value="Average"/>
            <xs:enumeration value="Max"/>
            <xs:enumeration value="Min"/>
            <xs:enumeration value="StandardDeviation"/>
            <xs:enumeration value="Calculated"/>
            <xs:enumeration value="SetPoint"/>
            <xs:enumeration value="Output"/>
            <xs:enumeration value="Alert"/>
            <xs:enumeration value="Status"/>
            <xs:enumeration value="ManuallyInput"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="UpdateCycle" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
      <xs:element name="CalculationPeriod" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 j) Format structure-->
  <!--5.3 b) Format of measurement value-->
  <xs:complexType name="Format">
    <xs:sequence>
      <!--Type of the Format-->
      <xs:element name="Type" minOccurs="1" maxOccurs="1">
        <xs:simpleType>
          <xs:restriction base="xs:string">
            <xs:enumeration value="Decimal"/>
            <xs:enumeration value="Integer"/>
            <xs:enumeration value="Boolean"/>
            <xs:enumeration value="String"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <!--7.4.2 k) Restriction of the value-->
      <xs:element name="Restriction" minOccurs="0" maxOccurs="1">
        <xs:complexType>
          <xs:choice maxOccurs="unbounded">
            <xs:element name="Enumeration" type="xs:string" minOccurs="0"
maxOccurs="unbounded"/>
            <xs:element name="FractionDigits" type="xs: nonNegativeInteger " minOccurs="0"
```

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```
maxOccurs="1"/>
            <xs:element name="Length" type="xs:nonNegativeInteger " minOccurs="0"
maxOccurs="1"/>
            <xs:element name="MaxExclusive" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
            <xs:element name="MaxInclusive" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
            <xs:element name="MaxLength" type="xs:nonNegativeInteger " minOccurs="0"
maxOccurs="1"/>
            <xs:element name="MinExclusive" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
            <xs:element name="MinInclusive" type="xs:decimal" minOccurs="0" maxOccurs="1"/>
            <xs:element name="MinLength" type="xs:nonNegativeInteger " minOccurs="0"
maxOccurs="1"/>
            <xs:element name="Pattern" type="xs:string" minOccurs="0" maxOccurs="1"/>
            <xs:element name="TotalDigits" type="xs:positiveInteger " minOccurs="0"
maxOccurs="1"/>
            <xs:element name="WhiteSpace" minOccurs="0" maxOccurs="1">
              <xs:simpleType>
                <xs:restriction base="xs:string">
                  <xs:enumeration value="preserve"/>
                  <xs:enumeration value="replace"/>
                  <xs:enumeration value="collapse"/>
                </xs:restriction>
              </xs:simpleType>
            </xs:element>
          </xs:choice>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 l) Range structure-->
  <!--5.3 c) Range of measurement value-->
  <xs:complexType name="Range">
    <xs:sequence>
      <!--Higher limit of measurement value-->
      <xs:element name="High" type="sdd:emptyOrDecimal" minOccurs="1" maxOccurs="1"/>
      <!--Lower limit of measurement value-->
      <xs:element name="Low" type="sdd:emptyOrDecimal" minOccurs="1" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 m) Unit structure-->
  <!--5.3 d) Unit and quantity of measurement value-->
  <xs:complexType name="Unit">
    <xs:sequence>
      <!--Symbol of the unit-->
      <xs:element name="UnitSymbol" type="xs:string" minOccurs="1" maxOccurs="1"/>
      <!--Quantity name of the measurement value, that is defined in ISO 80000, IEC 80000 or
Table2 -->
      <xs:element name="QuantityName" type="xs:string" minOccurs="0" maxOccurs="1"/>
      <!--Extension point for custom Unit element, such as Quantity Symbol, Scale Factor,
etc.-->
      <xs:any processContents="lax" namespace="##other" minOccurs="0"  maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.4.2 n) NameObject structure-->
  <xs:complexType name="NameObject">
    <xs:sequence>
      <!--Name of NamingRule, see 5.2.3-->
      <xs:element name ="NamingRule" type="xs:string" minOccurs="1" maxOccurs="1"/>
      <!--Extension point for custom NameObjects, Definition of LocalDataName structure-->
      <xs:any processContents="lax" namespace="##other" minOccurs="0"  maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

  <!--empty value acceptable decimal-->
  <xs:simpleType name="emptyOrDecimal">
    <xs:union memberTypes="sdd:empty xs:decimal"/>
  </xs:simpleType>
  <xs:simpleType name="empty">
    <xs:restriction base="xs:string">
      <xs:enumeration value=""/>
```

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```
    </xs:restriction>
  </xs:simpleType>
</xs:schema>
```

c) XML representation

This example uses namespace:nr for custom elements. Custom elements are italicized for reference.

```
<?xml version="1.0" encoding="utf-8"?>
<Package xmlns="urn:ISO19848:SHIP_DATA_DEFINITION"
         xmlns:nr="urn:ISO19848:SHIP_DATA_DEFINITION:NAMING_SCHEME">
  <Header>
    <ShipID>IMO1234567</ShipID>
    <DataChannelListID>
      <ID>DataChannelList.xml</ID>
      <Version>1.0</Version>
      <TimeStamp>2016-01-01T00:00:00Z</TimeStamp>
    </DataChannelListID>
    <VersionInformation>
      <NamingRule>Naming_Scheme</NamingRule>
      <NamingSchemeVersion>2.0</NamingSchemeVersion>
      <ReferenceURL>http://somewhere.net</ReferenceURL>
    </VersionInformation>
    <Author>Author1</Author>
    <DateCreated>2015-12-01T00:00:00+00:00</DateCreated>
    <nr:CustomHeaderElement>Vender specific headers</nr:CustomHeaderElement>
  </Header>
  <DataChannelList>
    <DataChannel>
      <DataChannelID>
<LocalID>/Naming_Scheme/MainEngine/AirCooler1/CoolingFreshWater/Outlet/Temp
</LocalID>
        <ShortID>0010</ShortID>
        <NameObject>
          <NamingRule>Naming_Scheme</NamingRule>
          <nr:CustomNameObject>Vender specific NameObject</nr:CustomNameObject>
        </NameObject>
      </DataChannelID>
      <Property>
        <DataChannelType>
          <Type>Inst</Type>
          <UpdateCycle>1</UpdateCycle>
        </DataChannelType>
        <Format>
          <Type>Decimal</Type>
          <Restriction>
            <FractionDigits>1</FractionDigits>
            <MaxInclusive>200.0</MaxInclusive>
            <MinInclusive>-150.0</MinInclusive>
          </Restriction>
        </Format>
        <Range>
          <High>150.0</High>
          <Low>0.0</Low>
        </Range>
        <Unit>
          <UnitSymbol>°C</UnitSymbol>
          <QuantityName>Temperature</QuantityName>
        </Unit>
        <QualityCoding>OPC_QUALITY</QualityCoding>
        <Name>M/E #1 Air Cooler CFW OUT Temp</Name>
        <Remarks> Location: ECR, Manufacturer: AAA Company, Type: TYPE-AAA </Remarks>
        <nr:CustomPropertyElement>Vender specific Property</nr:CustomPropertyElement>
      </Property>
    </DataChannel>
    <DataChannel>
      <DataChannelID>

<LocalID>/Naming_Scheme/MainEngine/AirCooler1/CoolingFreshWater/Outlet/Press
</LocalID>
        <ShortID>0020</ShortID>
```

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```
        <NameObject>
          <NamingRule>Naming_Scheme</NamingRule>
          <nr:CustomNameObject>Vender specific NameObject</nr:CustomNameObject>
        </NameObject>
      </DataChannelID>
      <Property>
        <DataChannelType>
          <Type>Average</Type>
          <UpdateCycle>60</UpdateCycle>
          <CalculationPeriod>3600</CalculationPeriod>
        </DataChannelType>
        <Format>
          <Type>Integer</Type>
          <Restriction>
            <FractionDigits>1</FractionDigits>
            <MaxInclusive>200.0</MaxInclusive>
            <MinInclusive>-150.0</MinInclusive>
          </Restriction>
        </Format>
        <Range>
          <High>150.0</High>
          <Low>0.0</Low>
        </Range>
        <Unit>
<UnitSymbol>°C</UnitSymbol>
          <QuantityName>Temperature</QuantityName>
        </Unit>
        <QualityCoding>OPC_QUALITY</QualityCoding>
        <Name> M/E #1 Air Cooler CFW OUT Average Temp </Name>
        <Remarks> Location: ECR, Manufacturer: AAA Company, Type: TYPE-AAA </Remarks>
        <nr:CustomPropertyElement>Vender specific Property</nr:CustomPropertyElement>
      </Property>
    </DataChannel>
    <DataChannel>
      <DataChannelID>

<LocalID>/Naming_Scheme/MainEngine/AirCooler1/CoolingFreshWater/Outlet/Temp/Alert
</LocalID>
        <ShortID>0011</ShortID>
        <NameObject>
          <NamingRule>Naming_Scheme</NamingRule>
          <nr:CustomNameObject>Vender specific NameObject</nr:CustomNameObject>
        </NameObject>
      </DataChannelID>
      <Property>
        <DataChannelType>
          <Type>Alert</Type>
        </DataChannelType>
        <Format>
          <Type>String</Type>
          <Restriction>
            <Enumeration>High</Enumeration>
            <Enumeration>Low</Enumeration>
            <Enumeration>Normal</Enumeration>
          </Restriction>
        </Format>
        <QualityCoding>OPC_QUALITY</QualityCoding>
        <Name> M/E #1 Air Cooler CFW OUT Temp Status </Name>
        <Remarks> Location: ECR, Manufacturer: AAA Company, Type: TYPE-AAA </Remarks>
        <nr:CustomPropertyElement>Vender specific Property</nr:CustomPropertyElement>
      </Property>
    </DataChannel>
    <DataChannel>
      <DataChannelID>

<LocalID>/Naming_Scheme/MainEngine/AirCooler1/CoolingFreshWater/Outlet/Press/Alert
</LocalID>
        <ShortID>0021</ShortID>
        <NameObject>
          <NamingRule>Naming_Scheme</NamingRule>
          <nr:CustomNameObject>Vender specific NameObject</nr:CustomNameObject>
        </NameObject>
```


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```
      </DataChannelID>
      <Property>
        <DataChannelType>
          <Type>Alert</Type>
        </DataChannelType>
        <Format>
          <Type>String</Type>
          <Restriction>
            <Enumeration>High</Enumeration>
            <Enumeration>Low</Enumeration>
            <Enumeration>Normal</Enumeration>
          </Restriction>
        </Format>
        <QualityCoding>OPC_QUALITY</QualityCoding>
        <AlertPriority>Alarm</AlertPriority>
        <Name> M/E #1 Air Cooler CFW OUT Press Status </Name>
        <Remarks> Location: ECR, Manufacturer: AAA Company, Type: TYPE-AAA </Remarks>
        <nr:CustomPropertyElement>Vender specific Property</nr:CustomPropertyElement>
      </Property>
    </DataChannel>
  </DataChannelList>
</Package>
```

A.2.4 Time Series Data

a) Namespace

In Time Series Data, the following Namespace (sdt) shall be added.

XMLNamespace:sdt = urn:ISO19848:Ship_Data_Transport

b) XML Schema

When using XML, data structures in 7.5 shall be defined and validated by using the following XML Schema.

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:sdt="urn:ISO 19848:SHIP_DATA_TRANSPORT"
           attributeFormDefault="unqualified" elementFormDefault="qualified"
           targetNamespace="urn:ISO 19848:SHIP_DATA_TRANSPORT"
           xmlns:xs="https://www.w3.org/2001/XMLSchema">

  <!--7.5.2 a) Package structure-->
  <xs:element name="Package" type="sdt:Package"/>

  <!--7.5.2 a) Package structure-->
  <xs:complexType name="Package">
    <xs:sequence>
      <!--7.5.2 b) Header structure-->
      <xs:element name="Header" type="sdt:Header"
                  minOccurs="0" maxOccurs="1"/>
      <!--7.5.2 e) TimeSeriesData structure -->
      <xs:element name="TimeSeriesData" type="sdt:TimeSeriesData"
                  minOccurs="1" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

  <!--7.5.2 b) Header structure-->
  <xs:complexType name="Header">
    <xs:sequence>
      <!--IMO Number, HIN or other ship's identification number-->
      <xs:element name="ShipID" type="xs:string"
                  minOccurs="1" maxOccurs="1"/>
      <!--7.5.2 c) TimeSpan structure-->
      <xs:element name="TimeSpan" type="sdt:TimeSpan"
                  minOccurs="0" maxOccurs="1"/>
      <!--Date when data are created-->
      <xs:element name="DateCreated" type="xs:dateTime"
                  minOccurs="0" maxOccurs="1"/>
      <!--Date when data are modified-->
```

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```
    <xs:element name="DateModified" type="xs:dateTime"
                minOccurs="0" maxOccurs="1"/>
    <!--Author of data-->
    <xs:element name="Author" type="xs:string"
                minOccurs="0" maxOccurs="1"/>
    <!--7.5.2 d) Reference to system configuration -->
    <xs:element name="SystemConfiguration" type="sdt:ConfigurationReference"
                minOccurs="0" maxOccurs="unbounded"/>
    <!--Extension point for custom headers-->
    <xs:any processContents="lax" namespace="##other" minOccurs="0"  maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>

<!--7.5.2 c) TimeSpan structure-->
<xs:complexType name="TimeSpan">
  <xs:sequence>
    <!--TimeStamp of the oldest DataSet-->
    <xs:element name="Start" type="xs:dateTime" minOccurs="1" maxOccurs="1"/>
    <!--TimeStanp of the newest DataSet-->
    <xs:element name="End" type="xs:dateTime" minOccurs="1" maxOccurs="1"/>
  </xs:sequence>
</xs:complexType>

<!--7.5.2 d) ConfigurationReference structure-->
<xs:complexType name="ConfigurationReference">
  <xs:sequence>
    <xs:element name="ID" type="xs:string"  minOccurs="1" maxOccurs="1"/>
    <xs:element name="TimeStamp" type="xs:dateTime"  minOccurs="1" maxOccurs="1"/>
  </xs:sequence>
</xs:complexType>

<!--DataChannelID structure-->
<!--Value must be Local ID or Shor ID strings. see 6.1 for the details.-->
<xs:complexType name="DataChannelID">
  <xs:simpleContent>
    <xs:extension base="xs:string">
      <!--Ordinal number of the DataChannelID array-->
      <xs:attribute name="id" type="xs:positiveInteger" use="required" />
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>

<!--7.5.2 e) TimeSeriesData structure -->
<xs:complexType name="TimeSeriesData">
  <xs:sequence>
    <!--7.5.2 d) ConfigurationReference structure -->
    <xs:element name="DataConfiguration" type="sdt:ConfigurationReference"
                minOccurs="0" maxOccurs="1" />
    <!--7.5.2 f) TabularData structure -->
    <xs:element name="TabularData" type="sdt:TabularData"
                minOccurs="0" maxOccurs="unbounded" />
    <!--7.5.2 g) EventData structure -->
    <xs:element name="EventData" type="sdt:EventData"
                minOccurs="0" maxOccurs="1" />
    <!--Extension point for custom data kinds-->
    <xs:any processContents="lax" namespace="##other" minOccurs="0"  maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>

<!--7.5.2 f) TabularData structure -->
<xs:complexType name="TabularData">
  <xs:sequence>
    <!--Number of DataSet elements under the hierarchy -->
    <xs:element name="NumberOfDataSet" type="xs:nonNegativeInteger"
                minOccurs="0" maxOccurs="1" />
    <!--Number of DataChannels for each DataSources-->
    <xs:element name="NumberOfDataChannel" type="xs:nonNegativeInteger"
                minOccurs="0" maxOccurs="1"/>
    <!--Identifiers of target DataChannels-->
    <xs:element name="DataChannelID" type="sdt:DataChannelID"
                minOccurs="0" maxOccurs="unbounded"/>
    <!--7.5.2 h) DataSet structure -->
```

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```
      <xs:element name="DataSet" type="sdt:DataSet_Tabular"
                  minOccurs="0" maxOccurs="unbounded" />
    </xs:sequence>
  </xs:complexType>

  <!--7.5.2 g) EventData structure -->
  <xs:complexType name="EventData">
    <xs:sequence>
      <!--Number of DataSet elements under the hierarchy -->
      <xs:element name="NumberOfDataSet" type="xs:nonNegativeInteger"
                  minOccurs="0" maxOccurs="1" />
      <!--7.5.2 i) DataSet structure -->
      <xs:element name="DataSet" type="sdt:DataSet_Event"
                  minOccurs="0" maxOccurs="unbounded" />
    </xs:sequence>
  </xs:complexType>

  <!--7.5.2 h) DataSet structure for Tabular Data -->
  <xs:complexType name="DataSet_Tabular">
    <xs:sequence>
      <!--Measurement value -->
      <!--Measurement value can be empty-->
      <xs:element name="Value" type="sdt:Value"
                  minOccurs="1" maxOccurs="unbounded"/>
    </xs:sequence>
    <!--ISO 8601-1 date & time structure shall be used-->
    <xs:attribute name="timeStamp" type="xs:dateTime" use="required"/>
  </xs:complexType>

  <!--7.5.2 i) DataSet structure for Event Data-->
  <xs:complexType name="DataSet_Event">
    <xs:sequence>
      <xs:element name="DataChannelID" type="xs:string"
                  minOccurs="1" maxOccurs="1"/>
      <!--Measurement value -->
      <!--Measurement value can be empty-->
      <xs:element name="Value" type="xs:string"
                  minOccurs="1" maxOccurs="1"/>
    </xs:sequence>
    <!--ISO 8601-1 date & time structure shall be used-->
    <xs:attribute name="timeStamp" type="xs:dateTime" use="required"/>

    <xs:attribute name="quality" type="xs:string" use="optional"/>
  </xs:complexType>

  <!--Value structure for Tabular Data -->
  <xs:complexType name="Value">
    <xs:simpleContent>
      <xs:extension base="xs:string">
        <!--Ordinal number of the Value array.
        Order of the array shall be the same as TabularData/DataChannelID array.-->
        <xs:attribute name="ref" type="xs:positiveInteger" use="required" />
        <xs:attribute name="quality" type="xs:string" use="optional"/>
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:schema>
```

c) XML representation

An example of XML representation is as follows.

```
<?xml version="1.0" encoding="utf-8" ?>
<Package xmlns="urn:ISO19848:SHIP_DATA_TRANSPORT">
  <Header>
    <ShipID>IMO1234567</ShipID>
    <TimeSpan>
      <Start>2016-01-01T12:00:00Z</Start>
      <End>2016-01-03T12:00:00Z</End>
    </TimeSpan>
    <DateCreated>2016-01-03T12:00:00Z</DateCreated>
```

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```
    <DateModified>2016-01-03T12:00:00Z</DateModified>
    <Author>Shipboard data server</Author>
    <SystemConfiguration>
      <ID>SystemConfiguration.xml</ID>
      <TimeStamp>2016-01-01T00:00:00Z</TimeStamp>
    </SystemConfiguration>
    <SystemConfiguration>
      <ID>SystemConfiguration.xml</ID>
      <TimeStamp>2016-01-03T00:00:00Z</TimeStamp>
    </SystemConfiguration>
  </Header>
  <TimeSeriesData>
    <DataConfiguration>
      <ID>DataChannelList.xml</ID>
      <TimeStamp>2016-01-01T00:00:00Z</TimeStamp>
    </DataConfiguration>
    <TabularData>
      <NumberOfDataSet>2</NumberOfDataSet>
      <NumberOfDataChannel>2</NumberOfDataChannel>
      <!--ShortID of the DataChannel -->
      <DataChannelID id="1">0010</DataChannelID>
      <DataChannelID id="2">0020</DataChannelID>
      <DataSet timeStamp="2016-01-01T12:00:00Z">
        <!--TabularData/DataSet/Value@ref references TabularData/DataChannelID@id -->
        <!--measurement value of Data Channel:0010 at 2016-01-01T12:00:00Z -->
        <Value ref="1" quality="0">100.0</Value>
        <!--measurement value of Data Channel:0020 at 2016-01-01T12:00:00Z -->
        <Value ref="2" quality="0">200.0</Value>
      </DataSet>
      <DataSet timeStamp="2016-01-02T12:00:00Z">
        <!--measurement value of Data Channel:0010 at 2016-01-02T12:00:00Z -->
        <Value ref="1" quality="0">100.5</Value>
        <!--measurement value of Data Channel:0020 at 2016-01-02T12:00:00Z -->
        <Value ref="2" quality="0">205.0</Value>
      </DataSet>
    </TabularData>
    <TabularData>
      <NumberOfDataSet>3</NumberOfDataSet>
      <NumberOfDataChannel>1</NumberOfDataChannel>
      <DataChannelID id="1">0010</DataChannelID>
      <DataSet timeStamp="2016-01-01T12:00:00Z">
        <Value ref="1" quality="0">100.0</Value>
      </DataSet>
      <DataSet timeStamp="2016-01-02T00:00:00Z">
        <Value ref="1" quality="0">100.2</Value>
      </DataSet>
      <DataSet timeStamp="2016-01-02T12:00:00Z">
        <Value ref="1" quality="0">100.5</Value>
      </DataSet>
    </TabularData>
    <EventData>
      <NumberOfDataSet>3</NumberOfDataSet>
      <DataSet timeStamp="2016-01-01T12:00:01Z" quality="0">
        <DataChannelID>0011</DataChannelID>
        <Value>HIGH</Value>
      </DataSet>
      <DataSet timeStamp="2016-01-01T12:00:01Z" quality="0">
        <DataChannelID>0021</DataChannelID>
        <Value>HIGH</Value>
      </DataSet>
      <DataSet timeStamp="2016-01-01T12:00:23Z" quality="0">
        <DataChannelID>0011</DataChannelID>
        <Value>NORMAL</Value>
      </DataSet>
    </EventData>
  </TimeSeriesData>
  <TimeSeriesData>
    <DataConfiguration>
      <ID>DataChannelList.xml</ID>
      <TimeStamp>2016-01-03T00:00:00Z</TimeStamp>
    </DataConfiguration>
    <TabularData>
```


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