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Javni prevoz - Referenčni podatkovni model - 4. del: Spremljanje delovanja in nadzor

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

Öffentlicher Verkehr - Referenzdatenmodell - Teil 4: Betriebsüberwachung und Steuerung

Transports publics - Modèle de données de référence - Partie 4: Suivi et contrôle de l'exploitation

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English Version

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

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European foreword

This document (EN 12896-4:2026) has been prepared by Technical Committee CEN/TC 278 “Intelligent transport systems”, 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of an identical text or by endorsement, at the latest by January 2027 and conflicting national standards shall be withdrawn at the latest by January 2027.

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 supersedes EN 12896-4:2019.

Annex D provides details of the significant technical changes between this document and EN 12896-4:2019.

This document is part of the European Standard series EN 12896, known as “Transmodel”. This is a series of documents that comprises the following parts:

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

— EN 12896-2, Public transport - Reference data model - Part 2: Public transport network

— EN 12896-3, Public transport - Reference data model - Part 3: Timing information and vehicle scheduling

— EN 12896-4, Public transport - Reference data model - Part 4: Operations monitoring and control

— EN 12896-5, Public transport - Reference data model - Part 5: Fare management

— EN 12896-6, Public transport - Reference Data model - Part 6: Passenger information

— EN 12896-7, Public transport - Reference data model - Part 7: Driver management

— EN 12896-8, Public transport - Reference data model - Part 8: Management information and statistics

— EN 12896-10, Public transport – Reference data model – Part 10: Alternative modes

Together these documents create Transmodel version 6.2 and thus replace Transmodel V6.0.

In addition to the nine normative Parts of this European Standard, a Technical Report (Public Transport – Reference Data Model – Informative Documentation) was published in 2016 under the reference CEN/TR 12896-9. It provides 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 soon as all the normative parts are revised.

The split into several documents is intended to ease the task of users interested in particular functional domains. It corresponds to the modularisation of Transmodel into functionally related parts, each made up of distinct UML packages and subpackages that describe a particular aspect of public transport. The NeTEx UML model follows the same modularisation, allowing a direct mapping from the conceptual model to the implementation.

For information on the conventions, methodology and notations for conceptual modelling, for a clear overview to help understand the core principles, structure and purpose of Transmodel, and for information on the Functional domains and Modes of operation, refer to EN 12896-1.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

This document incorporates the following main data packages:

— Dated Production Components;

— Call;

— Dated Call;

— Production Plan;

— Detecting & Monitoring;

— Situation;

— Messaging;

— Control Action;

— Operational Event & Incident;

— Facility Monitoring & Availability;

— Occupancy.

It is composed of the following parts:

— main document representing the data model for the concepts shared by the different domains covered by Transmodel (normative);

— Annex A containing the data dictionary and attribute tables, i.e. the list of all the concepts presented in the main document together with their definitions (normative);

— Annex B presenting the model evolution (informative);

— Annex C detailing the mapping to DATEX-II and SIRI (informative).

— Annex D, providing details of the significant technical changes between this document and EN 12896-4:2019 (informative).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

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

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

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

3.1.1
relief
person taking the place of another person as responsible for a certain task (such as driving a bus)

3.2 Abbreviations

API	Application Programming Interface
AVM	Automatic Vehicle Monitoring
AVMS	Automated Vehicle Management System
GIS	Geographical Information System
GPS	Global Positioning System
HTTP	Hypertext Transfer Protocol
IFOPT	Identification of Fixed Objects in Public Transport
ISO	International Organization for Standardization
IT	Information Technology
NeTEx	Network and Timetable Exchange
PT	Public Transport
PTO	Public Transport Operator
OJP	Open API for Distributed Journey Planning
OpRa	Operating Raw Data and statistics exchange
SIRI	Service Interface for Real-time Information
SIRI— FM	Service Interface for Real-time Information Facility Monitoring (see CEN/TS 15531-4)
SIRI— SX	Service Interface for Real-time Information Situation Exchange (see CEN/TS 15531-5)
TM	Transmodel
UML	Unified Modelling Language
URI	Uniform Resource Identifier
URL	Universal Resource Locator
VDV	Verband Deutscher Verkehrsunternehmen (Germany)
WGS	World Geodetic Standard

4 General information

The following standards are based on the Transmodel conceptual data model for public transport domain to provide a harmonized, interoperable, and consistent approach for public transport data, service interfaces, and journey planning across Europe:

— EN 15531 series [10] to [16] – Service interfaces for real-time public transport operations.

— CEN/TS 16614 series (NeTEx) [17] to [22] – Network and timetable data exchange, including passenger information and accessibility.

— CEN/TS 17118 [23] – Open API for distributed journey planning.

5 Operations monitoring and control

5.1 Introduction

The operational management of public transport is classically divided into two distinct phases:

— a “tactical planning” phase, consisting of designing and building a reference schedule (described in EN 12896-2, Public transport - Reference data model - Part 2: Public transport network and EN 12896-3, Public transport - Reference data model - Part 3: Timing Information and Vehicle Scheduling); and

— a further phase of adapting the reference schedule to the real operating conditions, in a plan that is constantly updated during the operating day. This phase is known as “real-time control”.

Note that in the first phase, the “tactical planning” phase, data are typically handled on a macroscopic level describing significant parts of the intended operation as complete sets of coherent data. It is possible to prepare multiple complete sets of coherent data in parallel, reflecting different planning strategies on a higher level, with one such set selected to be the base for the operation on a certain day for a certain scope. In this case, the concept of organizing data into VERSION FRAMEs (as described in EN 12896-1, Public transport - Reference data model - Part 1: Common concepts) is useful as it provides a mechanism to work with, and choose between, coherent sets of data at a higher level for pre-selected scopes.

In the second phase, the “real-time control” phase, the higher-level plan is already partly in operation; the movement of real-world passengers, vehicles and personnel has already started, and the current plan cannot easily be replaced in its entirety with a different pre-prepared plan. Instead, changes to compensate for disturbances of different kinds need to be applied gradually and individually, taking the current position of personnel and vehicles into consideration. In this case the VERSION FRAME concept is of less relevance.

The data collected during real time operations is a constant source of information related to the theoretical reference schedules and is thus likely to be used as feedback to adapt them. The boundary between these two phases (tactical planning and real-time control) is, in most cases, fixed arbitrarily. It may take place at the beginning of the operating day, two days in advance, when the drivers are rostered, etc. Such a limit is often marked by the freezing of a “production plan”, which will be the reference for real-time control on a whole operating day.

The reference schedule is optimized to fit specified service quality objectives (e.g. frequency, punctuality, crowding or interchange management) whilst respecting operational constraints (e.g. constraints due to driver or vehicle management). However, it can only define an optimal plan in average operating conditions. When these average conditions are no longer present (e.g. because of disturbances such as change in traffic conditions, failures, incidents, etc.), it becomes necessary to carry out “control actions”, to compensate for the service deterioration.

It is commonly accepted that real-time control aims to relate operations to the reference schedule. However, if the situation is far from the average conditions, then the reference schedule is no longer a standard to be respected; in this case only the service quality objectives remain, guiding the control actions, modifying the reference schedule, and possibly resulting in a complete rescheduling.

Modern public transport networks are equipped with automated tools able to facilitate real-time control, usually named Automatic Vehicle Monitoring systems (AVMS). The main functions of an AVMS in the control process are:

— locating vehicles, with regard to the PT network and possibly to the infrastructure;

— controlling tolerance thresholds with respect to the service objectives, in order to help the controller in the detection of disturbances and to help the driver maintain the timetable or headway;

— controlling data and voice exchanges, for information of controllers, drivers and passengers;

— handling of (technical or operational) alarms;

— providing assistance for the design of control actions;

— computing data for traveller information (e.g. estimated passing times);

— various activation functions (e.g. traffic light priority); and

— collecting data for statistical purposes (e.g. observed run times).

The modelling requirements imply distinguishing some important abstract concepts, in particular:

— physical resources (e.g. a particular driver) and logical resources (e.g. a theoretical anonymous vehicle); and

— various states of the work plan, particularly the latest valid work plan (e.g. as ordered by the controller), the monitored situation (e.g. as monitored by the AVMS) and the expected situation (as forecasted, from the monitored situation and the plans).

5.2 Dated operational plans

5.2.1 Principles

Operations require an operational plan for each OPERATING DAY. Such dated plans are elaborated in anticipated time, on a short-term horizon (a few days or possibly a few weeks before the day of operations) and frequently updated. They are usually derived from tactical plans for DAY TYPEs. The latter are assigned to OPERATING DAYs, according to rules taking into account the characteristics of the considered calendar (see SERVICE CALENDAR described in EN 12896-1, Public transport - Reference data model - Part 1: Common concepts) and the PROPERTies OF DAY assigned to each OPERATING DAY. The composition of dated plans is rather similar to the composition of plans for day types (see in particular Dated Journey Model in EN 12896-2, Public transport - Reference data model - Part 2: Public transport network and EN 12896-3, Public transport - Reference data model - Part 3: Timing Information and Vehicle Scheduling). However, they include a lot of information that cannot be planned easily on a regular basis: occasional special services, results of the personnel disposition process (in particular planned rest days or other absences), etc. See Figure 1.

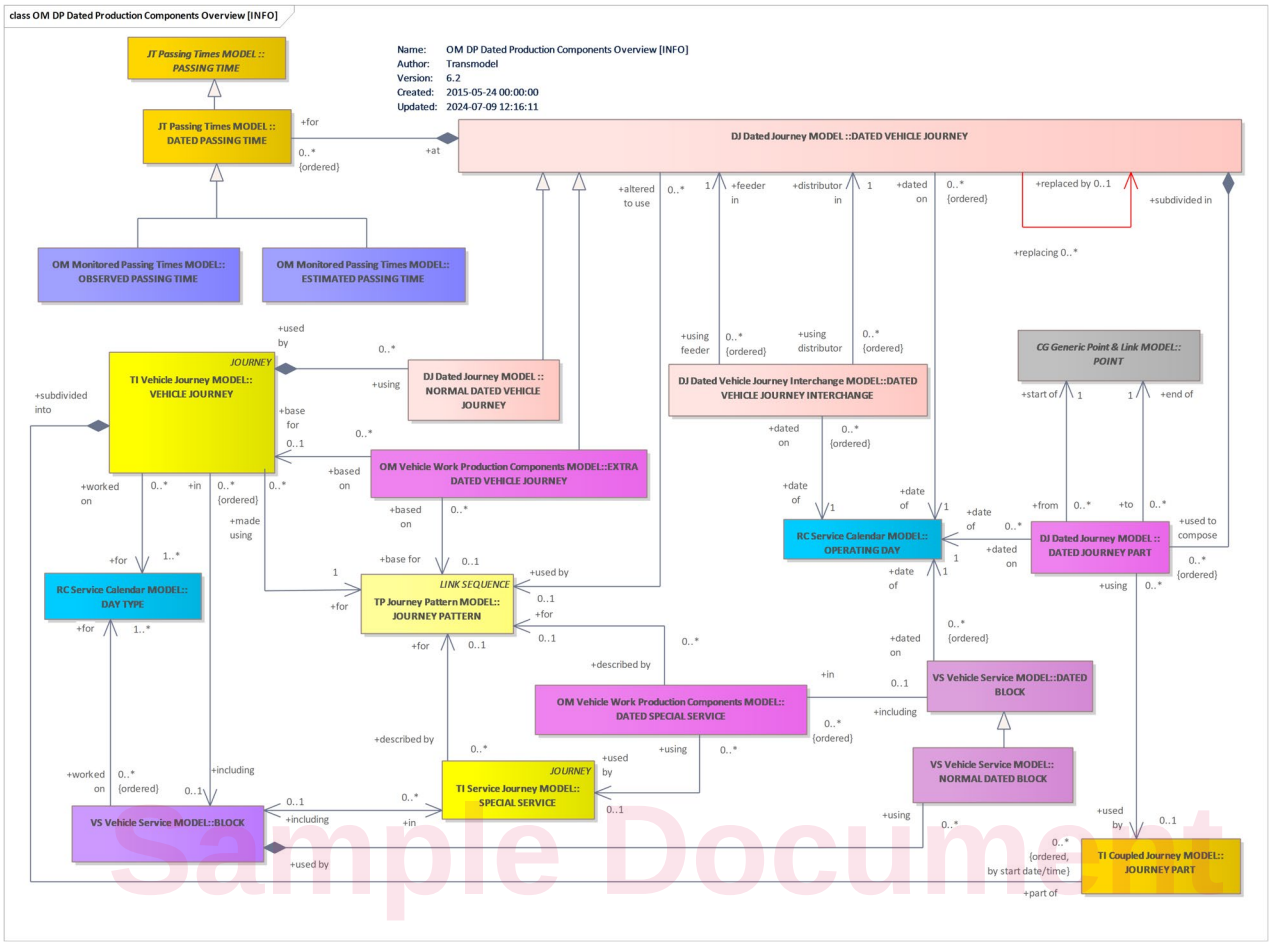

Figure 1 — Dated Production Components MODEL (overview)

Dated plans are constantly updated according to the available information. It is a common practice to freeze and store a conventional version of such a plan, a short time before the beginning of the OPERATING DAY. This version represents the PRODUCTION PLAN (see 5.2.7), serving as a reference for the production follow-up. Drivers are often rostered according to such a PRODUCTION PLAN. Moreover, the data transferred to the AVMS application is usually extracted from the PRODUCTION PLAN. During the OPERATING DAY, further modifications (CONTROL ACTIONs) occur, due to various events affecting the operations (failures, delays, absences, etc.).

Most monitoring systems constantly record a “latest valid plan”, which reflects all modifications to the operational plan that have been entered and validated up to now. This dynamic plan forms, in particular, the basis to inform the drivers, to adapt their driving to the plan.

5.2.2 Vehicle work production components

5.2.2.1 Dated journeys and special services

There are many reasons which lead to modification of the operational plan in the short-term: special events; changes in the road infrastructure; incidents; etc. Some DATED VEHICLE JOURNEYs may be added or deleted, may use alternative or shortened ROUTEs and JOURNEY PATTERNs, occasional services may be added, etc. If these changes are only valid for one or a few days, the reference schedule for a DAY TYPE is sometimes not modified, instead the changes are applied using CONTROL ACTIONs for the appropriate OPERATING DAYs. See Figure 2.

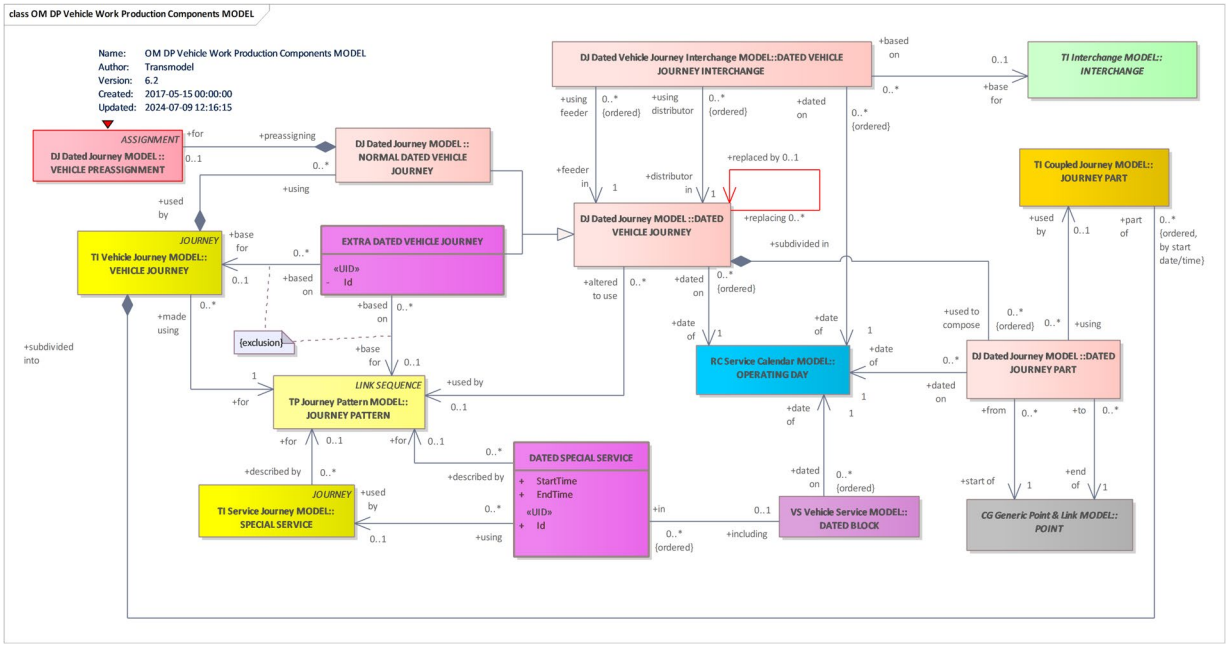

Figure 2 — Vehicle Work Production Components MODEL

The entity DATED VEHICLE JOURNEY describes a vehicle journey planned for one specific OPERATING DAY.

A NORMAL DATED VEHICLE JOURNEY is a pre-planned DATED VEHICLE JOURNEY. Thus, it is based on a VEHICLE JOURNEY constructed during the scheduling process, and that is planned to be run on the OPERATING DAY in question according to its DAY TYPE. If there is no disturbance in the service, these normal journeys will be an exact image of the theoretical plan, applied to the specific OPERATING DAY. However, short-term modifications may be applied to these journeys, for instance when the controller decides to let a vehicle turn before the terminus. This means that the last part of the vehicle's current journey is cancelled as well as the first part of the vehicle's next journey in the other direction. One way of doing this is by applying two PARTIAL JOURNEY CANCELLATION control actions (see 5.5.3.5). Such CONTROL ACTIONs update the latest valid plan and produce modified versions of the relevant DATED VEHICLE JOURNEYs.

Additional DATED VEHICLE JOURNEYs may be included in the PRODUCTION PLAN for an OPERATING DAY by applying the JOURNEY CREATION control action (see 5.5.3.2). Such EXTRA DATED VEHICLE JOURNEYs could be created from scratch, or by duplication of an existing journey with modification of the departure time, for instance. Sometimes EXTRA DATED VEHICLE JOURNEYs are based on existing JOURNEY PATTERNs. An EXTRA DATED VEHICLE JOURNEY may, for instance, correspond to a reinforcement of the service, or result from a complete rescheduling.

There are also situations when EXTRA DATED VEHICLE JOURNEYs are created to complement a DATED VEHICLE JOURNEY that is already running, but that will not be completed due to mechanical failures or large delays of the originally assigned vehicle. Sometimes such a replacement EXTRA DATED VEHICLE JOURNEY that is working the latter JOURNEY PARTs of the planned VEHICLE JOURNEY can be run at the same time as the original vehicle is still working to complete the first JOURNEY PARTs of the same planned VEHICLE JOURNEY.

A DATED VEHICLE JOURNEY serves one JOURNEY PATTERN. Any NORMAL DATED VEHICLE JOURNEY for which the working pattern has not been modified by a CONTROL ACTION will serve the JOURNEY PATTERN of its parent VEHICLE JOURNEY. In case of modification, the new JOURNEY PATTERN of the DATED VEHICLE JOURNEY is specified either by a reference to an existing JOURNEY PATTERN exactly matching the modification, or by a description of the relative modifications in relation to the original

JOURNEY PATTERN. The same applies to EXTRA DATED VEHICLE JOURNEYs; they can be described with a reference to an existing JOURNEY PATTERN that matches the intended JOURNEY PATTERN exactly, or by a reference to an existing JOURNEY PATTERN in combination with a description of relative modifications in relation to this JOURNEY PATTERN.

The classification of JOURNEY PATTERNs through TYPE OF JOURNEY PATTERN may include some categories of occasional JOURNEY PATTERNs, to be used only by extra or modified DATED VEHICLE JOURNEYs (e.g. for occasionally shortened or deviated routes).

The entity DATED VEHICLE JOURNEY has an attribute ‘departure time’. In case of a NORMAL DATED VEHICLE JOURNEY, this time will be the same as for the parent VEHICLE JOURNEY, unless modifications of this departure time have been ordered.

DATED SPECIAL SERVICEs are created following the same principles. Regular services will be derived from a SPECIAL SERVICE planned for a DAY TYPE. In most cases, DATED SPECIAL SERVICEs will be extra (occasional) special services, valid only for the considered OPERATING DAY.

5.2.2.2 Dated blocks

The changes made in the DATED VEHICLE JOURNEYs often generate changes in the BLOCKs planned for a DAY TYPE. Therefore, it is necessary to define DATED BLOCKs, which will be valid only on a specific OPERATING DAY (see EN 12896-3, Public transport - Reference data model - Part 3: Timing Information and Vehicle Scheduling).

Most of the DATED BLOCKs will be identical to an existing BLOCK, possibly with some modifications. These DATED BLOCKs are called NORMAL DATED BLOCKs, with a relationship with the parent BLOCK.

If an extra journey is planned, this may invoke the need for a new vehicle to come from a garage, in which case a complete new (extra) DATED BLOCK is created from scratch.

A DATED BLOCK shall in principle include DATED VEHICLE JOURNEYs or DATED SPECIAL SERVICEs. When a NORMAL DATED BLOCK is generated, it includes the journeys and services present in the planned (reference) BLOCK.

However, there may be changes during the OPERATING DAY and the complete set of DATED VEHICLE JOURNEYs, normal and extra, presently or historically, included in certain DATED BLOCKs. It may be possible to deduce, by checking the VEHICLE WORK ASSIGNMENT CONTROL ACTIONs, which LOGICAL VEHICLEs are related to which DATED BLOCKs and DATED VEHICLE JOURNEYs.

In common with the DATED VEHICLE JOURNEY, a DATED BLOCK has a specific identifier (ID), in addition to the OPERATING DAY foreign key.

5.2.2.3 Dated vehicle journey interchanges

The entity DATED VEHICLE JOURNEY INTERCHANGE describes an INTERCHANGE between two DATED VEHICLE JOURNEYs (see EN 12896-3, Public transport - Reference data model - Part 3: Timing Information and Vehicle Scheduling). Often it is the result of a planned SERVICE JOURNEY INTERCHANGE or the application of an INTERCHANGE RULE, but it can also be the result of a CONTROL ACTION.

Short-term modifications may be applied to DATED VEHICLE JOURNEY INTERCHANGEs, for instance when the controller decides to extend the time span that the distributor VEHICLE should wait for the feeder VEHICLE, cancels a DATED VEHICLE JOURNEY INTERCHANGE or adds a new DATED VEHICLE JOURNEY INTERCHANGE to the PRODUCTION PLAN for an OPERATING DAY.

5.2.3 Dated vehicle service

In addition to the DATED BLOCK that represents the work of a logical vehicle on a particular OPERATING DAY from the time it leaves a PARKING POINT after parking until its next return to park at a PARKING POINT, there is also a concept that allows the operators to distinguish additional sequences of DATED BLOCKs starting and ending in a garage (i.e. the end points shall be GARAGE POINTs). Such a DATED VEHICLE SERVICE PART may be composed, for instance, of two DATED BLOCKs, separated by a parking period spent, without any driver, at a PARKING POINT which is not a GARAGE POINT (e.g. parking periods at off-peak hours for buses, at a parking point in the city).

The whole work of a LOGICAL VEHICLE for an OPERATING DAY is described by a DATED VEHICLE SERVICE, composed of one or several DATED VEHICLE SERVICE PARTs. See Figure 3.

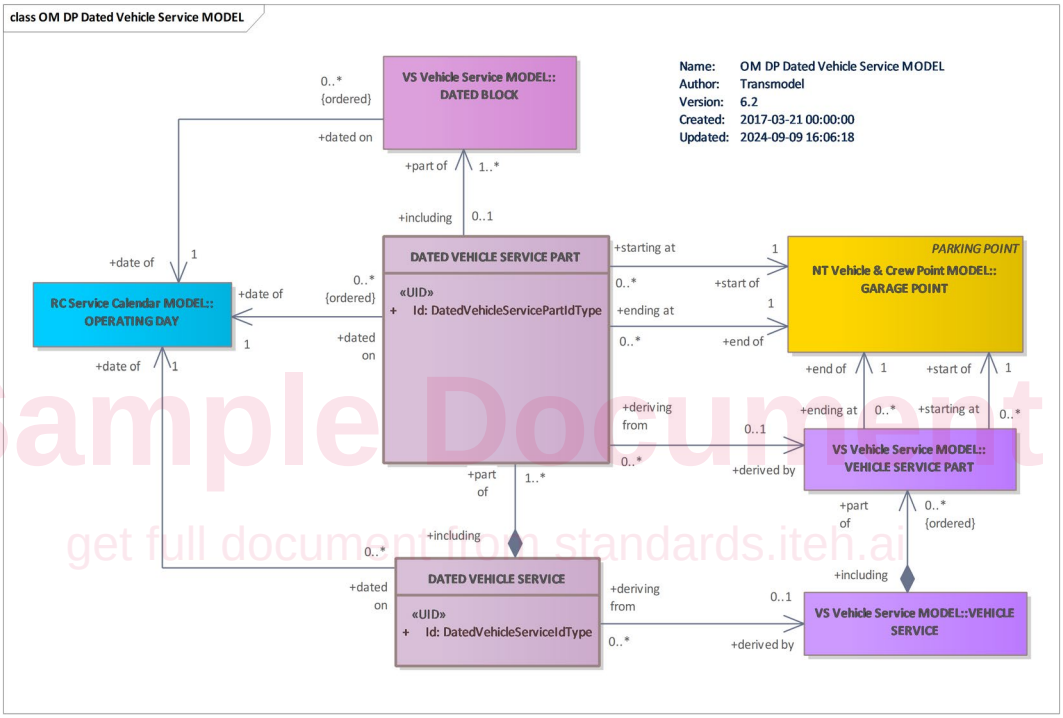

Figure 3 — Dated Vehicle Service MODEL

However, many users of the reference model will not implement these three levels (DATED BLOCK, DATED VEHICLE SERVICE PART and DATED VEHICLE SERVICE) of activities. The concept of DATED VEHICLE SERVICE is not strictly necessary, once the number of required vehicles has been optimized and, in many situations, the distinction between DATED BLOCK and DATED VEHICLE SERVICE PART is not useful. Therefore, in an organization data model, two or all three concepts may be merged in a single concept (e.g. DATED BLOCK).

5.2.4 Call

Transmodel is in principle built out of elementary entities, not ones that are derived or aggregated. One of the few exceptions to this rule is the CALL concept which provides a general view that simplifies the grouping of some types of commonly used data. See Figure 4.