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BSI Standards Publication

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

Part 18: Traffic flow and prediction application (TPEG2-TFP)

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National foreword

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Part 18: Traffic flow and prediction application (TPEG2-TFP)

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Foreword

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and TISA 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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 204 *Intelligent transport systems*, in cooperation with the Traveller Information Services Association (TISA), TPEG Applications Working Group through Category A Liaison status.

ISO/TS 21219 consists of the following parts, under the general title *Intelligent transport systems — Traffic and travel information (TTI) via transport protocol expert group, generation 2 (TPEG2)*:

— *Part 2: UML modelling rules* [Technical Specification]

— *Part 3: UML to binary conversion rules* [Technical Specification]

— *Part 4: UML to XML conversion rules* [Technical Specification]

— *Part 5: Service framework* [Technical Specification]

— *Part 6: Message management container* [Technical Specification]

— *Part 7: Location referencing container* [Technical Specification]

— *Part 18: Traffic flow and prediction application* [Technical Specification]

The following parts are planned:

— *Part 1: Introduction, numbering and versions* [Technical Specification]

— *Part 9: Service and network information* [Technical Specification]

— *Part 10: Conditional access information* [Technical Specification]

— *Part 14: Parking information application* [Technical Specification]

— *Part 15: Traffic event compact application* [Technical Specification]

— *Part 16: Fuel price information application* [Technical Specification]

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— *Part 19: Weather information application* [Technical Specification]

— *Part 20: Extended TMC location referencing* [Technical Specification]

— *Part 21: Geographic location referencing* [Technical Specification]

— Part 22: *OpenLR·location·referencing* [Technical Specification]

— Part 23: *Roads·and·multi-modal·routes·application* [Technical Specification]

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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/WG 4, in conjunction with ISO/TC 204/WG 10, established a project group comprising members of the former EBU B/TPEG and they continued the work concurrently. 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 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

With the inauguration of the Traveller Information Services Association (TISA) in December 2007 derived from former Forums and the CEN/ISO development project group, the TPEG Applications Working Group took over development work for TPEG technology.

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 Parts 2, 3, 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.

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TPEG2 has a three container conceptual structure: Message Management (Part 6), Application (many Parts) and Location Referencing (Part 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:

Toolkit parts: TPEG2-INV (Part 1), TPEG2-UML (Part 2), TPEG2-UBCR (Part 3), TPEG2-UXCR (Part 4), TPEG2-SFW (Part 5), TPEG2-MMC (Part 6), TPEG2-LRC (Part 7)

Special applications: TPEG2-SNI (Part 9), TPEG2-CAI (Part 10)

Location referencing: TPEG2-ULR (Part 11), TPEG2-ETL (Part 20), TPEG2-GLR (Part 21), TPEG2-OLR (Part 22)

Applications: TPEG2-PKI (Part 14), TPEG2-TEC (Part 15), TPEG2-FPI (Part 16), TPEG2-TFP (Part 18), TPEG2-WEA (Part 19), TPEG2-RMR (Part 23)

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 Technical Specification is based on the TISA specification technical/editorial version number: TPEG2-TFP/1.0/003.

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

Part 18:
Traffic flow and prediction application (TPEG2-TFP)

1 Scope

This Technical Specification specifies the TPEG application Traffic Flow and Prediction (TFP). It has been specifically designed to provide information to a variety of receivers using different channels, including in the first instance Digital Broadcasting and Internet technologies. Traffic flow and prediction messages are intended for in-car applications and may be as well presented directly to the user by textual, voiced and graphically output devices.

TFP is status oriented, i.e. the transmitted information updates continuously the receiver's knowledge for a dedicated road network. In particular the traffic states are delivered any time and for all road sections of the network, even when there are no abnormal traffic situations.

Generally, TFP focuses on the following requirements:

— provide dynamic navigation systems with up-to-date traffic state information,

— ensure travel safety for the driver,

— enable the calculation of alternative routes,

— avoid delays (e.g. traffic jams),

— lower traffic load on over-saturated parts of the network,

— keep driver informed about current and upcoming traffic,

— compact and efficient coding of the traffic information.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 17572-1:2008, *Intelligent transport systems (ITS) — Location referencing for geographic databases — Part 1: General requirements and conceptual model*

ISO 17572-2:2008, *Intelligent transport systems (ITS) — Location referencing for geographic databases — Part 2: Pre-coded location references (pre-coded profile)*

ISO 17572-3:2008, *Intelligent transport systems (ITS) — Location referencing for geographic databases — Part 3: Dynamic location references (dynamic profile)*

ISO/TS 18234-1:2013, *Intelligent transport systems — Traffic and travel information via transport protocol experts group, generation 1 (TPEG1) binary data format — Part 1: Introduction, numbering and versions (TPEG1-INV)*

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ISO/TS 18234-6:2006, *Traffic and Travel Information (TTI) — TTI via Transport Protocol Expert Group (TPEG) data-streams — Part 6: Location referencing applications*

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

ISO/TS 21219-3, *Intelligent transport systems — Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) — Part 3: UML to binary conversion rules*

ISO/TS 21219-4, *Intelligent transport systems — Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) — Part 4: UML to XML conversion rules*

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

ISO/TS 21219-6, *Intelligent transport systems — Traffic and travel information via transport protocol experts group, generation 2(TPEG2) — Part 6: Message management container (TPEG2-MMC)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
Message Management Container
concept applied to the grouping of all message elements including Message Management Information of a TPEG-Message together in one place

3.1.2
Location Referencing
means to provide information that allows a system to accurately identify a location

Note 1 to entry: The content of a location reference allows the location to be presented in a graphical or textual manner to the end-user (e.g. coloured network graphs) as well as to be used for navigational systems purposes.

3.1.3
Location Referencing Container
concept applied to the grouping of all the Location Referencing elements, of a TPEG-Message, together in one place

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3.2 Abbreviated terms

ADC	Application Data Container
AID	TPEG Application ID
CEN	Comité Européen de Normalization
EBU	European Broadcasting Union
LRC	Location Referencing Container
MMC	Message Management Container
OSI	Open Systems Interconnection
SSF	TPEG Specification: Syntax, Semantics and Framing Structures
TPEG	Transport Protocol Expert Group
TTI	Traffic and Traveller Information
UML	Unified Modelling Language
XML	Extensible Markup Language
XSD	XML Schema Definition

4 Application specific constraints

Ordered Components

TPEG-TFP requires a fixed order of TPEG components. The order for the TFP message component is shown in Figure 1; the first component shall be the *Message Management Container.* This shall be the only component if the message is a cancellation message. Otherwise, the MMC component shall be followed by the *Application Data Container* component which includes the traffic flow information. This shall be followed by the *Location Referencing Container* component, if the LRC is present in this message (see also 6.1).

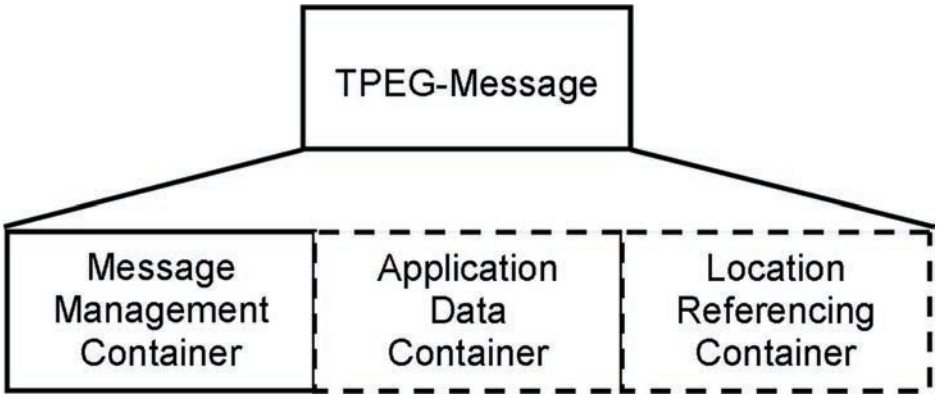

Figure 1 — Composition of TPEG messages

Extendibility

The requirement of a fixed component order does not affect the extension of TFP. Future application extensions may insert new components or may replace existing components by new ones without losing backward compatibility. That means a TFP decoder shall be able to detect and skip unknown components.

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For reasons of efficiency some data structures of TFP which may potentially require extensions in future are defined as TPEG *DataStructures* though these structures are not extensible in a backward compatible way. To ensure extensibility dedicated extension components are added to these DataStructures which may be used for future TFP extensions of TFP (DataStructures 'FlowVectorSection', 'StatusParameters', 'Restrictions', 'StatisticalParameters', see also 6.1).

TPEG Service Component Frame

TFP makes use of the "Service Component Frame with dataCRC, groupPriority, and messageCount" according to ISO/TS 21219-5.

Version number signalling

Version numbering is used to track the separate versions of an application through its development and deployment. The differences between these versions may have an impact on client devices.

For services basing on this TFP specification the following version numbers shall be signalled in the SNI:

— major version number 1

— minor version number 0

Application ID (AID)

The TFP application ID is assigned by ISO/TS 18234-1:2013. As this document requires some time for update with the recent AIDs it may not include all assigned AIDs. In this case, please contact TISA for further information.

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5 TFP Structure

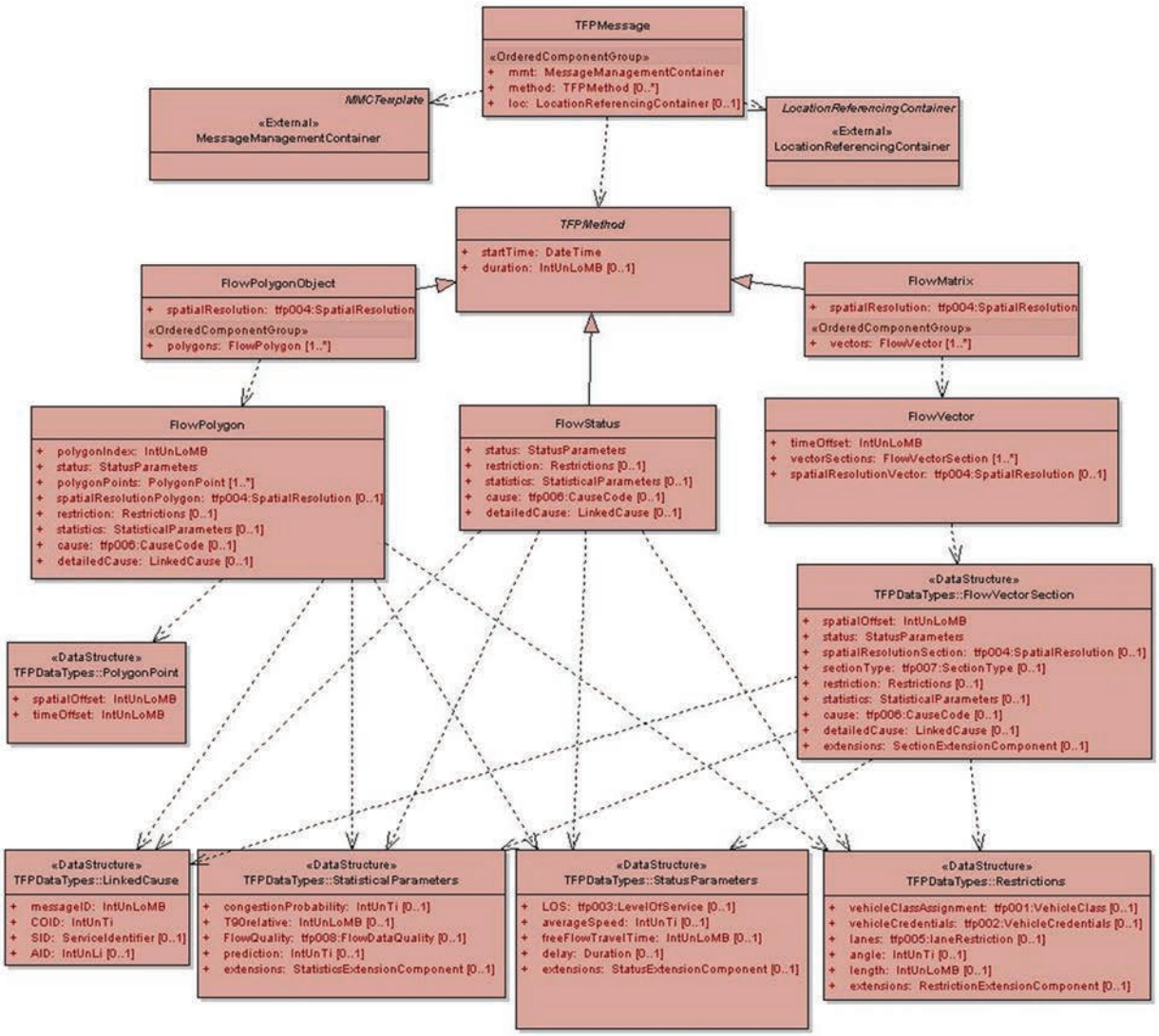

Figure 2 — UML Class Model of TPEG-TFP

6 TFP Message components

6.1 TFPMessage

A 'TFPMessage' component is the top container of a TFP message. It contains all information about a particular part of the network, for example the traffic state for a road segment.

The traffic flow content of a TFPMessage is typically highly dynamic while the affected road stretch defined by the Location Referencing Container (LRC) shall remain static during the life cycle of a message. Thus, partial message management (ISO/TS 21219-6) may be applied to update the traffic flow states of a message frequently whereas the LRC may be repeated with a longer repetition interval. Accordingly, a TFP message can include alternatively

— One MMC only in case of a cancellation message (ISO/TS 21219-6)

— One MMC, one or several ADCs and one LRC in case of monolithic message management (ISO/TS 21219-6):

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— Partial message management (ISO/TS 21219-6):

  — One MMC only, including the multipart message directory

  — One MMC and one or several ADCs

  — One MMC and one LRC

TFP provides three methods for the representation of current and predicted traffic flow states which may be used alternatively, i.e. just one method shall be applied within one TFP message:

— Flow-Polygon-Method: The traffic flow is modelled by a number of spatial/temporal 'FlowPolygonObjects' (see description of component 'FlowPolygonObject', 6.5).

— FlowStatus-Method: A flow status applied to the overall road stretch defined by the LRC of the message (see description of component 'FlowStatus', 6.7). A TFP message using this method and which is not a cancellation message shall contain exactly one 'FlowStatus' container.

— Flow-Matrix-Method: The road stretch is divided into sections each with a homogenous flow state, thus building a 'FlowVector'. A 'FlowMatrix' consists of one or several FlowVectors for dedicated temporal intervals, e.g. with one FlowVector for the current flow status and another one for prognosis in 15 min (see description of components 'FlowMatrix', 6.8). A TFP message using this method and which is not a cancellation message shall contain exactly one 'FlowMatrix' container.

To minimize the length of TFP messages the spatial positions of the Flow-Matrix and Flow-Polygon methods are coded by spatial offsets to the location reference in the LRC. These offsets shall be calculated in upstream direction to the end of the road stretch as defined by the location reference of the message (see also 6.3). The location reference in the LRC shall cover the entire road stretch required for this TFP message. The Flow-Matrix method allows also the usage of relative offsets (see 6.8).

The attributes of the 'TFPMessage' component are listed hereunder:

Name	Type	Multiplicity	Description
Ordered Components			
mmc	MessageManagementContainer (external)	1	Message Management Container
method	Component TFPMethod	0..*	Traffic flow data
loc	LocationReferencingContainer (external)	0..1	Location Referencing Container

6.2 MessageManagementContainer

The MessageManagementContainer is a placeholder for the MessageManagementContainer as defined in the MMC-toolkit specification (ISO/TS 21219-6). It assigns the Traffic Flow and Prediction application specific local component ID for the MMC container (see A.3.4).

This component contains all and only information related to message management. The TPEG server side, especially the instance generating the transmission data, has to ensure that the message management information allows unambiguous interpretation over time and in appropriate scenarios with disturbed reception specific to the transmission channel.

TFP implementations may use both monolithic and partial message management (ISO/TS 21219-6). A TPEG service may contain messages with both MMC methods but it shall be used alternatively for a particular message, i.e. a dedicated message shall not be transmitted with an alternating partial/monolithic MMC.

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6.3 LocationReferencingContainer

The LocationReferencingContainer component is a placeholder for the LocationReferencingContainer (LRC) as described in the LRC toolkit specification (ISO/TS 18234-6:2006). It assigns the Traffic Flow and Prediction (TFP) application specific local component ID for the LRC container (see also A.3.5). All component IDs within the LRC container are local to the LRC toolkit

The location of a TFP message (e.g. a road stretch) may be quite stable where the related traffic flow values may change dynamically. Thus, the LRC may not be required in each version of the message. The MMC Partial Update mechanism if the LRC is not present in a TFP message the receiver shall use the LRC of the most recently received message with the same Message ID (MID) for determining the location. Accordingly, the sender side shall use a new message ID if the location respectively the LRC is changed.

The LRC component contains all information describing the location where the situation described in TFP is taking place. TFP shall use only linear locations to define the road stretch affected, but no area or point locations.

The **end of the LRC location** (in driving direction) defines the **Spatial Reference Point**. Based on this Reference Point offsets are used to dedicated points on the road stretch, e.g. Polygon Points (see description of the Flow-Polygon-Method, 6.5) or delimiters of road sections (see description of the Flow-Matrix-Method, see 6.8).

If TMC location referencing (ISO 17572-3:2008) is used in the LRC, the Spatial Reference Point shall be always the Primary Location. As the TMC Primary Location defines only an intersection and is thus not very accurate the following convention shall be applied in TFP for TMC locations (see also Figure 3):

It is strongly recommended that TFP services use only one-directional but no bi-directional location references.

As TFP uses linear locations only the TMC extent defining the secondary location shall be greater than 0.

The Spatial Reference Point for TMC locations is the position on the road stretch where the last entry or exit in driving direction is entering or leaving the road stretch (see Figure 3 below).

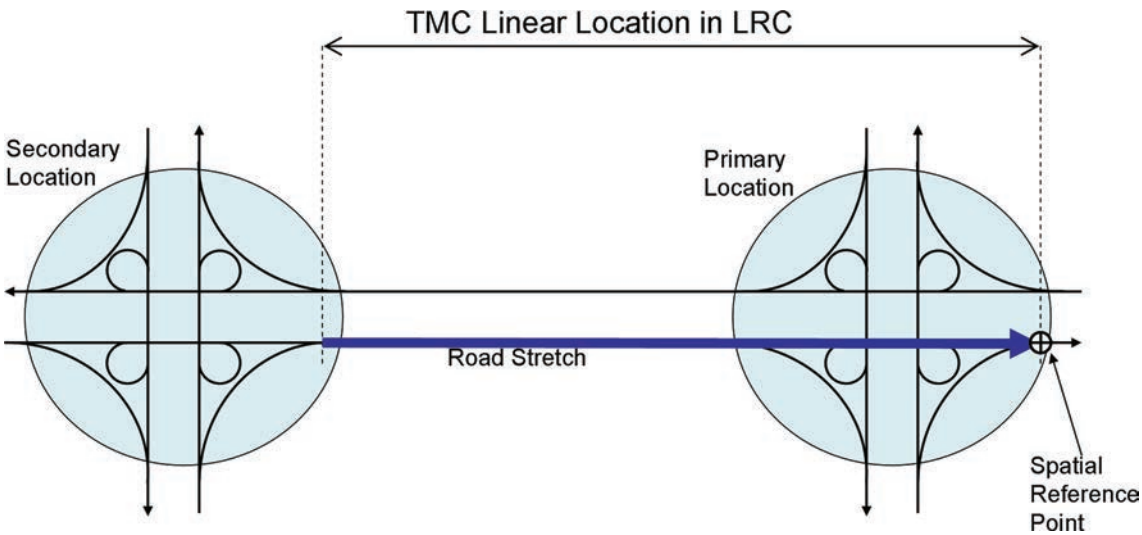

Figure 3 — Application of TMC location references in TFP

6.4 TFPMethod

Traffic conditions are modelled as traffic flow objects. TFP provides three different methods to define such an object, for details see descriptions of components 'FlowPolygonObject' (see 6.5), FlowStatus' (see 6.7) and FlowMatrix' (see 6.8).

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The template 'TFPMethod' is the generalization of these three methods.

Name	Type	Multiplicity	Description
startTime	DateTime	1	The start of the time period for which the provided content is valid.
duration	IntUnLoMB	0..1	The duration [min] of the time period for which the provided content is valid. The period starts at 'startTime' and ends at 'start-Time'+'duration'. This attribute shall be used by the 'PolygonFlow-Object' component and may be used if required otherwise.

6.5 FlowPolygonObject

The Flow Polygon method describes the traffic situation within the network by a number of 'FlowPolygonObjects'. Each of these objects defines a spatial and temporal area with critical or congested conditions, whereas the rest of the considered road network is assumed to be in a free-flow state (see Figure 4 below).

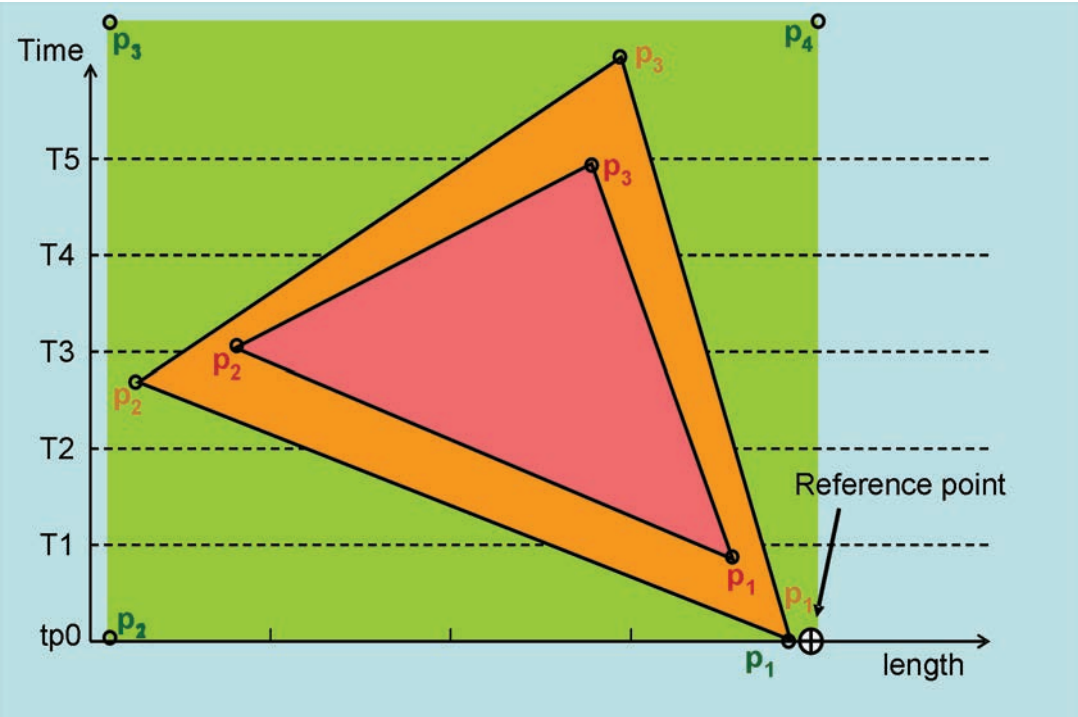

Figure 4 — Example of a Flow Polygon Object with 2 Flow Polygons

A particular 'FlowPolygonObject' consists of a set of nested 'FlowPolygons'. A Flow Polygon represents a distinct traffic flow state within a spatial and temporal area surrounded by a polygon, which is defined by a vector of 'PolygonPoints'. For reasons of efficiency, these polygon points are using offset information:

— spatial offsets to the end of location reference related to the message (Spatial Reference Point)

— temporal offsets to the start-time defined by the 'validityPeriod' of the surrounding 'FlowPolygonObject'

The following requirements shall be fulfilled for the construction of the FlowPolygonObjects:

— Within a 'FlowPolygonObject' a traffic flow state related to a 'FlowPolygon' shall 'overwrite' in its temporal/spatial area the traffic status of a Flow Polygon with a lower value of the attribute 'polygonIndex' (e.g. in figure above the red polygon overrides the orange one).

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— For that, the Flow Polygons of a Flow Polygon Object shall be ordered from 'outer to inner', i.e. the temporal/spatial area covered by the Flow Polygon with polygonIndex A shall be a sub-area of the Flow Polygon with polygonIndex B, if B is smaller than A (see also definition of component 'FlowPolygon').

— Only convex Flow Polygons shall be used in TFP, i.e. very internal angle of the surrounded area is less than 180 degrees.

— The vector of 'PolygonPoints' of a 'FlowPolygon' shall be ordered in clockwise direction starting with Polygon Point with the minimum value of attribute 'timeOffset'.

Name	Type	Multiplicity	Description
startTime	DateTime	1	See 6.4
duration	IntUnLoMB	0..1	See 6.4; this attribute shall be present in the 'FlowPolygon-Object' component as it is required for the temporal interval flow polygon
spatialResolution	tfp004: SpatialResolution	1	Resolution of the spatial offset used in this structure in steps of 10/50/100/500 m or TMC-locations. This spatial resolution value shall be used for all spatial offsets in the embedded 'FlowPolygon' components if not overridden there by the corresponding attribute 'spatialResolutionPolygon'. Relative spatial offsets (table entries 5 and 6) shall not be used.
polygons	Component FlowPolygon	1..*	Flow polygon data; see 6.6

6.6 FlowPolygon

A 'FlowPolygon' includes a spatial/temporal area with a consistent traffic flow status.

Name	Type	Multiplicity	Description
polygonIndex	IntUnLoMB	1	Unique within related 'FlowPolygonObject'. Used for ordering the FlowPolygons within the 'FlowPolygonObject' (see 6.5).
status	StatusParameters	1	Attributes describing the traffic flow status within the polygon
polygonPoints	PolygonPoint	1..*	Vector with polygon points
spatialResolutionPolygon	tfp004: SpatialResolution	0..1	Resolution of the spatial offset used for this polygon, in steps of 10/50/100/500 m or TMC-locations. The value of this attribute - if present - overrides for this FlowPolygon the attribute value 'spatialResolution' of the related 'FlowPolygonObject' component. Relative spatial offsets (table entries 5 and 6) shall not be used.
restriction	Restrictions	0..1	Information on restrictions related to the reported information
statistics	StatisticalParameters	0..1	Statistical information related to the reported flow status
cause	tfp006: CauseCode	0..1	A simple cause for the reported traffic flow status may be added by this attribute; this parameter should be omitted if a detailed cause is available by an external message (see attribute 'linked cause')
detailedCause	LinkedCause	0..1	A detailed cause may be reported by a linked message (e.g. a TEC-message)

6.7 FlowStatus

The 'FlowStatus' component includes the information about the traffic flow status at a dedicated location defined by the LRC and for a distinct time interval.

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