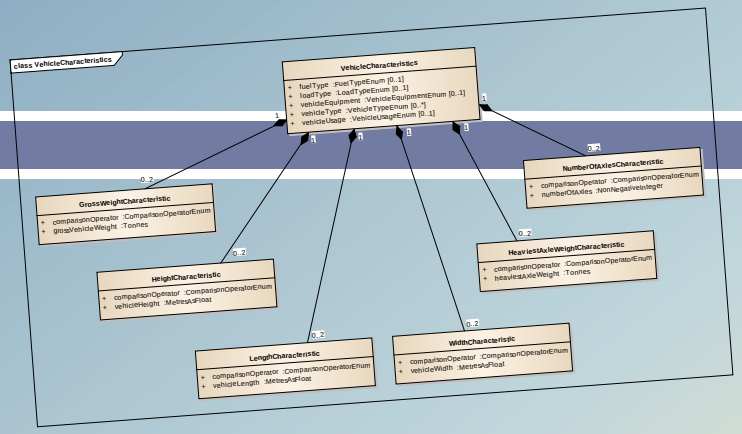
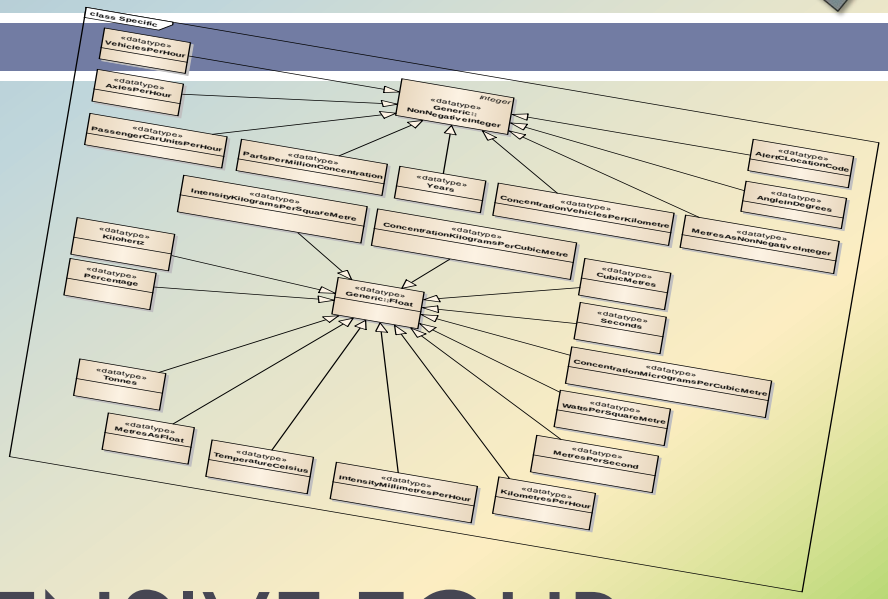
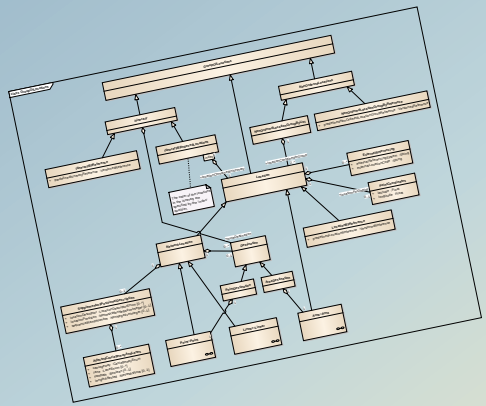






COMPREHENSIVE TOUR THROUGH THE DATEX DATA MODEL

Jörg Freudenstein

About me

- **Jörg Freudenstein**
- Computer scientist, born in 1977
- Since 2005 project engineer at AlbrechtConsult (Aachen, Germany)
- Emphasis on software engineering / software processes, communication networks und distributed systems, software architectures as well as data modelling
- Specification of DATEX II-profiles for the German Mobility Data Market Place (MDM)
- Participation in the DATEX development and standardisation
- Editor of the DATEX II parking extension

Todays hands on workshops

Overview

- Basics **Now**
- Tour through the DATEX Level A data model
- Creating of profiles
  - Data selection
  - Creation of subschemas
- Usage of extensions
  - Extension of the model with new content
- Creation of publications
- Perspective on current developments (e.g. intelligent truck parking)

What is DATEX II?

- An open, interoperable interface specification for the machine to machine exchange of dynamic road traffic and travel data between traffic centres and with third parties, including broadcasters and providers of commercial ITS services
- Consists of a set of artefacts:
  - Methodology (Meta data model ⊂ UML 1.4.2, rules) partly
  - Data model (dynamic road traffic data)
  - Software to generate data schema (~ message syntax)
  - Documentation partly
- Based on general accepted IT standards (UML, XML, http, ...)

Today

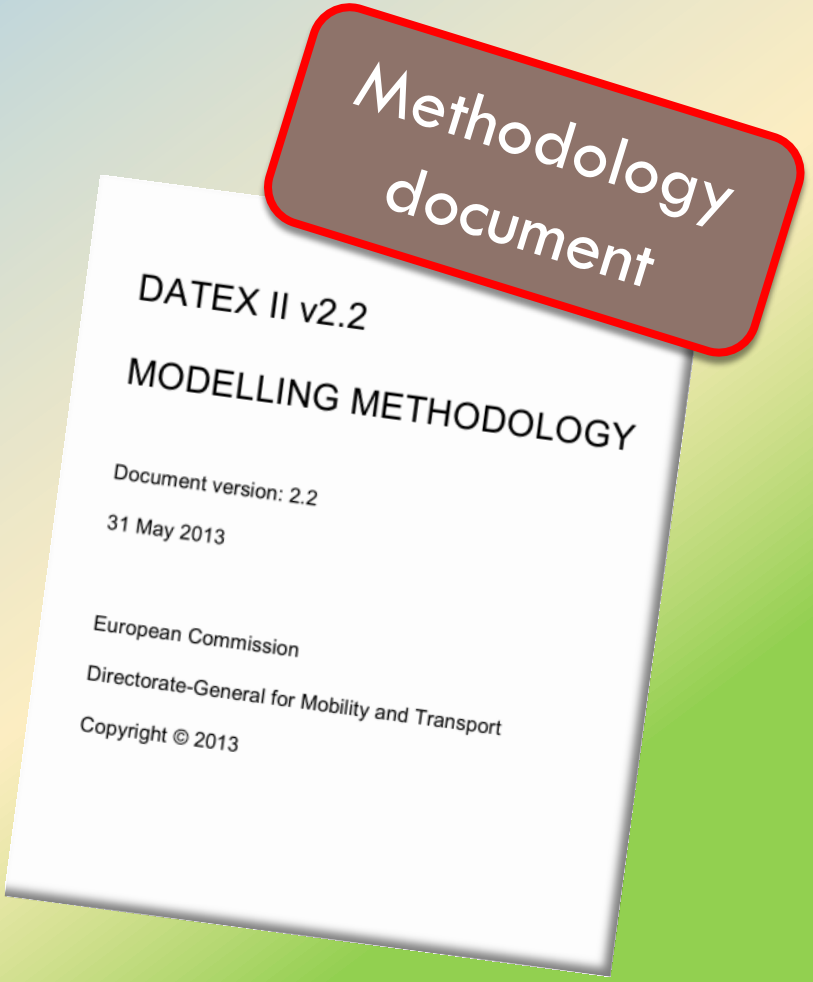
- Made available free of charge and without rights reserved by the DATEX user community (mainly road operators)
- → **standardized as CEN/TS 16157 Part 1 – Part 5** (as Technical Specification)

  (in a modified form, but content consistent)

DATEX Methodology

- Basis for the mapping of the data model in UML and for the creation of profiles and extensions
- Based on the division into three model levels:
  - M0: Data
  - M1: Data model
  - M2: Meta model

Where appropriate in this lecture, this methodology document is quoted.



Elements of DATEX II (v2.2)

Reference documents (normative)

- Data model (UML, as EAP-file or for web browser)
- Methodology (file „DATEX_II_Metodology.pdf“)
- XML schema
- XML-schema & software tool (Windows .NET) to generate a schema
- Exchange specification: text document (PDF) & WSDL-files

- Additional documents (informative)
  - Handbooks for users, for software development and the creation of extensions
  - Documentation of the platform independent exchange (Exchange-PIM)
  - Data Dictionary
  - Handbook for the XML schema generation tool
  - Example messages

DATEX II data model

- The data model (and all other files mentioned) are available on the DATEX website.
- To get access on the current documents, a login (free registration) is necessary:

http://www.datex2.eu

Get access

www.datex2.eu

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DATEX

EASYWAY

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Search

User login

Username: *
Joerg Freudenstein

Password: *
••••••••••

Log in

Create new account

Request new password

DATEX II newsletter

Stay informed on our latest news!

Previous issues

In Evidence

DATEX User Forum 2012 - Stockholm

The 2012 edition of the DATEX User Forum have been held in Stockholm on 20th-21st March

Session Presentations are now available from this link.

News

- DATEX II v2.1 has been released on DATEX II website
  DATEX II v2.1 is finalised and available for download on datex website www.datex2.eu Please visit...
- Final Programme for DATEX User Forum
  The final Programme for the DATEX User Forum is now available at the Forum 2012 Page. Online...
- Registration to User Forum Stockolm available

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The reference set of documentation defining the DATEX II specifications is downloadable from this page. This documentation set constitutes the official release of DATEX II.

The set comprises:
- the data model and the modelling methodology used to build it
- the XML schema and the tool used to automatically generate it from the data model
- the exchange platform specific model.

Further useful information for understanding and using this documentation set can be found at Supporting Documentation.

- DATEX II Schema generation tool 2.1
- DATEX II v2.1 Releases Notes
- DATEX II PIM v2.1
- DATEX II Exchange PSM
- DATEX II XML Schema 2.1
- DATEX II Modelling Methodology 2.1

DATEX II data model

- The data model (DATEX II PIM v2.2) is available as
  - Enterprise Architect format (.eap) (see before)
  - In HTML format for web browser, as offline ZIP or online browseable:

http://www.datex2.eu/datex-model/HTML.Version_2.2/index.htm

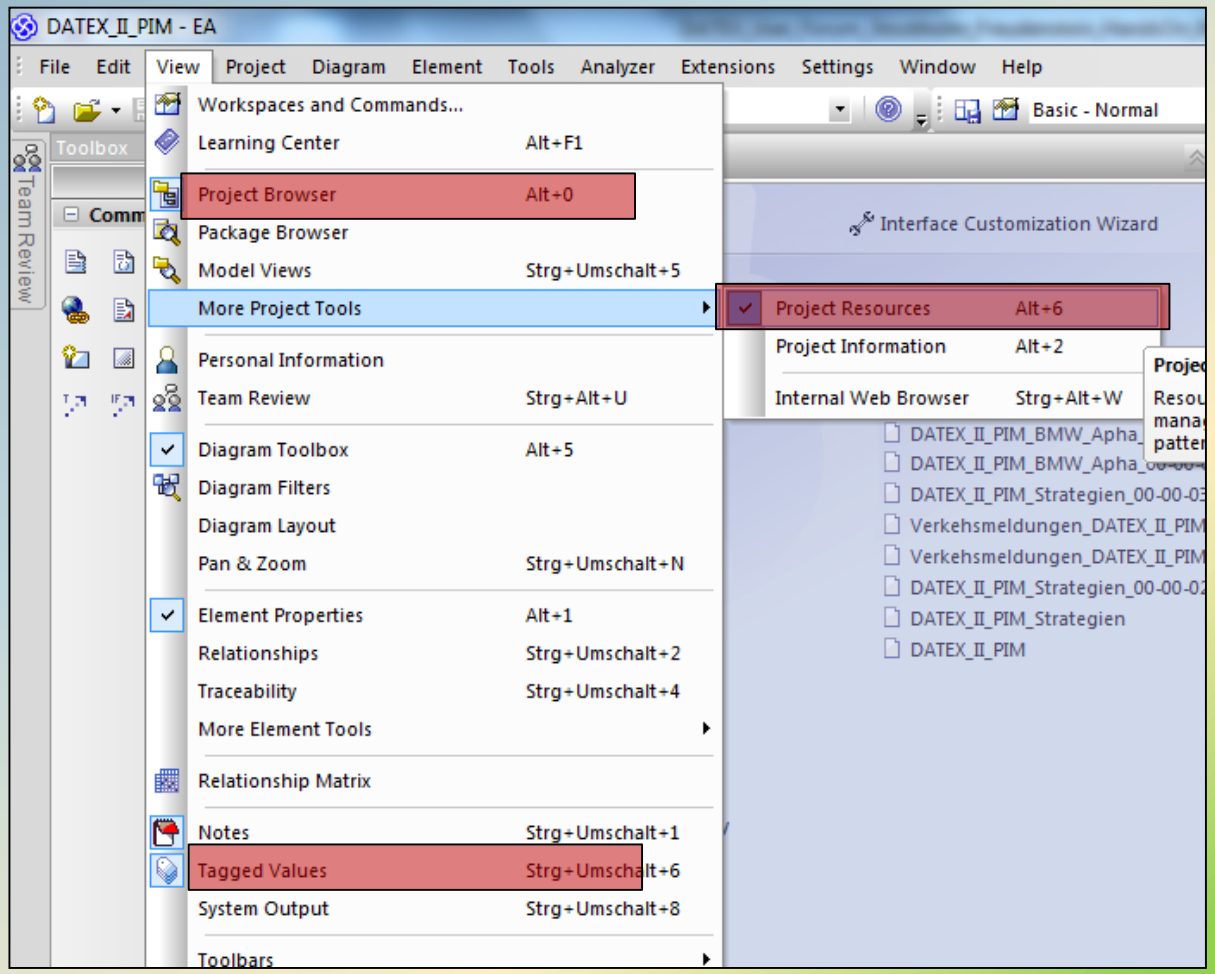
  - TamTam research developed an alternative online browser to search through the DATEX model:

http://datexbrowser.tamtamresearch.com

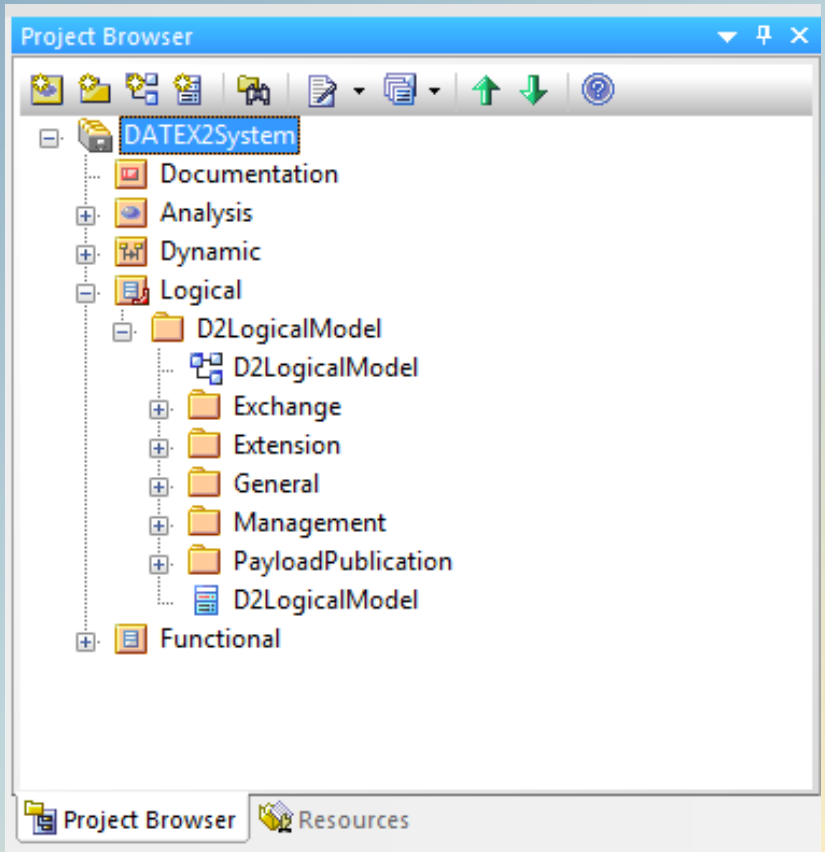
Enterprise Architect

- Inexpensive UML modelling tool used to view
- To obtain from Sparx Systems: http://www.sparxsystems.com/
- There is also a free version (viewing only) available!

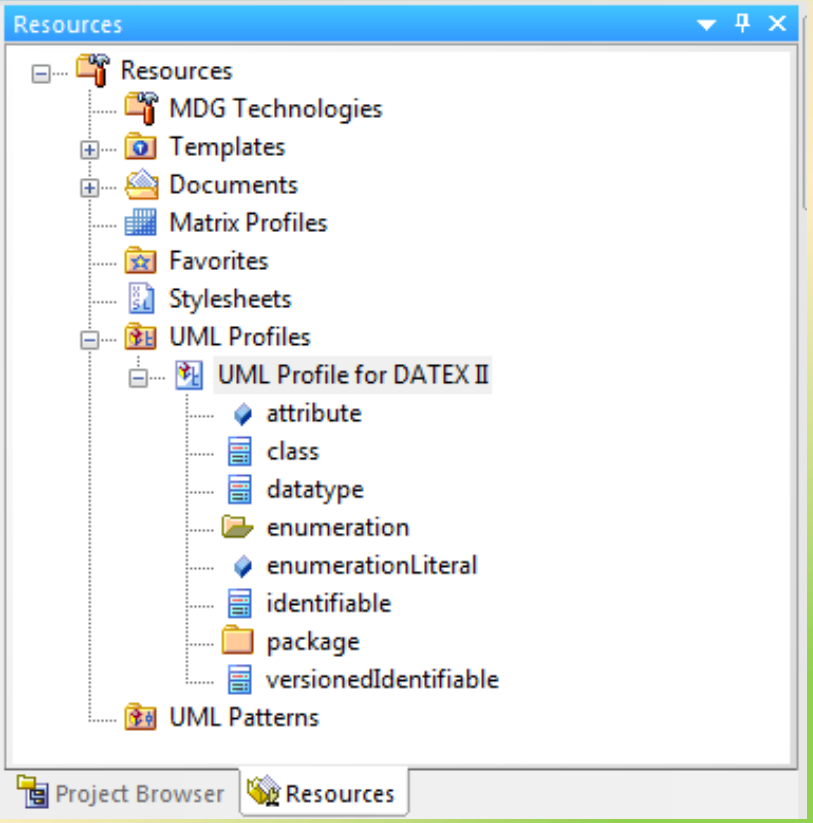
Settings in Enterprise Architect



Project Browser and Resources



Entry point for the model:
D2LogicalModel



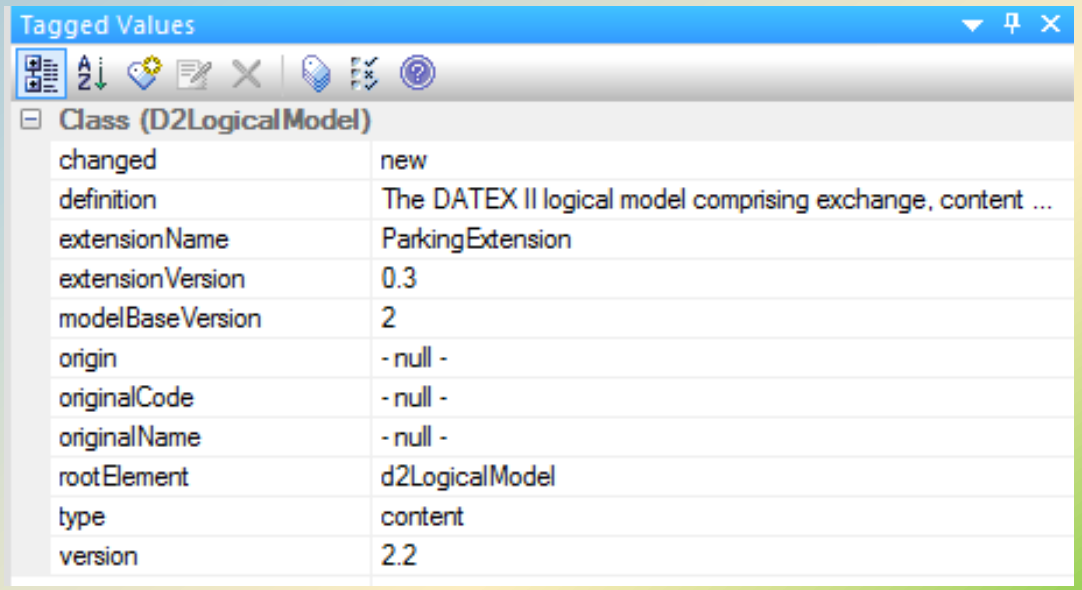
Special UML profile for DATEX for the generation of preconfigured UML elements

Tagged Values

Tagged values offer user-defined additional information and consist of a ‘tag' and an associated ‘value‘ element.

Within the meaning of UML (1.4!) tagged values can be associated to any element in any quantity.

In terms of the DATEX methodology, the used tagged values are well defined, however.



Tagged Values (cont.)

Attribute (measurementOrCalculationPeriod)	
definition	The time elapsed between the beginning and the end of the sampling or measurement period. This item may differ from the unit attribute; e...
order	0
origin	DATEX

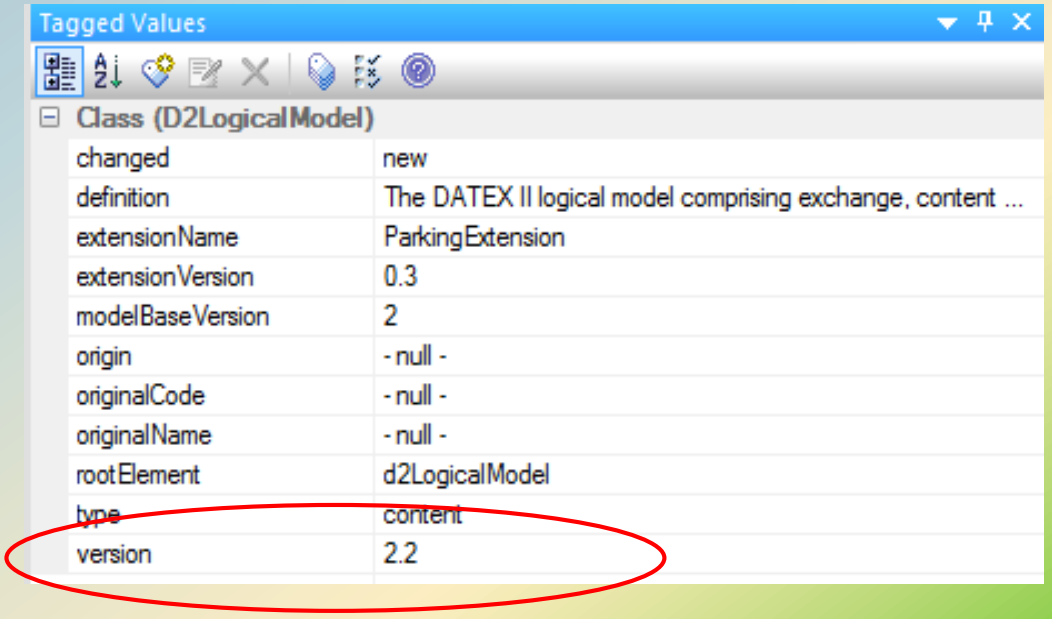
Two important DATEX tagged values:

- definition
  A definition for <u>each</u> component, attribute, literal and package.
  It becomes part of the schema and can be visualized by software tools.

- order
  An information for the relative position of this element within the schema.

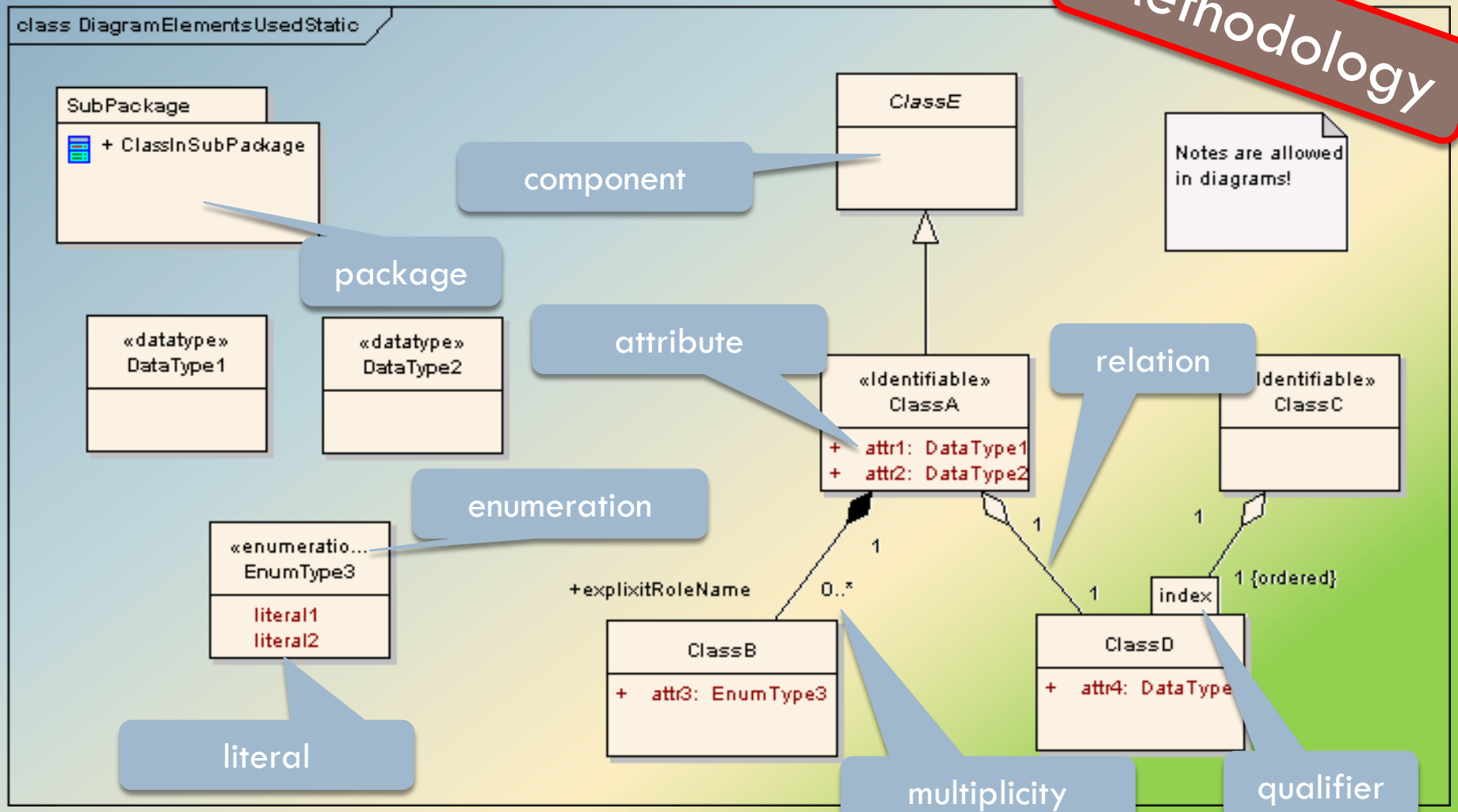
Check for the current version

Current version of DATEX II is 2.2.
(2.3. to come this year)
Older versions should not be used unless there is a need for it.
You can find the version information as a tagged value on the component ‚D2LogicalModel‘

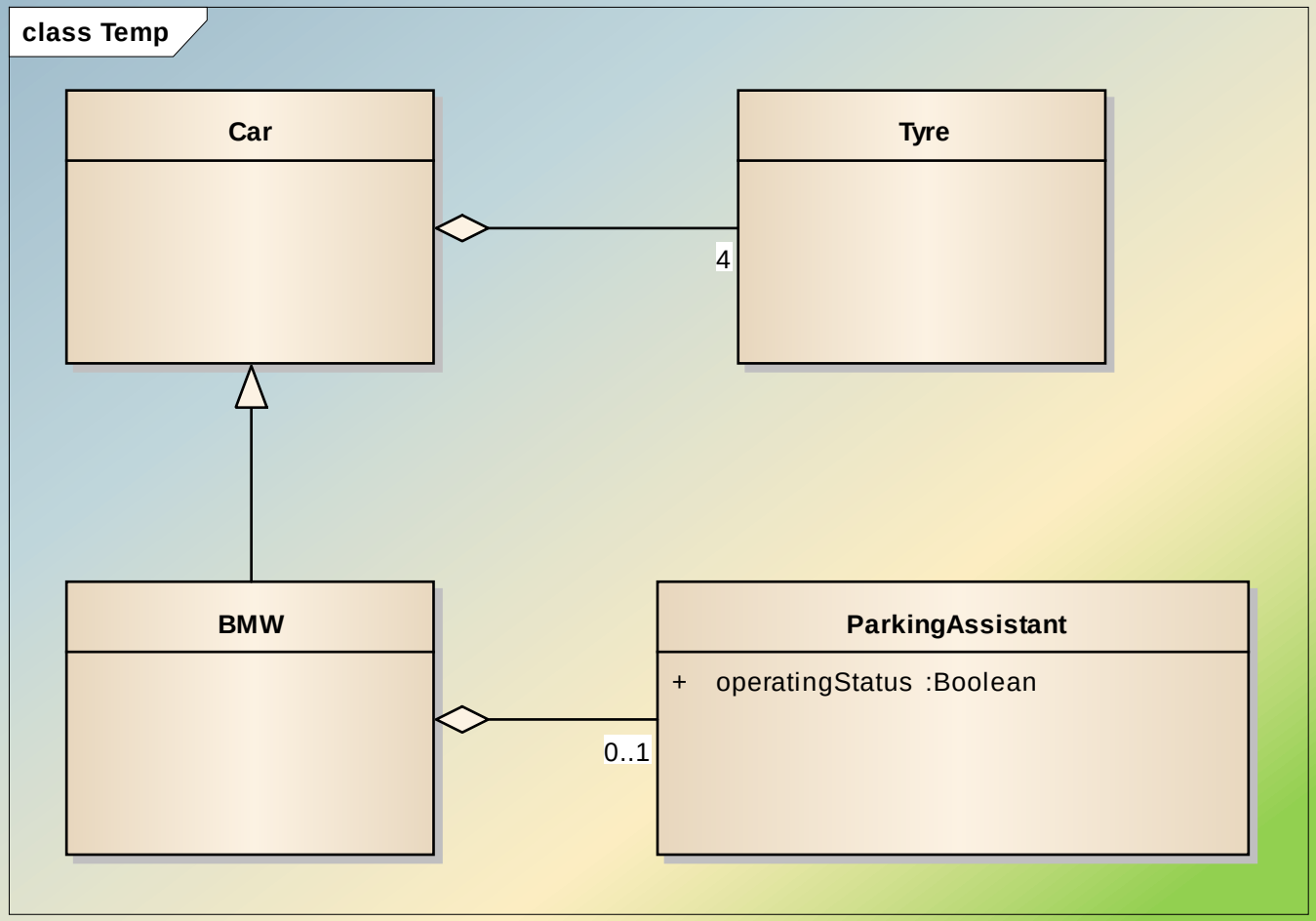


Used UML elements in DATEX II

Methodology



UML example

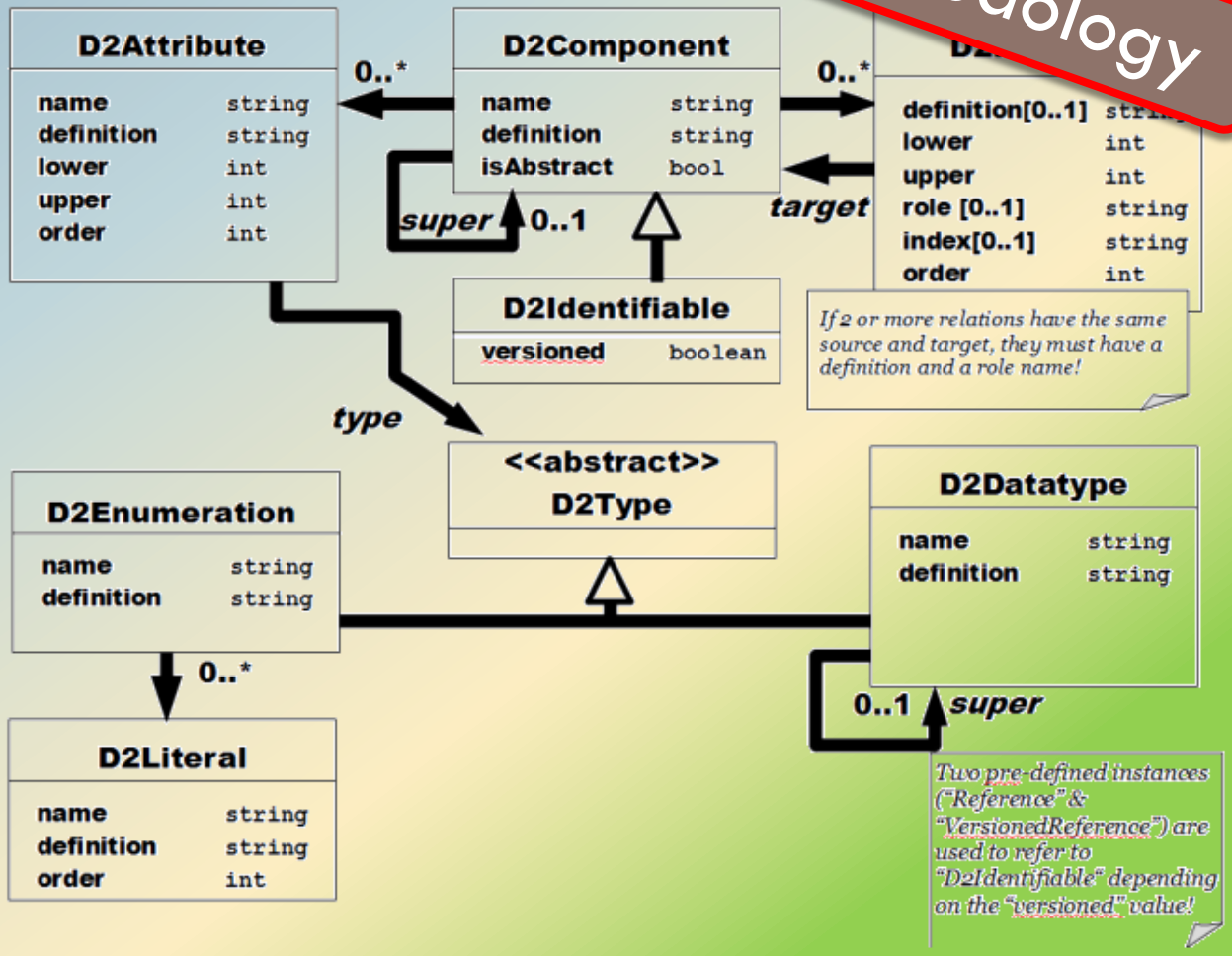

class Temp
Car
Tyre
4
BMW
ParkingAssistant
+ operatingStatus :Boolean
0..1

DATEX meta model

Methodology

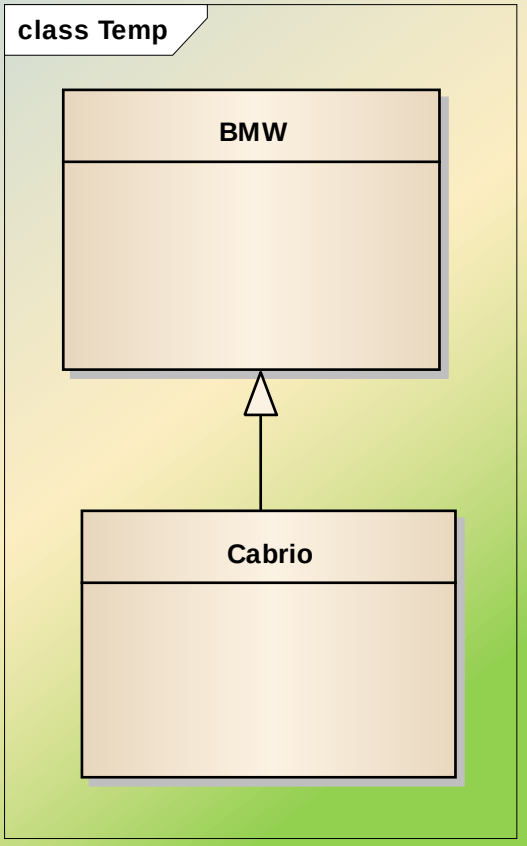
<u>An aside:</u>

Attributes, relations etc. for DATEX are defined in a meta model with the means of UML



Different Views in Enterprise Architect

- The data model can be visualized through customized figures. These figures all access the same data basis - the data model.
- Multiple figures can not contradict each other, but they can offer different views. They can focus different details or hide some elements.



This is no contradiction to the example before.
A Cabrio is also a car and may have a parking assistent.

Data basis („the truth“)

- Point
  - Point
  - AlertCPoint
    - alertCLocationCountryCode
    - alertCLocationTableNumber
    - alertCLocationTableVersion
  - Point
  - PointByCoordinates
    - bearing

Elements in one package

Connections / relations

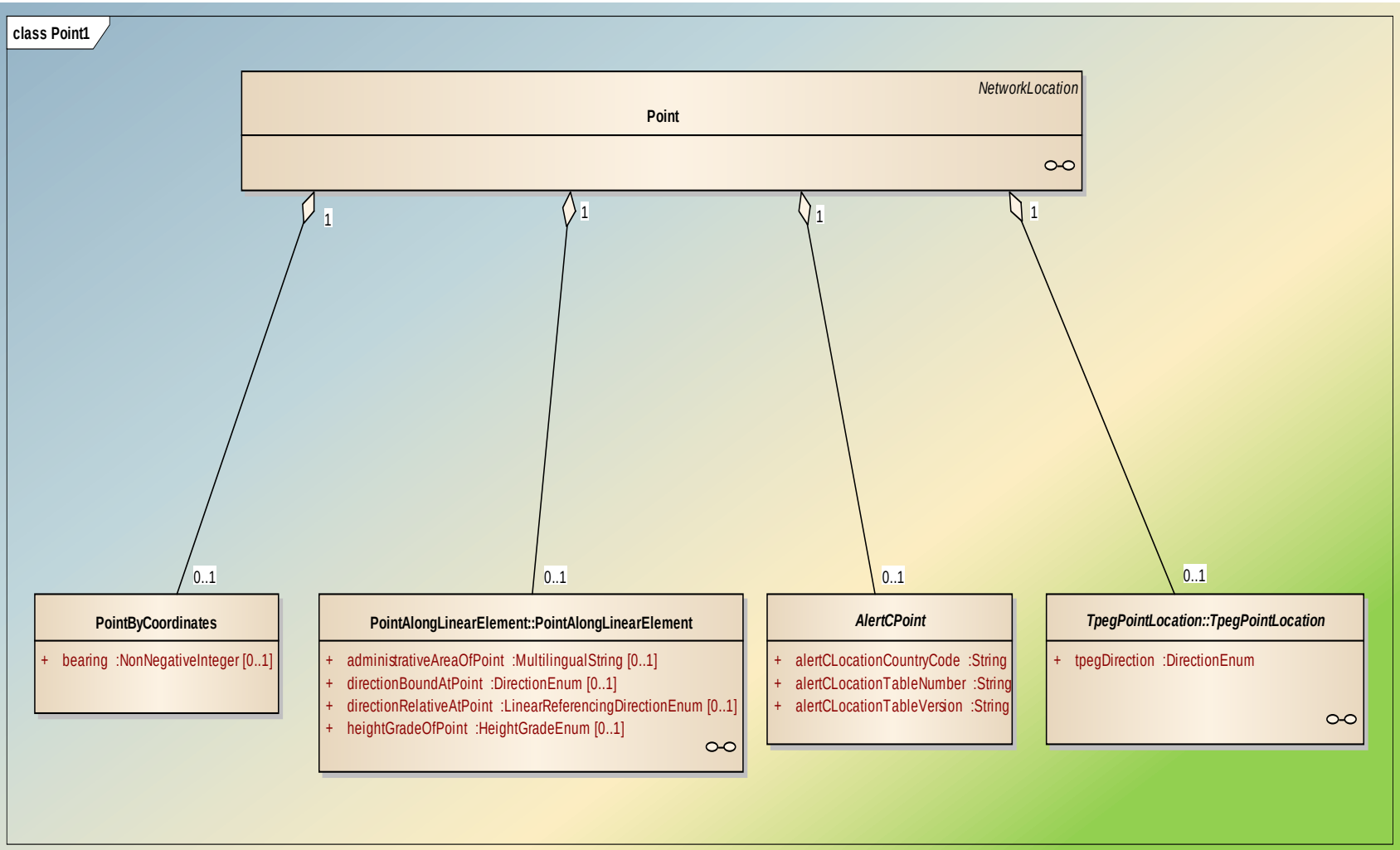
Class : Point

- Properties
  - General
  - Details
  - Templates
  - Advanced
  - Tagged Values
- Rules
  - Requirements
  - Constraints
  - Scenarios
- Related
  - Files
  - Links

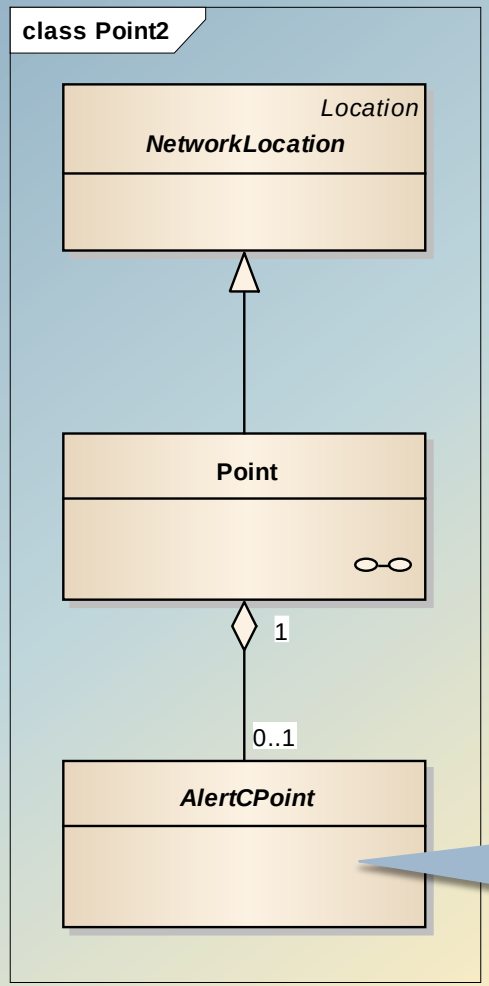
Relationships

Element	Element Stereotype	Type	Connection
AlertCPoint		Class	Aggregation
AssignedParkingSpaces		Class	Aggregation
AssignedParkingSpaces		Class	Aggregation
NetworkLocation		Class	Generaliza...
ParkingFacility	versionedIdentifiable	Class	Aggregation
ParkingFacility	versionedIdentifiable	Class	Aggregation
PointAlongLinearElement		Class	Aggregation
PointByCoordinates		Class	Aggregation
PointDestination		Class	Aggregation
TpegPointLocation		Class	Aggregation

Views on the Point item



Views on the Point item



In this view, the possibility to express a point by coordinates is not shown, however, this is still a valid method.

A little awkward, because mandatory attributes are not shown. Anyway, it's not forbidden.

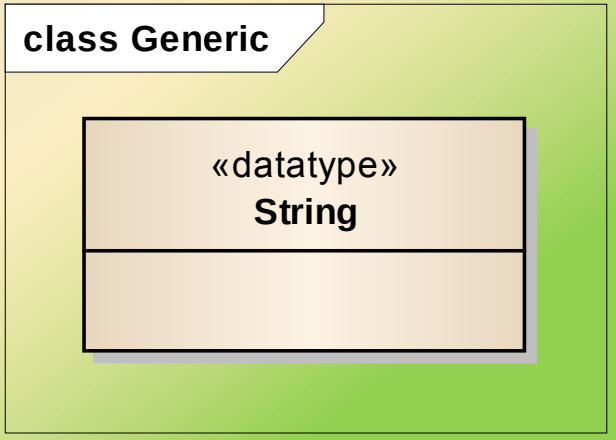
Data types

- All used (simple) data types are also realized in the form of DATEX components. A distinction is made between generic and specific data types. The latter are derived from the generic types.
  DATEX simple data types are mapped to the corresponding XSD simple types (using the tagged value 'schemaType').

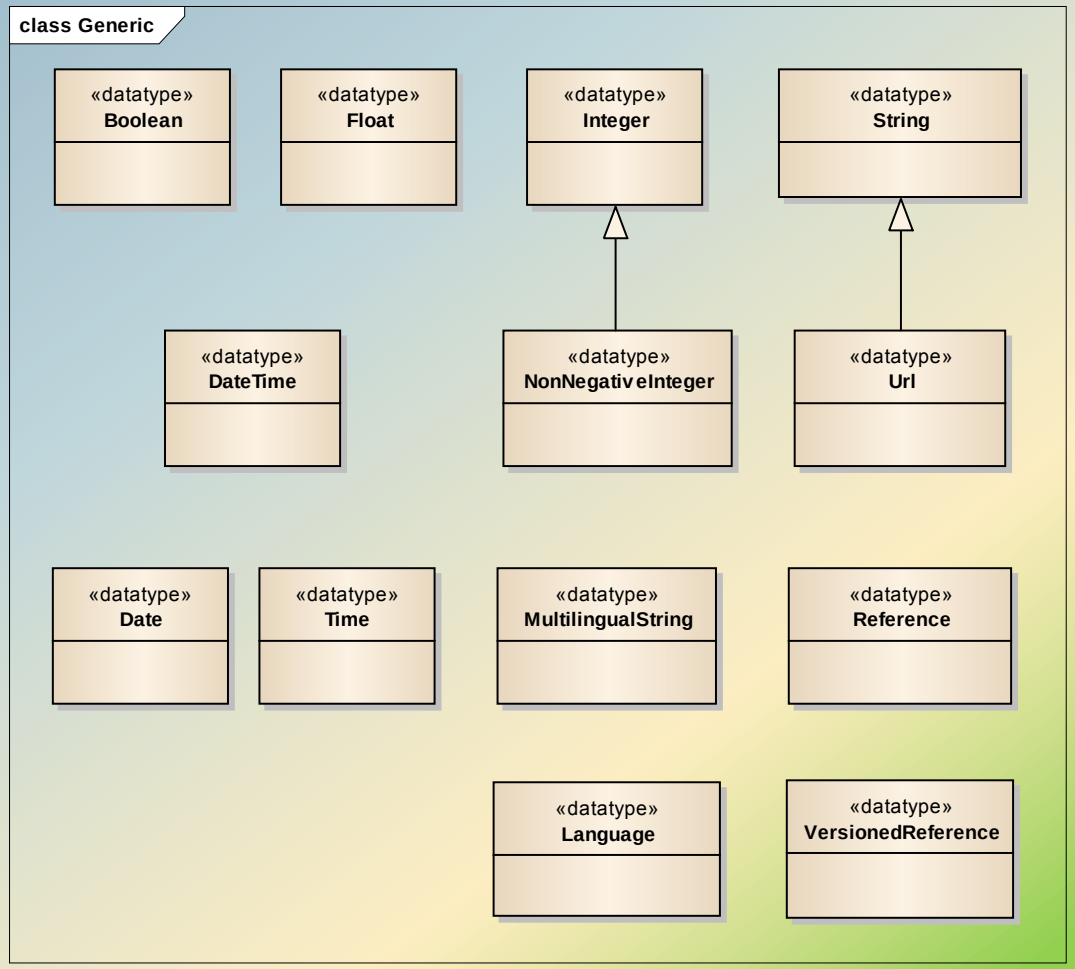
Tagged Values

Class (String)

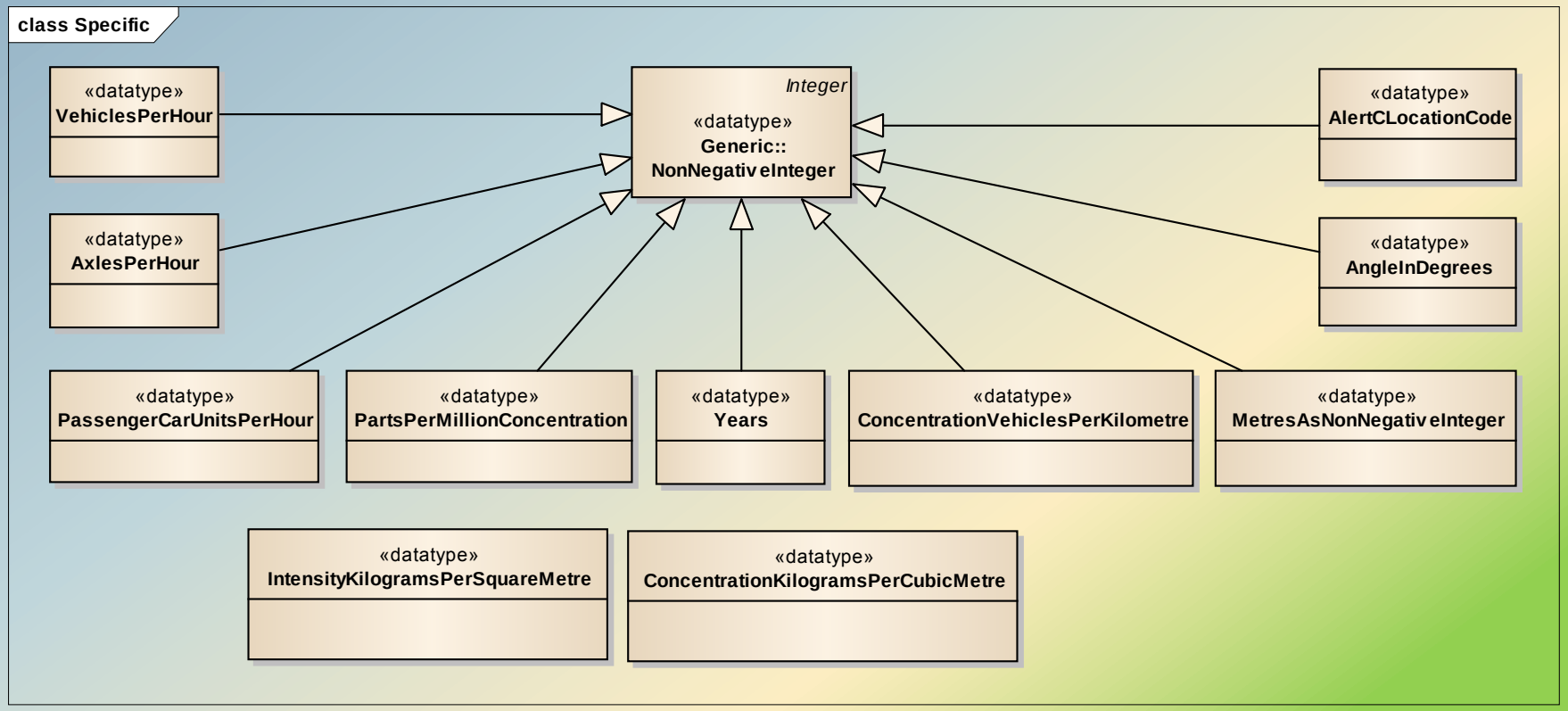
changed	new
definition	A character string whose value sp
facets	<xs:maxLength value="1024"/>
origin	- null -
originalCode	- null -
originalName	- null -
schemaType	string
type	content



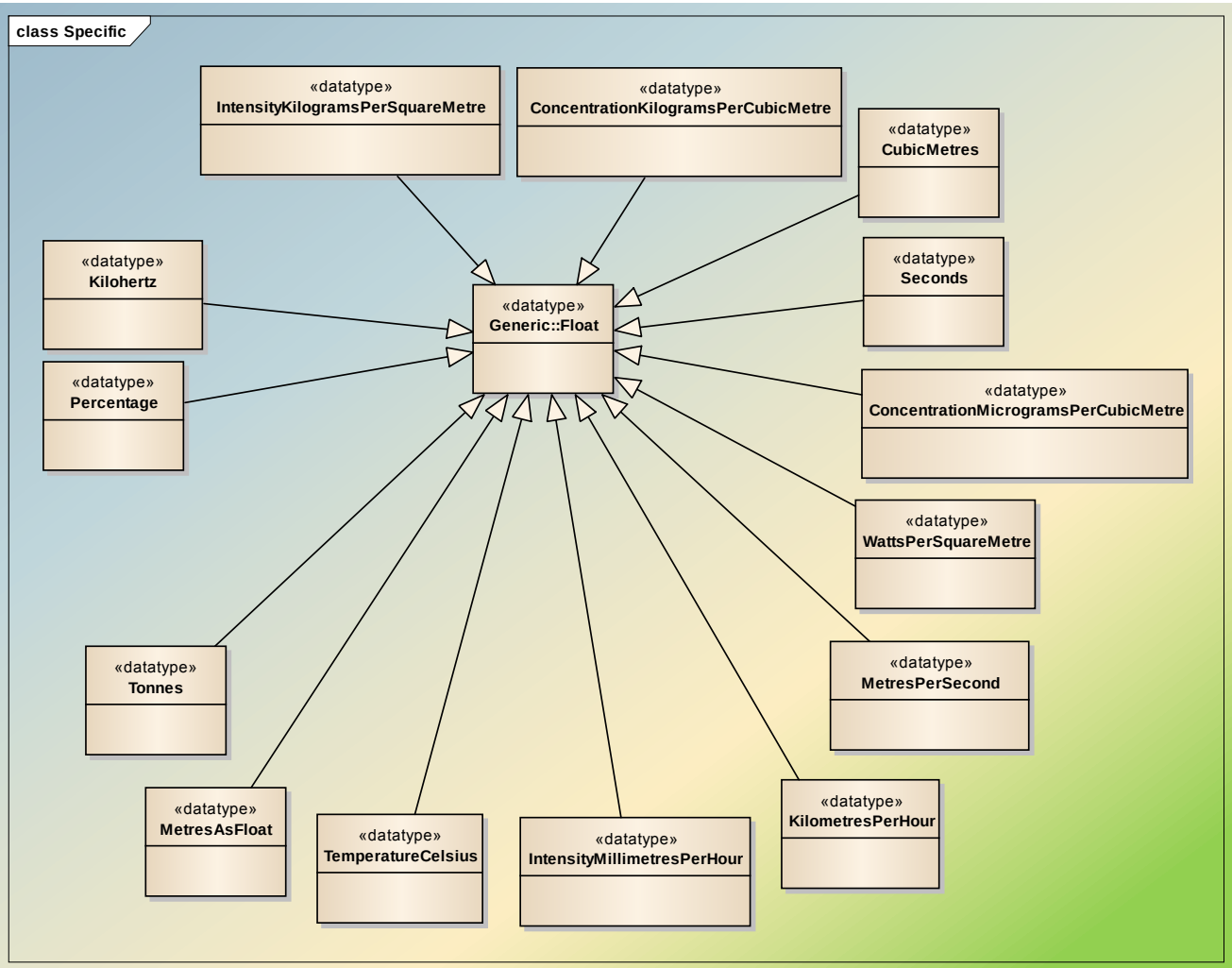
Data types (generic)



Data types (specific I)

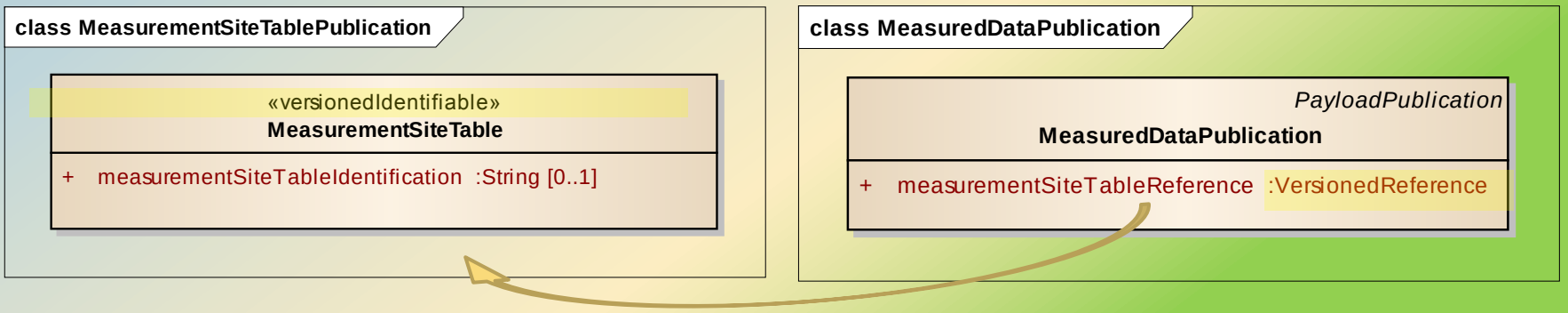


Data types (specific II)



References

- Using cross references as an alternative to direct aggregation or between different messages
- Example: Relationship between static data (e.g. infrastructure information) and dynamic data (e.g. high-frequency measurements)
- Identification by stereotype ‘identifiable‘ (using an ID "unique in space and time")
- Reference with data type ‘Reference ‘
- Different versions: Usage of ‘versionedIdentifiable‘ and 'VersionedReference '.



References in XML instance example

Definition of MeasurementSiteTable in static message:

```
<measurementSiteTable id="92126FC7-3D2E-4AAE-A1AC-FE33812D572F" version="1">
    <measurementSiteTableIdentification>Diebg12</measurementSiteTableIdentification>
    <measurementSiteRecord id="C69BE0FB-CA4C-43CE-A00F-9B3A77E5CB86" version="1">
        <measurementEquipmentTypeUsed>
```

Reference in dynamic message:

```
<payloadPublication xsi:type="MeasuredDataPublication" lang="de">
    <publicationTime>2012-08-14T09:00:01.0Z</publicationTime>
    <publicationCreator>
        <country>de</country>
        <nationalIdentifier>DE-MDM-xxxxxxxx</nationalIdentifier>
    </publicationCreator>
    <measurementSiteTableReference targetClass="MeasurementSiteTable" id="92126FC7-3D2E-4AAE-A1AC-FE33812D572F" version="1"/>
    <headerInformation>
        <confidentiality>noRestriction</confidentiality>
        <informationStatus>test</informationStatus>
    </headerInformation>
```

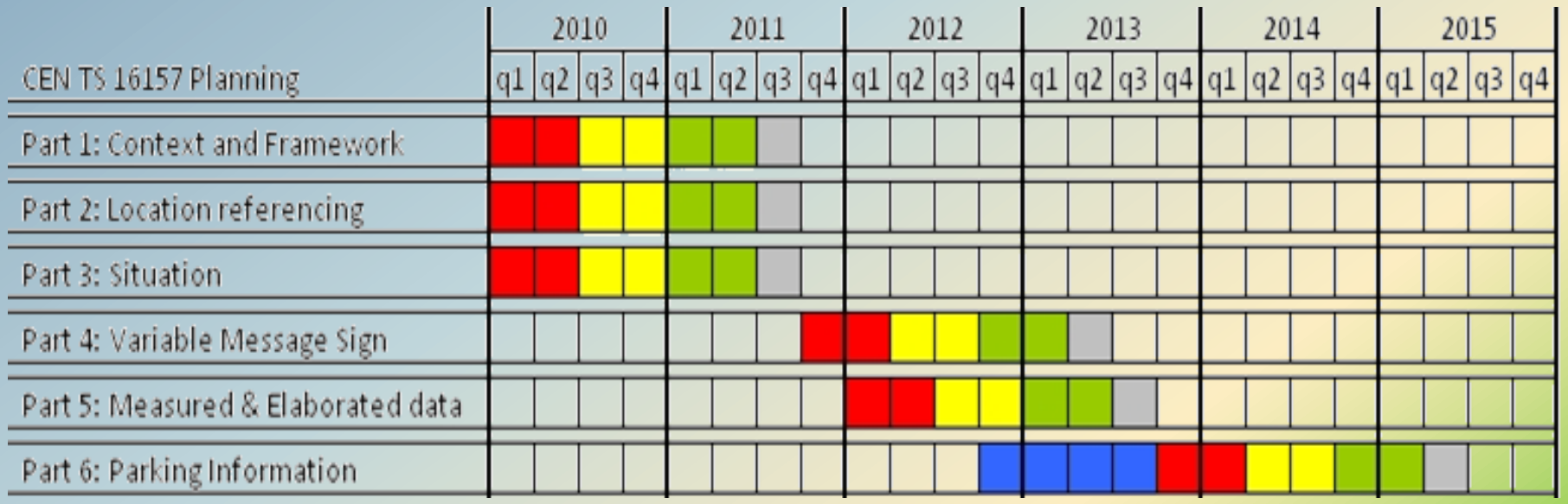
a so called UUID was used (Universally Unique Identifier)

Data model Level A

PRESENTATION DATA MODEL (LEVEL A)

European Commission
Mobility & Transport

Standardisation time schedule



= Ratification and preparation of definitive texts by CMC (3m)
= Preparation of TCA-draft by CMC and Voting (6,5m)
= TC-review, processing comments by WG (6m)
= Drafting stage (6m)
= Preliminary stage, optional (12m)

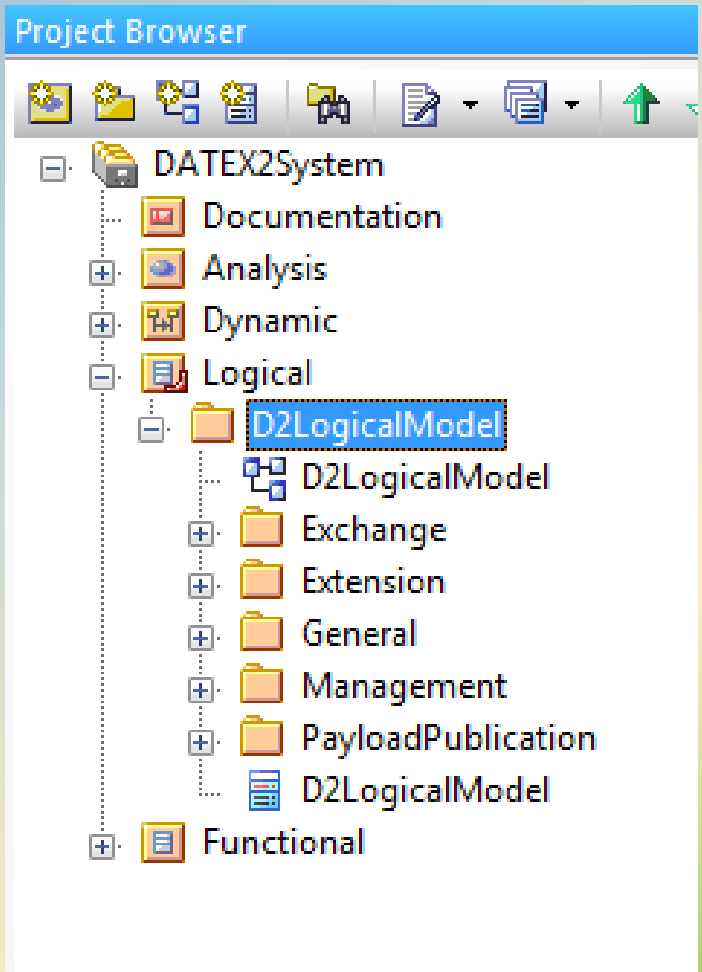
DATEX data model ‚interoperability levels‘

Level A

- ‚Existing’ data model
- Data catalogue, ontology, data registry, ….
- The Level A model is ‘fix‘ and can only be adjusted within new DATEX versions, but not in general
  (but see also profile creation)

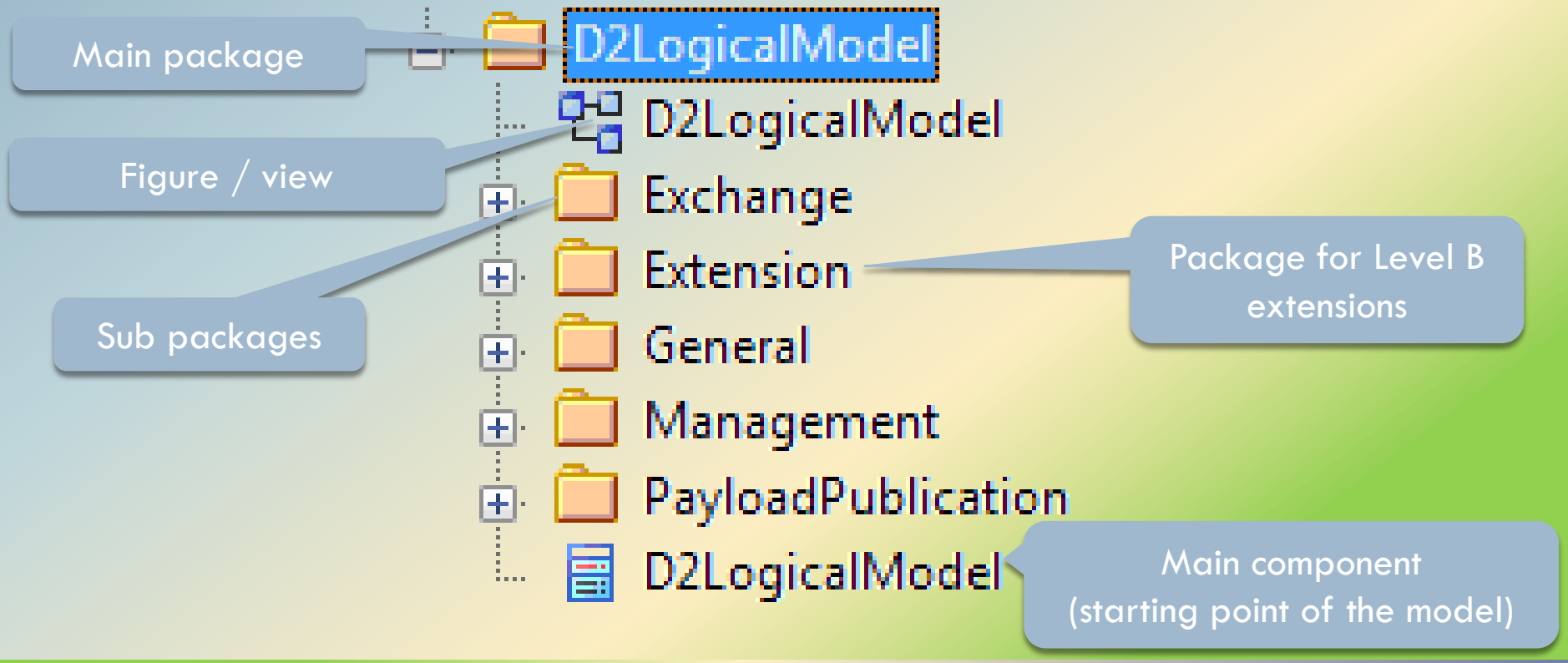
- Level B
  - Backward compatible extension/amendment to Level A
- Level C
  - Completely independent, no longer to Level A compatible scheme which corresponds to the DATEX methodology anyway.

DATEX Data model Level A

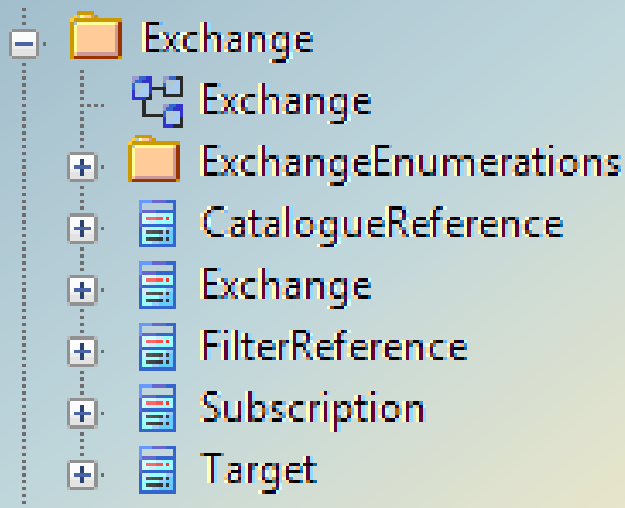


DATEX Data model Level A

- Tree structure of Enterprise Architect Project Browser:

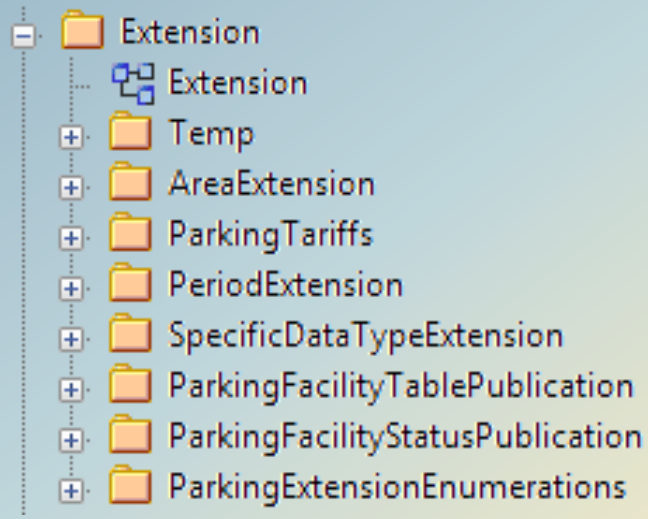


The packages: Exchange



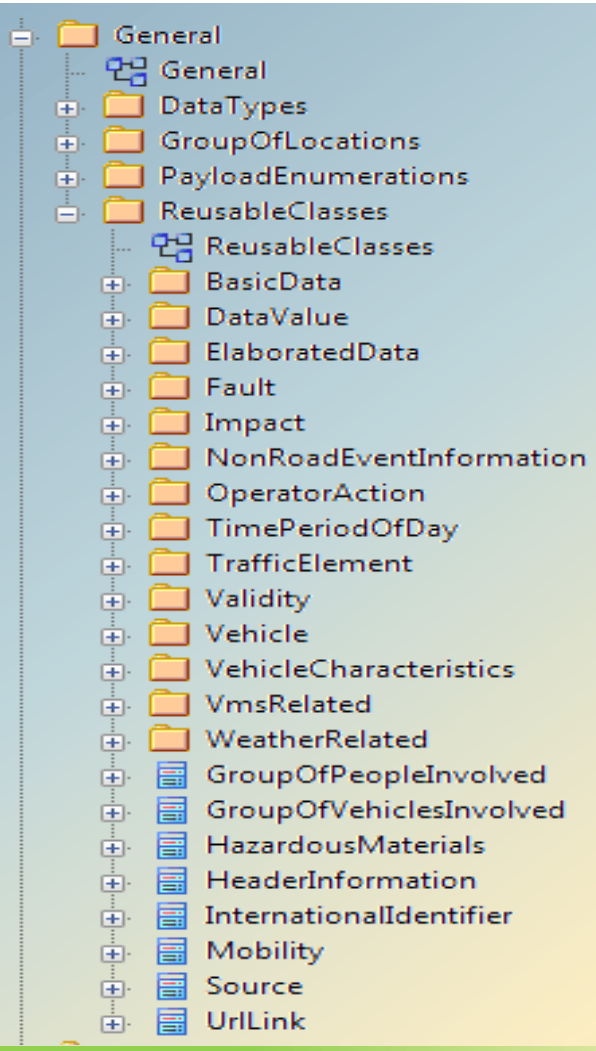
- Protocol relevant data like for example
  - type of subscription
  - keep alive message
  - delivery interval
  - update method
- no content related data
- The Exchange specification is currently being updated

The packages: Exchange



- space for customized Level B extensions
- since DATEX II version 2.1, this package already contains the Parking extension
  (please note, that this is a antecessor of the current CEN workitem Parking extension)

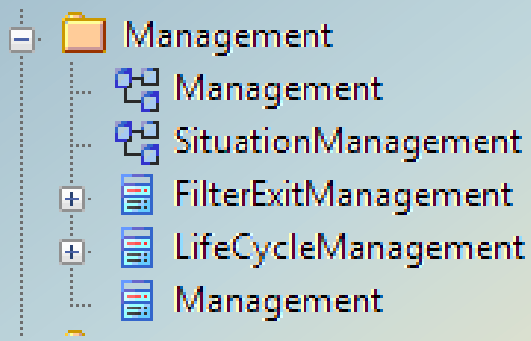
The packages: General



'General' contains

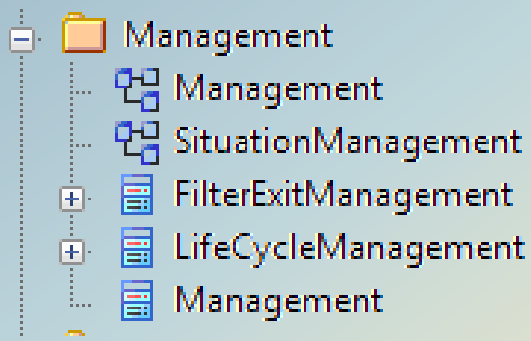
- data types package (generic, specific)
- groups of location package (georeference)
- all enumerations (because of their mass divided into alphabetically sub packages)
- reusable classes, i.e. structures, which are used elsewhere in the model

The packages: Management



A small package containing some information for the life cycle of situations (e.g. traffic messages)

The packages: Management



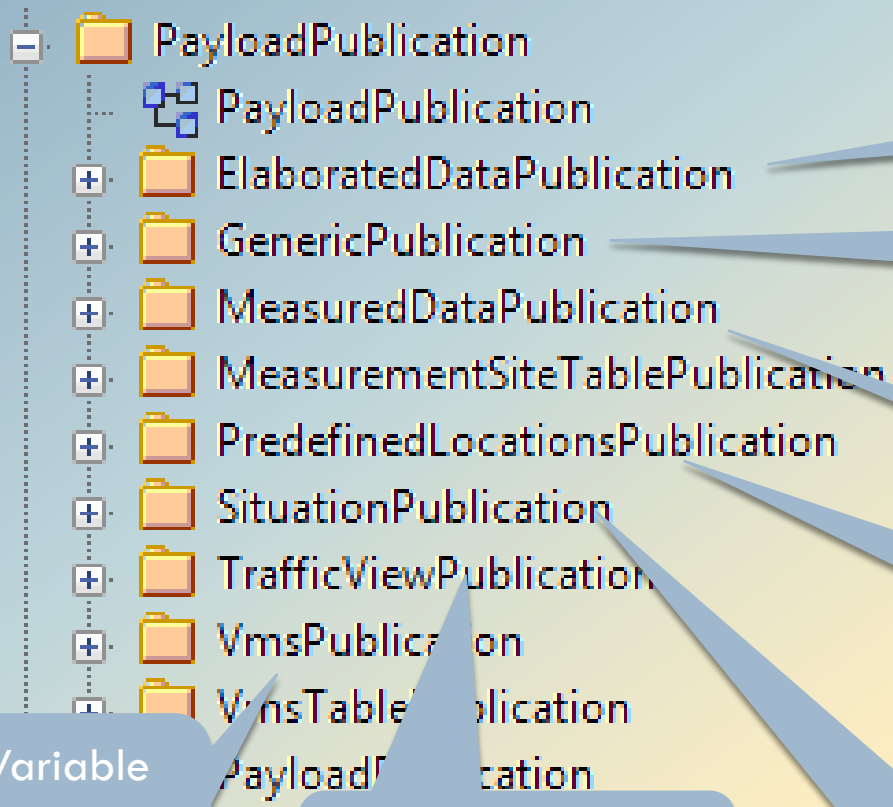
A small package containing some information for the life cycle of situations (e.g. traffic messages)

The packages: PayloadPublication

- PayloadPublication
  - PayloadPublication
  - ElaboratedDataPublication
  - GenericPublication
  - MeasuredDataPublication
  - MeasurementSiteTablePublication
  - PredefinedLocationsPublication
  - SituationPublication
  - TrafficViewPublication
  - VmsPublication
  - VmsTablePublication
  - PayloadPublication

The main payload packages for different types of messages.

The packages: PayloadPublication



Data created through algorithms

Empty structure to add customized publications

Data directly recorded

Using locations by reference to define them just once

Traffic messages

Traffic view on particular section

Variable message signs

DATEX II objects

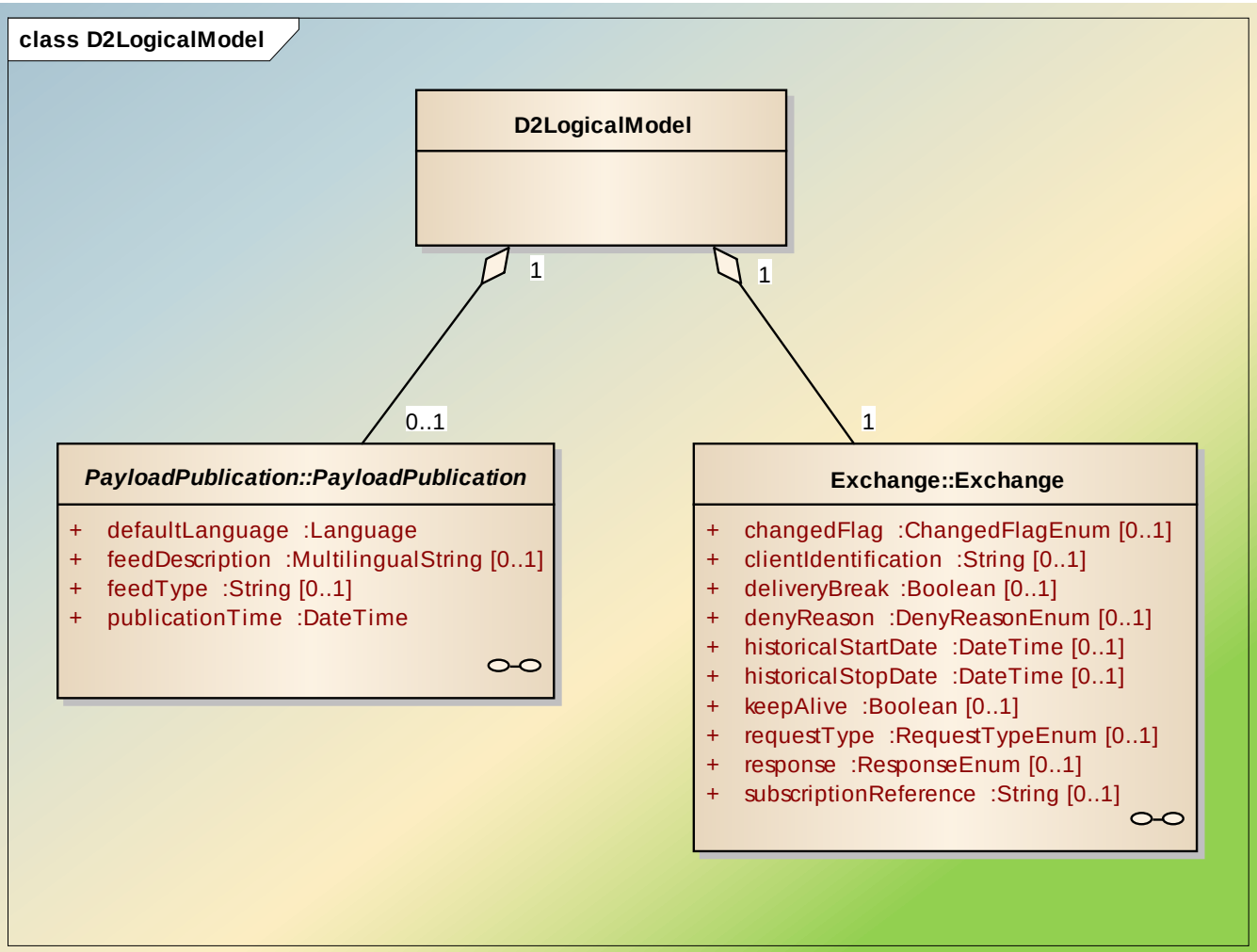
Basic objects (only dynamic)
Elaborated Data
Traffic Elements Congestion, Accident…
Operator Actions Network Mngmt, Roadworks…

Basic objects (static and dynamic part)
Measurements
Variable Message Signs
Parking (Level B)

Additional objects
Location Referencing Area, Point, Linear ALERT-C, ISO 19148, Coordinates, TPEG-LOC, OpenLR (extension) Predefined Locations Additional Positional Descriptions
Validity
Comments, URL, …
Impact, Source, Causes
Data Quality and Faults

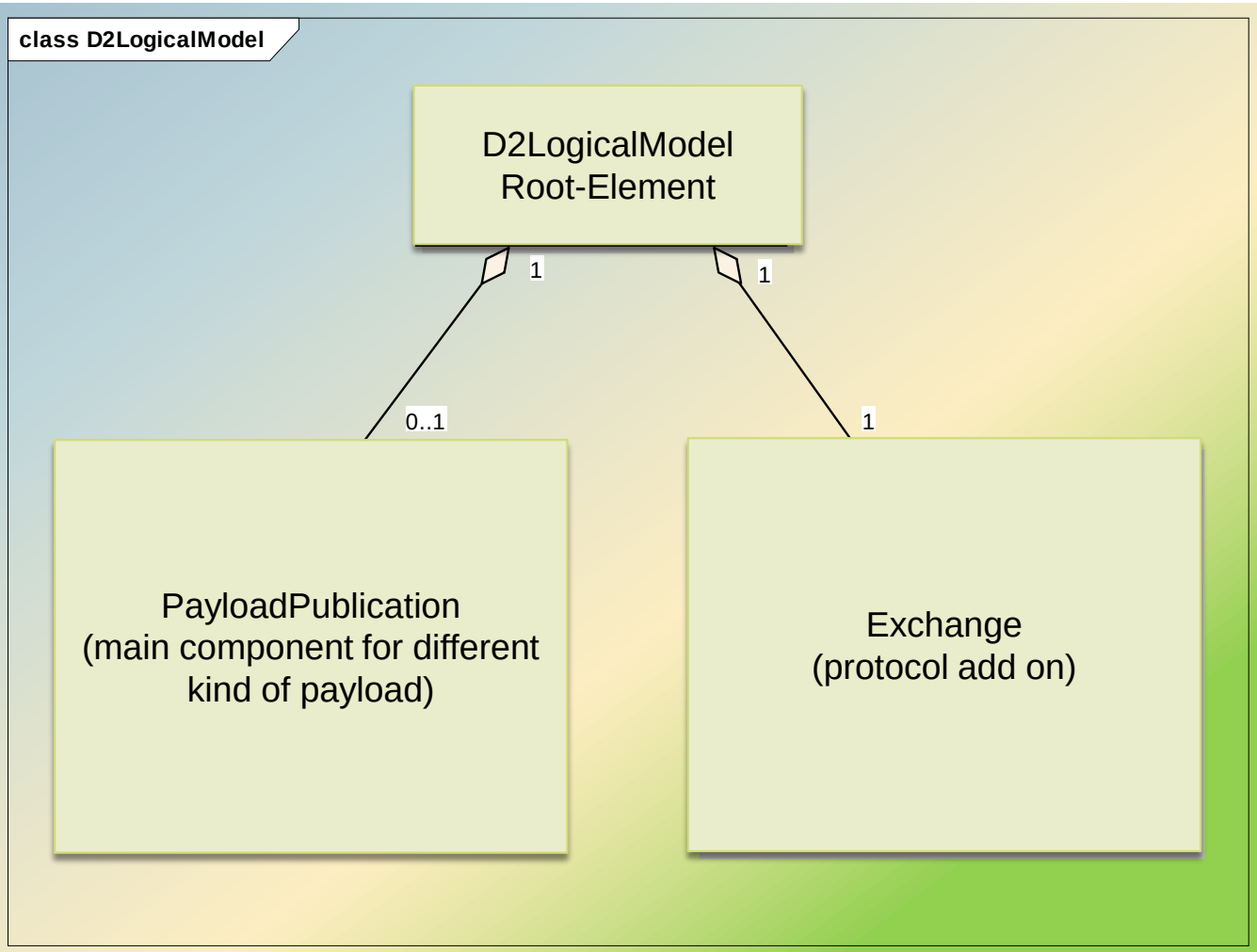
DATEX Data model Level A

Access to the model:

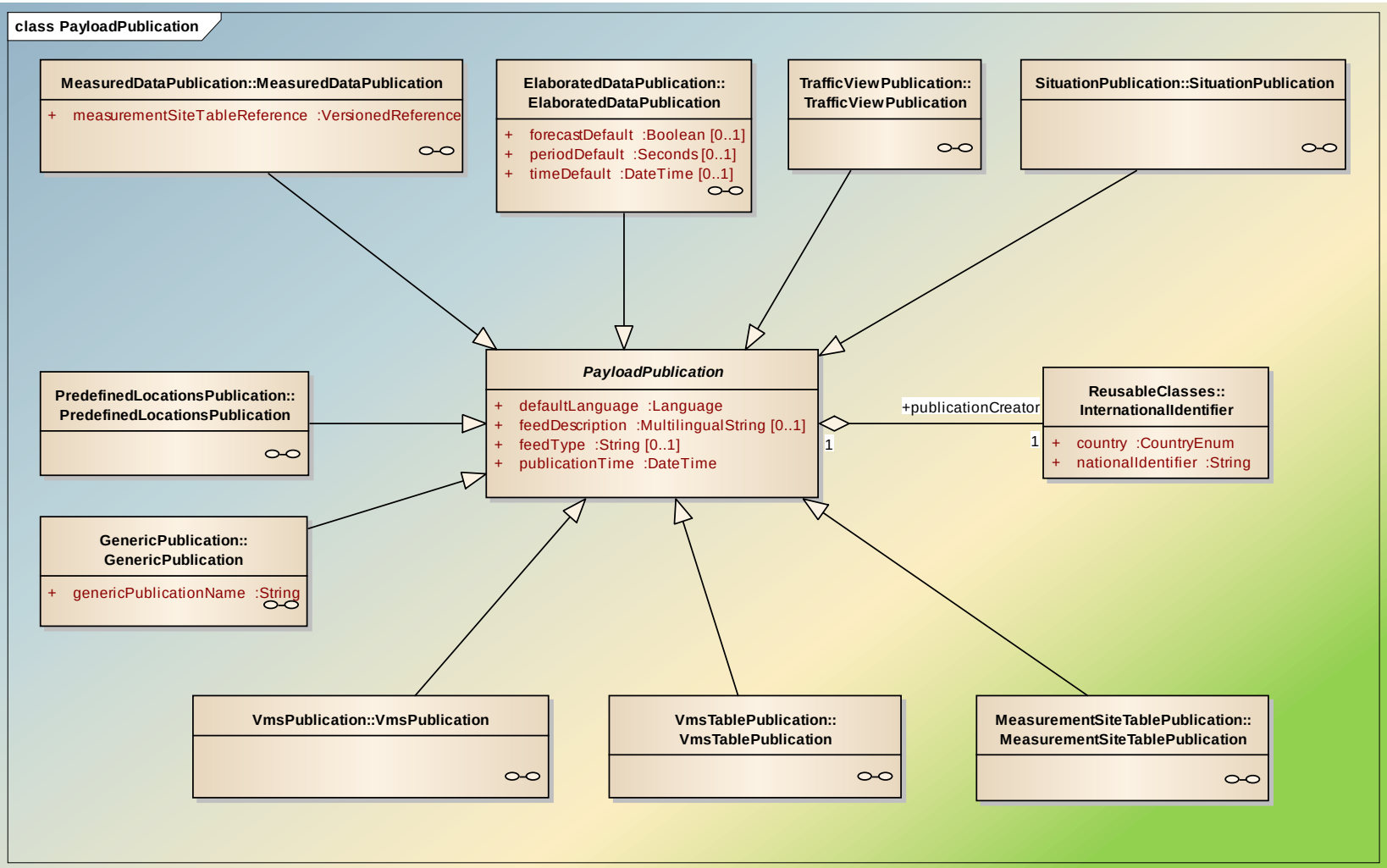


DATEX Data model Level A

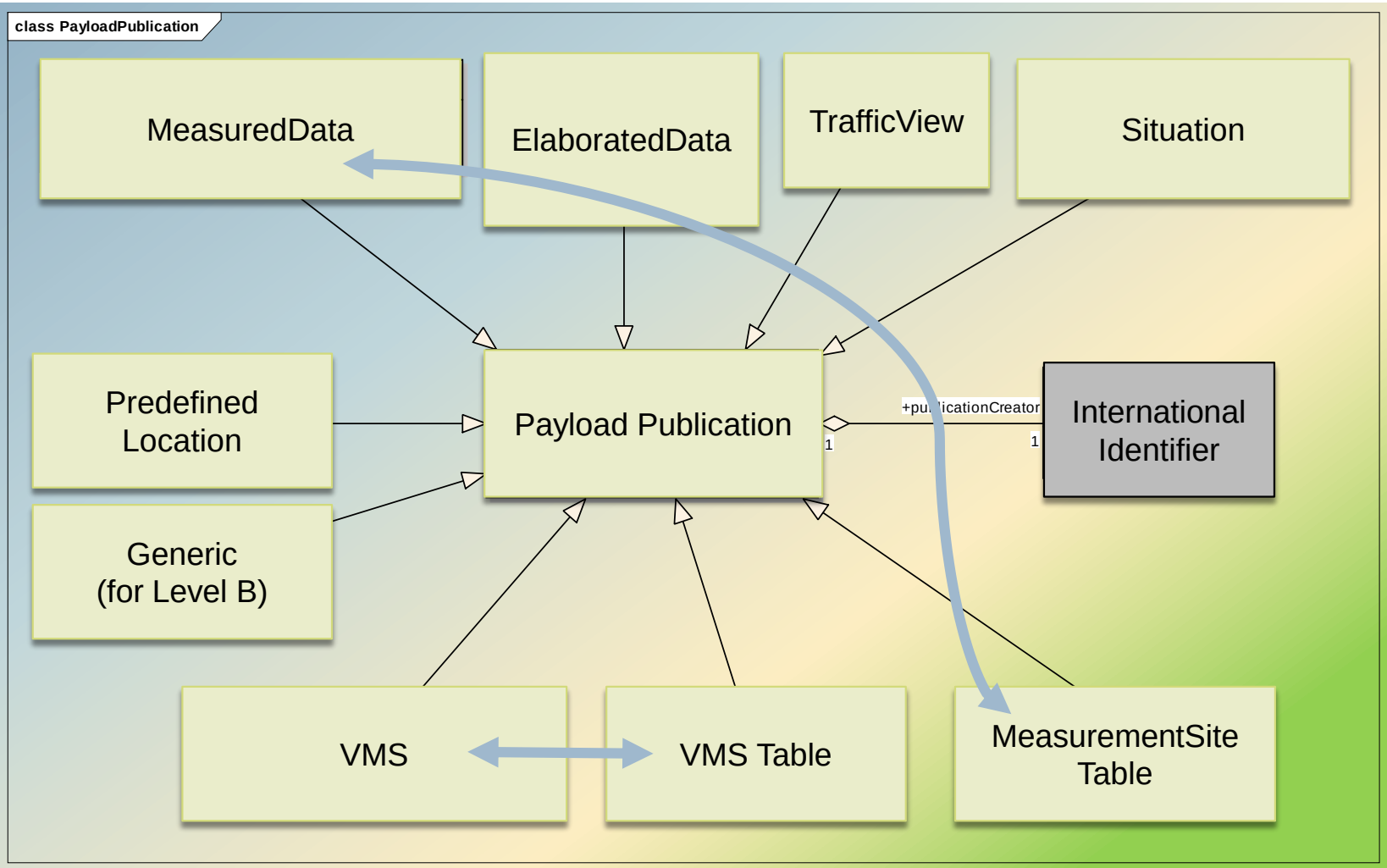
Access to the model:



PayloadPublication



PayloadPublication

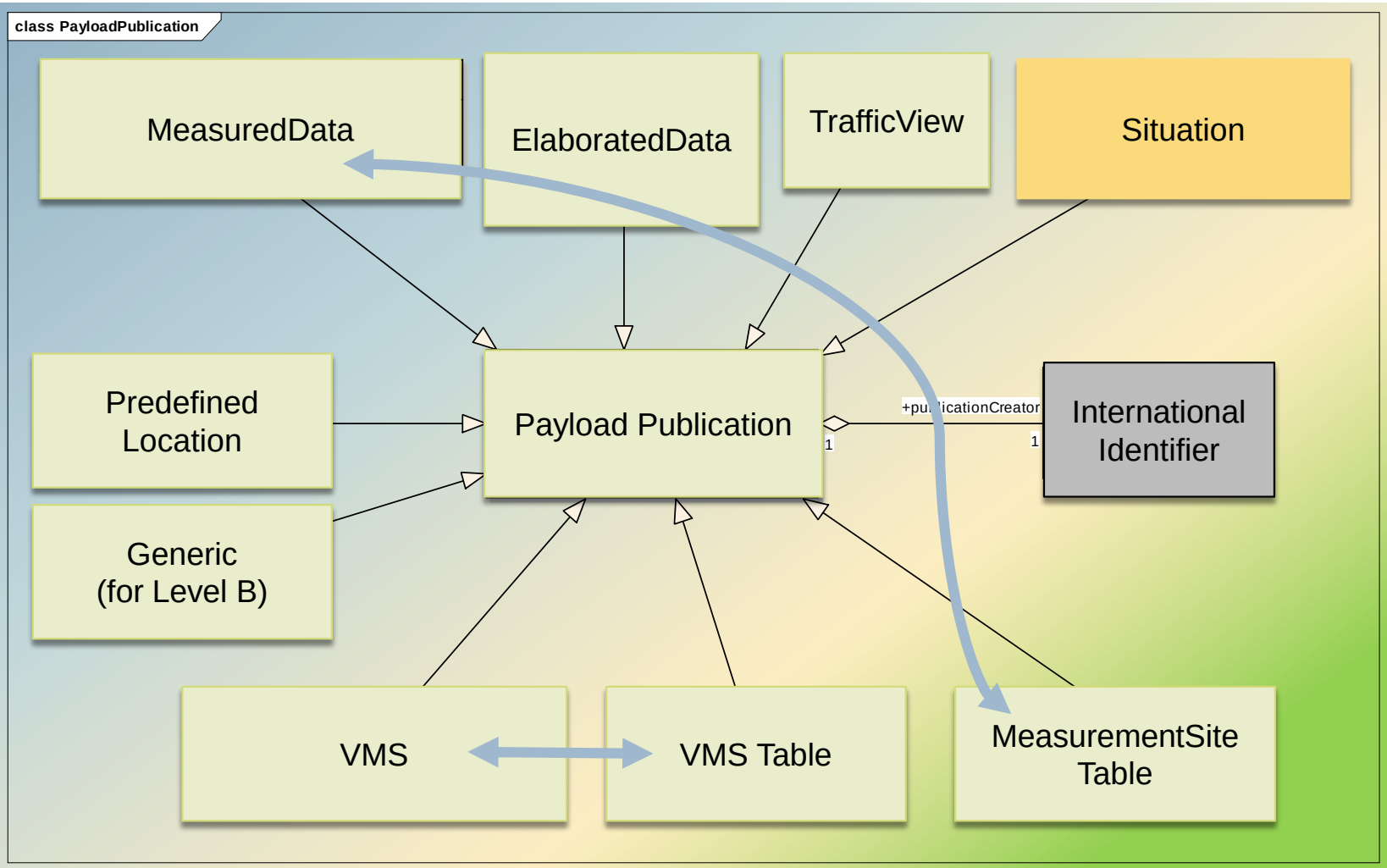


Data model Level A

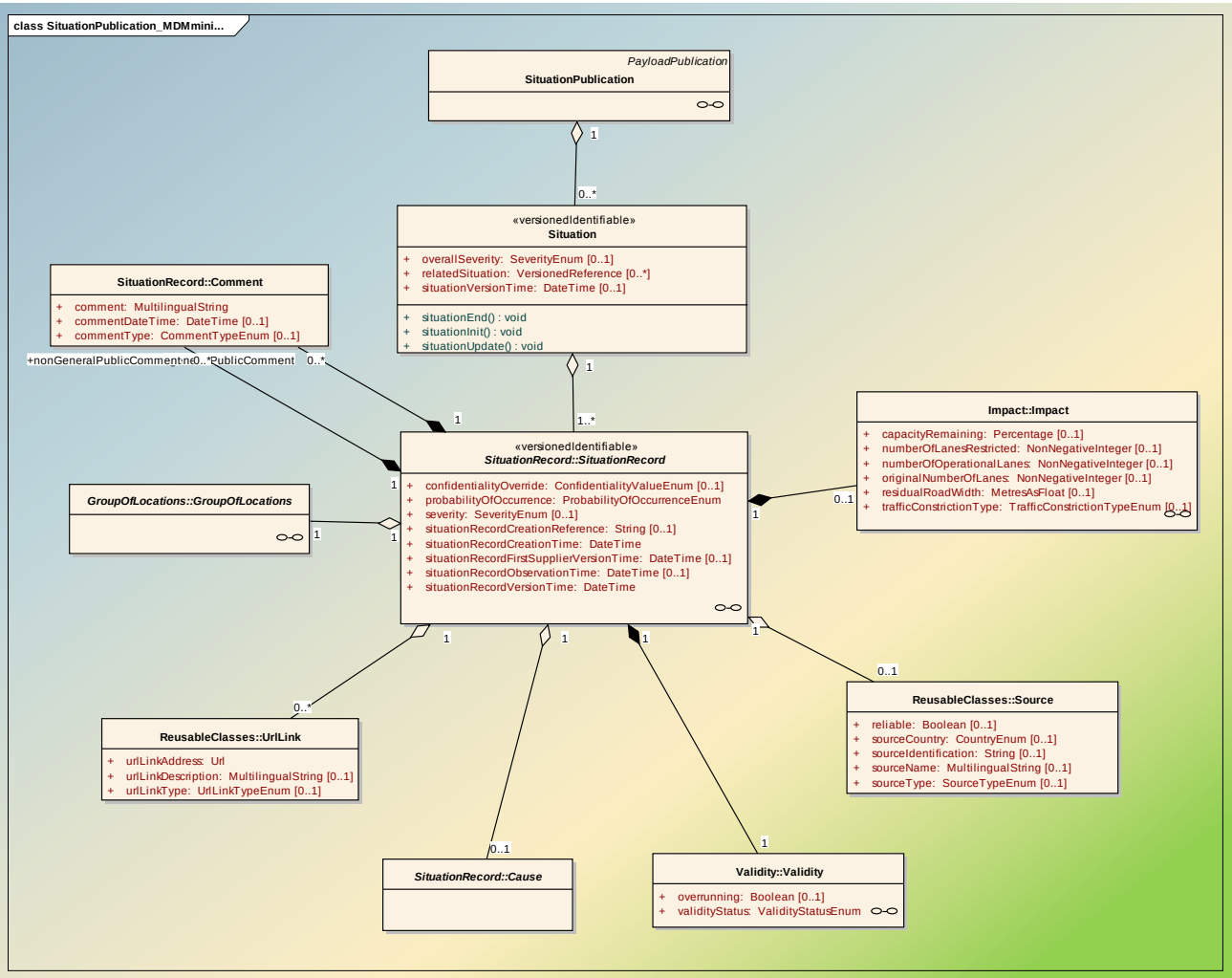
DETAILED EXAMPLE 1:

SITUATION
(TRAFFIC MESSAGES)

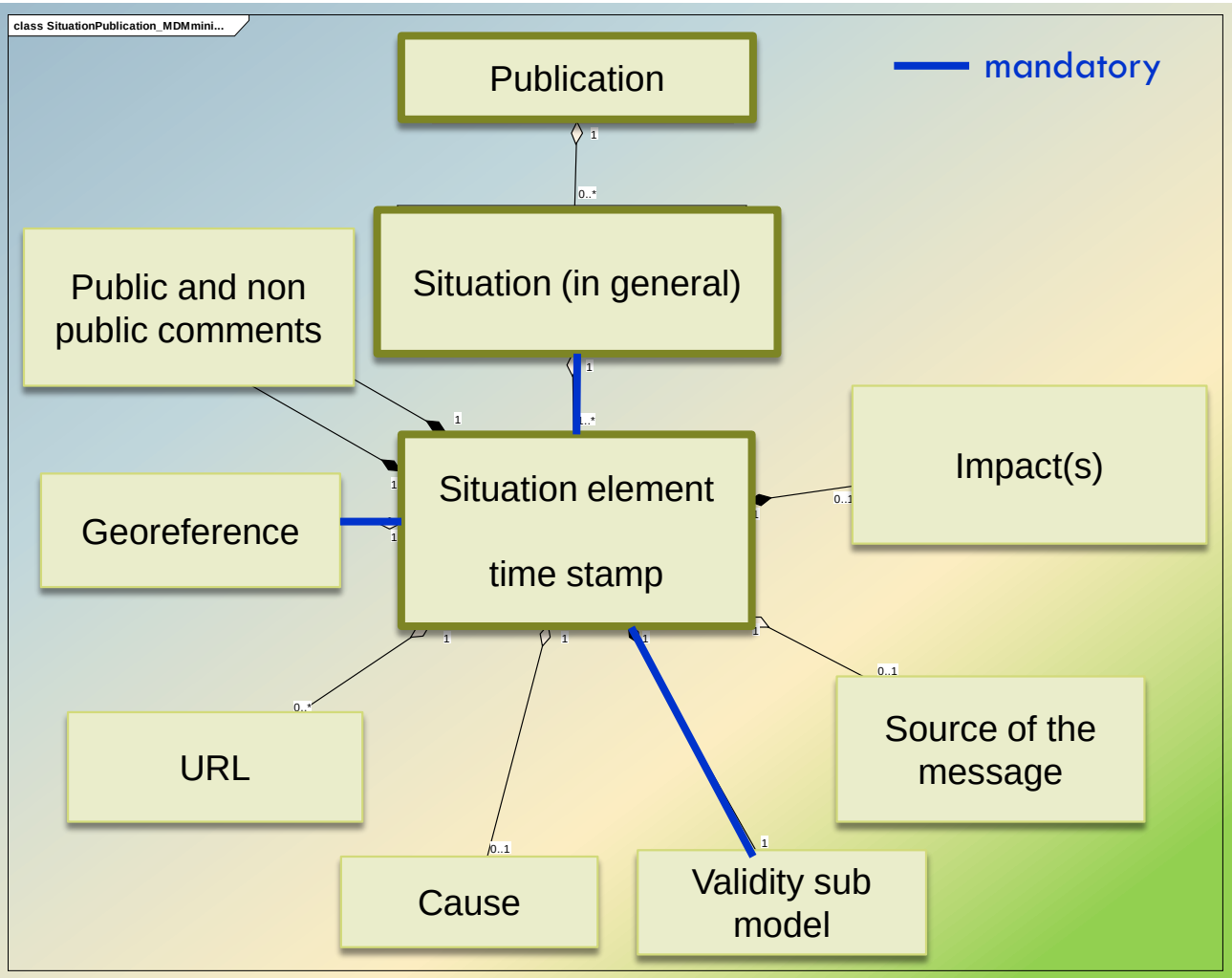
PayloadPublication



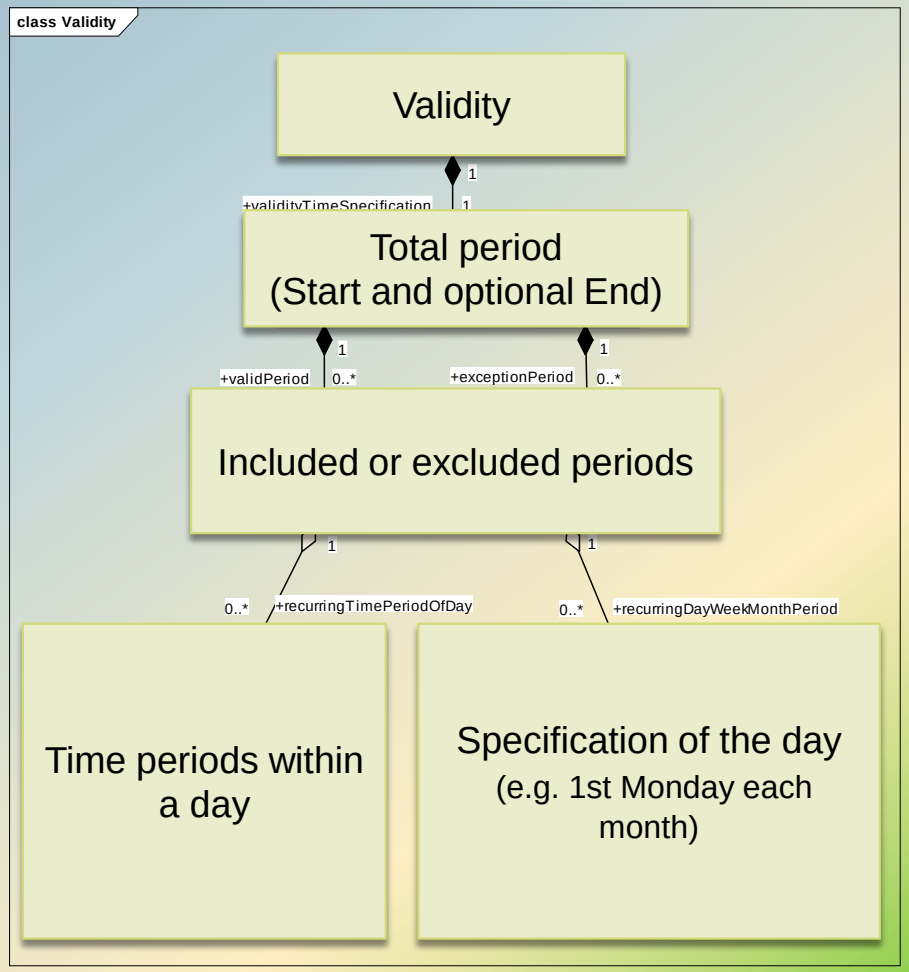
Message type „Situation“



Message type „Situation“



Validity model



Validity model

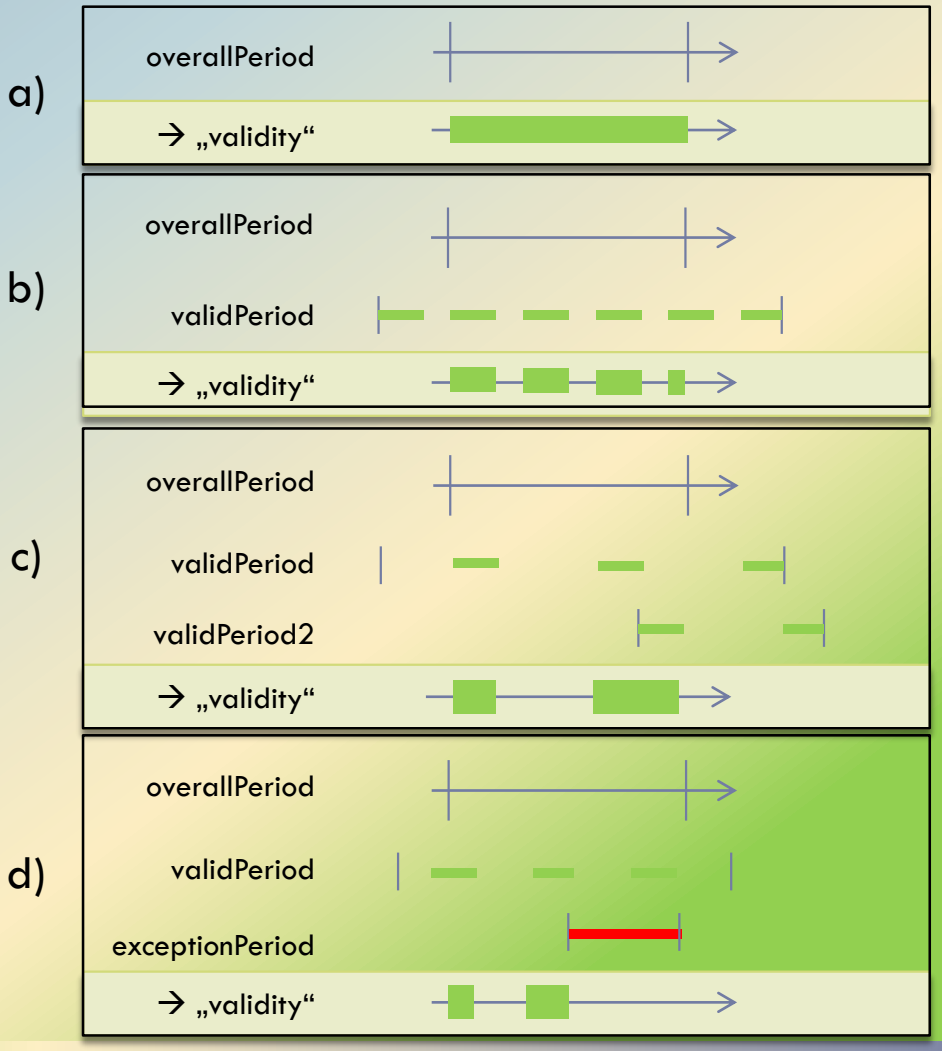
The validity results from the intersection of

- Overall period
- Union of all other specified periods
- Complement of the union of all exclusion periods

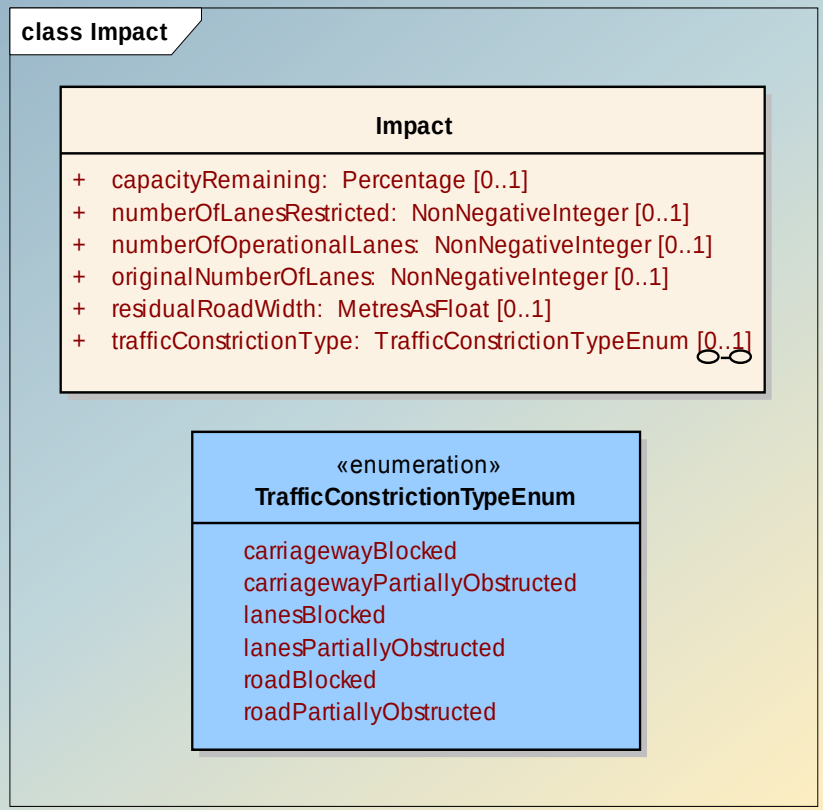
All periods can be defined on date, times, days of the week etc..
example:
Every 1st Monday of the month from 15-18 clock from April 1 to May 30 except May 1

The specification of validity is particularly interesting for planned road works or closures.

The model can also be used for opening times (for example, gas stations or parking facilities).
For traffic information usually only the start time is indicated (even the end time is already optional).

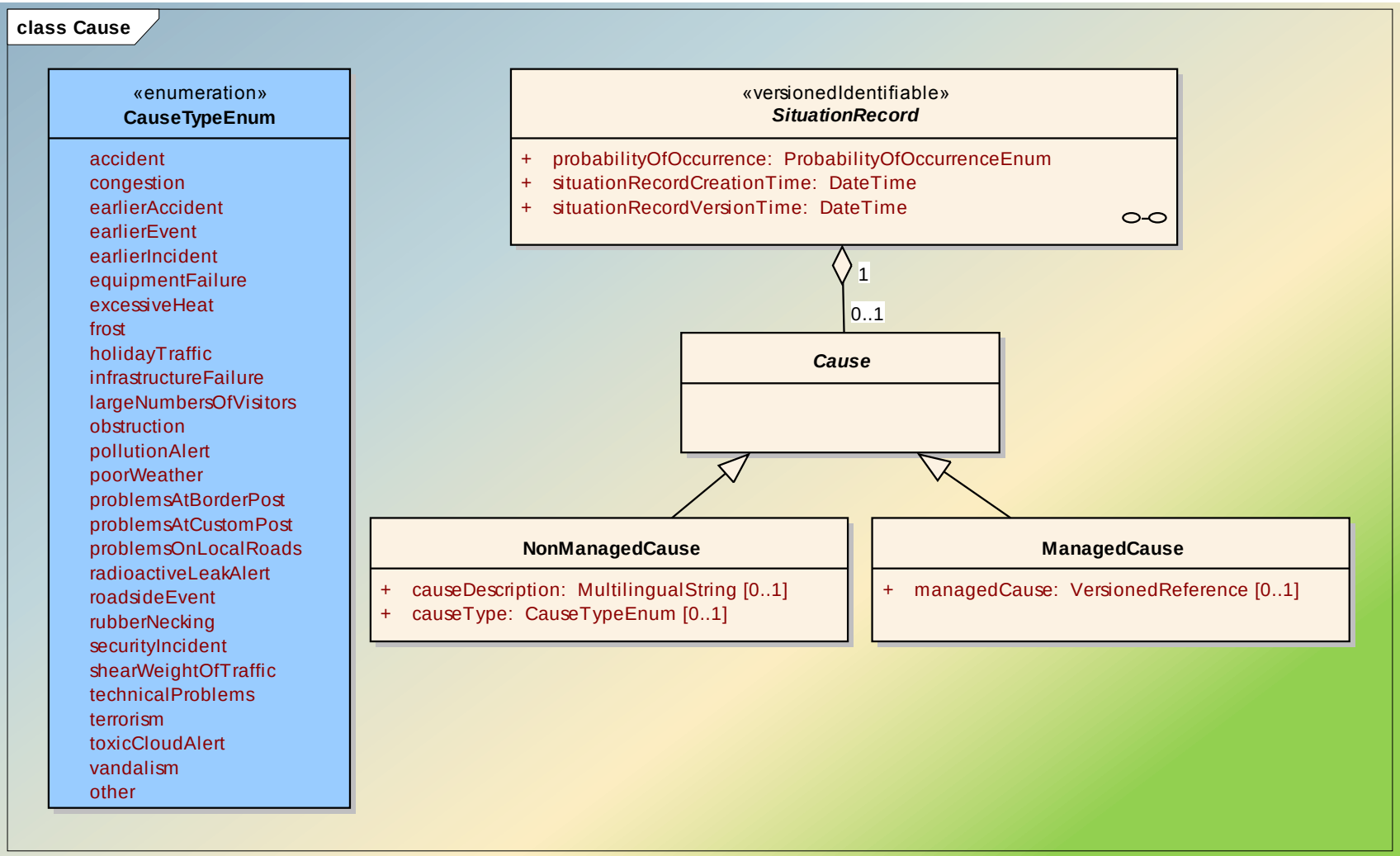


Impacts

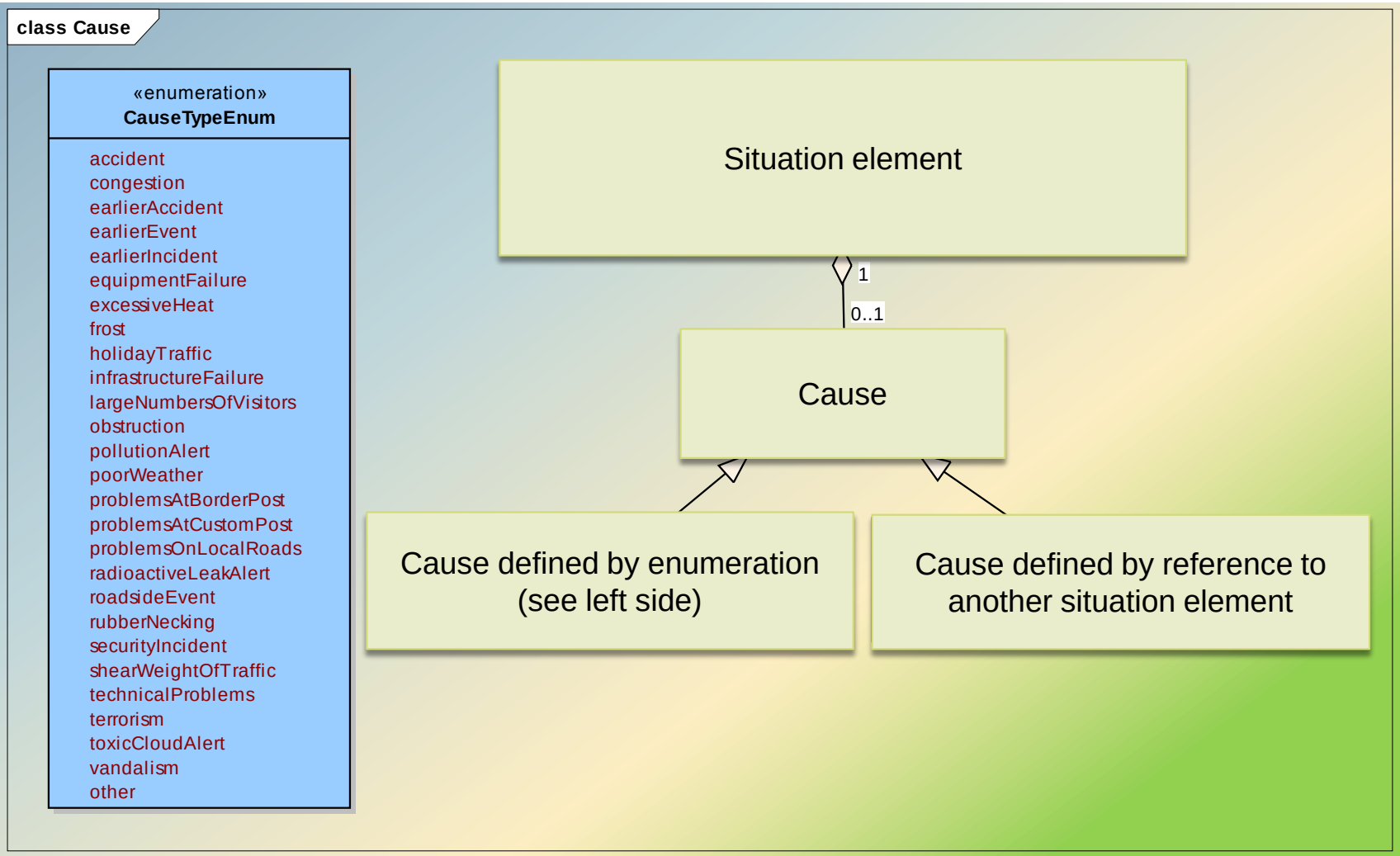


- Remaining capacity
- Number of blocked lanes
- Original number of lanes
- Total width available
- Type of constriction:
  - *Lanes (partially) blocked*
  - *Road (partially) blocked*
  - *Carriageway (partially) blocked*

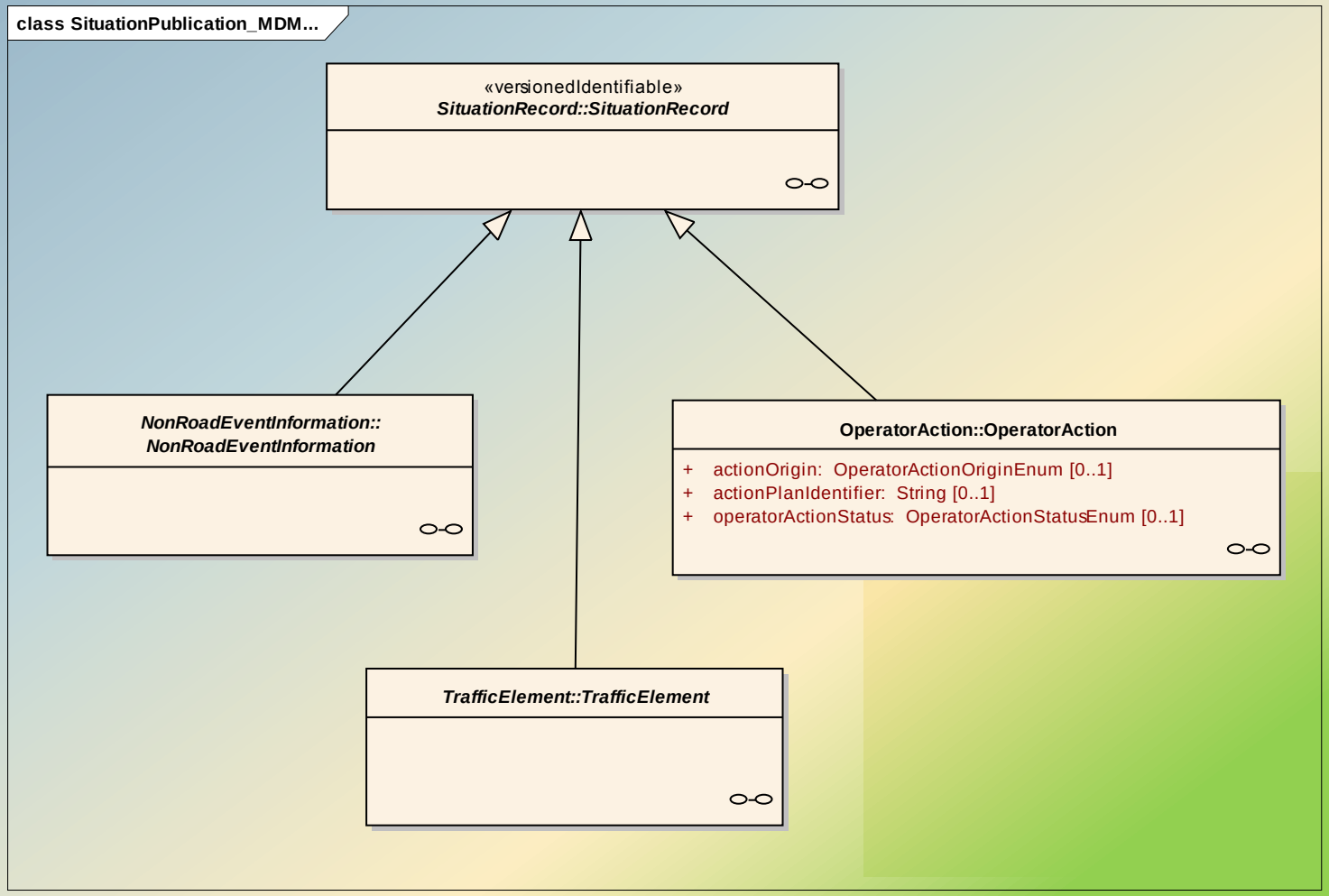
Cause


class Cause
«enumeration»
CauseTypeEnum
accident
congestion
earlierAccident
earlierEvent
earlierIncident
equipmentFailure
excessiveHeat
frost
holidayTraffic
infrastructureFailure
largeNumbersOfVisitors
obstruction
pollutionAlert
poorWeather
problemsAtBorderPost
problemsAtCustomPost
problemsOnLocalRoads
radioactiveLeakAlert
roadsideEvent
rubberNecking
securityIncident
shearWeightOfTraffic
technicalProblems
terrorism
toxicCloudAlert
vandalism
other
«versionedIdentifiable»
SituationRecord
+ probabilityOfOccurrence: ProbabilityOfOccurrenceEnum
+ situationRecordCreationTime: DateTime
+ situationRecordVersionTime: DateTime
1
0..1
Cause
NonManagedCause
+ causeDescription: MultilingualString [0..1]
+ causeType: CauseTypeEnum [0..1]
ManagedCause
+ managedCause: VersionedReference [0..1]

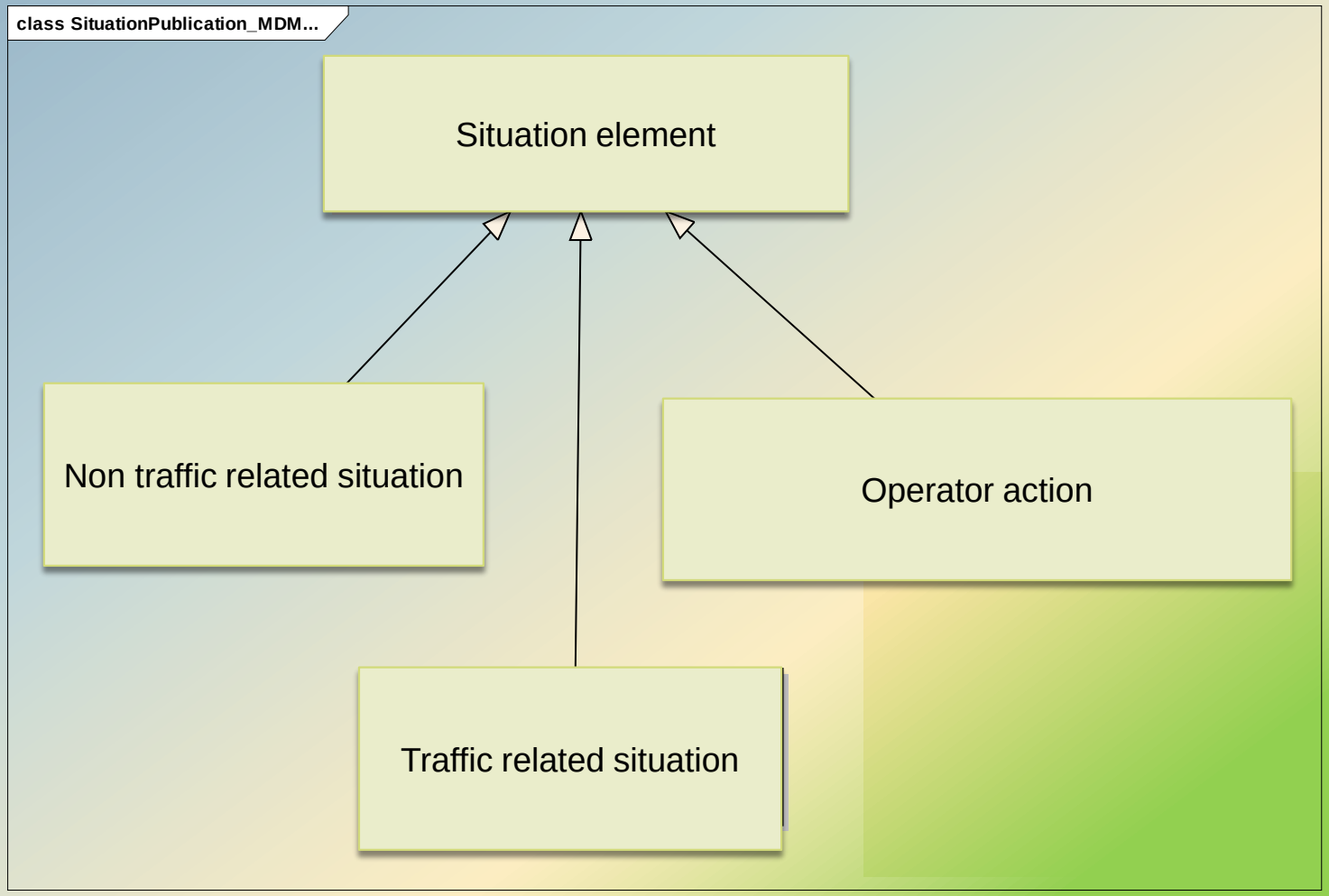
Cause


class Cause
«enumeration»
CauseTypeEnum
accident
congestion
earlierAccident
earlierEvent
earlierIncident
equipmentFailure
excessiveHeat
frost
holidayTraffic
infrastructureFailure
largeNumbersOfVisitors
obstruction
pollutionAlert
poorWeather
problemsAtBorderPost
problemsAtCustomPost
problemsOnLocalRoads
radioactiveLeakAlert
roadsideEvent
rubberNecking
securityIncident
shearWeightOfTraffic
technicalProblems
terrorism
toxicCloudAlert
vandalism
other
Situation element
1
0..1
Cause
Cause defined by enumeration (see left side)
Cause defined by reference to another situation element

Types of Situation elements



Types of Situation elements

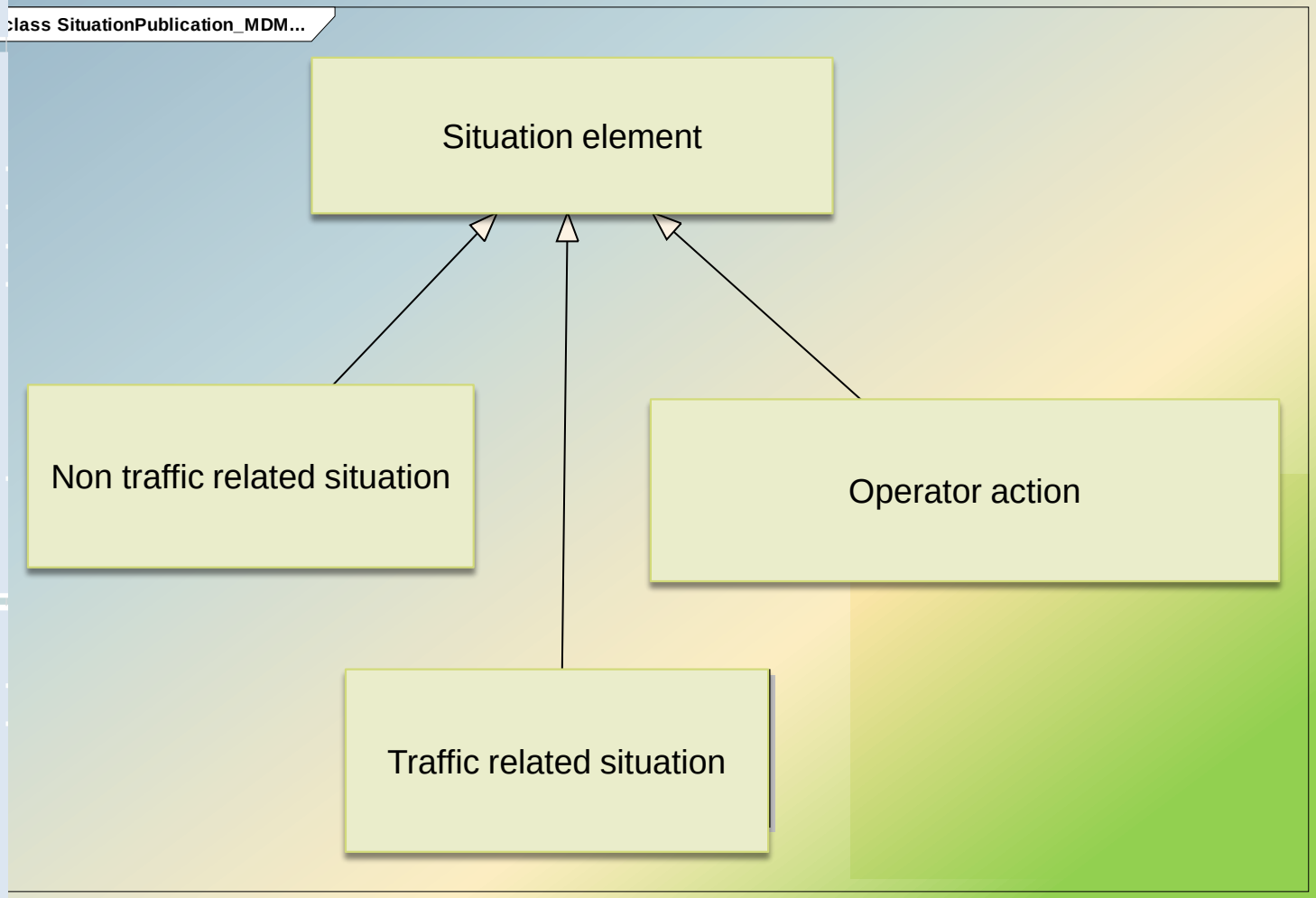


Types of Situation elements

NonRoadEvent-Information

TrafficElement

OperatorAction

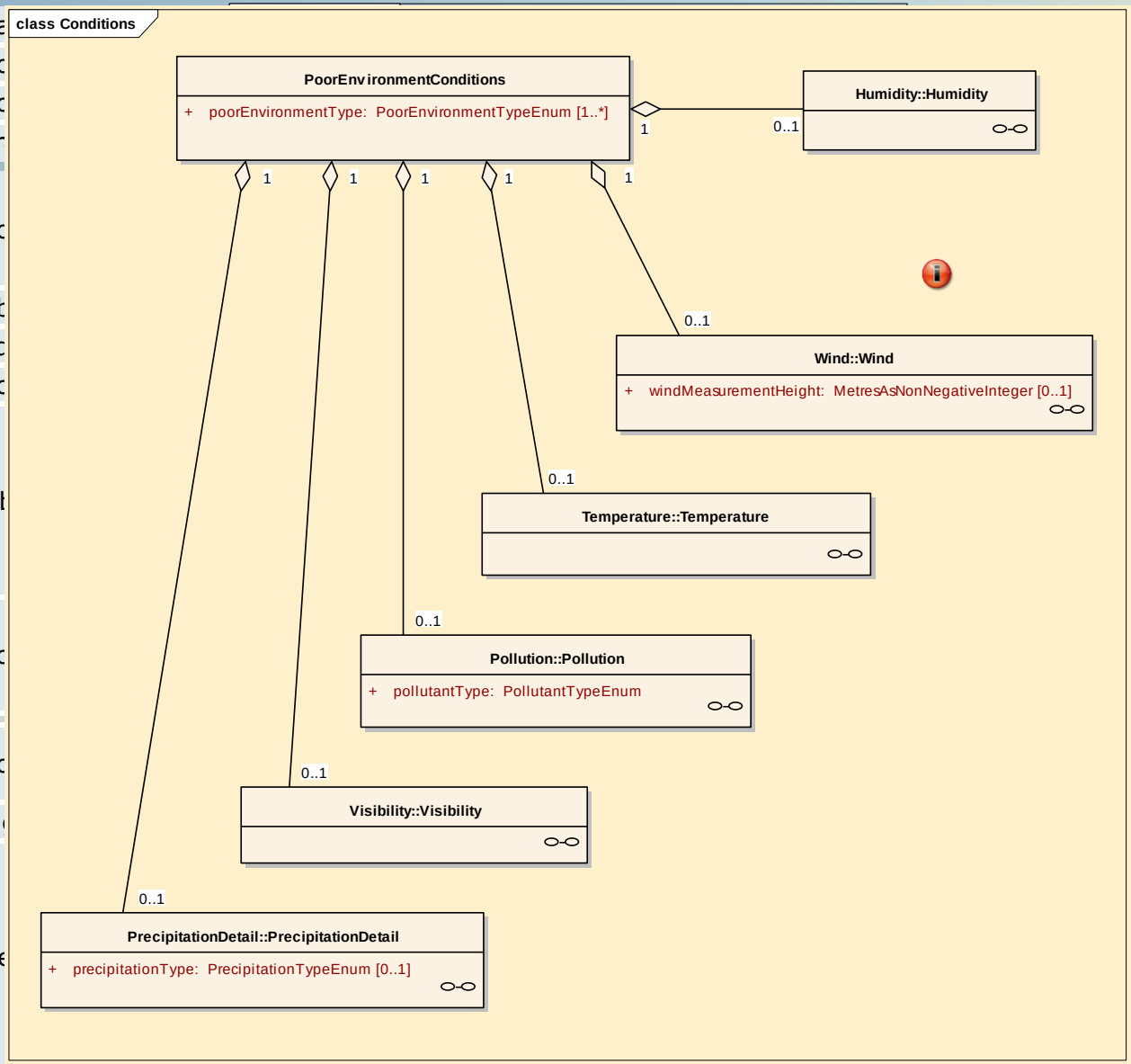


Types of Situation elements

NonRoadEvent-Information

TrafficElement

OperatorAction



alized here.

tedRoadConditions (1+)

RelatedRoadConditions

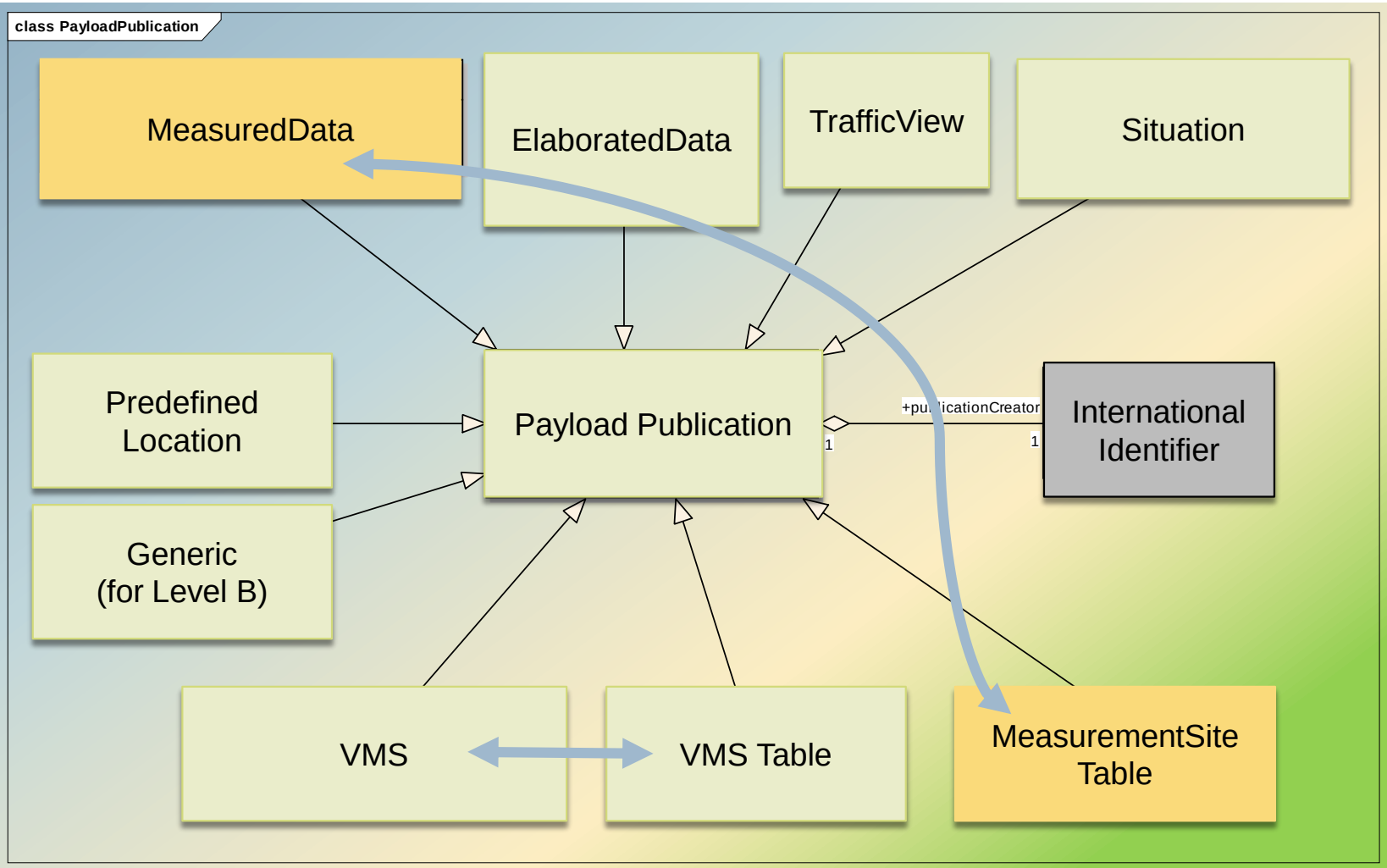
Data model Level A

DETAILED EXAMPLE 2:

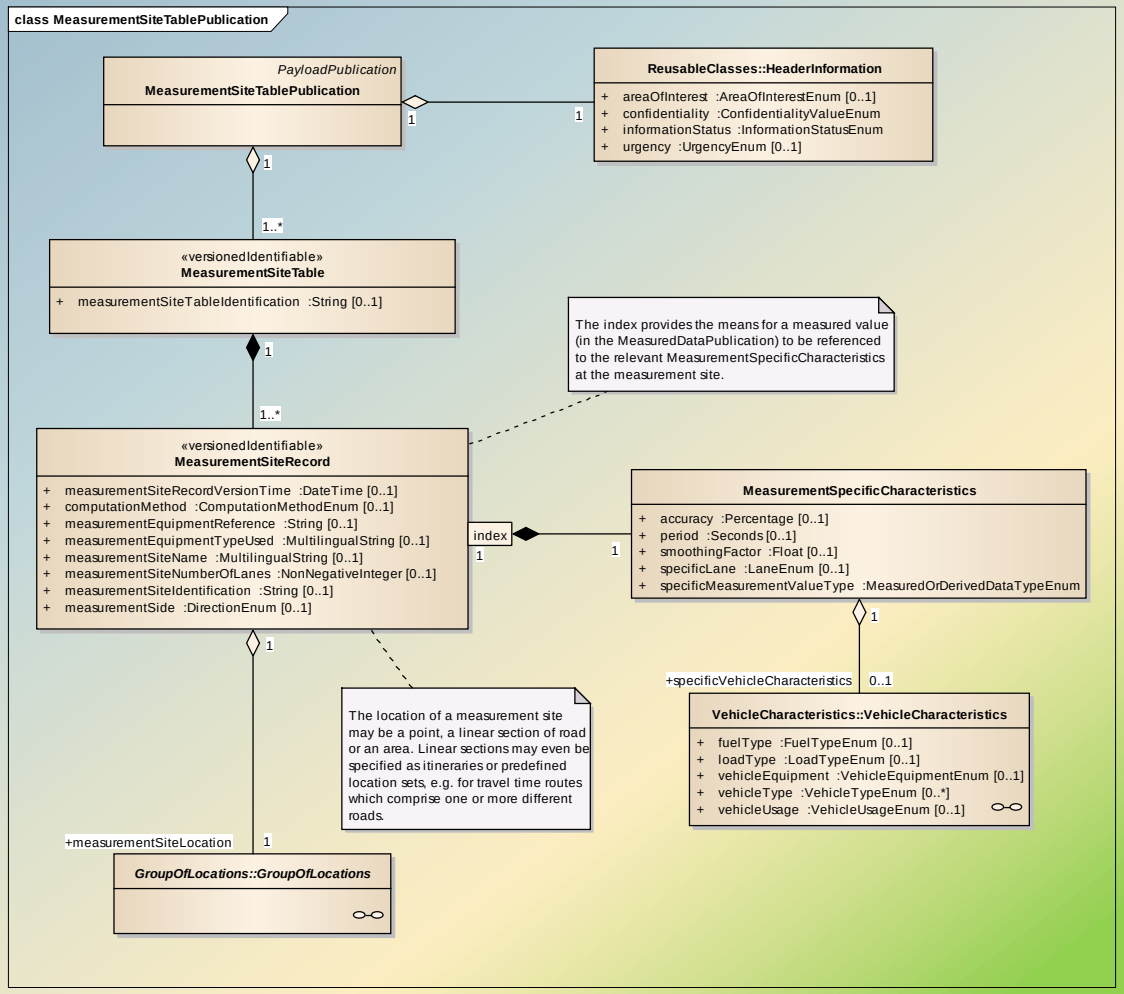
MEASUREMENT SITES AND MEASURED DATA

European Commission
Mobility & Transport

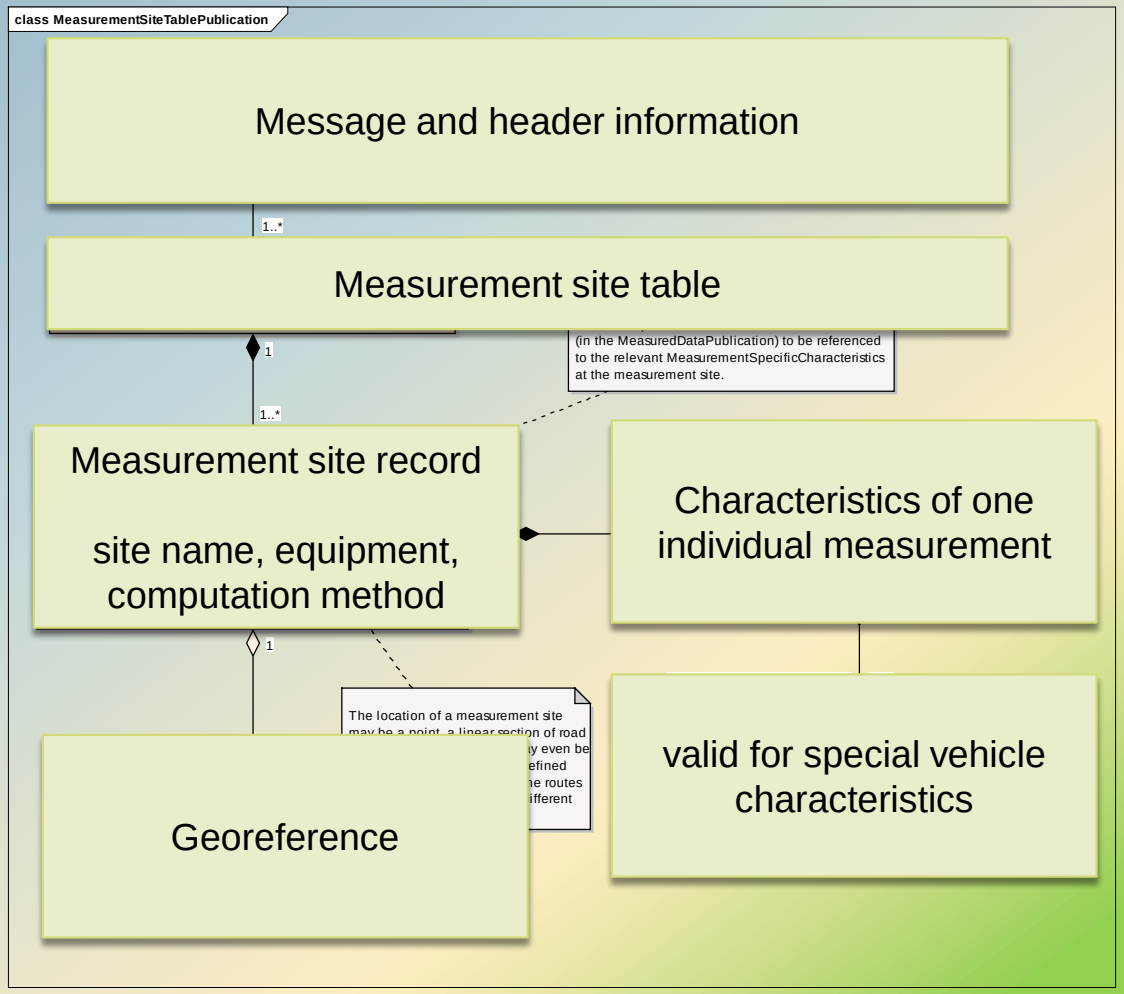
PayloadPublication



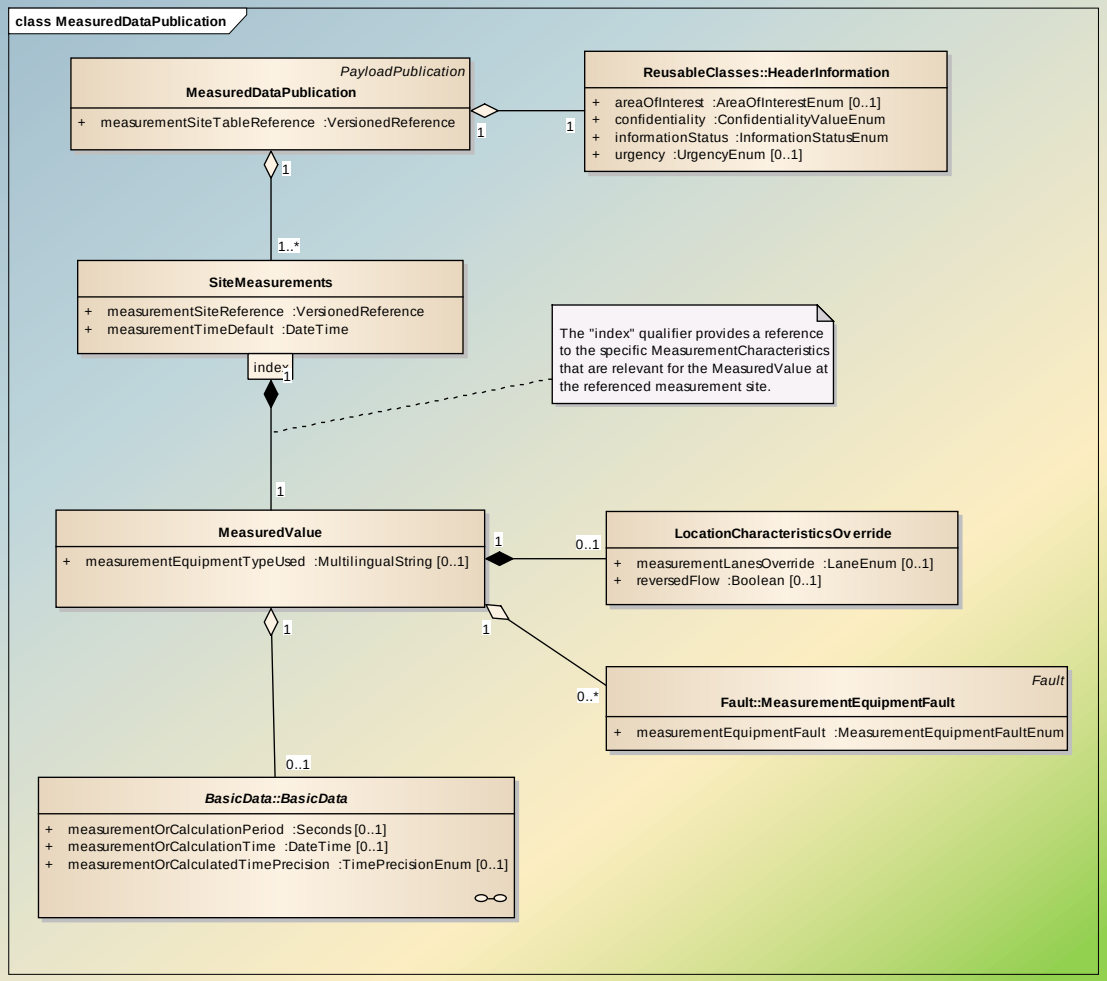
Measurement Site Table (static)



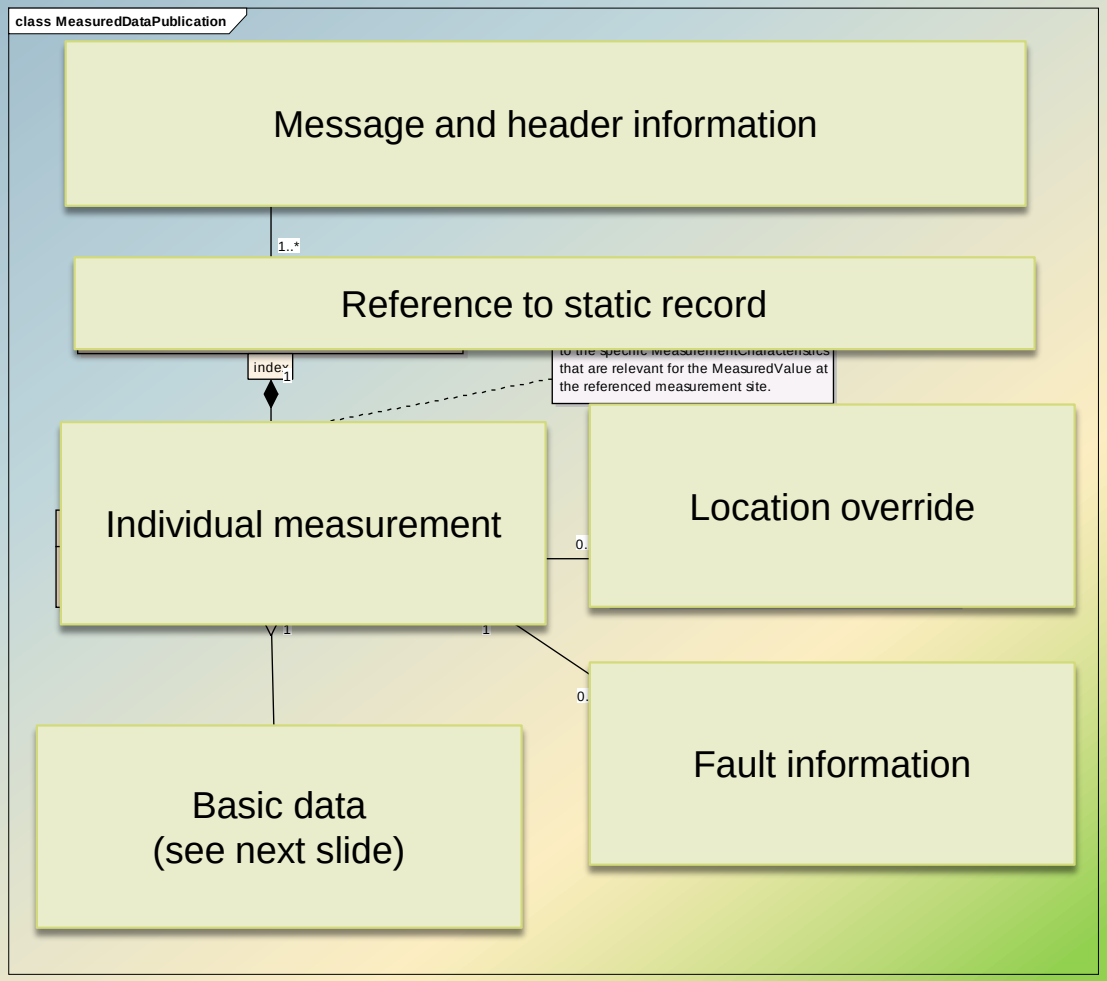
Measurement Site Table (static)



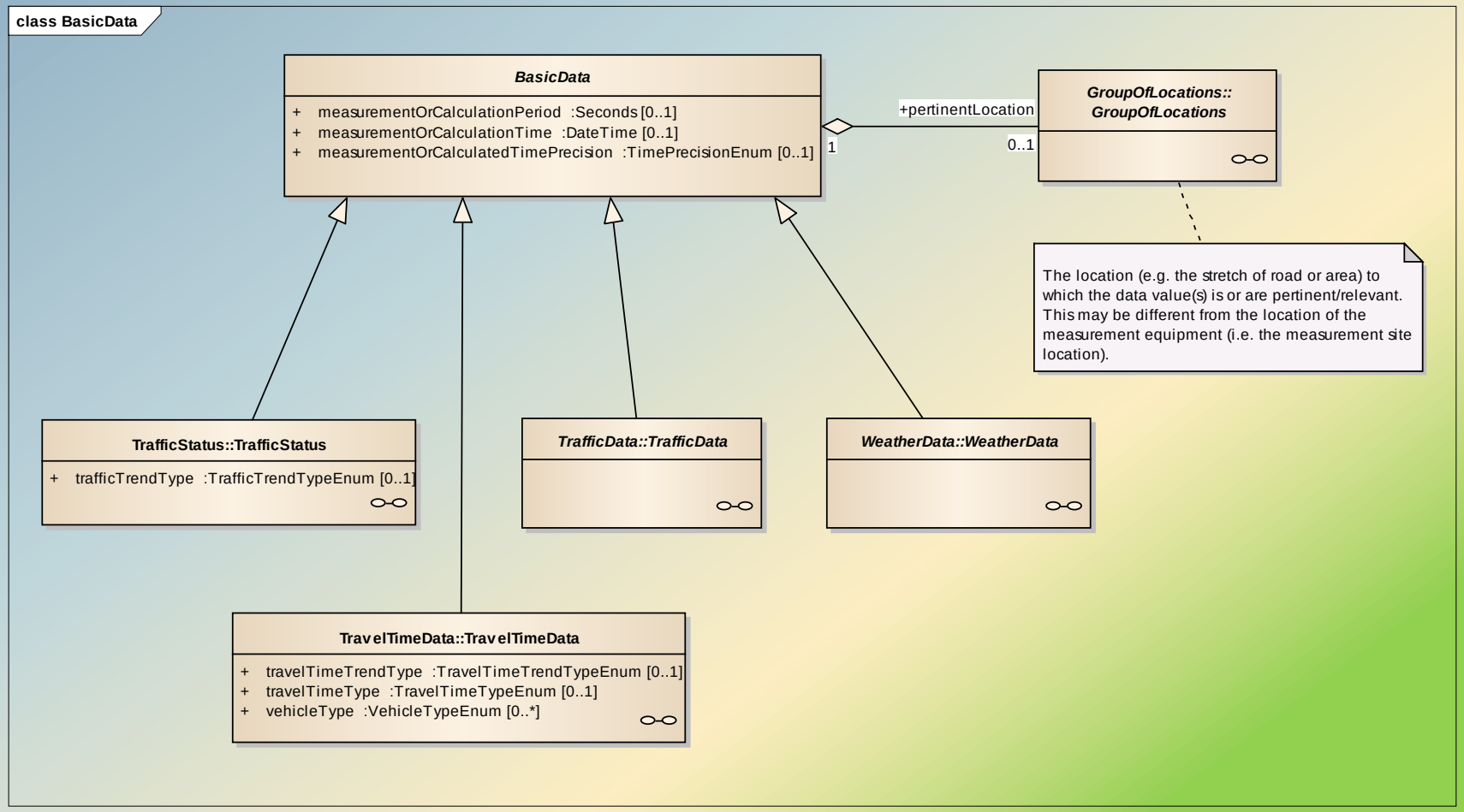
Measured Data (dynamic)



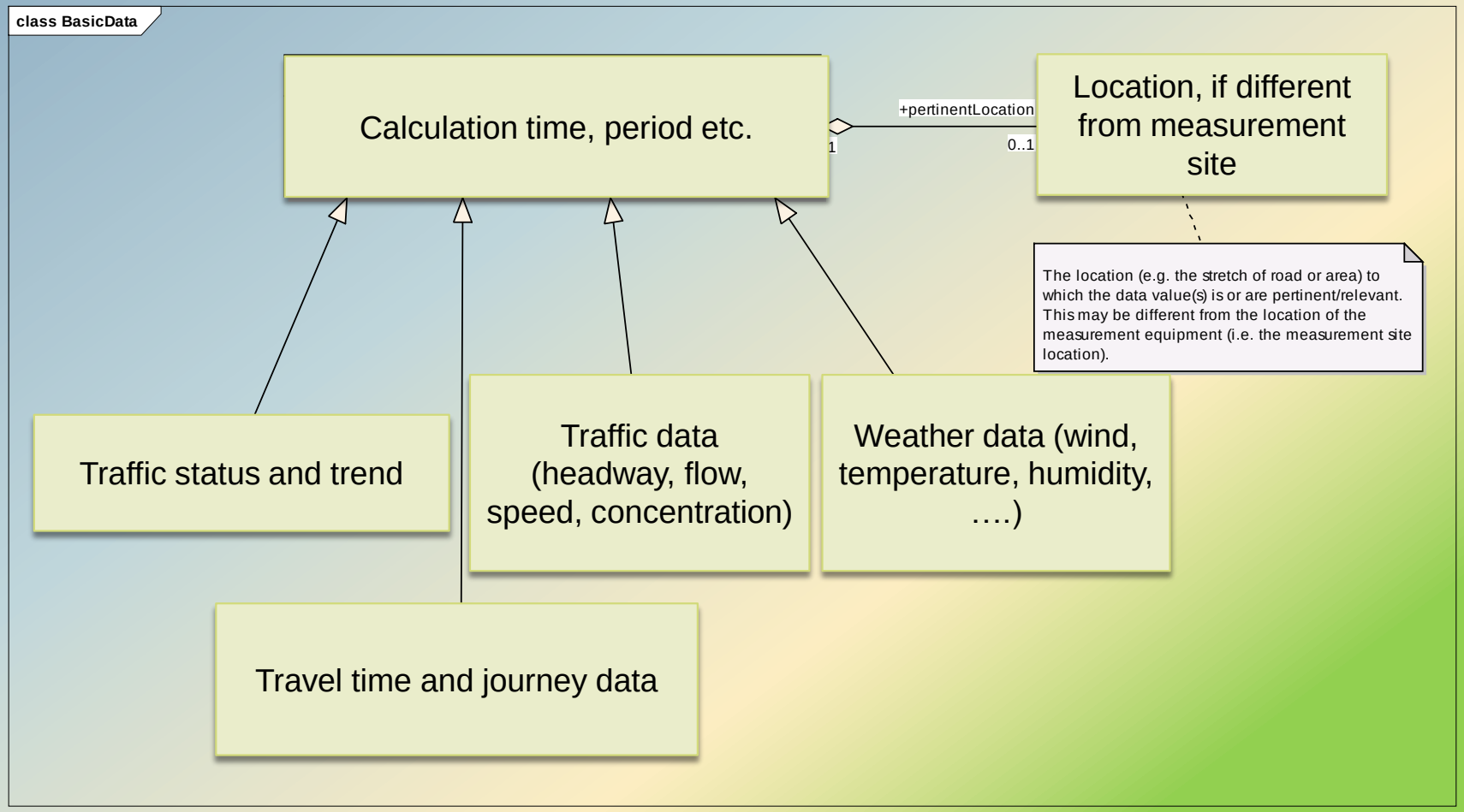
Measured Data (dynamic)



Basic Data (dynamic)



Basic Data (dynamic)



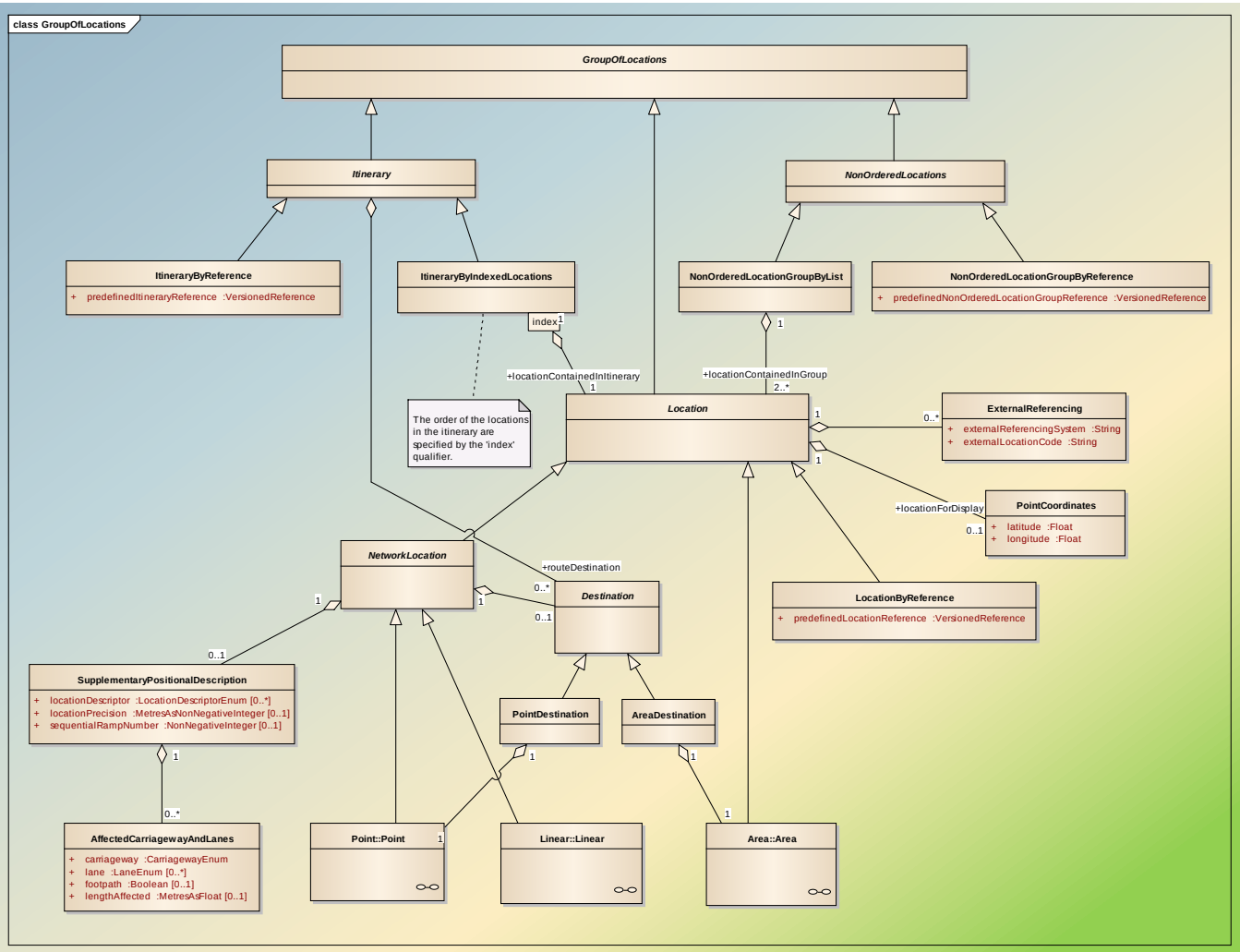
Data model Level A

DETAILED EXAMPLE 3:

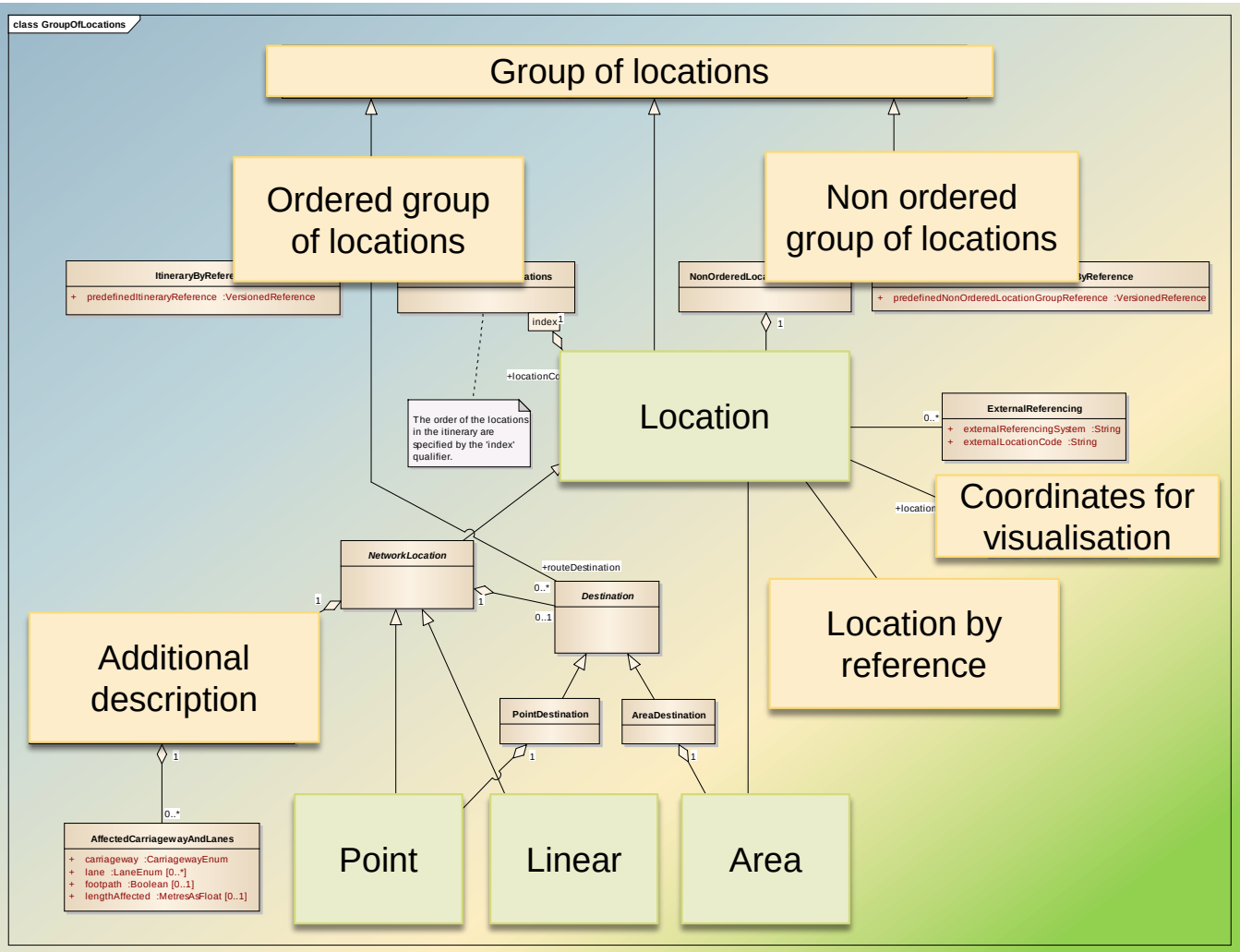
GEOREFERENCE

European Commission
Mobility & Transport

Georeference



Georeference



Point location

1. Coordinates (ETRS89)
   - WGS84 coordinates can be used instead, because the discrepancy is very small
   - *Optional:* bearing
   - *Optional:* coordinates for visualisation (in addition to above)
   - *Optional:* lane

2. Point on a Linear (ISO 19148)
   a) Start-, middle and endpoints of Linear with ETRS89 oder
   b) ID of linear

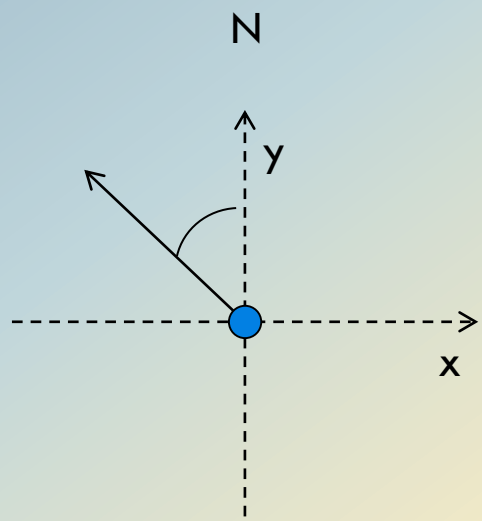
   For both cases:
   - Distance between Point and the beginning of the Linear
   - *Optional:* road name and road class

3. ALERT-C, here as example method 4
   - Location code with offset (method 2 without offset)

4. TPEG-Point

5. OpenLR-Point (not part of Level A)

Georeference – Point Coordinates

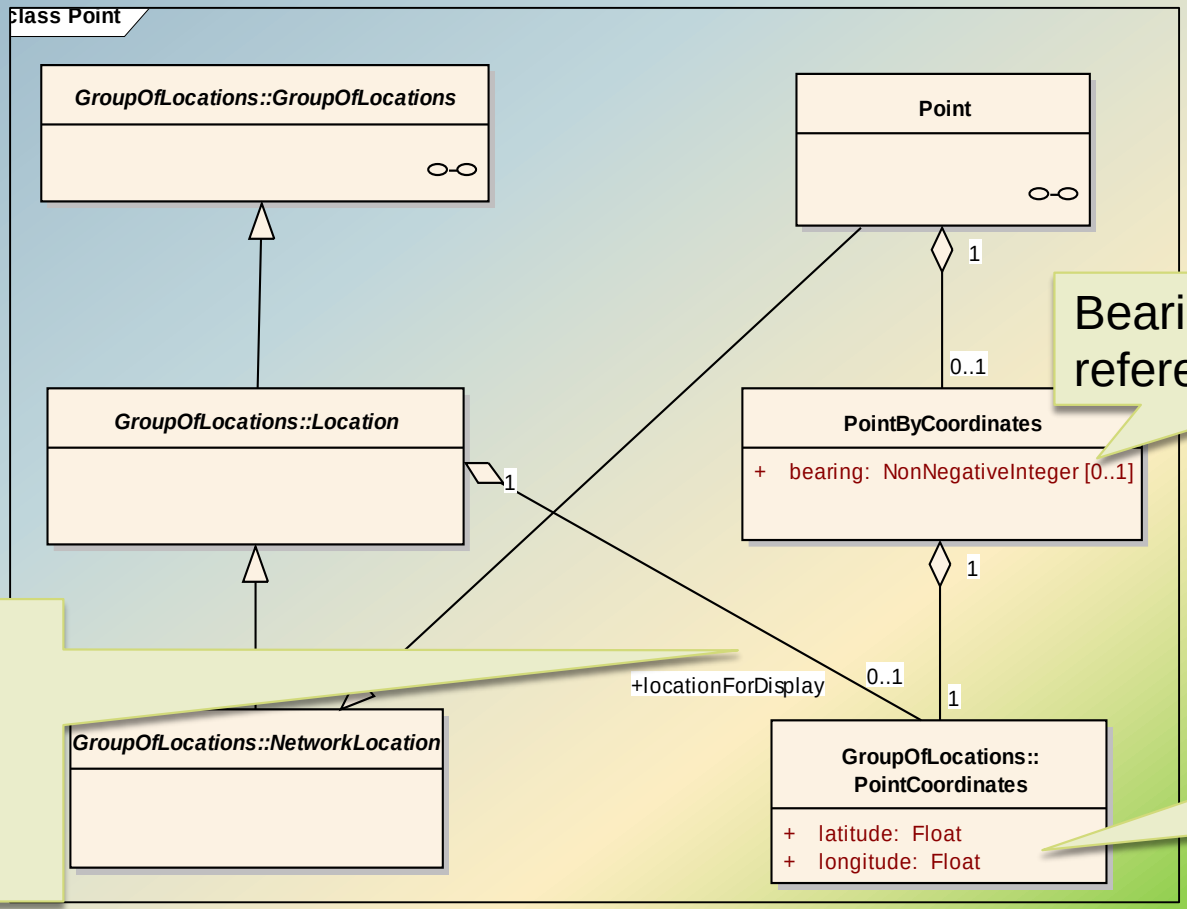


Specifying coordinates in **ETRS89** (European Terrestrial Reference system)

- Three-dimensional, geodetic reference system
- Discrepancy to WGS84 coordinates is currently about 1,20m (+2 cm / year)

Additional bearing (360°, Reference North) possible (→ directed point)

Georeference – Point Coordinates



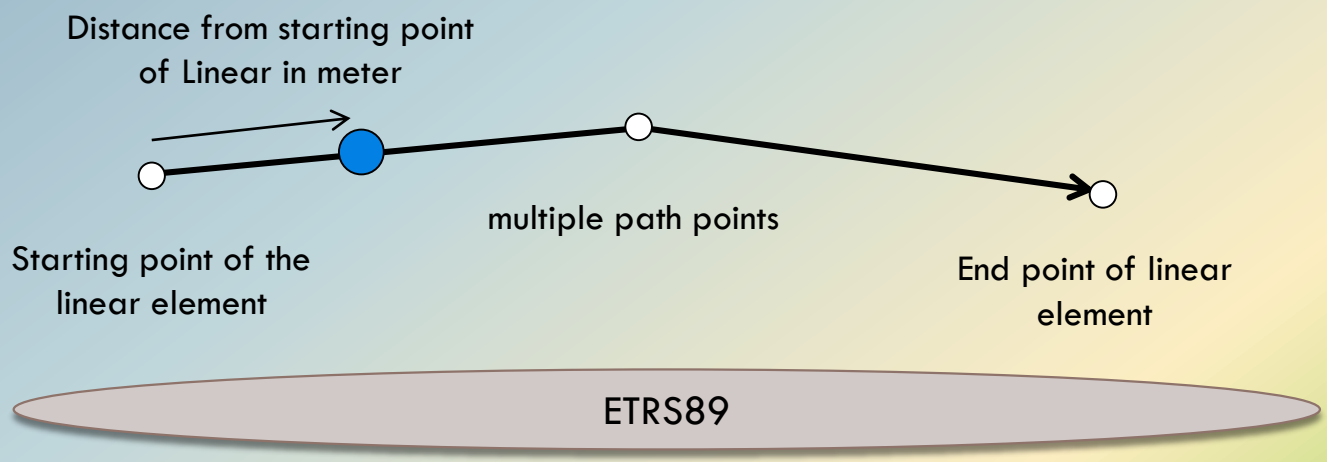
Bearing 360 degree, reference North

Additional coordinates for visualisation

ETRS89

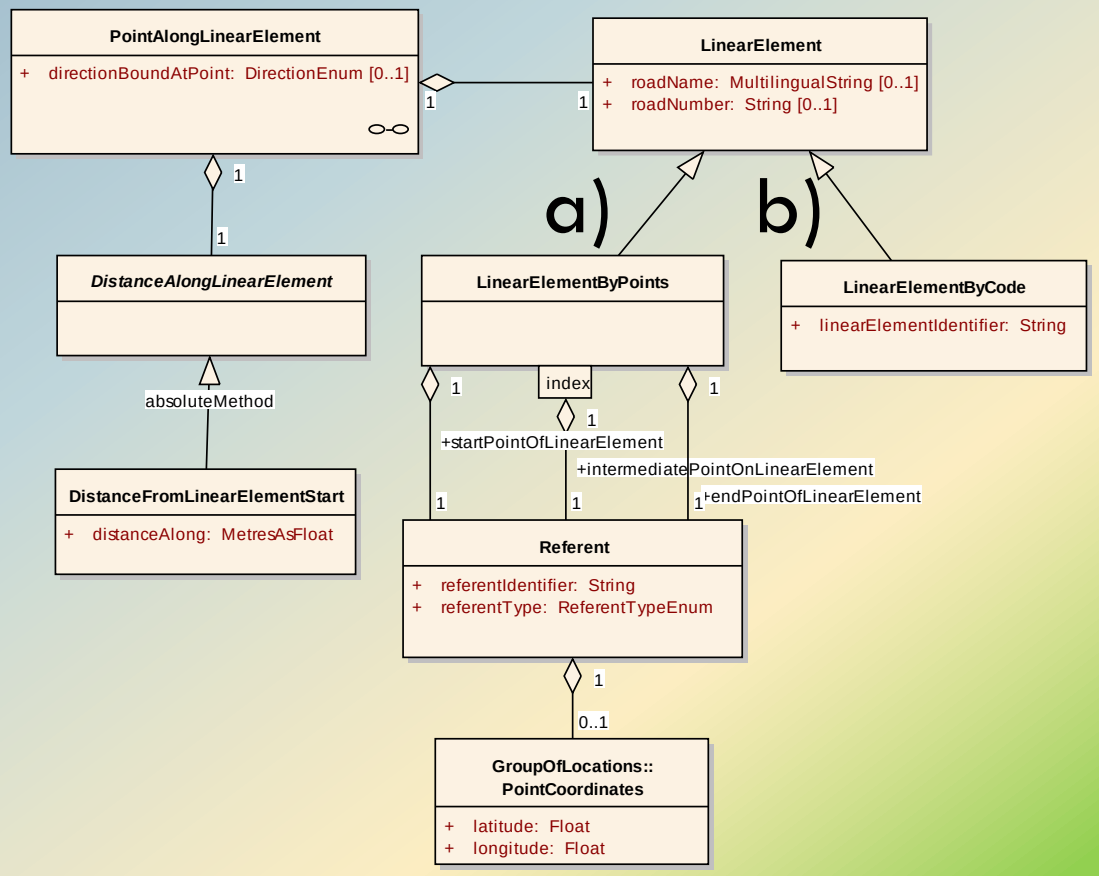
Georeference – Point as ISO 19148

a)

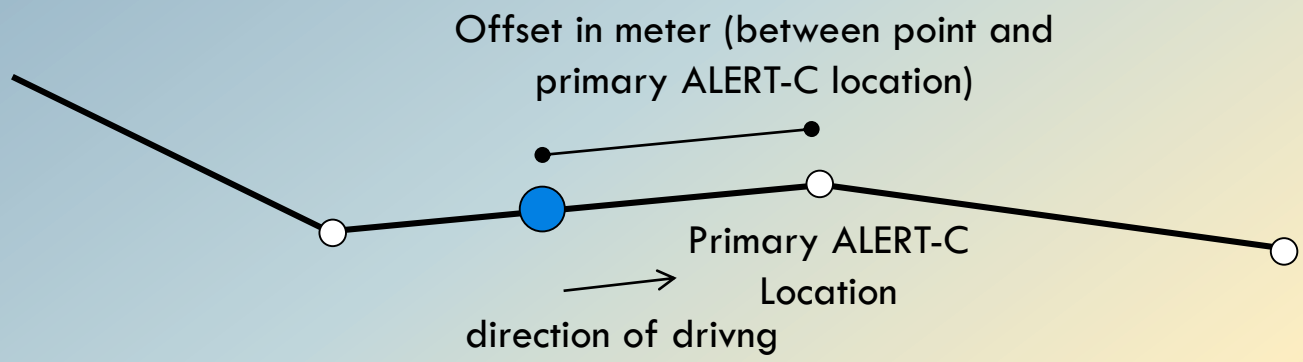


or b) Linear by ID

Georeference – Point as ISO 19148



Georeference – Point as ALERT-C (M4)

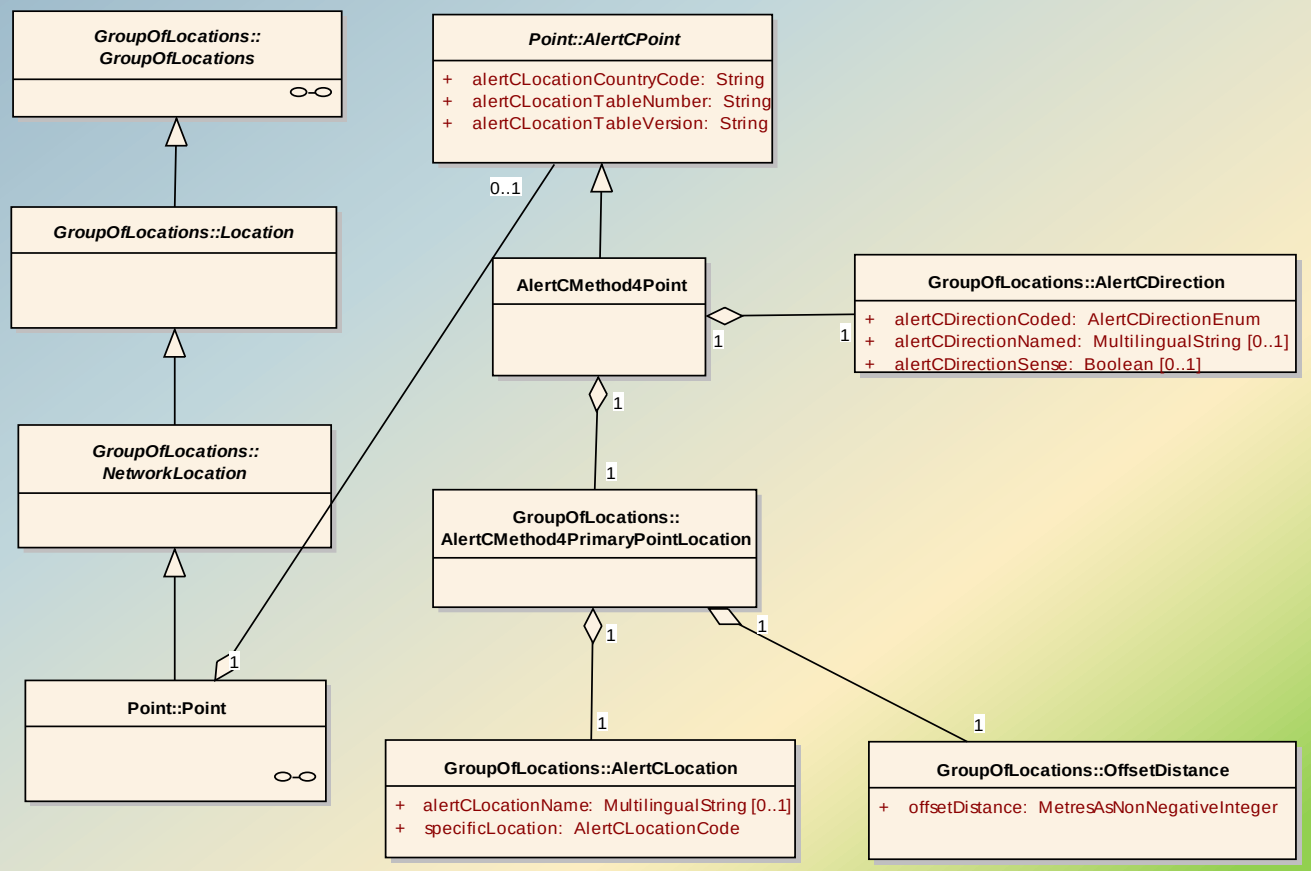


Location Codes as from country spefiic location tables

From the point considered the Primary ALERT-C location is always located in driving direction (with given offset distance).

It must be specified, whether the direction of travel is the same or the opposite direction than the ALERT-C coupling of points.

Georeference – Point as ALERT-C (M4)



Links

- DATEX II
  - http://www.datex2.eu
- DATEX II Modelling Methodology
  - http://www.datex2.eu/sites/www.datex2.eu/files/DATEX_II_Methodology_2.pdf
- Enterprise Architect
  - http://sparxsystems.eu/
  - http://www.sparxsystems.eu/enterprisearchitect/download-trial/
  - http://www.sparxsystems.com.au/bin/EALite.exe
- DATEX platform independent model
  - http://www.datex2.eu/sites/www.datex2.eu/files/DATEX_II_PIM.EAP
- DATEX schema generation tool
  - http://www.datex2.eu/sites/www.datex2.eu/files/DATEX_II_Schema_generation_tool.zip
- DATEX schema
  - http://www.datex2.eu/sites/www.datex2.eu/files/Schema-2.0.zip
- XML Viewer
  - http://www.microsoft.com/download/en/details.aspx?id=7973
- Comparing files
  - http://winmerge.org/

Thank you

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