



BSI Standards Publication

# Public transport — Reference data model

Part 3: Timing information and vehicle scheduling

**National foreword**

This British Standard is the UK implementation of EN 12896-3:2016. Together with BS EN 12896-1:2016, BS EN 12896-2:2016, BS EN 12896-4, BS EN 12896-5, BS EN 12896-6, BS EN 12896-7 and BS EN 12896-8 it supersedes BS EN 12896:2006 which will be withdrawn upon publication of all parts of the series.

The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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EUROPEAN STANDARD  
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# EN 12896-3

September 2016

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Supersedes EN 12896:2006

English Version

## Public transport - Reference data model - Part 3: Timing information and vehicle scheduling

Télématique du transport routier et de la circulation -  
Modèle de données de référence - Partie 3 :  
Informations horaires et horaires des véhicules

Öffentlicher Verkehr - Datenreferenzmodell - Teil 3:  
Taktinformationen und Fahrzeugdisposition

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## European foreword

This document (EN 12896-3:2016) has been prepared by Technical Committee CEN/TC 278 “Transmodel”, the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2017, and conflicting national standards shall be withdrawn at the latest by March 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document together with documents EN 12896-1:2016 and EN 12896-2:2016 supersedes EN 12896:2006.

The series composed of the following documents:

Public transport - Reference data model - Part 1: Common concepts

Public transport - Reference data model - Part 2: Public transport network

Public transport - Reference data model - Part 3: Timing information and vehicle scheduling

Public transport - Reference data model - Part 4: Operations monitoring and control

Public transport - Reference data model - Part 5: Fare management

Public transport - Reference data model - Part 6: Passenger information

Public transport - Reference data model - Part 7: Driver management

Public transport - Reference data model - Part 8: Management information and statistics

Together these create version 6 of the European Standard EN 12896, known as “Transmodel” and thus replace Transmodel V5.1.

The split into several documents intends to ease the task of users interested in particular functional domains. Modularisation of Transmodel, undertaken within the NeTEx project, has contributed significantly to this new edition of Transmodel.

In addition to the eight Parts of this European Standard, an informative Technical Report (Public transport – Reference data model – Informative documentation) is also being prepared to provide additional information to help those implementing projects involving the use of Transmodel. It is intended that this Technical Report will be extended and republished as all the eight parts are completed.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## Introduction

EN 12896-3 presents the following items:

- rationale for the Transmodel Standard;
- use of the Transmodel Standard;
- applicability of the Transmodel Standard;
- conformance statement;
- Transmodel origins;
- reference to the previous version and other documents.

The data structures represented in EN 12896-1 are generic patterns that are referenced by different other parts.

EN 12896-2 presents space-related data structures.

This European Standard presents time-related data structures and replaces the sections of EN 12896:2006 referring to the *time-related* tactical planning components and to vehicle scheduling.

# 1 Scope

## 1.1 General scope of the Standard

The main objective of the present standard is to present the reference data model for public transport, based on:

- the reference data model, EN 12896, known as Transmodel V5.1;
- EN 28701, known as IFOPT;

incorporating the requirements of:

- EN 15531-1 to -3 and CEN/TS 15531-4 and CEN/TS 15531-5, *Service interface for real-time information relating to public transport operations (SIRI)*;
- CEN/TS 16614-1 and CEN/TS 16614-2, *Network and Timetable Exchange (NeTEx)*, in particular, the specific needs for long distance train operation.

A particular attention is drawn to the data model structure and methodology:

- the data model is described in a modular form in order to facilitate the understanding and the use of the model;
- the data model is entirely described in UML.

In particular, a Reference Data Model kernel is described, referring to the data domain:

- network description: routes, lines, journey patterns, timing patterns, service patterns, scheduled stop points and stop places.

This part corresponds to the Transmodel V5.1 network description extended by the IFOPT relevant parts.

Furthermore, the following functional domains are considered:

- timing information and vehicle scheduling (runtimes, vehicle journeys, day type-related vehicle schedules);
- passenger information (planned and real-time);
- fare management (fare structure, sales, validation, control);
- operations monitoring and control: operating day-related data, vehicle follow-up, control actions;
- management information and statistics (including data dedicated to service performance indicators);
- driver management:
  - driver scheduling (day-type related driver schedules);
  - rostering (ordering of driver duties into sequences according to some chosen methods);
  - driving personnel disposition (assignment of logical drivers to physical drivers and recording of driver performance).

The data modules dedicated to cover most functions of the above domains will be specified.

Several concepts are shared by the different functional domains. This data domain is called “common concepts”.

## 1.2 Functional domain description

The different functional domains taken into account in the present standard and of which the data have been represented as the reference data model are described in “Public transport reference data model - part 1: Common concepts”.

They are:

- public transport network and stop description;
- timing information and vehicle scheduling;
- passenger information;
- fare management;
- operations monitoring and control;
- management information;
- personnel management: driver scheduling, rostering, personnel disposition.

The aspects of multi-modal operation and multiple operators’ environment are also taken into account.

## 1.3 Particular scope of this document

The present European Standard entitled “Reference data model for public transport – Part 3: Timing information and vehicle scheduling” incorporates:

- journey and journey times model: describes the time-related information at the level of vehicle journeys, i.e. planned timing for the vehicles at day-type level;
- dated journey model: describes the link of the timing information for a single operating day and the day type related timing;
- passing times model: describes all the different types of passing times for the day type related information;
- vehicle service model: describes the information related the work of vehicles as planned for days types. it constitutes the main part of the vehicle scheduling data domain;
- vehicle journey assignment model: describes operational assignments (advertised vehicle labels, stopping positions) related to particular vehicle journeys.

This document itself is composed of the following parts:

- main document (normative) representing the data model;
- Annex A (normative), containing the data dictionary and attributes tables, i.e. the list of all the concepts present in the main document together with the definitions;
- Annex B (informative), indicating the data model evolutions.

## 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.

EN 12896-1:2016, *Public transport - Reference data model - Part 1: Common concepts*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12896-1:2016 apply.

## 4 Symbols and abbreviations

|       |                                                     |
|-------|-----------------------------------------------------|
| AVM   | Automated vehicle monitoring                        |
| AVMS  | Automated vehicle management system                 |
| IFOPT | Identification of fixed objects in public transport |
| ISO   | International standards organization                |
| IT    | Information technology                              |
| NeTEx | Network and Timetable Exchange                      |
| PT    | Public transport                                    |
| PTO   | Public transport operator                           |
| SIRI  | Service interface for real-time information         |
| UML   | Unified modelling language                          |
| URI   | Uniform resource identifier                         |
| URL   | Universal resource locator                          |

## 5 Timing information and vehicle scheduling data domain

### 5.1 Introduction

The work of the vehicles necessary to provide the service offer advertised to the public consists of service journeys and dead runs (unproductive journeys are necessary to transfer vehicles where they are needed, mainly from the depot into service and vice versa). Vehicle journeys are defined for day types rather than individual operating days. A day type is a classification of all operating days for which the same service offer has been planned. The whole tactical planning process is seen on the level of day types in the reference data model, with all entities necessary to develop schedules. These include a series of entities describing different types of run times and wait times, scheduled interchanges, turnaround times etc.

Chaining vehicle journeys into blocks of vehicle operations, and cutting driver duties from the vehicle blocks, are parts of the main functions of vehicle scheduling and driver scheduling, respectively. The corresponding entities and relationships included in the reference data model allow a comprehensive description of the data needs associated with this functionality, independently of the particular methods and algorithms applied by the different software systems.

## 5.2 Overview

### 5.2.1 Model and document structure

The timing information model is split into four main sub-models defined as UML packages.

- Journey and journey times model: describes the time-related information at the level of vehicle journeys, i.e. planned timing for the vehicles at day-type level. It splits into:
  - vehicle journey model;
  - service journey model;
  - time demand times model;
  - journey timing model ;
  - journey pattern times model;
  - vehicle journey times model;
  - interchange model;
  - interchange rule model;
  - coupled journey model;
  - flexible service model;
  - journey accounting model;
- dated journey model: describes the link of the timing information for a single operating day and the day type related timing;
- passing times model: describes all the different types of passing times for the day type related information;
- vehicle service model: describes the information related the work of vehicles as planned for days types. It constitutes the main part of the vehicle scheduling data domain.

## 5.3 Journey and journey times

### 5.3.1 Vehicle journey

#### 5.3.1.1 VEHICLE JOURNEY – Conceptual model

##### 5.3.1.1.1 General

The daily operation of a vehicle is described by VEHICLE JOURNEYS. A VEHICLE JOURNEY is the defined movement of a vehicle using a specified JOURNEY PATTERN on a particular ROUTE. This movement is made between the first and the last POINTS IN JOURNEY PATTERN. Being defined for a DAY TYPE (cf. [7]), a VEHICLE JOURNEY is a class of journeys that would take place at the same time on each day of a specific DAY TYPE.

### 5.3.1.1.2 Basic vehicle journey – Conceptual model

There are two different main types of VEHICLE JOURNEYS: passenger-carrying SERVICE JOURNEYS and non-service DEAD RUNS.

- A SERVICE JOURNEY is a VEHICLE JOURNEY on which passengers will be allowed to board or alight from vehicles at stops. These journeys are usually published and known by passengers.
- A DEAD RUN may be necessary for the vehicle to proceed from the PARKING POINT (cf. [7]) at which it was parked to the first SCHEDULED STOP POINT of the JOURNEY PATTERN (cf. [8]) where it will start its service operation. In the opposite direction, a DEAD RUN may relate the last SCHEDULED STOP POINT the vehicle has stopped at (finishing its service) to the PARKING POINT where it will be parked. A DEAD RUN may also occur when a vehicle changes from one ROUTE (cf. [8]) to another one in order to continue its service there, or for various other reasons.

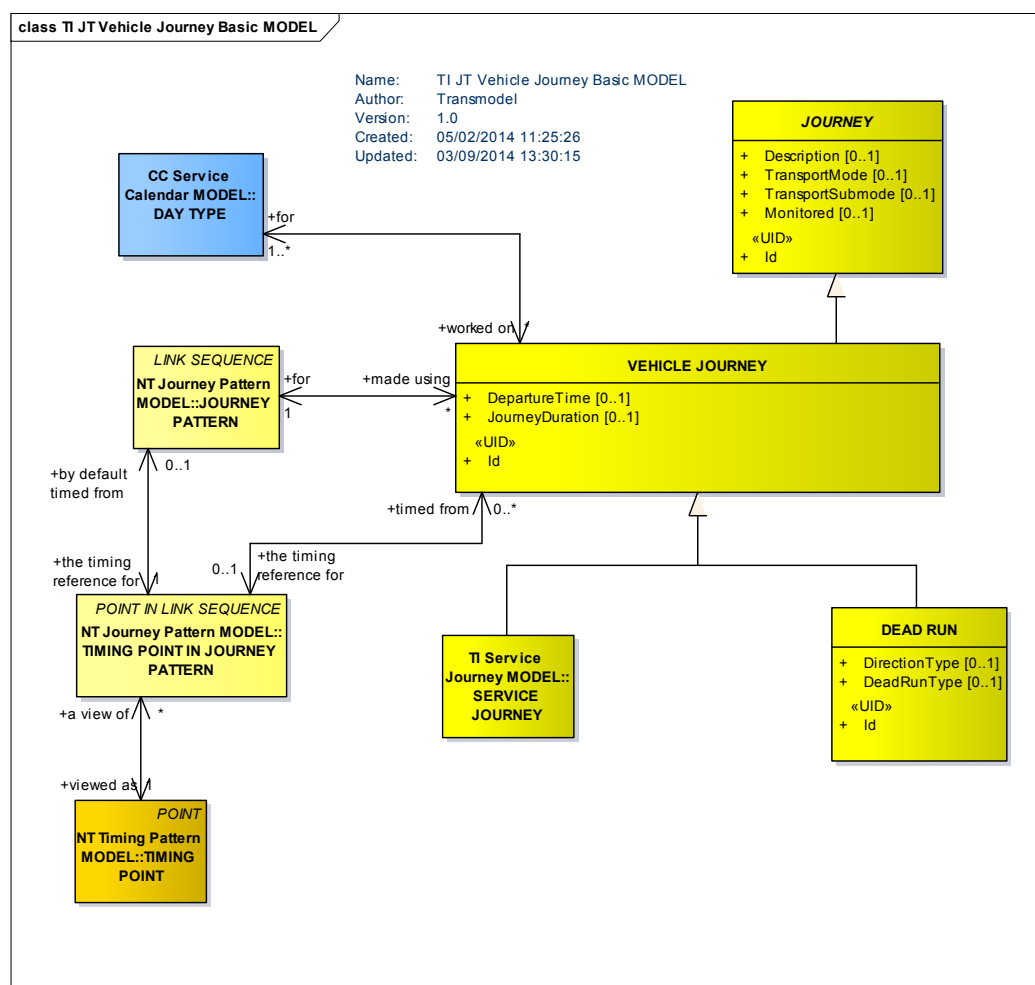


Figure 1 — Vehicle journey – Basic conceptual model (UML)

### 5.3.1.1.3 Vehicle journey details – Conceptual model

A VEHICLE JOURNEY may be further defined by a number of other elements, as shown in Figure 2. These include interactions with other journeys (JOURNEY PART, JOURNEY MEETING, etc.); temporal and other conditions (DAY TYPE, VALIDITY CONDITION, cf. [7]); further descriptive and classification

information (TRAIN NUMBER, PRODUCT CATEGORY, TYPE OF SERVICE, stops etc.); and operational data (BLOCK).

A TEMPLATE JOURNEY allows a set of VEHICLE JOURNEYS to be defined that follow a common temporal pattern.

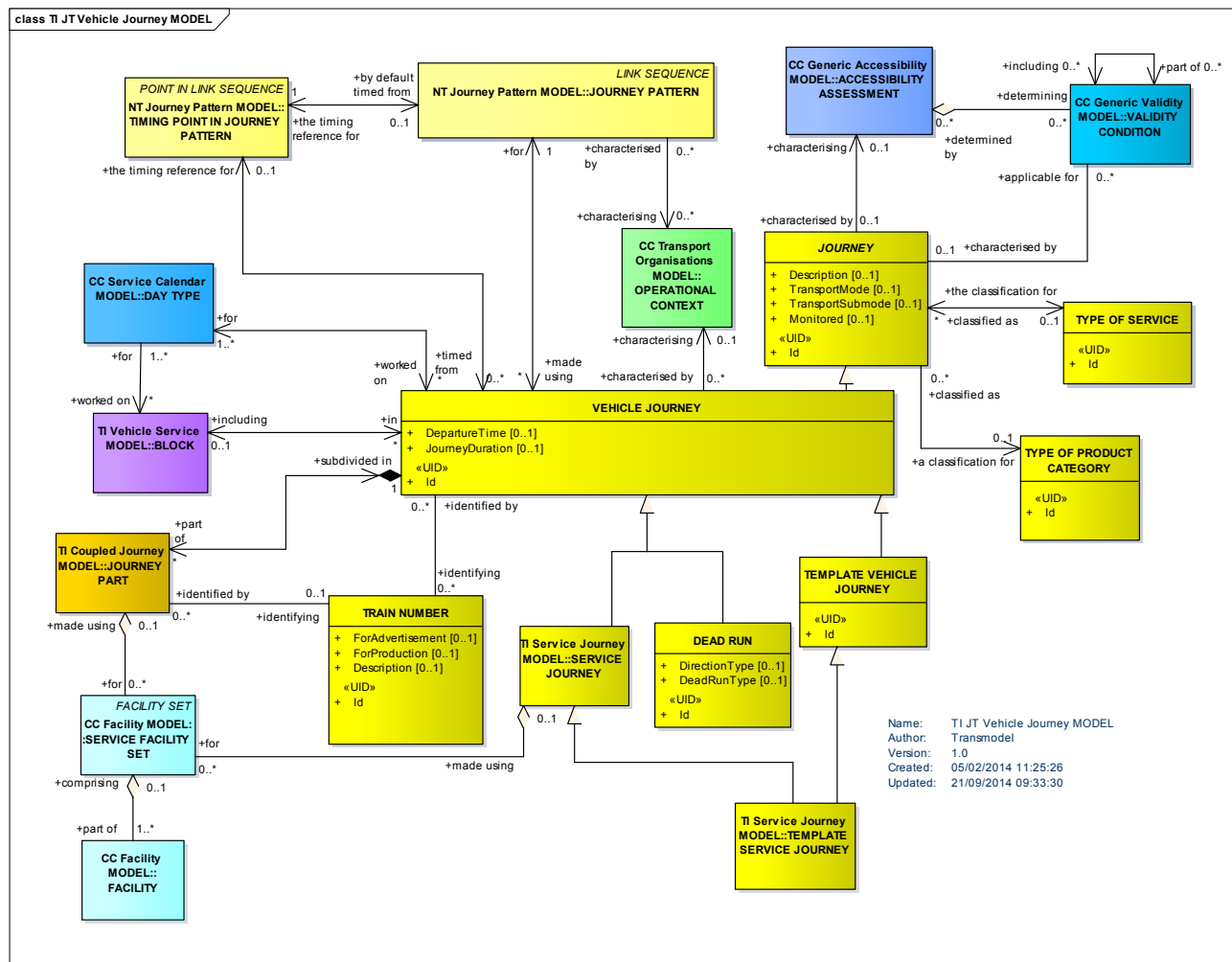


Figure 2 — Vehicle journey – conceptual model (UML)

### 5.3.1.2 Vehicle journey notice assignment

For passenger information (or sometimes driver information) purposes, it is often useful to attach remarks to various parts of the supply (a point, a line, a section, etc.). For instance, the fact that a shortened journey pattern is used exceptionally may be emphasized. Such remarks are usually printed as footnotes on public timetables at stops, timetable booklets or, for driver information, on driver cards.

The entity NOTICE (cf. [7]). describes such remarks. It may concern a whole LINE, or a GROUP OF POINTS, e.g. one or several STOP AREAS.

More frequently, a NOTICE will be assigned to a JOURNEY PATTERN, a COMMON SECTION (cf. [8]), or even a specific VEHICLE JOURNEY. In such a case, the same NOTICE often will be assigned to several objects (e.g. to several consecutive VEHICLE JOURNEYS).

Moreover, the validity of a NOTICE, for instance on a JOURNEY PATTERN or a COMMON SECTION, may be restricted from a POINT IN JOURNEY PATTERN, or to another POINT IN JOURNEY PATTERN.

The entity NOTICE ASSIGNMENT (cf. [8]) describes these spatial or operational assignments. Only the most frequent assignments are represented in the model. Other may be added using the same construction.

A NOTICE ASSIGNMENT may be subject to various other conditions of validity (such as DAY TYPE, TIME BAND), represented by VALIDITY CONDITIONS.

A NOTICE has a different meaning than a DESTINATION DISPLAY (cf. [8]). The first is designed to specify some characteristics of a journey or a journey pattern which are likely to evolve. They are in most cases printed in leaflets, but may also be queried by dynamic trip planning tools. A DESTINATION DISPLAY corresponds to stable information attached to a JOURNEY PATTERN, for instance the destination announcement displayed on bus headsigns.

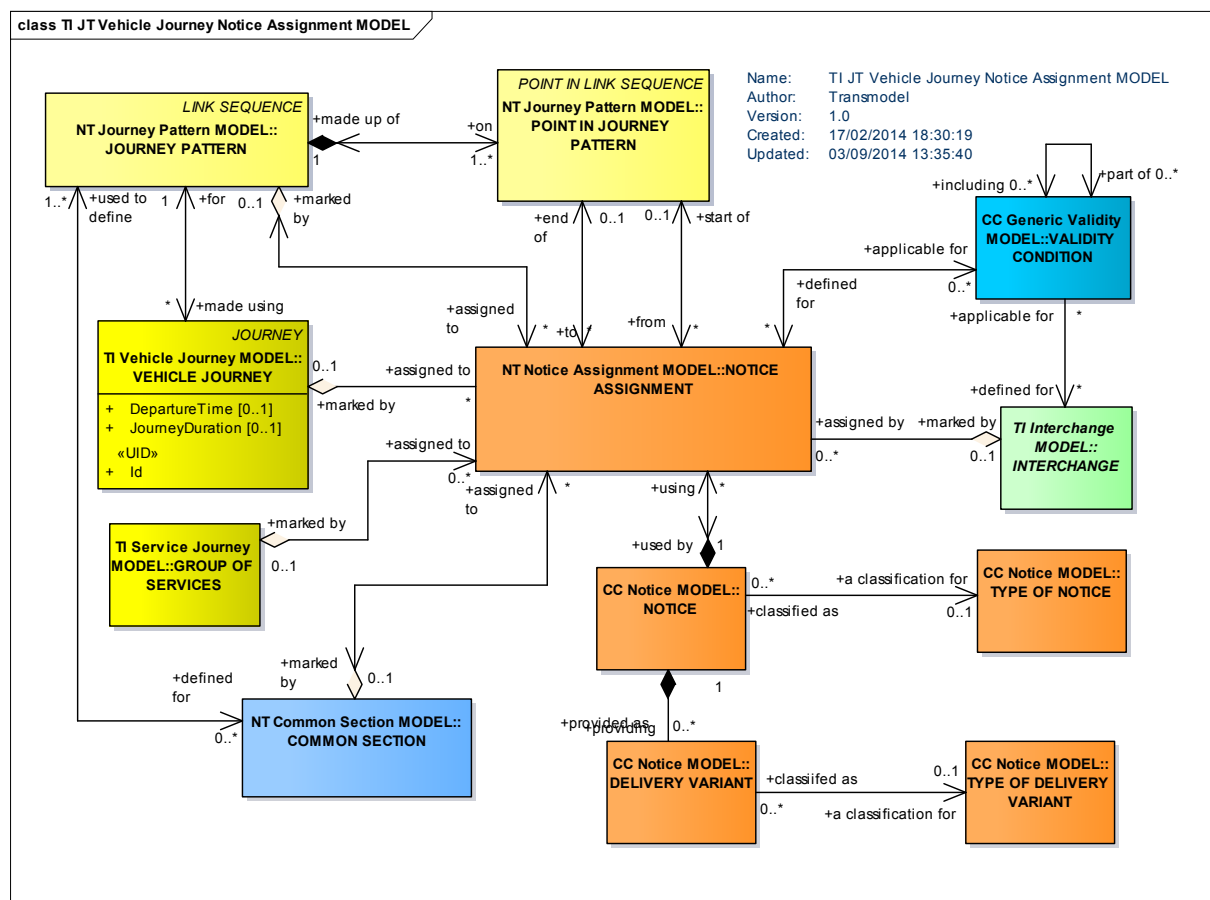


Figure 3 — Vehicle journey notice assignment – Conceptual model (UML)

### 5.3.2 Service journey

#### 5.3.2.1 SERVICE JOURNEY – Conceptual model

A SERVICE JOURNEY is a VEHICLE JOURNEY on which passengers will be allowed to board or alight from vehicles at stops. There are several different possible ways to define SERVICE JOURNEYS, in particular the two following:

- as the service between an origin and a destination, as advertised to the public;
- as the longest service during which a passenger is allowed to stay on the same vehicle.

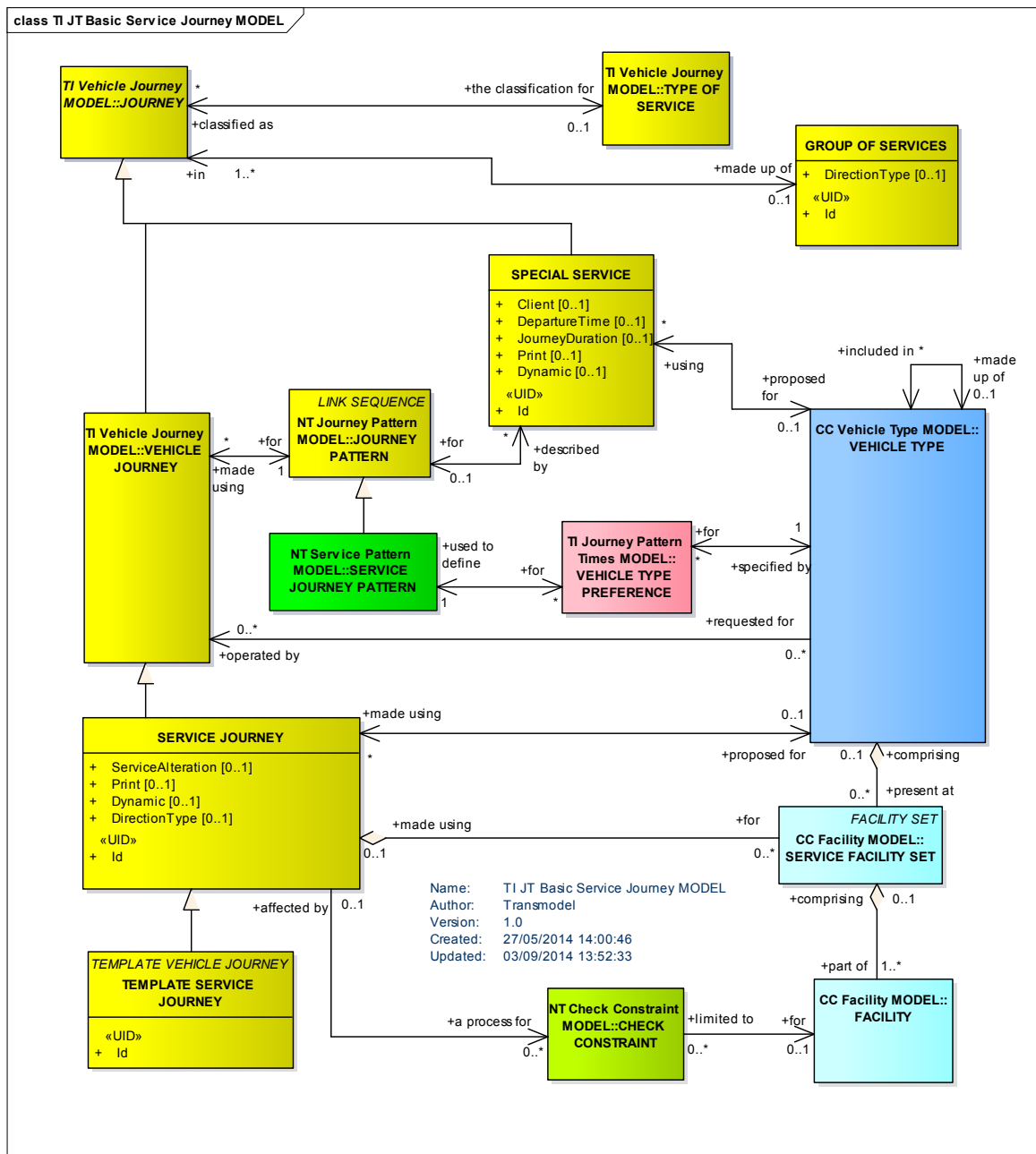


Figure 4 — Service journey – basic conceptual model (UML)

In addition to the distinction between SERVICE JOURNEYS and DEAD RUNS, operators may wish to classify VEHICLE JOURNEYS by further criteria. For these purposes a TYPE OF SERVICE may be assigned to a VEHICLE JOURNEY, which would express other common properties (e.g. “journey at the maximum load period”).

A default VEHICLE TYPE (cf. [7]) may be proposed for a journey, chosen according to the time of day at which a SERVICE JOURNEY takes place, and the ROUTE and JOURNEY PATTERN (cf. [8]) it covers. The proposed VEHICLE TYPE preferably will be taken into account by the scheduling algorithm used to compile blocks of vehicle operation. The choice of such a preference may take into account a ranked list of VEHICLE TYPEs for each SERVICE JOURNEY PATTERN. This is described by the class VEHICLE TYPE PREFERENCE, depending on a particular SERVICE JOURNEY PATTERN, for which a priority ‘rank’ is given for each VEHICLE TYPE, for each DAY TYPE and TIME DEMAND TYPE.

SERVICE JOURNEY INTERCHANGE (the scheduled possibility for transfer of passengers between two SERVICE JOURNEYS at the same or different SCHEDULED STOP POINTs) occurring on the SERVICE JOURNEY and facilities (grouped in a SERVICE FACILITY SET) available for the SERVICE JOURNEY, are also important related information, especially when advertising to the public.

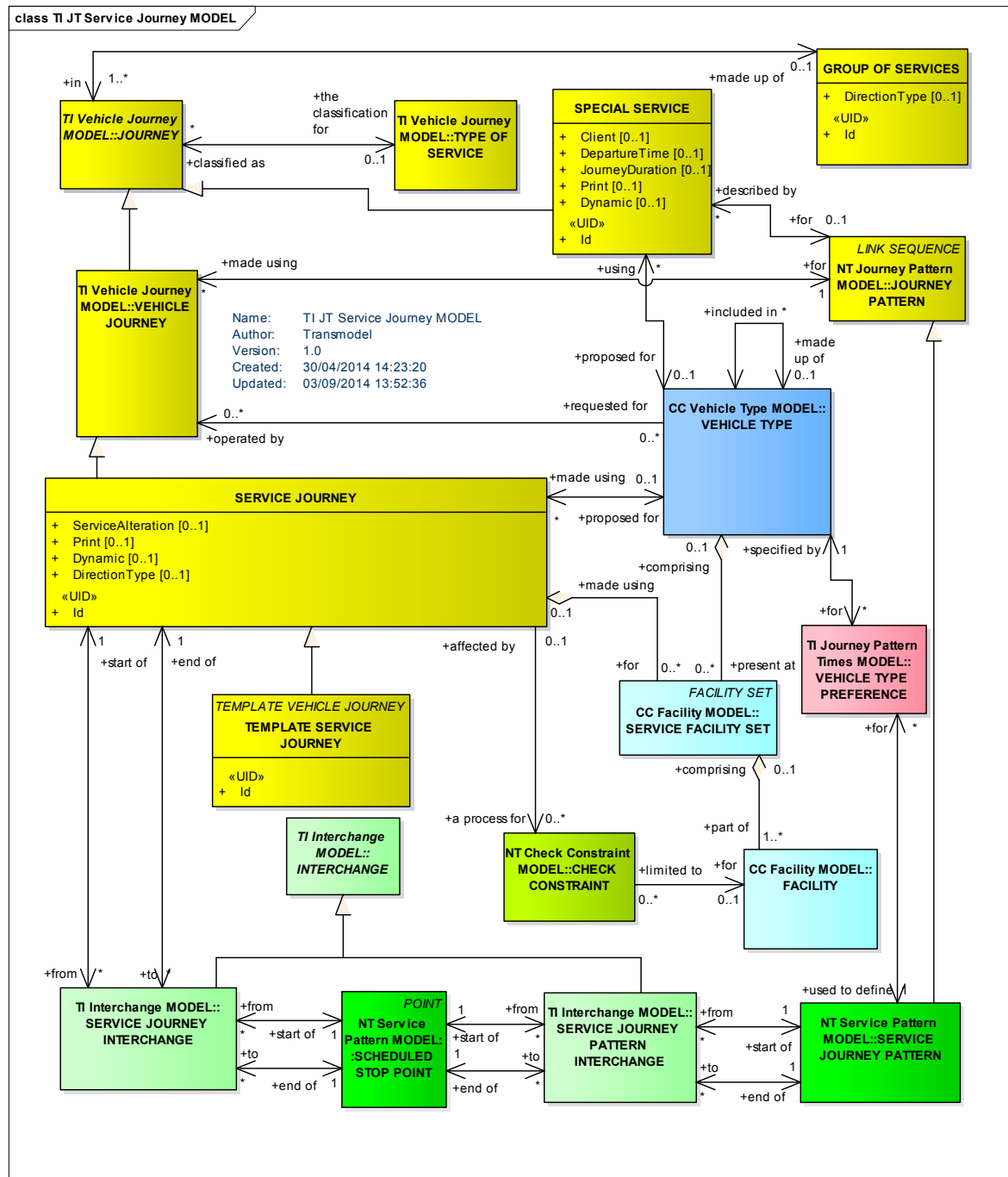


Figure 5 — Service journey – Conceptual model (UML)

### 5.3.2.2 Special services

Most public transport services are operated in a classical way, on a LINE grouping two or more SERVICE JOURNEY PATTERNS, along which passengers may board or alight at fixed stop points, paying fares

according to the fare system in use. However, some other types of service may be offered (school services, occasional services, demand-responsive services, etc.). They are usually named “special” services.

The differences between classical services and special services may refer to a number of different aspects, the most important being that the access rights to SPECIAL SERVICES may differ from the others. Besides occasional services for which the usual fare system applies (e.g. a football match), there are other services using a different system: special fares, access restricted to certain population groups (e.g. pupils from a particular school), etc. In some cases, the service is not directly ordered by the authority in charge of the classical services, but by another authority or by a particular client (which for instance books a bus for a trip or a whole day). Special services are generally not planned in a schedule designed for a DAY TYPE, though it may be the case for very regular services (e.g. school service planned between two SERVICE JOURNEYS). More often, they are added to the production plan for each particular operating day, according to the requirements for that day. The mission for a special service is usually not described using classical ROUTES and JOURNEY PATTERNS. Regular special services may have only a rough indication of their origin and destination, which is the case for most occasional services. Some places may play the role of SCHEDULED STOP POINT for a special service but are not registered as such by the operator, because no equipment (post or shelter) is installed, etc.

The entity SPECIAL SERVICE describes a service that is not operated in the classical way, i.e. differing from a VEHICLE JOURNEY by some characteristics. A SPECIAL SERVICE is a regular service planned for a DAY TYPE. It has as main attributes a ‘start time’ and an ‘end time’.

A SPECIAL SERVICE is characterized by a TYPE OF SERVICE, which allows various distinguishing categories of services, according to the needs of the user. This classification also allows distinguishing the DEAD RUNS necessary to perform the sold services. SPECIAL SERVICES are usually grouped into GROUPS OF SERVICES, which sometimes may be advertised (e.g. the school services may have a published number).

The mission corresponding to a special service may be described by a JOURNEY PATTERN, as classical VEHICLE JOURNEYS. This is the case for some relatively frequent services, using normal SCHEDULED STOP POINTS (e.g. service for football match). More frequently, they are only described by a ROUTE, often reduced to an origin and a destination POINTS. However, as these end points shall be TIMING POINTS, the mission of a SPECIAL SERVICE is described by a simplified JOURNEY PATTERN.

### 5.3.3 Time demand times

#### 5.3.3.1 TIME DEMAND times – Conceptual model

Run times and wait times vary during the day, depending in particular on traffic conditions and on the number of passengers boarding or alighting from vehicles at stops. A classification of these conditions into arbitrary levels of demand is defined by the TIME DEMAND TYPE concept (cf. [8]).

The TIME DEMAND TYPES mainly indicate situations like “peak hour traffic conditions”, “off-peak traffic”, “night-owl traffic” etc. In bus operation for instance, the duration of run times usually differs between these situations. Wait times at stops rather depend on the passenger demand, which also varies with the time of day, but in a very similar pattern to the traffic conditions on the roads. Therefore, the TIME DEMAND TYPE serves as an indicator to classify standard run times as well as wait times, depending on specific conditions.

Each VEHICLE JOURNEY takes place at a defined time which can be characterized by specific traffic conditions and a certain passenger demand level. To express these characteristics, a TIME DEMAND TYPE may be assigned to a VEHICLE JOURNEY, in order to choose easily the appropriate run and wait times.

Figure 7 represents timing information associated with the TIME DEMAND TYPE: RUN TIMES, WAIT TIMES, and a few other timing information like HEADWAY frequency, TURNAROUND TIME LIMIT and JOURNEY PATTERN LAYOVER.

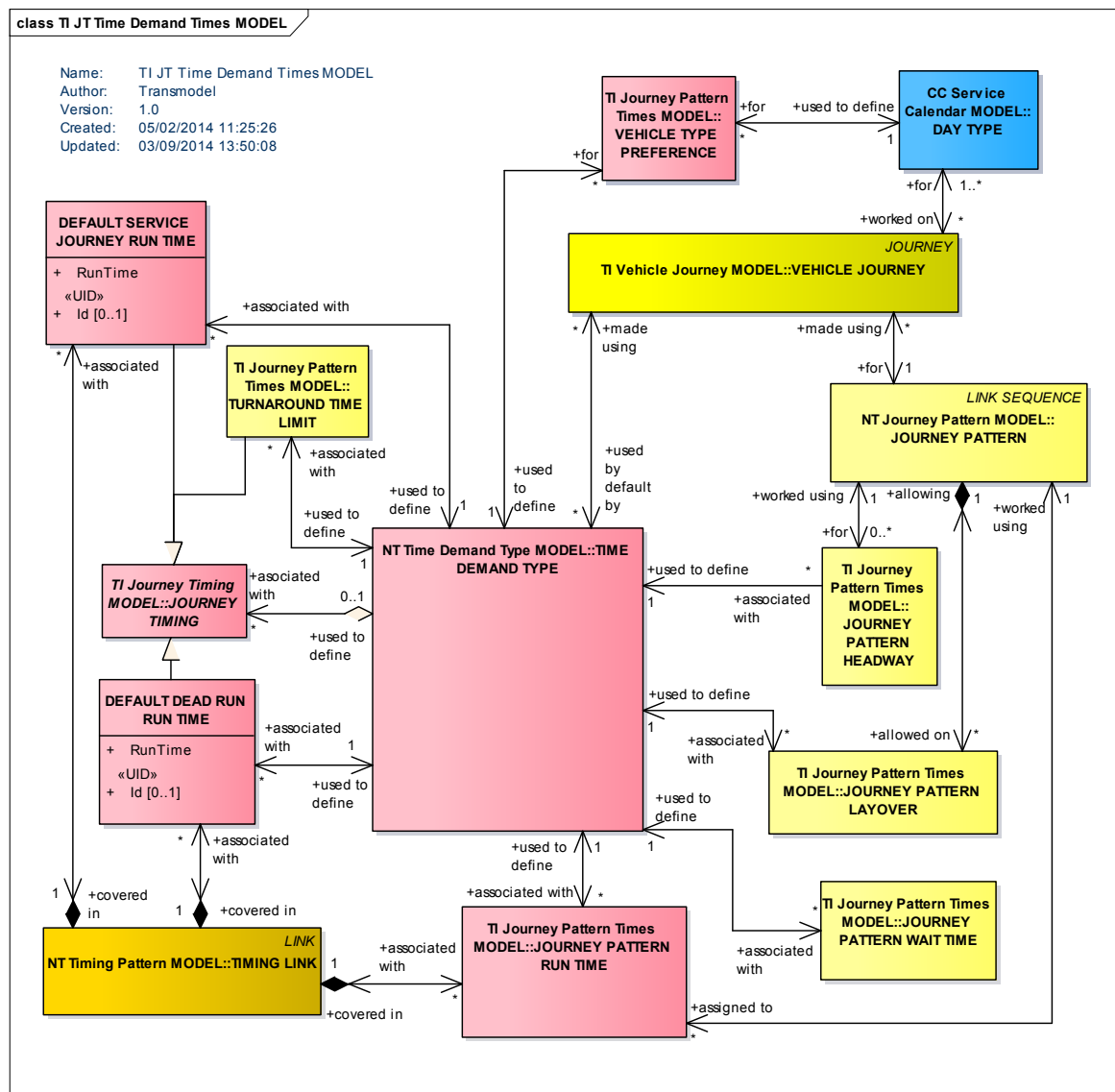


Figure 6 —Time demand times – Conceptual model (UML)

A set of DEFAULT RUN TIMES (for SERVICE JOURNEYS and DEAD RUNS) may be recorded for any TIMING LINK, one run time corresponding to one TIME DEMAND TYPE. If the TIMING LINK (cf. [8]) is used by several JOURNEY PATTERNS, the default times may be applied any time it is covered by a VEHICLE JOURNEY, regardless of the JOURNEY PATTERN.

A more precise control of run times is possible: a JOURNEY PATTERN RUN TIME is a run time for a TIMING LINK that will be valid only for VEHICLE JOURNEYS made on the specified JOURNEY PATTERN. It will override the default run times for this TIMING LINK.

JOURNEY PATTERN RUN TIMES are sets of run times for different TIME DEMAND TYPES. The TIME DEMAND TYPE for a particular VEHICLE JOURNEY is used to select the appropriate time from the set recorded for a particular TIMING LINK belonging to the JOURNEY PATTERN covered.

A JOURNEY PATTERN WAIT TIME may be recorded to define the time a vehicle will have to wait at a specified TIMING POINT, e.g. to allow a large number of passengers to board or alight, or to wait for a connecting vehicle on another LINE. These wait times depend on the JOURNEY PATTERN that the VEHICLE JOURNEY covers, and on the TIME DEMAND TYPE.

JOURNEY PATTERN WAIT TIMES may occur on DEAD RUNs also, e.g. at a certain TIMING POINT in a DEAD RUN PATTERN where the driver will be relieved.

A minimum layover time may be defined separately at the end of each JOURNEY PATTERN. This will be stored in the JOURNEY PATTERN LAYOVER entity, depending on a TIME DEMAND TYPE.

A turnaround time is the time taken by a vehicle to proceed from the end of a ROUTE to the start of another. The TURNAROUND TIME LIMIT is dependent on a TIME DEMAND TYPE and is stored against a pair of TIMING POINTs.

The VEHICLE TYPE PREFERENCE, depending on a particular SERVICE JOURNEY PATTERN, defines a priority 'rank' given for each VEHICLE TYPE, for each DAY TYPE and TIME DEMAND TYPE.

Lastly, HEADWAY JOURNEY GROUP (5.3.4 and 5.3.6) and JOURNEY PATTERN HEADWAY, used to define services based on headway frequencies (defined in 5.3.5), are both potentially dependent on TIME DEMAND TYPE.

### **5.3.4 Journey timing**

#### **5.3.4.1 JOURNEY TIMING – Conceptual model**

##### **5.3.4.1.1 General**

The JOURNEY TIMING model defines common properties for timing elements that can be specialized in the VEHICLE JOURNEY and JOURNEY PATTERN timing models.

A JOURNEY TIMING provides an abstract type for a number of different specialized types of timing information:

- JOURNEY LAYOVER;
- JOURNEY WAIT TIME;
- JOURNEY HEADWAY;
- JOURNEY RUN TIME;
- TURNAROUND TIME LIMIT;
- DEFAULT DEAD RUN TIME;
- DEFAULT SERVICE JOURNEY RUN TIME.

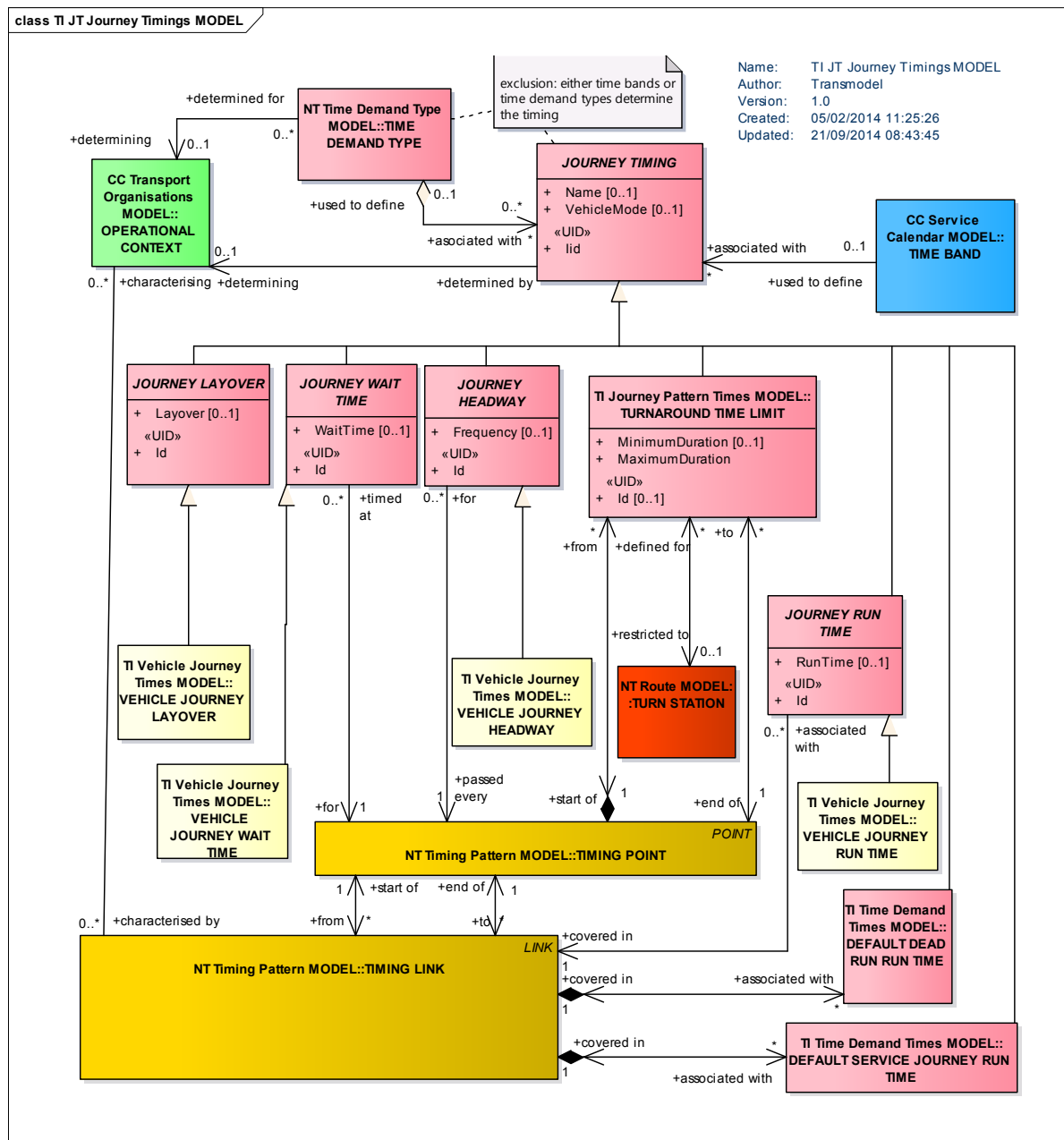


Figure 7 — Journey timing – Conceptual model (UML)

### 5.3.4.1.2 Layover times

LAYOVER TIMES describe a certain time allowance that may be given at the end of each VEHICLE JOURNEY, before starting the next one, to compensate for delays or for other purposes (e.g. rest time for the driver). This “layover time” can be regarded as a buffer time, which may or may not be actually consumed in real time operation.

A minimum layover time may be defined separately at the end of each JOURNEY PATTERN. This will be stored in the JOURNEY PATTERN LAYOVER entity, depending on a TIME DEMAND TYPE.

Such standard layover times may be superseded by a layover time defined for a specific VEHICLE JOURNEY.

#### 5.3.4.1.3 Wait times

A WAIT TIME may be recorded to define the time a vehicle will have to wait at a specified TIMING POINT, e.g. to allow a large number of passengers to board or alight, or to wait for a connecting vehicle on another LINE. These wait times depend on the JOURNEY PATTERN that the VEHICLE JOURNEY covers, and on the TIME DEMAND TYPE. JOURNEY PATTERN WAIT TIMES may occur on DEAD RUNS also, e.g. at a certain TIMING POINT in a DEAD RUN PATTERN where the driver will be relieved.

A JOURNEY WAIT TIME may be stored for each individual VEHICLE JOURNEY, at any TIMING POINT IN JOURNEY PATTERN, in the covered JOURNEY PATTERN.

A VEHICLE JOURNEY WAIT TIME, if it exists, overrides any JOURNEY PATTERN WAIT TIMES that may have been stored for the TIMING POINT in question.

#### 5.3.4.1.4 Headway times

Headway frequency information that is available for a VEHICLE JOURNEY supersedes the JOURNEY PATTERN HEADWAY. It has to be understood as the time interval between the previous and the next VEHICLE JOURNEY. This information shall be consistent with HEADWAY JOURNEY GROUP if available (HEADWAY JOURNEY GROUP being a more detailed way of describing headway services).

#### 5.3.4.1.5 Run times

A precise control of run times is possible by using the JOURNEY RUN TIME. It defines a run time for a TIMING LINK that will be valid only for specific VEHICLE JOURNEYS and overrides the default run times for this TIMING LINK.

JOURNEY RUN TIMES are sets of run times for different TIME DEMAND TYPEs. The TIME DEMAND TYPE for a particular VEHICLE JOURNEY is used to select the appropriate time from the set recorded for a particular TIMING LINK belonging to the JOURNEY PATTERN covered.

A VEHICLE JOURNEY RUN TIME is specific to one VEHICLE JOURNEY and applies to a particular TIMING LINK. If it exists, it overrides any run time that may have been stored for the TIMING LINK in question.

#### 5.3.4.1.6 Turnaround times

Another constraint to be taken into account in fixing layover times may be a maximal or minimal turnaround time. A turnaround time is the time taken by a vehicle to proceed from the end of a ROUTE to the start of another. There are some limitations for turnaround times, which are used as parameters by scheduling systems for the vehicle scheduling procedure.

The TURNAROUND TIME LIMIT is dependent on a TIME DEMAND TYPE and is stored against a pair of TIMING POINTs. These points represent a TIMING POINT where a vehicle may end a SERVICE JOURNEY and a TIMING POINT where a subsequent SERVICE JOURNEY may start from. The duration of a DEAD RUN (relating the two TIMING POINTs) possibly scheduled between these two SERVICE JOURNEYS is included in the turnaround time.

#### 5.3.4.1.7 Times for dead runs

The path to proceed from the end point of a SERVICE JOURNEY to the start point of the following is normally described by a DEAD RUN PATTERN. However, it is often not worth modelling explicitly a short movement as a DEAD RUN, covering an explicit DEAD RUN PATTERN. In such a case, a 'minimum duration' may be stored in the TURNAROUND TIME LIMIT, as the minimum time needed by a vehicle to cover this short path. This minimum duration will of course be superseded by the run times (plus wait times, if any) associated with an explicitly modelled DEAD RUN between the two TIMING POINTs concerned.

In the case of a SERVICE JOURNEY, there are SCHEDULED STOP POINTs in the JOURNEY PATTERN where passengers can board or alight from the vehicle. Therefore, run times probably will be different if a vehicle crosses a TIMING LINK during a SERVICE JOURNEY or a DEAD RUN. Default run times are hence recorded in two different entities: DEFAULT SERVICE JOURNEY RUN TIME and DEFAULT DEAD RUN RUN TIME.

Using these default run times, the timing information for each VEHICLE JOURNEY can be derived by looking for the TIMING POINTs in the associated JOURNEY PATTERN, accessing the TIMING LINKs between these TIMING POINTs and choosing the appropriate run time. These times will be found, for each TIMING LINK, in the DEFAULT SERVICE JOURNEY RUN TIME or DEFAULT DEAD RUN RUN TIME entity, according to the type of journey.

The choice among the run times recorded for one TIMING LINK is determined by the TIME DEMAND TYPE which has been assigned to the VEHICLE JOURNEY.

### **5.3.5 Journey pattern times**

#### **5.3.5.1 JOURNEY PATTERN TIMES – Conceptual model**

##### **5.3.5.1.1 Default times**

For any TIMING LINK, run times corresponding to one TIME DEMAND TYPE may be recorded. In some cases, such run times are default run times and if the TIMING LINK is used by several JOURNEY PATTERNs, the default times may be applied any time it is covered by a VEHICLE JOURNEY, regardless the JOURNEY PATTERN.

##### **5.3.5.1.2 Journey pattern run times**

A more precise control of run times than is possible by using default times at TIMING LINK level, can be achieved using JOURNEY PATTERN RUN TIMES. A JOURNEY PATTERN RUN TIME is a run time for a TIMING LINK that will be valid only for VEHICLE JOURNEYS made on the specified JOURNEY PATTERN. It overrides the default run times that might have been defined for this TIMING LINK.

JOURNEY PATTERN RUN TIMES are sets of run times for different TIME DEMAND TYPEs. The TIME DEMAND TYPE for a particular VEHICLE JOURNEY is used to select the appropriate time from the set recorded for a particular TIMING LINK belonging to the JOURNEY PATTERN covered.

A JOURNEY PATTERN WAIT TIME may be recorded to define the time a vehicle will have to wait at a specified TIMING POINT, e.g. to allow a large number of passengers to board or alight, or to wait for a connecting vehicle on another LINE. These wait times depend on the JOURNEY PATTERN that the VEHICLE JOURNEY covers, and on the TIME DEMAND TYPE.

##### **5.3.5.1.3 Layover times**

A certain time allowance may be given at the end of each VEHICLE JOURNEY, before starting the next one, to compensate delays or for other purposes (e.g. rest time for the driver). This “layover time” can be regarded as a buffer time on a specified JOURNEY PATTERN for the different TIME DEMAND TYPEs. This layover may be superseded by a specific VEHICLE JOURNEY LAYOVER.

##### **5.3.5.1.4 Frequency-based services**

In the case of frequency-based services, another type of information is needed, namely headway duration information. It is given by JOURNEY PATTERN HEADWAY that is available for all the VEHICLE JOURNEYS running on the JOURNEY PATTERN at the TIMING POINTs IN JOURNEY PATTERN depending upon the different TIME DEMAND TYPEs.

#### **5.3.5.1.5 Journey pattern wait times**

The JOURNEY PATTERN WAIT TIME represents the time a vehicle has to wait at a specific TIMING POINT IN JOURNEY PATTERN, for a specified TIME DEMAND TYPE. This wait time can be superseded by a VEHICLE JOURNEY WAIT TIME (described in 5.3.6).

#### **5.3.5.1.6 Vehicle type preference**

The VEHICLE TYPE PREFERENCE represents a default VEHICLE TYPE proposed for the journeys, depending on the JOURNEY PATTERN covered and the TIME DEMAND TYPE. It is not a truly temporal concept but has to be understood as a proposal to be taken into account for BLOCK compilation (described in 5.3.9.2 and 5.6.3.2). It may be a ranked list of VEHICLE TYPEs for each SERVICE JOURNEY PATTERN and for each DAY TYPE and TIME DEMAND TYPE.

#### **5.3.5.1.7 Operational context dependency**

Figure 10 provides a reminder that all this timing information is to be considered in a specific OPERATIONAL CONTEXT, that expresses the characterization of a set of operational objects, such as timing or links determined either by a DEPARTMENT or by an ORGANIZATIONAL UNIT (cf. [7]).

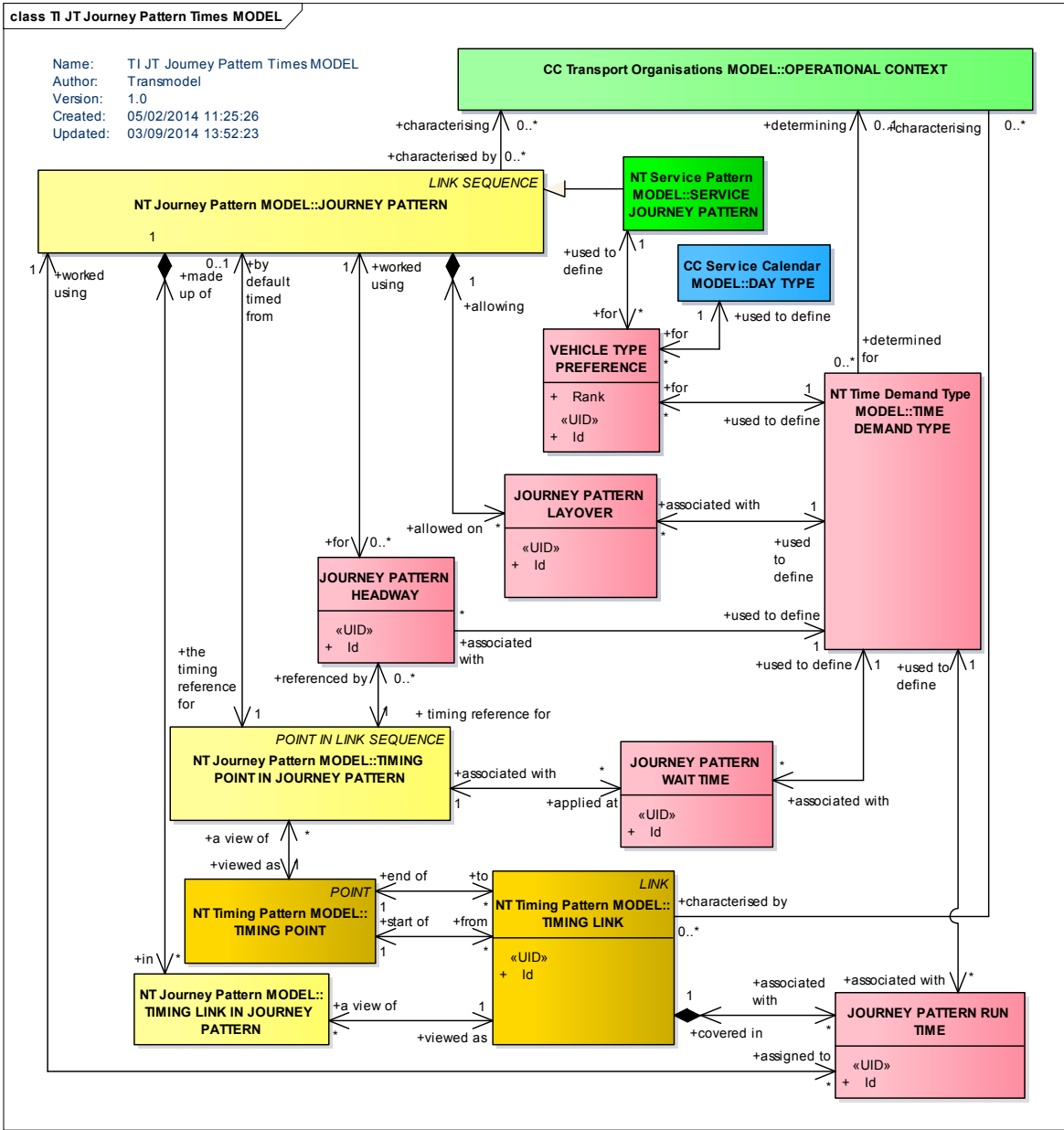


**Figure 8 — Journey Pattern Times - Conceptual Model (UML)**

### 5.3.6 Vehicle journey times

### 5.3.6.1 VEHICLE JOURNEY TIMES – Conceptual model

#### 5.3.6.1.1 Requirements for exceptions

There may be reasons for needing a more precise control of run and wait times than is possible using the standard times at JOURNEY PATTERN level. Some exception times may be required for a single VEHICLE JOURNEY. For instance, a vehicle may be slowed intentionally on a particular VEHICLE JOURNEY to meet a scheduled interchange. Some companies adjust the times (e.g. wait times, but even run times) to cope with driver scheduling regulations. In the case of a very long VEHICLE JOURNEY, e.g. in a rural area, a single TIME DEMAND TYPE may not apply to the whole journey, because traffic conditions change substantially between its start and end.

It is hence necessary to be able to override the standard times by times for a specific VEHICLE JOURNEY.

#### **5.3.6.1.2 Journey timing overview**

A number of specializations of JOURNEY TIMING are used to provide VEHICLE JOURNEY:

- VEHICLE JOURNEY RUN TIME is the time taken to traverse a specified TIMING LINK IN JOURNEY PATTERN on a specified VEHICLE JOURNEY. This gives the most detailed control over times and overrides the DEFAULT SERVICE JOURNEY RUN TIME, the JOURNEY PATTERN RUN TIME and the DEFAULT DEAD RUN RUN TIME.
- VEHICLE JOURNEY WAIT TIME is the time for a vehicle to wait at a particular TIMING POINT IN JOURNEY PATTERN on a specified VEHICLE JOURNEY. This wait time will override the JOURNEY PATTERN WAIT TIME.
- VEHICLE JOURNEY LAYOVER is the time allowance at the end of a specified VEHICLE JOURNEY. This time supersedes any global layover or JOURNEY PATTERN LAYOVER.
- VEHICLE JOURNEY HEADWAY is the headway frequency information that is available for a VEHICLE JOURNEY (to be understood as the time interval between the previous and the next VEHICLE JOURNEY).

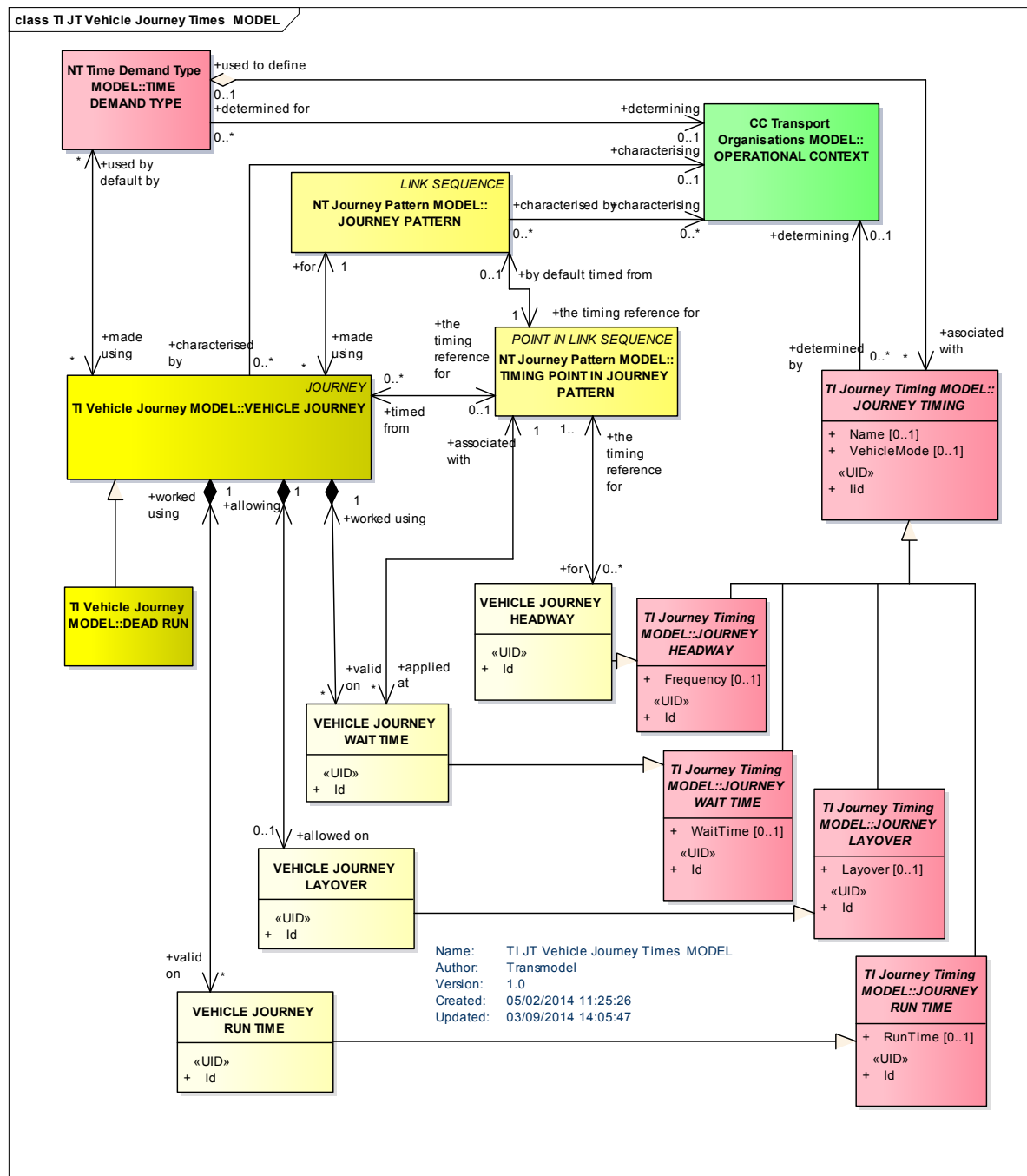


Figure 9 — Vehicle journey times — Conceptual model (UML)

A more detailed model of frequency-based services is discussed in the next section.

### 5.3.6.2 Frequency based service- Conceptual model

Two different types of services are commonly found, representing journeys with a particular behaviour as to the regularity of their timing.

One of them is the common frequency-based service, based on the concept of HEADWAY INTERVAL, i.e. a regular interval duration between the journeys such as 'every 10 min', for example.

Another possibility is that of a particular ‘rhythm’ occurring over every hour, for example, services running at ‘xx10’, ‘xx25’, ‘xx45’ past each hour.

In either case a TEMPLATE VEHICLE JOURNEY is associated with a JOURNEY FREQUENCY GROUP to represents a group of JOURNEYS running at the given frequency. Such behaviour can be conditional upon the TIME DEMAND TYPE and TIME BAND.

Often in passenger information systems there is a requirement to show multiple journeys as a single column in a timetable for example “And then every 20 minutes until 6 pm”. The model allows groups of journeys to be aggregated using a TEMPLATE JOURNEY and an overall frequency to be specified for them, using either a HEADWAY JOURNEY GROUP (e.g. *‘every 10 min’*) or a RHYTHMICAL JOURNEY GROUP – one that runs at a regular interval past each hour (for example *‘xx10’*, *‘xx25’* and *‘xx45’*).

Even though every scheduled VEHICLE JOURNEY has a specific set of PASSING TIMES that it will run to, these will not necessarily be revealed to the passenger and a JOURNEY FREQUENCY can be used to present the journey as frequency based.

For passenger information purposes it is possible to consider a TEMPLATE VEHICLE JOURNEY without any concrete VEHICLE JOURNEYS.

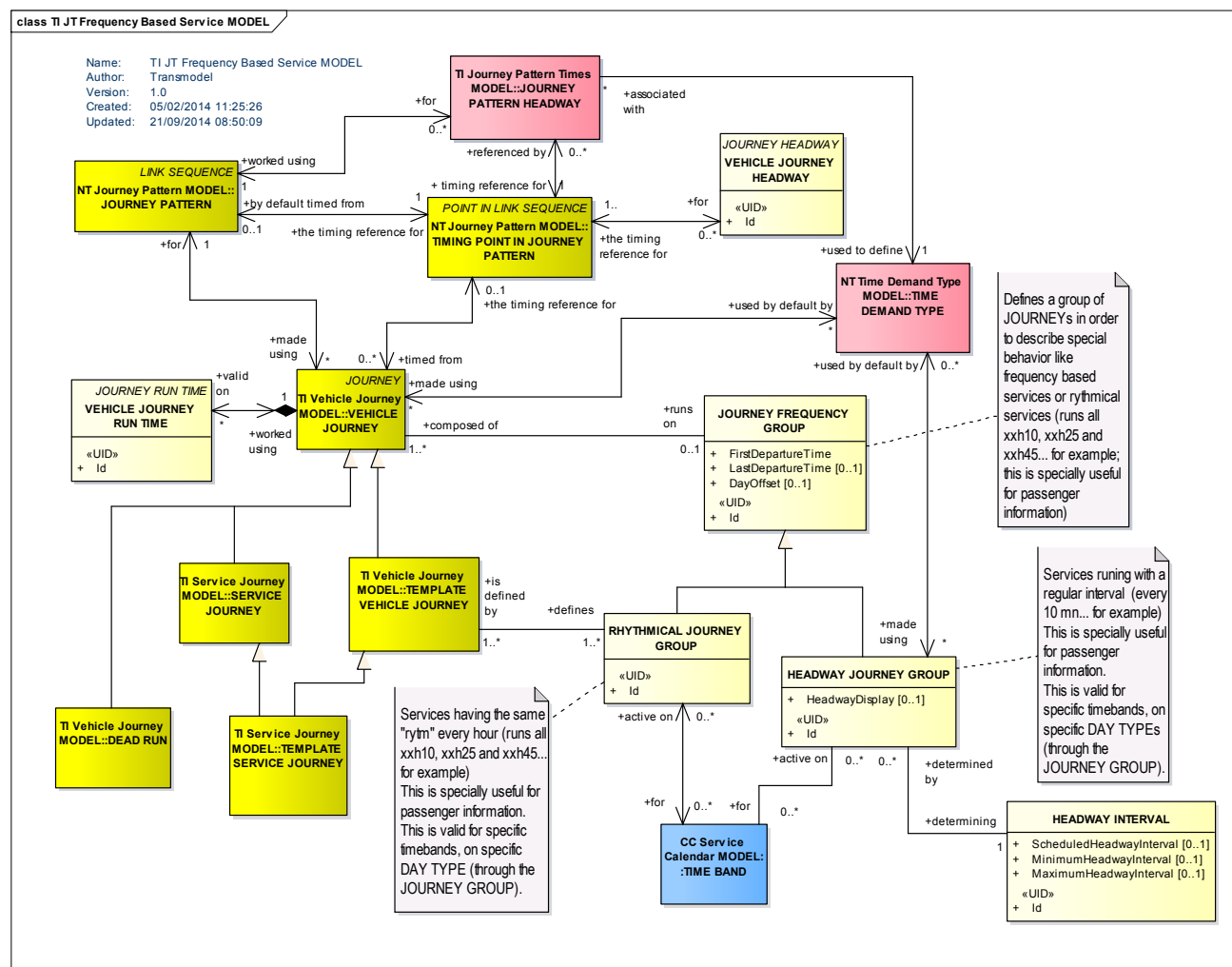


**Figure 10 — Vehicle journey frequency - Conceptual model (UML)**

## 5.3.7 Interchange

### 5.3.7.1 INTERCHANGE – Conceptual model

#### 5.3.7.1.1 Interchange, connection and navigation path

In order to reach the destination of a trip if there is no direct service between the origin and the destination SCHEDULED STOP POINTs, a passenger will have to interchange between vehicles. A transfer will be necessary where the passenger will leave the vehicle at a particular SCHEDULED STOP POINT and enter another vehicle (which serves another SERVICE JOURNEY, usually on a different LINE (cf. [8]) at the same or another SCHEDULED STOP POINT.

Each SERVICE JOURNEY INTERCHANGE involves two different SERVICE JOURNEYS. The passenger makes the transfer from a feeder SERVICE JOURNEY to a distributor (“fetcher”) SERVICE JOURNEY.

Sometimes both SERVICE JOURNEYS are planned to stop at exactly the same SCHEDULED STOP POINT but in other cases there are two different (but nearby) SCHEDULED STOP POINTs involved. In such a case, these SCHEDULED STOP POINTs will often (but need not necessarily) belong to the same STOP AREA. Passengers will have to walk a certain distance after disembarking from the feeder SERVICE JOURNEY to reach the stop position of the distributor SERVICE JOURNEY.

A CONNECTION (cf. [8]) expresses that there is a possible walking link that is suitable for a passenger to interchange from one public transport vehicle to another between two specified SCHEDULED STOP POINTs and the time allocated for a passenger to traverse the link.

Software used to control guaranteed interchanges can use the time information given for using a CONNECTION to calculate how long a distributor SERVICE JOURNEY needs to wait after a fetcher SERVICE JOURNEY has arrived before it can depart. If no specific CONNECTION is available, timings from a DEFAULT CONNECTION may be used.

The CONNECTION time information could also be used for passenger information such as in travel planners, however sometimes more detailed information about timings and suitable paths adapted to the individual traveller’s specific preferences and capabilities is necessary. In that case additional information can be retrieved from attributes related to the physical model, such as PATH LINKs and NAVIGATION PATHs (cf. [8]).

#### 5.3.7.1.2 Interchange specific aspects

In some cases, a SERVICE JOURNEY INTERCHANGE expresses an interchange between two SERVICE JOURNEYS specifically planned to be operated by the same physical vehicle. This concept is for instance used for circular lines and coupled journeys. This means that passenger information should be adapted to the fact that the passenger should not change vehicle as the transfer is implicit. In this case it is also important that operation control staff are aware of the consequences to passengers if the operation is altered in such a way that two different vehicles are used for the two SERVICE JOURNEYS involved.

In real-time operation, interchanges that are advertised to the public should be controlled. For instance, vehicles may sometimes have to wait if the arriving vehicle for an interchange is delayed. The company will probably define certain rules and instructions for drivers on how to react in case of deviations from the planned schedule.

The SERVICE JOURNEY INTERCHANGE may be used to store some information on the planned interchange between two SERVICE JOURNEYS such as if it is advertised or not, if it is guaranteed or not and the maximum time a vehicle may wait for a connecting vehicle, beyond the planned departure time.