



**PUBLIC TRANSPORT
NETWORK TIMETABLE EXCHANGE
(NeTEx)**

REPRESENTING FARES IN NeTEx

CEN TC278/WG3/SG9 NeTEx PT001

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INTRODUCTION

The NeTEx (Network Timetable Exchange) is a CEN standard for exchanging public transport data. This white paper provides an overview of how Fare data can be represented in NeTEx.

The NeTEx model is innovative in that it establishes a uniform model capable of representing fares for all modes of transport - something not found in any existing national standard. It separates the different concerns of describing fares, and provides a set of ready made conditions to describe, in both machine and human readable form, the many and various conditions that may apply to the use of fares. Furthermore, it includes novel abstractions to support the sophisticated products and charging regimes found in modern electronic and card based , alongside a range of traditional fare products. It reuses and is integrated with the network and timetable components of the rest of NeTEx, all designed for multisource integration and pan-European use.

AUDIENCE

The paper is intended to convey a high level view sufficient for a technical manager to appreciate the capabilities of the CEN standard NeTEx and omits all detailed considerations - see detailed documentation [N1], [N2] and in particular for fares [N3]. The paper builds on related white paper [W6] to describe networks and timetables [W9], which should be read first.

SCOPE

NeTEx Part3 [N3] covers fare data and is the main focus of this white paper; it is concerned with data for the following purposes:

(i) To describe the many and various possible fare structures that arise in public transport (for example, flat fares, zonal fares, time-dependent fares, distance based fares, stage fares, pay as you go fares, season passes, etc).

(ii) To describe the fare products that may be purchased having these fare structures and to describe the conditions that may be attached to particular fares, for example if restricted to specific groups of users, or subject to temporal restrictions. These conditions may be complex.

(iii) To allow actual fare price data to be exchanged. Note however that NeTEx does not itself specify pricing algorithms or how fares should be calculated. This is the concern of Fare Management Systems. It may be used however to exchange various parameters required for pricing calculations that are needed to explain or justify a fare, and each price may indicate their derivation from another price using a named method.

(iv) To include the attributes and the text descriptions necessary to present fares and their conditions of sale and use to the public. The conditions are in a machine readable form that an application program may utilize.

FUNCTIONAL AREAS

The Transmodel model [T1], [T2], [T3], on which NeTEx is based, breaks down “fare collection” into the following functional areas:

FARE POLICY SPECIFICATION

- Characterisation of different fare structures through spatial and/or temporal parameters (e.g. sections, zones, time periods, etc).
- Specification of the access rights allowed on a network, i.e. access to services provided on a transport network (e.g. trip on the metro network, trip on the bus network, access to the 1st class waiting area, etc.) within a fare structure and the ways of using them (e.g. trip on the metro network during a time period of 2 hours, without successive on-board validations, trip on an open bus network during 1h30 with mandatory on-board validations and with the obligation to show an entitlement to use this right).
- Specification of combinations of marketable access rights, called fare products (e.g. service consumption rights granted through a simple ticket), being possibly combinations of access rights determined by different fare.
- Description of sale principles applied to the fare products (e.g. specification of fare products sold as a sales package, and parameters describing the purchaser rights, as for instance the obligation to show an entitlement to purchase a certain fare product).

Sales management

- Management of the sales network (not covered by Transmodel V5.1)
- Sales operations (including fulfilment) (partly covered by Transmodel V5.1)
- NeTEx for Basic Rail fare data NeTEx & TAP TSI - V0.6-Draft.docx Page 13 Management of customers (partly covered by Transmodel V5.1)
- Collecting funds or accounting (not covered by Transmodel V5.1)

Pricing

- Pricing parameters specification (partly covered by Transmodel V5.1)
- Exact price calculation (not covered by Transmodel)

Consumption control

- Access right validation & control (covered by Transmodel V5.1)
- Fraud management (partly covered by Transmodel)
- Collection and aggregation of consumption data (not covered by Transmodel V5.1)
- Management of revenue sharing and clearing house activities (not covered in Transmodel V5.1)

PROVISION OF INFORMATION ON FARES

NeTEx covers only certain of the “upstream” processes of fare management sufficient to provide passenger information on fares; it is not concerned with reservation and ticketing processes. Thus “Fare policy specification” and “Provision of information on fares” are in the scope of NeTEx. “Pricing”, limited to “pricing parameters specification”, is part of NeTEx and represents an extension to Transmodel V5.1. Collection and aggregation of consumption data is also in the scope of NeTEx. Sales Management, Consumption control and other downstream process are outside the scope.

The following diagram summarises this

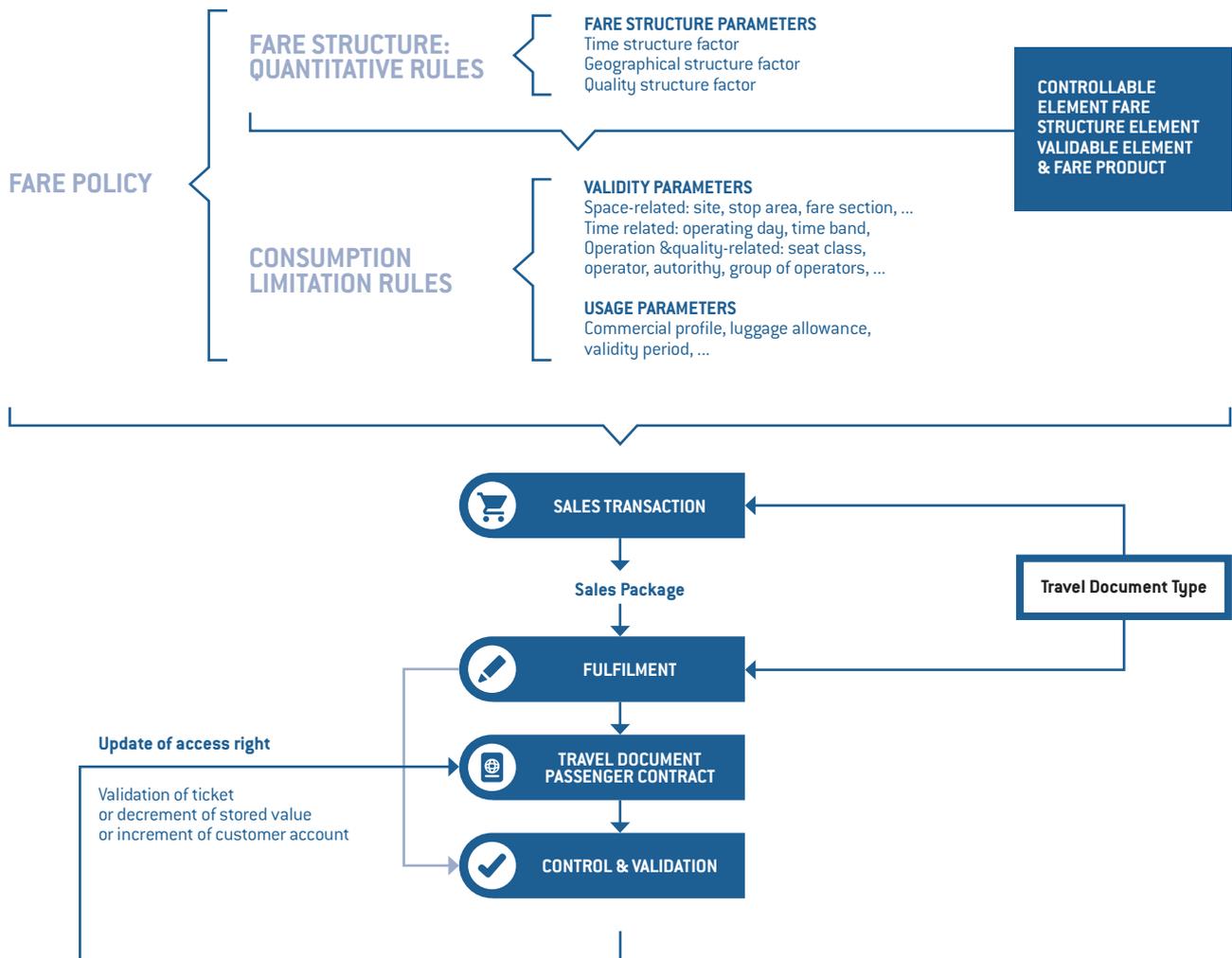


Figure 1 - NeTEx Fare Overview

APPROACH

In practice, fares range from the extremely simple – say a simple flat fare for anyone for the whole network, to the excruciatingly complex; for example ones that depend on the route taken, time of travel, length of travel, the type and number of users, time of purchase, method of purchase, amount of other travel made in a given period, and payment method. NeTEx can describe even very complex fares, using a uniform set of elements applicable to any mode of transport.

The essence of the NeTEx approach is to break the description of fares down into a number of separate, reusable elements, which can be combined flexibly to create a huge range of different fares.

FARE STRUCTURE ELEMENTS

The FARE STRUCTURE describes the underlying basis for the fare, which might for example relate to zones visited, a route, a specific origin and destination, a period of time for which travel is made, a specific journey on a specific service (all defined in terms of elements defined in Part1 and Part2).

As a very simple example of using just one type of element to define a simple fare structure, the following figure shows one of the most common (and straightforward) structures – a simple table of point-to-point fares on a transport network with four stops.

ASK AV ✕	✕				
BATH PL ✕	£ 0.40 ✕	✕			
CAM SQ ✕	£ 0.50 ✕	£ 0.40 ✕	✕		
DEE ST ✕	£ 0.75 ✕	£ 0.75 ✕	£ 0.50 ✕	✕	
ELY RD ✕	£ 1.00 ✕	£ 1.00 ✕	£ 0.75 ✕	£ 0.40 ✕	✕
✕	ASK AV ✕	BATH PL ✕	CAM SQ ✕	DEE ST ✕	ELY RD ✕

Table 1 - Triangular FAre Table with Absolute Prices

Each cell can be represented in NeTEx as a DISTANCE MATRIX ELEMENT, which specifies travel between two stops (or two zones) – both stops (SCHEDULED STOP POINTs) and zones (TARIFF ZONE) are network definition elements specified in NeTEx Part1. This set of elements gives a basis upon which to define products and to associate prices with the cells. In the figure, we show just one simple price – in practice even for a simple standard fare product there are likely to be different sets of prices for different classes of user (adult, child, senior, etc), and for single / return tickets. Additional conditions and prices might apply to products intended to encourage different times of travel (rush hour, off-peak), or for bulk products such as monthly passes and season tickets (see conditions and products below). All can still make use of the same DISTANCE MATRIX ELEMENTs.

Other types of FARE STRUCTURE ELEMENT allowed in NeTEx include those based on time intervals, (e.g. for day and week passes), zones; sequence of zones, etc; specific journey elements in prescribed sequence (e.g. parking use, followed by a train ride, then a metro ride); specific routings, etc. In reality, some very intricate ‘edge cases’ can be found, such the requirement to in a particular sequence of zones or not to get out at particular stops – NeTEx ‘s separation of concerns generally it possible to express such structure precisely and in a way that can be related to the subsequent control (i.e. of checking) of fares.

ACCESS RIGHTS AND FARE PRODUCTS

The FARE PRODUCTS that passengers can actually buy are then specified with reference the relevant fare structure elements (using VALIDABLE ELEMENTS) to scope the travel that may be made, further qualified with conditions restricting use, attached as VALIDITY PARAMETERS.

Products are thus defined as combinations of rights to access the system as characterised by the fare structure elements. In the following greatly simplified diagram (Figure 3 – Usage Parameters), an ACCESS RIGHT ASSIGNMENT specifies access rights (i.e. which fare structure elements may be used, possibly with constraints on order, time, or occurrence of use) and other limitations on using the system (USAGE PARAMETERS, such as passenger types as described by a USER PROFILE) or to apply to specified products.

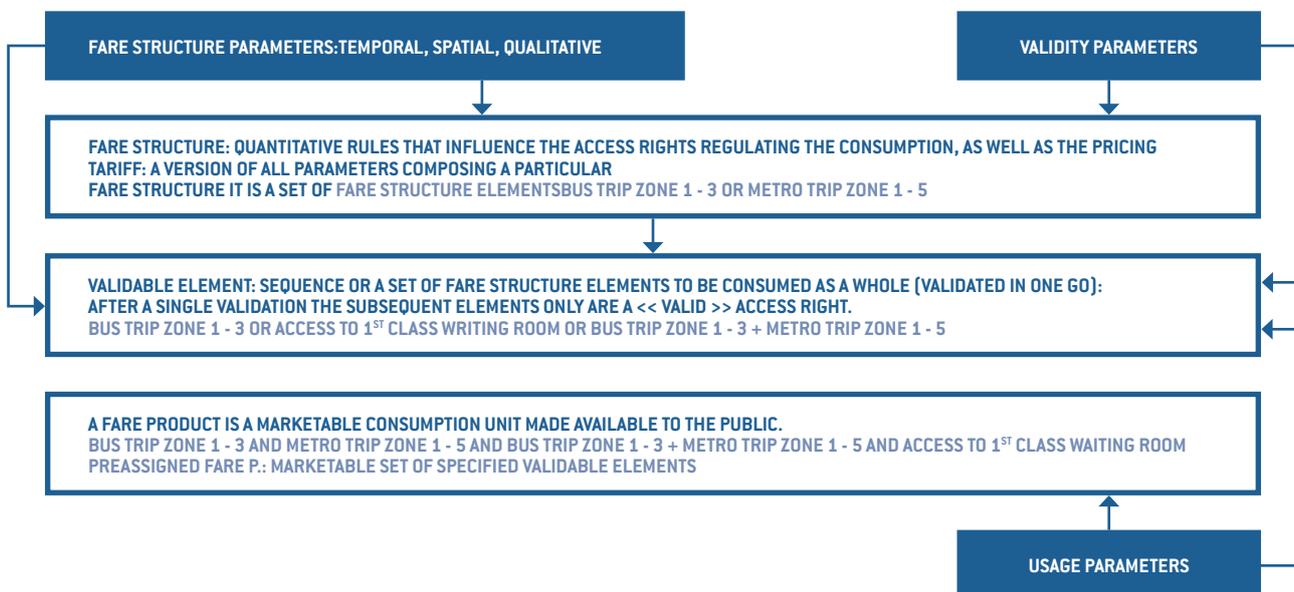


Figure 2 – Access Rights overview

Access rights allow a very precise expression of conditions along with a high degree of reuse and are one of the key innovations of NeTEx's Fare model. Consumable elements for services other than transport may also be incorporated into composite products, such as rights to use a first class lounge or have a meal.

NeTEx distinguishes a FARE PRODUCT – an underlying product with general conditions of use, from a SALES PACKAGE, which will be a marketed product that applies particular specific sales conditions to a FARE PRODUCT. Thus for example a rail “NRT fare” (Non reservable fare) or a “IRT fare” (Reservation required fare) are two different types of FARE PRODUCTS, each with different commercial conditions. Single person and group tickets might then be marketed as separate SALES PACKAGES of the respective products, the latter limited to a group of more than a specified number of users travelling together and with differing conditions of purchase. The choice of SALES PACKAGES is to some extent arbitrary, that is to say, reflects the marketing strategy of a particular operator in a particular context rather than having a necessary logic – NeTEx's approach allows an operator to flexibly define products and packages that reflect their requirements.

RESTRICTIONS AND CONDITIONS

NeTEx supports a large number of different usage parameters, derived from the study of actual fare conditions in a wide spectrum of real-world examples for different modes of travel, including rail.

These describe limitations on the product, for example, those governing travel allowed such as USAGE VALIDITY PERIOD, MINIMUM STAY, ROUND TRIP, STEP LIMIT, etc; those stating the prerequisites; such as ENTITLEMENT REQUIRED; or commercial conditions, such as PURCHASE WINDOW, RESERVING, EXCHANGING, TRANSFERABILITY, etc, etc. Some parameters may have prices, discounts or fees associated with them.

Each of the usage parameters has a number of specific attributes describing the various possible properties of the condition. To illustrate this the following diagram shows an example details for just one subset of the USAGE parameters relating to travel restrictions.

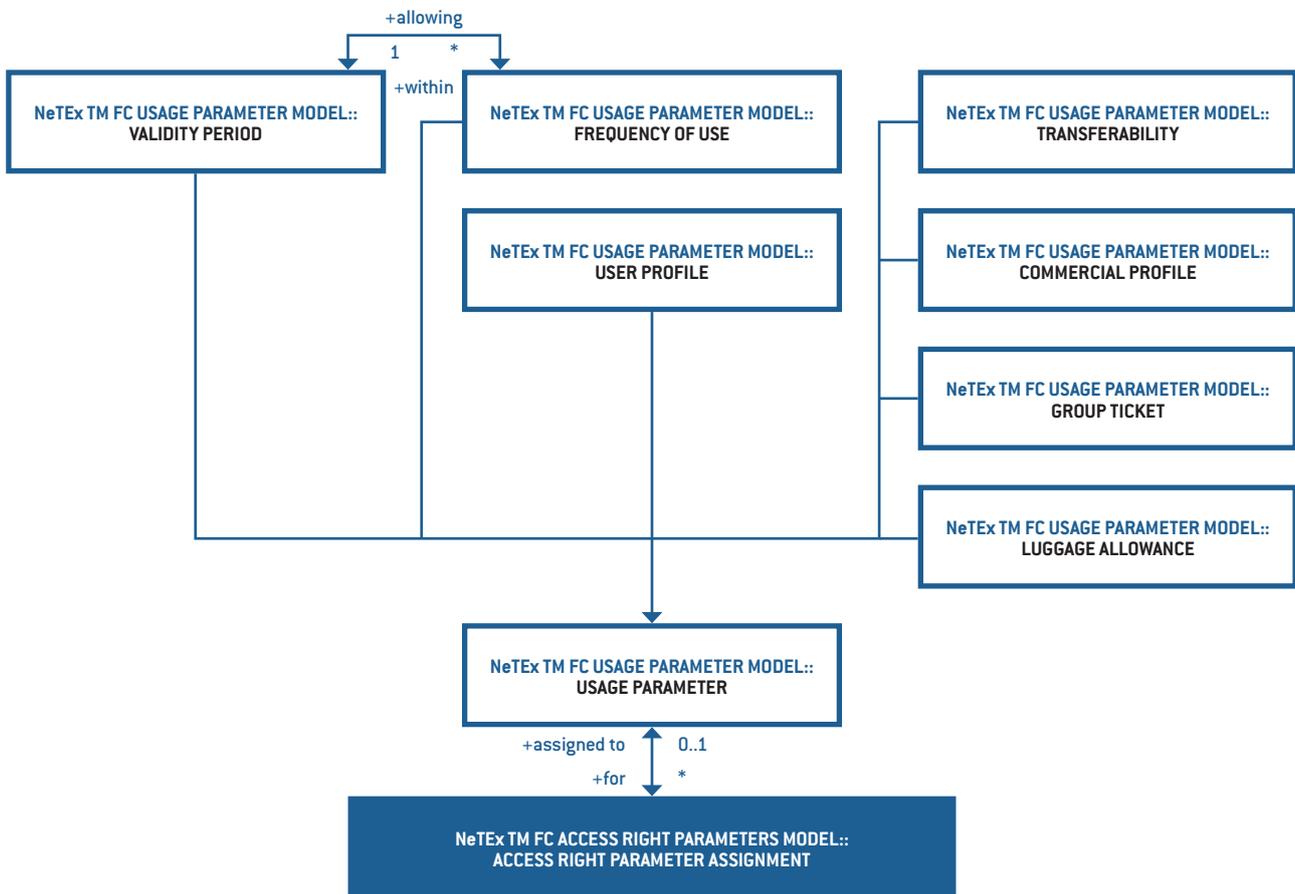


Figure 3 – Usage Parameters

NeTEx supports a wide variety of validity parameters to specify the access rights to use the system, for example TRAIN NUMBER, LINE, FACILITY SET, CLASS OF USE, OPERATOR, etc. The following diagram summarises these.

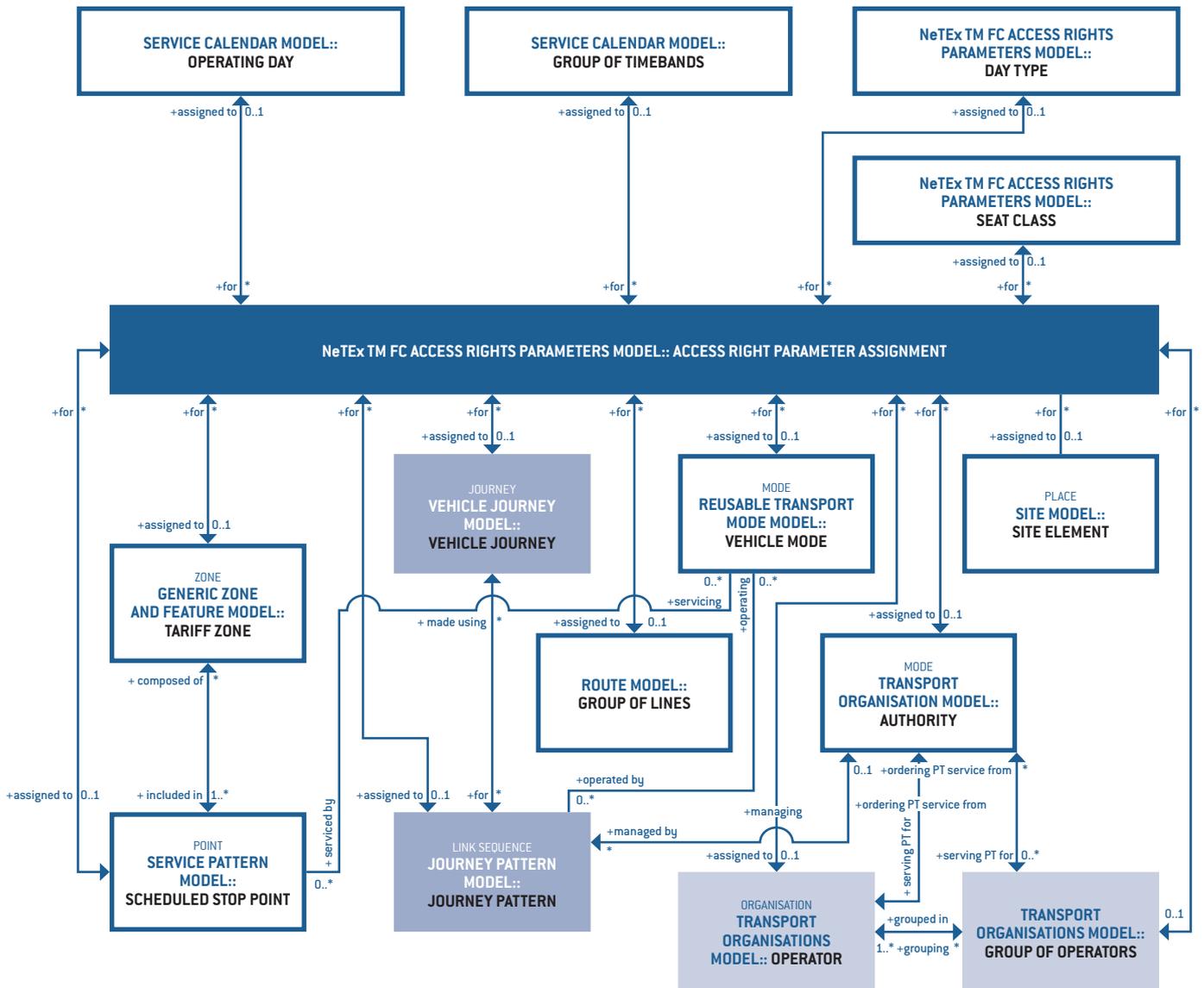


Figure 4 – Validity Parameters

SELECTING A FARE

A given PRODUCT or a SALES PACKAGE does not represent a single combination of elements (say an adult off peak fare between A and B), but rather comprises a whole set of allowed potential combinations that share the same fare structure, and might include many alternate fares such as concessionary fares, full fares and return fares. For example, a single product might be used for all the ten possible point-to-point fares in the table shown earlier above, as well as for separate concessionary fares for adult, child and disabled USER PROFILES. When someone selects a specific journey (for example, an adult off-peak fare between C & D), a TRAVEL SPECIFICATION is created, recording the actual choice or origin destination, user type etc, and a price is obtained. The specification can also be used in a SALES TRANSACTION to describe a record of a payment.

PRICING A FARE

An important principle followed in NeTEx is to hold prices as separate entities from the elements being priced. This makes it possible have multiple prices, or to change the prices without modifying the fare structure.

Depending on the application it may be appropriate to hold precomputed set of prices for every possible combination of fare elements and condition, or to compute prices dynamically using a set of base prices and pricing parameters (discount, rounding, etc). NeTEx supports either approach; where a price is derived from another the nature of the derivation can be shown.

NeTEx does not cover the actual computational rules for calculating a price, but can indicate the elements used to derive a given price from another price. It is also possible to indicate the pricing service to use to fetch a dynamically computed price, so that NeTEx may be used in conjunction with yield managed services.

ELECTRONIC FARE PRODUCTS AND NeTEx

NeTEx supports a number of different types of fare product, allowing not just the description of traditional prepaid travel tickets, but also usage and discount rights (such as a rail discount card), units of value (such as coupon based products) and stored value and pay as you go products. These can also be distinguished by the CHARGING MOMENT, that is, is the product paid for before use, at the beginning of travel, or even after the journey? NeTEx also allows a CUSTOMER and SALES CONTRACT to be represented so that account based products can be described. The value of this approach can be seen when considering the requirements of modern electronic payment systems. The following table, taken from the next step in creating Electronic Ticketing Interoperability for Europe, a Memorandum of understanding issued by ITSO, VDV KA, Calypso Networks, AFIMB and UITP in February 2012, also shows a categorization by charging moment for account based and anonymous card products

Table 1 Payment Methods

<i>USE CASE</i>	<i>PAPER BASED</i>	<i>CARD CENTRIC</i>	<i>BACK OFFICE CENTRIC</i>	<i>PAYMENT</i>
	Payment Offline gates/validators & inspection	Payment Off line gates/validators and inspection	On line gates/validators and inspection	
1 Pre-defined products Tickets, Concession	Product on paper ticket	Product on media	ID on media. Product in back office	Payment before usage
2 Pay as You Go with prepaid stored value	N/A	Stored value on media	ID on media Stored value in back office	Add-value before usage
3 Pay as You Go with customer account giving permission to travel Standard, Concessionary	N/A	N/A	ID on media Account in back office Payment means ID in back-office	Billing after usage according to accounting contract
4 Pay as You Go With payment registration at gate			Bank ID on media. Billing in Back Office	Payment when usage Usage may be aggregated by short periods

These products may be found packaged on Transport cards (Use cases 1, 2 and 3), Contactless bankcards (Use cases 3 and 4) or NFC-enabled Mobile Phone (all cases).

The NeTEx model can describe all the various types of product above since, although NeTEx is not itself concerned with the mechanics of packaging and selling products on media, it is nonetheless necessary to be able to describe the types of product available and their conditions of purchase and use in order to provide accurate fare information in journey planners and elsewhere. NeTEx can also describe where products may be purchased, methods of payment and collection.

ACKNOWLEDGEMENT

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FURTHER READING

THE NeTEx STANDARD

- [N1] NeTEx-Part 1: *Public Transport Network Topology exchange format, CEN/TS 16614-1:2014*
 - [N2] NeTEx-Part 2: *Public Transport Scheduled Timetables exchange format, CEN/TS 16614-2:2014*
 - [N3] NeTEx-Part 3: *Fare Information exchange format, CEN/TS 16614-3:2014*
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OTHER NeTEx WHITE PAPERS

- [W1] NeTEx *Introduction* - White Paper
 - [W2] NeTEx *Getting Started* - White Paper
 - [W3] NeTEx *Design Methodology* - White Paper
 - [W4] NeTEx *Framework* - White Paper
 - [W5] NeTEx *Reusable Components* - White Paper
 - [W6] NeTEx *Networks* - White Paper
 - [W7] NeTEx *Flexible Networks and Multimodality* - White Paper
 - [W8] NeTEx *Accessibility* - White Paper
 - [W9] NeTEx *Timetable* - White Paper
-

OTHER REFERENCES

- [T1] *Public Transport Reference Data Model - Part 1: Common Concepts (Transmodel)*, EN12896-1
 - [T2] *Public Transport Reference Data Model - Part 2: Public Transport Network (Transmodel)*, EN12896-2
 - [T3] *Public Transport Reference Data Model - Part 3: Timing Information and Vehicle Scheduling (Transmodel)*, EN12896-3
 - [G1] *General Transport Feed Specification* <https://developers.google.com/transit/gtfs/>
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FURTHER INFORMATION

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