DEUTSCHE NORM

Dezember 2016

DIN EN 12896-1

ICS 35.240.60

Mit DIN EN 12896-2:2016-12 und
DIN EN 12896-3:2016-12
Ersatz für
DIN EN 12896:2008-02

Öffentlicher Verkehr – Datenreferenzmodell – Teil 1: Gemeinsame Konzepte; Englische Fassung EN 12896-1:2016

Public transport –
Reference data model –
Part 1: Common concepts;
English version EN 12896-1:2016

Transports publics –
Modèle de données de référence –
Partie 1: Concepts communs;
Version anglaise EN 12896-1:2016

Gesamtumfang 138 Seiten

DIN-Normenausschuss Automobiltechnik (NAAutomobil)
DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

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Full document details: DIN EN 12896-1:2016-12

Nationales Vorwort

Dieses Dokument (EN 12896-1:2016) wurde vom Technischen Komitee CEN/TC 278 „Intelligente Transportsysteme“ ausgearbeitet, dessen Sekretariat vom NEN (Niederlande) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Gemeinschaftsarbeitsausschuss NA 052-00-71 GA „Intelligente Verkehrssysteme“ des Normenausschusses Automobiltechnik.

Das Präsidium des DIN hat mit seinem Beschluss 1/2004 festgelegt, dass von dem in den Regeln der europäischen Normungsarbeit von CEN/CENELEC verankerten Grundsatz, wonach Europäische Normen in den drei offiziellen Sprachen Deutsch, Englisch und Französisch veröffentlicht werden, in begründeten Ausnahmefällen abgewichen und auf die deutsche Sprachfassung verzichtet werden kann.

Dienste im öffentlichen Verkehr verlassen sich zunehmend auf Informationssysteme, um Zuverlässigkeit, einen effizienten Betrieb und einen weitgehenden Zugriff auf zuverlässige Passagierinformationen sicherzustellen. Diese Systeme werden für die folgenden Anwendungen genutzt:

— Bereitstellung von Fahrplänen;

— Steuerung der Fahrzeugflotte;

— Ausstellung von Tickets und Quittungen;

— Bereitstellung von Echtzeitinformationen (Ankunft, Abfahrt, etc.).

Diese Normenreihe verbessert eine Reihe von Informationseigenschaften im öffentlichen Verkehr, wie Interoperabilität zwischen Informationsprozesssystemen der Transportbetreiber und Behörden, indem ähnliche Definitionen, Strukturen und Bedeutungen deren Systemdaten benutzt werden. Das bezieht sich sowohl auf die Verbindung verschiedener Anwendungen innerhalb einer Organisation als auch auf die Verbindung von Anwendungen zwischen verschiedenen Organisationen.

Diese Normenreihe erlaubt Betreibern, Behörden und Softwarelieferanten eine einfachere Zusammenarbeit in der Herstellung integrierter Systeme.

Änderungen

Gegenüber DIN EN 12896:2008-02 wurden folgende Änderungen vorgenommen:

a) Dokument zum Transmodel V5.1 wird in insgesamt 8 Teile aufgeteilt;

b) dieser Teil beschreibt die gemeinsamen Konzepte;

c) alle neuen Teile ergeben die Version 6 des Transmodels.

Frühere Ausgaben

DIN EN 12896: 2008-02

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Nationaler Anhang NA
(informativ)

Begriffe

Für dieses Dokument gelten die folgenden Begriffe und Definitionen

3.1
Attribut
(en: attribute)
Eigenschaft einer Einheit

3.2
konzeptuelles Datenmodell
(en: conceptual data modell)
Beschreibung einer realen Domain in Bezug auf Einheiten, Beziehungen und Attributen in implementierungsunabhängiger Art und Weise eine Struktur bereitstellen sollte, auf der der Rest einer Systemanwendungsentwicklung basiert werden kann

3.3
konzeptuelles Niveau
(en: conceptual level)
in Bezug auf Datenmodellierung das konzeptuelle Datenmodell

3.4
Datenbank
(en: database)
Datensammlung, die oftmals im Sinne der physikalischen Implementierung eines Datenmodells verwendet wird

3.5
Datendomain
(en: data domain)
Datenstruktur (in dieser europäischen Norm ein Teil des Referenzdatenmodells für den öffentlichen Verkehr), das aus aufeinander bezogenen Daten zusammengesetzt wurde, basierend auf der Tatsache, dass ein funktionelles Gebiet oder eine Gruppe von Funktionen besteht, welche(s) die Datenmenge als Ganzes nutzt(en)

3.6
Datenmodell
(en: data modell)
Beschreibung einer realen Domain in Bezug auf Daten und Beziehungen

3.7
Einheit
(en: entity)
(Daten-)Objekt, das seine eigene Existenz hat (im Gegensatz zu einem Attribut)

3.8
Fahrgeldmanagement
(en: fare management)
alle Aktivitäten, die auf das Sammeln von Geld von Fahrgästen bezogen sind

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3.9
Funktion
(en: function)
Aktivität, bzw. in dieser europäischen Norm eine Unteraktivität eines funktionellen Gebietes

3.10
funktionales Gebiet
(en: functional area)
zufällig festgelegte Menge von Aktivitäten, die in dieser europäischen Norm zur Festlegung von Zielen und Grenzen des Datenmodells verwendet wird

3.11
geografische Dateien
GDF
(en: geographical files)
Standard, welcher den Inhalt und das Format von geographischen Dateien festlegt und zur Beschreibung, Klassifizierung und Verschlüsselung von Straßennetzen und Straßenumgebungseigenschaften verwendet wird

3.12
Datenbank für geografische Dateien
(en: GDF database)
Datenbank, die geografische Informationen des Straßennetzwerks in einem spezifischen Anwendungsgebiet beinhaltet sowie möglicherweise Informationen über Positionen von Punkten des öffentlichen Verkehrs, Verbindungen und Diensten (Routen)

3.13
Interoperabilität
(en: interoperability)
Fähigkeit von (Sub-)Systemen mit anderen (Sub-)Systemen anhand vordefinierter Regeln zu interagieren (Schnittstelle)

3.14
logisches Datenmodell
(en: logical data model)
Datendesign, das den verwendeten Datenbanktypen, aber nicht die Mittel für die Verwendung von Platz oder Zugriff berücksichtigt

3.15
logisches nichtnormalisiertes Modell
(en: logical denormalised model)
relationales Datenmodell, das nicht vollständig normalisiert ist, das heißt nicht vollständig den Normalisierungsregeln folgt und redundant sein könnte

3.16
logisches Niveau
(en: logical level)
in Bezug auf Datenmodellierung das logische Datenmodell

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3.17
Betriebsinformationen
(en: management information)
alle Aktivitäten, die es dem Management einer Firma erlauben, Informationen zu sammeln, die zur Problemlösung notwendig sind

Anmerkung 1 zum Begriff: Daten von Betriebssystemen werden zu diesem Zweck gefiltert und aggregiert und dem Nutzer interaktiv oder in Form von vordefinierten Berichten und Zusammenfassungen zur Verfügung gestellt werden. Solche Funktionen sind prinzipiell mit allen funktionellen Gebieten einer Firma verbunden, besonders mit der Steuerung statistischer Ergebnisse.

3.18
objektorientiertes Datenmodell
(en: object-oriented data model)
Datenstruktur, die nach den Prinzipien ausgedrückt wird, die eine direkte Implementierung als objektorientierte Datenbank erlaubt, in der Informationen in Form von Objekten dargestellt wird, das heißt speziell unter Berücksichtigung von Einbindungsprinzipien, mit denen alle Daten über dazugehörige Operationen (Methoden) zugreifen oder verändern können

3.19
Betriebsüberwachung und Steuerung
Echtzeitsteuerung
(en: operations monitoring and control, real-time control)
alle auf den Transportprozess bezogenen Aktivitäten wie z. B. Echtzeitfunktionen, die auf das Fahren und den Transport von Passagieren nach gegebenen Anweisungen bezogen sind, inklusive der Überwachung des Fahrprozesses und dessen Steuerung im Falle von Abweichungen sowie alle Aktivitäten, die den Fahrprozess unterstützen (Prioritätssteuerung von Ampeln, Fahrwegschaltung, Bahnsteigauswahl, Vorab/Verzögerungsempfehlung usw.)

Anmerkung 1 zum Begriff: Diese Funktionen werden im Allgemeinen von computerunterstützten Werkzeugen begleitet, die als automatische Fahrzeugüberwachung (AVM, en: Automated Vehicle Monitoring) bekannt sind.

3.20
Fahrgastinformationen
(en: passenger information)
alle Aktivitäten, die der Information des Nutzers entweder zur geplanten oder zur gegenwärtigen Beförderung dienen

3.21
Disposition des Personals
(en: personnel disposition)
alle Aktivitäten, die sich auf das mittelfristiges oder langfristiges Fahrermanagement beziehen

3.22
bezogenes Datenmodell
(en: relational data model)
Typ eines logischen Datenmodells, welches Informationen als Reihe von Tabellen (Beziehungen) und Attributen bereitstellt

Anmerkung 1 zum Begriff: Es weist die folgenden Charakteristiken auf: 1. Alle Attributwerte sind atomar, 2. Alle „Tupels“ (Reihen/Auftritte) sind eindeutig, 3. Kein Teil des primären Schlüssels darf Null sein, 4. Fremde Schlüsselwerte entsprechen einem bestehenden Primärschlüssel in einer anderen Beziehung oder Null.

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3.23
taktische Planung
Ablaufplanung
(en: tactical planning, scheduling)
alle Aktivitäten, die sich auf die taktische Planung des Transports, wie Aufteilung des Fahrzeugablaufs, Fahrereinteilung, Dienstpläne, beziehen

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12896-1

September 2016

ICS 35.240.60

Supersedes EN 12896:2006

English Version

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

Transports publics - Modèle de données de référence - Partie 1: Concepts communs

Öffentlicher Verkehr - Datenreferenzmodell - Teil 1: Gemeinsame Konzepte

This European Standard was approved by CEN on 5 May 2016.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 12896-1:2016 E

Documents
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Full document details: DIN EN 12896-1:2016-12

Contents

Page

European foreword ... 5
0 Introduction ... 6
0.1 Rationale for the Transmodel Standard ... 6
0.2 Use of the Transmodel Standard ... 6
0.3 Applicability of the Transmodel Standard ... 7
0.3.1 General ... 7
0.3.2 Specification of information architecture ... 7
0.3.3 Specification of a database ... 8
0.3.4 Specification of an interface ... 8
0.4 Conformance statement ... 8
0.5 Transmodel origins ... 9
0.5.1 ENV 12896 ... 9
0.5.2 Titan ... 9
0.5.3 SITP and SITP2 ... 9
0.5.4 CEN TC 278 WG 3 SG 4 ... 9
0.6 Reference to the previous version and other projects and documents ... 10
0.6.1 General ... 10
0.6.2 SIRI ... 10
0.6.3 IFOPT ... 10
0.6.4 NeTEx ... 10
0.7 Typographic conventions ... 10
0.8 Methodology for conceptual modelling ... 11
0.8.1 General ... 11
0.8.2 Packages ... 11
0.8.3 Class diagrams ... 13
0.8.4 Classes and attributes ... 14
0.8.5 Association relationships ... 17
0.8.6 Reflexive association relationship ... 17
0.8.7 Composition association relationship ... 18
0.8.8 Aggregation association relationship ... 18
0.8.9 Generalization association relationship ... 19
0.9 Summary of rules for Transmodel representation ... 19
1 Scope ... 21
1.1 General scope of the Standard ... 21
1.2 Functional domain description ... 22
1.2.1 Public transport network and stop description ... 22
1.2.2 Timing information and vehicle scheduling ... 22
1.2.3 Passenger information ... 23
1.2.4 Fare management ... 23
1.2.5 Operations monitoring and control ... 24
1.2.6 Management information ... 24
1.2.7 Multi-modal operation aspects ... 25
1.2.8 Multiple operators' environment aspects ... 25
1.2.9 Personnel management: driver scheduling, rostering, personnel disposition ... 25
1.3 Particular scope of this document ... 26

Documents
Document Sharing Hub
Full document details: DIN EN 12896-1:2016-12

2 Normative references ... 26
3 Terms and definitions ... 26
4 Abbreviations ... 29
5 Common concepts domain ... 29
5.1 Introduction to the common concepts ... 29
5.2 Versions and validity ... 31
5.2.1 Introduction ... 31
5.2.2 Version and validity – Model overview ... 32
5.2.3 Generic entity ... 32
5.2.4 Generic version ... 33
5.2.5 Generic version frame ... 34
5.2.6 Generic validity ... 36
5.2.7 Generic delta model ... 37
5.3 Responsibility ... 38
5.3.1 Introduction ... 38
5.3.2 Responsibility – Model overview ... 39
5.3.3 Generic responsibility ... 39
5.3.4 Responsibility role ... 41
5.3.5 Generic organization ... 42
5.4 Explicit frames ... 43
5.4.1 Composite frame ... 44
5.4.2 General frame ... 45
5.4.3 Resource frame ... 46
5.4.4 Service calendar frame ... 47
5.4.5 Other explicit frames ... 48
5.5 Generic framework model ... 49
5.5.1 General ... 49
5.5.2 Generic framework – Model overview ... 49
5.5.3 Location Model ... 49
5.5.4 Generic grouping - Introduction ... 50
5.5.5 Generic point and link ... 52
5.5.6 Generic point and link sequence ... 55
5.5.7 Generic zone and feature ... 56
5.5.8 Generic projection ... 58
5.5.9 Generic place ... 63
5.5.10 Accessibility ... 64
5.6 Reusable Components ... 67
5.6.1 General ... 67
5.6.2 Reusable components – Model overview ... 67
5.6.3 Transport Mode ... 68
5.6.4 Transport Submode ... 69
5.6.5 Service calendar ... 69
5.6.6 Availability condition ... 71
5.6.7 Topographic place ... 72
5.6.8 Transport organizations ... 73
5.6.9 Additional organizations ... 74
5.6.10 Generic equipment ... 76
5.6.11 Vehicle type ... 78
5.6.12 Actual vehicle equipment ... 79
5.6.13 Vehicle passenger equipment ... 80
5.6.14 Facility ... 81

AVA Documents
Document Sharing Hub

Full document details: DIN EN 12896-1:2016-12

5.6.15 Train 82
5.6.16 Schematic map 85
5.6.17 Notice 86
5.6.18 Service restriction 87
5.6.19 Alternative name 88

Annex A (normative) Data Dictionary 90

Annex B (informative) Status of the Textual Descriptions and Model Evolution 128

Bibliography 132

Documents
Document Sharing Hub
Full document details: DIN EN 12896-1:2016-12

European foreword

This document (EN 12896-1:2016) 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 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 12896-2:2016 and EN 12896-3:2016 supersedes EN 12896:2006.

The series comprises 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 is intended 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.

Documents
Document Sharing Hub

Full document details: DIN EN 12896-1:2016-12

0 Introduction

0.1 Rationale for the Transmodel Standard

Public transport services rely increasingly on information systems to ensure reliable, efficient operation and widely accessible, accurate passenger information. These systems are used for a range of specific purposes: setting schedules and timetables, managing vehicle fleets, issuing tickets and receipts, providing real time information on service running, and so on.

This standard will improve a number of features of public transport information and service management: in particular, the standard will facilitate interoperability between information processing systems of the transport operators and agencies by using similar definitions, structures and meanings for their data for the systems being part of one solution. This applies both to connecting different applications within an organization, and also to connecting applications between interworking organizations (for instance, a public authority and a transport operator).

The Transmodel standard presented in this European Standard provides a framework for defining and agreeing data models, and covers the whole area of public transport operations. By making use of this European Standard, and of data models derived from it, it will be possible for operators, authorities and software suppliers to work together much more easily towards integrated systems. Moreover, the breadth of the standard will help to ensure that future systems' developments can be accommodated with the minimum of difficulty.

0.2 Use of the Transmodel Standard

This European Standard presents version **6.0** of the European Standard EN 12896, known as "Transmodel". Transmodel **6.0** is a reference standard which provides a conceptual data model for use by organizations with an interest in information systems for the public transport industry.

As a reference standard, it is not necessary for individual systems or specifications to implement Transmodel as a whole.

It needs to be possible to describe (for those elements of systems, interfaces and specifications which fall within the scope of Transmodel):

— the aspects of Transmodel that they have adopted;

— the aspects of Transmodel that they have chosen not to adopt.

Transmodel may prove of value to:

— organizations within the public transport industry that specify, acquire and operate information systems;

— organizations that design, develop and supply information systems for the public transport industry.

For an organization within the public transport industry wishing to specify, acquire and operate information systems, Transmodel may be distilled, refined, or adapted to form a comprehensive data model for the organization. This will enable the organization to specify its database structures and/or its system interfaces, in such a way that separate modules can be openly tendered but will still integrate easily. The organization also has a greater likelihood that information exchange interfaces with external organizations will be easily achieved.

For an organization wishing to design, develop and supply information systems for the public transport industry, Transmodel may be distilled, refined, or adapted to form a comprehensive data model for the product suite. This will enable the organization to develop its products in such a way that separate

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modules will integrate easily, but also so that they may be sold separately to clients seeking Transmodel-compliant systems.

Transmodel is a large and complex model, and allows for great flexibility. Consequently it takes some skills and resource to apply it effectively in order to develop the physical data model and its implementations for a particular aspect, e.g. one particular functional domain, such as vehicle scheduling or fare management or for a particular interface, as between a ticket machine and a management system, or a particular organizational boundary, as between two connecting transport operators.

For such situations, Transmodel provides a wider setting and a starting point. The specific elements of Transmodel have to be refined, attributes and data formats will have to be completed, for a specific sub-model of the Transmodel data model. The resulting specification, although specific, will facilitate the built of a coherent overall systems framework, since it will coexist more readily with other Transmodel-based specifications.

For all of these potential users, the adoption of Transmodel as a basis for development means that a common language is being used. Thus, users will understand and assess the claims of suppliers better, and specification developers will be more likely to be working in alignment with each other.

0.3 Applicability of the Transmodel Standard

0.3.1 General

Transmodel may be applied to any framework for information systems within the public transport industry, but there are three circumstances to which it is particularly suited:

— specification of an organization's 'information architecture';

— specification of a database;

— specification of a data exchange interface.

0.3.2 Specification of information architecture

An 'information architecture' refers to the overall structure of information used by an information system, which is used to determine:

— the structure of data held in system databases;

— the structure of data exchanged across interfaces between systems.

It may be used as a strategic guide to system planning and evolution, and as the basis for the specification and acquisition of individual systems.

An information architecture made up of independent modules with well-defined interfaces is easier to maintain. A malfunctioning module can be taken out of service or completely replaced without disrupting the rest of the system. This is particularly beneficial for online or safety critical systems. The modules can also be more easily reconfigured on to hardware located elsewhere on the network to fit in with changes in organizational arrangements for managing the business and data administration processes.

The information architecture itself should be evaluated from time to time to make sure that it is still meeting the needs of the organization. Technological changes in communications and computing are continuously bringing forward new opportunities for evolving the systems supporting the business.

Documents
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0.3.3 Specification of a database

At a more technical level, an organization's systems will have a collection of data in one or more databases, which may be associated with individual applications or may be common to many applications.

In either case, Transmodel can serve as a starting point for the definition of a database schema, which will be used for the physical implementation of databases. Whether applications access a common database built to this schema, or have their own databases and exchange data built to consistent schemas, the use of an overall reference data model assists integration.

Technical constraints (such as memory capacity restrictions of smart cards) may affect the detail and complexity of the data models that can be used in particular data storage devices. Transmodel does not itself specify a level of detail to adopt.

0.3.4 Specification of an interface

Public transport organizations may require different applications to exchange data with each other. Also, public transport organizations may exchange data with other organizations. In either case, the reference data model can be used to help design the interfaces.

Again, technical constraints (such as bandwidth limitations of radio communications links) may affect the detail and complexity of the data models that can be used for particular interfaces. Transmodel does not itself specify a level of detail to adopt.

0.4 Conformance statement

A specification which cites Transmodel needs to include comparisons of the specification against the Transmodel reference data model in at least two conformance levels:

— level 1 (the global level) identifies which data domains within the specification are drawn from the Transmodel data domains, and which are not;

— level 2 (the detailed level) compares the data model within the specification against the Transmodel entities.

The level 1 conformance statement should be presented as a table based on one of the following:

— the Transmodel data domains as described in the normative part of the document: description of the network, versions/validity/layers, tactical planning components, vehicle scheduling, driver scheduling, schedules and versions, rostering, personnel disposition, operations monitoring and control, passenger information, fare collection, management information, multi-modal operation, multiple operators' environment;

— alternatively, the corresponding UML diagrams as presented in this document.

The level 2 conformance statement shall be presented as a table in which the data concepts used in the specification are described as:

— "Unmodified": concepts in the specification which have the same definition, properties and relationships as in the corresponding Transmodel domain;

— "Modified": concepts in the specification which are similar to a Transmodel concept but which differ in the details of certain attributes and/or relationships (e.g. attributes added);

— "Alternative": concepts or groups of concepts in the specification which model the same concepts as Transmodel but in a significantly different way;

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— "Additional": concepts in the specification which are not drawn from Transmodel;

— "Omitted": concepts in Transmodel which are not used in the specification.

0.5 Transmodel origins

0.5.1 ENV 12896

The prestandard ENV 12896 was prepared by the work area Transmodel of the EuroBus project (1992-1994) and by the DRIVE II task force Harpist (1995). The EuroBus/Transmodel and Harpist kernel team was established as a subgroup (SG4) of CEN TC278 Working Group 3 (WG3) and led by TransExpert (F). The results of these projects were based upon earlier results reached within the Drive I Cassiope project and the ÖPNV data model for public transport, a German national standard. The prestandard reflected the contents of deliverable C1 of the Harpist task force, published in May 1995, with modifications resulting from the discussion process in CEN TC278/WG3 between May and October 1995.

The different organizations that have technically contributed to the preparation of the prestandard ENV 12896 were the partners of EuroBus/Transmodel and the Harpist task force: Beachcroft Systems (UK), CETE-méditerranée (F), CTA Systems (NL), Ingénieur Conseil Bruno Bert (F), Koninklijk Nederlands Vervoer (NL), Leeds University (UK), Régie des Transports de Marseille (F), SNV Studiengesellschaft Verkehr (D), Stuttgarter Straßenbahnen AG (D), TransExpert (F), TransTeC (D) and VSN Groep (NL).

The sponsors of the project were the European Communities (EC, DG XIII, F/5, Drive Programme, 1992-94), the French Ministry of Transportation, the Dutch Ministry of Transportation and the German Federal Ministry of Research and Technology.

0.5.2 Titan

The EC project Titan concerned validation and further development of ENV 12896. The different organizations that have technically contributed to the Titan project were: CETE-Méditerranée (F), Üstra (D), OASA (GR), RATP (F), SLTC (F), Salzburger Stadtwerke AG (A), TransExpert (F), TransTeC (D), Synergy (GR), TRUST EEIG (D).

The sponsoring partner was the French Ministry of Transport (DTT/SAE). The project was co-funded by the European Communities and some of the partners, in particular the pilot sites – Lyon (F), Hanover (D) and Salzburg (A).

0.5.3 SITP and SITP2

The French-led project SITP (Système d'Information Transport Public) was sponsored by the French Ministry of Transport (Direction des Transports Terrestres – DTT), the companies Gemplus (F) and Setec ITS (F), and the Transmodel Users' Support Team EEIG (F and D).

SITP built on the prestandard ENV 12896 (issued May 1997) and the results of the EC project Titan (1996-1998). SITP produced the extensions requested of ENV 12896; these were validated during 1999-2000. A successor project, SITP2, developed the standard further during 2001-2002.

0.5.4 CEN TC 278 WG 3 SG 4

During 2002-2003, CEN continued to convene SG4 of TC 278 WG3 to consider how Transmodel should be taken forward. It considered responses to previous drafts of Transmodel as well as the work of SITP/SITP2, the German VDV specifications, and a range of UK projects.

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SG4 was led by the UK Department for Transport, with participants from VDV (D), RATP (F), HÜR (DK), Setec (F), TRUST E.E.I.G. (Transmodel Users' Support Team) (F and D) and Centaur Consulting (UK). This group completed the work required for Transmodel v5.1 to be adopted as EN 12896.

Related documentation can be found (in French) at http://www.billettique.fr/spip.php?rubrique18.

0.6 Reference to the previous version and other projects and documents

0.6.1 General

Transmodel was published in 2006 as Transmodel V5.1 under the number EN 12896. It has been the basis for the development of the SIRI, IFOPT and NeTEx standards and specifications.

0.6.2 SIRI

The project SIRI has used EN 12896:2006 as an input to develop standard interfaces as regards exchanges of real-time data for passenger information. The present document does not intend to consider the task to establish the link between SIRI data model and the evolution of EN 12896, as at the time updates of Transmodel are under way, SIRI is proceeding to updates as well. However, possible extension requests formulated by the SIRI group are intended to be taken into account in the relevant parts of Transmodel 6.0.

0.6.3 IFOPT

The project IFOPT has used EN 12896:2006 as an input to develop a logical data model for the fixed objects, relevant for public transport, in particular for stops and points of interest. IFOPT has established an implicit link to EN 12896:2006 and has been published as EN 28701.

0.6.4 NeTEx

The project NeTEx developed 2009-2013 standard interfaces between systems aiming at the exchanges of network topology and timetable data based on the models EN 12896:2006 and EN 28701.

One of the tasks of NeTEx was to bring together both models (Transmodel V5.1 and IFOPT). The result of this task is one single conceptual model covering the domains network topology, timing information and information on fares.

The part of Transmodel diagrams that relate to the scope of the NeTEx project have been modularised within NeTEx. In some cases extensions or enhancements of the model have taken place. In order to keep the coherence between the standards, the NeTEx *conceptual diagrams* have been incorporated in the present version of the Public Transport Reference Data Model, generally without changes. The informative Annex B clarifies the status of the changes in comparison to the NeTEx conceptual diagrams.

The *textual descriptions* of this present version of the Public Transport Reference Data Model rely on one hand on the textual descriptions as in Transmodel V5.1, and on the other hand on the new descriptions as in NeTEx – Parts 1 and 2 and 3. The informative Annex B indicates the sources of the textual description.

0.7 Typographic conventions

This Standard makes use of specific typographic conventions that have been adopted for previous and related Standards and Technical Specifications. Unless the context dictates otherwise:

— Terms wholly in CAPITAL LETTERs refer to a concept which is defined in the Data dictionary in the relevant part or in a part with a lower number, i.e. capitalised concepts in Part 1 are defined in the Data dictionary of Part 1, capitalised concepts in Part 2 are defined either in the Data dictionary of

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Document Sharing Hub
Full document details: DIN EN 12896-1:2016-12

Part 2 or of Part 1, etc. Note that pluralisation of such an entity is indicated by the addition of a lower case "s". It is planned that a complete Data dictionary will be issued as a separate document, updated as additional Parts of this Standard are published;

— Terms wholly in CAPITAL LETTERs and in *italic characters* appearing mainly in the diagrams concern abstract classes, i.e. classes which cannot be instantiated directly. They represent common characteristics of all their sub-classes (specializations);

— Terms wholly in lower case letters refer to the use of those words in their normal everyday context;

— Terms in *italic characters* are used for explanatory text, particularly related to the context in which a defined entity may be found;

— Terms in UpperCamelCase are class attributes, such as PersonCapacity, AtCentre, IsExternal, etc.;

— The use of colours helps the reader to link the different classes with similar semantical meaning to a particular package;

— The word "model" is written either "model", or "Model", or "MODEL". The diagram notes marked MODEL refer to the corresponding conceptual diagrams of the NeTEx documentation.

0.8 Methodology for conceptual modelling

0.8.1 General

Notation UML 2 is object–oriented modelling notation and is used for describing (specifying, documenting and visualizing) the conceptual data model in Transmodel. The UML specification has proved efficient because it facilitates common understanding and use of conceptual data model.

Transmodel uses a notation that bears some features of UML 1 (or E/R conceptual modelling), in particular as regards the labelling of roles/relationship names.

The following section summarizes the UML features used in Transmodel and illustrates them with corresponding example diagrams. Diagrams in Transmodel documents are designed with the modelling tool Enterprise Architect version[1] 10.0 (EA).

0.8.2 Packages

Transmodel EA model is structured into main packages corresponding to the different parts (Part 1, Part 2, etc) containing sub-packages (models), which group classes according to a common functional objective. Specific packages "Explicit Frames" in the different parts are created and details of the models contained in them will be discussed in the relevant parts. The hierarchical modular structure is shown in Figure 1.

[1] A useful reference may be found at the following address:

http://www.sparxsystems.eu/resources/project-development-with-uml-and-ea/

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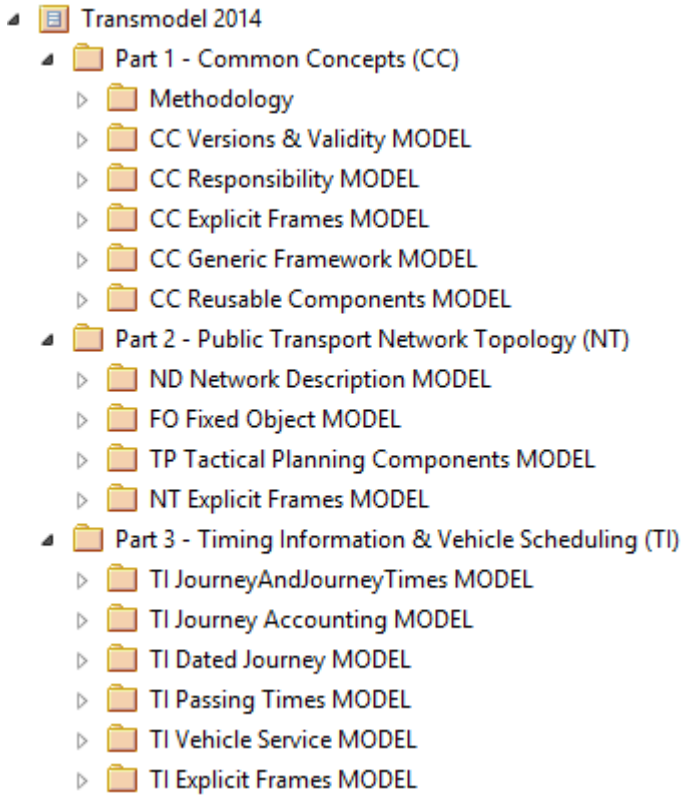

Figure 1 — Transmodel hierarchy of packages

A prefix in front of each package name indicates the part if the standard where this package has been introduced and described first, e.g.:

CC stands for common concepts

NT stands for network topology

ND stands for network description

FO stands for fixed objects

TP stands for tactical planning components

TI: timing information and vehicle scheduling

Etc

The classes are grouped together in a package for a specific task or functional purpose. Figure 2 shows content of the package “generic organization model”, which contains 8 classes. Each class has one and only one “home” package.

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Full document details: DIN EN 12896-1:2016-12

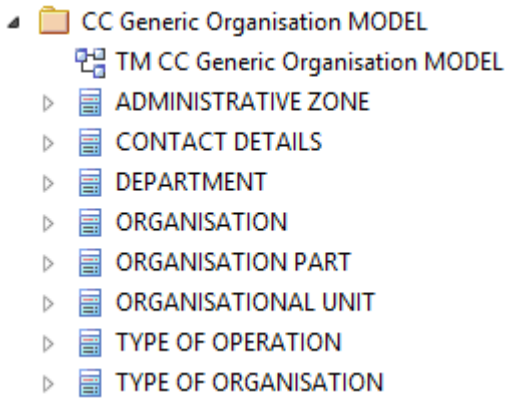

Figure 2 — Package content example

0.8.3 Class diagrams

Class diagram is a visual representation of the structure of a system by showing the system's classes, their attributes, operations and the relationships among the classes. Class diagram shows how objects in a system interact with each other. Figure 3 shows an example class diagram from the package “generic organization model” (described in the common concepts part).

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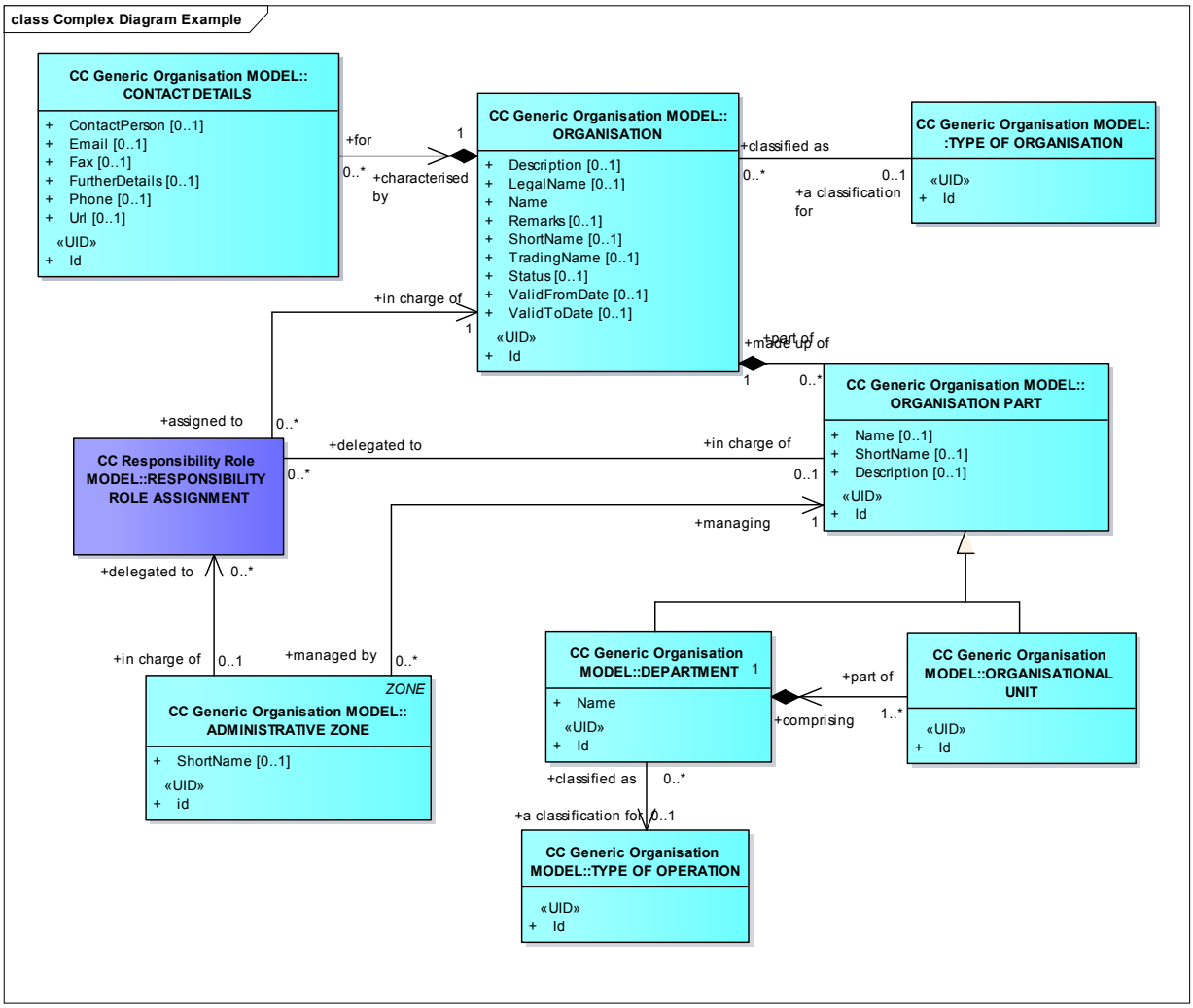

Figure 3 — Complex diagram example - Generic organization model

0.8.4 Classes and attributes

Classes are represented by boxes that are divided into three parts: the top part contains name of the class, the middle part contains the class's attributes and the bottom part shows possible operations that are associated with the class. In Transmodel only the top and middle parts are used for class name and attributes, respectively.

Figure 4 shows a class diagram containing a single class ORGANIZATION with its attributes.

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Full document details: DIN EN 12896-1:2016-12

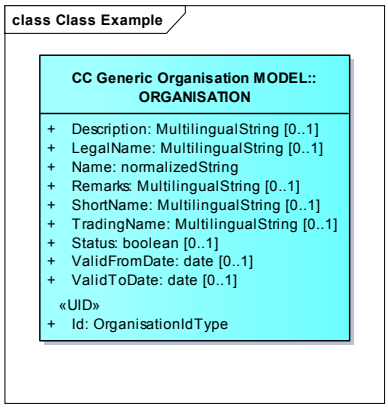

Figure 4 — Class example - ORGANIZATION

Table 1 describes some of the elements from the class "ORGANIZATION":

Table 1 — Elements in the class ORGANIZATION

Notation	Semantics
CC Generic Organization Model	Name of the package "Generic organization model", described in the Common Concepts (CC) part.
ORGANIZATION	Name of the class "ORGANIZATION" defined in the package "Generic organization model".
Description: MultilingualString [0..1]	Attribute "Description" of type "MultilingualString" is optional (mutiplicity: 0 or 1) for the class "ORGANIZATION"
Name: normalizedString	Attribute "Name" is mandatory
‹‹UID››	Stereotype indicating that a particular attribute (in general named id) is a unique identifier for this class.
+	Scope of the attribute is "Public": in general all attributes introduced are public
~	Scope of the attribute is "Package"

The attributes are indicated by at least their name. The full syntax is:

[Visibility] [Name [:Type] [Multiplicity]

Visibility (scope) is indicated by a:

— '+' if visibility is public;

— '~' if visibility is limited to its package.

Each class in Transmodel contains a UID (Unique Identifier) named "id". The id guarantees uniqueness for instances of the class.

Visibility of attribute types (example: MultilingualString [0..1]) is subject to the layout of the diagram. However, attribute types are always described in the class documentation.

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Full document details: DIN EN 12896-1:2016-12

The multiplicity indicates whether the attribute is:

— Optional: marked as [0..1] or;

— Mandatory: marked as [1] (or omitted).

Figure 5 shows a class diagram with three classes. The two (internal) classes LOCATION and LOCATING SYSTEM are defined in the package “location model”, while the (external) class POINT is defined in another package called “generic point and link model”.

For internal classes the package name is not mentioned in front of the class names.

The class POINT is inserted as a link from another (external) package named “generic point and link model”.

For the classes defined in external packages, the package name appears as a stereotype in front of the class name (e.g. generic point and link model:: POINT). Attributes of external classes are hidden.

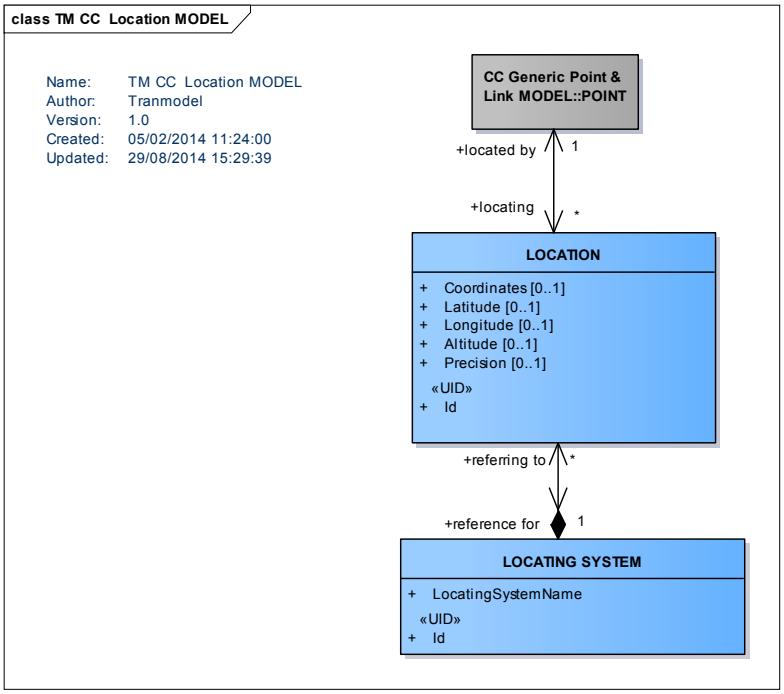

Figure 5 — Simple diagram example

Table 2 describes some elements of the class diagram.

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Full document details: DIN EN 12896-1:2016-12

Table 2 — Elements in a class diagram

Notation	Semantics
Location Model::LOCATION	Internal class "LOCATION" defined in the package "location model"
Generic Point and Link Model:: POINT	Class "POINT" linked from the external package "generic point and link model"
located by	Role name "located by" for the class POINT, which means: "each POINT is located by"
1	Multiplicity of the class POINT
locating	Role name "locating" for the class LOCATION, which means "each LOCATION is locating"
*	Multiplicity of the class LOCATION

The associations on the diagram present the following relationships between the classes LOCATION, POINT and LOCATING SYSTEM:

— a LOCATION is locating one and only one POINT;

— a POINT may be located by many LOCATIONs;

— a LOCATION is referring to one and only one LOCATING SYSTEM.

This means in particular that each POINT may be located through different types of LOCATIONs depending on the LOCATING SYSTEM.

In a class diagram, multiple classes can be in specific relation to each other. Different notations are used for different types of relationships. In the following subsections relationship types relevant for Transmodel are explained.

0.8.5 Association relationships

Association is the general relationship type between classes represented by a solid line connector. The connector may include role names at each end, cardinality (multiplicity), direction (arrowheads) and constraints. A relationship can be named to describe the nature of the relationship between the two classes.

Figure 5 shows a class diagram with two associations; one general association relationship and one composite association relationship. Each side of the relationship connector has a role name and a multiplicity (cardinality) number.

0.8.6 Reflexive association relationship

A reflexive (also called recursive) relationship is represented by a solid line connector that connects a single class to itself.

Figure 6 shows a class with reflexive relationship named "is adjacent to". A topographic place in PT network may have zero or many adjacent topographic places, which in turn may be adjacent to other topograhic places as well.

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Document Sharing Hub
Full document details: DIN EN 12896-1:2016-12

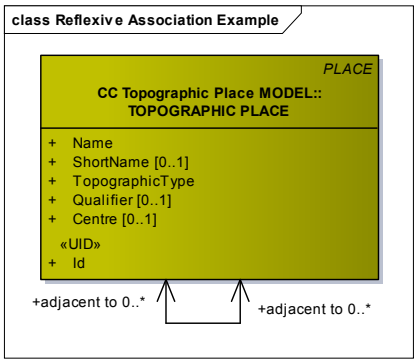

Figure 6 — Reflexive association example

0.8.7 Composition association relationship

A composition relationship is a strong form of association represented by a solid line with a filled (black) diamond at the relationship end, which is connected to the composite class. In a composition relationship component class depends on the composite class. If a composite object is removed, the component object is also removed.

Figure 5 shows a composition relationship between the classes LOCATION and LOCATING SYSTEM, which means:

— a LOCATING SYSTEM is a reference for zero or more (*) LOCATIONs;

— a LOCATION shall be referring to one and only one (1) LOCATING SYSTEM.

0.8.8 Aggregation association relationship

An aggregation relationship is a weak form of association represented by a solid line with a white diamond at the relationship end, which is connected to the aggregate class. In an aggregation relationship an aggregate class represents an assembly of component classes. If one aggregate object is removed, the component object may still exist.

Figure 7 shows an aggregate relationship between two classes, which means:

— a TIME BAND may be (optional relationship) in one GROUP OF TIME BANDS or A TIME BAND is in “0 or 1” GROUP OF TIME BANDS;

— a GROUP OF TIMEBANDS is made up of “0 to n” TIME BANDs.

This means in particular that a GROUP OF TIMEBANDs may still exist even if a TIME BAND is suppressed.

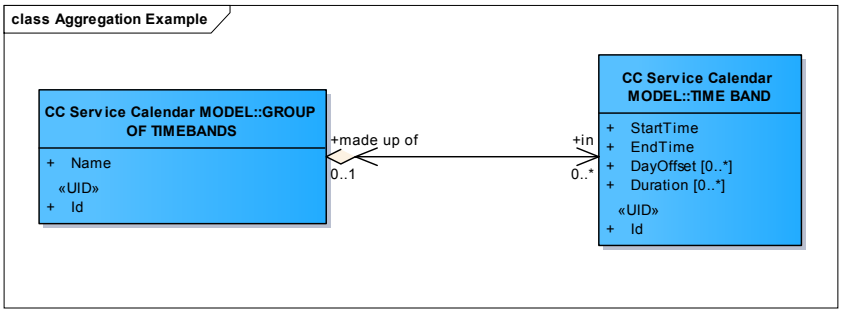

Figure 7 — Aggregation example

Documents
Document Sharing Hub
Full document details: DIN EN 12896-1:2016-12

0.8.9 Generalization association relationship

A generalization relationship indicates inheritance and is represented by a solid line with a white arrowhead at the relationship end. In the generalization relationship, a child class is based on a parent class. The child class captures and inherits attributes and relationships in the parent class. Child classes define only the attributes and relationships that are distinct from the parent class. Generalization relationships do not have names.

Figure 8 shows generalization relationship where "AUTHORITY and OPERATOR inherit from ORGANIZATION".

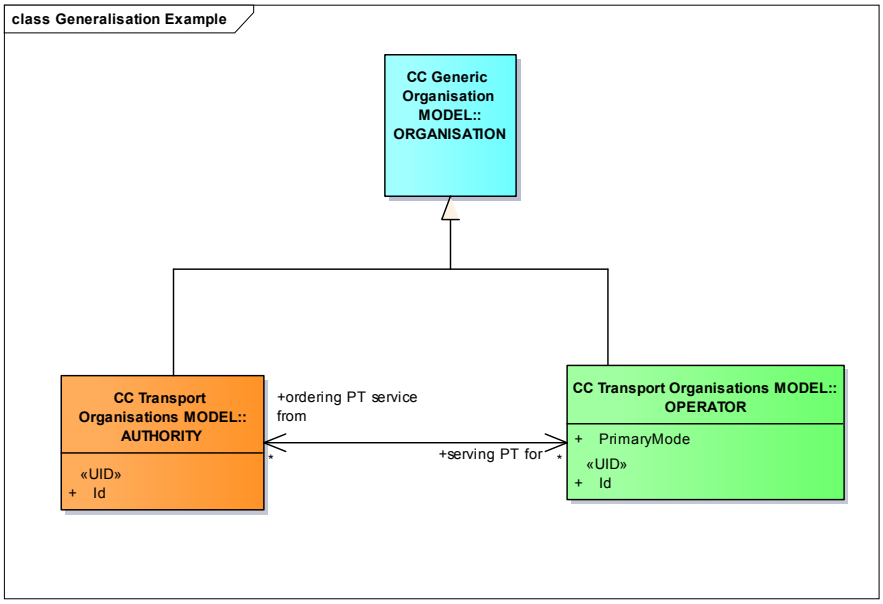

Figure 8 — Generalization example

The "parent class ORGANIZATION" may also appear on the diagram in the upper right corner of the corresponding class(es):

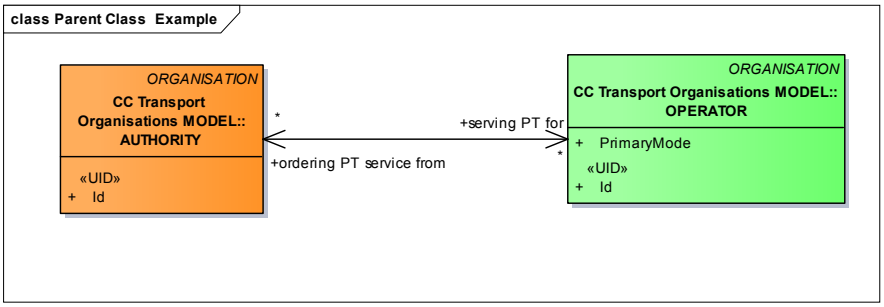

Figure 9 — Parent class example

0.9 Summary of rules for Transmodel representation

Rules for use of classes are shown in Table 3.

Documents
Document Sharing Hub
Full document details: DIN EN 12896-1:2016-12

Table 3 — Rules for the use of classes

Rule	Description
R1.1	Class names in class diagrams are written in UPPER CASE LETTERS.
R1.2	External class in a class diagram is named with its home package followed by double colon and its class name. Pattern is HOME-PACKAGE::CLASS-NAME.
R1.3	External class in a class diagram does not show its attributes.

Rules for use of **role names** in relationships are shown in Table 4.

Table 4 — Rules for the use of role names in relationships

Rule	Description
R2.1	Role name and multiplicity (cardinality) number belonging to a class are displayed on side of the class.
R2.2	Role names may be verbs in the present continuous/progressive tense form. Examples are: “containing”, “locating”, “including”, “composing”, “referring to”, etc.
R2.3	Role names may be verbs in the passive tense form. Examples are: “contained in”, “located by”, “included in”, “composed of”, “referenced in”, etc.
R2.4	Pair of role names of the two connected classes shall be mutual in meaning. Examples are: “containing/contained in”, “locating/located by”, “including/included in”, “composing/composed of”, “referring to/referenced in” etc.
R2.5	If a relationship between classes is named then role names are not necessary.
R2.6	If role names are used then a relationship name is not necessary.

Rules for use of **multiplicity** (cardinality) in relationships are shown in Table 5.

Table 5 — Rules for the use of multiplicity / cardinality in relationships

Rule	Multiplicity	Description
R3.1	1 or 1..1	“exactly one”
R3.2	* or 0..*	“zero or more”, “none to many”
R3.3	0..1	“zero or one”
R3.4	1..*	“at least one”, “one or many”
R3.5	n..m	“at least n, but no more than m”

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Document Sharing Hub
Full document details: DIN EN 12896-1:2016-12

1 Scope

1.1 General scope of the Standard

The main objective of this European Standard is to present the Public transport reference data model based on:

— the Public transport reference data model published 2006 as EN 12896 and known as Transmodel V5.1;

— the model for the identification of fixed objects for Public transport, published in 2009 as EN 28701 and 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.

Particular attention is drawn to the data model structure and methodology:

— the data model is described in a modular form in order to facilitate understanding and 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 network description as in Transmodel V5.1 extended by the relevant parts of IFOPT.

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);

— operations monitoring and control: operating day-related data, vehicle follow-up, control actions;

— fare management (fare structure and access rights definition, sales, validation, control);

— 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);

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— 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

1.2.1 Public transport network and stop description

The reference data model includes entity definitions for different types of points and links as the building elements of the topological network. Stop points, timing points and route points, for instance, reflect the different roles one point may have in the network definition: whether it is used for the definition of (topological or geographical) routes, as a point served by vehicles when operating on a line, or as a location against which timing information like departure, passing, or wait times are stored in order to construct the timetables.

The line network is the fundamental infrastructure for the service offer, to be provided in the form of vehicle journeys which passengers may use for their trips. The main entities describing the line network in the reference data model are the line, the route and the journey pattern, which refer to the concepts of an identified service offer to the public, the possible variants of itineraries vehicles would follow when serving the line, and the (possibly different) successions of stop points served by the vehicles when operating on the route.

The functional views of the network are described as layers. A projection is a mechanism enabling the description of the correspondence between the different layers. This mapping between the layers is particularly useful when spatial data from different environments (sources, functional domains) have to be combined. An example of such a situation is the mapping of the public transport network on the road network.

The geographical data files (GDF) standard (developed within ISO TC204 WG3) includes a data model for the geographical description of road networks. It provides a basic network description upon which various layers describing specific aspects of the use of the infrastructure network may be placed. Public transport companies or providers of other associated services may want to couple their applications and information basis to geographical information. In this case, the exchange of data between a geographical information system and the public transport applications concerned will become necessary. For this purpose, an interface between the GDF data model and the relevant part of the topological network representation in the reference data model for public transport, already drafted in EN 12896:2006 and GDF v5.0, is under development within ISO TC204 WG3 to be integrated into the next version of GDF.

1.2.2 Timing information and vehicle scheduling

The work of the vehicles necessary to provide the service offer advertised to the public consists of service journeys and dead runs (unproductive journeys that 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

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Full document details: DIN EN 12896-1:2016-12

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.

1.2.3 Passenger information

In its passenger information model part, the reference data model does not only describe the data which are needed for applications providing passengers with the relevant information on the planned as well as on the actual service, but also the data resulting from the planning and control processes which may result in service modifications possibly to be made known to the public. Consequently, the passenger information data model includes data descriptions which go far beyond the planned timetable, which is the main source for the classic timetable information, but does not take into account any dynamic issues.

These additional concepts refer to:

— passenger information facilities and their utilization for passenger queries;

— detailed description of all conceptual components of a passenger trip, as possibly needed by an interactive passenger information system when answering a passenger query;

— basic definitions of run times and wait times needed to calculate trip duration;

— planned, predicted, and actual passing times of journeys at individual stops;

— service modifications decided by the schedulers or the control staff, resulting in changes of the vehicle journeys and blocks, compared to the original plan.

Basically, all types of passenger information generally use many elements of the topological network definition, the lines and journeys which form the service offer, the definition of run and wait times, and other fundamental definitions. Geographical information may possibly be provided in some cases, if corresponding application systems are available. Specific types of passenger queries may be related to fares, where the relevant information elements are included in the fare collection sub-model of the reference data model.

Thus, the information basis for passenger information systems is widely spread over the whole reference data model, and the genuine passenger information data model covers only those elements which cannot be derived from, and are not explicitly included in, other parts of the model.

1.2.4 Fare management

The fare management data model aims at a most generic description of the data objects and elements needed to support functions like definition of the fare structure and its parameters, operating sales, validating the consumption and charging customers. These functions and their underlying data structures are handled differently between European countries, and even between the public transport operators within one country.

This situation leads to a considerable complexity of the concepts to be taken into account in the attempt to define one single fare management data model, which aims at covering as many existing solutions and practices as possible. In order to cope with this complexity, the fare management data model concentrates on the abstract, generic concepts that form the core of any fare system, independently of how these abstract concepts are implemented by a set of concrete fare products (e.g. tickets or passes) offered for sale to the public.

The starting point for the description of these fundamental concepts is the definition of theoretical access rights. These can be combined to immaterial fare products, which are linked to travel documents

Documents
Document Sharing Hub
Full document details: DIN EN 12896-1:2016-12

in order to form sales packages to be sold to passengers. Controls may be applied to these travel documents to validate the utilization of the public transport system. Price components are linked to the access rights, fare products and sales packages; they are used to calculate the price to be paid by a customer for a specific consumption (e.g. sale on a vending machine, debiting a value card, post-payment).

1.2.5 Operations monitoring and control

The domain of operations monitoring and control concerns all activities related to the actual transportation process. It is also known as real-time control, or operations management.

The supply basis for each operating day is known as a production plan, composed of the planned work of each available resource (e.g. vehicles and drivers). It includes for instance all dated journeys planned on the considered day, including occasional services.

The transportation control process supposes a frequent detection of the operating resources (in particular vehicle identification and location tracking). Such collected information is compared to the planned data (e.g. work plan for a vehicle or a driver), thus providing a monitoring of these resources.

The monitored data are used for:

— controlling the various resource assignments (e.g. vehicle assignment to a dated block);

— assisting drivers and controllers to respect the plan (e.g. schedule adherence, interchange control);

— alerting on possible disturbances (e.g. delay thresholds, incidents);

— helping the design of corrective control actions according to the service objectives and overall control strategy; the model describes a range of such control actions (e.g. departure lag);

— activation of various associated processes (e.g. traffic light priority, track switching);

— passenger information on the actual service (e.g. automatic display of the expected waiting time at stop points); and

— follow-up and quality statistics.

Other aspects, such as communication between actors, are taken into account.

1.2.6 Management information

The data model part supporting management information and statistics provides some additional data descriptions which may be needed apart from the information elements already included in the scheduling, operations management and control, passenger information and fare management sub-models. Statistical information may of course be provided for any object of interest that is included in the company's specific data model and for which information is recorded in a database, whether for the company management or for other organizational units.

However, some additional information needs and sources are necessary, which cannot be derived from the model parts mentioned above and are specifically related to the evaluation of the operational process, especially to the evaluation of the current timetable and the comparison between the scheduled performance and actual performance. These include:

— events and recordings describing the actual course of vehicle journeys and the resulting service performance;

— the actual status of the planned and advertised interchanges and the resulting service quality; and

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Full document details: DIN EN 12896-1:2016-12

— recordings of the actual use of the service offer, i.e. actual passenger rides and trips.

1.2.7 Multi-modal operation aspects

All mass public transport modes are taken into account by this standard, including train, bus, coach, metro, tramway, ferry, and their submodes. It is possible to describe airports and air journeys, but there has not been any specific consideration of any additional requirements that apply specifically to air transport.

1.2.8 Multiple operators' environment aspects

The standard takes into account the situation where several operators are present in one geographical area. The model addresses problems related to the management of the different responsibilities for resources and services, between authorities and operators (and their organizational units). Problems related to the provision of information to passengers when the timetable data comes from different sources are also solved (merged timetables). The problem of interchanges in this situation is also described.

As regards to the fare management aspects, the reference data model for fare management is developed in a way to associate data from different operators, using various transport modes or even providing other services. It is therefore designed where necessary to meet requirements of an integrated fare management system.

1.2.9 Personnel management: driver scheduling, rostering, personnel disposition

This part of the reference data model describes all the information that is necessary to schedule (logical) drivers to work the blocks and duties necessary to provide the defined service offer to the passengers.

The process of ordering driver duties into sequences in order to obtain a balanced work share among the driving personnel over the planning period, and to keep the resulting work time in harmonization with legal regulations and internal agreements between drivers and the company management, is known as rostering. The reference data model offers a model part covering the information needs associated with some classical rostering methods, widely used in European countries. There may, however, be other (particularly more advanced, dynamic) methods applied in some cases, which would probably need additional or other entities than described in the rostering part of the reference data model.

The personnel disposition domain of the reference data model covers the data needs of the relevant driver management functions with respect to the two major tasks of:

— assigning physical drivers to the logical drivers identified in the scheduled duty plan;

— recording the performance of drivers on the actual day of operation.

The assignment of drivers for the actual operating day to the duty plan set up for the whole planning period is usually done in a staged procedure. The assignment will mostly start from default assignments for the whole period in question, which can be continuously overridden by changes and adjustments due to regular absences of drivers from work, changes initiated by drivers according to their preferences or by the control staff according to operational needs. Short-term adjustments may become necessary to balance unplanned absences and other circumstances principally not known in advance.

Records to document the actual driver activities are usually taken to control the driver performance and compare it with the original plan, and to prepare these data in a suitable way for wage accounting. This mainly refers to the specification of the time worked by each driver on the individual day for each

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type of activity, and some additional classifications, which may result in appropriate modifications of the amount to be paid for the recorded activity in question.

1.3 Particular scope of this document

The present European Standard entitled "Public transport - Reference data model – Common concepts" incorporates data structures used by all other data domains of Transmodel. It is composed of the following data packages:

— versions and validity;

— responsibility;

— generic framework;

— reusable components;

— explicit frames referring to generic data.

The data structures represented in this part are either generic patterns that may be explicitly reused in other domains (e.g. a generic model for version frames, a generic grouping mechanism, etc.) or are referenced by different other parts (e.g. service calendar model).

This document itself is composed of two normative parts:

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

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

and an informative Annex B, indicating the data model evolutions.

2 Normative references

Not applicable.

3 Terms and definitions

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

3.1
attribute
property of an entity

3.2
conceptual data model
description of a real world domain in terms of entities, relationships and attributes, in an implementation independent manner, which should provide a structure on which the rest of the development of an application system can be based

3.3
conceptual level
conceptual data model in the context of data modelling

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3.4
database
collection of data; often used in the sense of the physical implementation of a data model

3.5
data domain
data structure (in this European Standard, a part of the Reference data model for public transport) made up of data related to each other, through the fact that there is a functional area or group of functions using this data set as a whole

3.6
data model
description of a real world domain in terms of data and relationships

3.7
entity
object (data) that has its own existence (as opposed to an attribute)

3.8
fare management
all activities related to the collection of money from passengers

3.9
function
activity, or in this European Standard, sub-activity of a functional area

3.10
functional area
arbitrarily defined set of activities, used, in this European Standard, to define the objectives and limits of the data model

3.11
geographical data files
GDF
standard defining the contents and format of geographical data files, used for the description, classification and encoding of road networks and road environment features

3.12
GDF database
database containing geographical information on the road network in a particular application area, possibly including information on the location of public transport points, links and services (routes)

3.13
interoperability
ability of (sub)systems to interact with other (sub)systems according to a set of predefined rules (interface)

3.14
logical data model
data design, that takes into account the type of database to be used, but does not consider means of utilization of space or access

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3.15
logical denormalized model
relational data model that is not fully normalized, i.e. does not completely follow the normalization rules and thus may be redundant

3.16
logical level
logical data model in the context of data modelling

3.17
management information
all activities allowing the company management to collect the information necessary to meet problem-solving needs

Note 1 to entry : Data of operational systems are filtered and aggregated for this purpose, and made available to the user interactively, or in the form of pre-defined reports and summaries. Such functions are in principle related to all functional areas of a company, with particular reference to the management of statistical results.

3.18
object-oriented data model
data structure expressed according to principles that allow for a direct implementation as an object-oriented database, where information is represented in form of objects, i.e. respecting the principle of encapsulation meaning in particular that each data is accessed or modified through operations (methods) belonging to it

3.19
operations monitoring and control
real-time control
all activities related to the transportation process, i.e. real-time functions related to the driving and transportation of passengers according to given instructions, including the monitoring of the driving process and its control in case of deviations, as well as all activities that support the driving process (traffic light priority, track switching, bay selection, advance/delay advice etc.)

Note 1 to entry: Such functions are often assisted by computer-aided tools, known as Automated Vehicle Monitoring (AVM)

3.20
passenger information
all activities related to informing the users either about the planned or about the actual transportation services

3.21
personnel disposition
all activities related to the mid-term and short-term management of drivers

3.22
relational data model
type of logical data model giving the information as series of tables (relations) and attributes

Note 1 to entry: It will have the following characteristics: 1. all attribute values are atomic, 2. all “tuples” (rows/occurrences) are distinct, 3. no part of the primary key may be null, 4. foreign key values will correspond to an existing primary key in another relation or be null.

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3.23
tactical planning
scheduling
all activities related to the tactical planning of transportation, split into vehicle scheduling, driver scheduling, rostering

4 Abbreviations

GPS	Global positioning system
HTTP	Hypertext transfer protocol
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
VDV	Verband Deutscher Verkehrsunternehmen (D)
WGS	World geodetic standard

5 Common concepts domain

5.1 Introduction to the common concepts

This section describes the data domain called common concepts (CC) of Transmodel that is shared by all Transmodel functional parts. This data domain has three different aspects.

Common mechanisms: provides mechanisms for common aspects of all Transmodel objects that are needed for effective data management and exchange, such as versioning, validity, grouping, and responsibility tracking. The mechanisms, implemented through common super types and containers, and specialized in the various Transmodel functional modules, can be understood and implemented uniformly for all Transmodel components, rather than on an ad hoc basis. This part splits into:

Versions and Validity model: describes the successive versions of data elements and the conditions to be attached to elements to precisely know when they should be used:

— generic entity model;

— generic version model;

— generic version frame model;

— generic validity model;

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— generic delta model.

Responsibility model: describes the type of responsibility or role the different organizations may have over the data:

— generic responsibility model;

— generic responsibility role model;

— generic organization model.

Generic framework: describes a number of generic objects and representational mechanisms that are not specific to transport but which are specialized or used by Transmodel transport related objects. This part splits into:

— generic location model;

— generic grouping model;

— generic point and link model;

— generic point and link sequence model;

— generic zone and feature model;

— generic layer model;

— generic projection model;

— generic accessibility model;

— generic place model.

Reusable components: Certain common low-level components, for example TRANSPORT MODE, SERVICE CALENDAR, DAY TYPE, etc. are not specific to any particular functional part of Transmodel but are widely used in several different functional areas. Such components are defined centrally as part of the common concepts.

Reusable components model: describes generic and reusable objects specific to public transport.

— transport mode model;

— transport submode model;

— service calendar model;

— availability condition model;

— topographic place model;

— transport organizations model;

— additional organization model;

— generic equipment model;

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— actual vehicle equipment model;

— vehicle type model;

— vehicle passenger equipment model;

— facility model;

— train model;

— schematic map model;

— notice model;

— service restriction model;

— alternative name model.

Explicit frames model describes the mechanisms useful to build coherent sets of versioned data. Part 1 presents explicit frames for data referring to the common concepts domain.

The present document is structured according to the model structure as shown above.

5.2 Versions and validity

5.2.1 Introduction

Information systems for public transport operation typically require the definition of many different types of data, produced by different organizations or operating divisions, and are subject to a multistage lifecycle from planning through to production and realization in real-time. These data are continuously evolving and are subject to a variety of different validity conditions as to when they are current, and as to which data are needed for a particular purpose. Transmodel includes uniform version and validity mechanisms to address these requirements; the mechanisms are part of the Transmodel framework and that can be applied to all data elements throughout their various lifecycles.

The **versioning** model allows successive versions of data elements to be identified, allowing the fine-grained identification of just those elements that have changed, and the auditing of changes. All references can also be versioned so that for composite data sets that comprise a number of related elements it is possible to be precise as to which version of each element is required. The versioning model also allows schemes where the responsibility for maintaining different parts of the data are split among several organizations and systems, each providing its partial data separately. In this case, references to external data are not explicitly versioned, but instead the correct version of the different referenced entities are deduced from validity conditions when combining the data.

A **version frame** mechanism provides a versionable container that allows a coherent set of related elements to be managed as a set or exchanged. Since pragmatically actual systems that contain data to be exchanged differ in the sophistication of their support for versioning, the mechanisms are designed so that they may be used either just in a course-grained manner at the level of the whole data set, or if support is available, in a more powerful way at the level of the individual data element.

The **validity** model allows conditions to be attached to elements as to when they are current or the circumstances in which they should be used. Validity conditions can be attached to specific elements and also, through version frames, to whole sets of objects so that it is possible to be explicit about the exact conditions governing the coherence and relevance of data. This makes it possible for systems to

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express the currency conditions for data they require and to describe the validity of data that is returned by a system.

5.2.2 Version and validity – Model overview

The versioning mechanisms are part of the core Transmodel framework, and are provided by a common set of modules that are referenced by all other Transmodel modules. The fundamental models are described in detail in the following sections.

— the ENTITY model describes the Transmodel basic object structure;

— the VERSION model adds in version control elements and attributes. VERSION FRAMES group multiple instances of versions of entities that make up a coherent version set;

— the RESPONSIBILITY model adds in metadata for ENTITY ownership and roles for data management;

— the VALIDITY package defines generic validity conditions for use in the framework;

— the DELTA package refers to the detailed changes of a given ENTITY IN VERSION from one VERSION to the next one.

5.2.3 Generic entity

The entity ENTITY represents an actual object instance of data present in an exchanged data set. An ENTITY may represent any instance of a CLASS IN REPOSITORY, corresponding to an instance of the object as stored in a specific database. All Transmodel objects are formal descendants of ENTITY.

CLASSes IN REPOSITORY can be grouped into sets of coherent versions using a CLASS IN FRAME. CLASS IN REPOSITORY and CLASS IN FRAME are part of the Transmodel conceptual model and help to make clear the difference between classes of objects effectively present in a repository (CLASS IN REPOSITORY) and classes of objects grouped to be managed as a coherent set (e.g. to be exchanged). Instances of objects are ENTITIes, more precisely a repository may contain many versions of an ENTITY. The TYPE of ENTITY defines a set of sub-categories that can be used to make arbitrary classifications of a specific ENTITY. Thus it is really a “category of ENTITY” rather a class or type. TYPE OF ENTITY is an abstract mechanism that is present in Transmodel to indicate the possibility of categorization. Actual Transmodel objects generally have a more specific categorization, e.g. TYPE OF POINT, etc. that specifies a category that is specific to the ENTITY type.

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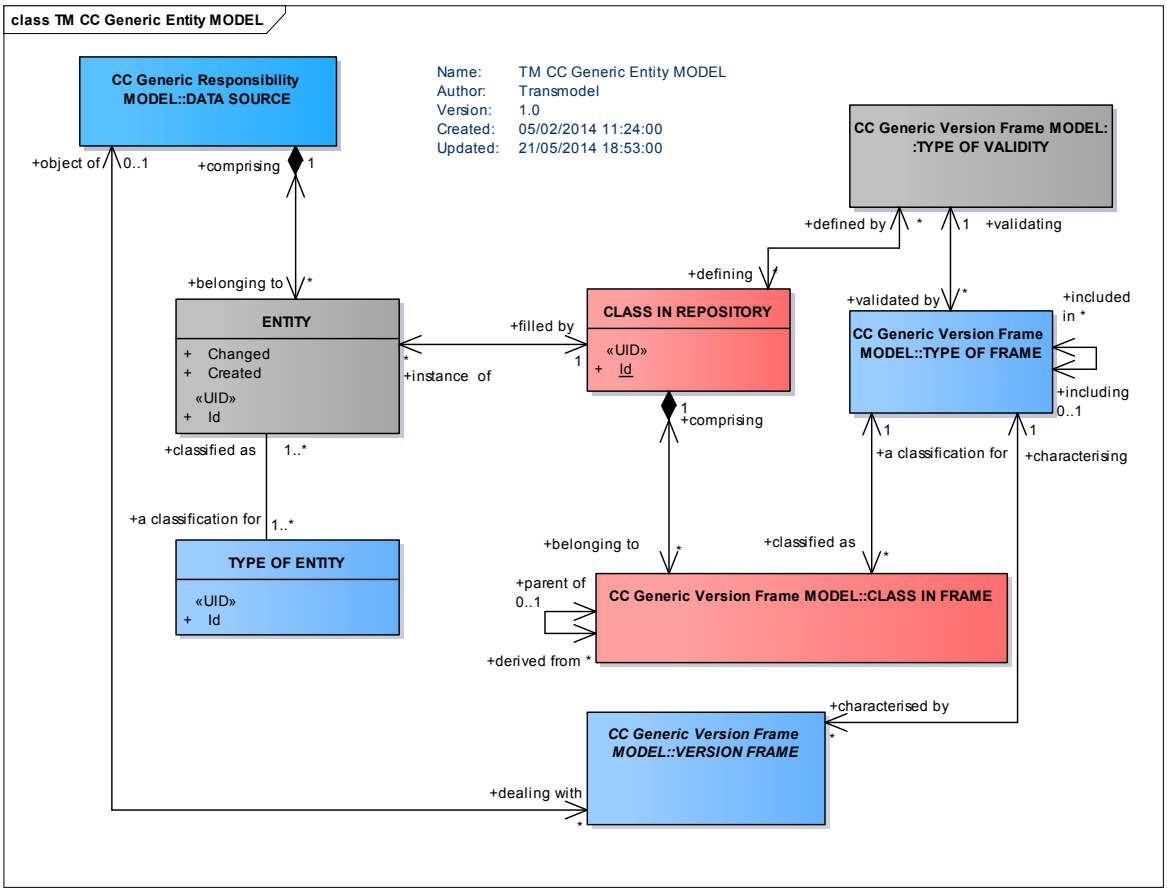

Figure 10 — Generic entity – Conceptual model

5.2.4 Generic version

5.2.4.1 General

The modelling of versions in Transmodel is in effect a version description model, not a model of a version management system. However, it is allows for fine grained versioning, and uses a uniform and generic approach that can be used for any time of complex data object. This versioning mechanism is available on all Transmodel elements, but not mandatory, thus allowing legacy systems without any versioning mechanism to use Transmodel simply by omitting the versioning attributes. In practice versioning will be often just done at an aggregate level and not that of the individual data instance.

Public transport data are in a permanent process of evolution; schedule and operational data typically undergo a regular cycle of planning, distribution and execution, while reference data describing the network, such as stop and line data, will change if the network or physical environment is modified. It is therefore necessary to be able to organize data elements to support such a lifecycle, with multiple versions of a given element being in use concurrently, and different assemblies of data referencing different versions for different purposes. This is achieved in Transmodel with VERSIONs and VERSION FRAMEs.

5.2.4.2 Generic VERSION – Conceptual model

Each state of an object, or a set of objects, is called a VERSION. VERSIONs of an object may be consecutive or competitive. *Consecutive* VERSIONs describe the successive states of an object, while *competitive* VERSIONs describe an alternative version to use in particular circumstances, i.e. under

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specific VALIDITY CONDITIONs (cf. Generic VALIDITY – conceptual model below). For example, there may be for a single line at the same time competitive versions of the line; a simulated line (for planning work or for study), and the operational line for particular operating periods.

The VERSION describes the identifier and purpose of a version state. The actual version state of the objects is described by an instance of ENTITY IN VERSION. Thus in a given repository or documents there will be a single instance of each Transmodel ENTITY and one or multiple instances of ENTITY IN VERSIONs for that ENTITY; these will be tried together by a common identifier and differentiated by distinct VERSION identifiers. For example an instance of the entity SCHEMATIC MAP may have multiple SCEMATIC MAP IN VERSION instances, etc.

The purpose of the VERSION may be categorized with an arbitrary classification using a TYPE OF VERSION, for example planning, scheduled, operational, etc.

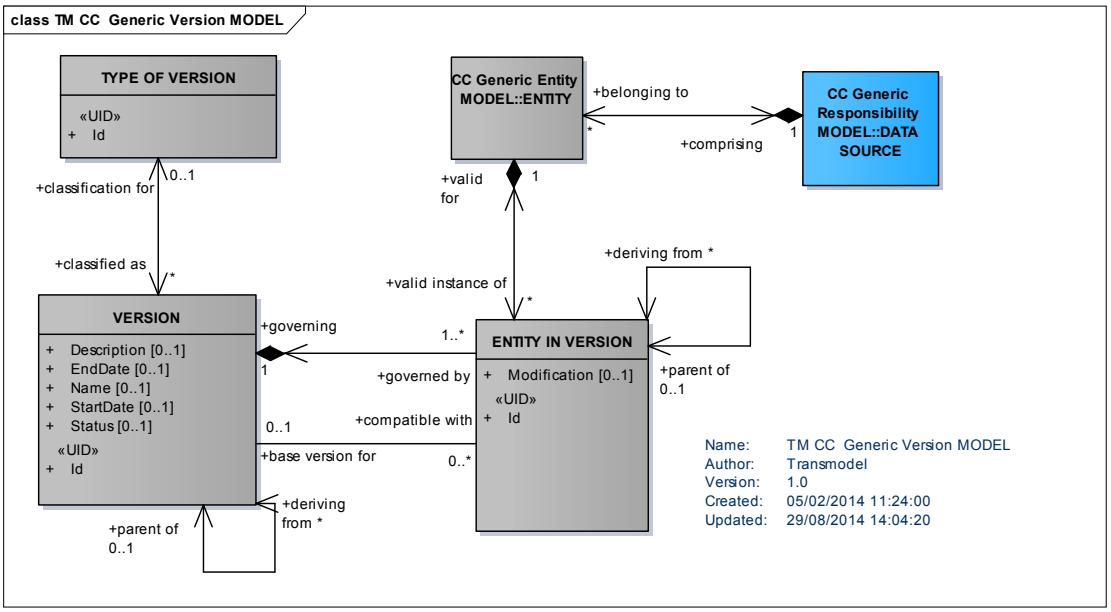

Figure 11 — Generic version – Conceptual model

5.2.5 Generic version frame

VERSION FRAMEs allow data to be managed and exchanged as a coherent version, that is a set of instances (ENTITIes IN VERSION) of different entity types that are consistent and correct as to referential integrity and other business semantics and so are suitable for use without extensive consistency checking, for example, by an importing application. A VERSION FRAME contains a list of specific versions of an entity, that is, instances of ENTITY IN VERSION.

The possibilities for including specific types of ENTITIes in VERSION in a FRAME are limited by the generic rules set by a corresponding CLASS IN FRAME. All the classes that are allowed to be present in the frame are defined by the CLASS IN FRAME, and each frame is defined by its TYPE OF FRAME. VERSION FRAMEs may have common properties as regards validity. This is described by the TYPE OF FRAME entity (e.g. vehicle schedules, network description for line versions, etc.). The main property of a TYPE OF FRAME is the purpose it is designed for.

Thus a particular VERSION FRAME, defined according to a TYPE OF FRAME, is usually limited by operational parameters: For example VERSION FRAME for network description of "*area West*" or for fare versions on "*tramway lines*", etc. When these limiting parameters are actual instances data, this may be described by instances of the VALIDITY CONDITION (cf. Validity Condition Conceptual Model

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below), related to the VERSION FRAME. For instance, a VALIDITY CONDITION may represent a TOPOGRAPHIC ZONE (*"area West"*) or a VEHICLE MODE (*"tramway"*).

A TYPE OF FRAME thus may be associated with a particular TYPE OF VALIDITY, which expresses a general validity environment. The TYPE OF VALIDITY will apply to any VERSION FRAMEs of that type. For instance, if the schedules designed for day types are to be distinguished from schedules planned for a particular operating day, different TYPEs OF VALIDITY, which will serve as a basis to select general validity rules, may specify this difference. Similarly, certain VERSION FRAMEs may be designed only for simulation purposes and be distinguished from production data, this classification being expressed with a different TYPE OF VALIDITY.

A TYPE OF FRAME may include other TYPEs OF FRAME, for which the validity rules and processes may be different. This is represented by a circular relationship on TYPE OF FRAME.

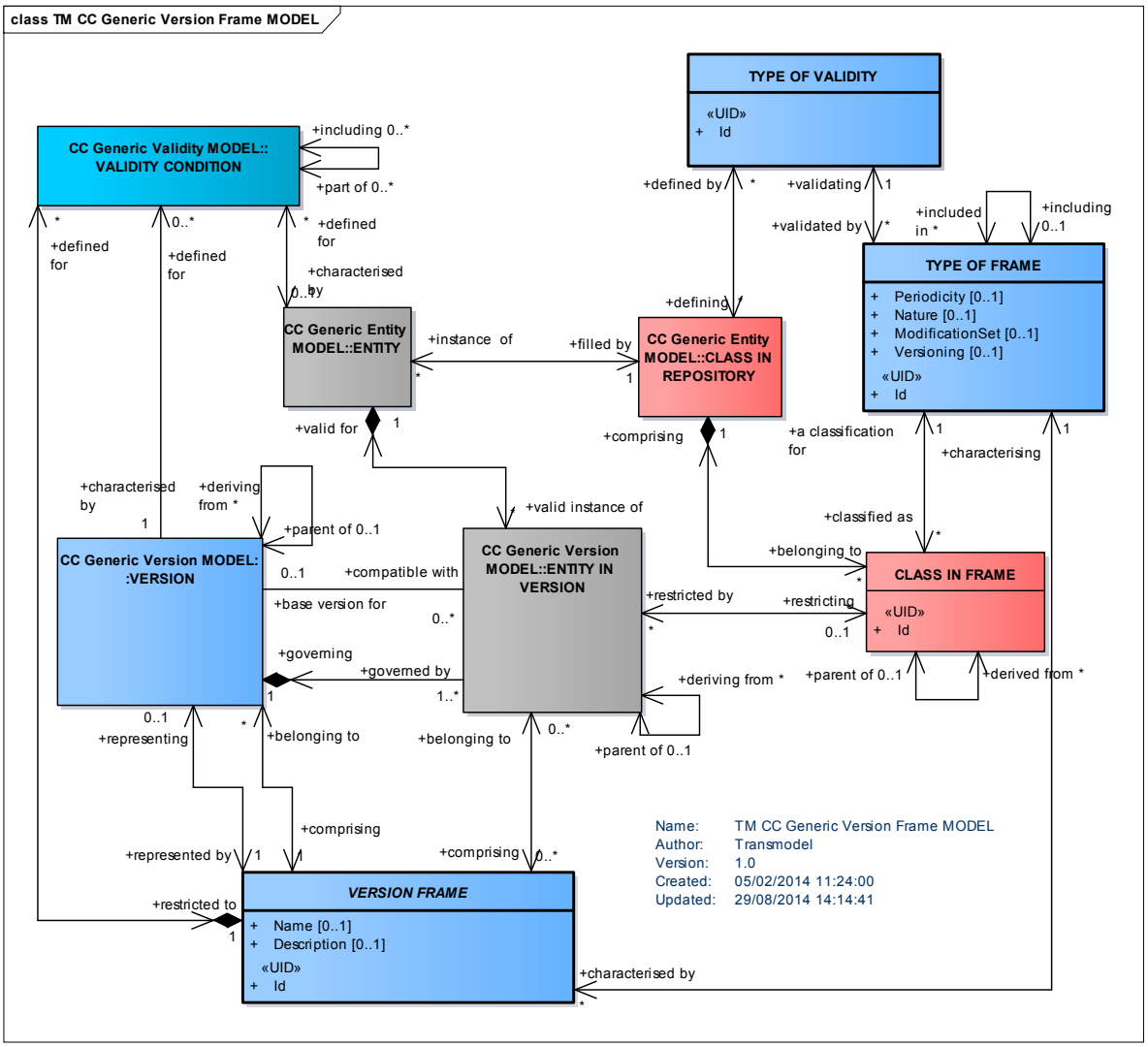

Figure 12 — Generic version frame – Conceptual model

The VERSION FRAME itself is versioned, so that if any change is made to the contents of a frame to add, change or delete its entities, then a new version of the frame shall be created.

For a defined group of object instances, there may be several (consecutive or competitive) VERSIONs of a VERSION FRAME. For example, the contents of a frame containing the stop points for a town will

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change as they are added, updated or deleted, so there will be successive versions of the same frame, or there may be successive instances of a given VERSION FRAME for timetables reflecting successive changes to a given schedule. In summary:

— a given aggregation may undergo successive versions as the data evolves through its lifecycle, so there may be several *consecutive* VERSIONs of a VERSION FRAME;

— a given aggregation may represent an alternative to be used in particular conditions, so there may be several *competitive* VERSIONs of a VERSION FRAME in which case a VALIDITY CONDITION shall be attached to the frame to discriminate the conditions for use.

5.2.6 Generic validity

An ENTITY, a VERSION or a VERSION FRAME may be associated with VALIDITY CONDITION, detailing under which conditions expressed e.g. by space- or time-related parameters a version is active or available.

Each VALIDITY CONDITION can consist of:

— a parameter (e.g. a start date);

— a type of application of this parameter (“for”, “from”, “until”, etc.).

A VALIDITY CONDITION parameter may be:

— a time-related parameter, which will be in general an instance of an ENTITY: OPERATING DAY,, PROPERTY OF DAY, DAY TYPE, TIME BAND, etc.;

— a VALIDITY TRIGGER (road works, rainy weather, until further advice, etc.), which will be activated thanks to a mechanism, an external output or a manual entry;

— Any other VALIDITY RULE PARAMETER.

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