Traffic Feed Format (TraFF)

Version 0.7

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Version History

Version	Date	Author	Comment
0.1	2018-01-18	Michael von Glasow	Initial specification
0.2	2018-06-30	Michael von Glasow	Added platform specifics Revisited TMC conversion Added area-specific queries and subscriptions as features for future versions
0.3	2018-08-11	Michael von Glasow	Added official DNS domain name
0.4	2018-10-06	Michael von Glasow	Moved reserved events `RESTRICTION_CONTRAFLOW`, `RESTRICTION_LANE_BLOCKED`, `RESTRICTION_LANE_CLOSED`, `RESTRICTION_REDUCED_LANES` and reserved quantifier `q:ints` to official specification
0.5	2018-10-22	Michael von Glasow	Changed unit of `length` attribute (`event` element) to meters
0.6	2018-10-27	Michael von Glasow	Added CC-BY-SA 4.0 license
0.7	2018-12-19	Michael von Glasow	Added requirement for resilience against messages being missed by consumers Added Message Expiration Clarified semantics of `event.speed` Corrected example for `q_time` use Changed quantifier attribues from `q:*` to `q_*`

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1 Introduction

This specification was created out of the desire to have a universal “hub” for traffic news, capable of aggregating traffic reports from multiple sources and delivering them to applications. Such sources include as TMC, various online sources or crowdsourcing platforms. In the latter case, the data format is intended to be used both for reports sent by individual contributors to a central platform and for aggregated feeds delivered by that platform to its users. Uses may include:

- Offline navigation systems, which consider the current traffic situation when calculating routes
- Traffic maps with a color visualization of the traffic situation
- Long-term analysis to develop a forecast model for traffic density

Various formats were studied, but none was found to be sufficient for the intended purpose.

XML- or JSON-based formats, such as those used by Bing[i] or Waze[ii], have the advantage of relying upon well-established data formats. Parsers are widely available, and the raw data is easily parseable by humans. Feeds are self-contained, requiring no external data to interpret them. Locations can be encoded in a variety of formats, ultimately by means of coordinates. The data format is carrier-agnostic, allowing it to be transferred over a variety of channels. Bandwidth requirements are moderate, allowing their use over a narrow-band Internet connection (e.g. EDGE or dial-up). However, machine parseability of events is mediocre, as vital parts of the information are given in textual form: some aspects of the information cannot easily be transferred into a form which applications can utilize, and presentation to the user is limited to the language the announcements are written in.

TMC was designed to be used over unidirectional links with highly limited bandwidth, and a complete message can be encoded in as few as 21 bits. As there is no way to transmit prose descriptions, events and their locations are transmitted as identifiers, which the receiving end translates into human-readable descriptions using lookup tables. As a result, messages are completely machine-parseable. The downside is that lookup tables are required on the receiver side to decode both the events and their locations. For events this is less of an issue: the event table covers a wide range of events, including even codes for bull fights and air raids, currently using 1552 out of 2047 possible codes, is fairly static and detail can be added by combining multiple events in a single message.

Locations, however, are subject to serious constraints: each country has a separate location table; sometimes different services for the same country use different location tables. Availability of location tables varies greatly: some are freely downloadable, others require signing a contract imposing narrow restrictions on usage, while yet other services are commercial or semi-commercial and release their location tables only for a one-off or per-device royalty. Some countries have no TMC service at all and therefore lack TMC location tables. Locations which are not in the location table cannot be represented, and location tables typically cover only the main road network.

Additionally, the data format itself is bound to RDS as the carrier medium, relying on certain items of information from RDS (such as the country code).

The encoding presents some anomalies and redundancies: for instance, each event in a multi-event message has its own urgency, directionality and potentially parameters for speed and queue length, requiring a set of rules to resolve contradictory information between multiple events in a multi-event message. The event table has many “convenience codes” which could easily be substituted by adding more events, a quantifier, supplementary information, queue length and/or a speed limit to the message. These were probably introduced in order fit some commonly-used combinations into a single RDS group, sacrificing orthogonality for transmission efficiency.

Bing, Waze	**TMC**
• Well-established data formats (XML, JSON), parsers widely available • Raw data easily parseable by humans • Self-contained feeds (no external data required to interpret) • Carrier-agnostic data format	• Custom, complex binary format, requiring custom parser • Raw data difficult to parse by humans • Feeds require external lookup tables (events, locations) to interpret • Data format bound to carrier medium • Data format allows for anomalies • Redundant event codes
• Moderate bandwidth requirements (EDGE, dialup) • Any location can be encoded • Not all information can be parsed as details are in prose only • Few parseable event codes • Presentation to user bound to language in which announcement is written	• Low bandwidth requirements (~100 bytes/sec) • Only predefined locations can be encoded • Fully machine-parseable (all information encoded) • Large number of event codes, multiple event codes per message allowed • Presentation can be in any language

TraFF aims to eliminate these shortcomings and take the best of both worlds:

- Well-established data format for which parsers are widely available and which is easily parseable by humans in raw form
- Minimal reliance on external data for interpretation; where such data is required, it shall be as static as possible
- Carrier-agnostic data format with moderate bandwidth requirements
- Fully parseable event information with high level of detail, allowing presentation in any language suported by the target application
- Support for encoding of arbitrary locations, without relying on a set of predefined locations

The approach chosen is essentially based upon the following principles:

- Use the TMC data model as a starting point
- Encode data in XML
- Resolve event codes into mnemonics
- Where multiple semantically equivalent codes exist that differ only in an explicit or implied quantifier, combine them into one and make the quantifier a parameter
- Instead of location codes, use locations based on coordinates
- Eliminate anomalies

2 Concepts

2.1 Source

A TraFF source gathers and aggregates traffic reports and broadcasts feeds of TraFF messages. Possible examples are:

- A TMC receiver which receives traffic reports from different radio stations and converts them into TraFF messages
- A client for a crowdsourced service which receives reports from other users (either directly or through an aggregator) and supplies aggregated TraFF messages to applications
- A client which receives traffic reports from an online source (city municipalities, highway operators) and forwards them to applications

Every source must have a unique identifier, with which it prefixes the identifiers of messages it emits. Nested source identifiers are possible: for example, if the source is a TMC receiver which picks up messages from different TMC services, it may prefix the resulting messages with its global identifier, followed by an identifier for the TMC service.

2.2 Transport

The TraFF data format aims to be transport-agnostic. Being an XML-based format with no explicit carrier dependencies, it is suitable for use over any connection which supports UTF encoded XML data. With an anticipated typical message size of around 800 bytes (the shortest messages being in the range of 400 bytes), message delivery rates of TMC can easily be exceeded with an analog modem or a 2.5G mobile data connection.

Possible transport mechanisms which have been considered are:

- The operating system's request broker architecture, such as D-Bus on Linux or Binder on Android
- A raw TCP connection
- HTTP (or HTTPS)

2.3 Feed

A feed is an aggregation of messages transmitted together.

Feeds can contain one or more messages. Single-message feeds are commonly used to pass individual messages as they are received, e.g. when messages are delivered in a continuous fashion via a broadcast-like channel. Multi-message feeds are used either when messages are received in bursts of two or more messages, or when querying the messages cached by an aggregator.

2.4 Message

A message is the atomic element of traffic information, referring to a particular condition at a given location. Examples:

- 1 km of stationary traffic on the A8/A9 before Barriera Milano Nord in northwestbound direction.
- L198 closed between Lech and Warth for at least the next day.
- Heavy snowfall in the area of Vilnius.

Every message in TraFF is identified by an alphanumeric identifier which incorporates the identifier of the source from which the message originated. No two messages with the same identifier can exist at the same time.

After a message expires, its identifier can be re-used for a new message. If a message has been explicitly canceled or replaced, its identifier should not be re-used until the last expiration time ever associated with this ID has elapsed. This is to avoid confusing receivers which may have missed some updates and may therefore assume the old ID to still be valid.

2.5 Event and Event Class

An event refers to a condition, its cause or its effect. Examples:

- Queuing traffic
- Road closure
- Accident

A message may contain multiple events. For example, if a road is closed due to an accident, the message would report events for an accident and a road closure.

Similar events may be grouped into event classes, for example:

- Congestions: This class comprises various events for different types of congestion, such as heavy traffic, slow traffic or stationary traffic.
- Hazards: This class includes events such as objects on the road, nearby fires, unprotected accident areas or black ice.
- Restrictions: This includes closed lanes, complete road closures as well as temporary weight or size limits.

2.6 Supplementary Information

Supplementary information is extra information which can be added to an event. Multiple supplementary information items can be added to the same event. They are qualifiers, not events in their own right. Examples:

- Vehicle types to which a restriction applies
- Refinements to the position (e.g. in a tunnel, in the left lane)
- Instructions to drivers (e.g. avoid the area, approach with care)

2.7 Location and Directionality

Locations can take many shapes in a traffic report. For example:

Type	Example
Point	S16, at exit Landeck-West
Pair of points	A12, between Zams and Imst-Pitztal
Area	Rosenheim

At the minimum, they are represented by one or more coordinates. However, coordinates come with several constraints:

- Low accuracy: Some formats use a single point to represent multiple adjacent points in reality. For example, TMC generally represents motorway junctions as a single point, whereas physically they are really four distinct points (entry and exit in both directions).
- Different map data: The encoding and decoding end may work with different maps, on which coordinates for the same feature may differ slightly. The same issue arises when the

two sides use different versions of the same map: changed road layouts may be reflected in one map but not in the other.

TMC presents an additional challenge for ramps and connecting carriageways at motorway junctions: these are represented by a single coordinate pair (that of the junction). The fact that the message refers to the ramps rather than the motorway, as well as the ramps affected, must be inferred from event and/or supplementary information codes. The direction is expressed through the direction of the motorway.

For this reason, extra information should be included where applicable and available:

- Road class
- Road names and numbers
- Junction names and numbers
- Carriageways affected, if the message does not refer to the main carriageway

When matching a location to a map, data users should treat the above information as hints, not as hard requirements, as different map data on both ends may cause differences:

- Maps may disagree on the road class, or the road class may have changed
- Road names may be spelled differently (Via Rossi vs. Via Marco Rossi vs. Via Rossi Marco vs. Via privata Marco Rossi; Kowalskiego vs. ulica Kowalskiego; Jono Jonaičio gatvė vs. J. Jonaičio g.)
- Road numbers may differ in delimiters (A4 vs. A 4 vs. A-4), case differences (SS342DIR vs. SS342dir), use of prefixes (DK 8 vs. 8; FFB 11 vs. K FFB 11) or even different prefixes (A 8 vs. BAB 8); some sources even invent their own road numbers (TMC for local roads in Germany).

These possibilities need to be taken into account. Rather than opting for a “match or no match” decision, data users should establish criteria for ranking matches based on their quality.

Linear features, as well as points located on linear features, additionally have a directionality indicating the direction of travel to which the report applies. Directionality is expressed by an attribute marking the location as unidirectional or bidirectional. For unidirectional locations, the direction can be expressed in one of the following ways:

- Linear features have an inherent directionality, expressed by ordering the points in the order in which they are passed (i.e. from the end of the queue to the obstruction).
- For points located on linear features, the same can be achieved by two auxiliary points on the linear feature,

Illustration 1: A stretch of road running against the principal direction of the road

one situated before, the other after the target location (as seen in the direction of travel). One of these points may coincide with the target location. If map data is available, this can be achieved by picking two points adjacent to the target location on the line feature. When translating TMC events into TraFF, an offset in either direction can be used.

- A compass direction, such as “northbound”. However, this may be ambiguous in situations as the one shown in the illustration: the point lies on a stretch of the road whose direction is contrary to the general direction of the road. What is southbound with respect to the whole road is northbound with respect to the stretch between the two adjacent turns, and vice versa.
- A destination on the road, such as “towards Chur” or “towards Bellinzona”. While this is easy to turn into a human-readable indication, it is difficult to translate into a direction on a map. This is only possible with map data to translate the destinations into coordinates, and unless the road in question is tagged with a matching destination, the destination indication suffers from similar ambiguities as a compass direction.

Ring roads present additional challenges here:

- The concept of a compass direction has only local relevance. Global designators would be “clockwise” and “counterclockwise”, although this may be similarly difficult to establish in practice if the road has sharp turns.
- Destinations are equally challenging, as any destination on a complete ring road can be reached in either direction. A destination on a ring road is only meaningful when coupled with the constraint to follow the shorter route, although establishing the shorter of the two possible routes may consume a significant amount of computation resources in practice, and may still be ambiguous if the location and the indicated destination are at near-opposite positions of the ring road.
- Directionality on ring roads can be expressed by an auxiliary point located in the middle of the condition, i.e. between the two end points and not coinciding with either end point. This results in three points and an order in which they are encountered, which unambiguously specifies the direction.
- The concept of a middle point will not work when converting from a service which relies on a location table (as TMC does) if the end points of the location are immediate neighbors, with no point in between which could serve as the middle point. This could be resolved by specifying a point located either before or after the location endpoints, resulting in three points to be passed in a particular order. In fact, it is not even necessary to specify whether the auxiliary point is encountered *before* or *after* the location, as the order of points will always be *auxiliary—start—end—auxiliary*. In other words, the auxiliary point is simply a point which does *not* lie within the location.
- An auxiliary point outside the location is subject to the same constraints as a middle point. However, one of the two will always be well-defined as long as the road has at least three points. Ring roads with two points would break direction in TMC as well (as each point

would be the other point's neighbor in either direction) and therefore need not be considered.

- For point locations on ring roads, the direction is unambiguous if two auxiliary points (see above) are specified, along with the order in which a driver would encounter them.

Ultimately, it is advisable to rely on coordinates for directionality wherever possible. A destination or a compass direction may be added for easier representation in prose. In any case, these should be avoided where ambiguous.

A minimum of two points is necessary to unambiguously specify a direction on a road; three points (along with their order) are needed to specify a direction on a ring road.

A more comprehensive system for location referencing, based on similar concepts but more elaborate, is OpenLR.[iii] Due to its complexity, it is not being considered for version 0.7 of this specification, although this may be revisited in future versions.

2.8 Fuzziness

The characteristics of different traffic services have an impact on the resolution and accuracy with which they can represent locations:

- Services such as TMC are constrained by their use of location tables, which are mostly limited to junctions between major roads. Where the actual location does not coincide with one of these, the shortest pair of predefined locations which completely encloses the condition is used instead, which may cause the extent of the condition to appear longer than it actually is.
- Crowdsourced services which rely on reports by drivers inherently suffer from incomplete information: for example, a driver who has just approached the end of a traffic jam will not know how far away the obstruction is. Conversely, a driver who has just passed the obstruction has likely spent a significant amount of time in the queue and thus no longer knows how long the queue is, as it may have grown or shrunk while the driver was in it.

This is expressed by the fuzziness. The following constraints must be identifiable:

- Low resolution
- Start and/or end of condition unknown

2.9 Route Length

In prose, it is common to give reports like "8 km of stationary traffic between Kostomłoty and Kąty Wrocławskie". TMC messages may also specify the length of the route affected, which allows for a higher granularity than the location database alone.

This typically conflicts with the inherent length of the location itself (i.e. the distance between its start and and point, or zero for a point location). TMC requires that the end points should fully enclose the location, thus their distance will always be larger than the route length.

Route length interpretation is based on two considerations:

- Be compatible with TMC: A pair of points with a length is to be interpreted in the same manner as in TMC.
- Reflect actual traffic development: In most cases, the location of the obstruction is fixed while the tail of the queue (where drivers would encounter the condition) can vary over time. Therefore, the former should be determined based on coordinates given and the latter calculated based on route length.

This results in the following rules:

- For a point location, the length indicates a stretch of road through which traffic would reach the location. A point location with a route length thus effectively becomes a point-to-point location whose end (the obstruction) coincides with the given coordinates; its start (where drivers would first encounter the condition) is implied by the route length.
- For a point-to-point location longer than the indicated length, the affected section may be located anywhere within that location.
- For a point-to-point location shorter then the indicated length, the start (where a driver would first encounter the condition) is to be inferred from the end coordinates and the route length; the start coordinates should be ignored.

2.10 Updates, Cancellations and Mergers

Messages may need to be updated as the traffic situation changes: accidents are cleared, the weather changes, queue length increases or decreases, to name just a few examples. Updates are regular messages, subject to the same format. They repeat all elements of the original message which are not being changed. Since messages are referred to by their ID, a new message replaces any previous message with the same ID.

A receiver has no way of telling if a particular message is an update or a new message other than by looking at previously stored messages. If an update is sent, one receiver may have the previous message in memory and treat the update as an update, while another receiver may have started listening after the previous message was sent and treat the message as a new message.

Cancellations are sent in a similar way: they use the same message format but use a special attribute to indicate cancellation; no location or events are included in the message. Upon receiving a cancellation message, receivers shall delete the original message from memory and may perform additional steps (such as recalculating a route). If the original message is not found, receivers shall silently discard the cancellation message.

Crowdsourced services in particular have a need for a merge operation: Consider an accident on a motorway which causes a queue extending beyond the last junction before it. One driver approaches the end of the queue on the motorway, while another enters the motorway at the junction. Each driver sends a congestion report with a different location, and as it is not clear initially that both are referring to the same condition, two distinct messages exist. At a later time, a driver observing the

congestion from the opposite carriageway sends a report with the full length of the congestion. Now up to three messages with distinct identifiers exist, which are known to refer to the same condition and thus need to be merged.

A merge operation is similar to an update: it is a full message (including a location and an event list) but additionally contains references to the messages it replaces. The merge message may have a new identifier or inherit the identifier of one of the messages to be merged together. The merge message may at the same time be a cancellation message, cancelling multiple messages at once.

The architecture of TraFF does not guarantee that every consumer will always receive the entire sequence of updates. There are many reasons why a consumer might miss individual updates to a message and keep the stale message in memory. The design of TraFF neds to take this into consideration. Specfically, consumers which have missed one or ore updates to a message must have correct and up-to-date information after receiving the next update.

2.11 Message Expiration

Messages have multiple ways of indicating the period for which they are to be considered valid:

- Each message can specify an `expiration_time` attribute. This timestamp should be considered a checkpoint, i.e. the source must send an update before that time. The condition, however, may last longer than the expiration time, in which case the attribute needs to be increased through updates. After the expiration time has elapsed (unless other attributes indicate the message is still current), the message and the condition it indicates should be considered outdated. Therefore, TraFF sources should choose the duration for this attribute with care: ideally, it should be in the range of the expected duration of the condition.
- Messages can specify a `start_time` and/or `end_time` attribute, indicating when a condition is expected to begin or end. This is typically used with planned events, such as construction work or roads closed for mass events. If one or both of these are given, the message shall not be considered to have expired until the latest of these has elapsed.
- When a message updates or replaces another (including cancellations), the new message should not expire before any of the messages it supersedes would have expired. Unless enforced through other attributes, the `expiration_time` attribute should be used to indicate this.

3 XML Structure

An example of a TraFF feed may look like this:

```
<feed>
  <message id="tmc:5.1.1:5.1.1327.n.1" receive_time="2017-02-15T21:01:28+01:00"
update_time="2017-02-15T21:07:00+01:00" expiration_time="2017-02-
15T21:22:00+01:00">
    <events>
      <event class="CONGESTION" type="CONGESTION_SLOW_TRAFFIC"/>
    </events>
    <location road_class="MOTORWAY" road_ref="A4" fuzziness="LOW_RES">
      <from junction_name="Trezzo">+45.59612 +9.50253</from>
      <to junction_name="Dalmine">+45.64412 +9.62081</to>
    </location>
  </message>
</feed>
```

3.1 `feed`

Required	Yes, for multi-message feeds
Definition	This is the root element of a multi-message feed. It encapsulates all the messages in the feed.
Attributes	None
Example	`<messages>...</messages>`
Subtags	`message`
Subtag of	Root tag

3.2 `message`

Required	Yes	
Definition	Encapsulates a single message. This is the root element of a single-message field.	
Attributes	`cancellation`	Boolean/Optional. `true` marks this message as a cancellation, indicating that existing messages with the same ID should be deleted or no longer considered current. All other attributes and subtags of a cancellation message should be ignored. Default is `false`.
	`end_time`	String/Optional. A timestamp in ISO8601 format indicating how long the condition is expected to last.
	`expiration_time`	String/Recommended if `end_time` is not specified. A timestamp in ISO8601 format indicating when the message will expire if not updated. An expired message should be deleted or no longer be considered current. If `end_time` is specified and is longer than `expiration_time`, `end_time` should be used to govern expiration and this attribute ignored. The expiration time governs how consumers will treat a message if they do not receive any further updates, e.g. because they lose the data connection. Sources should therefore choose the expiration time carefully: if a situation is not expected to resolve in a certain period of time, the expiration time should not be shorter. Conversely, if a situation is likely to have resolved within a certain period of time, the expiration time should not be longer than that.
	`forecast`	Boolean/Optional. If `false`, the message describes a current situation. If `true`, it describes an expected situation in the future. Default is `false`.

	`id`	String/Required. An identifier, which remains stable over the entire lifecycle of the message. The colon (`:`) is a reserved character to separate different levels of source identifiers from each other and from the local message identifier.
	`receive_time`	String/Required. A timestamp in ISO8601 format indicating at what time the message was first received by the source. Sources are expected to keep this attribute stable across all updates.
	`start_time`	String/Optional. A timestamp in ISO8601 format indicating when the condition is expected to begin.
	`update_time`	String/Required. A timestamp in ISO8601 format indicating at what time the last update to this message was received by the source.
	`urgency`	String/Recommended. One of `NORMAL`, `URGENT` or `X_URGENT`. This allows the consumer to decide how the message should be presented to the user. `X_URGENT` messages should be presented immediately, `URGENT` messages may be delayed and `NORMAL` messages may not need to be presented at all (e.g. for delays, it is sufficient to route the driver around them). If omitted, `NORMAL` shall be assumed.
Example	`<message id="tmc:5.1.1:5.1.1327.n.1" receive_time="2017-02-15T21:01:28+01:00" update_time="2017-02-15T21:07:00+01:00" expiration_time="2017-02-15T21:22:00+01:00">...</message>`	
Subtags	`merge`, `events`, `location`	
Subtag of	`feed` for multi-event feeds, root tag for single-event feeds	

3.3 `merge`

Required	No
Definition	Denotes this message as a merge message and lists all messages which it replaces.
Attributes	None
Example	`<merge>...</merge>`
Subtags	`replaces`
Subtag of	`message`

3.4 `replaces`

Required	No	
Definition	A reference to another message which is replaced by this message. One element must be included for each message to be replaced. If a merge operation retains one of the original message identifiers, that message is not listed here.	
Attributes	`id`	String/Required. The identifier of a message which is replaced by the current message.
Example	`<replaces id="foo:user5552878:45.64412N9.62081E"/>`	
Subtags	None	
Subtag of	`merge`	

3.5 `location`

Required	Yes, except for cancellation messages

Definition	Encapsulates the location data for the message. As of version 0.7, a location cannot span multiple roads, i.e. at least one of the following must be true: • the road number remains unchanged throughout the location, • the road name remains unchanged throughout the location, • the stretch of road to which the location refers must not connect to any other road of the same or a higher category. Some sections are shared by multiple roads and bear multiple road numbers. They are considered as belonging to either road and may be referenced by either number. A location may at the same time span a shared section and no more than one of the roads it belongs to, and reference them with the respective road number.	
Attributes	`destination`	String/Optional for monodirectional locations, forbidden for bidirectional locations. A destination, preferably the one given on road signs, indicating that the message applies only to traffic going in that direction (e.g. “Milano”, “München”, “Vilnius”).
	`direction`	String/Optional for monodirectional locations, forbidden for bidirectional locations. A compass direction indicating the direction of travel to which this message applies (e.g. “N”, “SE”). Discouraged for ring roads (including partial ring roads) or for sections which significantly deviate from the principal direction of the main road.
	`directionality`	String/Recommended. One of `ONE_DIRECTION` or `BOTH_DIRECTIONS`. If omitted, `BOTH_DIRECTIONS` shall be assumed.
	`fuzziness`	String/Required where applicable. Permissible values: • `LOW_RES`: Locations are constrained to a predefined table; the actual extent of the condition may be shorter than indicated. • `END_UNKNOWN`: The end of the condition (where drivers leave the affected stretch) is unknown, as is typical for a report by a driver who has just encountered the end of a traffic jam. • `START_UNKNOWN`: The start of the condition (where drivers would first encounter it) is unknown, as is typical for a report by a driver who has just passed an obstruction. • `EXTENT_UNKNOWN`: It is unknown where the condition begins and ends, as is typical for a driver who is in the middle of a traffic jam.
	`ramps`	String/Required where applicable. Permissible values: • `ALL_RAMPS`: Affects the entry and exit ramps only. • `ENTRY_RAMP`: Affects the entry ramp only. • `EXIT_RAMP`: Affects the exit ramp only. • `NONE`: No ramps are affected. Default is `NONE`, indicating that the message refers to the carriageways of the main road. Any of the other values imply that *only* the specified ramps are affected while the main road is not. Note that if any value other than NONE is used, the `road_*` attributes refer to the main road served by the ramp, not the ramp itself. This is mainly intended for compatibility with TMC, where junctions with all their ramps are represented by a single point. Other sources should use coordinate pairs instead.

	`road_class`	String/Recommended. The importance of the road within the road network, which roughly corresponds to the OpenStreetMap classification. One of: • `MOTORWAY`: Part of the motorway network, usually with segregated carriageways, no level crossings and restricted to motor vehicles. • `TRUNK`: The highest tier of non-motorway roads, may or may not be expressways with segregated carriageways. • `PRIMARY`: The next tier within the road network, often linking larger towns. This is often the lowest level of the national road network if `TRUNK` is used for expressways. • `SECONDARY`: The next tier, often linking towns or quarters of towns and often no longer part of the national road network but regionally administered. • `TERTIARY`: The next tier, often linking smaller towns and villages or neighborhoods within a town and often the lowest tier for numbered roads. • `OTHER`: Any road that does not fit into this classification.
	`road_is_urban`	Boolean/Recommended. Indicates whether the road is in a built-up area (this information is used by some data models).
	`road_name`	String/Recommended. A road name (e.g. “Savanorių prospektas”, “Viale Certosa”, “Wasserburger Landstraße”). Do not use this attribute if the road name is not consistent throughout the entire location.
	`road_ref`	String/Recommended. A road number (e.g. SP526). Do not use this attribute if the road number is not consistent throughout the entire location.
Example	`<location directionality="ONE_DIRECTION">...</location>`	
Subtags	`from`, `to`, `at`, `via`, `not_via`, `polyline`	
Subtag of	`message`	

3.6 `from`

Required	Yes, for linear features and directional point locations on ring roads. For directional point locations on non-ring roads, either `from` or `to` must be specified along with `at`. Future versions of the specification may introduce other representations for geometries and relax the requirement for this element.	
Definition	The starting point of the location, i.e. the coordinates at which the driver would first encounter the condition reported. If `at` is specified, this element merely serves to indicate the direction, and the condition is limited to the point described by `at`.	
Attributes	`junction_name`	String/Recommended where applicable. The name of a motorway junction (e.g. “Lainate”).
	`junction_ref`	String/Recommended where applicable. The number of a motorway junction (e.g. 42).
Example	`<from junction_name="Trezzo">+45.59612 +9.50253</from>`	
Subtags	None	
Subtag of	`location`	

3.7 `to`

Required	Yes, for linear features and directional point locations on ring roads. For directional point locations on non-ring roads, either `from` or `to` must be specified along with `at`. Future versions of the specification may introduce other representations for geometries and relax the requirement for this element.

Definition	The end point of the location, i.e. the coordinates at which the driver would encounter the end of the condition reported. If `at` is specified, this element merely serves to indicate the direction, and the condition is limited to the point described by `at`.	
Attributes	`junction_name`	String/Recommended where applicable. The name of a motorway junction (e.g. “Lainate”).
	`junction_ref`	String/Recommended where applicable. The number of a motorway junction (e.g. 42).
Example	`<to junction_name="Dalmine">+45.64412 +9.62081</to>`	
Subtags	None	
Subtag of	`location`	

3.8 `at`

Required	Yes, for point locations. For directional point locations on non-ring roads, either `from` or `to` must be specified along with `at`. For directional point locations on ring roads, all of `from`, `at` and `to` must be specified and no two points may coincide.	
Definition	The coordinates of the condition reported. If `from` and/or `to` are specified, they merely serve to indicate the direction, and the condition is limited to the point described by `at`.	
Attributes	`junction_name`	String/Recommended where applicable. The name of a motorway junction (e.g. “Lainate”).
	`junction_ref`	String/Recommended where applicable. The number of a motorway junction (e.g. 42).
	`radius`	Not part of version 0.7 of the specification, reserved for future use.
Example	`<at junction_name="Dalmine">+45.64412 +9.62081</at>`	
Subtags	None	
Subtag of	`location`	

3.9 `via`

Required	Either `via` or `not_via` must be present for linear locations on ring roads. Both `from` and `to` must be specified along with `via`. Do not use for point locations.	
Definition	A location on the way between `from` and `to`, indicating the direction of a ring road to which the message applies.	
Attributes	`junction_name`	String/Recommended where applicable. The name of a motorway junction (e.g. “Lainate”).
	`junction_ref`	String/Recommended where applicable. The number of a motorway junction (e.g. 42).
	`radius`	Not part of version 0.7 of the specification, reserved for future use.
Example	`<via junction_name="Dalmine">+45.64412 +9.62081</at>`	
Subtags	None	
Subtag of	`location`	

3.10 `not_via`

Required	Either `via` or `not_via` must be present for linear locations on ring roads. Both `from` and `to` must be specified along with `via`. Do not use for point locations.

Definition	A location on the way between `from` and `to`, indicating the direction of a ring road to which the message applies.	
Attributes	`junction_name`	String/Recommended where applicable. The name of a motorway junction (e.g. “Lainate”).
	`junction_ref`	String/Recommended where applicable. The number of a motorway junction (e.g. 42).
	`radius`	Not part of version 0.7 of the specification, reserved for future use.
Example	`<not_via junction_name="Dalmine">+45.64412 +9.62081</at>`	
Subtags	None	
Subtag of	`location`	

3.11 `polyline`

Not part of version 0.7 of the specification, reserved for future use.

Required	Yes, for bidirectional locations and linear features, unless `from` and `to` are used
Definition	The course of the location, from the coordinates at which the driver would first encounter the condition reported to the coordinates at which the driver would encounter its end. The location is assumed to approximately follow an uninterrupted line from one coordinate pair to the next. It is permissible to simplify geometries by omitting points in between, as long as it is still possible to unambiguously reconstruct the route on a map. It is recommended to: • Retain one point for each intersection with another road (except in cases where all intersecting roads are dead ends). • Retain points at noticeable turns in the road so that the geometry of the road is well represented. This ensures compatibility with later versions of the map in which intersections may have been added.
Attributes	None
Example	`<polyline>+45.67781 +9.01643 +45.62333 +9.01344 +45.57642 +9.00929</polyline>`
Subtags	None
Subtag of	`location`

3.12 `events`

Required	Yes, except for cancellation messages
Definition	Encapsulates the events for the message
Attributes	None
Example	`<events>...</events>`
Subtags	`event`
Subtag of	`message`

3.13 `event`

Required	Yes	
Definition	Describes a single event, such as the cause of a disruption or its impact on traffic, in machine-parseable form.	
Attributes	`class`	String/Required. The event class (generic category).

	`length`	Integer/Optional. The length of the affected route in meters.
	`probability`	Not part of version 0.7 of the specification, reserved for future use. Integer/Optional for forecast events, forbidden otherwise. The probability in percent for the forecast (common in weather forecasts).
	`q_*`	Variant/Optional. Additional quantifier for events allowing this. Permissible data types and their meanings depend on the event type.
	`speed`	Integer/Optional. The speed at which vehicles can expect to pass through the affected stretch of road. This can either be a temporary speed limit or the average speed in practice: some events imply a particular interpretation; otherwise it refers to the lower of the two speeds.
	`type`	String/Required. The event type, which uniquely identifies the event and can be mapped to a string to be displayed to the user.
Example	`<event class="CONGESTION" type="CONGESTION_SLOW_TRAFFIC"> ...</event>`	
Subtags	`supplementary_info`	
Subtag of	`events`	

3.14 `supplementary_info`

Required	No	
Definition	Adds supplementary information to an event, such as vehicles or places to which the event applies, warnings or instructions.	
Attributes	`class`	String/Required. The supplementary information class (generic category).
	`q_*`	Variant/Optional. Additional quantifier for supplementary information types allowing this. Permissible data types and their meanings depend on the type.
	`type`	String/Required. The supplementary information type, which can be mapped to a string to be displayed to the user.
Example	`<supplementary_info class="..." type="..."/>`	
Subtags	None	
Subtag of	`event`	

4 Event Classes and Events

Version 0.7 of the TraFF specification defines the following event classes:

`CONGESTION`	Traffic congestion, typically indicating the approximate speed
`DELAY`	Delays (not necessarily related to road traffic), typically indicating the amount of extra waiting time
`RESTRICTION`	Temporary traffic restrictions, such as road or lane closures or size, weight or access restrictions

In the following tables, the F column (where present) marks events which can only be used in messages whose `forecast` attribute is `true`.

Text in angle brackets <> refers to a quantifier, speed or length of route attribute which is commonly used with the event. Such values are always optional.

4.1 Events in the `CONGESTION` Class

This class has different event types for different degrees of congestion, giving an indication of average speed:

- Heavy traffic, traffic [much] heavier than normal, (ES: tráfico verde, DE: reger Verkehr, [sehr viel] dichterer Verkehr als normal): Road is close to saturation. Ability to change lanes is somewhat restricted but average speed is close to the posted limit.
- Slow traffic (ES: tráfico amarillo, DE: dichter Verkehr): Capacity of the road is reached. Speed may vary rapidly and rarely reaches normal speed. Average speed is significantly lower than the posted limit but traffic is still moving.
- Queue (ES: tráfico rojo, DE: stockender Verkehr): Average speed 10–30 km/h.
- Stationary traffic (ES: tráfico rojo, DE: Stau): Average speed is less than 10 km/h.
- Long queues (ES: tráfico retenido, DE: lange Staus): Significant periods of standstill in which drivers turn off their engines and some leave their vehicles.
- Congestion (ES: congestión, DE: Verkehrsstörung): Generic category covering all of the previous four. Speed is significantly lower than the posted limit, anywhere between steadily moving traffic and long standstills. This event should be used when no accurate quantification is possible (as in the case of drivers observing a congestion without being in it, typically in the opposite direction of a dual-carriageway road).

If an explicit `speed` attribute is given, it takes precedence over the speed implied by the event. However, sources should keep the event consistent with the reported speed.

Label	F	Description
`CONGESTION_CLEARED`		Traffic congestion cleared
`CONGESTION_FORECAST_WITHDRAWN`	F	Traffic congestion forecast withdrawn
`CONGESTION_HEAVY_TRAFFIC`		Heavy traffic with average speeds of <`speed`>
`CONGESTION_LONG_QUEUE`		Long queues with average speeds of <`speed`>
`CONGESTION_NONE`		No problems to report
`CONGESTION_NORMAL_TRAFFIC`		Traffic has returned to normal
`CONGESTION_QUEUE`		Queuing traffic with average speeds of <`speed`>
`CONGESTION_QUEUE_LIKELY`		Danger of queuing traffic with average speeds of <`speed`>
`CONGESTION_SLOW_TRAFFIC`		Slow traffic with average speeds of <`speed`>
`CONGESTION_STATIONARY_TRAFFIC`		Stationary traffic (frequent standstills)
`CONGESTION_STATIONARY_TRAFFIC_LIKELY`		Danger of stationary traffic
`CONGESTION_TRAFFIC_BUILDING_UP`		Traffic building up with average speeds of <`speed`>
`CONGESTION_TRAFFIC_CONGESTION`		Traffic congestion with average speeds of <`speed`>
`CONGESTION_TRAFFIC_EASING`		Traffic easing

Label	F	Description
CONGESTION_TRAFFIC_FLOWING_FREELY		Traffic flowing freely with average speeds of <speed>
CONGESTION_TRAFFIC_HEAVIER_THAN_NORMAL		Traffic heavier than normal with average speeds of <speed>
CONGESTION_TRAFFIC_LIGHTER_THAN_NORMAL		Traffic lighter than normal with average speeds of <speed>
CONGESTION_TRAFFIC_MUCH_HEAVIER_THAN_NORMAL		Traffic very much heavier than normal with average speeds of <speed> (increased density but no significant decrease in speed)
CONGESTION_TRAFFIC_PROBLEM		Traffic problem

4.2 Events in the DELAY Class

Label	F	Description
DELAY_CLEARANCE		Delays cleared
DELAY_DELAY		Delays up to <q_timespan>
DELAY_DELAY_POSSIBLE	F	Delays up to <q_timespan> possible
DELAY_FORECAST_WITHDRAWN	F	Delay forecast withdrawn
DELAY_LONG_DELAY		Long delays up to <q_timespan>
DELAY_SEVERAL_HOURS		Delays of several hours
DELAY_UNCERTAIN_DURATION		Delays of uncertain duration
DELAY_VERY_LONG_DELAY		Very long delays up to <q_timespan>

4.3 Events in the RESTRICTION Class

Label	Description
RESTRICTION_ACCESS_RESTRICTIONS_LIFTED	Traffic restrictions lifted: reopened for all traffic, other restrictions (overtaking etc.) remain in place
RESTRICTION_ALL_CARRIAGEWAYS_CLEARED	All carriageways cleared
RESTRICTION_ALL_CARRIAGEWAYS_REOPENED	All carriageways reopened
RESTRICTION_BATCH_SERVICE	Batch service (to limit the amount of traffic passing through a section, unlike single alternate line traffic)
RESTRICTION_BLOCKED	Blocked (refers to the entire road; separate codes exist for blockages of individual lanes or carriageways)
RESTRICTION_BLOCKED_AHEAD	Blocked ahead (at a point beyond the indicated location)
RESTRICTION_CARRIAGEWAY_BLOCKED	Carriageway blocked[1] (main carriageway, unless otherwise indicated in supplementary information)
RESTRICTION_CARRIAGEWAY_CLOSED	Carriageway closed (main carriageway, unless otherwise indicated in supplementary information)

1 In TMC, this event may be accompanied by a supplementary information item “use parallel carriageway”, indicating other carriageways are available which are not affected. Where this is not the case (and only one carriageway is present), this event indicates a blocked/closed road.

Label	Description
RESTRICTION_CLOSED	Closed until <q_time> (refers to the entire road; separate codes exist for closures of individual lanes or carriageways)
RESTRICTION_CLOSED_AHEAD	Closed ahead (at a point beyond the indicated location)
RESTRICTION_CONTRAFLOW	Contraflow
RESTRICTION_ENTRY_BLOCKED	<q_int> th entry slip road blocked
RESTRICTION_ENTRY_REOPENED	Entry reopened
RESTRICTION_EXIT_BLOCKED	<q_int> th exit slip road blocked
RESTRICTION_EXIT_REOPENED	Exit reopened
RESTRICTION_INTERMITTENT_CLOSURES	Intermittent short term closures
RESTRICTION_OPEN	Open
RESTRICTION_LANE_BLOCKED	<q_int> lane(s) blocked
RESTRICTION_LANE_CLOSED	<q_int> lane(s) closed
RESTRICTION_RAMP_BLOCKED	Ramps blocked
RESTRICTION_RAMP_CLOSED	Ramps closed
RESTRICTION_RAMP_REOPENED	Ramps reopened
RESTRICTION_REDUCED_LANES	Carriageway reduced from <q_ints> lanes to <q_ints> lanes (if the quantifier has only one element, it refers to the number of available lanes, not counting closed lanes)
RESTRICTION_REOPENED	Reopened
RESTRICTION_ROAD_CLEARED	Road cleared
RESTRICTION_SINGLE_ALTERNATE_LINE_TRAFFIC	Single alternate line traffic (because the affected stretch of road can only be used in one direction at a time, different from batch service)
RESTRICTION_SPEED_LIMIT	Speed limit <speed> in force
RESTRICTION_SPEED_LIMIT_LIFTED	Speed limit lifted

5 Supplementary Information

Version 0.7 of the TraFF specification defines the following supplementary information classes:

PLACE	Qualifiers specifying the place(s) to which the event refers
TENDENCY	Traffic density development
VEHICLE	Specifies categories of vehicles to which the event applies

5.1 Supplementary Information in the PLACE Category

Label	Description
S_PLACE_BRIDGE	On bridges
S_PLACE_RAMP	On ramps (entry/exit)
S_PLACE_ROADWORKS	In the roadworks area
S_PLACE_TUNNEL	In tunnels

5.2 Supplementary Information in the TENDENCY Category

Label	Description
S_TENDENCY_QUEUE_DECREASING	Traffic queue length decreasing at an average rate of <q_speed>
S_TENDENCY_QUEUE_INCREASING	Traffic queue length increasing at an average rate of <q_speed>

5.3 Supplementary Information in the VEHICLE Category

Label	Description
S_VEHICLE_ALL	For all vehicles
S_VEHICLE_BUS	For buses only
S_VEHICLE_CAR	For cars only
S_VEHICLE_CAR_WITH_CARAVAN	For cars with caravans only
S_VEHICLE_CAR_WITH_TRAILER	For cars with trailers only
S_VEHICLE_HAZMAT	For hazardous loads only
S_VEHICLE_HGV	For heavy trucks only
S_VEHICLE_MOTOR	For all motor vehicles
S_VEHICLE_WITH_TRAILER	For vehicles with trailers only

6 Quantifiers

Quantifiers can be used with events and with supplementary information. The syntax is the same in both cases.

The quantifier type is specified in the attribute name itself. The following quantifier types are specified in version 0.7:

Name	Description	Default unit	Examples
q_duration	A duration (e.g. delay)	Minutes, hours/minutes	20 min 1:30 3 h
q_int	An integer (e.g. number of distinct events, available spaces)	None	2 40
q_ints	A list of integer values	None	3,2 2 (single integer value)
q_speed	A speed that does *not* refer to moving traffic (e.g. wind, queue length increase/ decrease). Note that the speed of moving traffic is expressed through the speed attribute.	km/h	40 km/h
q_time	Time of day (e.g. ferry departure time)	ISO8601	2017-02-17T21:30+01:00

Units other than the default unit may be used (e.g. imperial instead of metric units) but must be specified explicitly. The default unit is assumed if no unit is given.

7 Platform Specifics

In order to pass traffic updates between applications, TraFF generally relies on the platform's native IPC mechanisms.

Where identifiers are derived from DNS names, `org.traffxml.traff` should be used as the base name. The `traffxml.org` domain has been registered for this purpose.

7.1 Linux

TraFF relies on Dbus for inter-process communication. Details are yet to be specified.

7.2 Android

TraFF on Android relies on broadcasts as a transport medium. The following intents are currently defined:

- `org.traffxml.traff.FEED` is sent by a TraFF source to inform consumers about new messages. The actual data is sent as a string extra, `feed`.
- `org.traffxml.traff.POLL` is sent by a TraFF consumer to query all currently active messages from sources.

These intent names are final. Preliminary names used in earlier drafts are no longer valid and should no longer be used.

7.2.1 Security

While TraFF messages are generally public information, the broadcasts may allow conclusions about the location of the device: Some sources (such as TMC) are restricted to national, regional or even metropolitan areas, allowing the approimate location of the device to be determined from the messages received. Future versions of TraFF may allow queries or subscriptions based on a geographical area. These broadcasts would also allow for conclusions on the location of the device, which is likely to be within the area queried.

For this reason, both sources and consumers should obtain the `ACCESS_COARSE_LOCATION` permission (or `ACCESS_FINE_LOCATION`, which includes the former) from the system.

Sources should require `ACCESS_COARSE_LOCATION` to receive feed broadcasts if one or more of the following are true:

- The service is bound to the region of the device (as is the case with TMC).
- The feed was sent as a response to a query or subscription restricted to a geographical area.

Consumers should require `ACCESS_COARSE_LOCATION` to receive query or subscription broadcasts if these are restricted to a geographical area.

7.2.2 Broadcast Receivers

Android distinguishes between implicit broadcasts, which are sent to any receiver listening to them, and explicit ones, which are sent only to the package and component specified in the broadcast.

Broadcast receivers can be either declared in the manifest or registered at runtime. Some broadcasts are sent only to runtime-registered receivers, while others may require the receiver to be declared in the manifest.

Android 8.0 introduces some restrictions on broadcasts for applications targeting that version: implicit broadcasts will only be delivered to runtime-registered receivers. Only a few system-defined broadcasts are exempt from this rule, whereas all other broadcasts (including all application-defined broadcasts) must now be explicit, or receivers must be registered at runtime. Some distributions of Android come with similar restrictions in earlier versions: For example, LineageOS 14 (Android 7) will not deliver implicit broadcasts to manifest-declared receivers unless the application is already running.

Enumerating all receivers which will pick up a particular broadcast is only possible for manifest-declared receivers, not for runtime-declared ones.

For this reason, the following requirements apply:

- TraFF sources must listen for poll requests through manifest-declared broadcast receivers (as runtime-registered receivers may not pick up all poll requests).
- TraFF sources must send out feeds as implicit intents (this may change if subscriptions are introduced).
- TraFF consumers must send poll requests as explicit intents (after querying the package manager for all receivers, see sample code below).
- TraFF consumers must register receivers for feeds at runtime (as manifest-declared receivers will not work on Android 8 or later).

Sample code to poll for TraFF messages using explicit intents:

```
/* Broadcast a poll intent */
Intent outIntent = new Intent("org.traffxml.traff.POLL");
PackageManager pm = this.getPackageManager();
List<ResolveInfo> receivers = pm.queryBroadcastReceivers(outIntent, 0);
if (receivers != null)
    for (ResolveInfo receiver : receivers) {
        ComponentName cn = new ComponentName(
                receiver.activityInfo.applicationInfo.packageName,
                receiver.activityInfo.name);
        outIntent = new Intent("org.traffxml .traff.POLL");
        outIntent.setComponent(cn);
        sendBroadcast(outIntent, Manifest.permission.ACCESS_COARSE_LOCATION);
    }
```

8 TMC Conversion

8.1 Identifiers

Two levels of TraFF source identifiers are used: The first is the global identifier for TMC. The second level identifies the TMC service from which the message originated. It consists of the 4-bit country code, Location Table Number and Service Identifier.

The local message identifier contains the elements of the message which are not contained in the source identifier and, as per the TMC specification, are used to determine if a message overrides another: location code, direction, update classes and duration (the latter is for forecast messages only).

Because TMC messages may contain multiple events, each belonging to a different update class, and messages can override each other if any update class matches, it is impossible to design an identifier that is generated from the above identifiers, collision-free and at the same time guaranteed to be identical for any two messages which can override each other. Similar issues apply to the service identifier, as different services may be allowed to override each other's messages.

As identifiers need to be stable across updates, an updated message will always inherit the identifier of the message it replaces. This may result in discrepancies between the update classes of the updated message and those reported in the identifier: for example, if a message comprising events for update classes 1 and 2 is replaced with a message comprising events for update classes 2 and 3, the identifier will still report update classes 1 and 2. Similarly, if a message was first received by a service with SID 5 but later updated by a service with SID 6 (assuming the two services allow updates between each other), it will continue to report SID 5 in its ID.

Note that this also means that TMC converters on two different devices may assign different identifiers to the same message:

- Device A receives the first message in the sequence, as well as all updates to it. By the time device B picks up the first update to theat message, the set of update classes has changed and device B will report different update classes in its identifier than device A does.
- Device A and B are listening to two different TMC services (different SIDs) which can update messages between them and share some or all of the messages they transmit. Both may receive the same message but assign it IDs reporting a different SID.

An example for a fully qualified TMC message ID would be `tmc:a.1.0:a.1.32908.n.3,5`. This can be broken down as follows:

- The message was received via TMC
- The Country Code of the service which sent this message is A (together with the Location Table Number, this identifies Austria)
- The Location Table Number of the service which sent this message is 1
- The Service Identifier is 0

- The Country Code and Location Table Number to resolve the Location Code are A and 1, respectively (same as for the sending service, unless it is an INTER-ROAD message)
- The Location Code is 32908
- The message refers to the negative direction of the road (but may be either unidirectional or bidirectional)
- The original message comprises events of update classes 3 and 5. (To minimize ambiguities, update classes should be deduplicated and sorted.)

Since the system has been designed to be primarily collision-free, messages with the same identifier can override each other in most cases. There are, however, scenarios in which this can break:

- A message with update classes 2 is received and assigned an ID that reports this update class.
- An update for the message is received, which now includes update class 2 and 3.
- Another update is received, which now includes only update class 3. Note that the ID still reports update class 2, and only 2.
- Now a different message is received, from the same service, referring to the same location and direction, and with update class 2. This message can coexist with our previous message in a TMC receiver. However, it would be assigned the same TraFF identifier as the previous message, therefore a TraFF consumer would treat it as an update to the earlier message.

This could be mitigated by the following approach:

- Generate the ID for each message (including updates) from scratch
- If the message updates an existing message and its ID is different from the ID of the old message, add a `replaces` element for the old ID. This element should be repeated in all updates until the expiration time for the last message with the old ID has elapsed.

Alternatively:

- When a new message is received and it does not replace an existing message, check if its generated ID is unique.
- If the generated ID is not unique, append a distinguishing element (e.g. a dot followed by a number which is incremented until the resulting ID is unique).

8.2 Events

Some TMC events have a direct equivalent in TraFF. However, many TMC events are “convenience” elements which assign a single event code to several items of information which frequently occur together. Since TraFF was designed for orthogonality rather than bandwidth economy, such TMC events may convert to several items of information in TraFF:

- One or more events

- A Supplementary Information item for each event
- A `speed` attribute or quantifier

8.3 Supplementary Information

Converting supplementary information from TMC into TraFF is straightforward in most cases. The two main points to be aware of are:

- Supplementary information in TraFF supports quantifiers just like events do. The quantifier format is the same.
- Some supplementary information items in TMC translate into events in TraFF.

8.4 Event and Message Nature

TMC defines three event *natures*: Info, Forecast and Silent. Info describes a current situation while Forecast describes a situation expected for the near future. Silent denotes messages which are to be processed internally without being presented to the user.

Each event has an assigned nature, which cannot be changed. Consequently, there are many event pairs, one referring to a current situation and the other referring to the same situation being expected in the future. The overall nature of the message is determined by the event which immediately precedes the duration field.

As only few events are of Silent nature and since TraFF leaves the decision how to process or present them to the processing application, TraFF lacks an explicit counterpart to Silent.

Whether a message describes a current situation or is a forecast message is expressed in an attribute of the `message` element, as TraFF has no mechanism to infer this information from events. TMC receivers are therefore expected to evaluate the nature of each received message and set the `forecast` attribute accordingly.

8.5 Location

A TMC message defines a *location*, a *direction* and an *extent*. A direction is even specified for bidirectional messages. The extent, together with the direction, implies a secondary location; however, the secondary location coincides with the primary location if the extent is zero. A zero extent thus implies a point location, a nonzero extent implies a linear location.

The road class implies whether the road is a ring road.

A TMC location can thus be transformed into a TraFF location in the following way:

If the extent is zero, the location is a point location and its coordinates must be stored in the `at` element. Unless the message is bidirectional, auxiliary points must be specified. `from` can be filled by obtaining the next point in the direction of the event; `to` can be filled by obtaining the next point

in the opposite direction. One of these two can be omitted if no further points exist in the respective direction. On ring roads, two adjacent points will always be available.

If the extent is nonzero, the location is a linear location. The coordinates of the location must be stored in the `to` element. The `from` element is populated with the coordinates of the point at the offset indicated by the extent in the given direction. (Should no point be available at that offset, e.g. because the message is corrupt or an outdated location table is used, use the last point which can be retrieved.)

If the location is a linear location and the road class indicates a ring road, either the `via` or the `not_via` point must be populated. It can be obtained by picking an arbitrary offset that is greater than zero but less than the extent for `via` or greater than the extent (but less than the total number of points on the road) for `not_via`, and using the point at that offset in the given direction. The recommendation is to use `via` if the extent is greater than 1, and `not_via` with an extent of 2 otherwise.

9 Appendix

9.1 Features for Future Versions

- Dealing with mixed-nature TMC events such as “roadworks, delays expected”, whose TraFF equivalent is composed of two events, one of which is a forecast while the other is not.
- Parent messages: event in one location causing events in other locations
- Equivalents to TMC update class 30 (area and level of detail covered by this service)

9.1.1 Locations

Locations may be extended to include:

- Areas (delimited by a polygon)
- Fuzzy areas (areas without a clear delimitation)
- Administrative areas

9.1.2 Diversions

Messages may specify a recommended diversion. This is a feature already present in TMC, where a diversion is valid for the whole message.

TMC has two ways to specify a recommended diversion:

- A diversion flag. Setting this flag indicates that drivers are recommended to take a diversion route which is marked on the ground and valid for all destinations.
- An explicit diversion, given as a sequence of locations. Such diversions may be indicated as being valid for a particular destination only. Multiple explicit diversions may be specified.

Where multiple diversions are specified, all but one must refer to a particular destination.

9.1.3 Area-Specific Queries

When polling for active messages, consumers can specify an area they are interested in. Sources are to interpret this area as a recommendation: a source may reduce the area if it covers only a part of it, or it may extend the area if it is a regional service and the volume of messages is not expected to be high.

Each feed reports the area it actually covers.

9.1.4 Subscriptions

Consumers may subscibe to updates for a specific area. Sources must then send updates addressed specifically to the subscriber. If the IPC architecture does not provide for such a distinction, the source must mark such updates as pertaining to ap particular subscription. Subscriptions are always area-specific and work in the same manner as area-specific queries.

9.2 Reserved Events

The following event classes are reserved for future versions and not part of version 0.7 of the specification:

`ACTIVITY`	Major events, usually attended by a large number of people, which typically cause traffic disruptions due to road closures and/or heavy traffic
`AUDIO_BROADCAST`	Announcements of radio broadcasts where further information about a situation will be provided
`CARPOOL`	Conditions affecting car pools
`CONSTRUCTION`	Roadworks and other construction work which may have an impact on traffic flow or traffic restrictions
`ENVIRONMENT`	Air quality (smog and pollen)
`EQUIPMENT_STATUS`	Traffic equipment irregularities which may result in disruptions or hazards
`HAZARD`	Hazards and dangerous situations requiring drivers to be alert
`INCIDENT`	Incidents which may cause traffic disruptions or hazards
`PARKING`	Availability of parking spaces
`SECURITY`	Security warnings, presence of security forces
`SERVICE`	Traffic information service status
`SPECIAL`	System messages
`TRANSPORT`	Availability of transport-related services
`TRAVEL_TIME`	Trip time for transport services
`WEATHER`	Weather conditions and weather-related hazards

9.2.1 Reserved Events in the `CONGESTION` Class

None.

9.2.2 Reserved Events in the DELAY Class

None.

9.2.3 Reserved Events in the RESTRICTION Class

Label	Description
RESTRICTION_CONTRAFLOW_REMOVED	Contraflow removed
RESTRICTION_CONVOY_SERVICE_REQUIRED	Convoy service required (e.g. due to bad weather or hazardous road conditions)
RESTRICTION_FIREMEN_DIRECTING_TRAFFIC	Firemen directing traffic
RESTRICTION_HAZMAT_STOP	Vehicles carrying hazardous materials have to stop at next safe place
RESTRICTION_HGV_STOP_RECOMMENDED_OVER_WEIGHT	Drivers of heavy trucks over <q_weight> are recommended to stop at next safe place
RESTRICTION_LANE_BLOCKAGE_CLEARED	Lane blockages cleared
RESTRICTION_LANE_CLOSURE_REMOVED	Lane closures removed
RESTRICTION_LANE_REGULATIONS_RESTORED	Normal lane regulations restored
RESTRICTION_LANE_RESTRICTIONS_LIFTED	Lane restrictions lifted
RESTRICTION_LET_EMERGENCY_SERVICES_PASS	Allow emergency vehicles to pass
RESTRICTION_LOW_EMISSION_ZONE	Low Emission Zone restriction in force
RESTRICTION_MAX_WEIGHT	Closed for heavy vehicles over <q_weight>
RESTRICTION_N_ENTRIES_CLOSED	<q_int> entry slip road(s) closed
RESTRICTION_N_EXITS_CLOSED	<q_int> exit slip road(s) closed
RESTRICTION_NARROW_LANES	Narrow lanes
RESTRICTION_NO_OVERTAKING	Overtaking prohibited
RESTRICTION_NO_OVERTAKING_OVER_WEIGHT	Overtaking prohibited for heavy vehicles over <q_weight>
RESTRICTION_NTH_ENTRY_CLOSED	<q_int> th entry slip road closed
RESTRICTION_NTH_EXIT_CLOSED	<q_int> th exit slip road closed
RESTRICTION_OVERTAKING_RESTRICTION_LIFTED	Overtaking restriction lifted
RESTRICTION_POLICE_DIRECTING_TRAFFIC	Police directing traffic
RESTRICTION_RAMP_RESTRICTIONS	Ramp restrictions
RESTRICTION_RESTRICTIONS	Restrictions
RESTRICTION_SERVICE_AREA_BUSY	Service area busy
RESTRICTION_SERVICE_AREA_FUEL_STATION_CLOSED	Service area, fuel station closed
RESTRICTION_SERVICE_AREA_FUEL_STATION_REOPENED	Fuel station reopened
RESTRICTION_SERVICE_AREA_OVERCROWDED	Service area overcrowded, drive to another service area
RESTRICTION_SERVICE_AREA_RESTAURANT_CLOSED	Service area, restaurant closed
RESTRICTION_SERVICE_AREA_RESTAURANT_REOPENED	Restaurant reopened
RESTRICTION_SMOG_ALERT	Smog alert
RESTRICTION_SMOG_ALERT_ENDED	Smog alert ended

Label	Description
RESTRICTION_TEMP_MAX_AXLE_LOAD	Temporary axle load limit <q_weight>
RESTRICTION_TEMP_MAX_AXLE_LOAD_LIFTED	Temporary axle weight limit lifted
RESTRICTION_TEMP_MAX_HEIGHT	Temporary height limit <q_dimension>
RESTRICTION_TEMP_MAX_HEIGHT_LIFTED	Temporary height limit lifted
RESTRICTION_TEMP_MAX_LENGTH	Temporary length limit <q_dimension>
RESTRICTION_TEMP_MAX_LENGTH_LIFTED	Temporary length limit lifted
RESTRICTION_TEMP_MAX_WEIGHT	Temporary gross weight limit <q_weight>
RESTRICTION_TEMP_MAX_WEIGHT_LIFTED	Temporary gross weight limit lifted
RESTRICTION_TEMP_MAX_WIDTH	Temporary width limit <q_dimension>
RESTRICTION_TEMP_MAX_WIDTH_LIFTED	Temporary width limit lifted
RESTRICTION_THROUGH_HGV_MAX_WEIGHT	No through traffic for heavy trucks over <q_weight>
RESTRICTION_TRAFFIC_REGULATIONS_CHANGED	Traffic regulations have been changed
RESTRICTION_TRAFFIC_WARDENS_DIRECTING_TRAFFIC	Traffic wardens directing traffic
RESTRICTION_USE_BUS_LANE	Bus lane available for all vehicles
RESTRICTION_USE_CARPOOL_LANE	Carpool lane available for all vehicles
RESTRICTION_USE_HEAVY_VEHICLE_LANE	Heavy vehicle lane available for all vehicles
RESTRICTION_USE_SHOULDER	Use of hard shoulder allowed

9.2.4 Reserved Events in the SPECIAL Class

Label	Description
SPECIAL_NO_REPORT	Nothing to report
SPECIAL_NULL	Null event, no event description but other message parts (e.g. supplementary information) can be transferred
SPECIAL_TEST_MESSAGE	This message is for test purposes only number <q_int>, please ignore

9.3 Reserved Supplementary Information Types

The following supplementary information classes are reserved for future versions and not part of version 0.7 of the specification:

COURTESY	Courtesy phrases
DIRECTION	Indications of the direction to which an event applies
DIVERSION	Diversion recommendations and availability of diversions
INSTRUCTION	Instructions to drivers in the affected area
LANE_USAGE	Instructions to use particular lanes
POSITION	Position on a road (lanes, carriageways) to which the event refers
QUALIFIER	Generic qualifiers specifying groups of drivers, periods of time, reliability of reports or service levels
REASON	Reasons for traffic conditions
SPEED	Warnings and instructions related to speed

SUGGESTION	Suggestions to drivers
WARNING	Warnings regarding dangerous situations
WINTER	Winter-specific information, such as requirements for winter equipment or winter closures

9.3.1 Reserved Supplementary Information in the PLACE Category

Label	Description
S_PLACE_BEND	Around a bend in the road
S_PLACE_CITY_CENTER	In the city centre
S_PLACE_HIGH_ALTITUDE	At high altitudes
S_PLACE_HILL	Over the crest of a hill
S_PLACE_INNER_CITY	In the inner city area
S_PLACE_LOW_AREA	In low-lying areas
S_PLACE_SHADE	In shaded areas
S_PLACE_TUNNEL_PORTAL	Entering or leaving tunnels

9.3.2 Reserved Supplementary Information in the VEHICLE Category

Label	Description
S_VEHICLE_4WD_WITH_SNOW_TIRES_OR_CHAINS	For 4-wheel-drive with snow tyres or chains only
S_VEHICLE_ABNORMAL_LOAD	For abnormal loads only
S_VEHICLE_ARTICULATED	For articulated vehicles only
S_VEHICLE_CAR_AND_LIGHT	For cars and light vehicles only
S_VEHICLE_DIESEL	For diesel powered vehicles only
S_VEHICLE_EVEN_PLATE	With even-numbered registration plates
S_VEHICLE_EXCEPTIONAL_LOAD	For exceptional loads only
S_VEHICLE_FERRY	For ferry service
S_VEHICLE_GASOLINE	For gasoline powered vehicles only
S_VEHICLE_HEAVY	For heavy vehicles only
S_VEHICLE_HIGH_SIDED	For high-sided vehicles only
S_VEHICLE_LIGHT	For light vehicles only
S_VEHICLE_LPG	For LPG vehicles only
S_VEHICLE_ODD_PLATE	With odd-numbered registration plates
S_VEHICLE_RAIL	For rail services
S_VEHICLE_THROUGH_TRAFFIC	For through traffic
S_VEHICLE_UNDERGROUND	On the underground
S_VEHICLE_WITH_CAT	For vehicles with catalytic converters
S_VEHICLE_WITHOUT_CAT	For vehicles without catalytic converters

9.4 Reserved Quantifier Types

The following quantifier types are reserved for use in future versions:

Name	Description	Default unit	Examples

`q_dimension`	A dimension (e.g. length/width/height restriction, visibility, amount of precipitation). Note that queue length or length of the route affected are expressed through the `length` attribute.	m	`100 m`
			`2.5 m`
			`255 cm`
			`0.5 cm`
			`5 mm`

`q_frequency`	A radio frequency (e.g. for a radio station broadcasting further information)	MHz	`99.0 MHz` `720 kHz`
`q_percent`	A percentage	%	`50 %`
`q_temperature`	A temperature	°C	`-20 °C` `40 °C`
`q_weight`	A weight (e.g. weight beyond which a restriction applies)	t	`20 t`

i Traffic Incident Data. https://msdn.microsoft.com/en-us/library/hh441730.aspx, retrieved 2017-04-11.
ii CIFS: Waze Closure and Incident Feed Specification v2.0, https://blog.waze.com/p/blog-page_19.html, retrieved 2017-04-11.
iii OpenLR. http://www.openlr.org/, retrieved 2017-04-11.