

PARADIGMA

# MMTD

---

## Multimodal Transport Data

**René Papesch**

**22.July 2009**

[Geben Sie hier das Exposee für das Dokument ein. Das Exposee ist meist eine Kurzbeschreibung des Dokumentinhalts. Geben Sie hier das Exposee für das Dokument ein. Das Exposee ist meist eine Kurzbeschreibung des Dokumentinhalts.]

## Table of Contents

|   |    |
|---|----|
| Objektives.....   | 3  |
| Background.....   | 3  |
| Scope/Focus.....  | 3  |
| Expected results.....                                     | 3  |
| User Story: Analyzing Traffic Flow.....                   | 3  |
| User Story: Calculating Port Performance Indicators ..... | 3  |
| User Story: Performing competitive analysis.....          | 3  |
| Method of resolution .....                                | 4  |
| Definitions.....  | 5  |
| Data source characteristics .....                         | 5  |
| Data sources .....  | 6  |
| Data marts.....   | 7  |
| Loading data into the MMTD Database .....                 | 8  |
| Location Data .....                                       | 8  |
| Specification Data.....                                   | 12 |
| Qualification Data.....                                   | 12 |
| Building the Data Marts.....                              | 12 |
| Conceptual design .....                                   | 13 |
| Definitions.....  | 14 |
| Used UN/CEFACT Recommendations .....                      | 14 |
| Used Terms.....   | 15 |
| Entity Relationship Diagram .....                         | 20 |
| Coverage of UN/CEFACT Recommendations .....               | 21 |
| Deliverables.....   | 22 |

## **Objektives**

## **Background**

## **Scope/Focus**

Traffic flow, integration of different data sources

## **Expected results**

One system → bunch of analysis

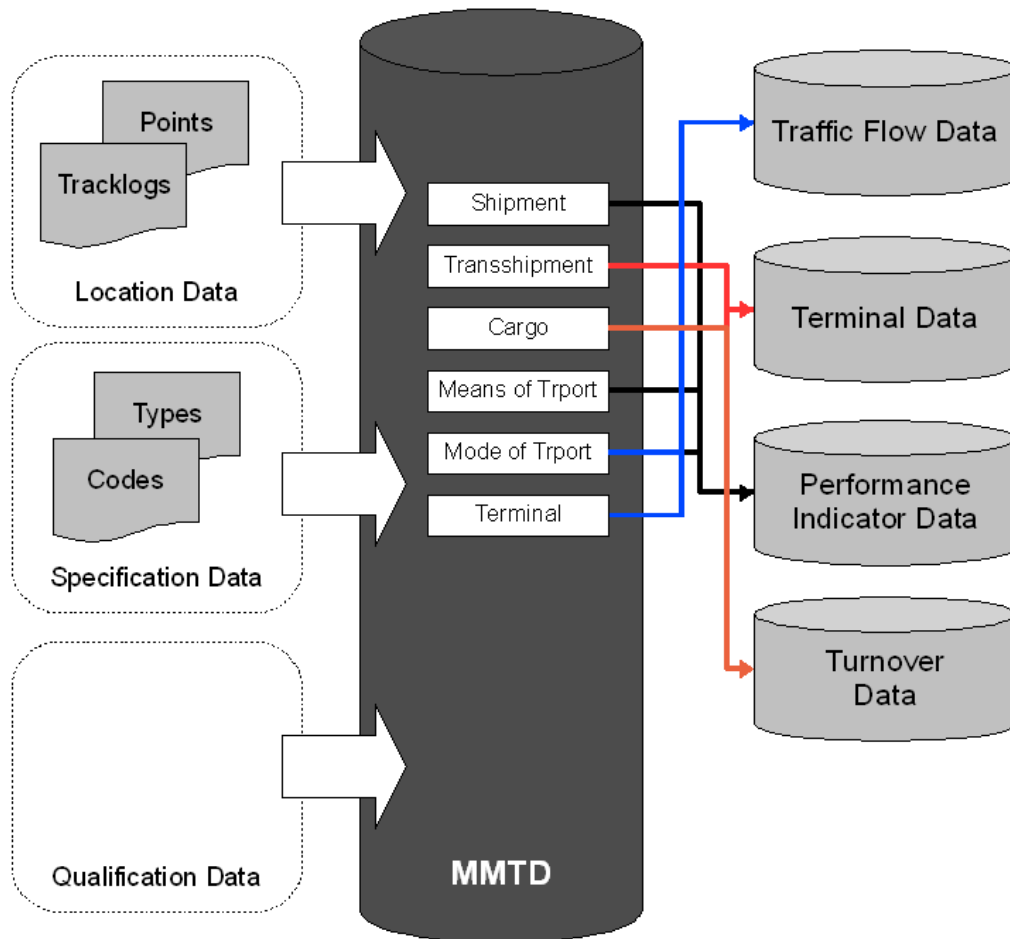
**User Story: Analyzing Traffic Flow**

**User Story: Calculating Port Performance Indicators**

**User Story: Performing competitive analysis**

## Method of resolution

The implementation of the MMTD model is done in three steps: First the model will be filled with different data sources such as tracklogs and data from 3<sup>rd</sup> party systems, then these data will be linked together and in the final step data marts for analysis purposes are build.



## **Definitions**

### **Data source characteristics**

We have classified those types of data along their project-relevant characteristics into the following two broad categories:

#### ***Longitudinal***

Examples for this category are data produced by transport companies' fleet monitoring systems, GPS devices in vehicle navigation systems and security-related applications in maritime navigation (e.g., Automatic Identification System defined by the IMO's SOLAS regulation).

Statistical units are trips of vehicles. Variables are position (longitude and latitude) and a time stamp, speed as well as a status of the vehicle.

Road transport statistics produced by national or supra-national organizations also fall in this category. While information on vehicle position is usually not specified as precisely as with geographic coordinates and timestamps, they comprise variables like origin and destination of the trip as well as sometimes one or more transit points. These attributes are classified by geographic classifications (political regions like cities, counties, provinces or countries).

Longitudinal surveys take a strategic point of view and provide the basis for decisions in public transport policies, business and infrastructure planning. As such they refer to periods between a quarter and multiple years.

#### ***Cross-sectional***

This category represents road count surveys conducted by road operators and governmental agencies. Statistical units are vehicles passing a defined point in the road network (e.g., a road section monitored with counting equipment). Items surveyed are type, direction, speed of the vehicle, the time(stamp) it has passed the monitored road section and location of the counting station.

Cross-sectional studies usually do not carry any information on the route a vehicle has taken. They allow to analyze the utilization of transport infrastructure at a particular point. Cross-sectional surveys are targeted at tactical decisions in traffic management (e.g, traffic redirection, infrastructure utilization, etc.). Reference periods of data typically range from an hour or less to a day. Traffic intensities (averages of vehicle numbers) have base periods of a month up to a year.

## **Data sources**

The MMTD model contains three different types of data sources: Location Data, Specification Data and Qualification Data.

### ***Location Data***

Location data are characterized that they can be printed on a spatial map. The main purpose of location data is to answer following questions:

- How long was the actual duration of stay in a specified region?
- How long did the journey between two regions take?
- How many means of transport moved between two regions?

### **Positions**

One position data record contains at least following elements:

- Latitude
- Longitude
- Timestamp
- Identifier such as license number, radio identification number, ...

As a result of this definition each position data record represents one point on a spatial map. Because of the fact that the record was taken at a specified time it represents also the status of the means of transport, therefore additional information namely voyage relevant data will be provided:

- Speed
- Draft
- Status
- ETA - estimated time of arrival
- ...

### **Tracklogs**

The tracklog can be defined as the combination of multiple position records into one tracklog record. Spatially spoken position records are connected to a line which represents the route of the means of transport. If a tracklog record is created from position records, all voyage data will be aggregated hence only the median, maximum, minimum, etc. information will be available.

### **Zones**

A zone covers a specified area on a spatial map. It could be the area of a terminal or also of a complete port. Zones are generally loosely defined and they are used to cut tracklogs into pieces. Longitudinal data (= position data) is converted into cross-sectional data which can be combined with qualification data sources.

***Specification Data***

Description of this category

**Codes**

**Types**

***Qualification Data***

Description of this category

**Data marts**

***Traffic Flow Data***

***Terminal Data***

***Turnover Data***

***Performance Indicator Data***

## Loading data into the MMTD Database

Each data source type will be used to fill a partition of the MMTD database. If the expected results may be reached, it will be necessary to load location data, specification data and also qualification data into the database.

The following section will describe step-by-step how to successfully transform and load data into the MMTD database.

### Location Data

Normally location data sources are containing a list of points which were recorded by a GPS device or something similar. A detailed specification of position records can be found in section Location Data.

The main purpose of MMTD is not to analyze a specified route of a means of transport, for instance visualization and optimization of the fuel consumption of a vessel. Much more interesting are questions like where did the vessel come from and how long was the duration of stay in the port. For this application voyage relevant data at one position is not important, it's not necessary to know that a vessel had at position x speed y but for example we want to know that that the distance between Venice and Trieste took the vessel an duration of z.

Therefore for the loading of the MMTD model simplified tracklogs as shown in Abbildung 1 are built:



Abbildung 1

These simplified tracklogs are created using zones. Zones will cut the tracklogs into pieces and these tracklogs within a zone are simplified so that only two points are left: The first and the last position in zone.

Now the simplified tracklog contains two different types of movements:

- One movement between the first and the last position, called *within zone movement*
- The second movement between the last position from one zone to the first position of the next zone, called *between zone movement*

For these movements following information is created:

- Duration of stay in a zone
- Duration of journey between two zones
- Time of arrival
- Time of departure
- Mileage distance from one zone to another
- Movement distance within a zone

Using these attributes combined with other data sources make complex analysis possible.

### ***Data Requirements***

If the location data should be loaded successfully following at least data sources must be provided:

- Position records as described in section Location Data: At least latitude, longitude, identifier and geo reference system. Additionally voyage relevant data which will be used for statistical purpose.
- Zone specification: The zone must contain a unique identifier, the polygon which defines the zone and the geo reference system.

The polygon can be described in following ways:

- A closed linestring that defines the exterior ring of the resulting polygon, e.g.  
`'polygon (10 20, 10 40, 20 30, 10 20)'`
- A well-known text representation
- A well-known binary representation
- A shape representation, ESRI shapefile
- A representation in the geography markup language (GML)

## ***Loading process***

The complete location data loading process can be split into following steps:

### **1. Loading of zones**

First of all specified zones must be imported because afterwards these data will be used for cutting the tracklogs.

### **2. Loading and flagging of position records**

Whenever position data is loaded, the system has to check in which zone the point is located. This information will be saved to the position record, now it's possible to get all points in a specified zone.

### **3. Transforming position records into tracklog records**

For each means of transport all points are ordered by time and then linked together. Now the tracklog records are built, plotting these on a spatial map you will get **Abbildung 2**.



**Abbildung 2**

#### 4. Cutting tracklogs with zones

In this step the created tracklog records will be simplified so that for one tracklog only two points, the entering position and the exiting position, in each zone are kept.

If you list the tracklog in ordered way you will get following record:

| ID       | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Time     | 08:20 | 08:21 | 08:22 | 08:23 | 08:24 | 08:25 | 09:23 | 09:24 | 09:25 | 09:26 |
| Position | 22    | 23    | 24    | 25    | 26    | 27    | 41    | 42    | 45    | 46    |
| Zone     | A     | A     | A     | -     | -     | -     | B     | B     | B     | -     |

can see the zone will change when the means of transport enters or exits. The change event can be found when each position record is compared to its predecessor and its successor. Weather the predecessor has another zone then it's an *entry point* and weather the successor has another zone then it's an *exit point*.

These results may be saved in a pre-MMTD model called STRACKLOG which will be the basis for the loading of location data into MMTD. Following entities are recommended:

- POSITION
- ZONE
- BETWEEN\_ZONE\_MOVEMENT
- WITHIN\_ZONE\_MOVEMENT

#### 5. Loading MMTD

The final step of the loading process is the transformation of the intermediate result as described in Step 4 into the MMTD model. The matching of the entities of the pre-model and the entities in the MMTD is done via following tables:

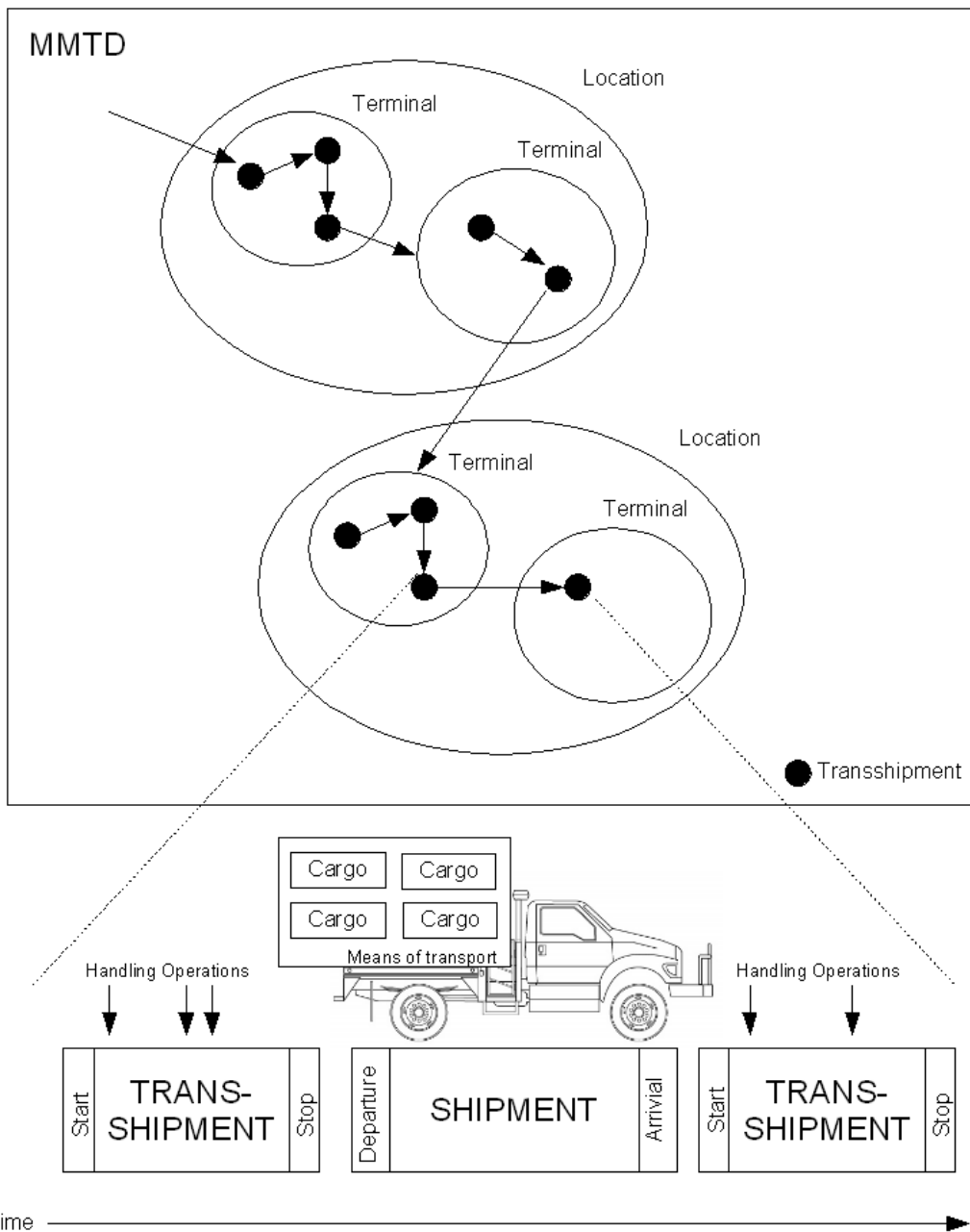
- stracklog.ZONE and mmttd.TERMINAL
- stracklog.BETWEEN\_ZONE\_MOVEMENT and mmttd.SHIPMENT
- stracklog.WITHIN\_ZONE\_MOVEMENT and mmttd.TRANSSHIPMENT

**Specification Data**

**Qualification Data**

**Building the Data Marts**

## Conceptual design



## **Definitions**

**Used UN/CEFACT Recommendations  
Recommendations 16**

**Recommendations 19**

**Recommendations 21**

**Recommendations 28**

## Used Terms

| Means of transport   |  |
|----------------------|--|
| <b>Definition</b>    | Particular aircraft, vehicle, vessel or other device used for the transport of goods or persons. |
| <b>Reference</b>     | UN Recommendation 28   |
| <b>Example</b>       | Lorry with licence number W-23542S   |
| <b>Code Examples</b> | Code: 51      RoRo/Container vessel<br>Code: 114      Lorry, flat, 15 tonne                      |

| Mode of transport    |   |
|----------------------|---|
| <b>Definition</b>    | Method of transport used for the carriage of goods.   |
| <b>Reference</b>     | UN Recommendation 19  |
| <b>Example</b>       | Lorry, flat, 15 tonne (Code 114) uses Road transport  |
| <b>Code Examples</b> | Code: 1      Maritime transport<br>Code: 2      Rail transport<br>Code: 3      Road transport |

| Multimodal transport |   |
|----------------------|---|
| <b>Definition</b>    | The carriage of goods by at least two different modes of transport. |
| <b>Reference</b>     | UN Recommendation 19  |
| <b>Example</b>       |   |

| <b>Shipment</b>   |   |
|-------------------|---|
| <b>Definition</b> | Cargo tendered by one shipper, on one bill of lading, from one point of departure, for one consignee, to one destination, at one time, via a single point of discharge. |
| <b>Reference</b>  | Schenker's Dictionary of International Trade 7 <sup>th</sup> Edition  |
| <b>Example</b>    |   |

| <b>Transshipment</b> |  |
|----------------------|--|
| <b>Definition</b>    | Shipment of goods to an intermediate destination, and then from there to yet another destination; done between two shipments, often used for changing mode of transport. |
| <b>Reference</b>     | EN Wikipedia: Transshipment  |
| <b>Example</b>       |  |

| <b>Consignment</b> |  |
|--------------------|--|
| <b>Definition</b>  | Shipment of one or more pieces of property, accepted by a carrier for one shipper at one time, receipted for in one lot, and moving on bill of lading. |
| <b>Reference</b>   | Schenker's Dictionary of International Trade 7 <sup>th</sup> Edition   |
| <b>Example</b>     |  |

| <b>Handling Operation</b> |  |
|---------------------------|--|
| <b>Definition</b>         |  |
| <b>Reference</b>          |  |
| <b>Example</b>            |  |

| <b>Location</b>   |  |        |               |        |                 |
|-------------------|--|--------|---------------|--------|-----------------|
| <b>Definition</b> | Any named geographical place, recognized by a competent national body, either with permanent facilities used for goods movements associated with trade, and used for these purposes. |        |               |        |                 |
| <b>Reference</b>  | UN Recommendation 16   |        |               |        |                 |
| <b>Examples</b>   | <table border="0"> <tr> <td>IT VCE</td> <td>Venice, Italy</td> </tr> <tr> <td>AT VIE</td> <td>Vienna, Austria</td> </tr> </table>  | IT VCE | Venice, Italy | AT VIE | Vienna, Austria |
| IT VCE            | Venice, Italy  |        |               |        |                 |
| AT VIE            | Vienna, Austria  |        |               |        |                 |

| <b>Location Function</b> |  |
|--------------------------|--|
| <b>Definition</b>        | Classifier code for the location. One Location may have multiple functions.    |
| <b>Reference</b>         | UN Recommendation 16   |
| <b>Example</b>           | Port, Airport, Inland Clearance Depot (ICD), Inland freight terminal, Location |

| <b>Good</b>       |   |
|-------------------|---|
| <b>Definition</b> | Method of transport used for the carriage of goods.     |
| <b>Reference</b>  | UN Recommendation 21                                    |
| <b>Example</b>    | Maritime transport, Rail transport, Road transport, ... |

| <b>Package</b>    |  |
|-------------------|--|
| <b>Definition</b> | <p>The complete product of a packaging operation, as prepared for transport and consisting of the packaging (receptacle, container) and its contained goods.</p> <p>The term package includes all articles used and, in particular, holders used as external or internal coverings for goods, holders on which goods are rolled, wound or attached, containers (other than those defined in international conventions) and receptacles. The term excludes means of transport and articles of transport equipment such as pallets and freight containers.</p> |
| <b>Reference</b>  | UN Recommendation 21   |
| <b>Example</b>    | Maritime transport, Rail transport, Road transport, ...  |

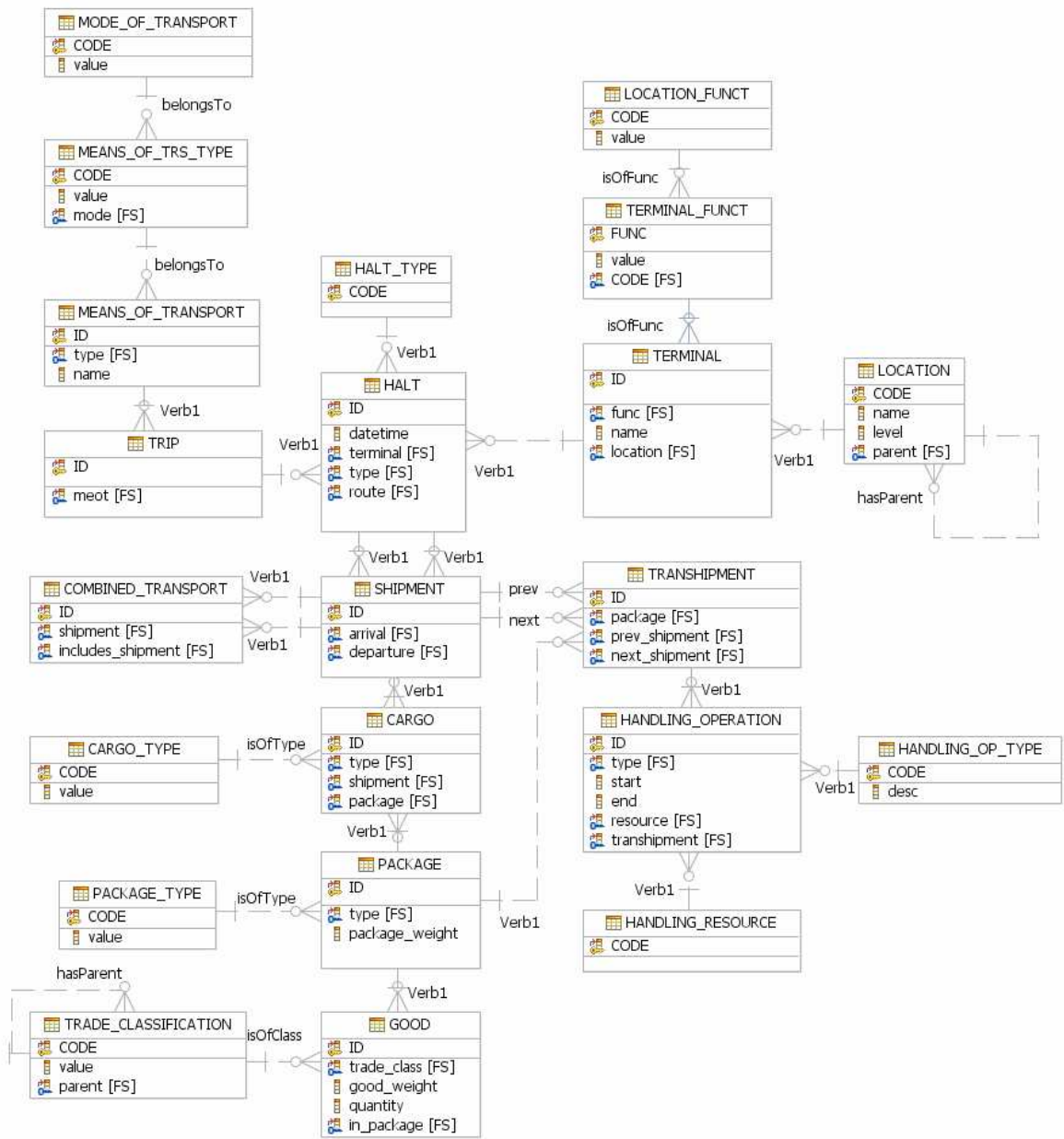
| <b>Package type</b> |  |
|---------------------|--|
| <b>Definition</b>   | The shape or configuration of a package as it appears for transport. |
| <b>Reference</b>    | UN Recommendation 21   |

|                |  |
|----------------|--|
| <b>Example</b> | <ul style="list-style-type: none"> <li>0 Bulk</li> <li>1 Loose, unpacked (excluding bulk)</li> <li>2 Rigid, box-type, (prismatic)</li> <li>3 Rigid, drum-type, (cylindrical)</li> <li>4 Rigid, bulb-type, (spherical)</li> <li>5 Rigid, other</li> <li>6 Flexible, bag-type</li> <li>7 (for future use)</li> <li>8 (Reserved)</li> <li>9 Other, or special packages</li> </ul> |
|----------------|--|

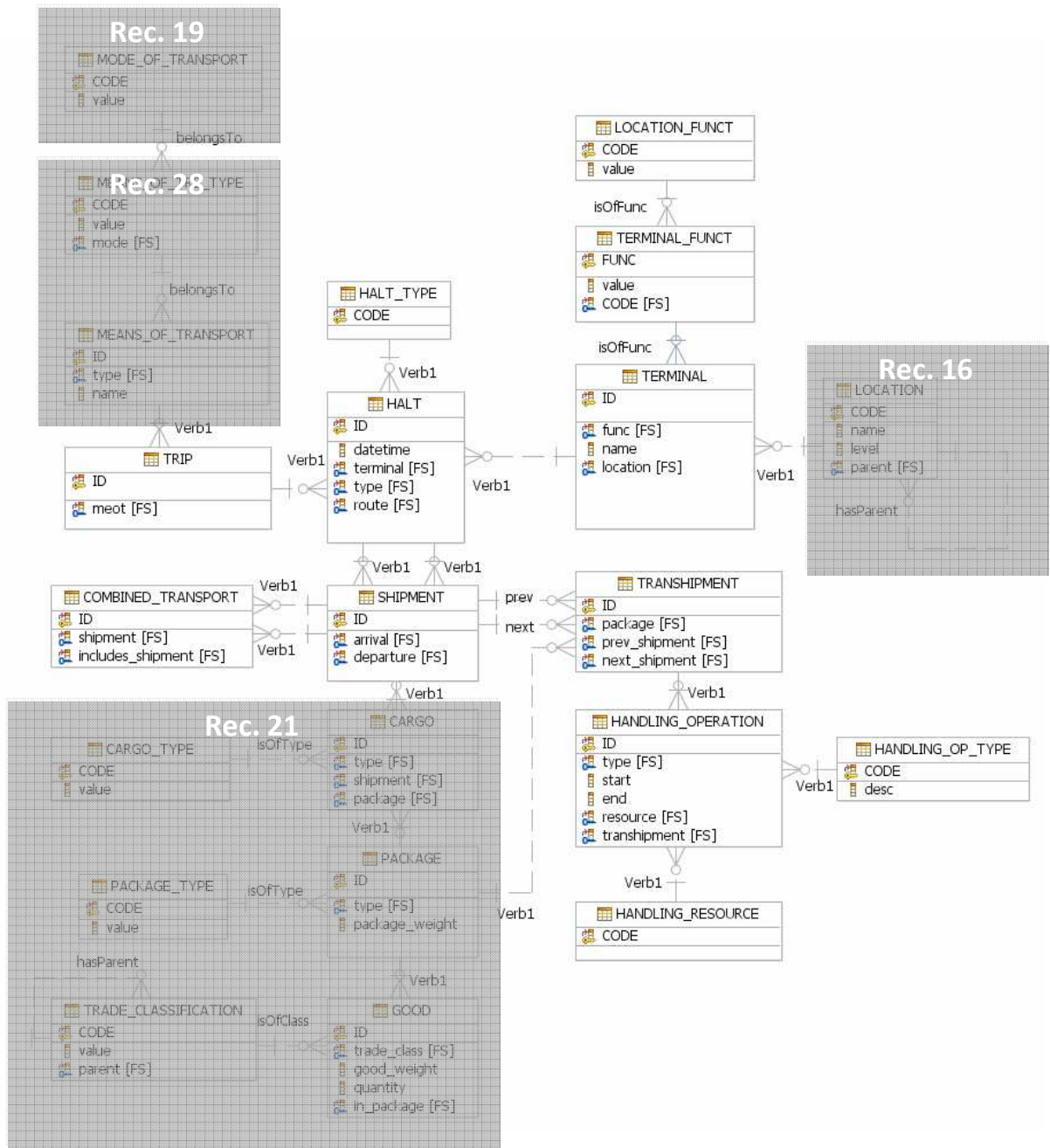
| <b>Cargo</b>      |  |
|-------------------|--|
| <b>Definition</b> | The load of goods carried on board a ship or on another means of transport |
| <b>Reference</b>  | UN Recommendation 21   |
| <b>Example</b>    |  |

| <b>Cargo type</b> |  |
|-------------------|--|
| <b>Definition</b> | A classification of cargo carried, or intended to be carried, on means of transport, based on its general appearance.  |
| <b>Reference</b>  | UN Recommendation 21   |
| <b>Example</b>    | <ul style="list-style-type: none"> <li>0 No cargo unit (liquid bulk goods)</li> <li>1 No cargo unit (solid bulk goods)</li> <li>2 Large freight containers</li> <li>3 Other freight containers</li> <li>4 Palletized</li> <li>5 Pre-slung</li> <li>6 Mobile self-propelled units</li> <li>7 Other mobile units</li> <li>8 Passengers</li> <li>9 Other cargo types</li> </ul> |

# Entity Relationship Diagram



## Coverage of UN/CEFACT Recommendations



**Deliverables**