
**Intelligent transport systems —
Traffic and travel information (TTI)
via transport protocol experts group,
generation 2 (TPEG2) —**

Part 3:

**UML to binary conversion rules
(TPEG2-UBCR)**

*Systèmes intelligents de transport — Informations sur le trafic et le
tourisme via le groupe expert du protocole de transport, génération 2
(TPEG2) —*

Partie 3: Règles de conversion d'UML à système binaire

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 204, *Intelligent transport systems*.

This first edition cancels and replaces ISO/TS 21219-3:2015 which has been technically revised. The main changes compared to the previous edition are as follows:

A list of all parts in the ISO 21219 series can be found on the ISO website.

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

History

TPEG technology was originally proposed by the European Broadcasting Union (EBU) Broadcast Management Committee, who established the B/TPEG project group in the autumn of 1997 with a brief to develop, as soon as possible, a new protocol for broadcasting traffic and travel-related information in the multimedia environment. TPEG technology, its applications and service features were designed to enable travel-related messages to be coded, decoded, filtered and understood by humans (visually and/or audibly in the user's language) and by agent systems. Originally, a byte-oriented data stream format, which may be carried on almost any digital bearer with an appropriate adaptation layer, was developed. Hierarchically structured TPEG messages from service providers to end-users were designed to transfer information from the service provider database to an end-user's equipment.

One year later, in December 1998, the B/TPEG group produced its first EBU specifications. Two documents were released. Part 2 (TPEG-SSF, which became ISO/TS 18234-2) described the syntax, semantics and framing structure, which was used for all TPEG applications. Meanwhile, Part 4 (TPEG-RTM, which became ISO/TS 18234-4) described the first application for road traffic messages.

Subsequently, in March 1999, CEN/TC 278, in conjunction with ISO/TC 204, established a group comprising members of the former EBU B/TPEG and this working group continued development work. Further parts were developed to make the initial set of four parts, enabling the implementation of a consistent service. Part 3 (TPEG-SNI, ISO/TS 18234-3) described the service and network information application used by all service implementations to ensure appropriate referencing from one service source to another.

Part 1 (TPEG-INV, ISO/TS 18234-1) completed the series by describing the other parts and their relationship; it also contained the application IDs used within the other parts. Additionally, Part 5, the public transport information application (TPEG-PTI, ISO/TS 18234-5), was developed. The so-called TPEG-LOC location referencing method, which enabled both map-based TPEG-decoders and non-map-based ones to deliver either map-based location referencing or human readable text information, was issued as ISO/TS 18234-6 to be used in association with the other applications of parts of the ISO/TS 18234 series to provide location referencing.

The ISO/TS 18234 series has become known as TPEG Generation 1.

TPEG Generation 2

When the Traveller Information Services Association (TISA), derived from former forums, was inaugurated in December 2007, TPEG development was taken over by TISA and continued in the TPEG applications working group.

It was about this time that the (then) new Unified Modelling Language (UML) was seen as having major advantages for the development of new TPEG applications in communities who would not necessarily have binary physical format skills required to extend the original TPEG TS work. It was also realized that the XML format for TPEG described within the ISO/TS 24530 series (now superseded) had a greater significance than previously foreseen, especially in the content-generation segment and that keeping two physical formats in synchronism, in different standards series, would be rather difficult.

As a result, TISA set about the development of a new TPEG structure that would be UML-based. This has subsequently become known as TPEG Generation 2.

TPEG2 is embodied in the ISO/TS 21219 series and it comprises many parts that cover introduction, rules, toolkit and application components. TPEG2 is built around UML modelling and has a core of rules that contain the modelling strategy covered in ISO 21219-2, ISO 21219-3 and ISO 21219-4 and the conversion to two current physical formats: binary and XML; others could be added in the future. TISA uses an automated tool to convert from the agreed UML model XMI file directly into an MS Word document file, to minimize drafting errors, that forms the annex for each physical format.

ISO 21219-3:2019(E)

TPEG2 has a three-container conceptual structure: message management (ISO 21219-6), application (several parts) and location referencing (ISO/TS 21219-7). This structure has flexible capability and can accommodate many differing use cases that have been proposed within the TTI sector and wider for hierarchical message content.

TPEG2 also has many location referencing options as required by the service provider community, any of which may be delivered by vectoring data included in the location referencing container.

The following classification provides a helpful grouping of the different TPEG2 parts according to their intended purpose. Note that the list below may be incomplete, e.g. new TPEG2 parts may be introduced after publication of this document.

- Toolkit parts: TPEG2-INV (ISO/TS 21219-1), TPEG2-UML (ISO 21219-2), TPEG2-UBCR (ISO 21219-3), TPEG2-UXCR (ISO 21219-4), TPEG2-SFW (ISO 21219-5), TPEG2-MMC (ISO 21219-6), TPEG2-LRC (ISO/TS 21219-7).
- Special applications: TPEG2-SNI (ISO/TS 21219-9), TPEG2-CAI (ISO/TS 21219-10), TPEG2-LTE (ISO/TS 21219-24).
- Location referencing: TPEG2-OLR (ISO/TS 21219-22), TPEG2-GLR (ISO/TS 21219-21), TPEG2-TLR (ISO17572-2), TPEG2-DLR (ISO17572-3).
- Applications: TPEG2-PKI (ISO/TS 21219-14), TPEG2-TEC (ISO/TS 21219-15), TPEG2-FPI (ISO/TS 21219-16), TPEG2-TFP (ISO 21219-18), TPEG2-WEA (ISO/TS 21219-19), TPEG2-RMR (ISO/TS 21219-23), TPEG2-EMI (ISO/TS 21219-25), TPEG2-VLI (ISO/TS 21219-26).

TPEG2 has been developed to be broadly (but not totally) backward compatible with TPEG1 to assist in transitions from earlier implementations, while not hindering the TPEG2 innovative approach and being able to support many new features, such as dealing with applications having both long-term, unchanging content and highly dynamic content, such as parking information.

This document is based on the TISA specification technical/editorial version reference: SP10032.

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Intelligent transport systems — Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) —

Part 3: UML to binary conversion rules (TPEG2-UBCR)

1 Scope

TPEG applications are modelled in UML to provide an application description that is independent of a physical format representation. By separating semantics from application description, applications can easily be developed at a functional level. Different physical format representations can be generated following a well defined set of rules on how to convert UML classes to different physical formats.

This document specifies the rules for converting UML models of TPEG application to the TPEG binary format. It contains the binary format definition of the abstract data types defined in ISO 21219-2. Rules for converting compound data types are also defined.

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 21219-2, *Intelligent transport systems — Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) — Part 2: UML modelling rules*

ISO 21219-5, *Intelligent transport systems — Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) — Part 5: Service framework*

ISO/IEC/IEEE 60559, *Information technology — Microprocessor Systems — Floating-Point arithmetic*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

4 Abbreviated terms

The abbreviated terms defined in ISO 21219-2 and the following apply.

LSB	Least Significant Bit
LSByte	Least Significant Byte
MSB	Most Significant Bit
MSByte	Most Significant Byte

5 Rules for UML to binary format description conversion

5.1 Definition of binary format description

The binary format description of TPEG applications is included in application specifications as a normative annex. This annex shall be named according to the following scheme:

[Full application name], TPEG-binary representation

The annex shall have four subclauses: *Introduction*, *Application framing and signalling*, *Application components* and *Application datastructures*. The content of these subclauses is subject to the specifications in this clause.

The introduction shall use a similar formulation as in the following:

This chapter defines the application framing and the format of the *[Full application name]* message components, datastructures and its attributes for the TPEG binary representation of *[application abbreviation]* as described in *[reference to TPEG framework]*. For further descriptions of these objects see the related clauses *[reference to clauses]* in this specification.

The Application framing and signalling subclause shall have three parts: Application identification, Version number signalling, and Application framing. The Application identification part shall define the Application Identifier (AID) that is used for the application. The Version number signalling shall define the major and minor version number of the application that are signalled within the SNI application. The Application framing part shall state in what kind of service component the application shall be transmitted. TPEG Service Component (SC) types are defined in ISO 21219-5. Currently, the following Service Component types are defined:

- *ServCompFrame* — Standard SC
- *ServCompFrameProtected* — SC with data CRC
- *ServCompFrameCountedProtected* — SC with message count and data CRC
- *ServCompFramePrioritisedProtected* — SC with group priority and data CRC
- *ServCompFramePrioritisedCountedProtected* — SC with group priority, message count and data CRC

The wording shall be similar to the following:

TPEG binary format messages of the *[Full application name]* type are transmitted in Service Component Frames of the *[Service Component Frame type]* type. Service Component Frames are described in *[reference to TPEG framework]*.

The *Application components* description shall have a first subclause with title *List of generic component IDs*. This clause contains unique component IDs for each application UML class that is not stereotyped as <<DataStructure>>. The component IDs should be ordered in the order of appearance in the model.

The list of generic component IDs subclause is followed by subclauses providing the binary format description of each application UML class that is not stereotyped as <<DataStructure>>. This binary format description shall follow the rules as specified in 5.5. The generic component ID of each component defined in the list of generic component IDs shall be inserted in the binary format description where the rules of 5.5 read 'gcid'.

The *Application datastructures* description shall provide the binary format description of each application UML class that is stereotyped as <<DataStructure>>. This binary format description shall follow the rules as specified in 5.5.

5.2 Abstract data types

This clause presents the binary format definition of the abstract data types that are defined in the TPEG UML modelling rules document ISO 21219-5.

The following general rules were used for defining data types in the column "binary format definition":

A data type is written in upper camel case letters in one single expression. The data type may contain letters (a-z), number (0-9), underscore "_", round brackets "()" and colon ":"; the first must be a letter.

EXAMPLE IntUnLo stands for Integer Unsigned Long

A data type is framed by angle brackets "< >".

The content of a data type is defined by a colon followed by an equal sign " := ".

The end of a data type is indicated by a semicolon ";".

A descriptor written in lower camel case may be added to a data type as one single expression without spaces.

A descriptor is framed by round brackets " () ".

The descriptor contains either a value or a name of the associated type.

Data types in a definition list of another one are separated by commas ", ". The order of definition is defined as the order of occurrence in a data stream.

Curly brackets (braces) " {} " group together a block of data types.

Control statements ("if", "infinite", "unordered" or "external") are noted in lower case letters. A control statement is followed by a block statement or only one data type:

- 1) **if** defines a condition statement. The block's (or data type's) occurrence is conditional to the condition statement being valid. The condition statement is framed with round brackets. This statement applies to any data type.
- 2) **infinite** defines endless repetition of the block (or data type). This is only used to mark the main TPEG stream as not ending stream of data.
- 3) **unordered** defines that the following block contains data types which may occur in any order, not only the one used to specify subsequent data types. This statement applies to components only.
- 4) **ordered** defines that the following block contains data types of which the order of definition is defined as the order of occurrence in a data stream. This statement applies to components only.
- 5) **external** defines that the content of the data type is being defined external to the scope of given specification. The control statement "external" must be followed by only one data. A reference to the corresponding specification should follow in the comment. All types specified in TYP specification are treated as being in scope of any application.

The expression " n * " indicates multiplicity of occurrence of a data type. The lower and upper bound are implicitly from 0 to infinite; other bounds are described in square brackets between two points " .. " and behind the data type descriptor. The " * " stands for no limitation at upper bound.

Any text after a colon " : " is regarded as a comment.

For clear graphical presentation, lines in a coding box if they are too long to fit, are broken with a backslash “\” followed by a carriage return. The broken line restarts with an additional backslash.

Data type	Binary format definition																																																																								
BitArray	<p> <BitArray>:= $m * \langle \text{byte} \rangle [1..*];$ </p> <p> : Byte containing bits. MSB signals following bytes Bit set (= 1) signals logical true Bit not set (= 0) or not present signals logical false </p> <p> The bits in a BitArray are encoded in a sequence of bytes, where the first bit of each byte (MSB) is a continuation flag (marked as CF in the table below). If this bit is set (=1) there follows at least one more byte in this BitArray. The last byte always has the continuation flag not set (=0). A BitArray represents a list of Boolean values which is implemented in the same way as for all lists. The first byte holds bits numbered from zero to six in that order. The second byte holds bits numbered seven to 13, again in that order, and so on. </p> <p> The ordering is sequential from first bit (MSB) to last bit (LSB). </p> <p style="text-align: center;"> Table 1 — Binary format coding of BitArray </p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="8">Byte 0</th> <th colspan="8">Byte 1</th> <th colspan="2">...</th> </tr> <tr> <th colspan="2"></th> <th colspan="6">Bit number</th> <th colspan="2"></th> <th colspan="6">Bit number</th> <th colspan="2"></th> </tr> <tr> <th>CF</th> <th>0</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> <th>CF</th> <th>7</th> <th>8</th> <th>9</th> <th>10</th> <th>11</th> <th>12</th> <th>13</th> <th></th> <th>...</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p> If all bits after a certain bit in a BitArray are not set, the remaining bytes containing only unset bits may be removed. The continuation flag of the new last byte is set to false. Decoders shall interpret undefined bits as logical value false. </p> <p> EXAMPLE BitArray =05 hex: Bit 4 and bit 6 are set, the BitArray consists of only one byte (continuation flag not set). </p>	Byte 0								Byte 1								...				Bit number								Bit number								CF	0	1	2	3	4	5	6	CF	7	8	9	10	11	12	13		...																		
Byte 0								Byte 1								...																																																									
		Bit number								Bit number																																																															
CF	0	1	2	3	4	5	6	CF	7	8	9	10	11	12	13		...																																																								
Boolean	<p> The TPEG binary format knows three representations for Booleans. </p> <ul style="list-style-type: none"> — Mandatory Booleans are stored in the selector of a class — Multiple mandatory Booleans are stored in <MultipleBooleans> — Single, optional Booleans are stored in a table of type typ008:OptionalBoolean as defined in ISO 21219-2 <p> The default value of a Boolean is <i>false</i>. </p>																																																																								
DataStructure	<p> <DataStructure>:= : Name of data structure $\langle \dots \rangle,$: Content of data structure ...; </p>																																																																								
DateTime	<p> <DateTime>:= : Date and time $\langle \text{IntUnLo} \rangle;$: Number of seconds since 1970-01-01T00:00:00 Universal Coordinated Time (UTC) </p> <p> NOTE The formula for date and time calculation is given in ISO/TS 18234-2:2013, Annex D. </p>																																																																								