Transmodel Workshop

New Orleans, ISO TC204 WG8, 19/04/2010

K B I C

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Transmodel Workshop: agenda

1. General overview: rationale, solution, approach & method, main domains

2. Detailed presentation: Network description, tactical planning components, passenger information

3. Other domains: driver & vehicle scheduling, operations monitoring & control, fare collection, management information/statistics

4. Transmodel-based services: the example of NeTEx

1. **General overview:**
   - **Rationale**
   - **Solution**
   - **approach & method**
   - **main domains**

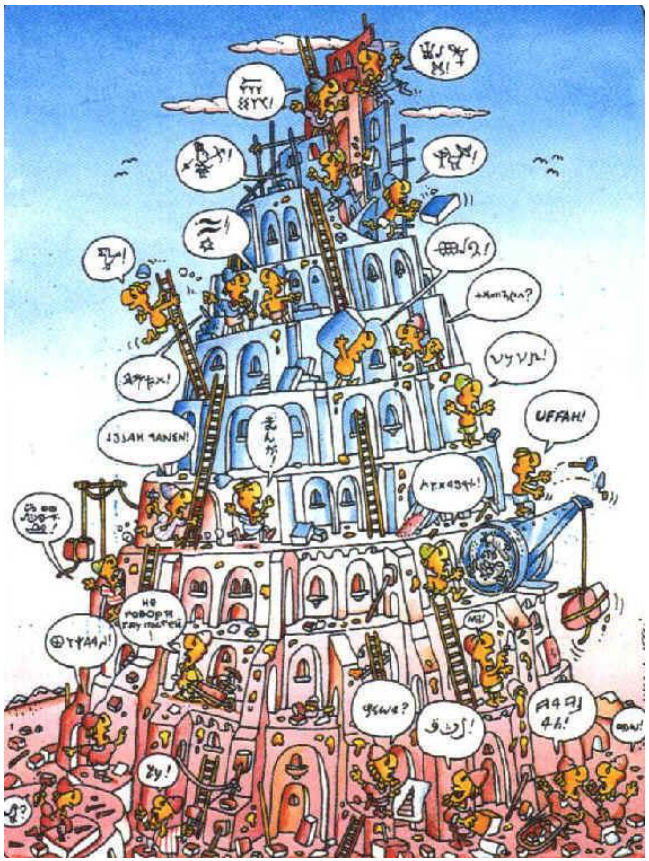
1. Detailed presentation: Network description, tactical planning components, passenger information

2. Other domains: driver & vehicle scheduling, operations monitoring & control, fare collection, management information/statistics

3. Transmodel-based services: the example of NeTEx

Rationale: an Urgent Need for a Communication Tool…

- Quick development of software technology and applications for Public Transport…

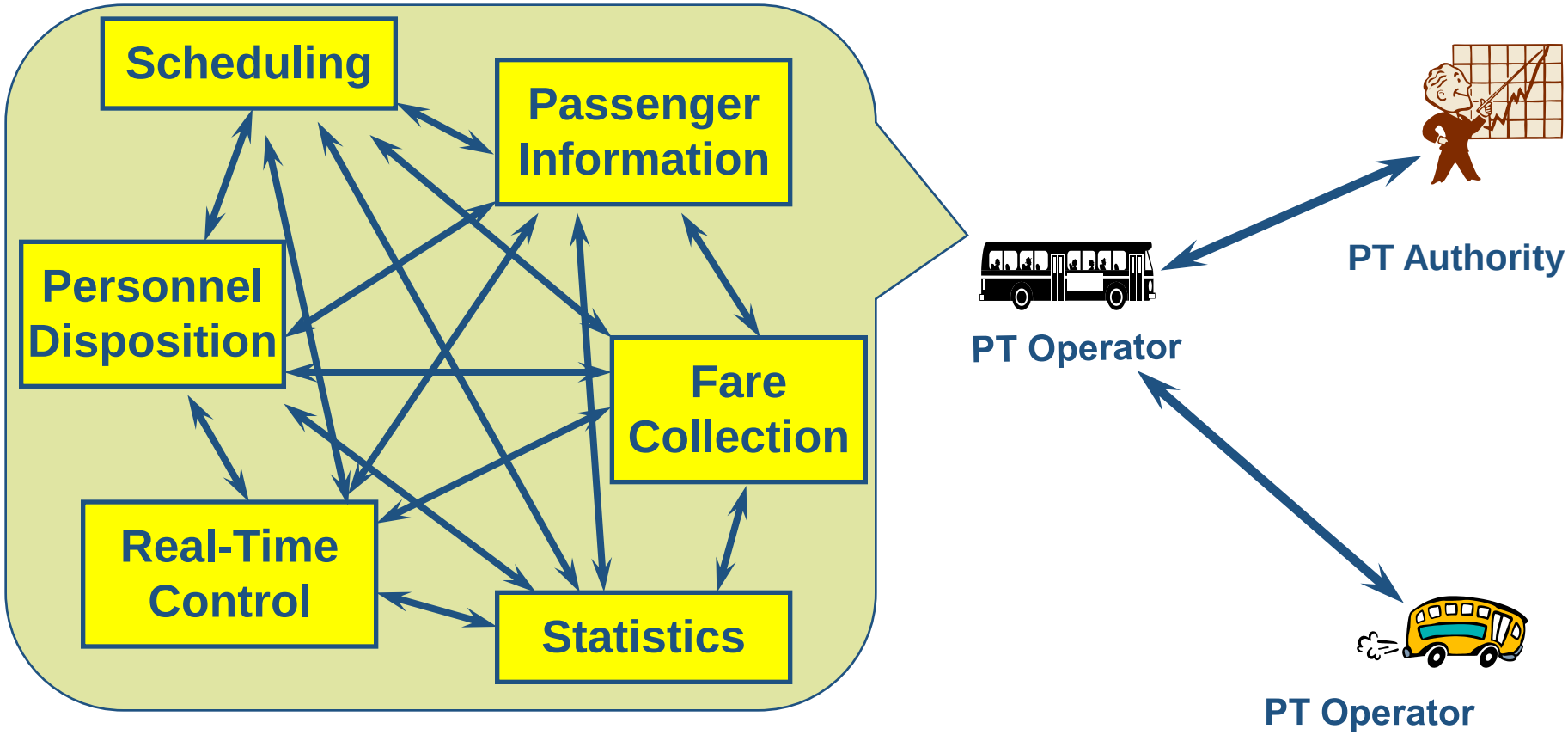


9 *…That is why it was called Babel because there the Lord confused the language of the whole world.*

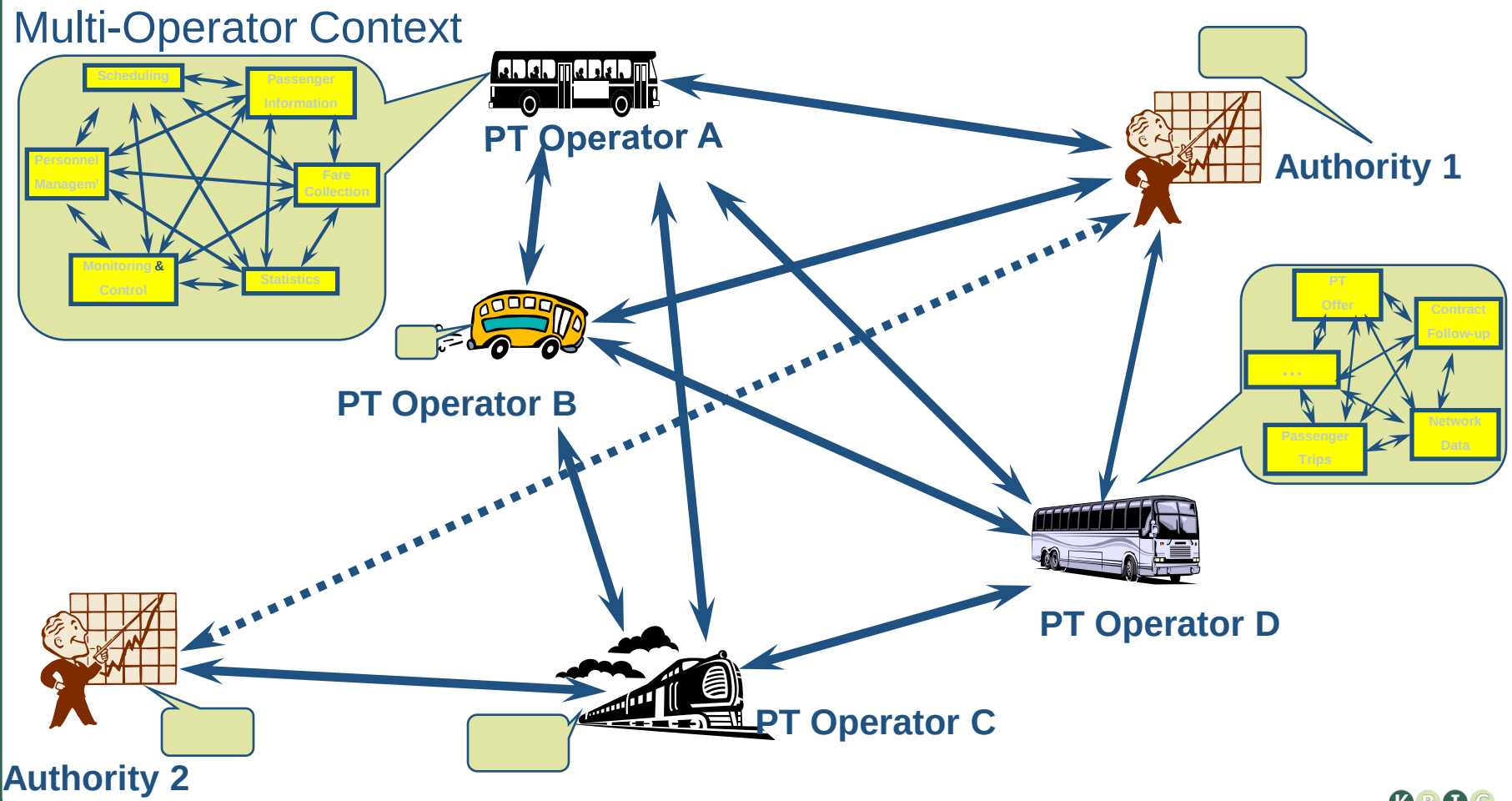
Genesis 11

Rationale: Lack of Generic Interfaces between Applications

Situation within one particular PT company

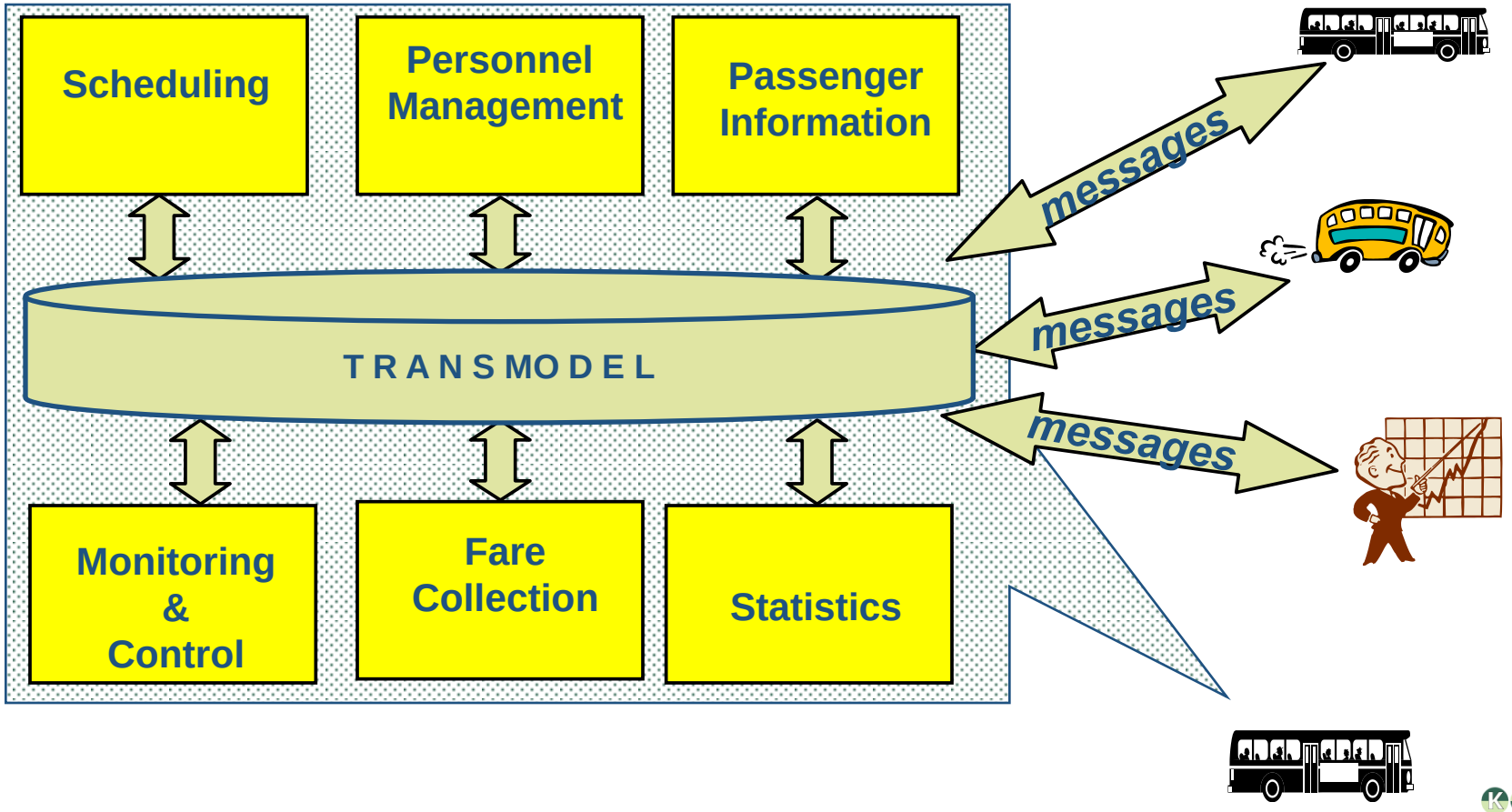


Rationale: Difficult Communication between Organisations



Solution: Common Reference Data Model

Data repository or exchange messages



Characteristics : a Communication Tool

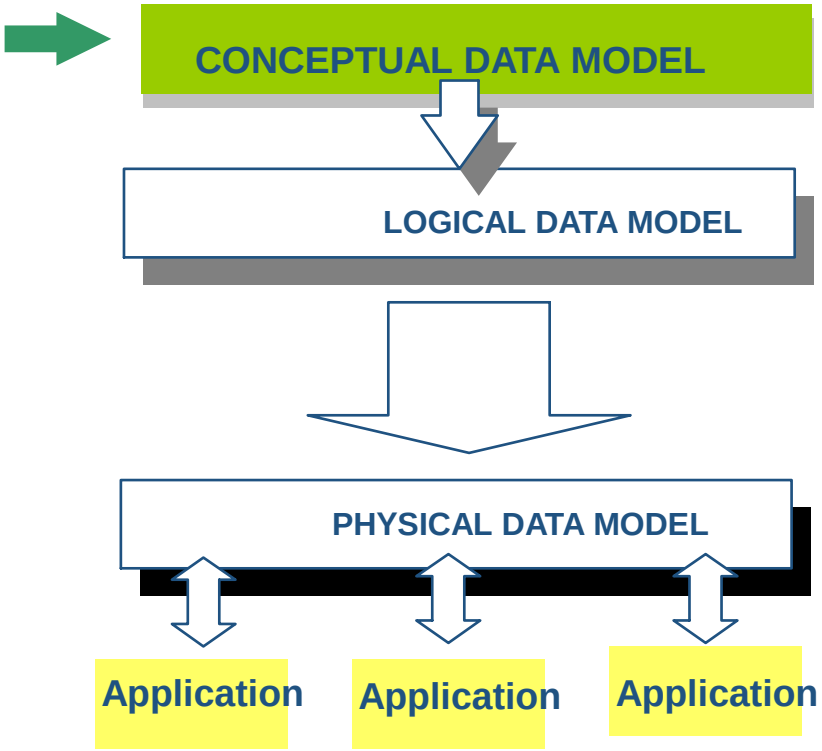
- Common terminology & definitions of concepts

- Common Data Structures: links between the concepts?
- No reduncancy: definition of elementary data
- Genericity: concepts have own meaning independently from a particular functional domain, from the user
- Layered approach: mechanism to show collections of data for a functional purpose

Characteristics : Data Model at Conceptual Level

Database design in 3 steps:

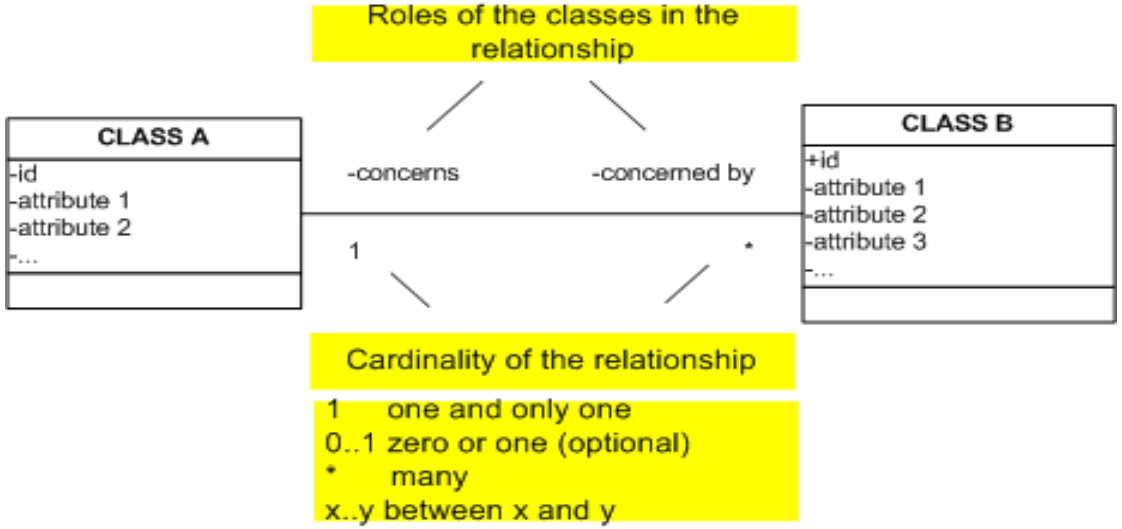
- Semantics of a domain
- Hardware Independent
- No redundancy

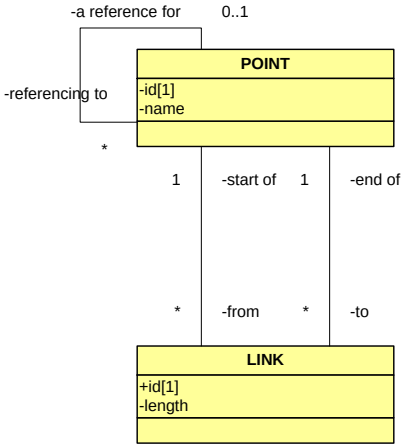


- Choice of a data base type

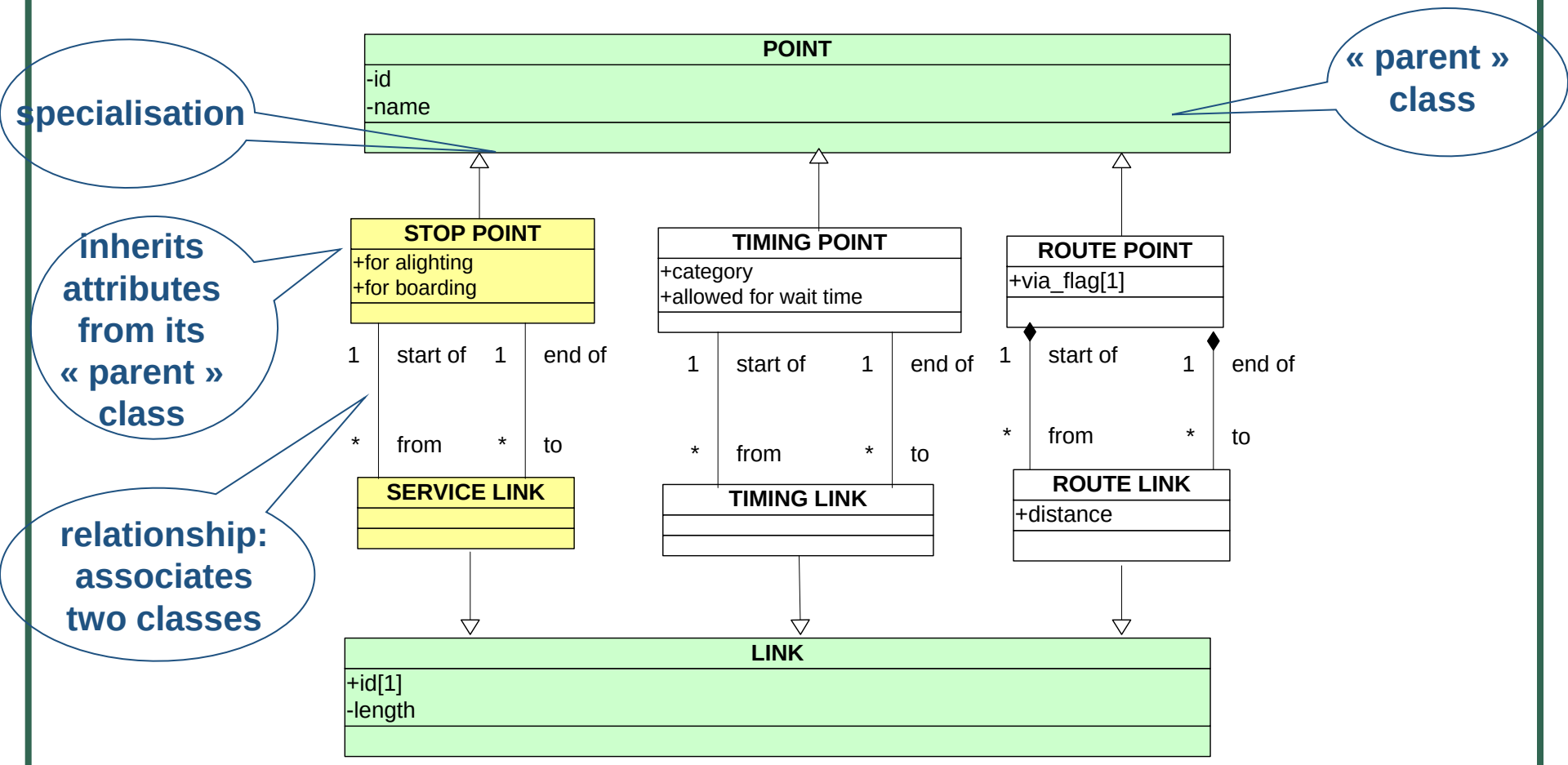
- Additional attributes
- Data formats
- Choice of a DBMS

- Controlled denormalisation optimisations & redundancies
- Organisational rules



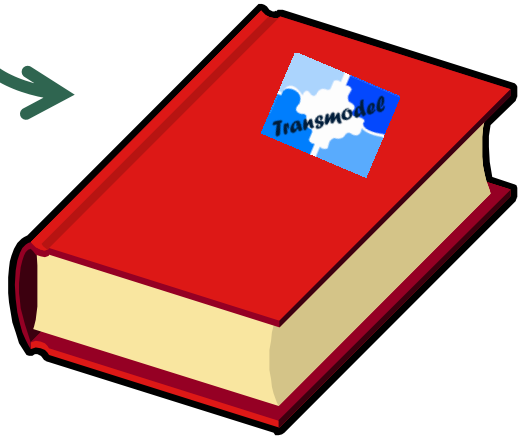


- A link between two points (here stop points)

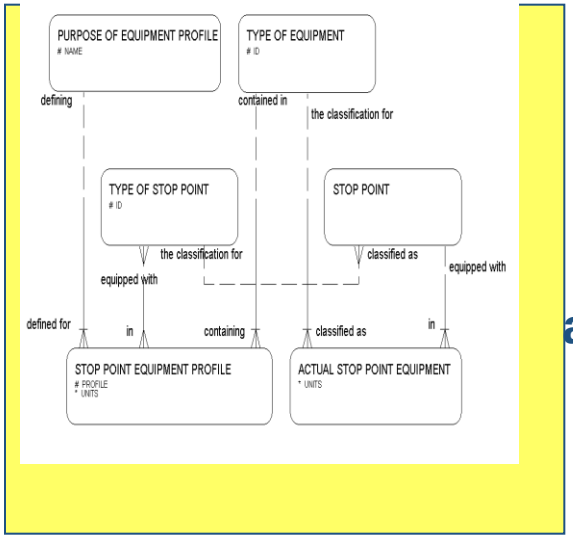

specialisation
« parent » class
inherits attributes from its « parent » class
relationship: associates two classes
POINT
-id
-name
STOP POINT
+for alighting
+for boarding
TIMING POINT
+category
+allowed for wait time
ROUTE POINT
+via_flag[1]
1
start of
1
end of
*
from
*
to
SERVICE LINK
TIMING LINK
ROUTE LINK
+distance
LINK
+id[1]
-length

Characteristics : Transmodel Documentation

Data Dictionary: 357 terms



Data Structures: 61 diagrams



E/R Barker « Oracle » formalism

expressed also in UML

azertqsd
fggghhs
dffghjkk
wxcvbb
bnnjjwc
hjkx

Textual explanations

Normative part (around 200 pages)
Informative appendices (around 400 pages)

Documentation : CEN TC278 : www.transmodel.org

Characteristics: Transmodel Data Dictionary

- definitions of concepts – short description
- main properties – no data formats

- **ROUTE**
- Description: An ordered list of located POINTs defining one single path through the road (or rail) network. A ROUTE may pass through the same POINT more than once.
- Identified by: NETWORK VERSION

Attributes:	Key	Attribute name	Opt
	#	ID	N
		NAME	Y

- **ROUTE LINK**
- Description: An oriented link between two ROUTE POINTs allowing the definition of a unique path through the network.
- Identified by: LINK, ROUTE POINT, ROUTE POINT

Attributes:	Key	Attribute name	Opt
		DISTANCE	Y

- **ROUTE POINT**
- Description: A POINT used to define the shape of a ROUTE through the network.
- Identified by: POINT

Attributes:	Key	Attribute name	Opt
		VIA_FLAG	N

Two characteristics among others…

- Genericity: separates concerns

Example1: network (space) - related vs. time – related components

- includes concepts related to space (points, links, point-sequences, link-sequences, zones)
- time-related components: are defined separately

Example2: services vs. topology

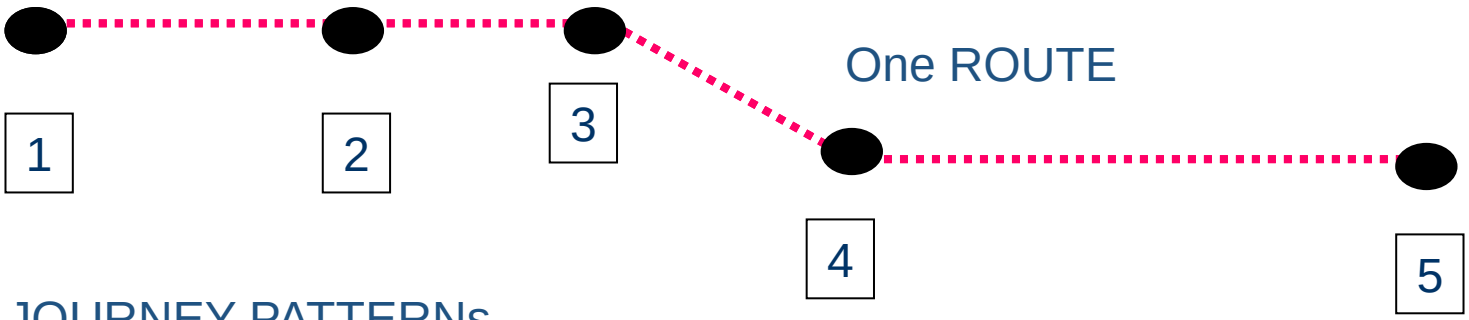
- network topology (routes and route points) is defined separately form the services (journey patterns and stop points)

- Elementary defines concepts out of which other information is derived

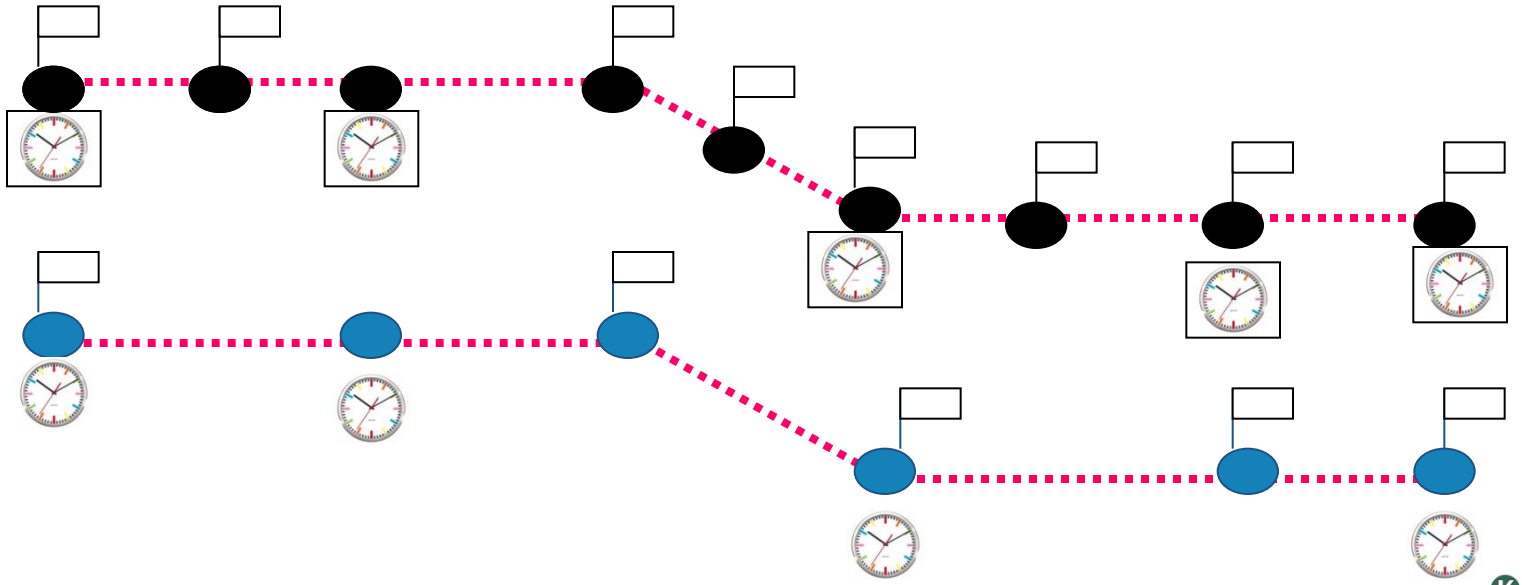
Example: timetables

- Timetables being aggregated concepts represent a certain “deviation” from the Transmodel philosophy!
- Time-related elementary concepts: run times, wait times, etc.
- They are related to points and links (space-related concepts).

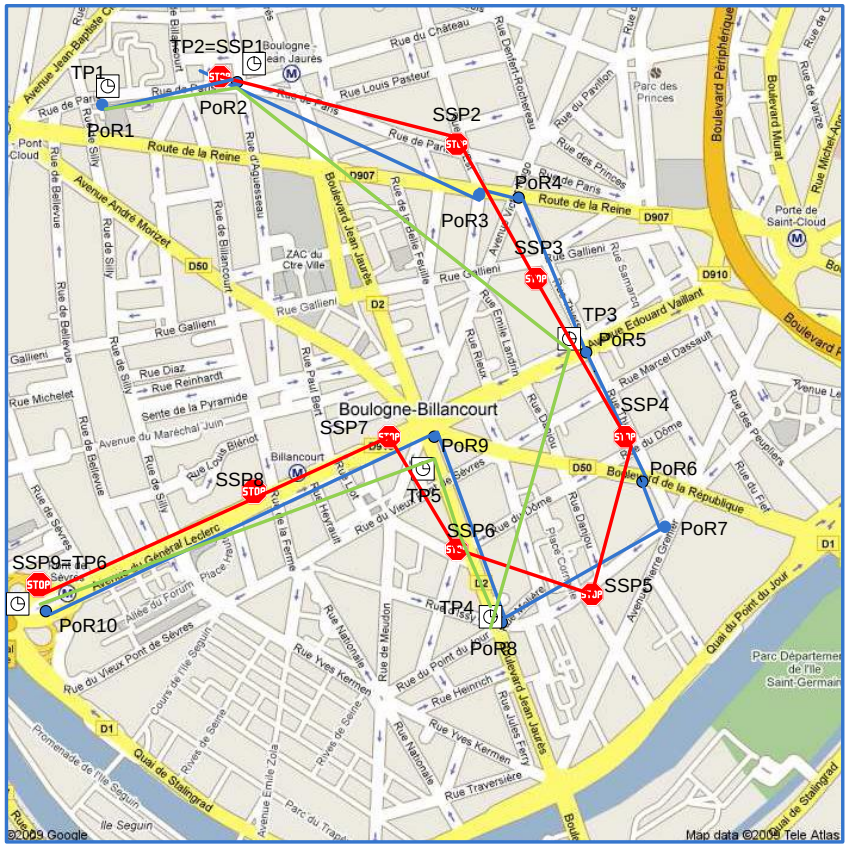
Transmodel separation of concerns: ROUTEs (network topology) differentiated from JOURNEY PATTERNs (services)



Two JOURNEY PATTERNs



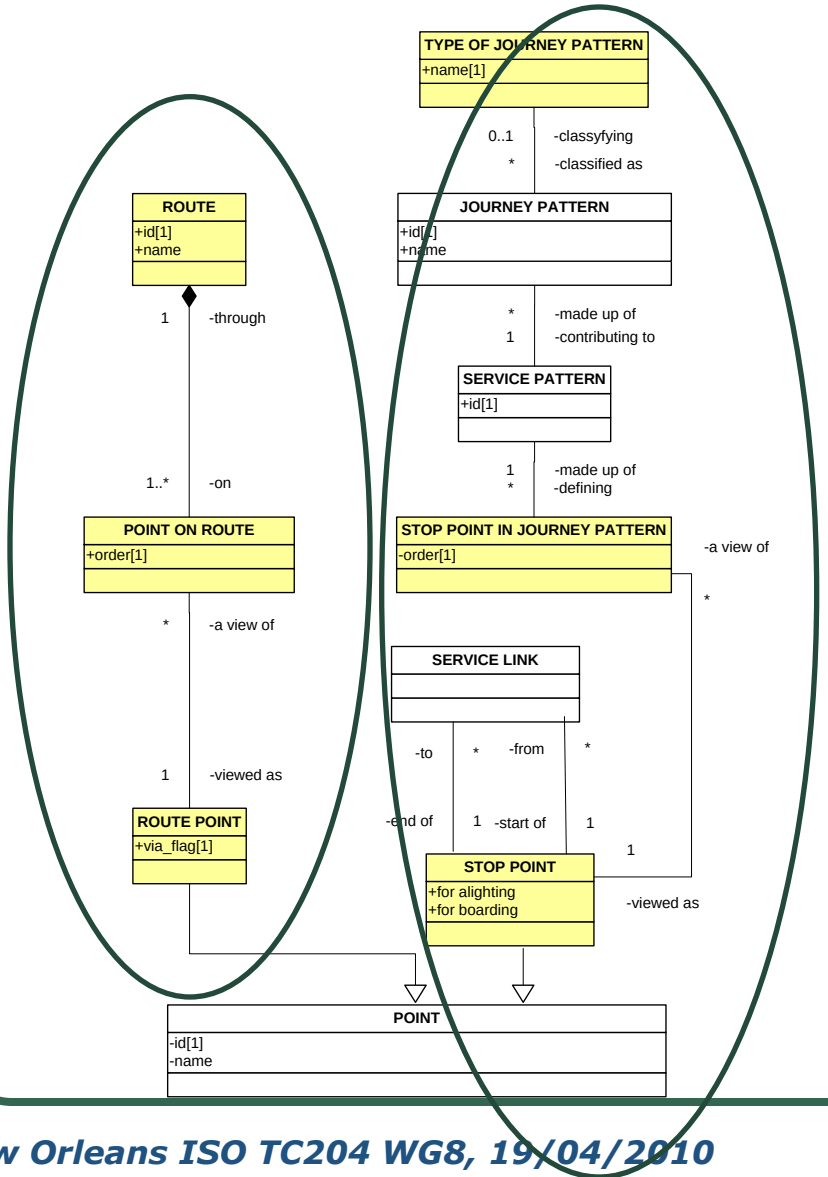
Transmodel separation of concerns: services related to network topology



- path taken by vehicles: ROUTE
- defined by POINTs ON ROUTE (PoR)
- work of vehicles (service):
  - SERVICE PATTERN
  - defined by SCHEDULED STOP POINTs (SSp)
  - TIMING PATTERN
  - defined by TIMING POINTs (TP

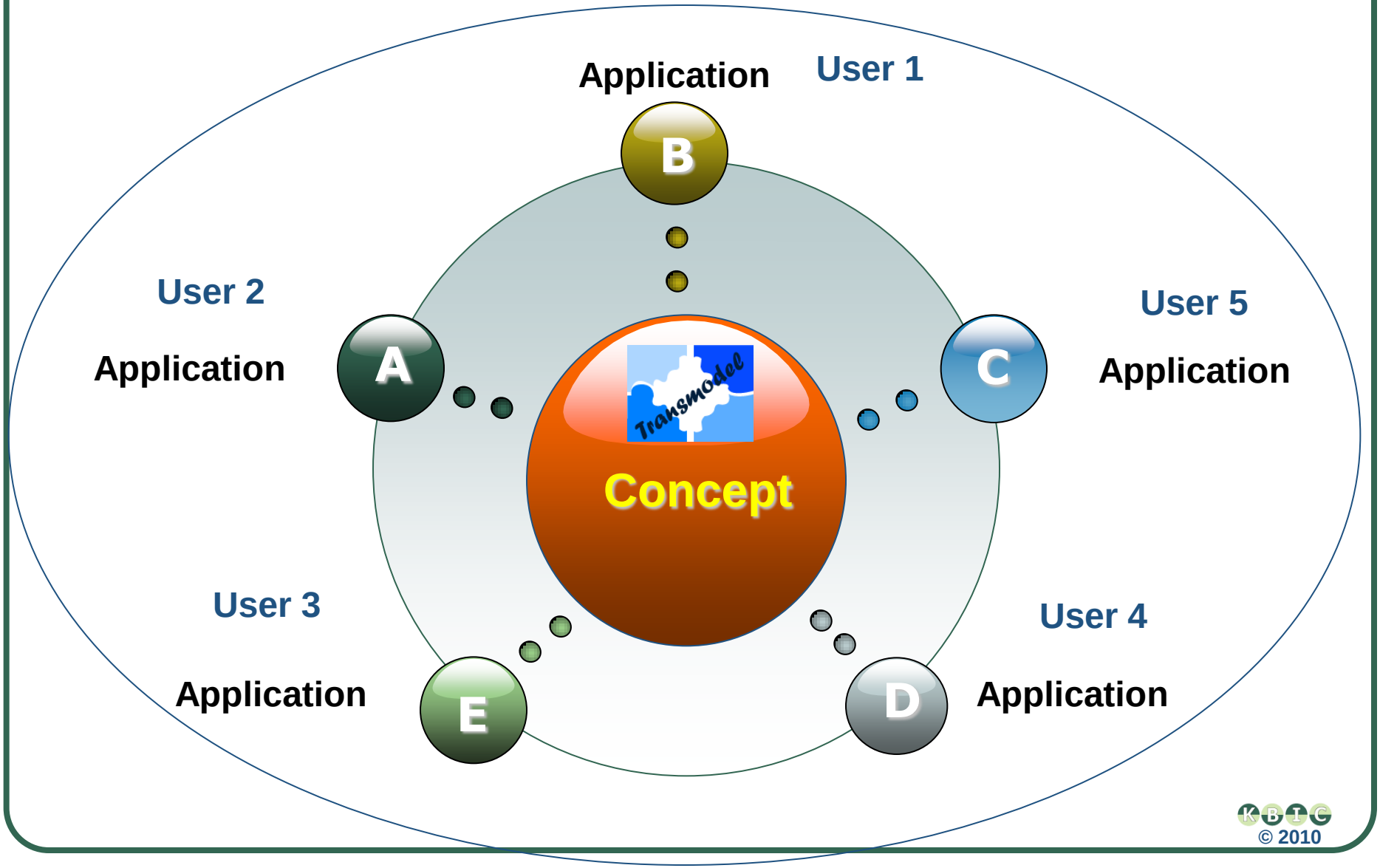
ROUTEs (network topology) differentiated from JOURNEY PATTERNs (services)

Transmodel separation of concerns: ROUTEs (network topology) differentiated from JOURNEY PATTERNs (services)



- SERVICE PATTERN: The subset of a JOURNEY PATTERN made up only of STOP POINTs IN JOURNEY PATTERN.
- TIMING PATTERN: The subset of a JOURNEY PATTERN made up only of TIMING POINTs IN JOURNEY PATTERN.
- Thus: one SERVICE PATTERN may be associated with one or more JOURNEY PATTERNs that differ by their TIMING PATTERNs.

Transmodel "philosophy"



Transmodel - dedicated to urban PT - considers several functional domains and practices throughout Europe

- Is large & complex (but reality is complex…)
- Is abstract in some aspects
- Additional analysis is necessary before implementation:
  - Extracts: what do we need ? what is not necessary for us?
  - Additions: do we need additional concepts? attributes?
  - Optimisations: e.g. do we need to access some data frequently?
  - Definition of data formats

Characteristics: Benefits

- Is hardware independent
- Considers a variety of European practices
- Provides a basis for new applications
- Allows for a progressive migration
- Opens the market
- Reduces development costs
- Takes into account intermodality and the multi-operator environment

Historical Background and Current Status

1989
1996

European Projects:
Cassiope, EuroBus,
Harpist

Transmodel V4.1
ENV 12896

E/R "Oracle" formalism

1997
1999

European Project
TITAN 1 & 2
Implementations
Transmodel V5.0: multi-modality, real-time control, layers, data versioning

2000
2003

French/German
Project SITP
Transmodel V5.1

UML formalism added

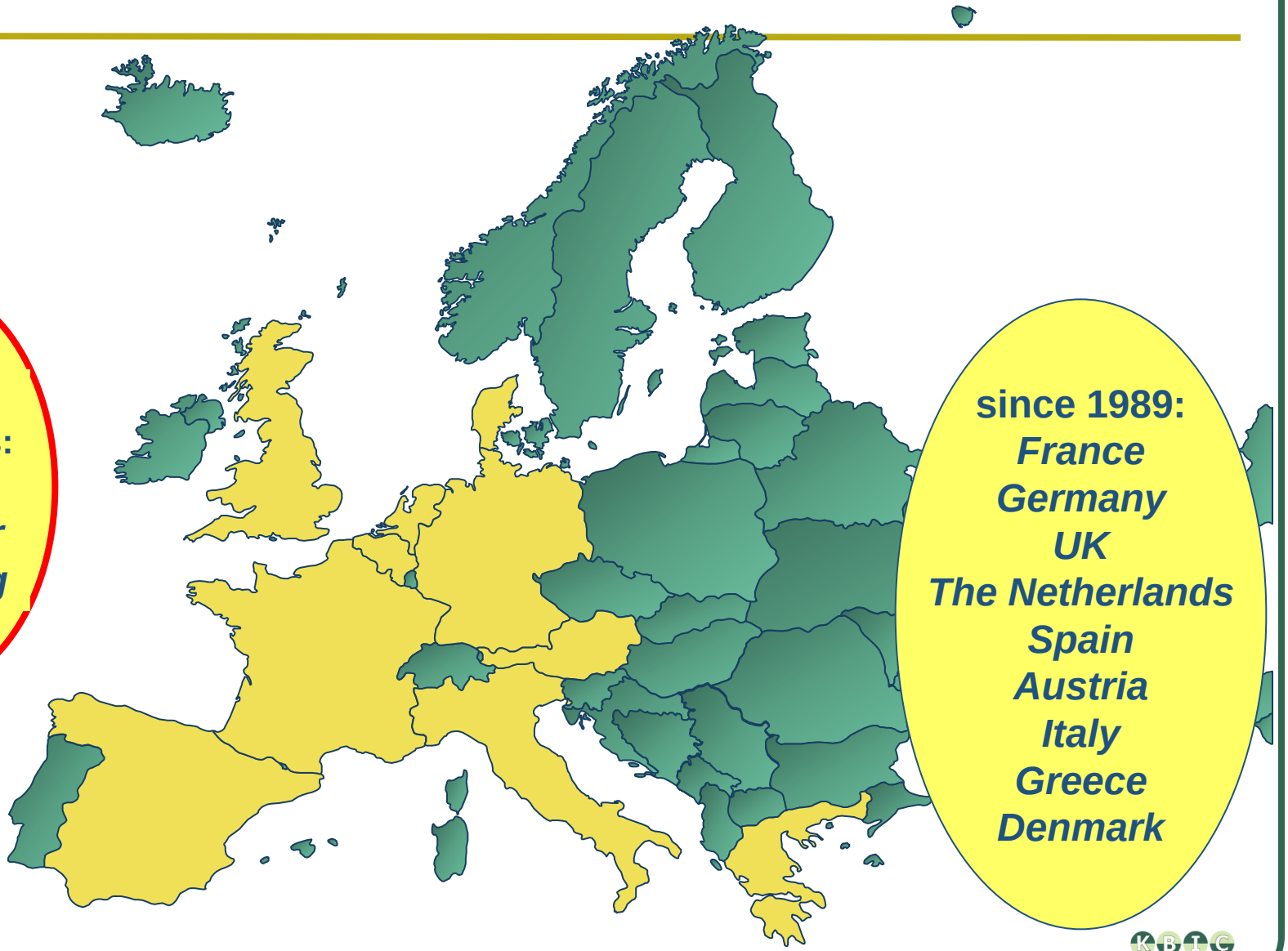
2006

CEN TC278 WG3 SG4:
Transmodel V5.1
voted as EN12896

to be revised 2011

Covers:
Network description
Versions management
Tactical planning
Personnel (driver) disposition
Operations monitoring and control
Passenger information
Fare collection
Management information and statistics
Multi-modal PT operation
Multiple operators environment

Transmodel Contributors



1998-99 field trials:
Lyons
Hanover
Salzburg

since 1989:
France
Germany
UK
The Netherlands
Spain
Austria
Italy
Greece
Denmark

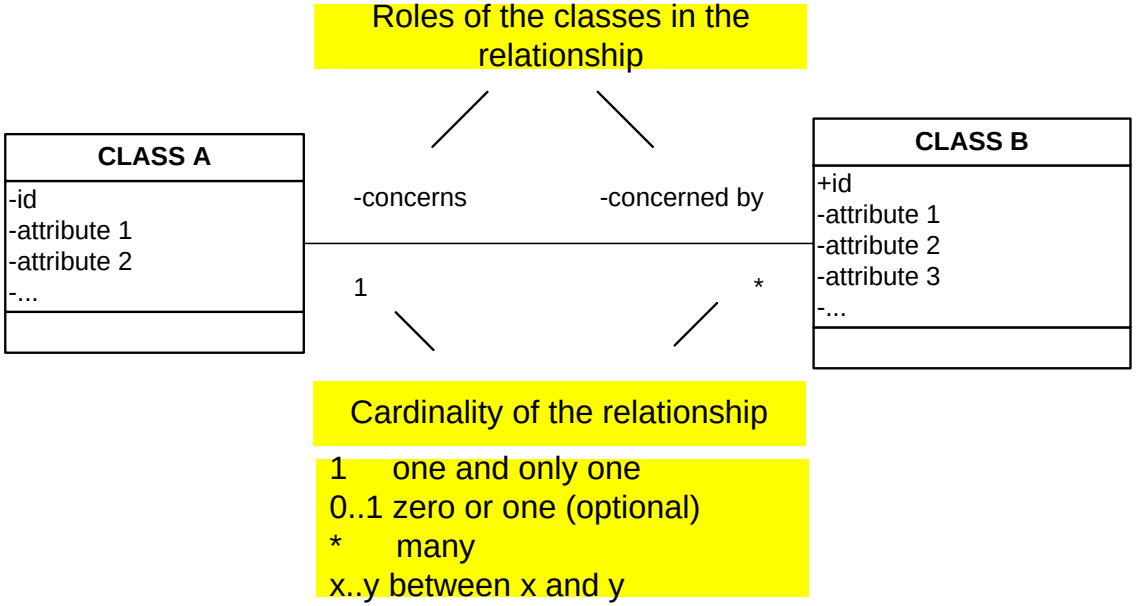
1. General overview: rationale, solution, approach & method, main domains
2. **Detailed presentation: Network description, tactical planning components, passenger information**
3. Other domains: driver & vehicle scheduling, operations monitoring & control, fare collection, management information/statistics
4. Transmodel-based services: the example of NeTEx

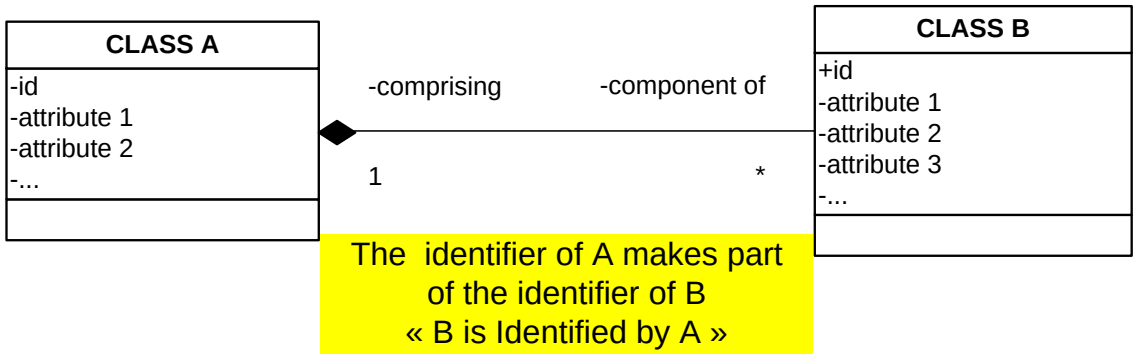
Transmodel data domains

- **Network description**
- Versions management
- Tactical planning
- Personnel (driver) disposition
- Operations monitoring and control
- Passenger information
- Fare collection
- Management information and statistics
- Multi-modal PT operation
- Multiple operators environment

Main elements of the UML formalism used

Relationships

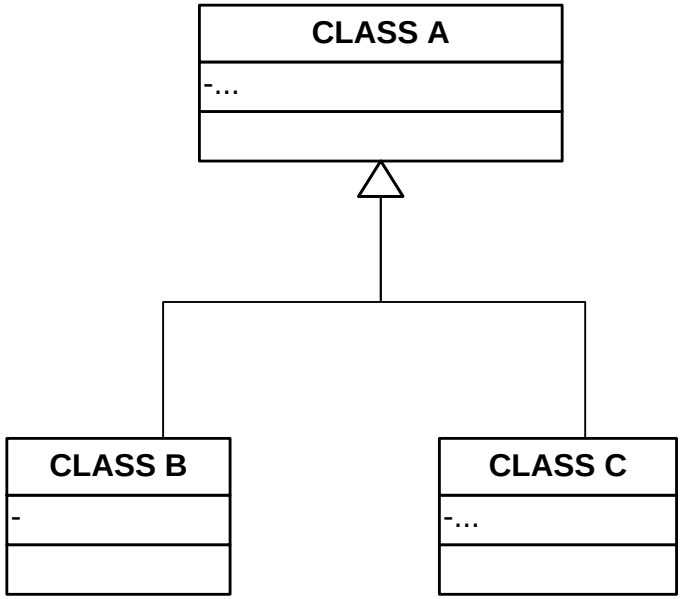




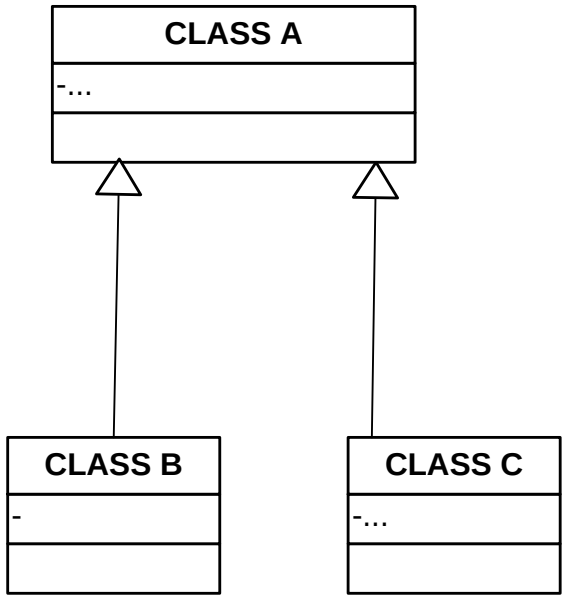
Main elements of the UML formalism used

Inheritance

CLASS A: parent class
is called « generalisation of B,C »



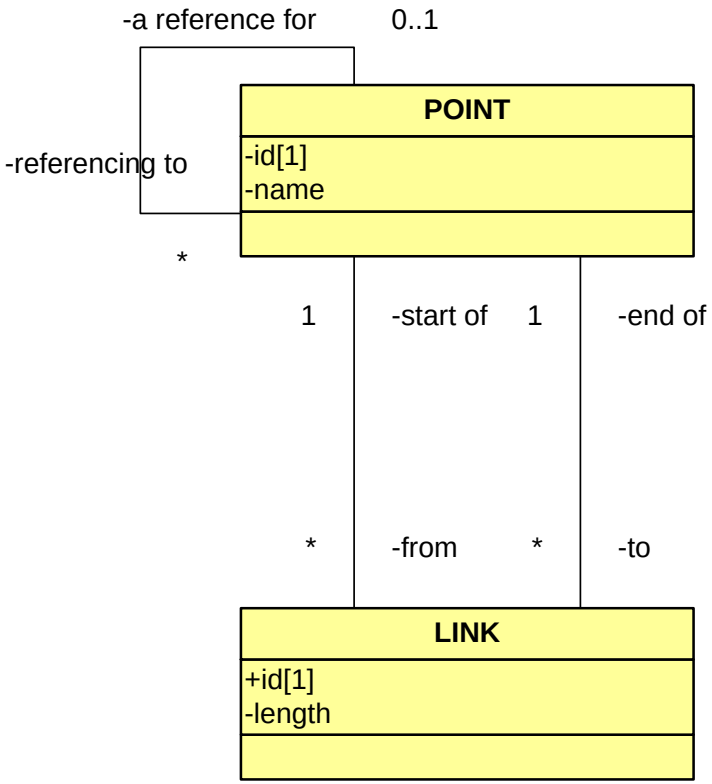
Exclusive inheritance



Non-exclusive inheritance

CLASSes B, C: children
inherit attributes from the parent class a
have own attributes
are called « specialisations of A »

POINTs and LINKs: What are the basic concepts used for network description?

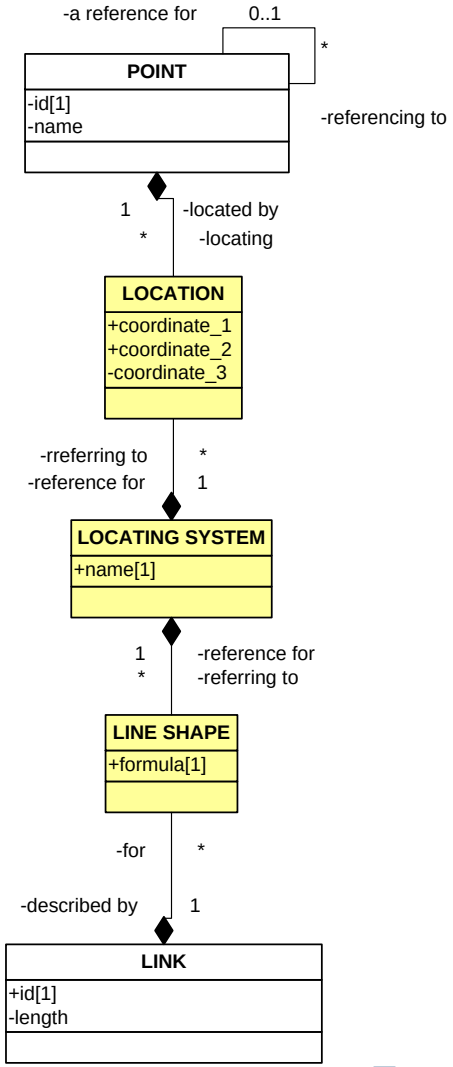


POINT: A 0-dimensional node used for the spatial description of the network.

LINK: An oriented spatial object of dimension 1 with view to the overall description of a network, describing a connection between two POINTs.

Extract Figure D.1

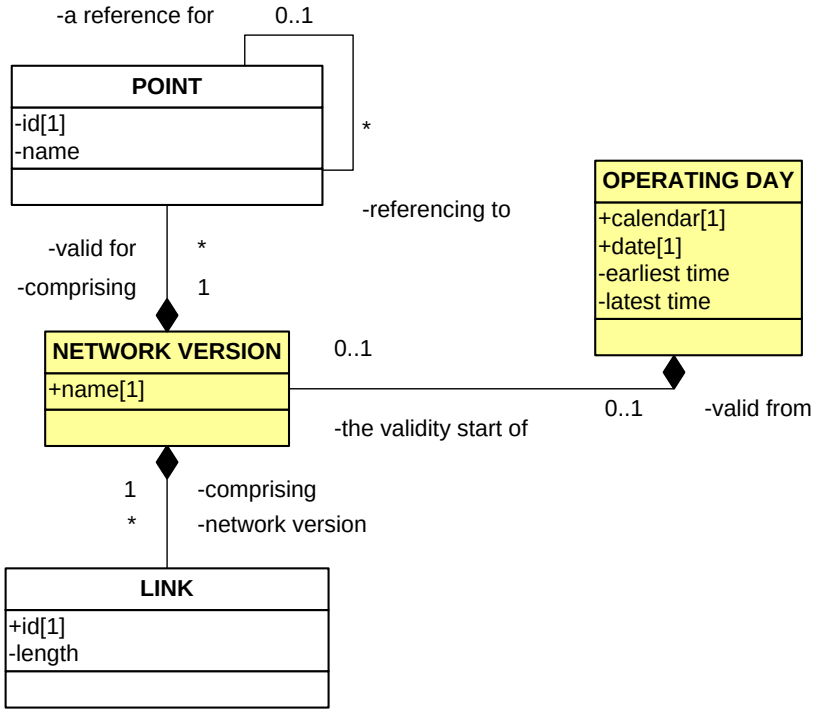
POINTs and LINKs: How to locate the POINTs of the network?



- POINTs may be located by a LOCATION in a given LOCATING SYSTEM.
- LOCATION: The position of a POINT with a reference to a given LOCATING SYSTEM (e. g. coordiantes).
- LOCATING SYSTEM: The system used as reference for location and graphical representation of the network and other spatial objects.
- LINE SHAPE: The graphical shape of a LINK obtained from a formula or other means, using the LOCATION of its limiting POINTs and depending on the LOCATING SYSTEM used for the graphical representation.

Extract Figure D.1

POINTs and LINKs: How to take into account the network data modifications over time?



Extract Figure D.1

- The NETWORK VERSION is a set of network data (and other data logically related to these) to which the same validity period has been assigned.
- NETWORK VERSION is valid from a given OPERATING DAY.
- OPERATING DAY: A day of public transport operation in a specific calendar. An OPERATING DAY may last more than 24 hours.
- *See also the modelling of VERSIONs*

LINK SEQUENCEs: How to represent the paths through the network?

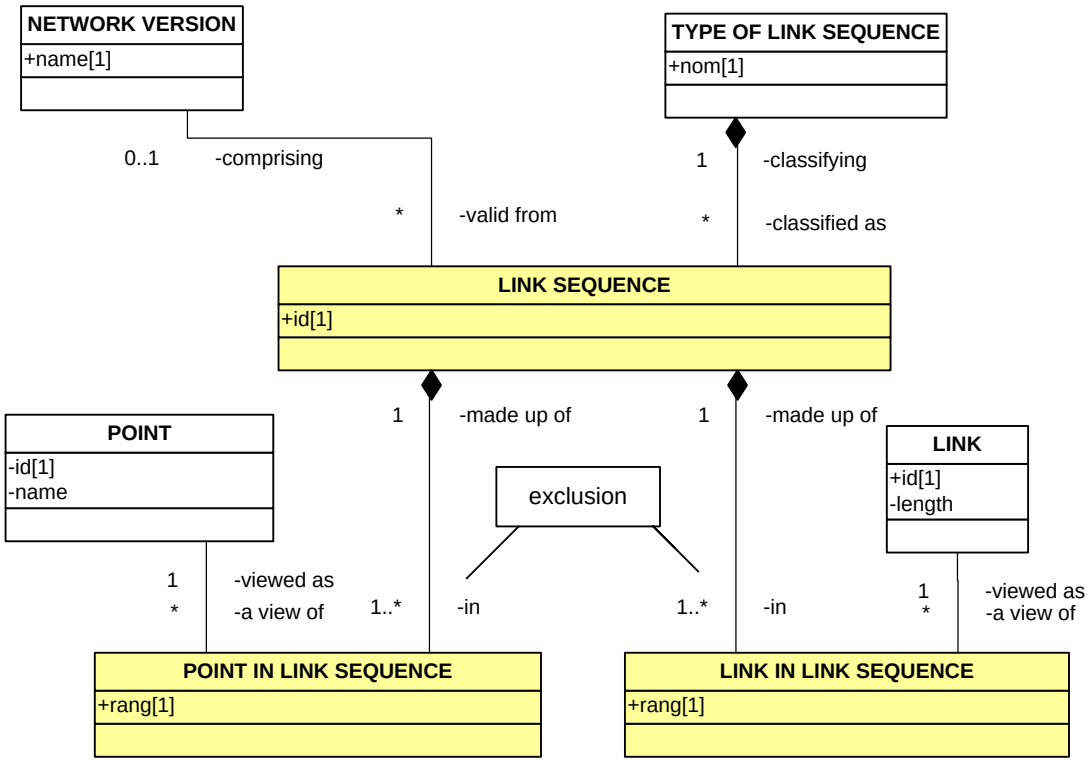
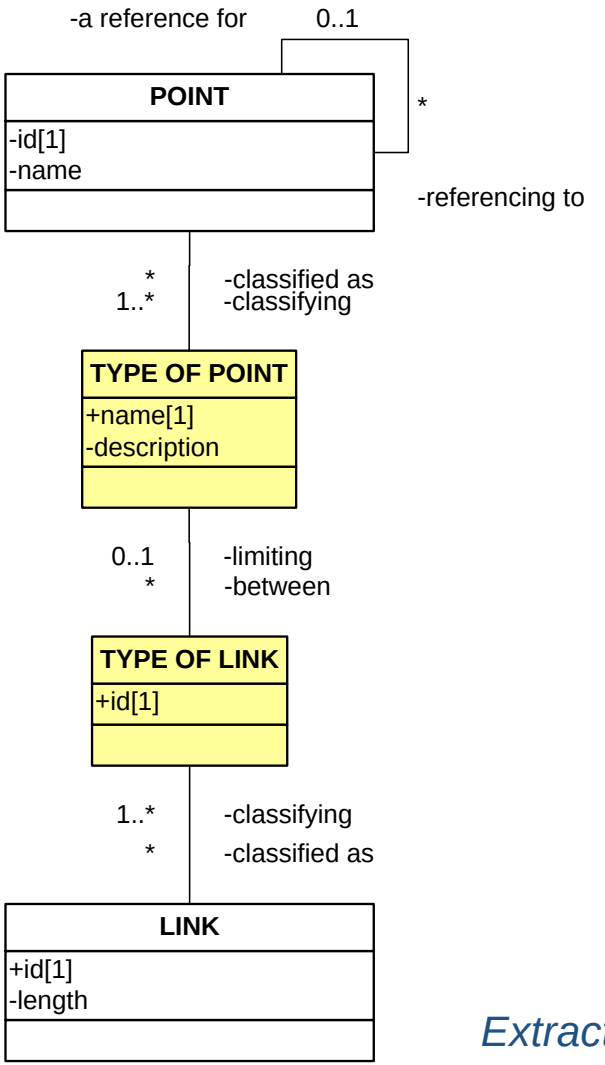


Figure D.9

- A LINK SEQUENCE is an ordered sequence either of POINTs or of LINKs, defining a path through the network.
- Note: there are two alternative possibilities to describe the network paths: either as a sequence of POINTs or as a sequence of LINKs.
- The TYPE OF LINK SEQUENCE gives a classification of LINK SEQUENCEs used to define the different functions a LINK SEQUENCE may be used for. E.g ROUTE, JOURNEY PATTERN, road, TRIP PATTERN, border line etc.

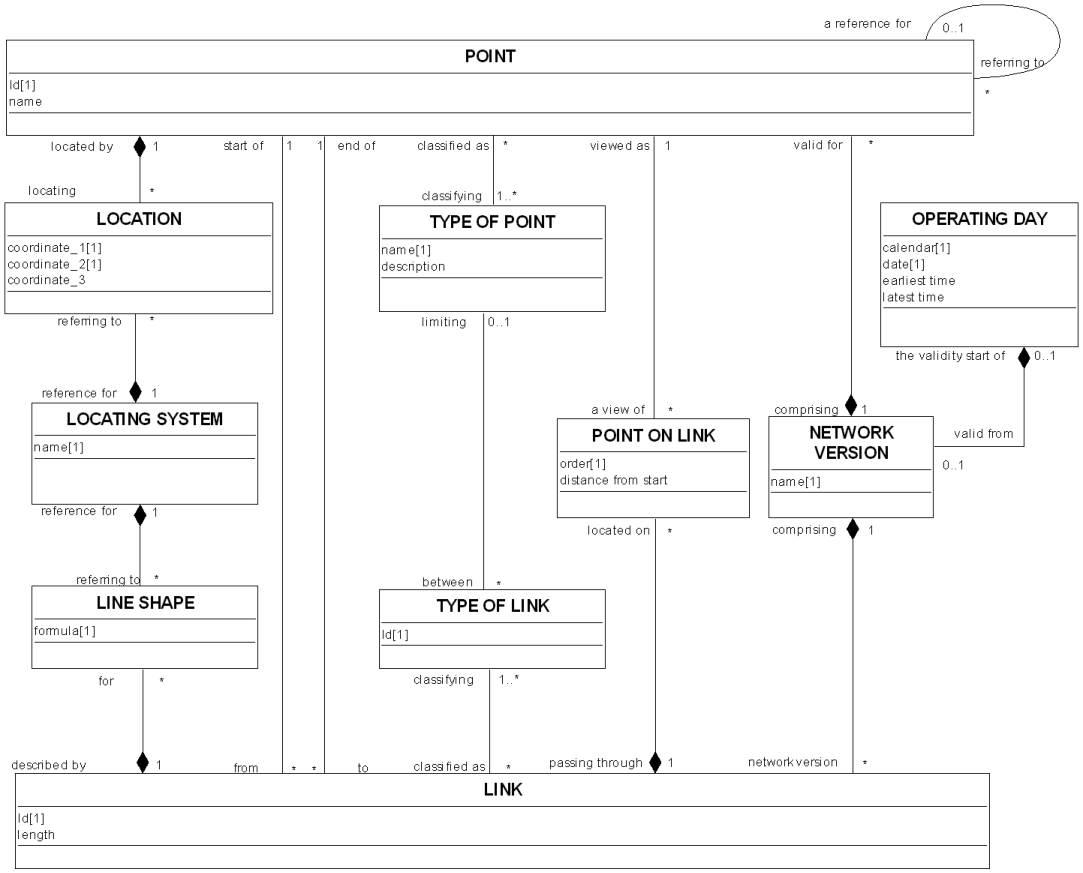
POINTs and LINKs: How is their classification represented?



- TYPE OF POINT gives a classification of POINTs according to their functional purpose.
- TYPE OF LINK provides a classification of LINKs to express the different functional roles of a LINK.

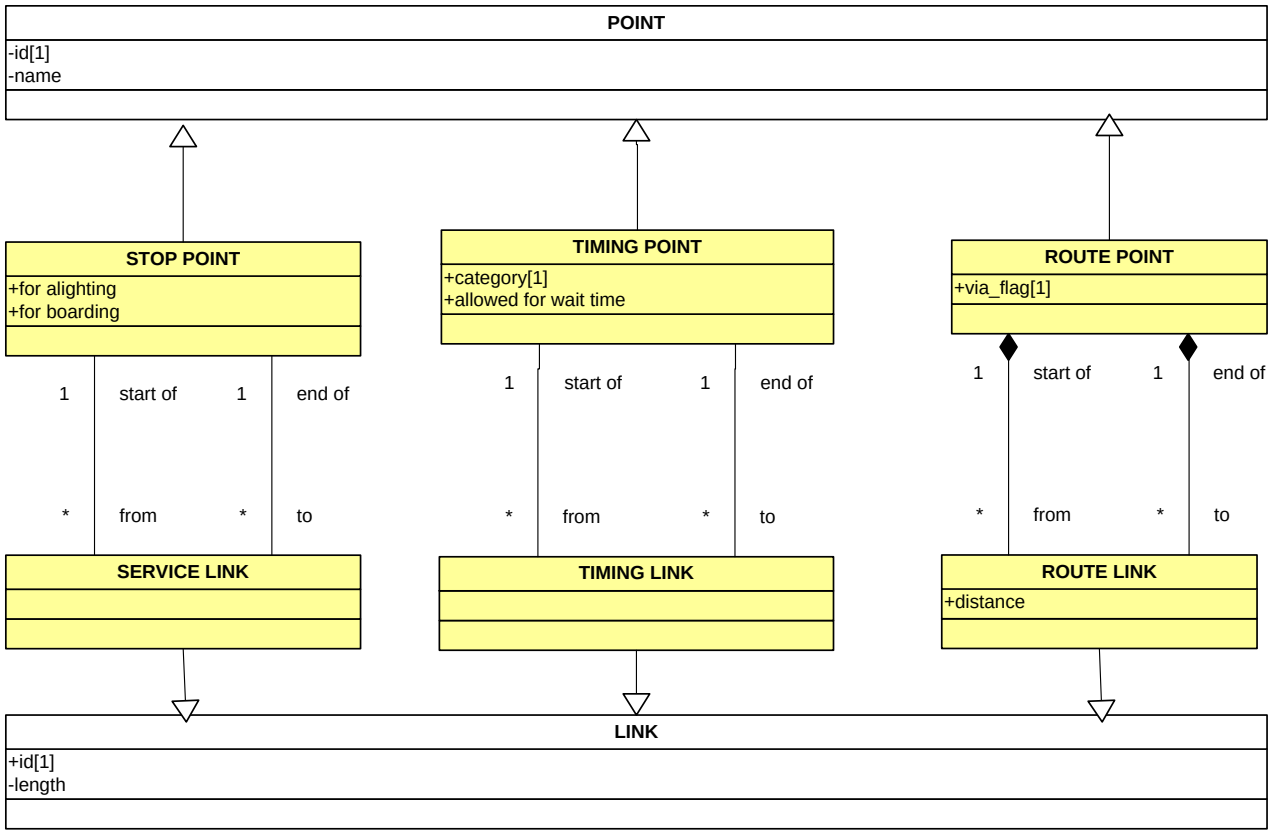
Extract Figure D.1

POINTs and LINKs: Figure D.1



- POINT ON LINK: A POINT on a LINK which is not needed for LINK definition, but may be used for other purposes, e.g. for purposes of AVM or PI, or for driver information.

Main types of POINTs and LINKs: what are they?

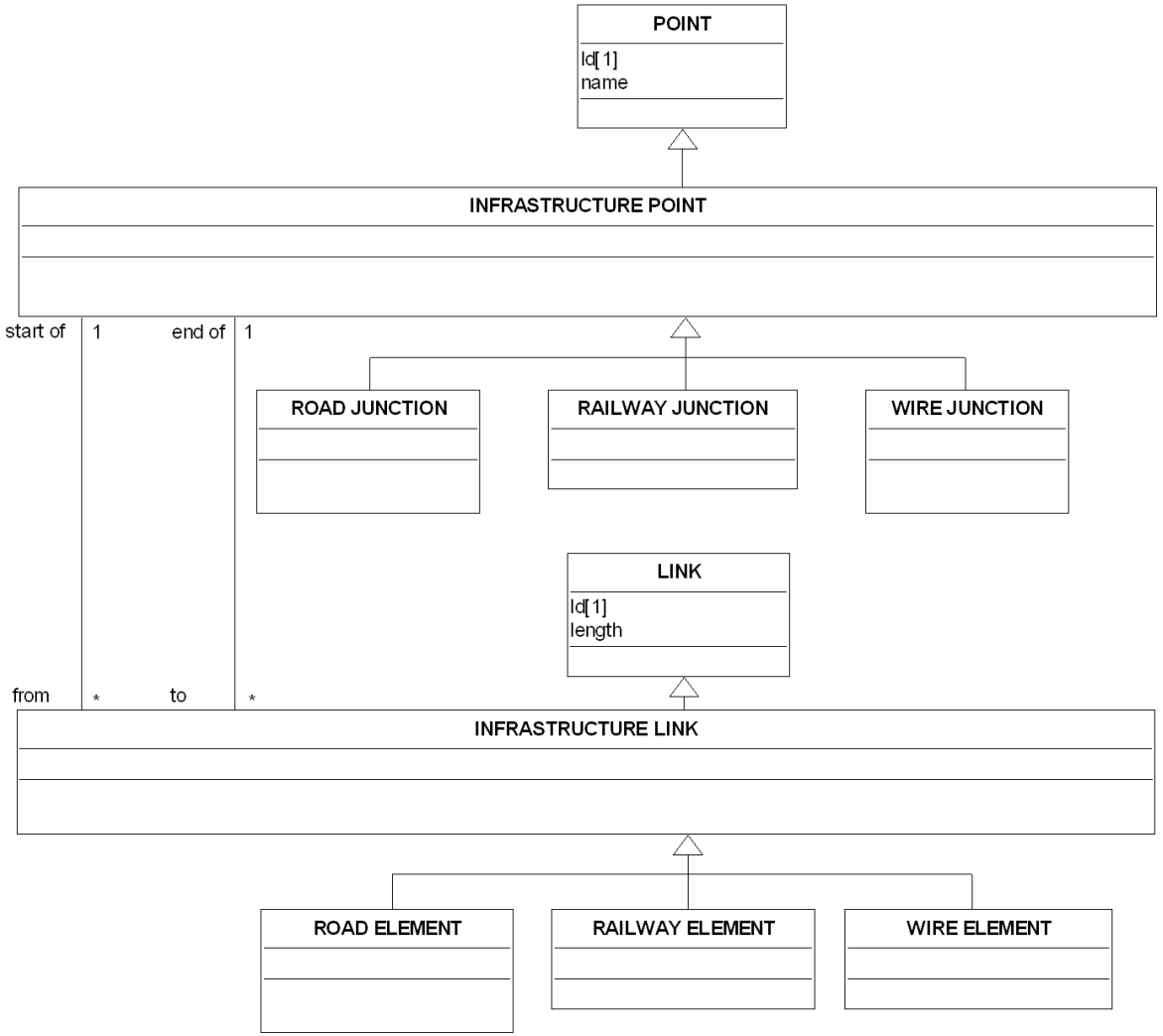


STOP POINT has to be considered as a « PLANNED » STOP POINT and differenciated from « physical » concepts like a QUAY or A BOARDING POSITION as in IFOPT

Figure D.2

- STOP POINT: A POINT where passengers can board or alight from vehicles.
- TIMING POINT: A POINT against which the timing information necessary to build schedules may be recorded.
- ROUTE POINT:A POINT used to define the shape of a ROUTE through the network.

Infrastructure: How are represented the physical aspects of the network?



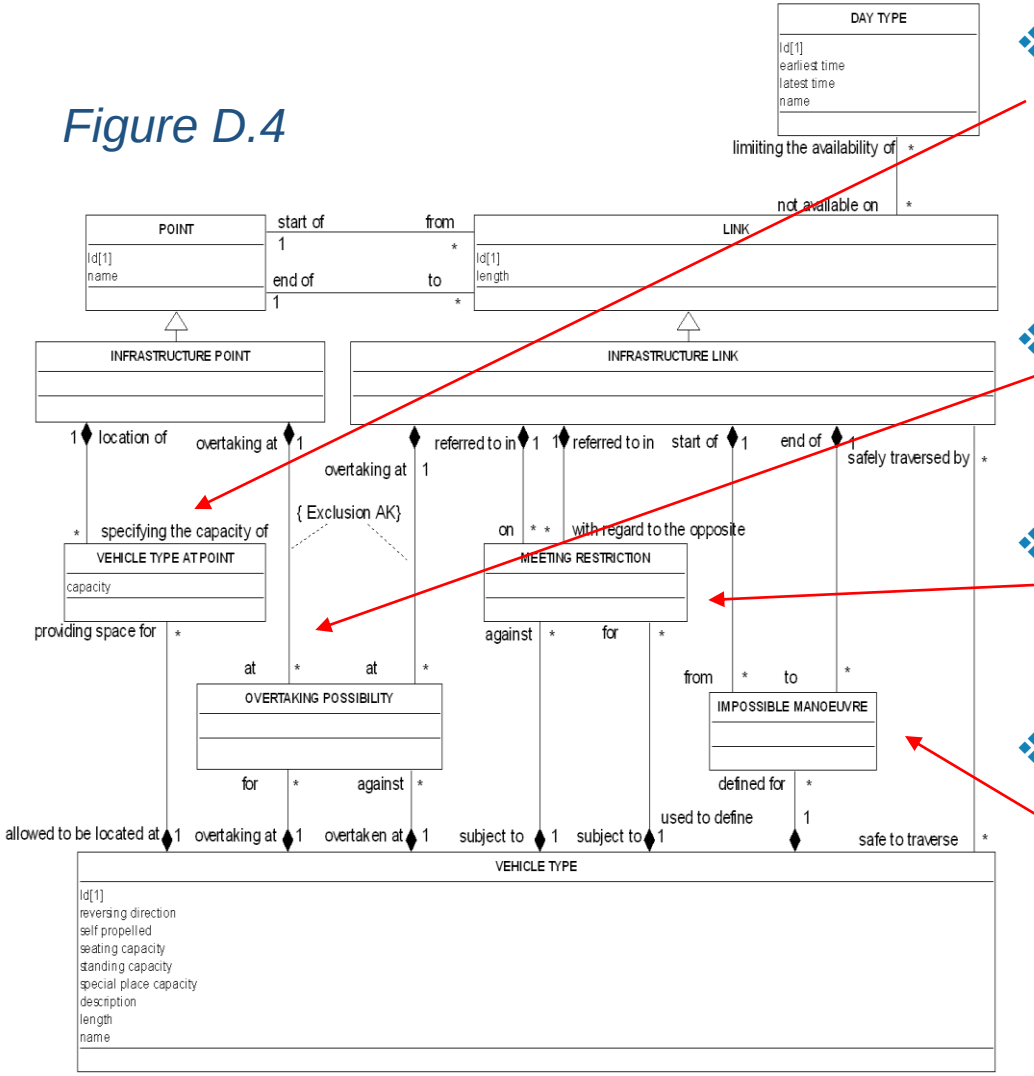
The description of the infrastructure has to be independent from the topological description of the PT network.

The modelling is similar: specific POINT and LINK types are used to define the road network, the railway network of the wire network.

Figure D.3

Restrictions: How are represented the operational restrictions due to the physical characteristics of the network?

Figure D.4

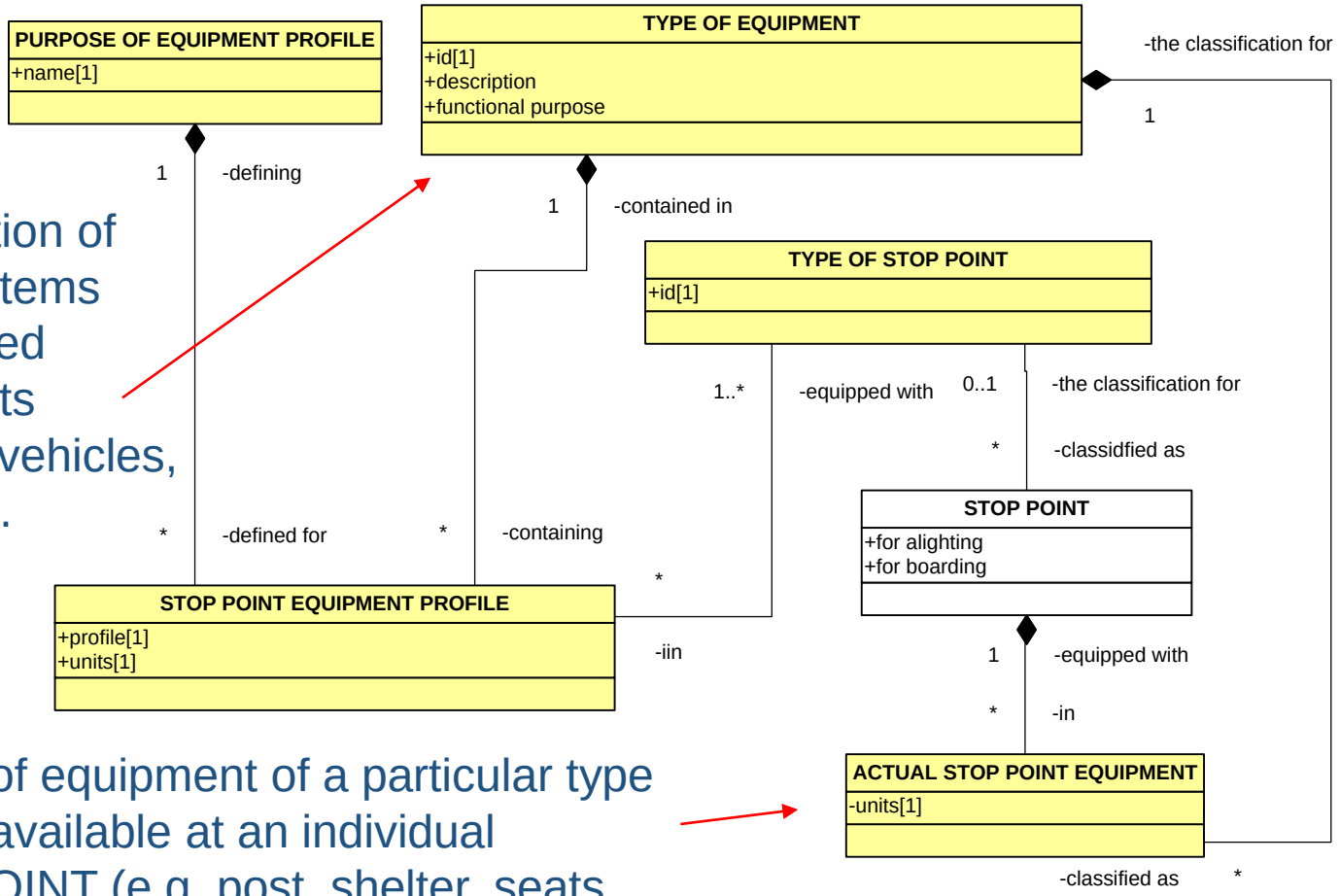


- The number of vehicles of a specified VEHICLE TYPE which may wait at a specified POINT at any one time. If the capacity is 0, then that type of vehicle may not stop there.
- A POINT or a LINK where vehicles of specified VEHICLE TYPEs are not allowed to overtake each other.
- A pair of INFRASTRUCTURE LINKs where vehicles of specified VEHICLE TYPEs are not allowed to meet.
- A specification of impossible move for a certain type of vehicle. It specifies from which INFRASTRUCTURE LINK to which other (adjacent) INFRASTRUCTURE LINK a certain VEHICLE TYPE cannot proceed, due to physical restrictions.

Stop Point Equipment: Figure D.6

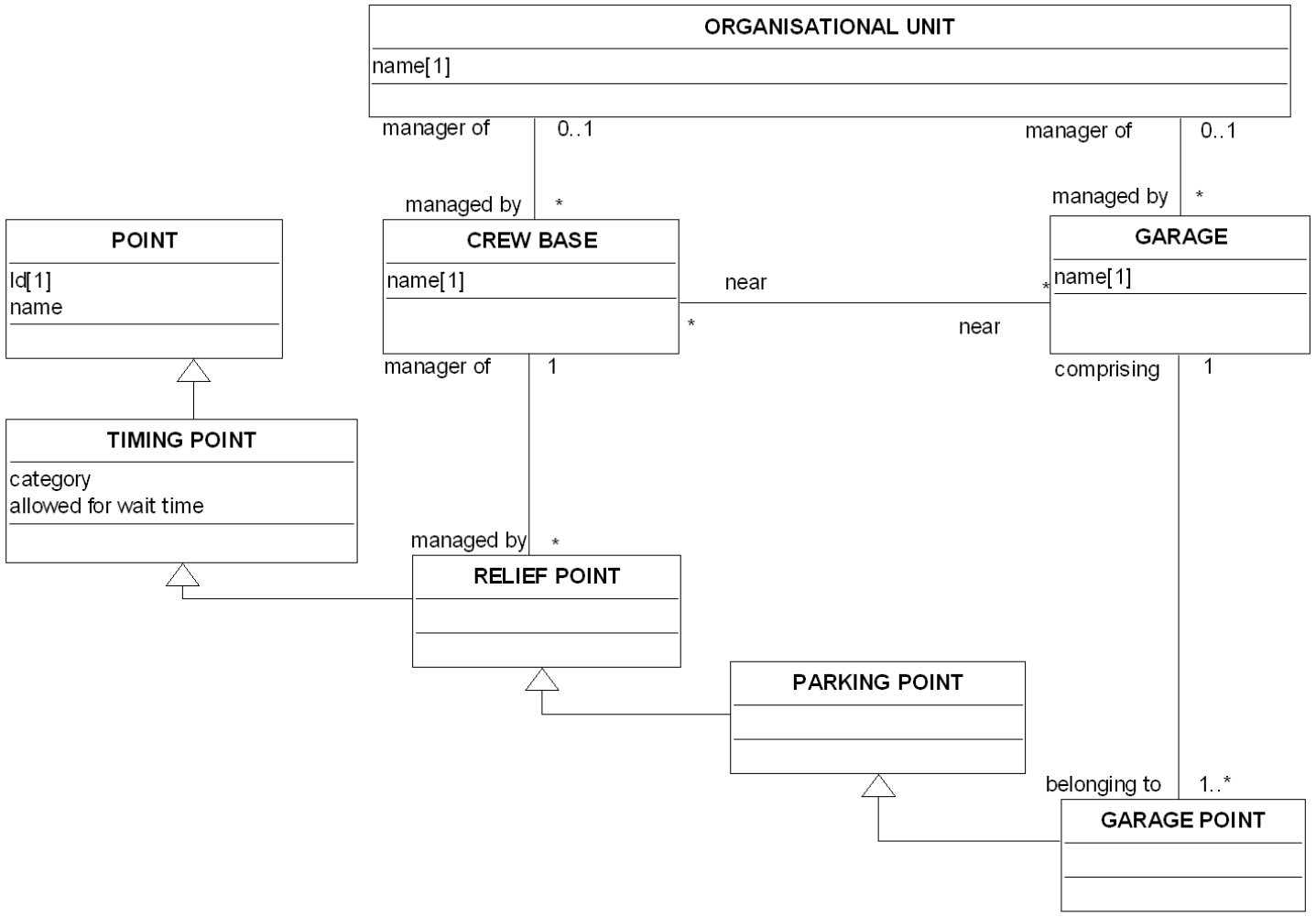
Depending upon the TYPE OF STOP POINT specific equipment is installed.

A classification of equipment items to be installed at stop points or onboard vehicles, for instance.

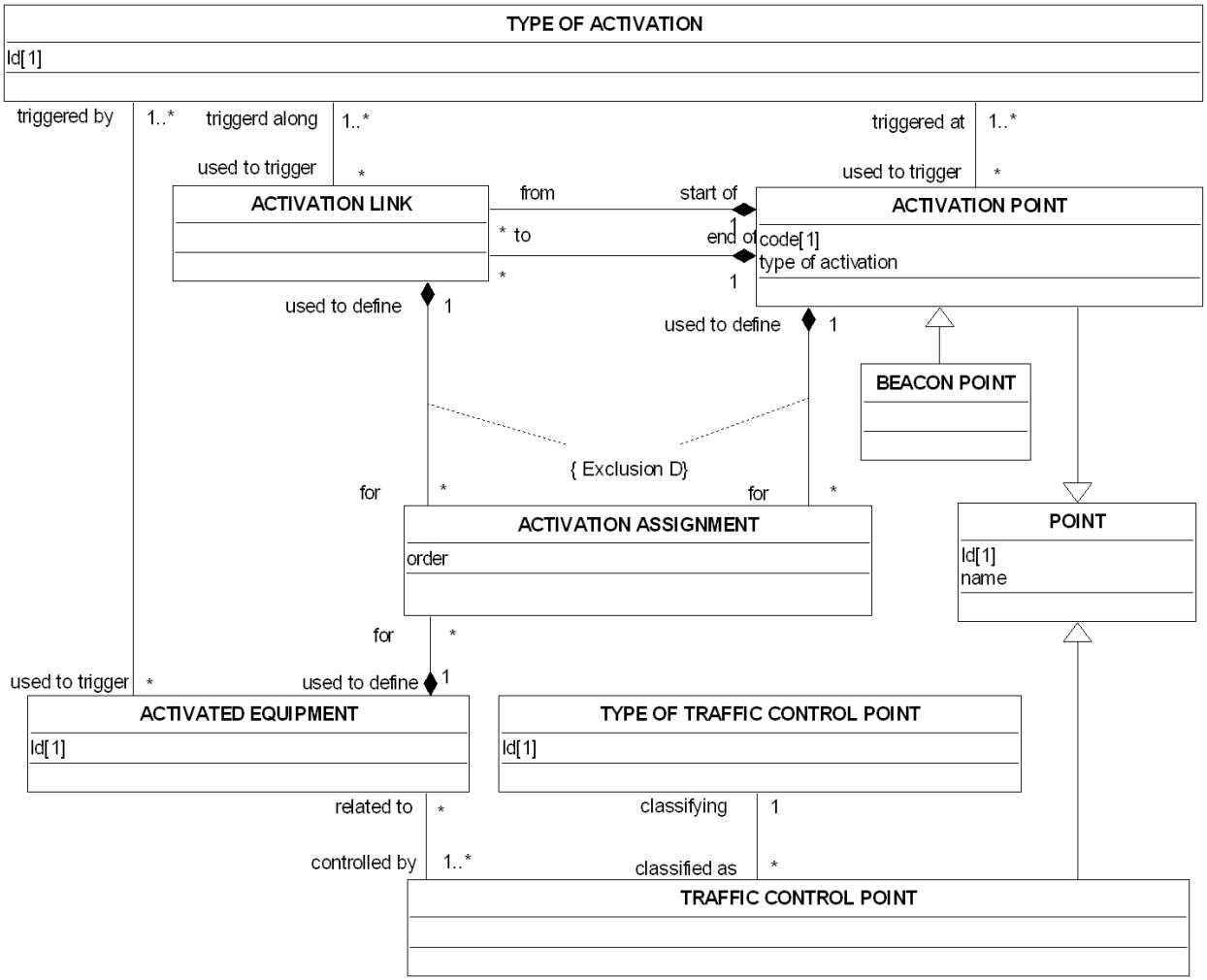


An item of equipment of a particular type actually available at an individual STOP POINT (e.g. post, shelter, seats, information display).

Resource Managemment Points: Figure D.7



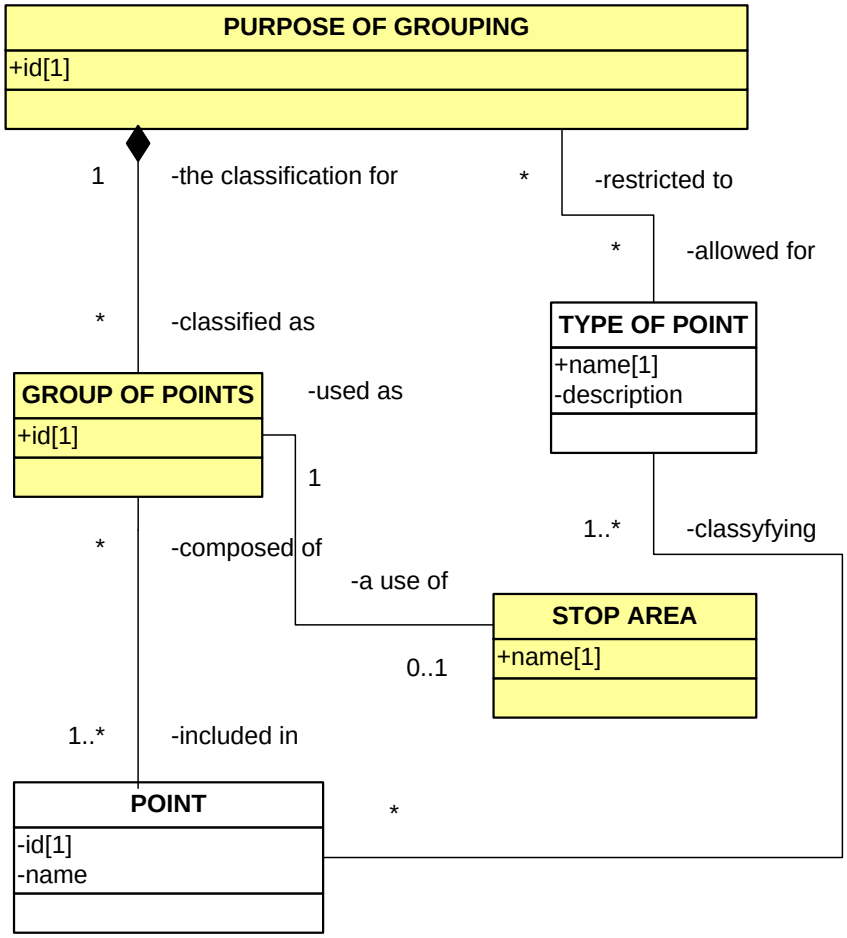
Activation Facilities: Figure D.8



These concepts do not concern the modelling of the equipment itself

They refer to the information necessary for the spacial management of the equipment dedicated to the RT control of operations.

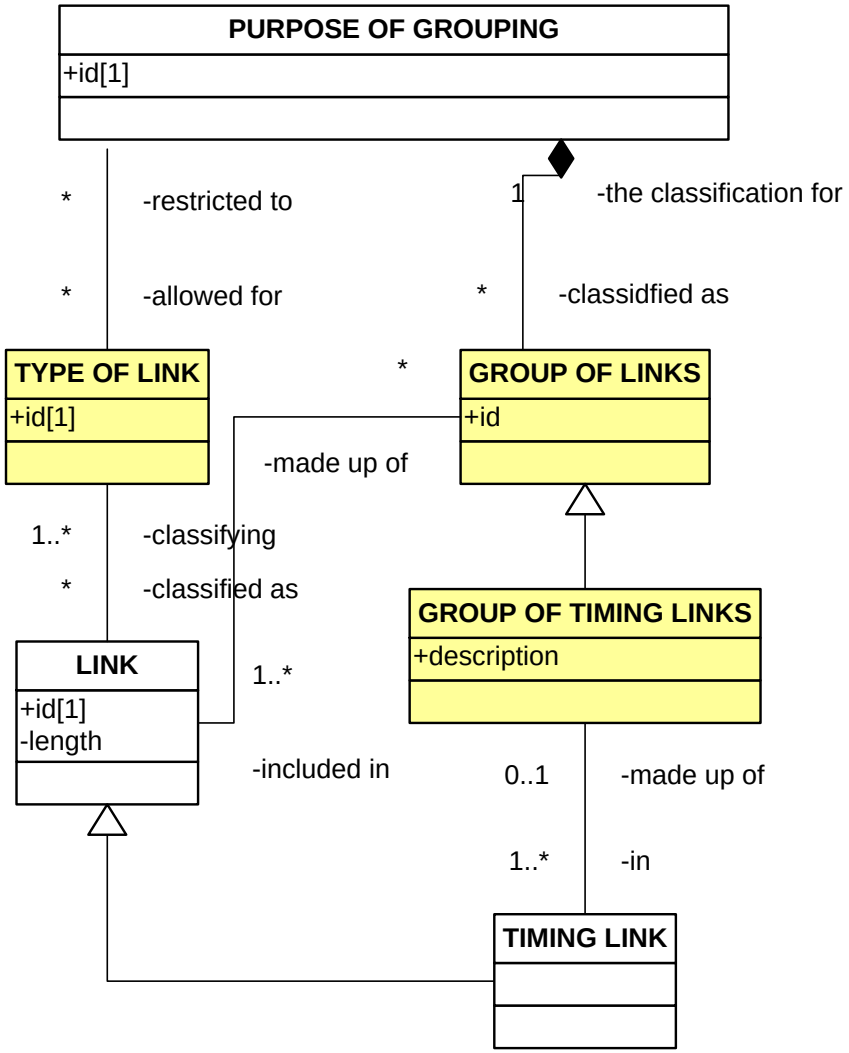
Grouping: how to represent the fact that some objects are used as a group?



- The functional purpose for which GROUPs of elements are defined is called PURPOSE GROUPING.
- The PURPOSE OF GROUPING may be restricted to one or more types of the given object.

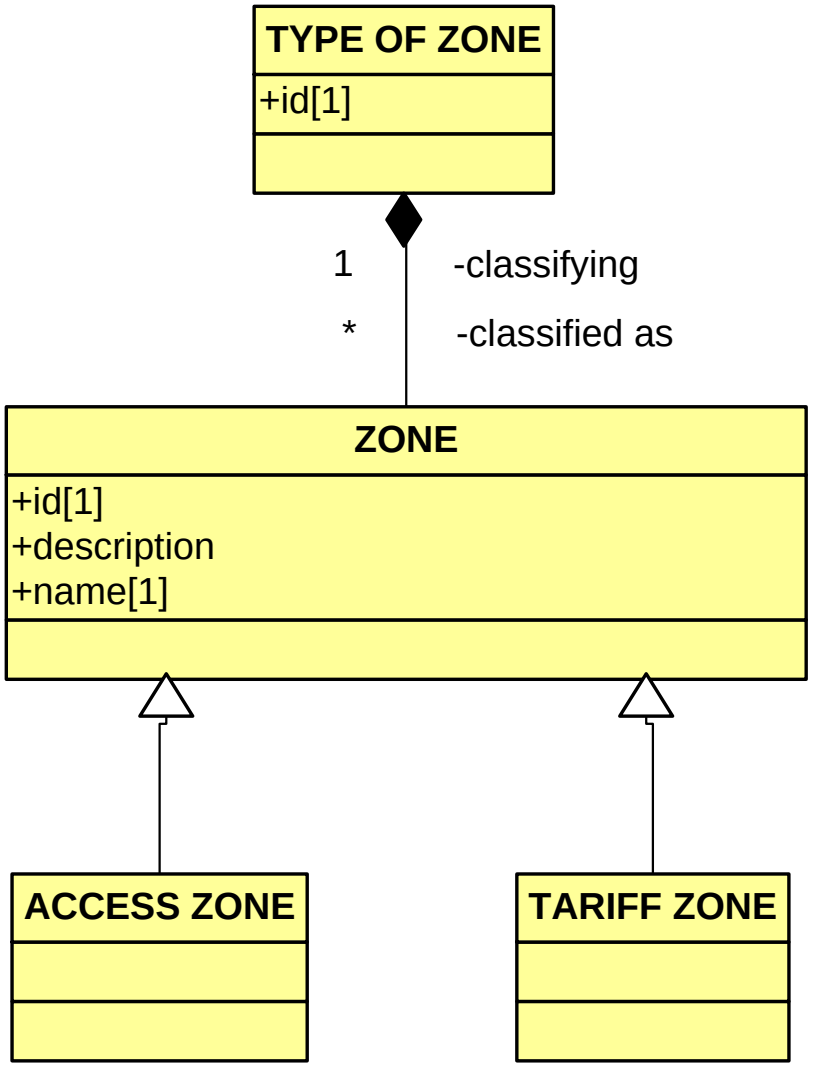
- For example: a STOP AREA a group of STOP POINTs close to each other.

Grouping: how to represent the grouping of linear objects?



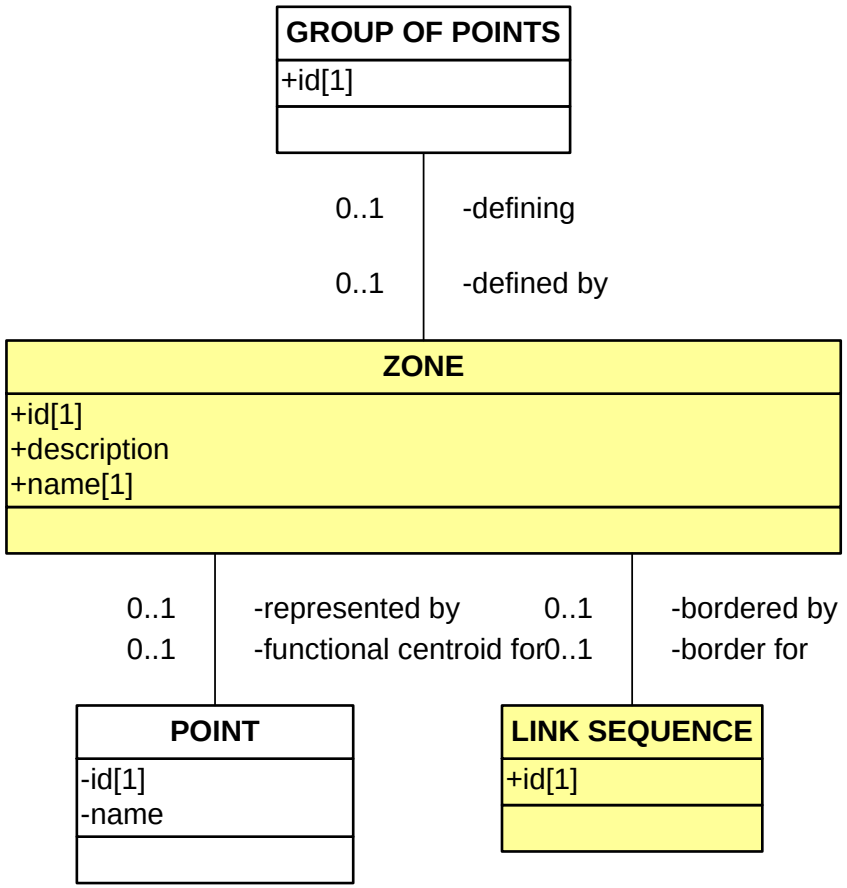
- The grouping mechanism may be applied to other concepts than POINTs, for instance to linear objects.
- One example is a LINE is group of linear objects (ROUTEs) which is generally known to the public by a similar name or number.
- Another example: a set of TIMING LINKs grouped together according to the similarity of TIME BANDs which are relevant to them.

Zones: how are represented the 2-dimensional objects?



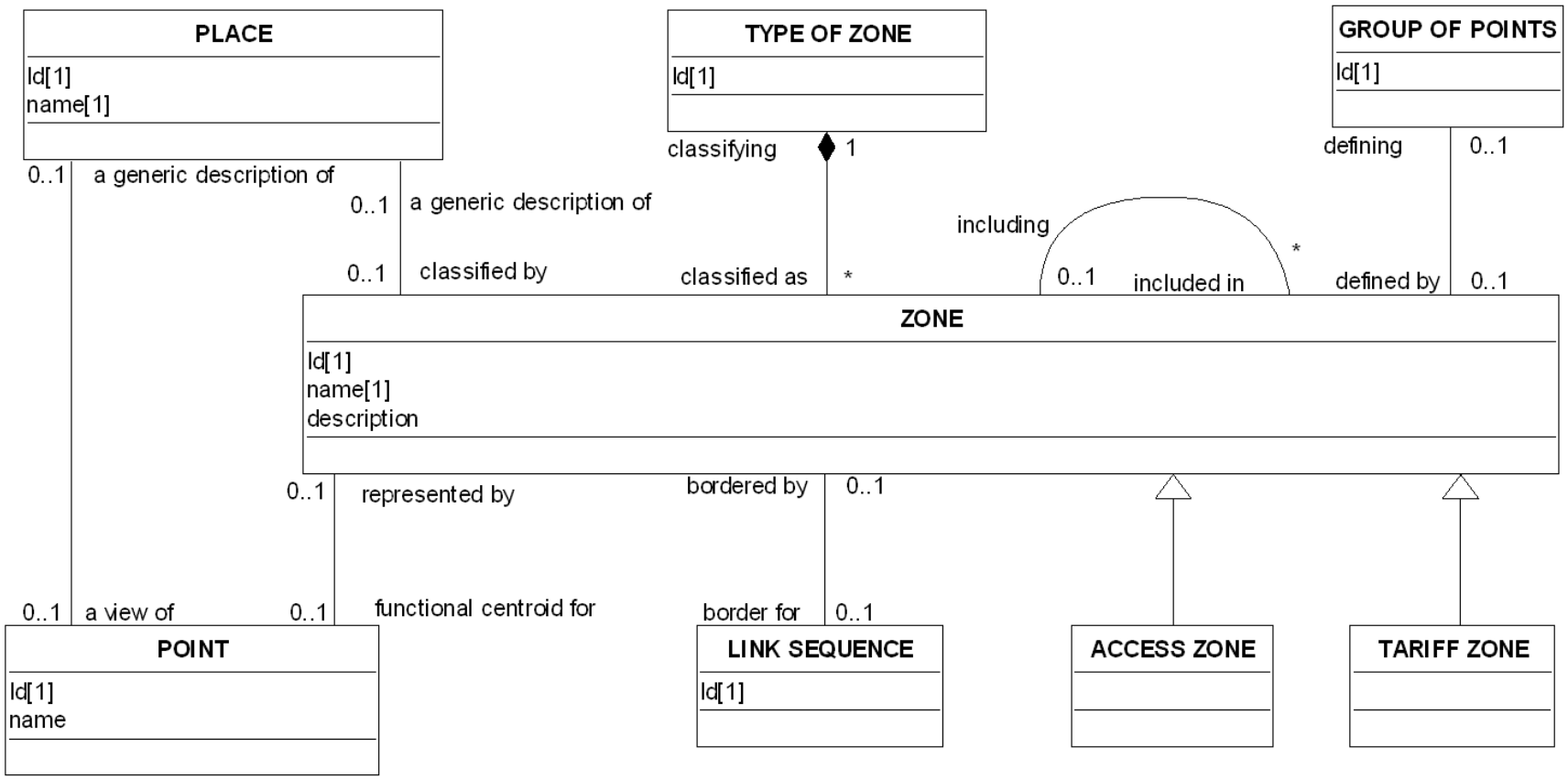
- A ZONE is a two-dimensional PLACE within the service area of a public transport operator (administrative zone, TARIFF ZONE, ACCESS ZONE, etc.).
- TYPE OF ZONE is a classification of ZONEs. E.g TARIFF ZONE, ADMINISTRATIVE ZONE are types explicitly modelled.
- A ZONE may also be considered as a group of points…

Zones: how are they represented in Transmodel?



- Two definitions of ZONE coexist:
  - As a GROUP OF POINTs
  - As a 2-dimensional PLACE
- Example: an ACESS ZONE - defined as a ZONE for which the duration to cover any ACCESS LINK to a particular STOP POINT is the same –
- May be a group of STOP POINTs (from which the chosen particular STOP POINT is reached within a given time)
- But also represent the space around this STOP POINT, bordered by a LINK SEQUENCE.

ZONEs: Figure D.11



COMPLEX FEATUREs: How to represent groupings of objects of different nature or dimension?

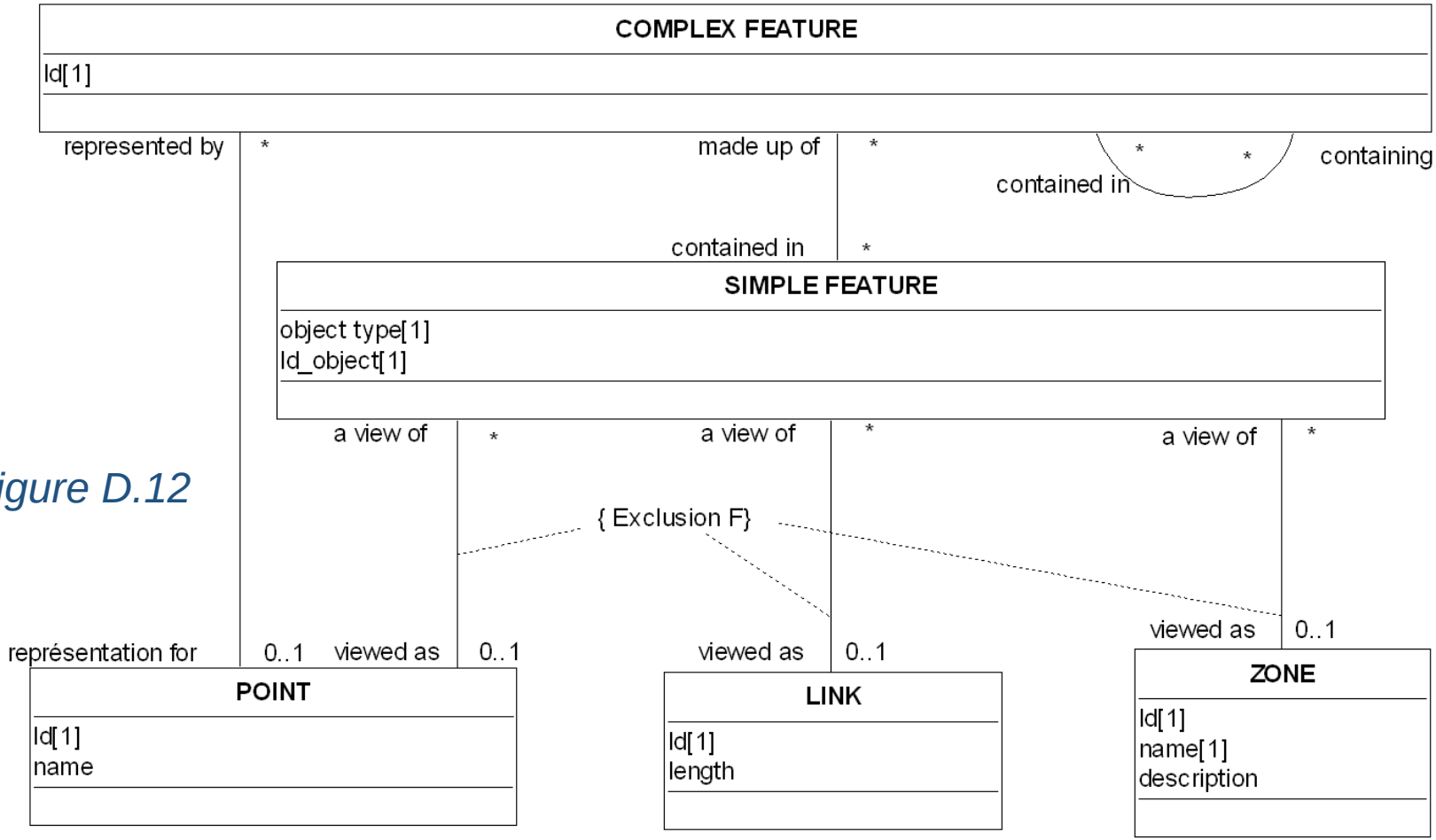
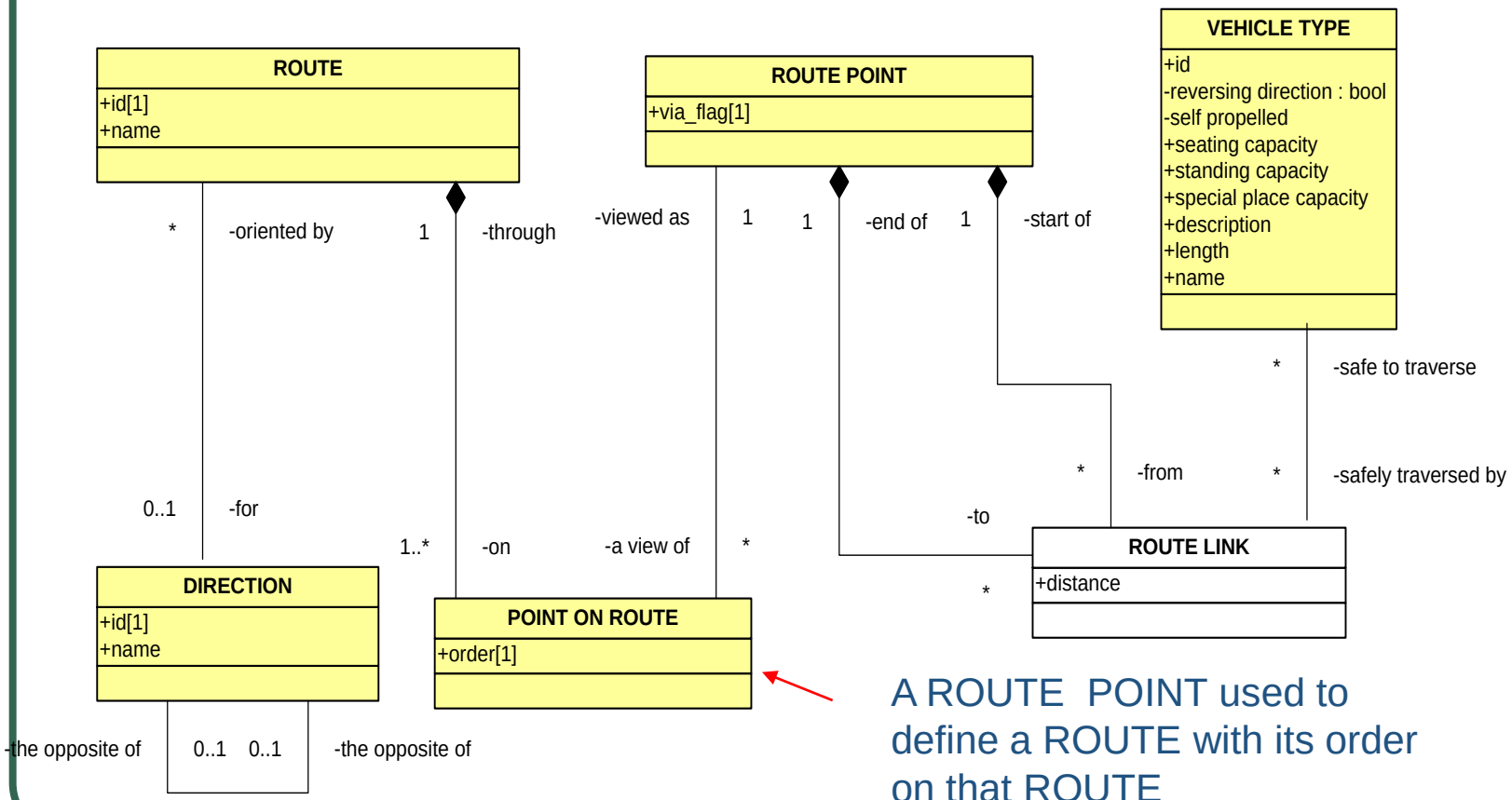


Figure D.12

Example: complex stops, composed of quays, vehicle stopping places,etc

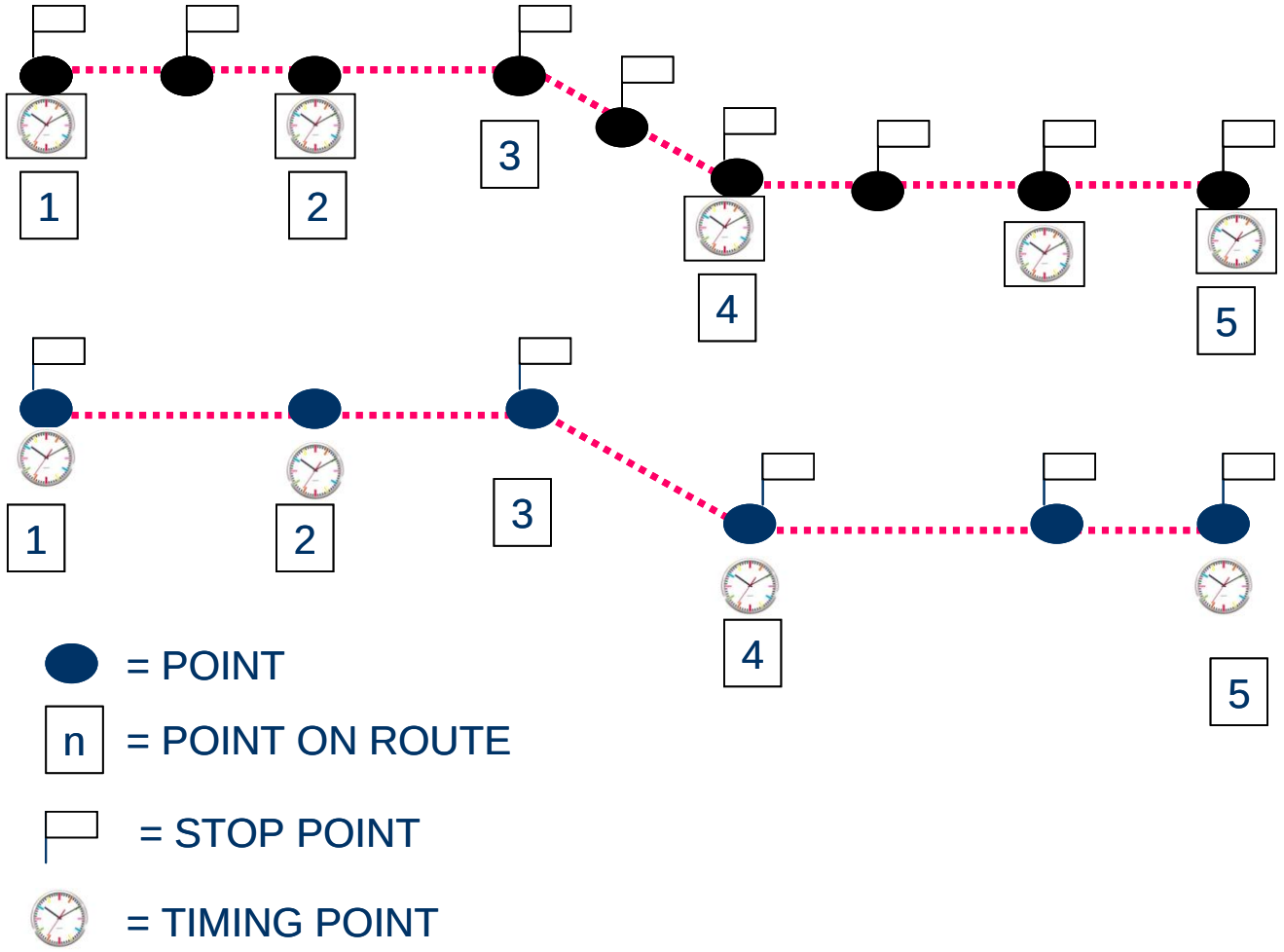
ROUTEs: Figure D.14

It is an ordered list of located POINTs defining one single path through the road (or rail) network.
A ROUTE may pass through the same POINT more than once.
It is an abstract concept, to be differentiated from a physical path.
ROUTE POINT: A POINT used to define the shape of a ROUTE through the network.



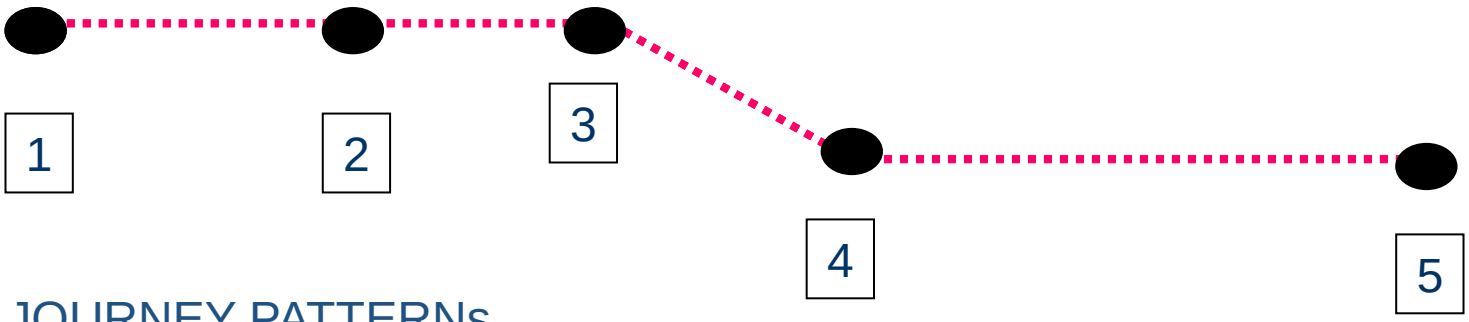
A ROUTE POINT used to define a ROUTE with its order on that ROUTE

JOURNEY PATTERNs: How to define the service on the PT network?

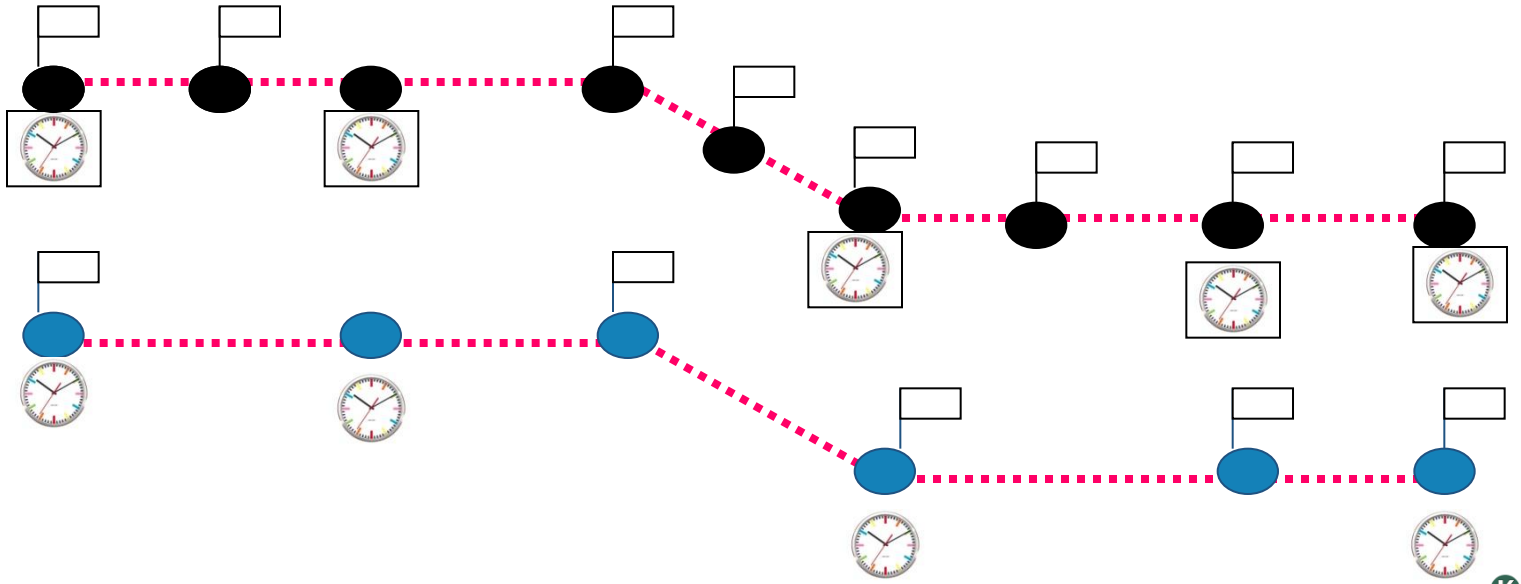


JOURNEY PATTERNs: How to define the service on the PT network?

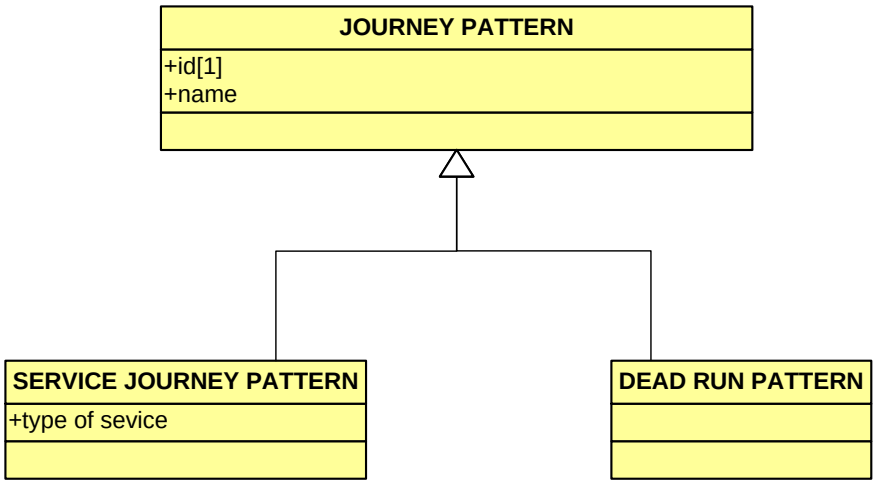
One ROUTE



Two JOURNEY PATTERNs

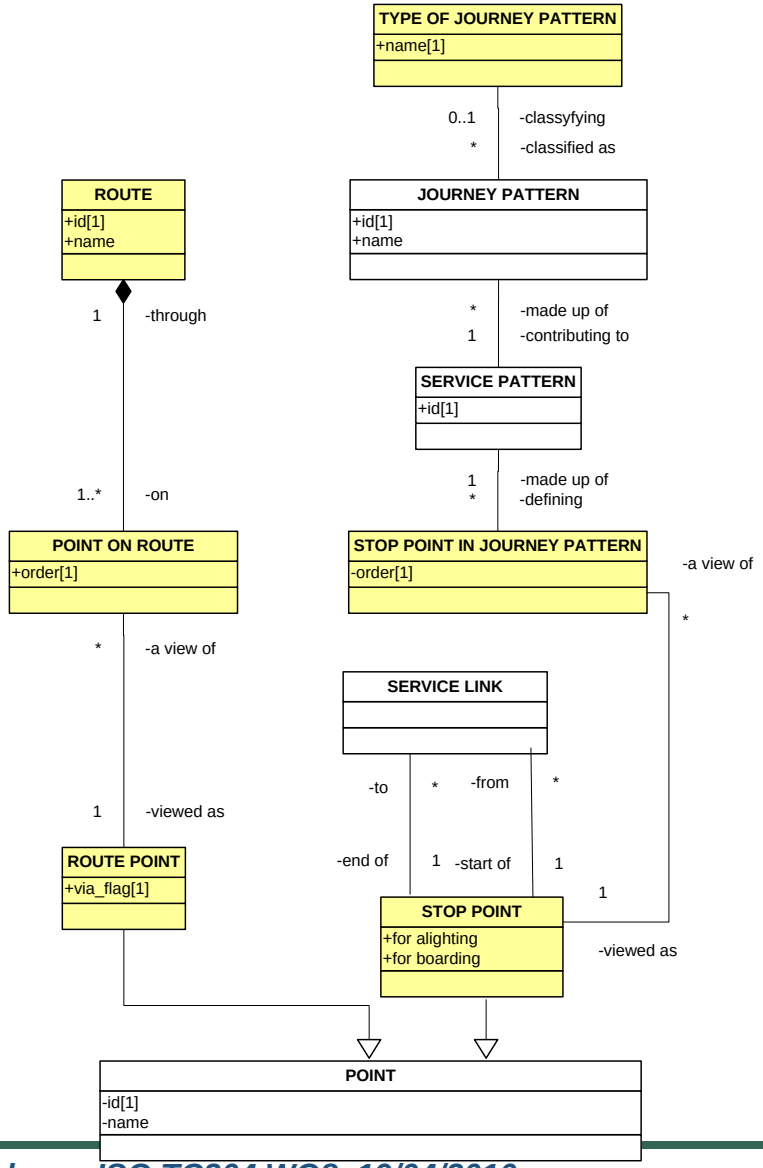


JOURNEY PATTERNs



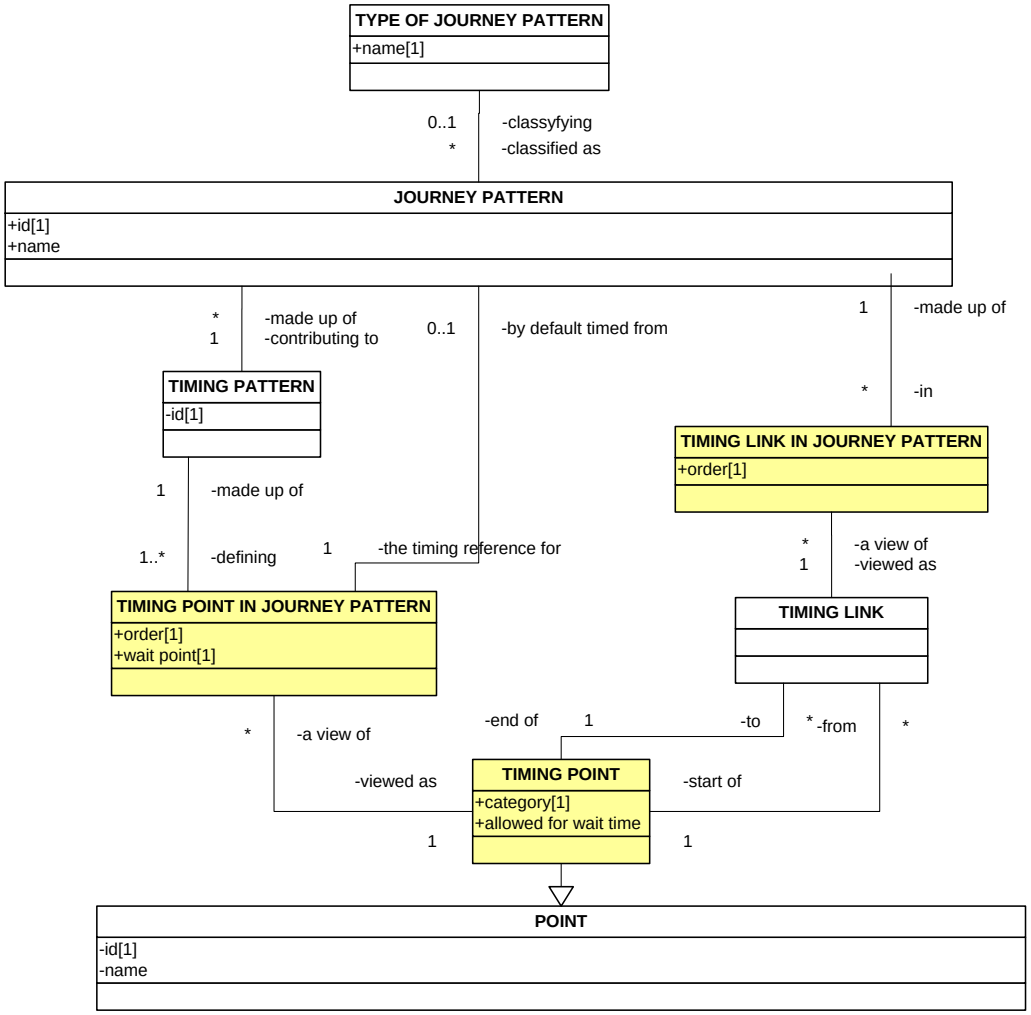
- A JOURNEY PATTERN is an ordered list of STOP POINTs and TIMING POINTs on a single ROUTE, describing the pattern of working for public transport vehicles.
- A JOURNEY PATTERN may pass through the same POINT more than once.
- The first point of a JOURNEY PATTERN is the origin. The last point is the destination.
- DEAD RUN PATTERN: A JOURNEY PATTERN to be used for DEAD RUNs.
  (DEAD RUN: A non-service VEHICLE JOURNEY
- SERVICE JOURNEY PATTERN: The JOURNEY PATTERN for a (passenger carrying) SERVICE JOURNEY.

JOURNEY PATTERNs



- SERVICE PATTERN: The subset of a JOURNEY PATTERN made up only of STOP POINTs IN JOURNEY PATTERN.
- TIMING PATTERN: The subset of a JOURNEY PATTERN made up only of TIMING POINTs IN JOURNEY PATTERN.
- Thus: one SERVICE PATTERN may be associated with one or more JOURNEY PATTERNs that differ by their TIMING PATTERNs.

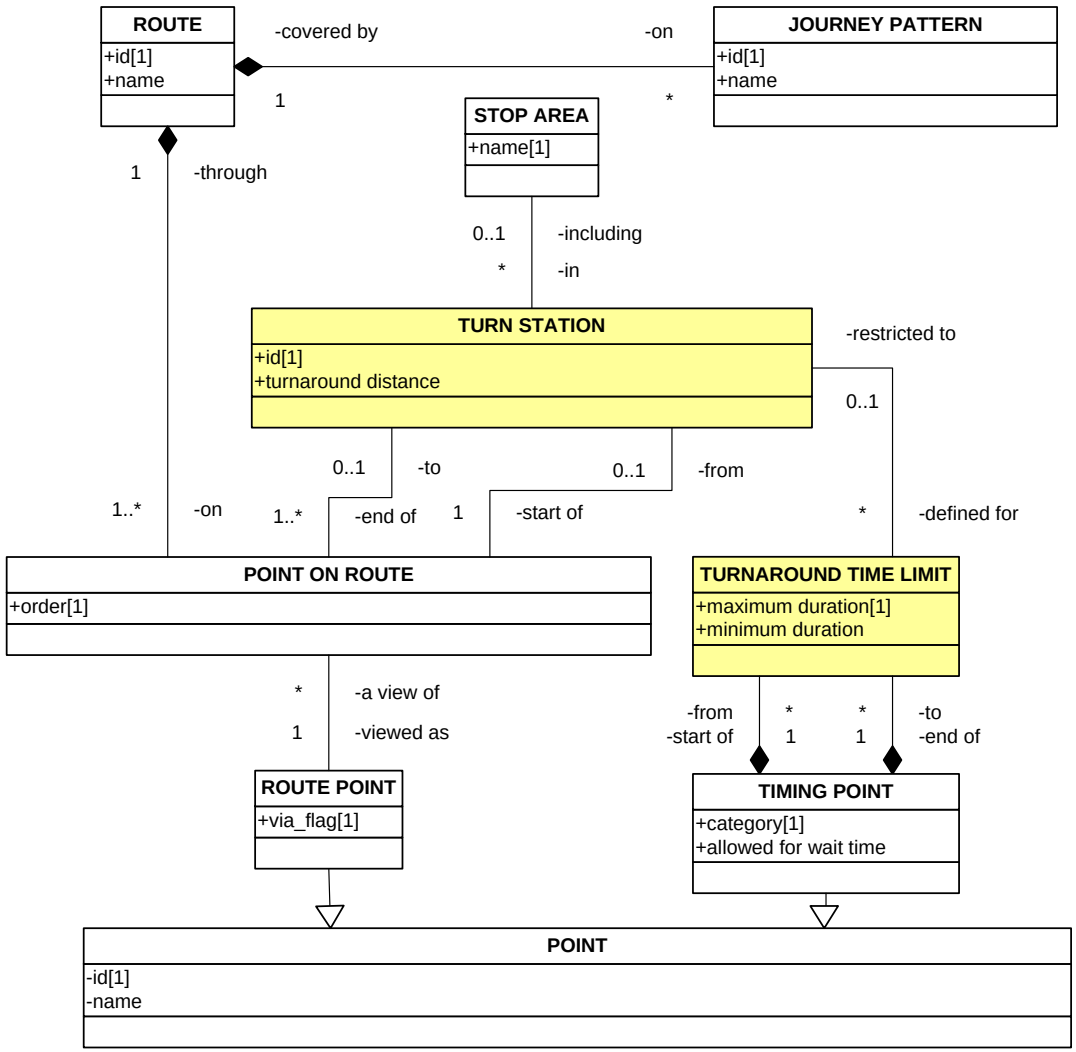
JOURNEY PATTERNs: temporal aspects



- TIMING POINT IN JOURNEY PATTERN: A POINT in a JOURNEY PATTERN which is a TIMING POINT.

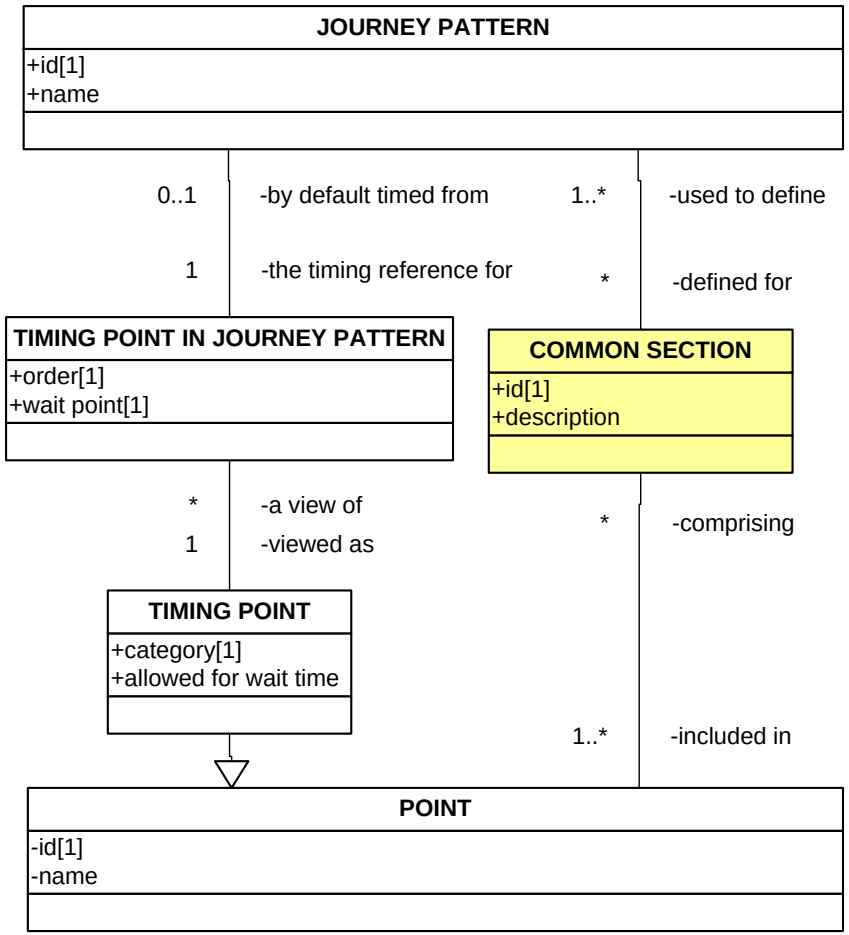
- TIMING LINK IN JOURNEY PATTERN: The position of a TIMING LINK in a JOURNEY PATTERN. This entity is needed if a TIMING LINK is repeated in the same JOURNEY PATTERN, and separate information is to be stored about each iteration of the TIMING LINK.

TURN STATIONs



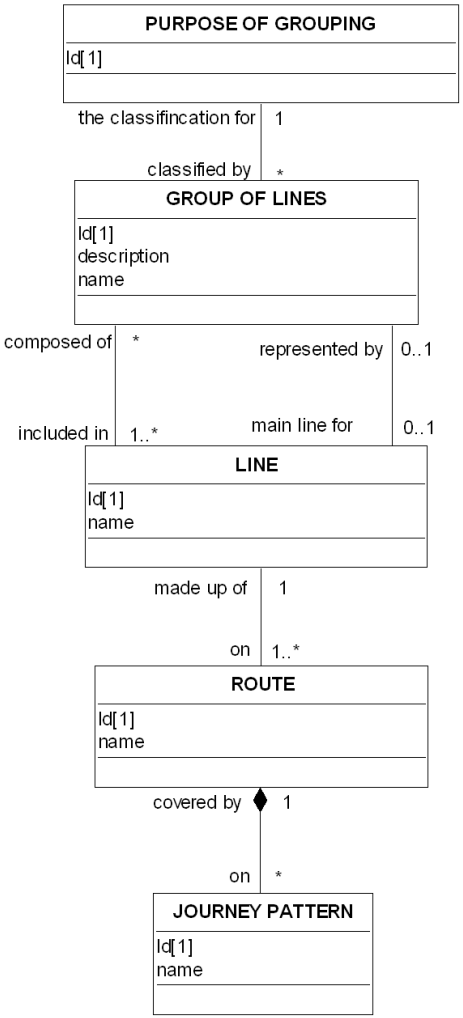
- TURN STATION
  - A place (often a terminus)where a vehicle can reverse its direction (from a ROUTE to another of opposite DIRECTION).
- TURNAROUND TIME LIMIT
  - the maximum time for which a vehicle may be scheduled to wait at a particular TIMING POINT (often included in a TURN STATION) without being returned to a PARKING POINT.
  - A minimum time for a vehicle to turn its direction may also be recorded. This may be superseded by a DEAD RUN.

COMMON SECTIONs



- COMMON SECTION: A part of a public transport network where the ROUTEs of several JOURNEY PATTERNs are going in parallel and where the synchronisation of SERVICE JOURNEYs may be planned and controlled with respect to commonly used LINKs and STOP POINTs.
- COMMON SECTIONs are defined arbitrarily and need not cover the total lengths of topologically bundled sections.

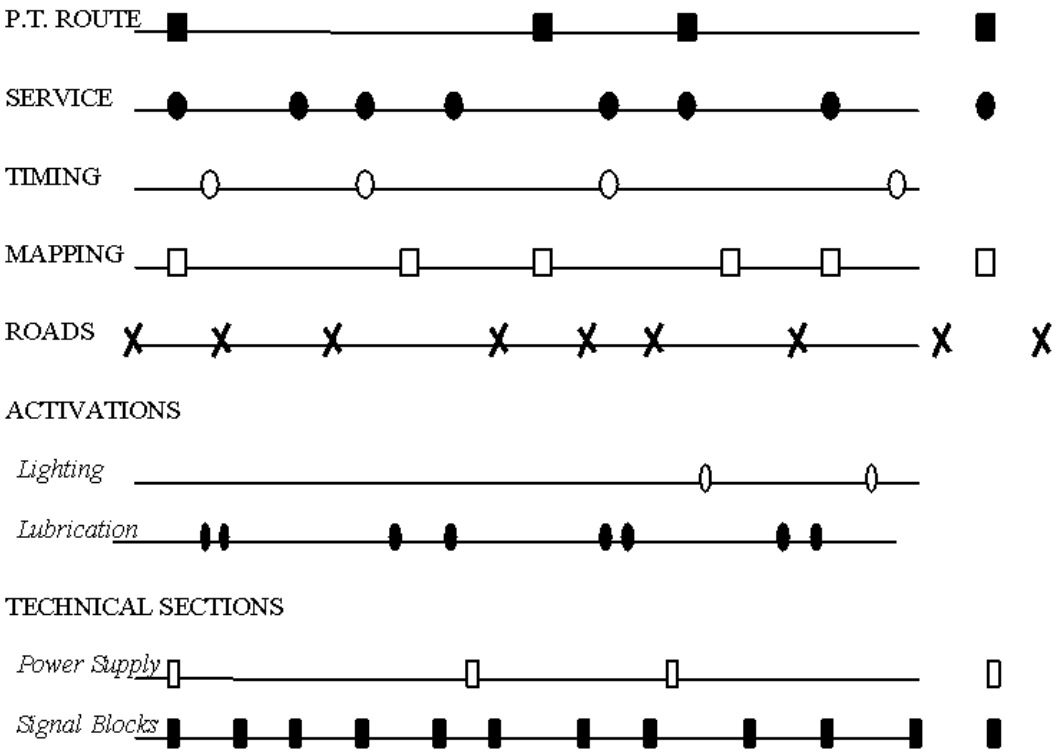
LINEs: Figure D.17



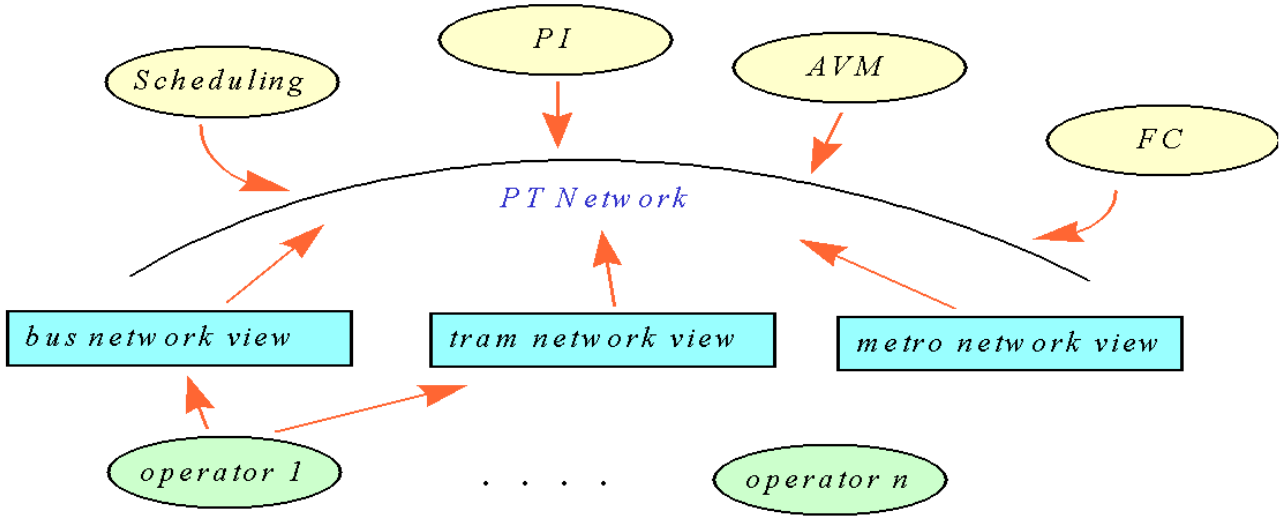
- LINE: A group of ROUTEs which is generally known to the public by a similar name or number.
- Example: two ROUTEs defining the same path but with opposite directions will often belong to the same LINE.
- The JOURNEY PATTERNs that follow these ROUTEs are alos associated to this LINE.
- LINEs may be grouped together according to a functional purpose, as for example to aggregate timetables or fares.

PROJECTIONs: Structures and layers

- The different views of a specific domain are called structures.
- A structure is a user-defined collection of objects characterising a data domain, dedicated to a specific functional purpose.



- The description of a public transport network, together with its interfaces with other systems (e.g. geographical data base) requires:
  - to manage in a coherent way versions of objects in each structure;
  - to locate in space the objects of a given structure, i.e. to represent them according to a location referencing system;
  - to manage and to represent independently objects of different structures.
- The layer concept addresses such requirements.
- A layer is a set of objects belonging to a particular structure, using a specific location referencing system and subject to different versions.



PROJECTIONs

- **A projection** is a spatial correspondence between objects belonging to different layers
- An object, considered as a source and belonging to a particular layer, is projected to another object, considered as target and belonging to another layer.

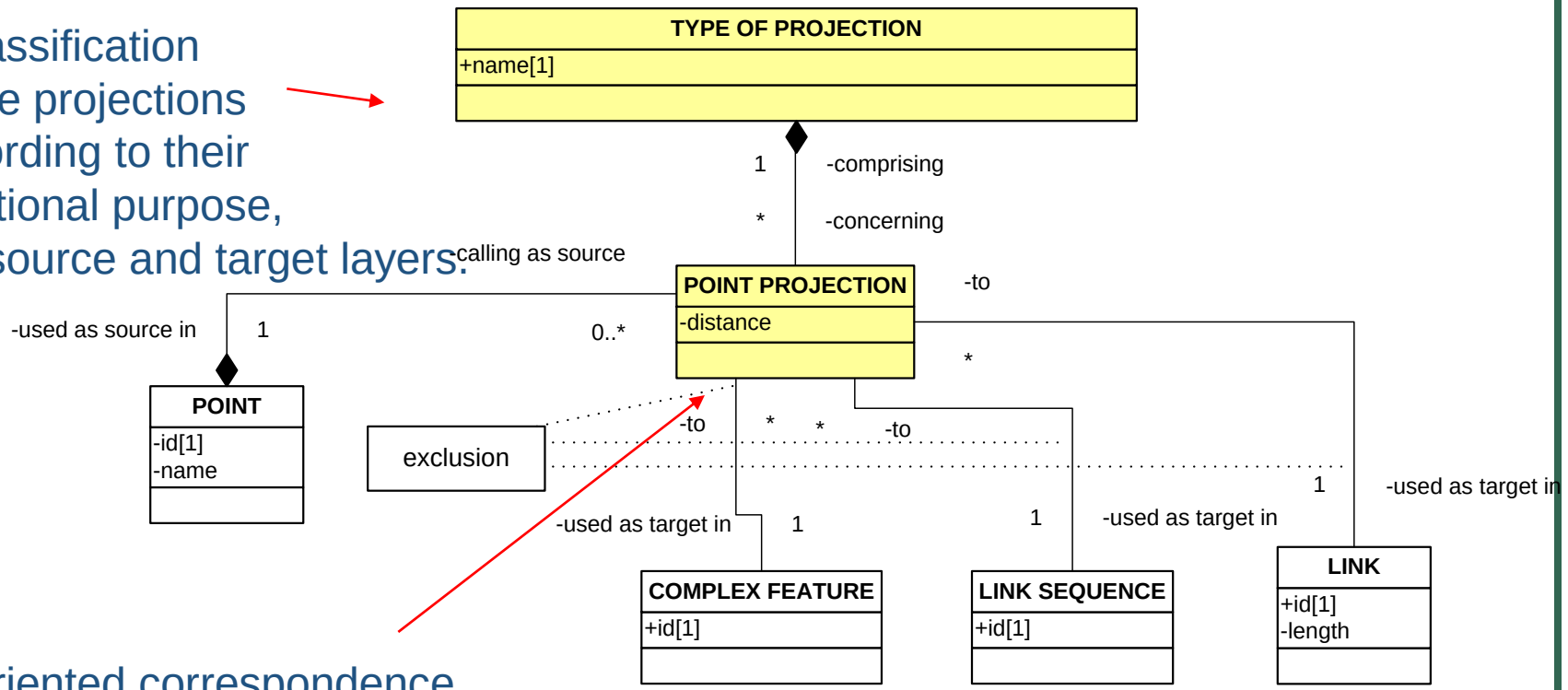
- Examples:
- a bus control system displays on a screen a layer describing the frame of road infrastructure, another layer describing the PT patterns and a third layer showing the bus located.
- the connection of a PT database with a geographical information system (GIS).

  It is not an objective of the reference model to specify a GIS layer, but to allow the users to relate the objects of their own system to various forms of standard GIS description (such as nodes, edges, raster map, complex linear features, etc.).

- THUS: the layers have to be defined **independently from each other, in particular because the location referencing system will often be different in the various layers.**

PROJECTIONs: Example of the POINT PROJECTION

A classification
of the projections
according to their
functional purpose,
the source and target layers:



An oriented correspondence
- from one POINT of a source layer,
- onto a entity in a target layer:
e.g. POINT, LINK, LINK SEQUENCE, COMPLEX FEATURE,
- within a defined TYPE OF PROJECTION.

PROJECTIONs

- In the reference model, only a limited number of TYPEs OF PROJECTION are described, according to the table below.
- Other types may be implemented if necessary

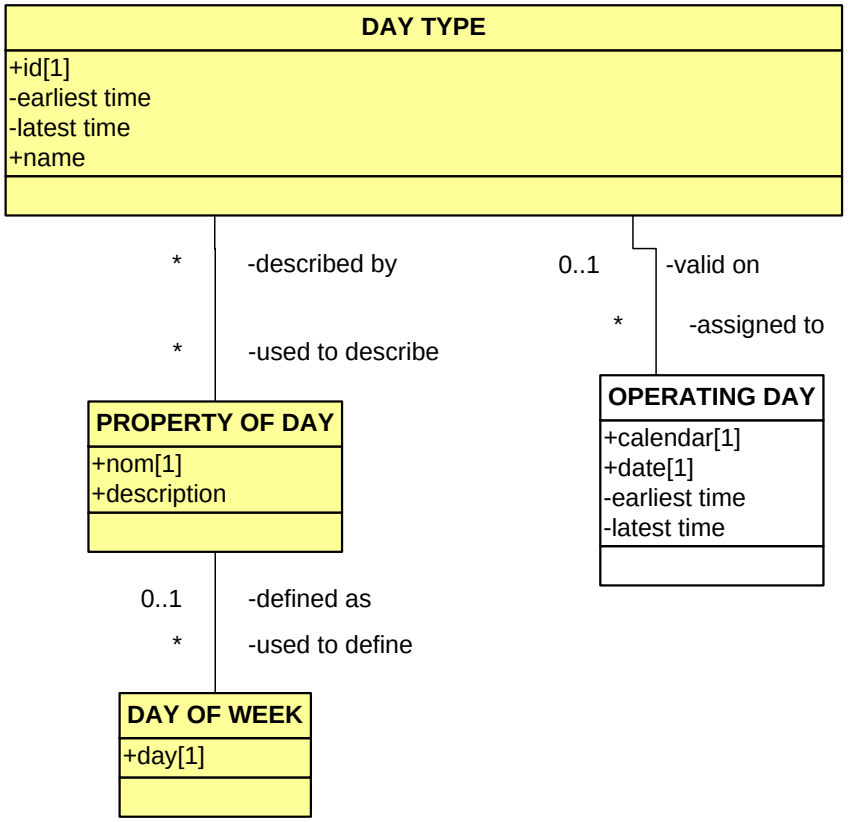
\ target source \	POINT	LINK	LINK SEQUENCE	COMPLEX FEATURE
POINT	yes	yes	yes	yes
LINK	not shown	not shown	yes	yes
ZONE	yes	not shown	not shown	yes
COMPLEX F.	yes	not shown	not shown	yes

The model does not show LINK SEQUENCE as source: a LINK SEQUENCE may be considered as a whole LINK and could be projected as any LINK.
The model does not show ZONE as target, as it would be equivalent to COMPLEX FEATURE as target.

Transmodel data domains

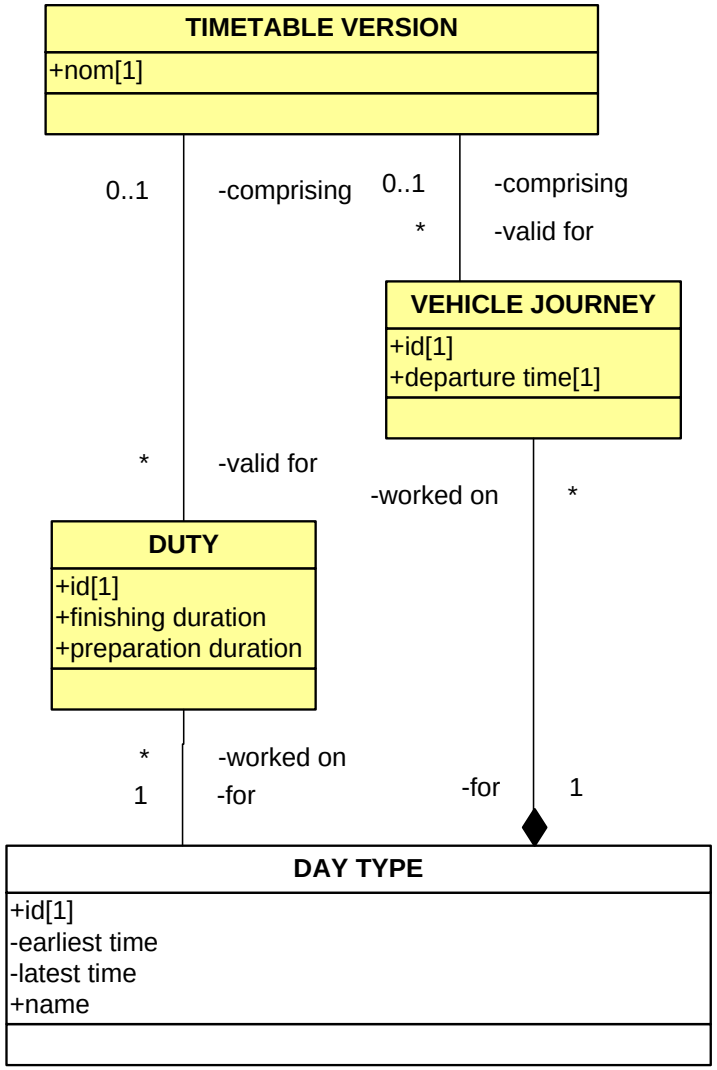
- Network description
- Versions management
- **Tactical planning**
- Personnel (driver) disposition
- Operations monitoring and control
- Passenger information
- Fare collection
- Management information and statistics
- Multi-modal PT operation
- Multiple operators environment

Tactical Planning Components: DAY TYPEs



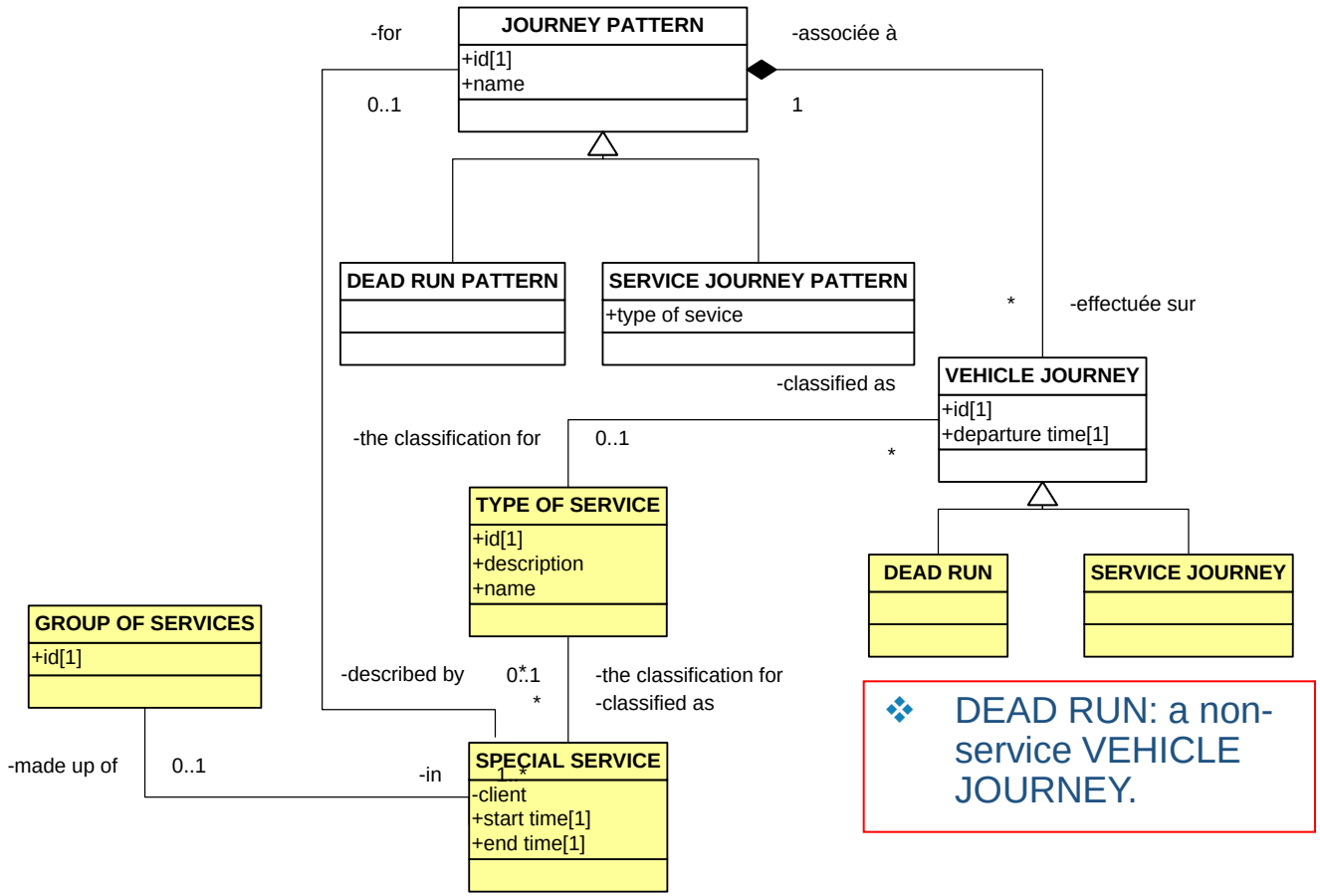
- DAY TYPE: A type of day characterised by one or more properties which affect public transport operation. For example: weekday in school holidays.
- PROPERTY OF DAY: a property which a day may posess, such as school holiday, weekday, summer, winter etc.
- OPERATING DAY: a day of public transport operation in a specific calendar. An OPERATING DAY may last more than 24 hours.

Tactical Planning Components: DUTY and VEHICLE JOURNEY



- TIMETABLE VERSION: A set of timetable data (VEHICLE JOURNEYs and BLOCKs) to which the same VALIDITY CONDITIONs have been assigned.
- DUTY:The work to be performed by a driver on a particular DAY TYPE.
- VEHICLE JOURNEY: the planned movement of a public transport vehicle on a DAY TYPE from the start point to the end point of a JOURNEY PATTERN on a specified ROUTE.
- *BLOCK: the work of a vehicle from the time it leaves a PARKING POINT after parking until its next return to park at a PARKING POINT. Any subsequent departure from a PARKING POINT after parking marks the start of a new BLOCK. The period of a BLOCK has to be covered by DUTies.*

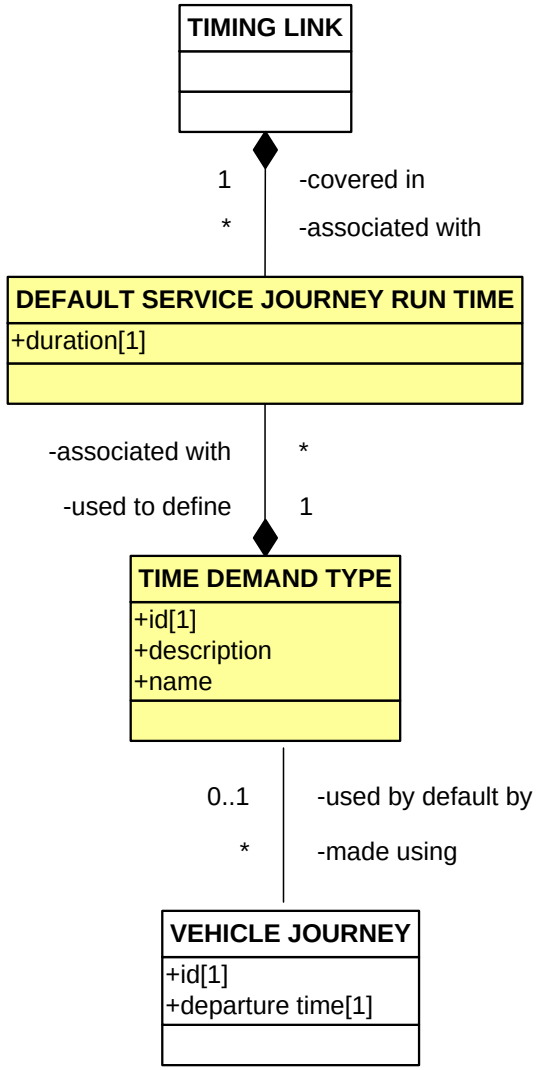
Tactical Planning Components: TYPE OF SERVICE



- DEAD RUN: a non-service VEHICLE JOURNEY.

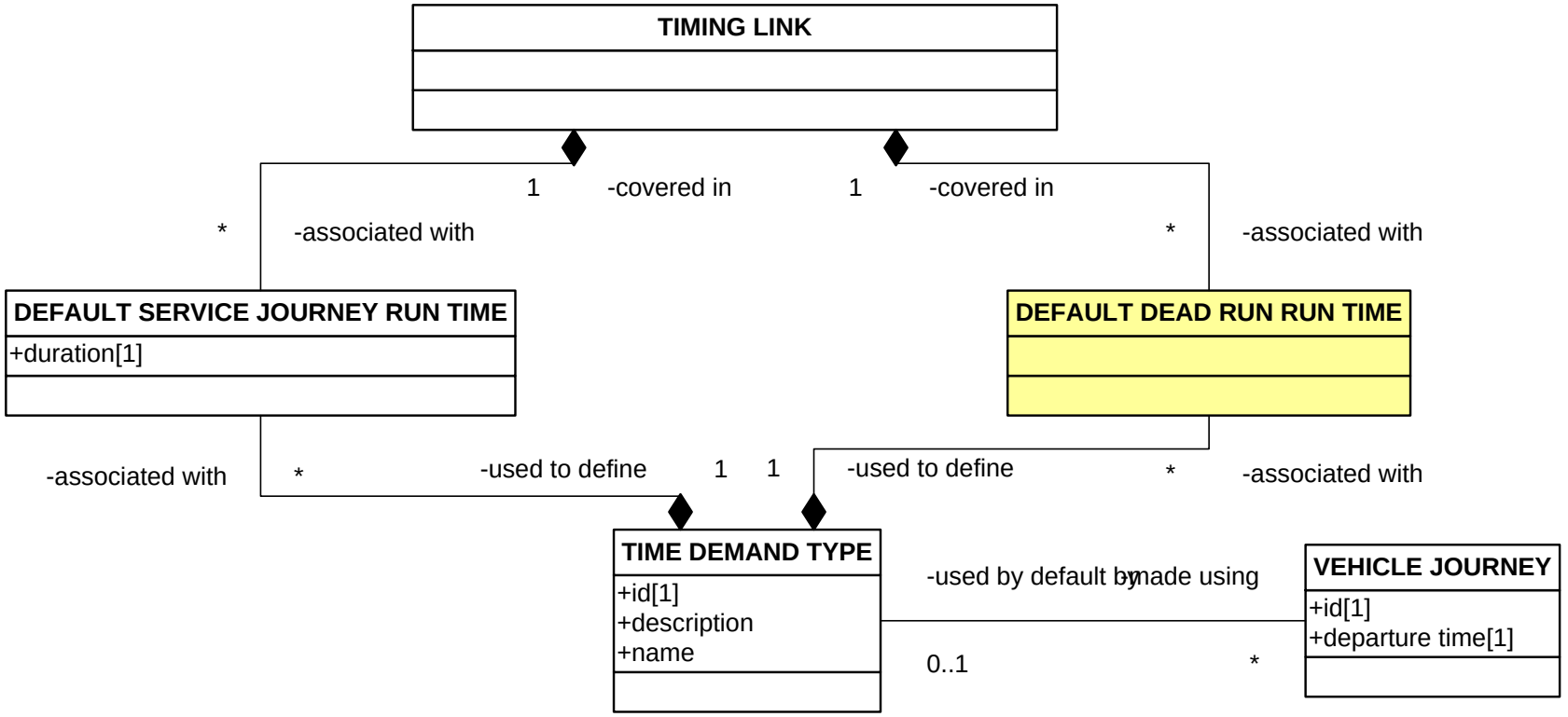
- SPECIAL SERVICE: a work of a vehicle that is not planned in a classical way, i.e. that is generally not based on VEHICLE JOURNEYs using JOURNEY PATTERNs. It involves specific characteristics (such as specific access rights)and/or may be operated under specific circumstances.

Tactical Planning Components: Standard Journey Times



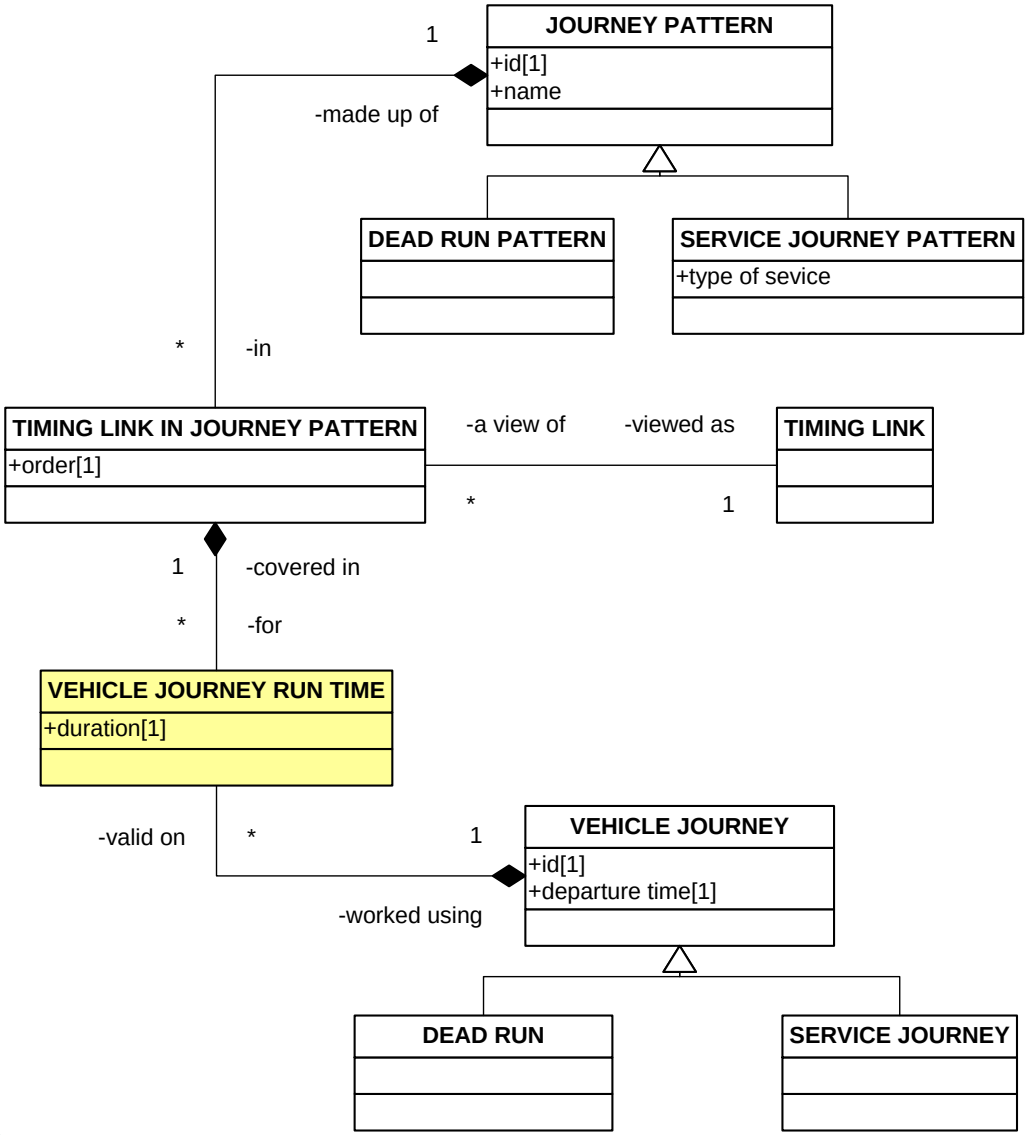
- The default time taken by a vehicle to traverse a TIMING LINK during a SERVICE JOURNEY, for a specified TIME DEMAND TYPE. This time may be superseded by the JOURNEY PATTERN RUN TIME or VEHICLE JOURNEY RUN TIME if these exist.
- An indicator of traffic conditions or other factors which may affect vehicle run or wait times.
- It may be entered directly by the scheduler or defined by the use of TIME BANDs.

Tactical Planning Components: Standard Journey Times



- The time taken to traverse a TIMING LINK during a DEAD RUN, for a specified TIME DEMAND TYPE.
- This time may be superseded by the JOURNEY PATTERN RUN TIME or VEHICLE JOURNEY RUN TIME if these exist.

Tactical Planning Components: Specific Journey Times

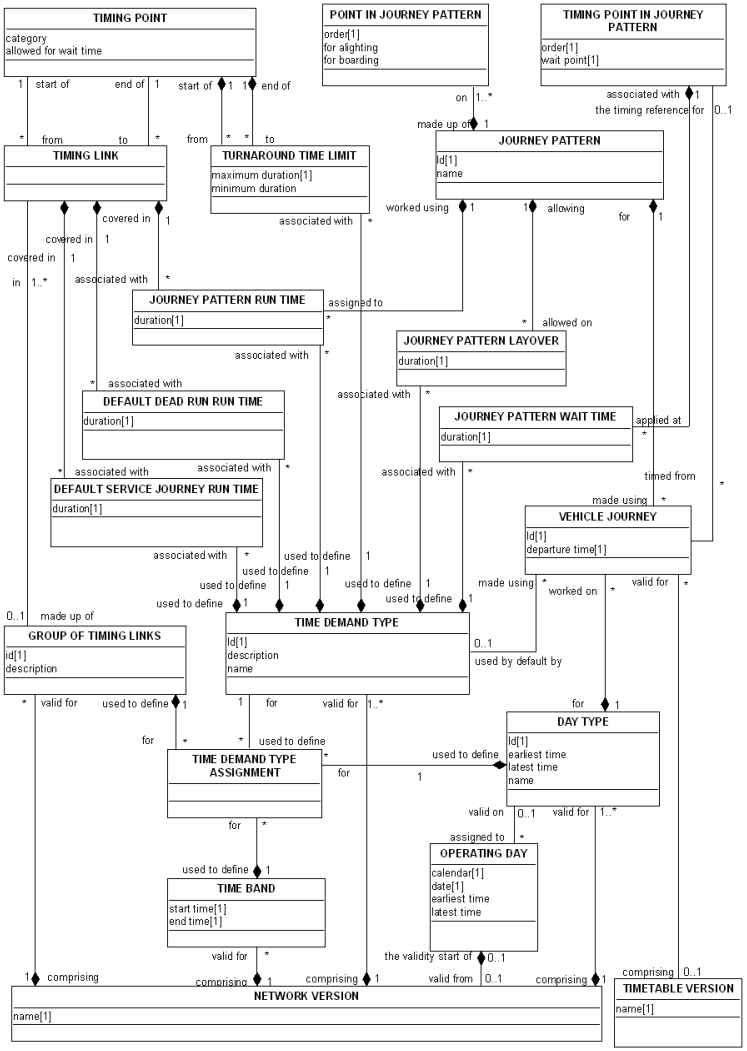


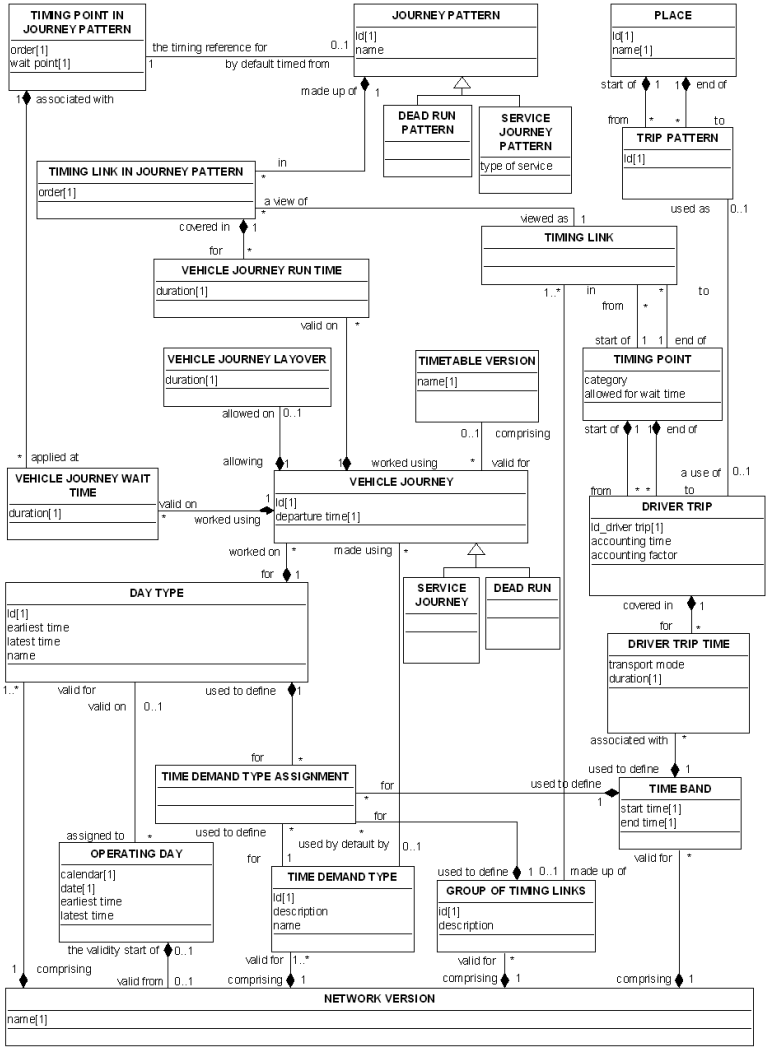
- In certain cases a more exact definition / control of times is required, namely for a single journey :
- VEHICLE JOURNEY RUN TIMEs

- Many other times are modelled:

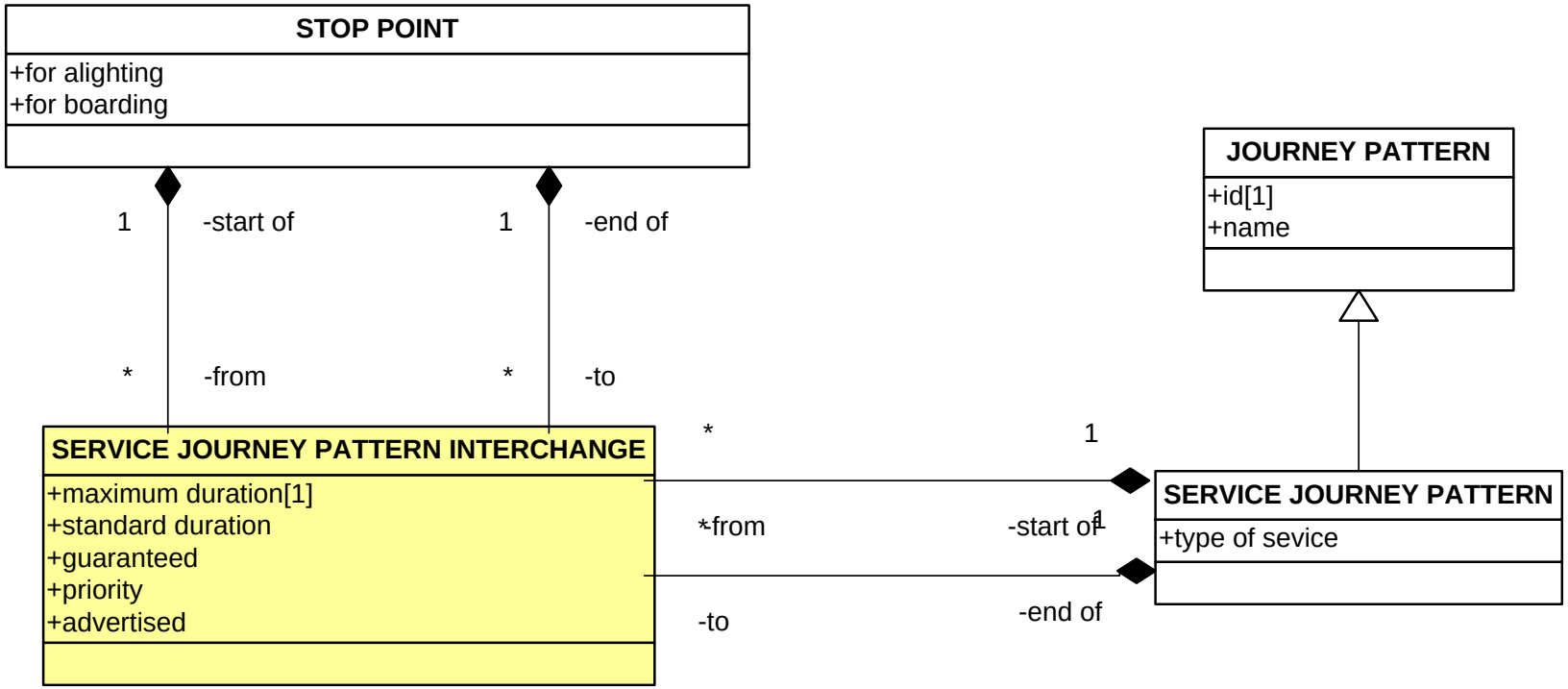
JOURNEY PATERN RUN TIME
JOURNEY PATTERN WAIT TIME
JOURNEY PATTERN LAYOVER
VEHICLE JOURNEY LAYOVER
VEHICLE JOURNEY WAIT TIME
DRIVER TRIP TIME
Etc Cf. Figures D.27-28

Tactical Planning Components: Times Figures D.27-28



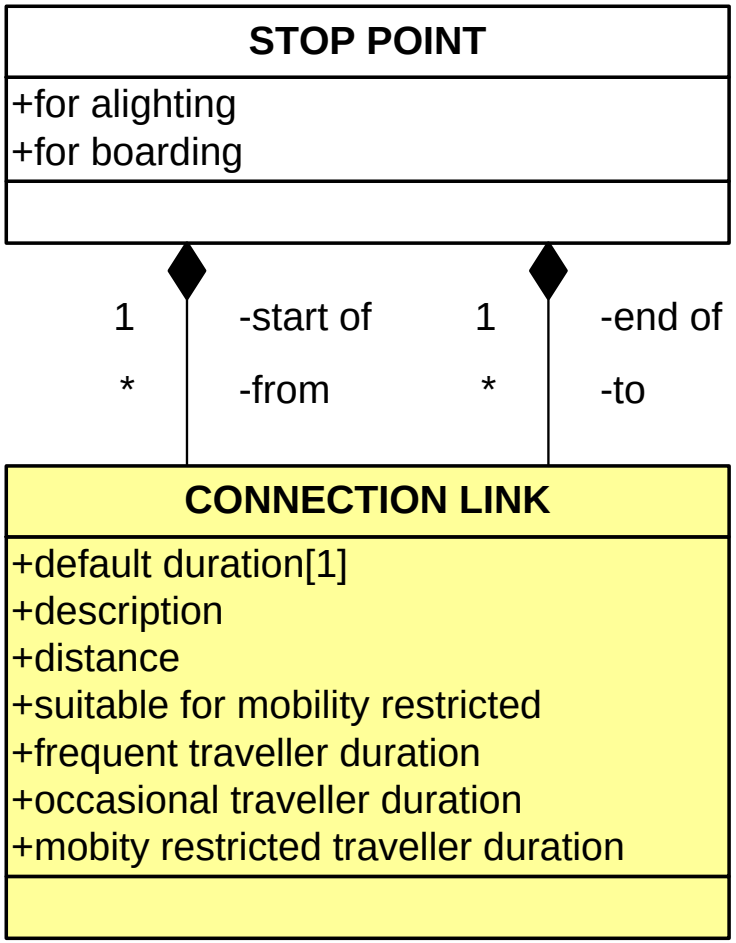


Tactical Planning Components: Interchanges



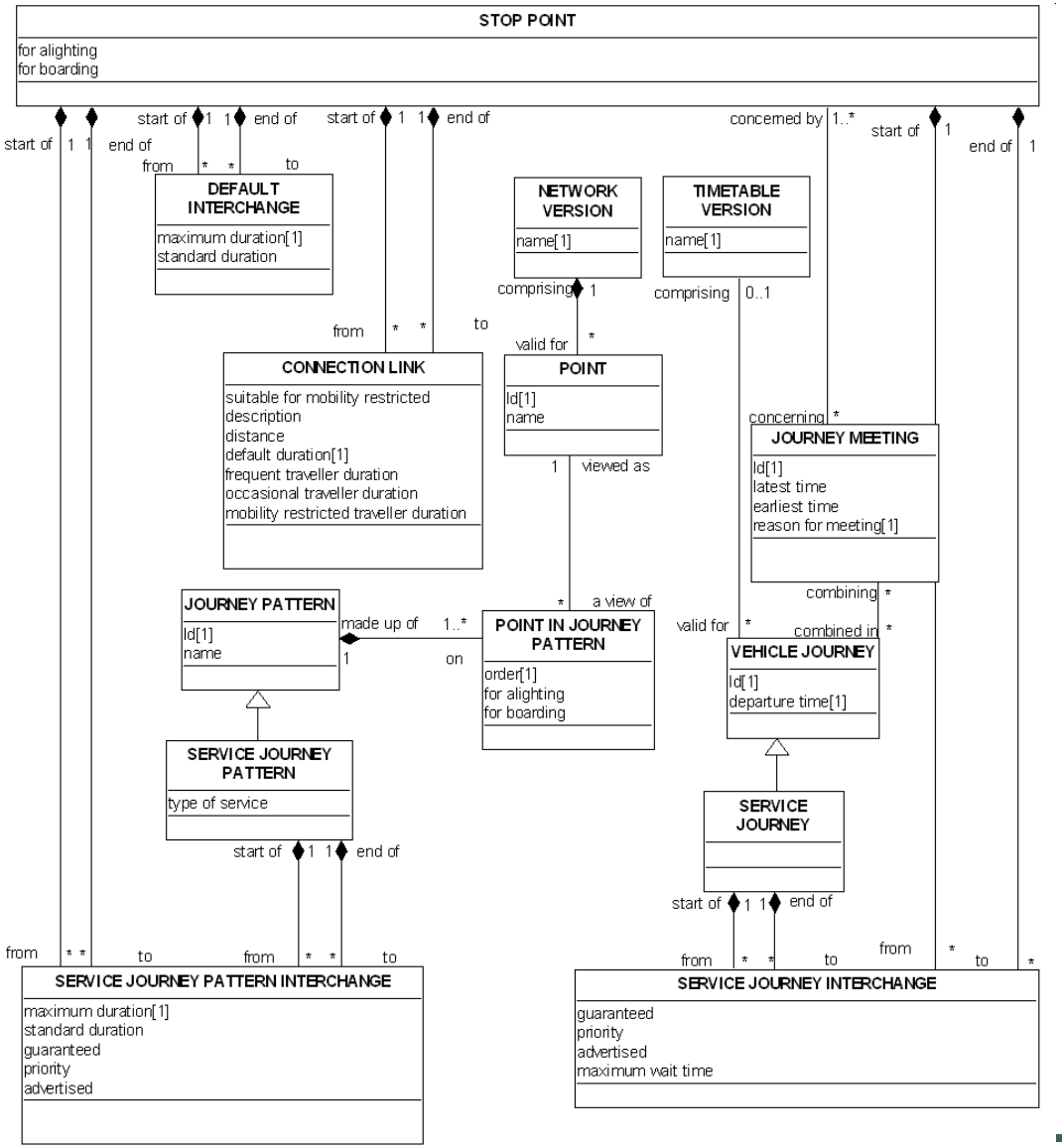
- A recognised/organised possibility for passengers to change public transport vehicles using two STOP POINTs (which may be identical) on two particular SERVICE JOURNEY PATTERNs, including the maximum wait duration allowed and the standard to be aimed at.
- Schedulers may use this entity for synchronisation of journeys.

Tactical Planning Components: Interchanges



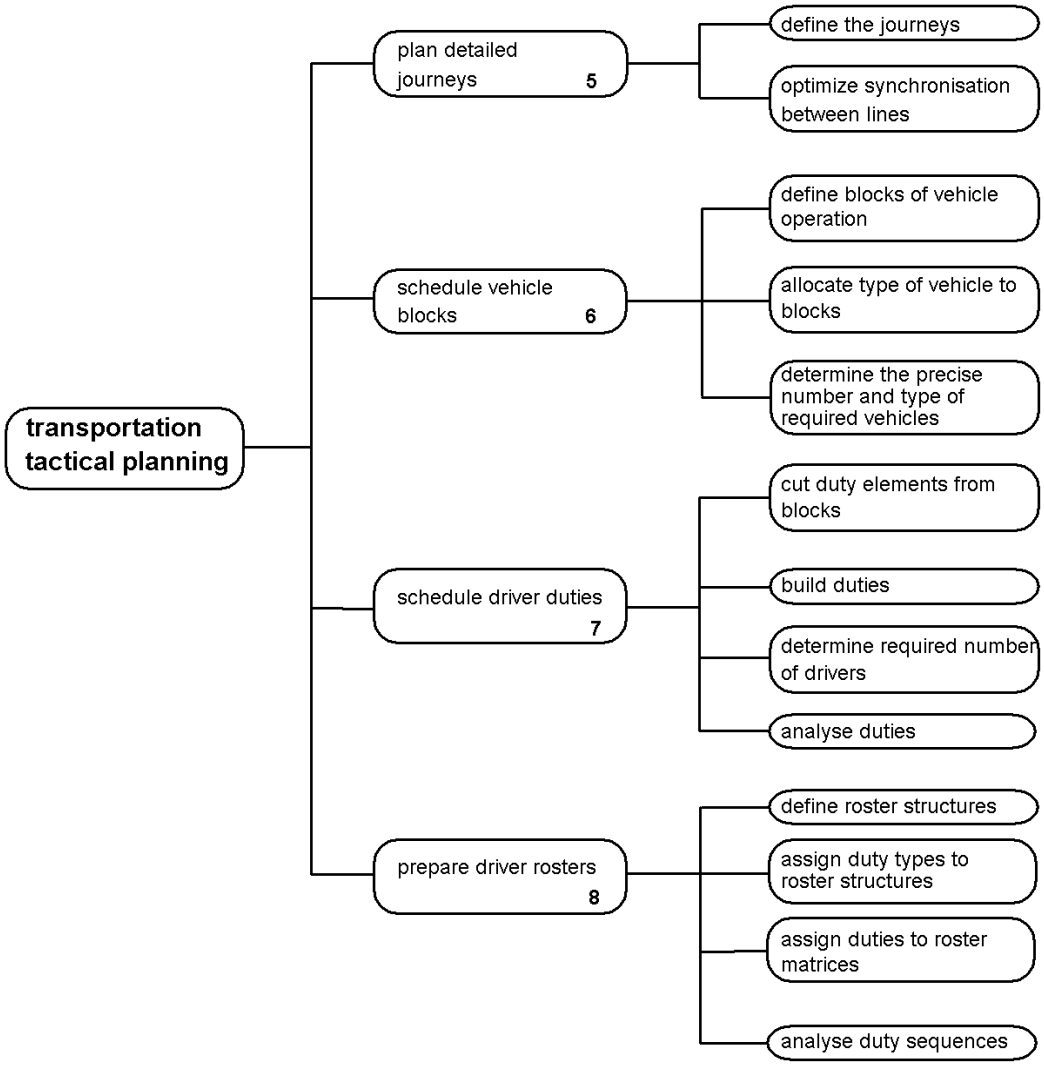
- Each time an interchange is estimated as being possible, i.e. when the walking link is suitable for an interchange, a CONNECTION LINK may be defined.
- It is the physical (spatial) possibility for a passenger to change from one public transport vehicle to another to continue the trip.
- Different times may be necessary to cover this link, depending on the kind of passenger
- Concept used for passenger information
- In spite of the name, CONNECTION LINK does not represent a “passenger path” but a « spacial possibility »: its mandatory attribute is « duration ».
- The corresponding physical paths are defined in IFOPT…

Tactical Planning Components: Interchanges Figure D.29



- JOURNEY MEETING: a time constraint for one or several SERVICE JOURNEYs fixing interchanges between them and/or an external event (e.g. arrival or departure of a feeder line, opening time of the theatre, etc.).

Tactical Planning



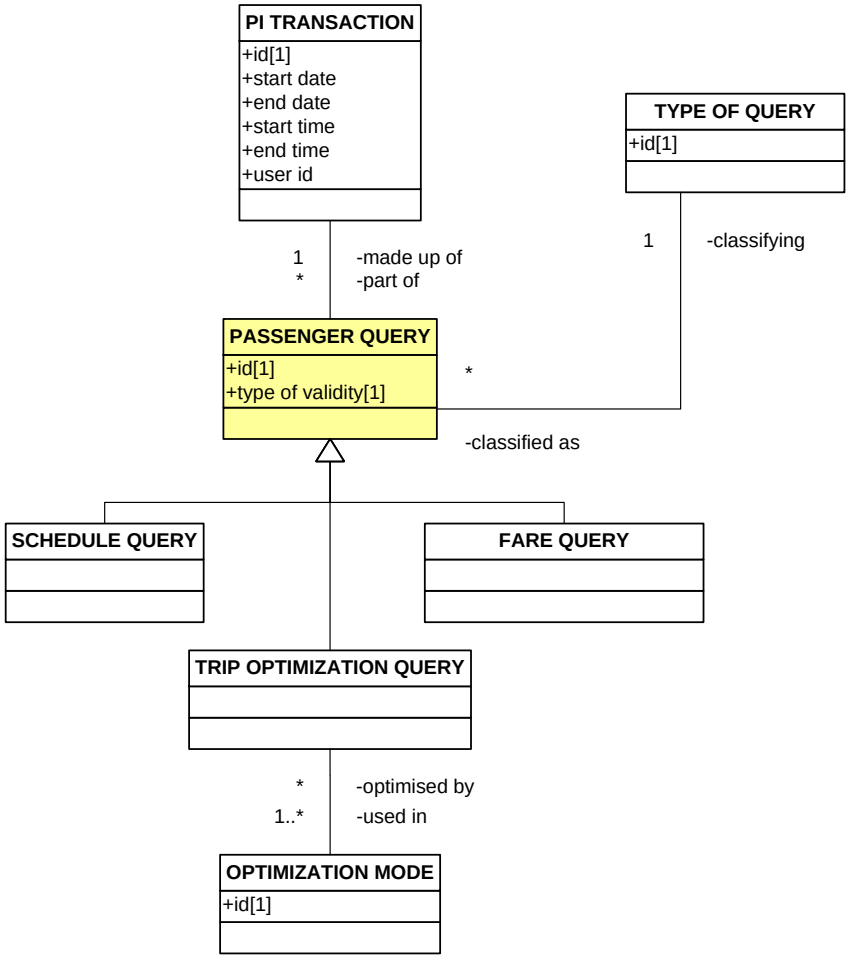
- Vehicle Scheduling
  - work of the vehicles: blocks
  - different points linked to it: relief, parking, etc
  - link of the work of the vehicles with vehicle requirements
- Driver Scheduling
  - work of the drivers: duties and its components (duty parts, stretches, spells), breaks, pauses, …
  - Link between the blocks and duties: resource plan
- Schedules : driver and vehicle schedules

- Rostering (normative only for specific rostering methods)

Transmodel data domains

- Network description
- Versions management
- Tactical planning
- Personnel (driver) disposition
- Operations monitoring and control
- **Passenger information**
- Fare collection
- Management information and statistics
- Multi-modal PT operation
- Multiple operators environment

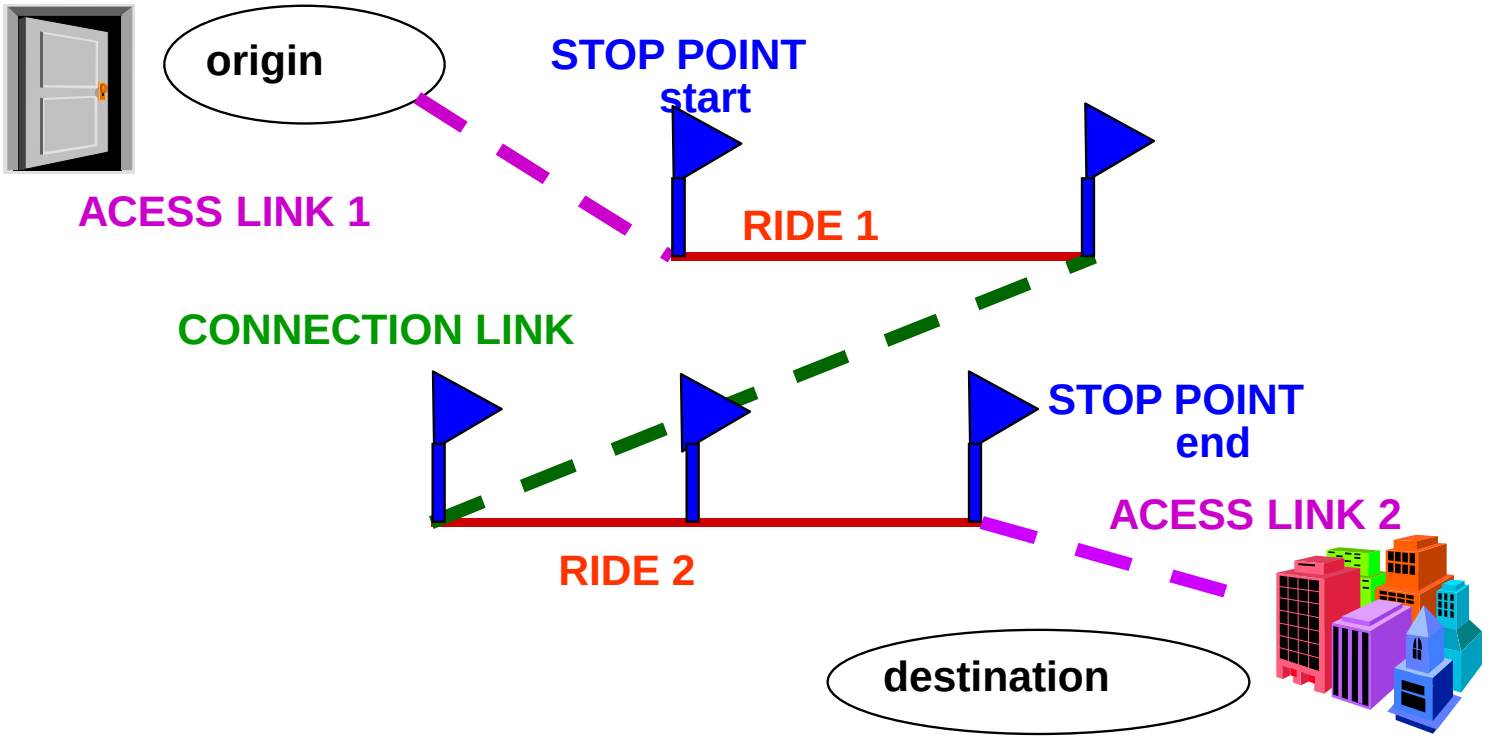
Passenger Information: PASSENGER QUERies



- PI TRANSACTION: A connection of a passenger to the operator information system, directly or via an employee, including one or several queries.

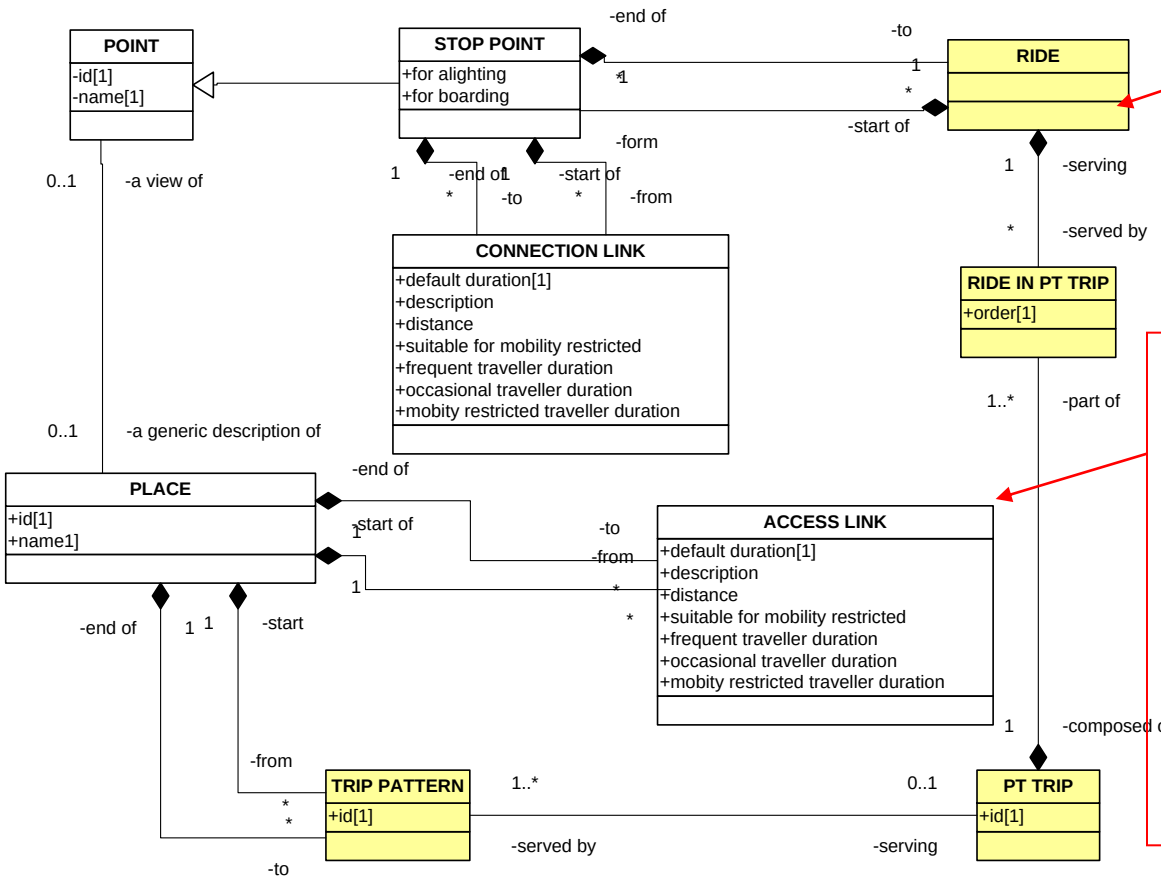
- PASSENGER QUERY: A request for a specific information on public transport, expressed during a PI TRANSACTION.

Passenger Information: TRIP PATTERN a description of a passenger trip



- TRIP PATTERN: the spatial pattern of a complete movement of a passenger (or another person, e.g. driver) from one PLACE of any sort to another. A trip may consist of one PT TRIP and the corresponding movements (usually walks) to cover the necessary ACCESS LINKs and CONNECTION LINKs, or of one walk only.

Passenger Information: Information necessary to describe Passenger Trips

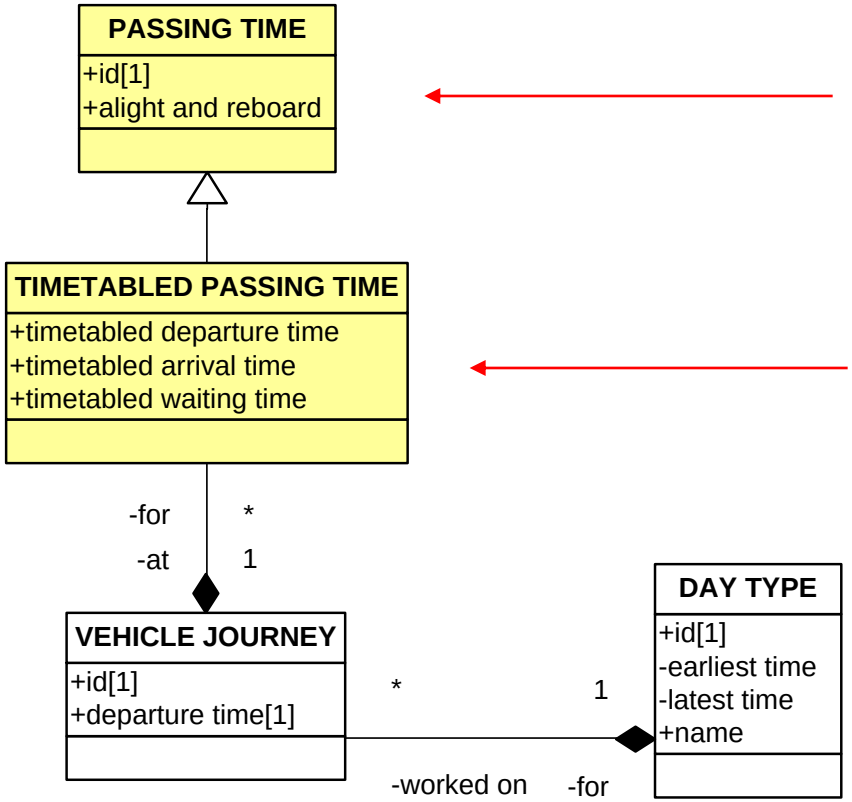


A part of a trip corresponding to the theoretical movement of a user (passenger, driver) on one and only one PT vehicle, from one STOP POINT to another, on one JOURNEY PATTERN.

The physical (spatial) possibility for a passenger to access or leave the public transport system. This link may be used during a trip for: the walking movement of a passenger from a PLACE (origin of the trip) to a STOP POINT(origin of the PT TRIP), or from a STOP POINT (destination of the PT TRIP) to a PLACE (destination of the trip).

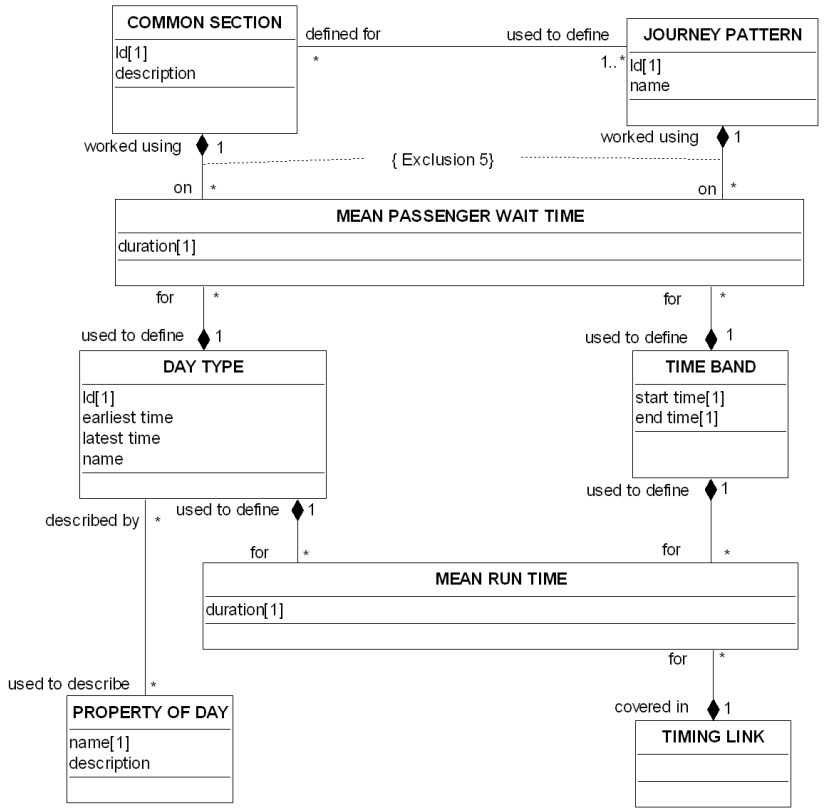
- PT TRIP: a part of a trip starting from the first boarding of a public transport vehicle to the last alighting from a public transport vehicle. A PT TRIP consists of one or more RIDEs and the movements (usually walks) necessary to cover the corresponding CONNECTION LINKs.

Passenger Information: Planned Passing Times



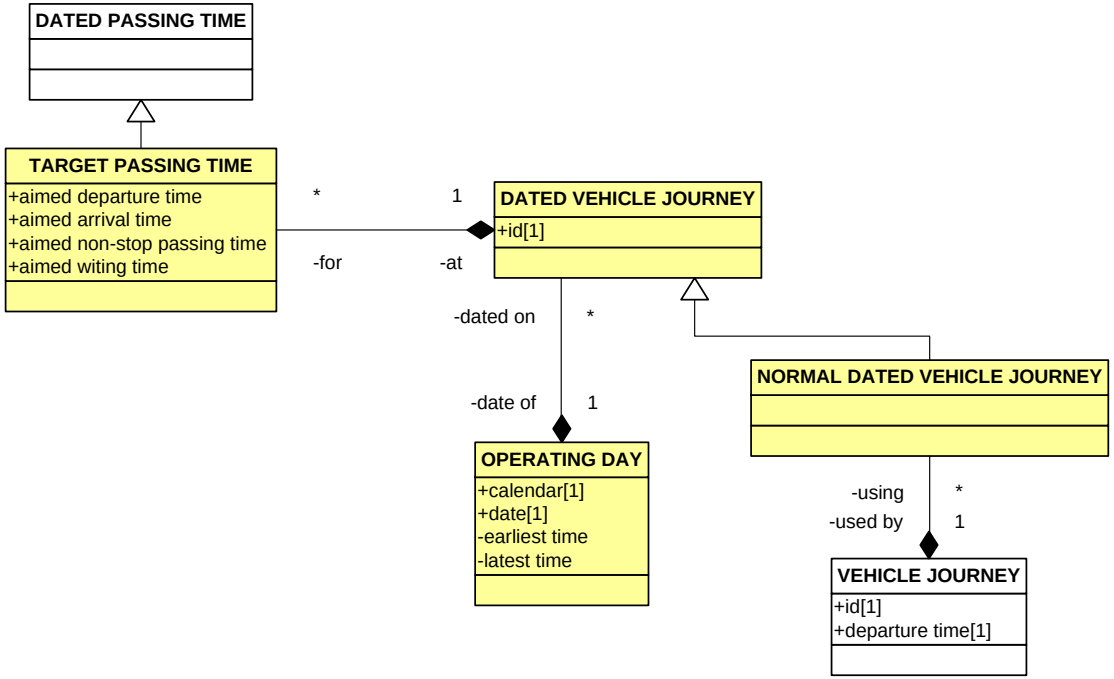
- Time data concerning public transport vehicles passing a particular POINT; e.g. arrival time, departure time, waiting time.
- Long-term planned time data concerning public transport vehicles passing a particular POINT IN JOURNEY PATTERN on a specified VEHICLE JOURNEY for a certain DAY TYPE.

Passenger Information: Passenger Trip Duration



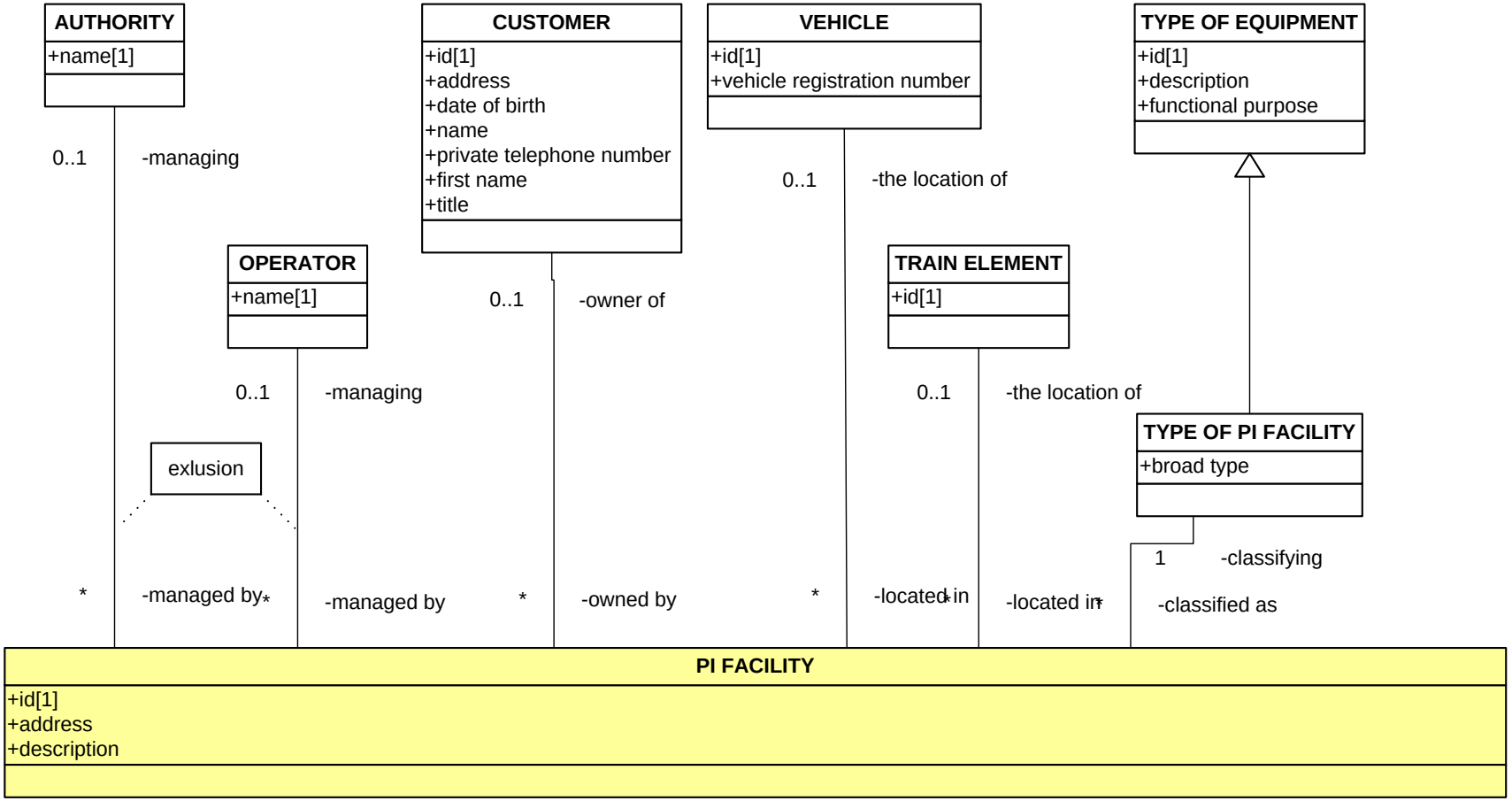
- MEAN PASSENGER WAIT TIME:an estimated mean waiting time for a passenger at a STOP POINT, used to calculate the approximate duration of a trip.
- This value is estimated from the mean interval between vehicles on a JOURNEY PATTERN or a COMMON SECTION.
- MEAN RUN TIME:an estimated value of the mean run time on a TIMING LINK, used to inform passengers on the mean duration of trips

Passenger Information: Actual Passing Times



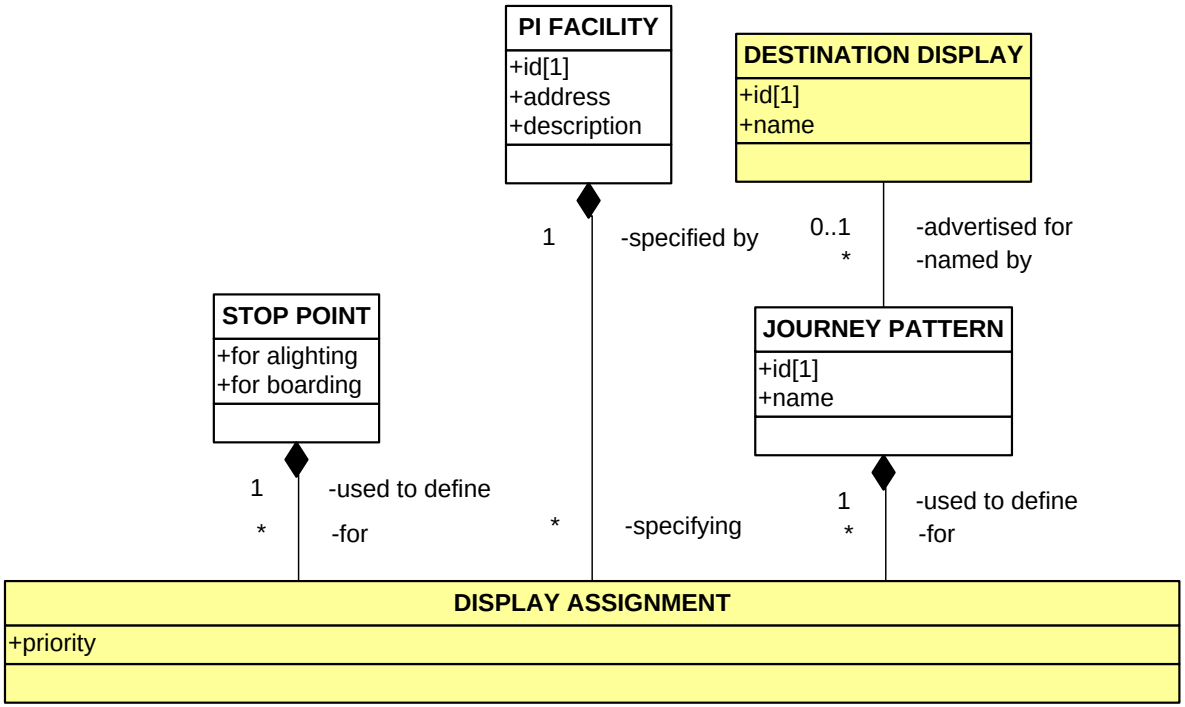
- Time data about when a public transport vehicle should pass a particular POINT IN JOURNEY PATTERN on a particular DATED VEHICLE JOURNEY, in order to match the latest valid plan.
- NORMAL DATED VEHICLE JOURNEY: A DATED VEHICLE JOURNEY identical to a long-term planned VEHICLE JOURNEY, possibly updated according to short-term modifications of the PRODUCTION PLAN decided by the control staff.
- Other sub - types of PASSING TIMEs and DATED PASSING TIMEs are defined ex. ESTIMATED PASSING TIMEs, etc. : to compile timetables for the users…

Passenger Information: Information Facilities



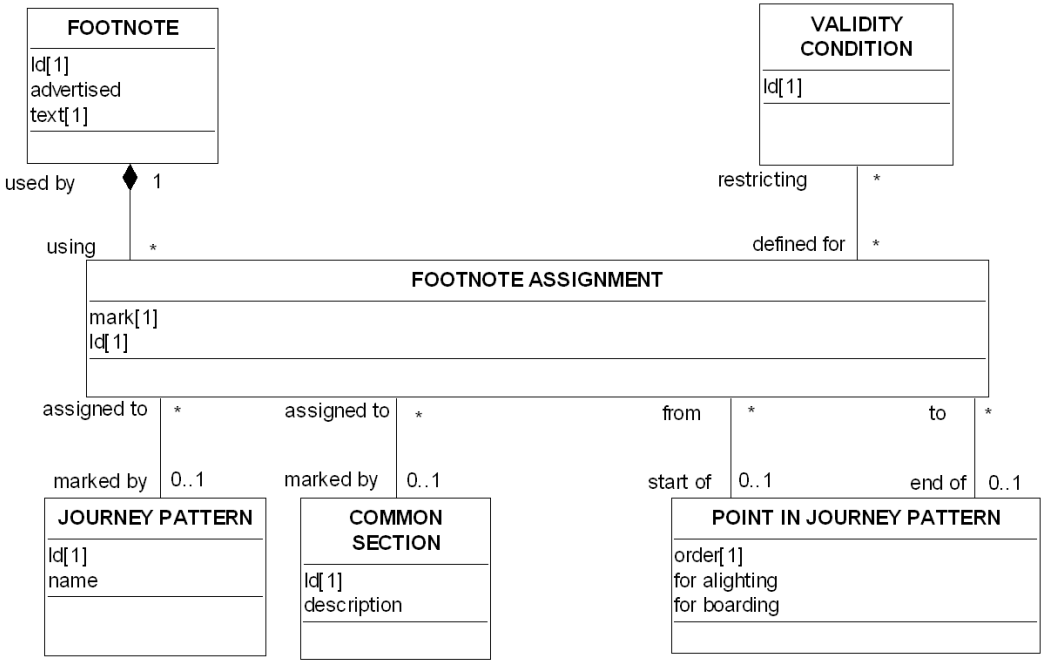
- A public transport information facility, as for instance terminals (on street, at information desks, telematic, ...) or printed material (leaflets displayed at stops, booklets, ...).

Passenger Information: Assignment of information to a facility



- PI FACILITY provides information on a limited part of the network
- DISPLAY ASSIGNMENT allows the distribution of this information automatically: for a specific PI FACILITY, each assignment specifies a STOP POINT about which information is provided and a JOURNEY PATTERN serving that STOP POINT
- Example: display of wait times for the corresponding services.
- It refers to a static assignment

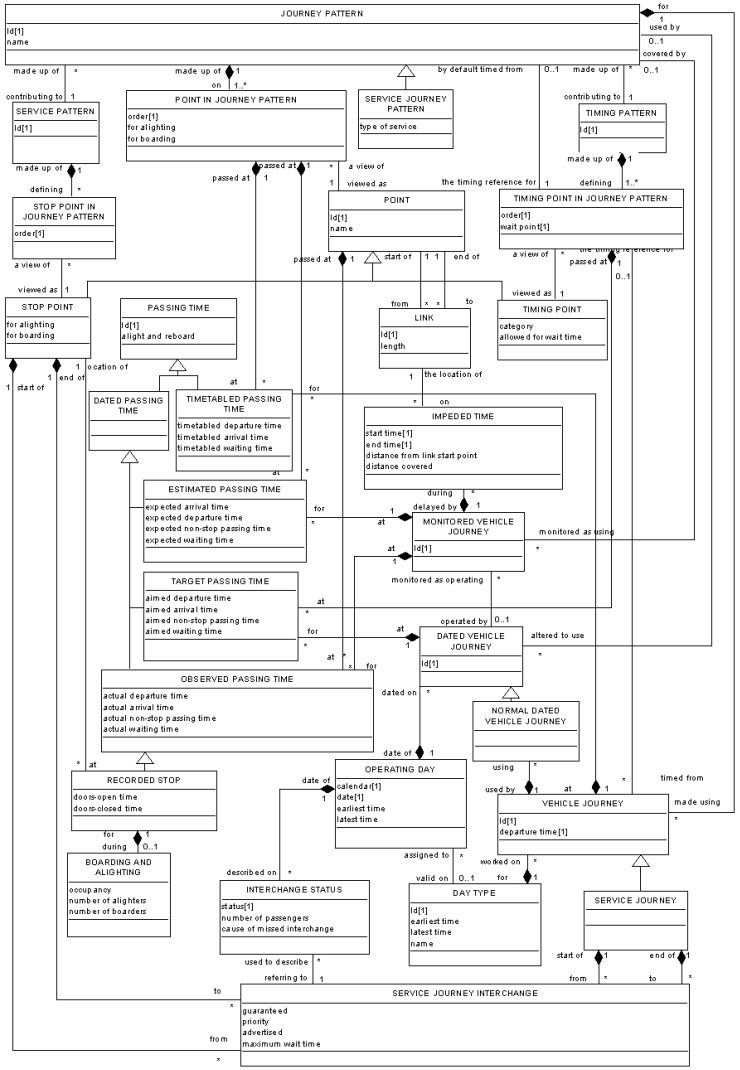
Passenger Information: FOOTNOTEs Figure D.46



- FOOTNOTE: A text for informational purposes on exceptions in a LINE, a JOURNEY PATTERN, etc. The information may be usable for passenger or driver information.

- The assignment of a FOOTNOTE showing an exception in a JOURNEY PATTERN, a COMMON SECTION, or a VEHICLE JOURNEY, possibly specifying at which POINT IN JOURNEY PATTERN the validity of the FOOTNOTE starts and ends respectively.

Passenger Information: Passing Times Figure D.47



Summary: What has been presented?

- Network Description
- Tactical Planning Components (partly)
- Passenger Information

- This presentation does not cover or the parts:
  - Versions, validity and layers
  - Vehicle Scheduling
  - Driver Scheduling
  - Schedules and versions
  - Rostering (normative for given rostering methods)
  - Personnel disposition (informative part)
  - Operations monitoring and control: in this part several concepts are relevant for RT Passenger Information
  - Fare Collection
  - Management Information
  - Multi-modal operation
  - Multiple operators' environment

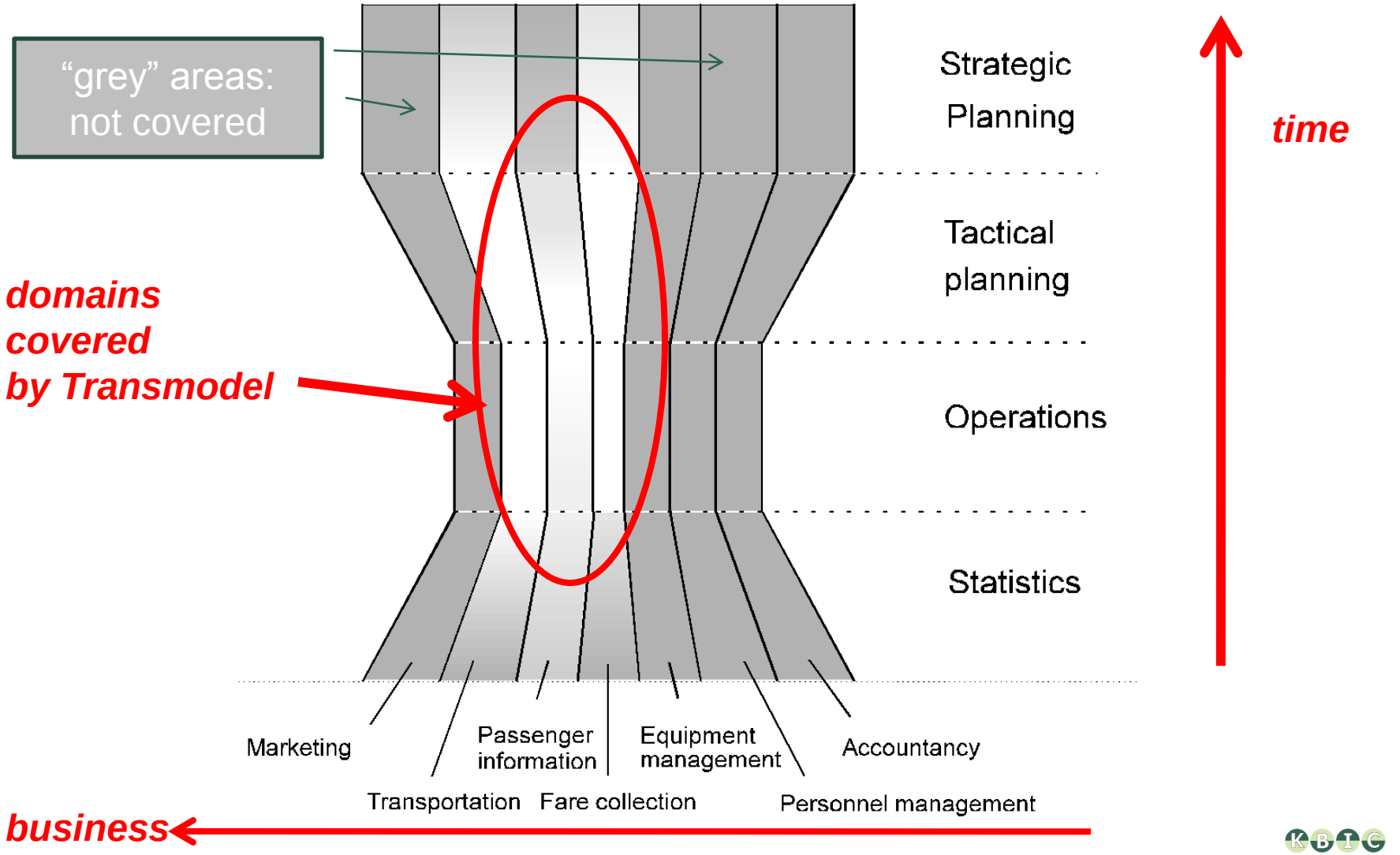
1. General overview: rationale, solution, approach & method, main domains

2. Detailed presentation: Network description, tactical planning components, passenger information

3. **Other domains:**
   - **operations monitoring & control**
   - **fare collection**
   - **management information/statistics**

1. Transmodel-based services: the example of NeTEx

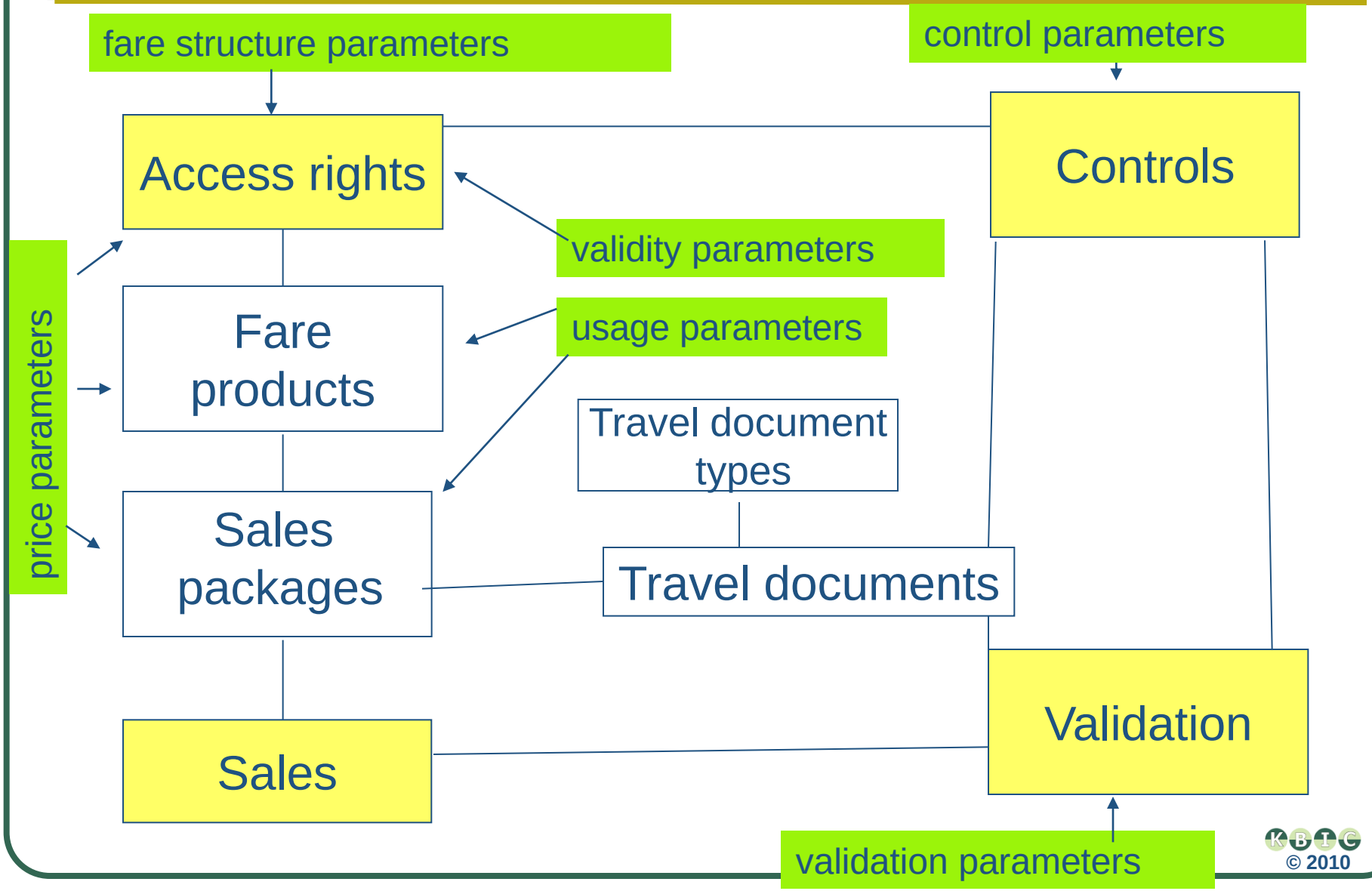
Transmodel Concerns and Limits



Transmodel data domains

- Network description
- Versions management
- Tactical planning
- Personnel (driver) disposition
- Operations monitoring and control
- Passenger information
- **Fare collection**
- Management information and statistics
- Multi-modal PT operation
- Multiple operators environment

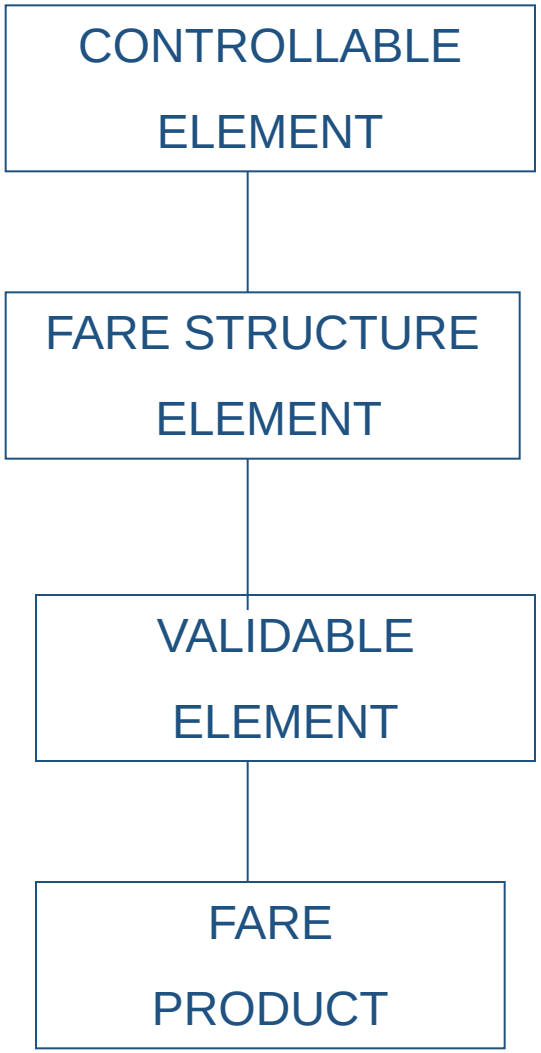
A « map » of the Fare Collection model



The Fare Collection Model in Brief

- Starting point: **access rights** defined through the **elements of a fare system**
- The fare system elements being defined through a range of **parameters** (quantitative parameters, validity parameters, usage parameters, …)
- Combined into **fare products**
  - Materialized as **travel documents**
  - Grouped into **sales packages** to be sold to the customers…
- The **controls** are applied to the access rights mentioned on the fare media in order to be able to
  - **validate** the use of the access rights
  - or to identify an offence to be reported on **blacklists**
- The **prices** to be paid by the customers may be calcuated taking into account elementary price elements linked to the access rights, fare products and sales packages.

Access rights



The smallest controllable element of public transport consumption, all along which any VALIDITY PARAMETER ASSIGNMENT remains valid.

A sequence or set of CONTROLLABLE ELEMENTs to which rules for limitation of access rights and calculation of prices (fare structure) are applied.

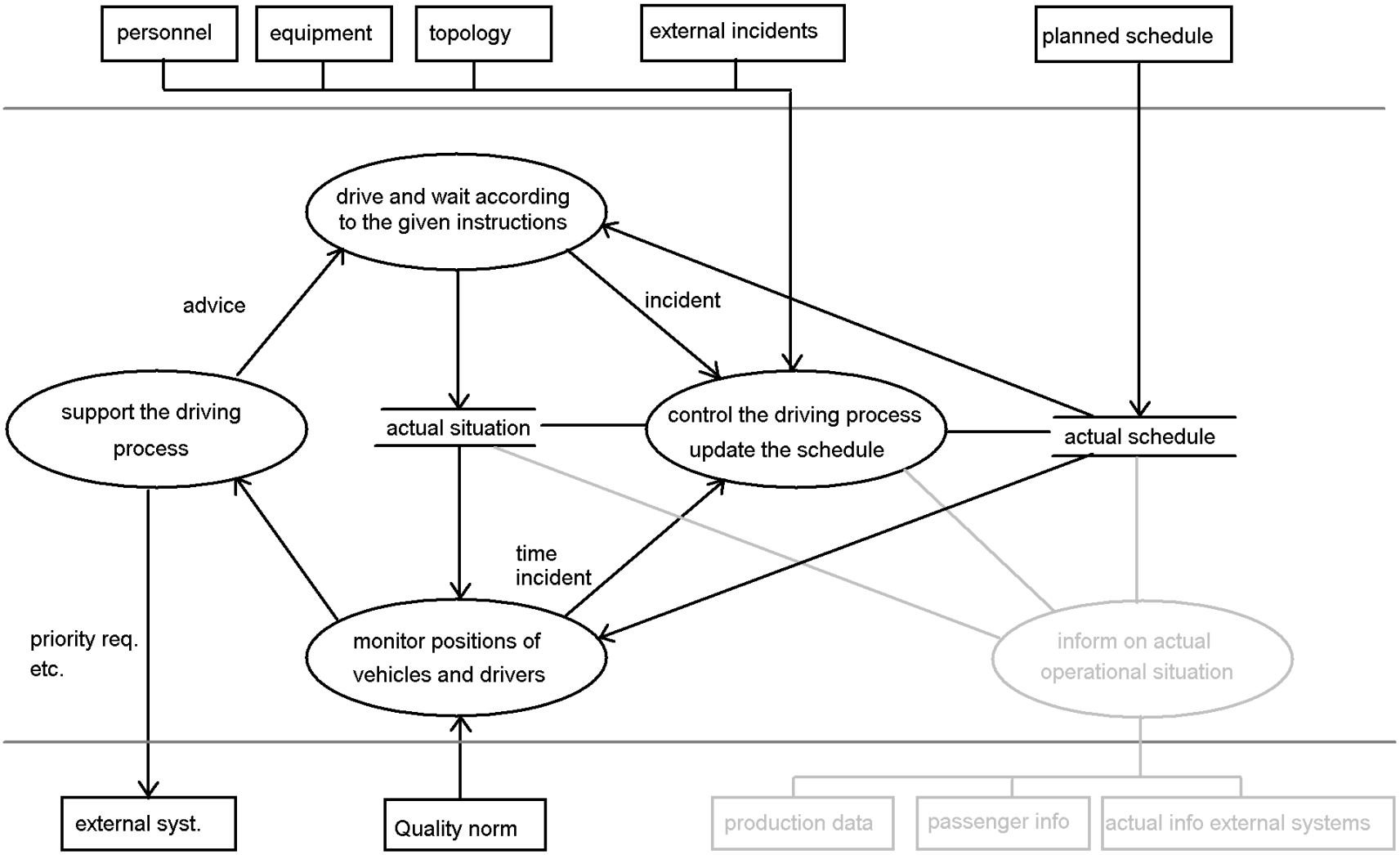
A sequence or set of FARE STRUCTURE ELEMENTs, grouped together to be validated in one go.

An immaterial marketable element (access rights, discount rights etc), specific to a CHARGING METHOD.

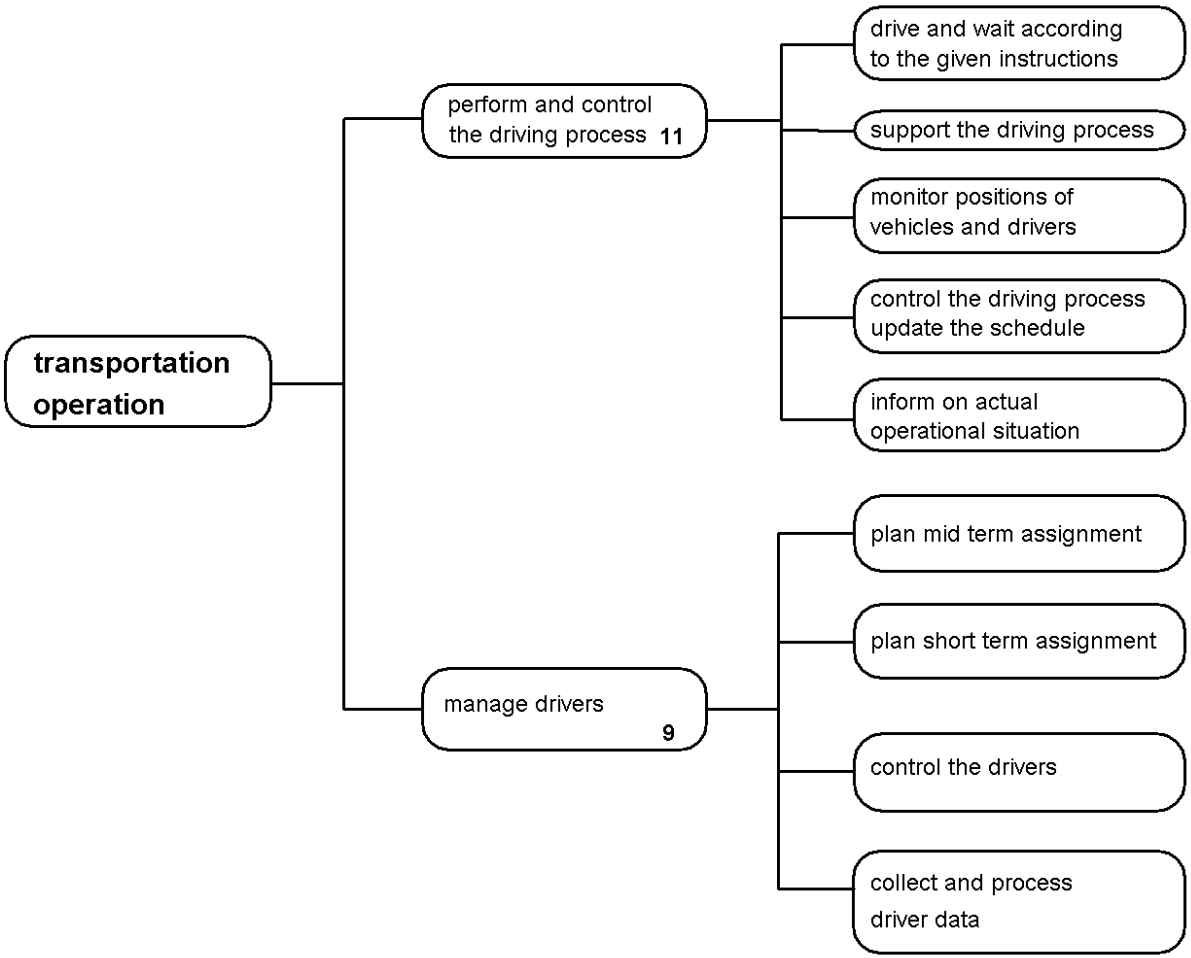
Transmodel data domains

- Network description
- Versions management
- Tactical planning
- Personnel (driver) disposition
- **Operations monitoring and control**
- Passenger information
- Fare collection
- Management information and statistics
- Multi-modal PT operation
- Multiple operators environment

Operations Monitoring & Control



Operations Monitoring & Control



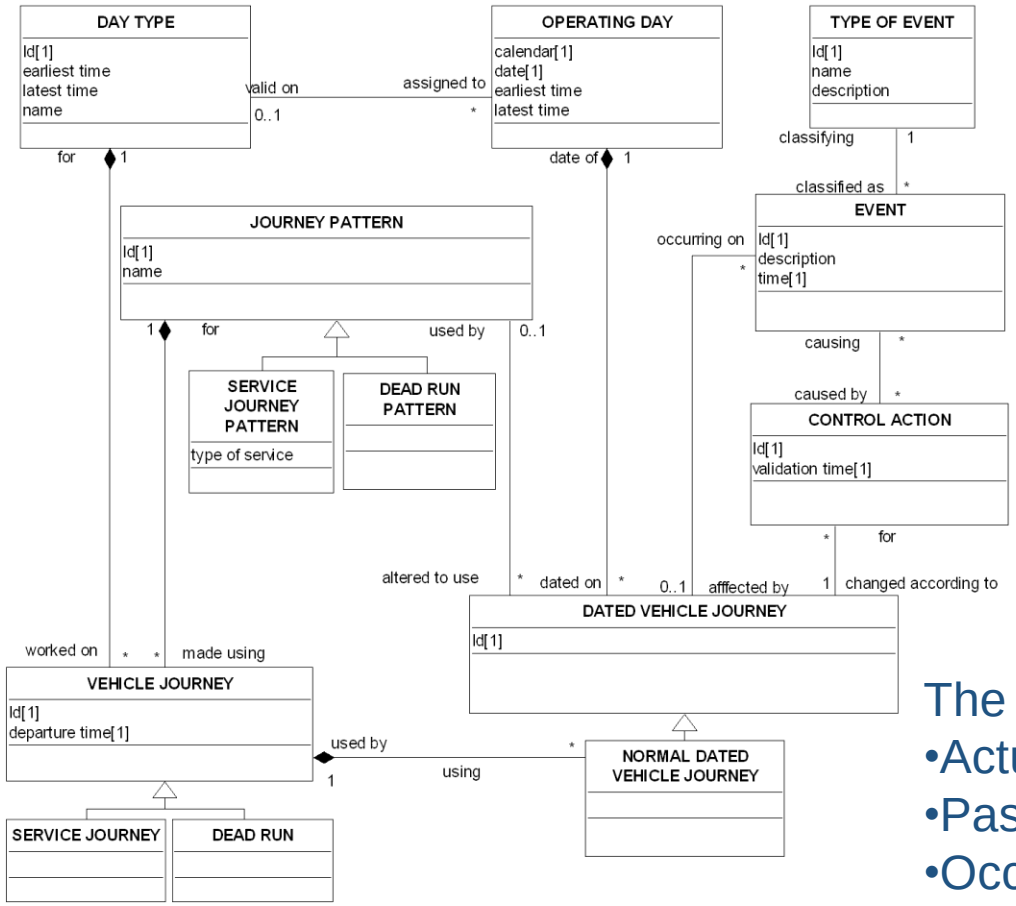
DATA DOMAINS

- Dated Production Components
- Production Plan
- Detection and Monitoring
- Control Actions
- Events
- Messages

Transmodel data domains

- Network description
- Versions management
- Tactical planning
- Personnel (driver) disposition
- Operations monitoring and control
- Passenger information
- Fare collection
- **Management information and statistics**
- Multi-modal PT operation
- Multiple operators environment

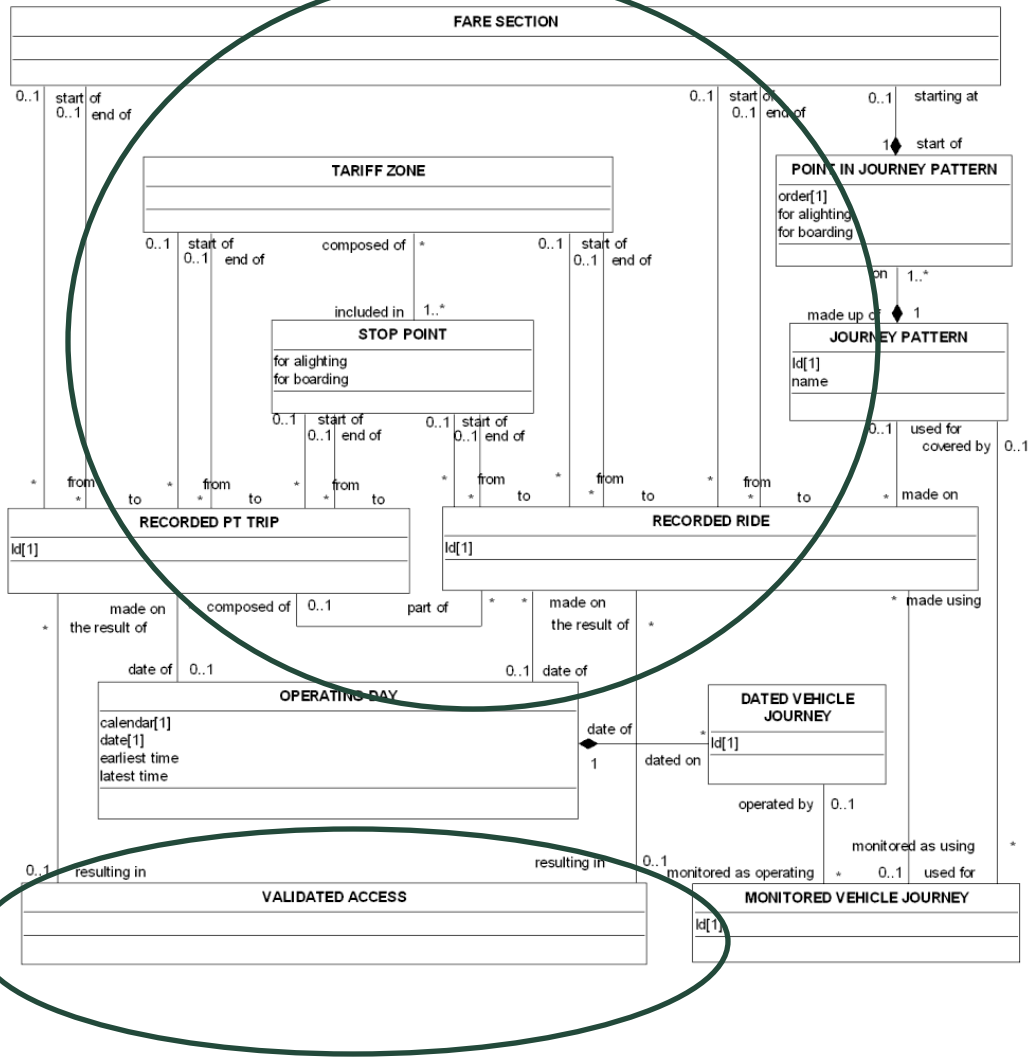
Management Information: Service Journey Performance



The main information to record:

- Actual passing times
- Passengers boarding and alighting
- Occurrence of impeded time
- Interchange realisation
- Occurrence of disturbances

Management Information: Recorded Use of Services (trips, validated accesses, …)



- A RECORDED PT TRIP is an actual trip undertaken by a passenger, from a certain origin place to a certain destination place, on a specific OPERATING DAY.
- In many cases, the origin and destination places will be expressed as STOP POINTs
- they will be sometimes described with less precision, as TARIFF ZONEs or FARE SECTIONs

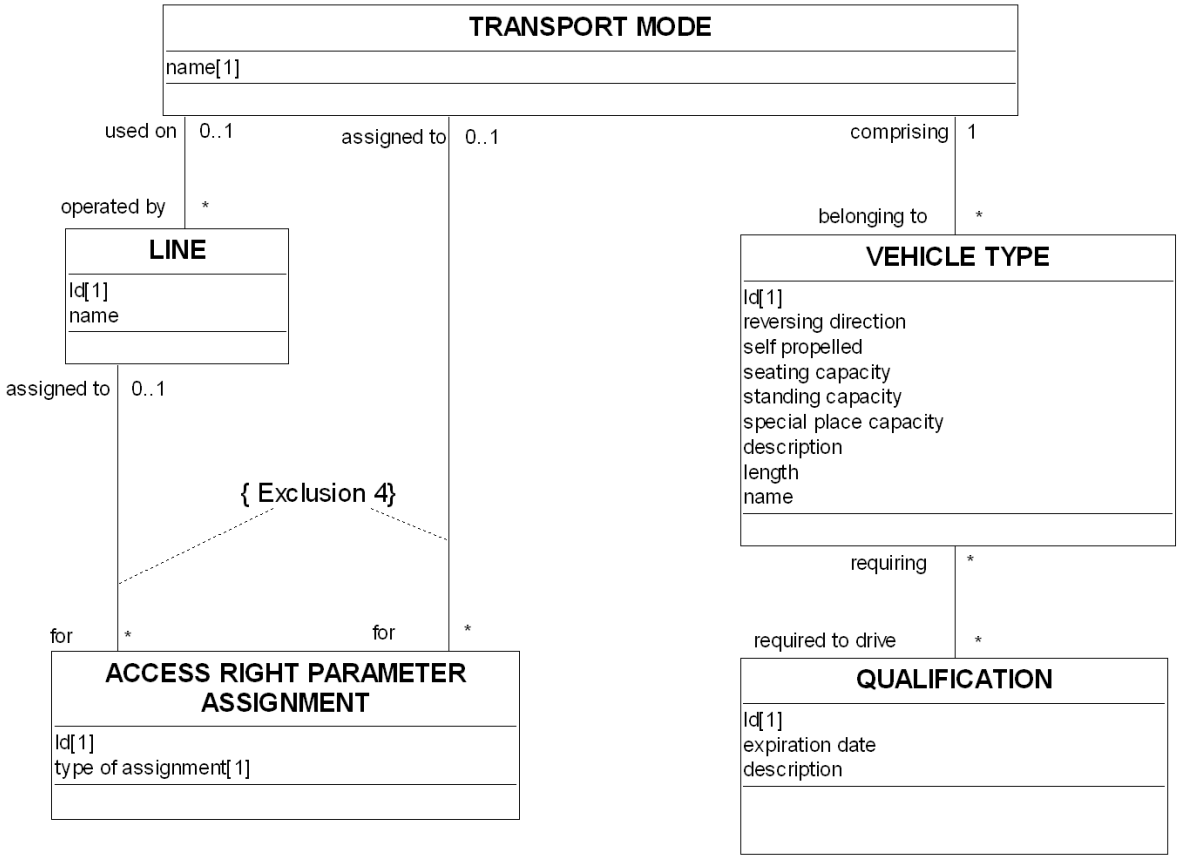
Transmodel data domains

- Network description
- Versions management
- Tactical planning
- Personnel (driver) disposition
- Operations monitoring and control
- Passenger information
- Fare collection
- Management information and statistics
- **Multi-modal PT operation**
- Multiple operators environment

Multi-modal operation

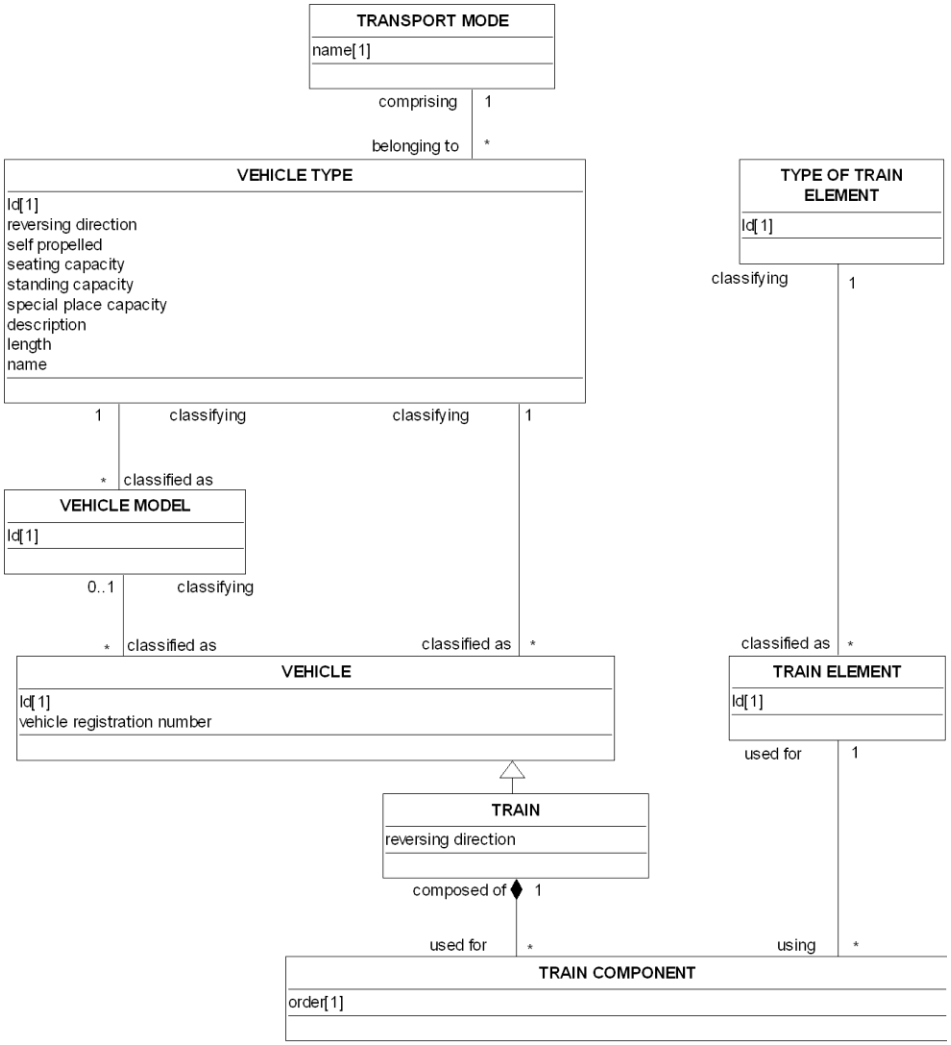
- A multi-modal public transport environment may be defined as the co-operation of technically different transport systems, as regards planning, operation or passenger information.
- Such an environment is not only characterised by the juxtaposition of several transport modes, but as well by their integration in various ways.
- The most significant needs addressed by the model are dealing with:
  - network description;
  - resource management;
  - operations;
  - passenger information;
  - fare collection.

Multi-modal operation: Transport Modes



The classification of vehicles reflects operational or organisational concerns rather than technical differences between vehicles,

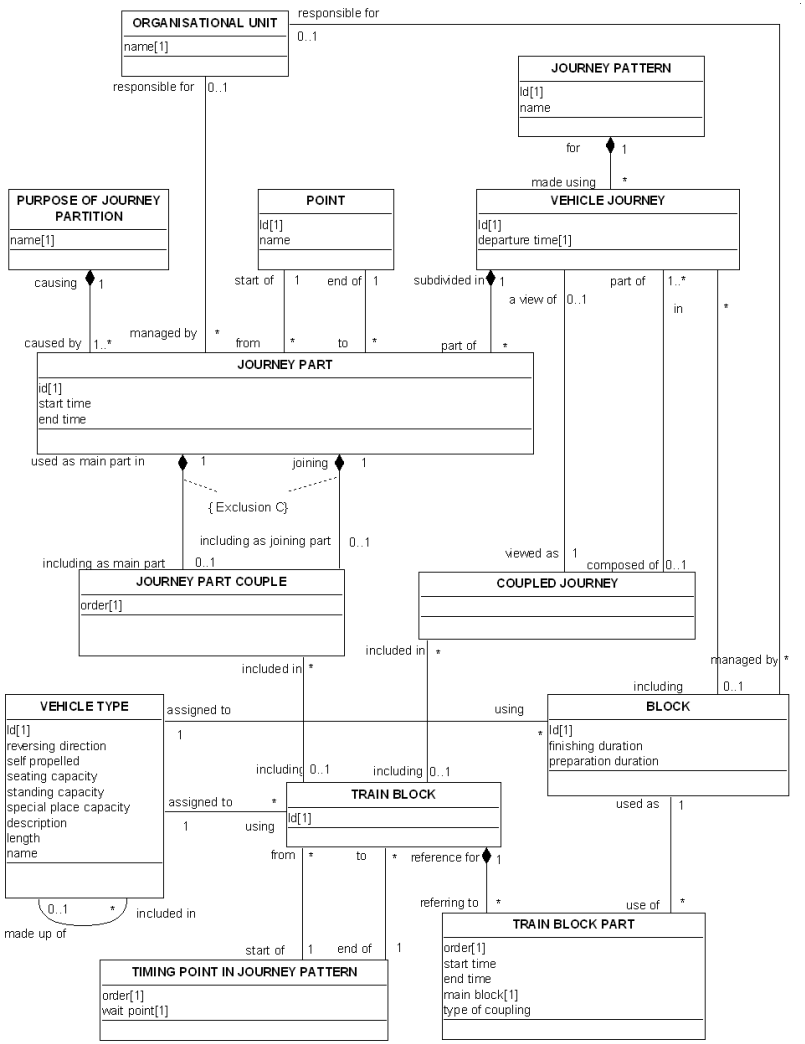
Multi-modal operation: Trains



A TRAIN consists of TRAIN ELEMENTs assembled together.

The composition of the TRAIN is provided by a TRAIN COMPONENT,
giving the order of the TRAIN ELEMENT in the TRAIN.

Multi-modal operation: Vehicle Coupling

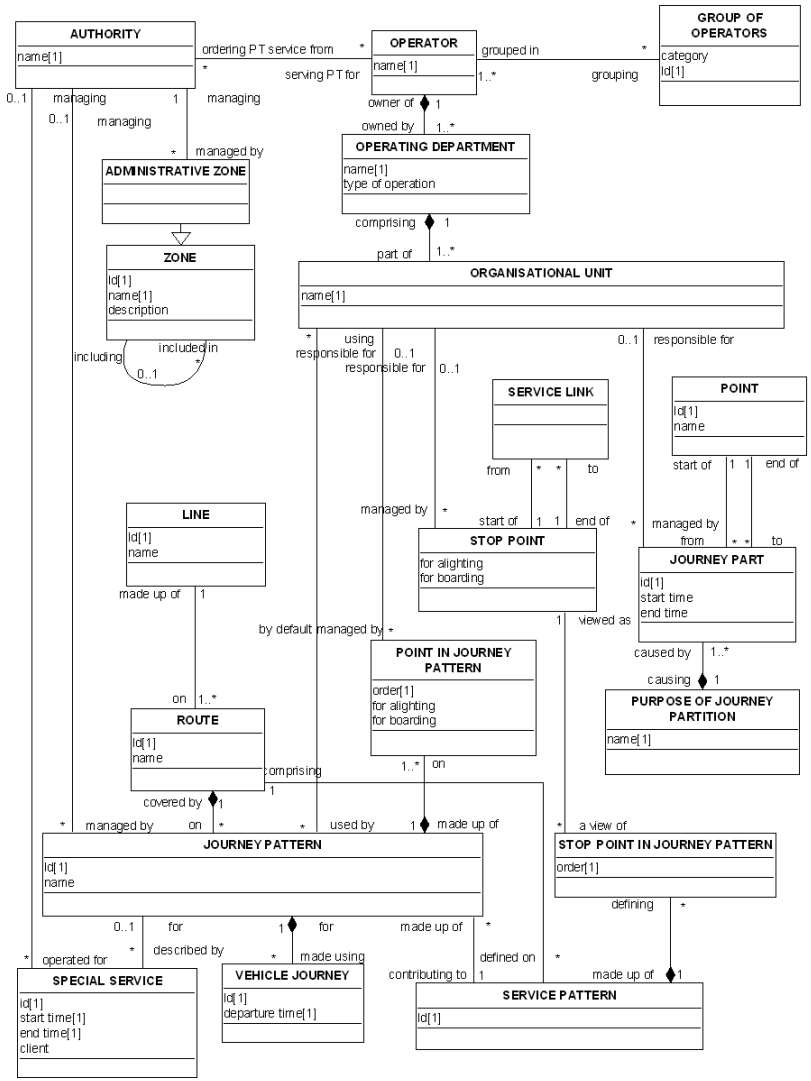


- A train may be separated in two (or more) parts at a particular branching point
- Conversely, two short trains coming from different feeding routes may be scheduled to meet at one interweaving point, where they are coupled to continue their service as one long train on a common route.

Transmodel data domains

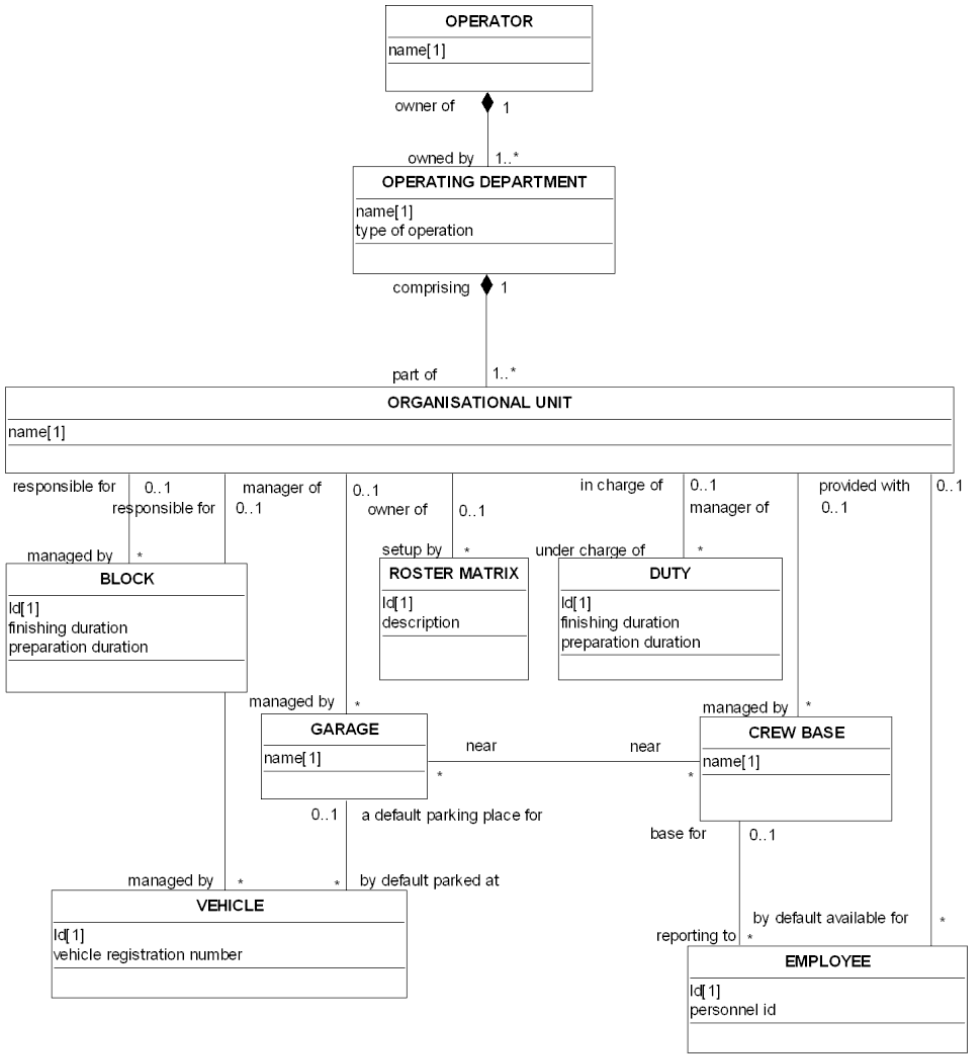
- Network description
- Versions management
- Tactical planning
- Personnel (driver) disposition
- Operations monitoring and control
- Passenger information
- Fare collection
- Management information and statistics
- Multi-modal PT operation
- **Multiple operators environment**

Multiple operators' environment : Responsibility for Services



- The AUTHORITY often imposes or controls the journey patterns served by an operator. In most cases, only SERVICE JOURNEY PATTERNs will be concerned by this control, which is expressed by a relationship between AUTHORITY and JOURNEY PATTERN. In addition, an AUTHORITY may order some SPECIAL SERVICEs.
- In many cases, the AUTHORITY control will concern all JOURNEY PATTERNs of a LINE together. In such a case, the implementation may be simplified with a relationship from AUTHORITY to LINE.

Multiple operators' environment : Responsibility for Resources



- A GARAGE is a place where VEHICLEs are parked and managed. A GARAGE is usually under the responsibility of an ORGANISATIONAL UNIT of a particular OPERATOR.
- The ORGANISATIONAL UNITs also manage physical VEHICLEs.
- ....
- organisational structures and practices may well vary considerably across companies and time
- all relationships describing the organisation are optional

Transmodel Characteristics and Benefits

- Transmodel is a generic data representation,
- represents a consensus at European level
- takes into account a variety of practices
- users may only implement parts of it or use it as a reference

Transmodel is USEFUL

- for multi-system interoperability:
  - avoids misunderstandings at least Europewide

- for new system design:
  - saves re-specification effort
  - enables a progressive integration
- to ensure data consistency
  - avoids redundancy, reduces errors at several levels
  - facilitates interface design
- to reference inconsistencies

Transmodel Workshop: agenda

1. General overview: rationale, solution, approach & method, main domains

2. Detailed presentation: Network description, tactical planning components, passenger information

3. Other domains: driver & vehicle scheduling, operations monitoring & control, fare collection, management information/statistics

4. **Transmodel-based services: the example of NeTEx**

Multimodal Information Standardisation

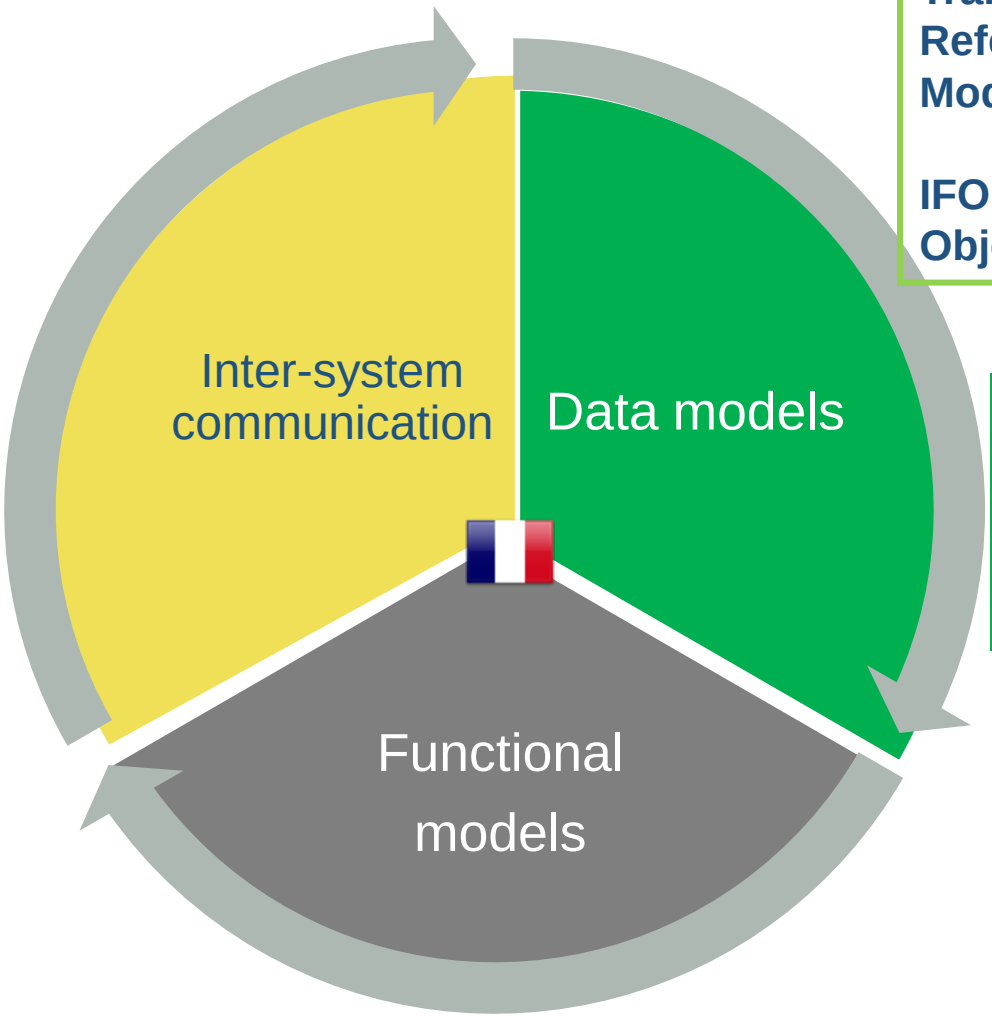
SIRI : Service Interface for Real-time Information

NeTEx: Network & Timetable Exchange

DJPS: Distributed Journey Planning

TI-VIP: Traveller Information for Visually Impaired

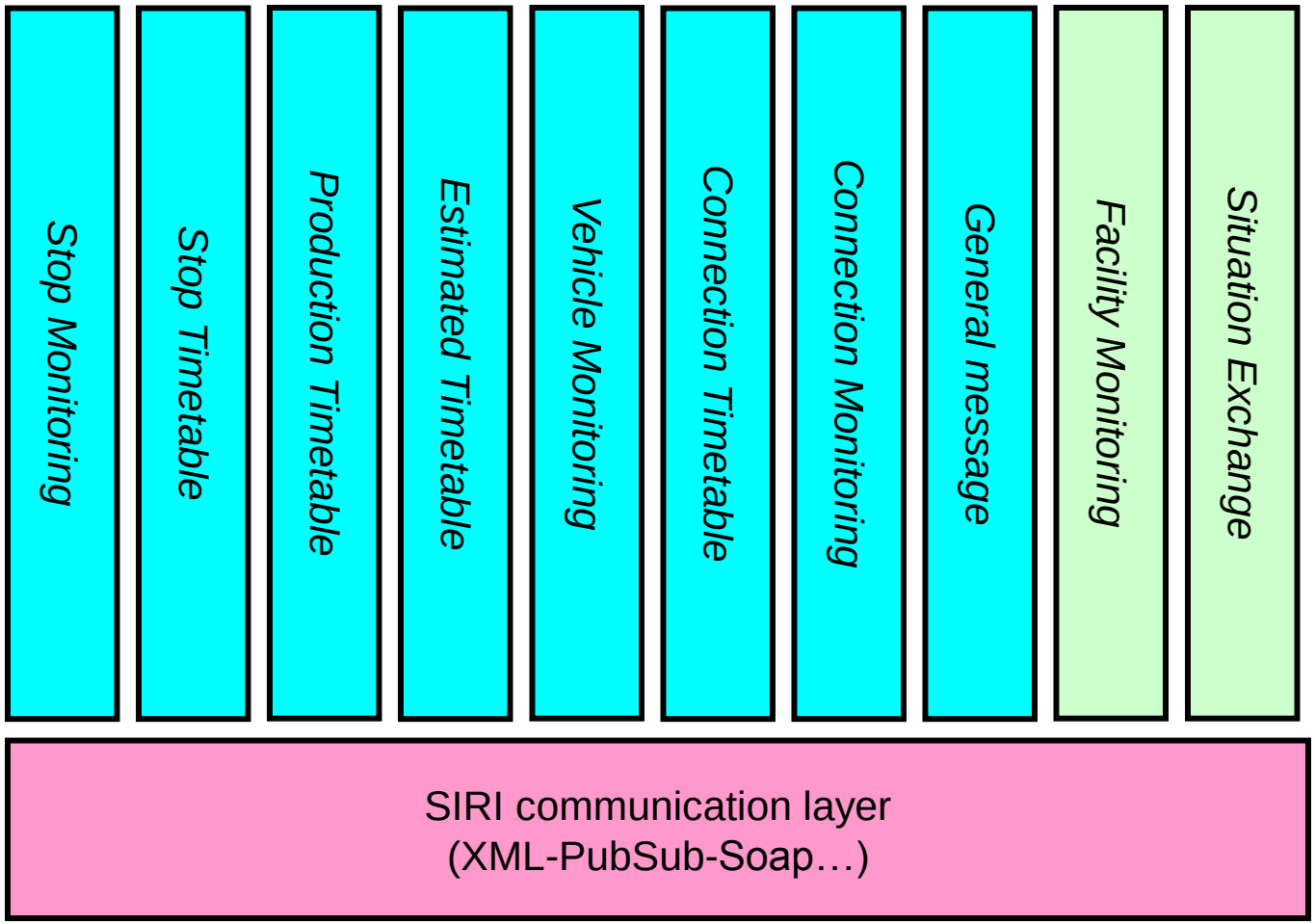
ISO / TCIP: équivalent américain de SIRI & NeTEx



Transmodel: Reference Data Model for PT

IFOPT: Fixed Objects for PT

ISO/ GDF: Geographic data Files


Stop Monitoring
Stop Timetable
Production Timetable
Estimated Timetable
Vehicle Monitoring
Connection Timetable
Connection Monitoring
General message
Facility Monitoring
Situation Exchange
SIRI communication layer
(XML-PubSub-Soap…)

- **Stop Timetable (ST) and Stop Monitoring services (SM) provide stop-centric information** about current and forthcoming vehicle arrivals and departures at a nominated stop or Monitoring Point, typically for departures within the next 20-60 minutes for display to the public.
  - The SM service is suited in particular for providing departure boards for web services and on all forms of device.

- **Vehicle Monitoring service (VM) provides information about of the current location and** expected activities of a particular **vehicle, and can give the current and subsequent Journey** and the Calling points on each journey, together with the scheduled and expected arrival times.
  - The VM service is suited in particular for onboard displays, and visualisation of vehicle movement, and for exchanging information on roaming vehicles between different control systems. It can be used for example to support a moving image showing the position of a bus on a map.
  - It also constitutes a detailed logging feed suitable for collecting historic about performance against schedule.

- **Production Timetable service (PT) exchanges information about the expected operation of a** transport network for a specified day in the near future.
  - Typically this is produced a few hours or days before the day in question and incorporates any changes to the timetables known at that stage. It can of course also be used to distributed timetables long in advance.
  - A Production Timetable can be filtered by Operator, Line and Date Range, allowing only the section of the timetable of interest to be selected.
  - Suited for provisioning AVL systems and smart devices with base timetables.

- **Estimated Timetable service (ET) provides details of the operation of the transport network** for a period within the current day, detailing real time deviations from the timetables and control actions affecting the Timetable (cancellations, additional Journeys and Detours).
  - An estimated timetable can be filtered by Operator or by Line, allowing only the section of the timetable that is of interest to be selected.
  - Suited for provisioning AVL systems and smart devices with real-time timetables.
  - Also suitable for the bulk exchange of data.

- **Connection Timetable (CT) and Connection Monitoring service (CM) allow transport** operators to exchange information about the real-time management of interchanges between feeder and distributor vehicles arriving and departing at a connection point, for example, to let passengers on a delayed train know that a local bus service will wait for them.
  - It can be used in particular for Guaranteed Interchange (Connection protection) services.

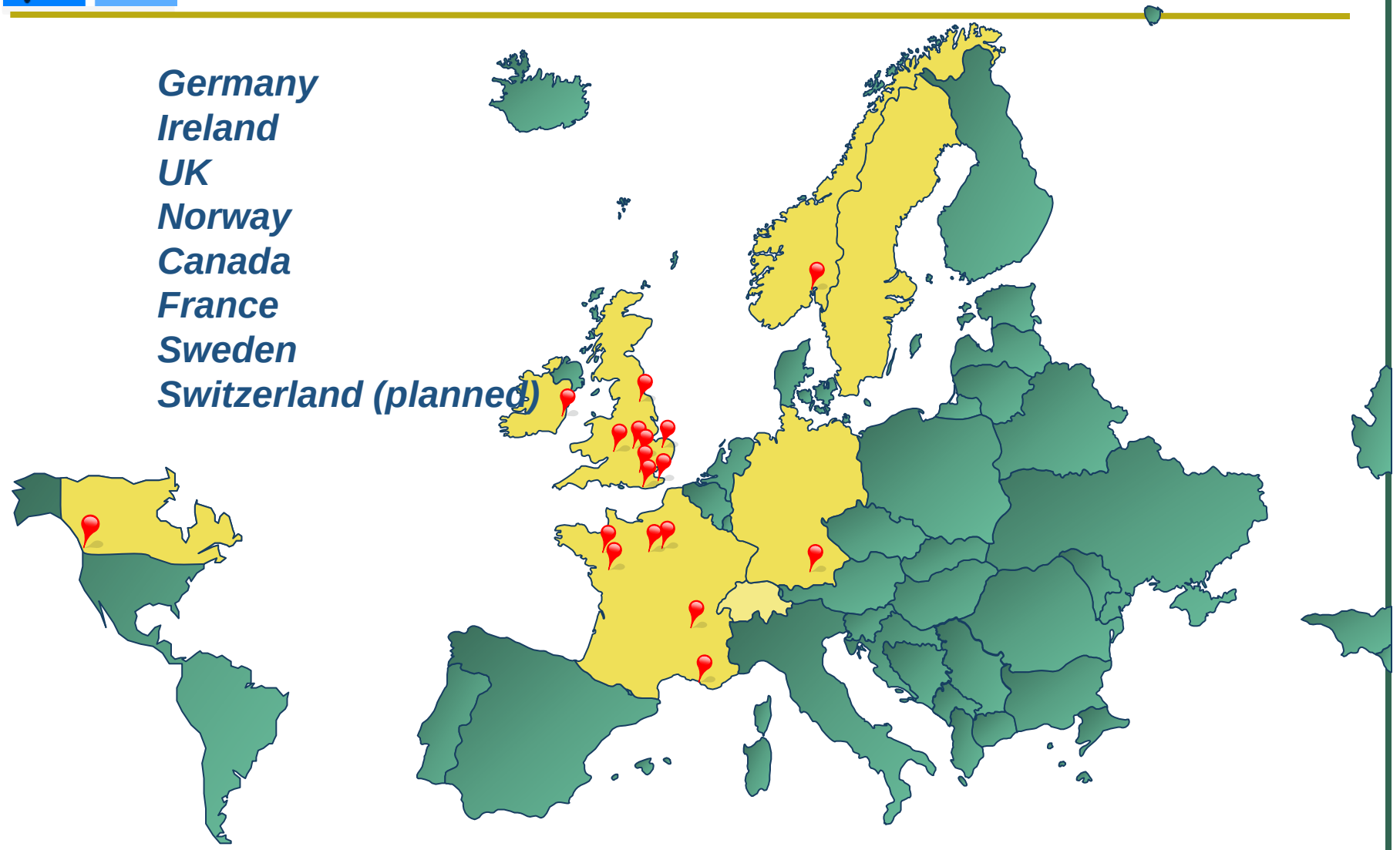
- **General Messaging Service (GM) provides a structured way to exchange arbitrary** informative messages between participants, such as travel news, or operational advice.
  - It can be used to link together incident management systems in a store and forward architecture.

- **Facilities Monitoring Service (FM) provides a information about changes in availability of equipment.**
- It can be used to link together equipment and incident management systems in a store and forward architecture.

- **Situation Exchange Service (SE) provides a fully featured service for exchanging planned and** unplanned incidents between control centres and distribution systems.
- It includes a structured incident model can be used to integrate incident incident management systems with other SIRI services and with external services

Some SIRI Users

Germany
Ireland
UK
Norway
Canada
France
Sweden
Switzerland (planned)

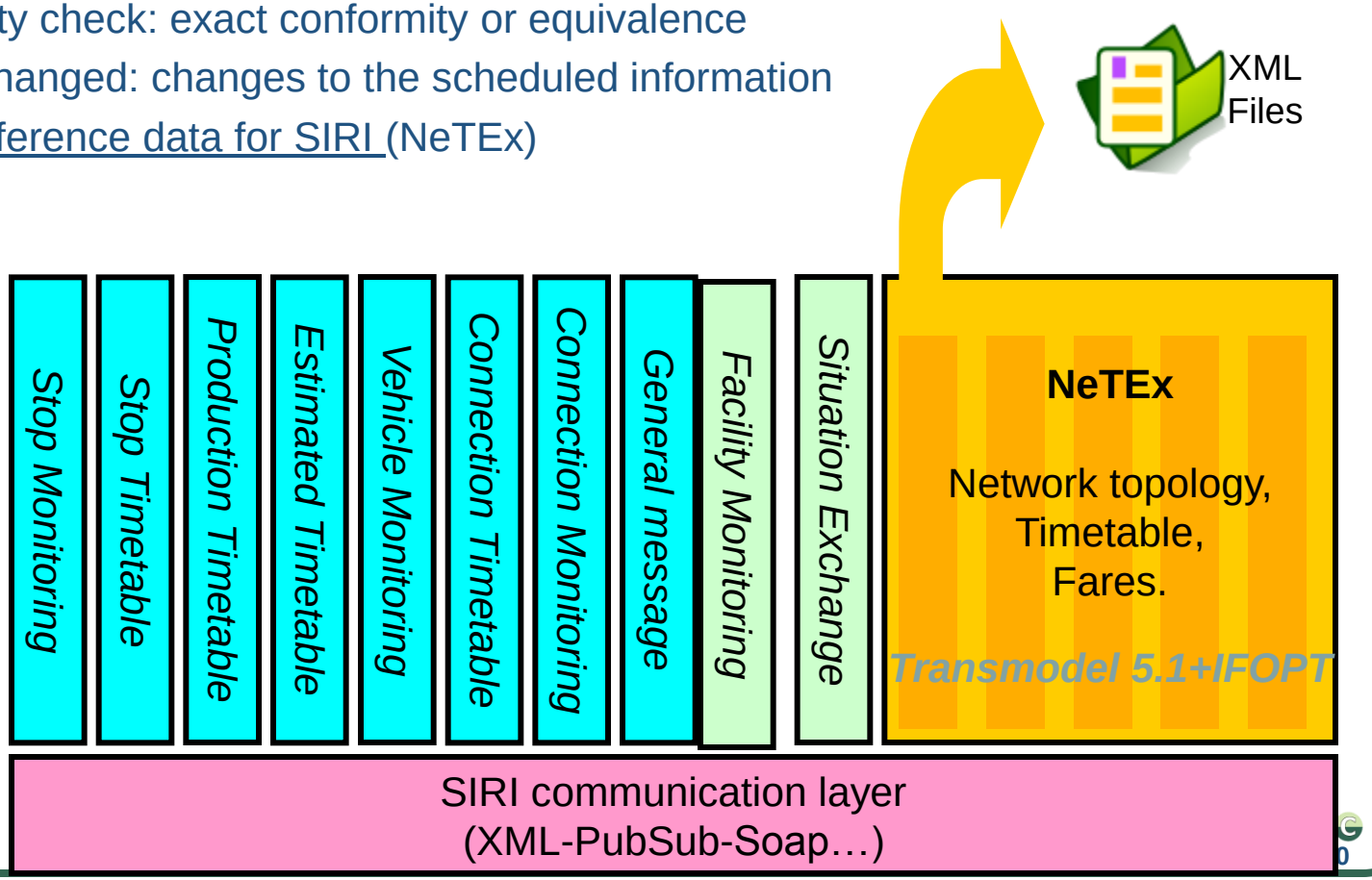


Conceptual Model vs. XML schema

From Transmodel to SIRI and vice versa:

- Messages built using Transmodel and national standards (UK, France, Germany)
- Reverse engineering → logical data model
- Conformity check: exact conformity or equivalence
- Data exchanged: changes to the scheduled information

→ Need for reference data for SIRI (NeTEx)



NeTEx Objectives

To specify Services for Exchanges of Scheduled Data

What data are exchanged?

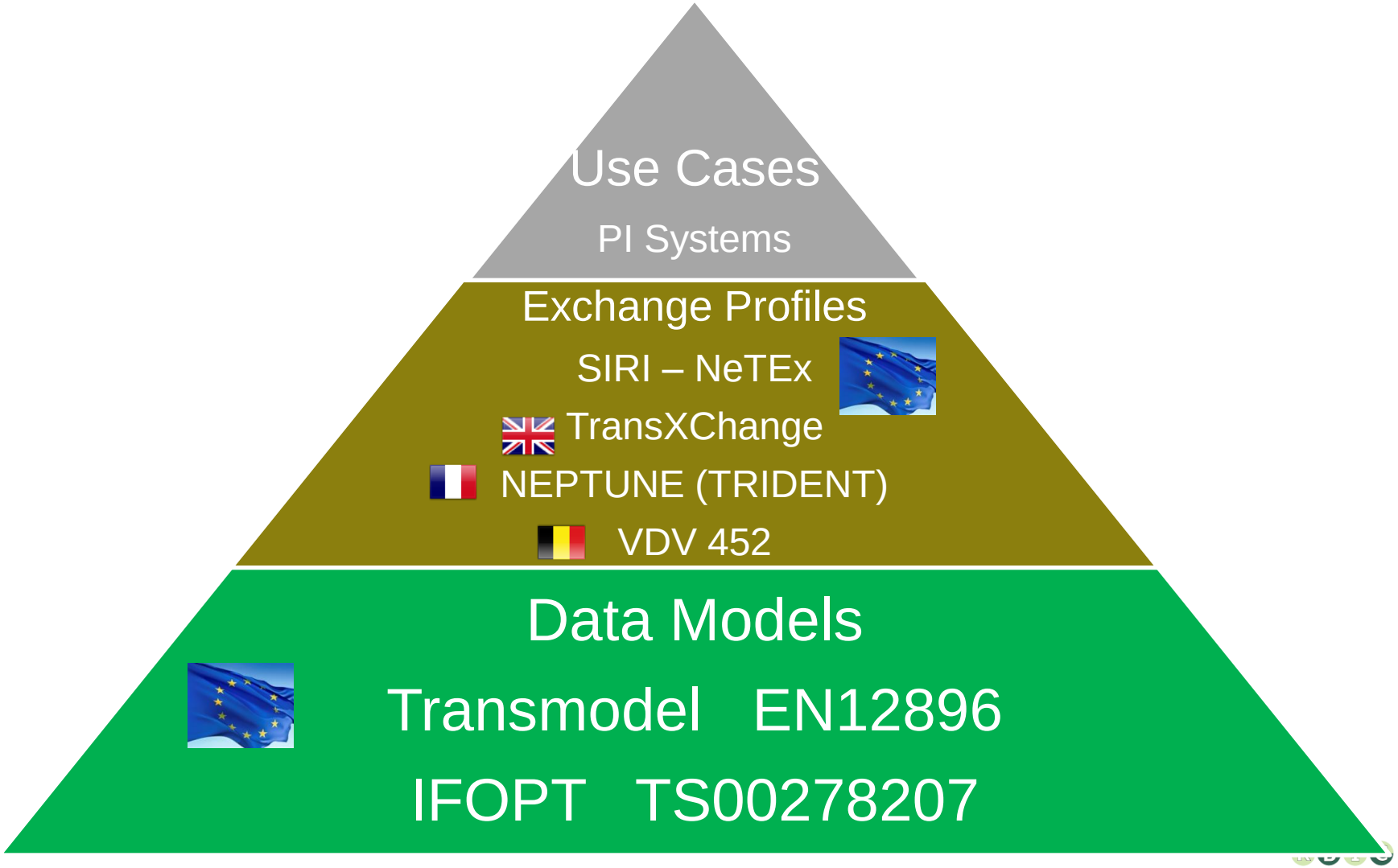
- Reference (scheduled) data : Network,Timetables and Fares

What systems are concerned?

- Information required for passenger information
- Information exchange between scheduling systems and AVMS

What standards are involved?

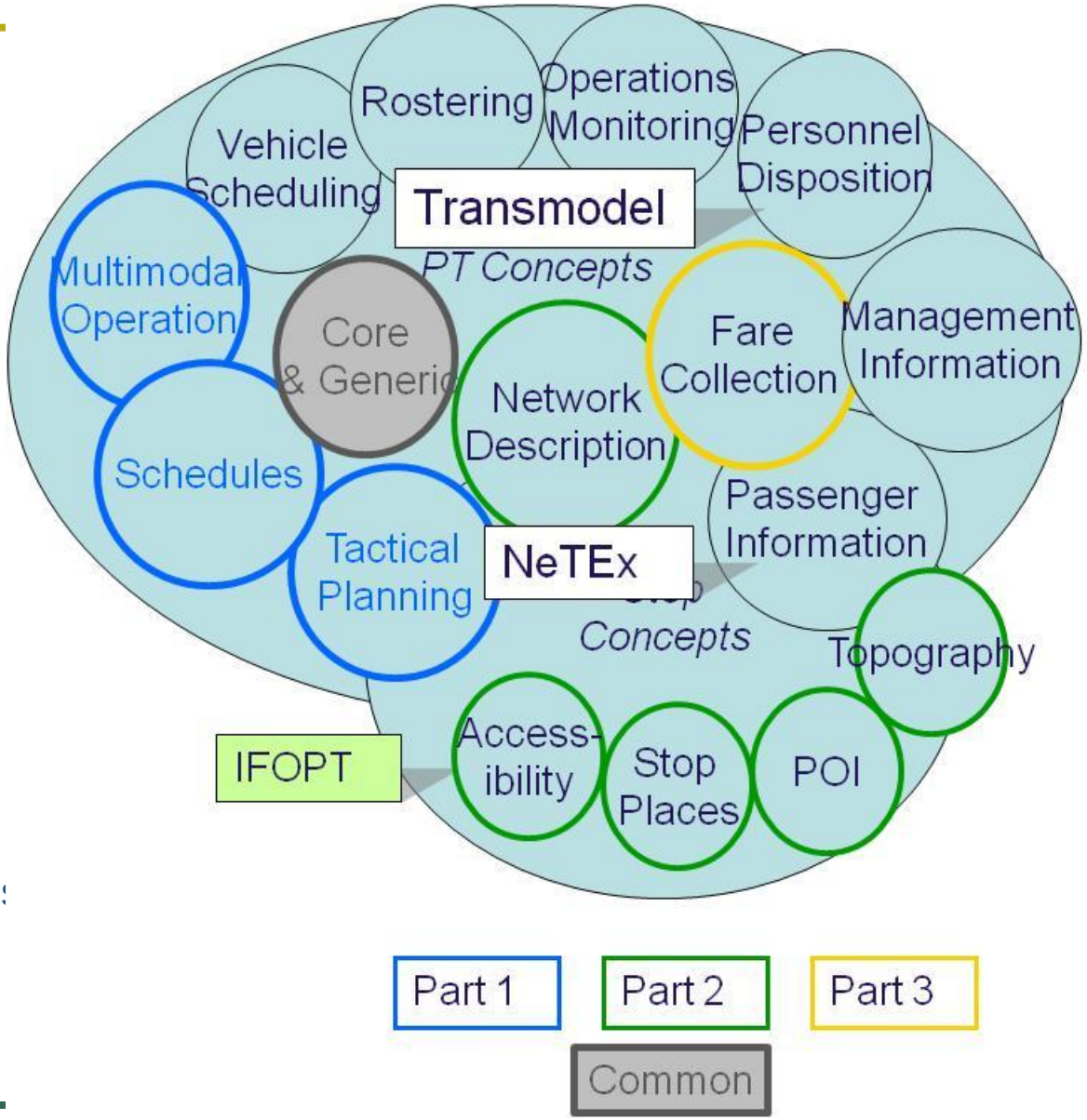
- Transmodel, IFOPT & SIRI
- TransXChange in UK
- VDV 452 in Germany
- NEPTUNE in France (based on the EU project TRIDENT)


Use Cases
PI Systems
Exchange Profiles
SIRI – NeTEx
TransXChange
NEPTUNE (TRIDENT)
VDV 452
Data Models
Transmodel EN12896
IFOPT TS00278207

NeTEx Scope

From Transmodel to NeTEx

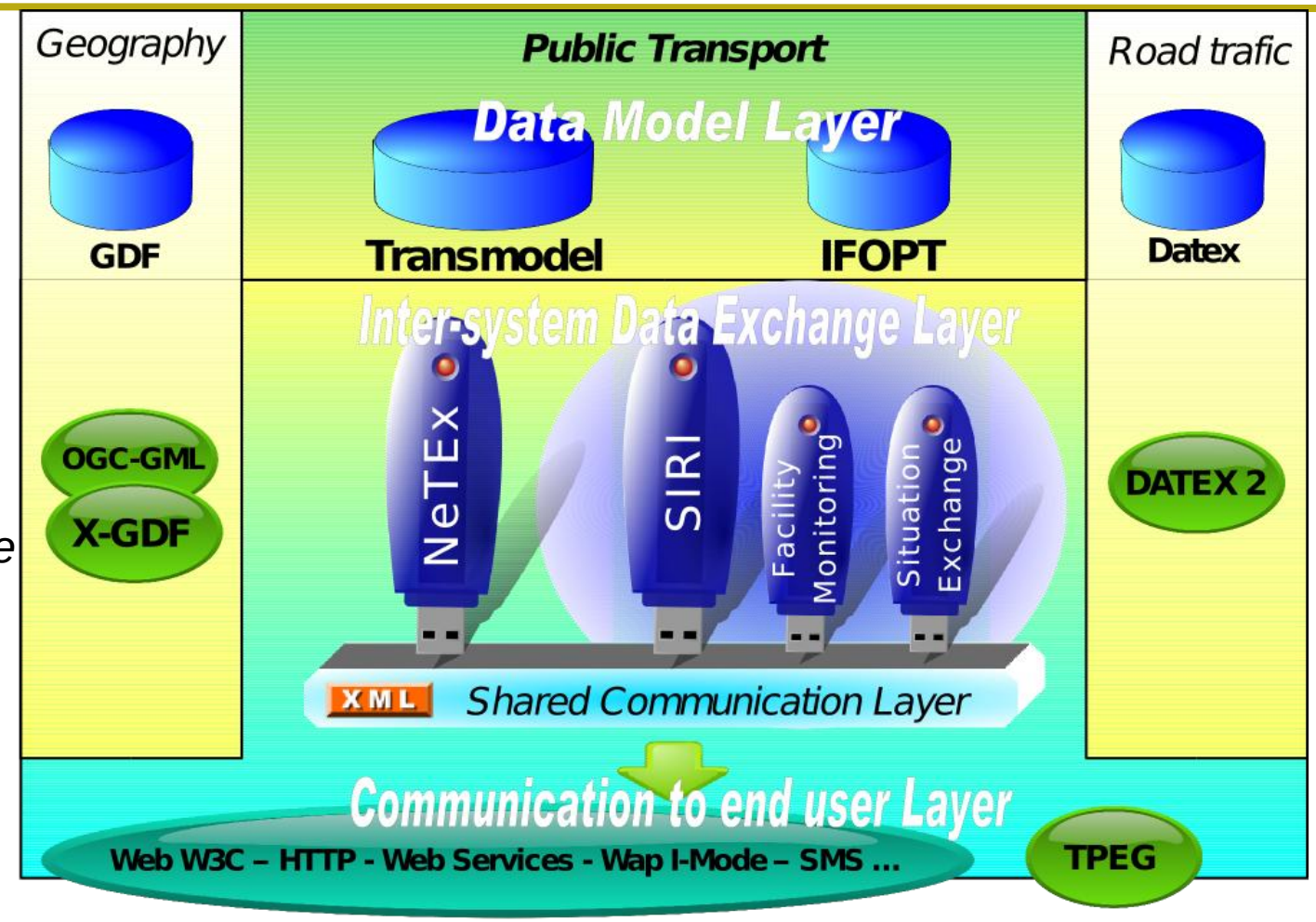
1. Modularise Transmodel Domain Model + harmonise with IFOPT
2. Create a concrete UML class model: add attributes, formats, etc
3. Encode as XML schema
   - Reusable, Modular subpackages
   - Well defined dependencies
   - Uniform versioning and data ownership model
   - Validation with Examples of data from each country



Data Model

Inter-System Data Exchange

End-user communication



Thank you !

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http://kasia.bouree.fr