Use Case Document

Parking Data Specification Technical Documentation

Version 4.0 Release

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Version Control

Date	Version	Status
16 August 2018	1.0	First release for consultation
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03 June 2021	3.0	Release 3.0 – for public review
07 June 2022	4.0	Release 4.0 – final

Contents

Introduction

The Alliance for Parking Data Standards (APDS) is managing the creation of a consensus - built international parking and kerbside data specification to establish a common language for data concepts and definitions in the parking, transportation, and mobility sectors that will facilitate seamless integration, compatibility, and communication between parking entities, the automotive sector, IT developers, services, and map and app providers, as well as other stakeholders. In addition, APDS has proposed these specifications to ISO as the basis of a future ISO global standard.

APDS Technical Documentation

The APDS Technical Documentation describes a set of data concepts and definitions that public and private parking owners, operators, service providers can adopt and use as a common language to facilitate the communication of data between themselves and other sectors.

The specification comprises a set of documents that define the various data related to parking and kerbside management operations and show the relation of these data to each other. The documentation includes the following documents and information:

- Information Model Document:
    - List of data namespaces and classes
    - Defined lists of acceptable entries for certain data elements
    - Identified references to other standards, as appropriate.
    - Relationship diagram showing how the data is organized and expected to be sent
- Use Case Document: example use cases for applying the data specification.
- Data Dictionary Document: Terminology and definitions for the data elements

The present document is the Use Case Document.

This document seeks to define common international definitions of data concepts, and their relationship for parking operations and other related activities. These definitions have been drawn from several existing sources of information and existing specifications and standards, including:

- Technical documentation supplied by the International Parking & Mobility Institute
- Technical documentation drawn from the Dutch National Parking Register
- Technical documentation supplied by the British Parking Institute
- CEN DATEX II Standards, in the CEN 16157 series

The data concepts defined in this document are modelled using UML (Unified Modeling Language) in a form that substantively aligns with the modelling approach defined in Part 1 of the CEN DATEX 16157 series (EN 16157-1:2018). Adaptations to this approach are defined in Annex B.

Use Cases and Examples

Analyzing Use Cases is an important and valuable means of understanding functional requirements. APDS employs this technique to identify and validate the elements of the data model supporting the specifications. Use Cases also help illustrate the scope and purpose of the APDS specifications. This document contains several Use Cases that are designed to:

- Describe 'real world' parking and mobility sector scenarios.
- Illustrate potential data model applications.
- Clarify the use of specific data domains.

Other Use Cases may be added as the data model is developed.

A number of Examples have been developed from these Use Case. These Examples are designed to contextualize the data model, showing how the model links to the Use Cases.

Together, the Use Cases and the Examples describe the range and types of data included within the scope of the APDS specifications.

Please note that the Use Cases or Examples are for illustration only and there is no suggestion that they describe actual data requirements or preferred data exchanges.

All Use Cases and Examples assume a request/response exchange model. However, this is for illustration only and the specifications are relevant to other methods of communication.

Data Exchange Examples

1. Place Domain Examples

C.1.1.1 Overview

A core domain of the data model is the identification and characteristics of locations related to parking or mobility operations. 'Parking locations' vary in structure and definition (e.g., a single structure, a number of structures or a part of a city organized as a zone) and this, coupled with the widespread use of the term "location" in standards to refer to a single point has led this document to use the term '*Place'*. A Place is defined as *where a vehicle may park, stand, rest, or briefly transit to allow a person to change modes of transport (i.e., taxi drop-off/pickup, ride share drop-off/pickup, valet stand, etc.)*.

This document defines a method to build a hierarchy of *Place* records. This enables an operation to breakdown a *Place* into discrete enclosures or operating areas to better communicate operating hours, space counts, operating restrictions, location, and pricing and utilization information in a consistent manner.

C.1.1.2 Find places within a radius of a specific location

C.1.1.2.1 Requirement

The data requestor defines the geographical area in which they are interested to identify a specific *Place* (with a radius) or *Places* within a polygon.[1] The request may contain other criteria to filter the search result set (for example, the request may include the arrival time, which would then exclude the appropriate *Campus, Place*, *SubplaceElement* and *IdentifiedArea* hierarchy components closed at the time of arrival).

Example 1: the service provider requests information for any *Campus, Place, SubplaceElement or IdentifiedArea* in a radius of a specific point. (i.e., 200 metres or 220 yards of a latitude/longitude point).

Example 2: the aggregator defines the polygon that follows the city limits and requests *Place(s)* within the polygon.

C.1.1.2.2 Data Request Example

The request will include a coordinate or polygon that defines the area of interest – for example:

- Spatial coordinates (including coordinate referencing system) – this may typically be latitude/longitude using WGS84/GPS,
- Radius of the request, or
- Polygon Shape.

Other requirements may be used to filter the search response.

[1] Note it is outside the scope of this specification to provide anything other than the locations containing *Campus, Place*, *SubplaceElement, and/or IdentifiedArea* . In the use cases described, the geographical areas of interest are created by the data requestors from data not related to parking (i.e., a specific building location and the city limits respectively).

C.1.1.2.3 Data Response Example

The response will be a list of candidate *Campus, Place*, *SubplaceElement, and/or IdentifiedArea*, including details such as:

- Spatial coordinates (including coordinate referencing system) –typically a latitude/longitude using WGS84/GPS.
- Distance from requested point (if a radius).
- *Campus, Place, SubplaceElement, IdentifiedArea* identifier (provided by the responder to enable further requests to be made).
- Physical Location/ Street Address (a human readable identifier).
- Name of the *Place* or *SubplaceElement* (a human readable identifier).

The sequence involved in this request/response may follow Figure C.1.

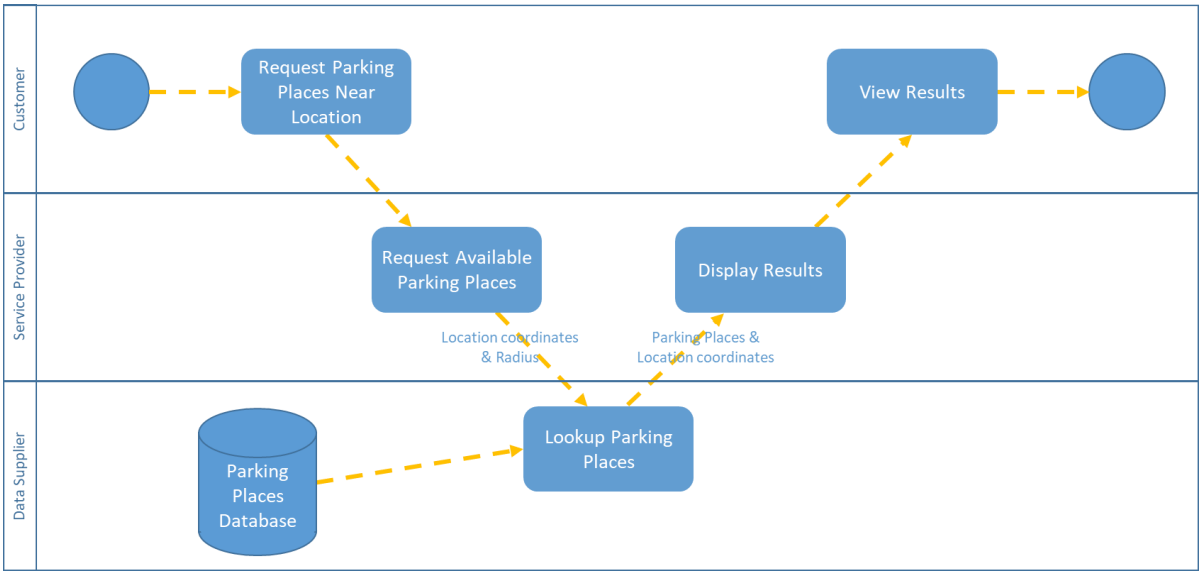

Figure C. 1 - Find places within a radius of coordinates - sequence example

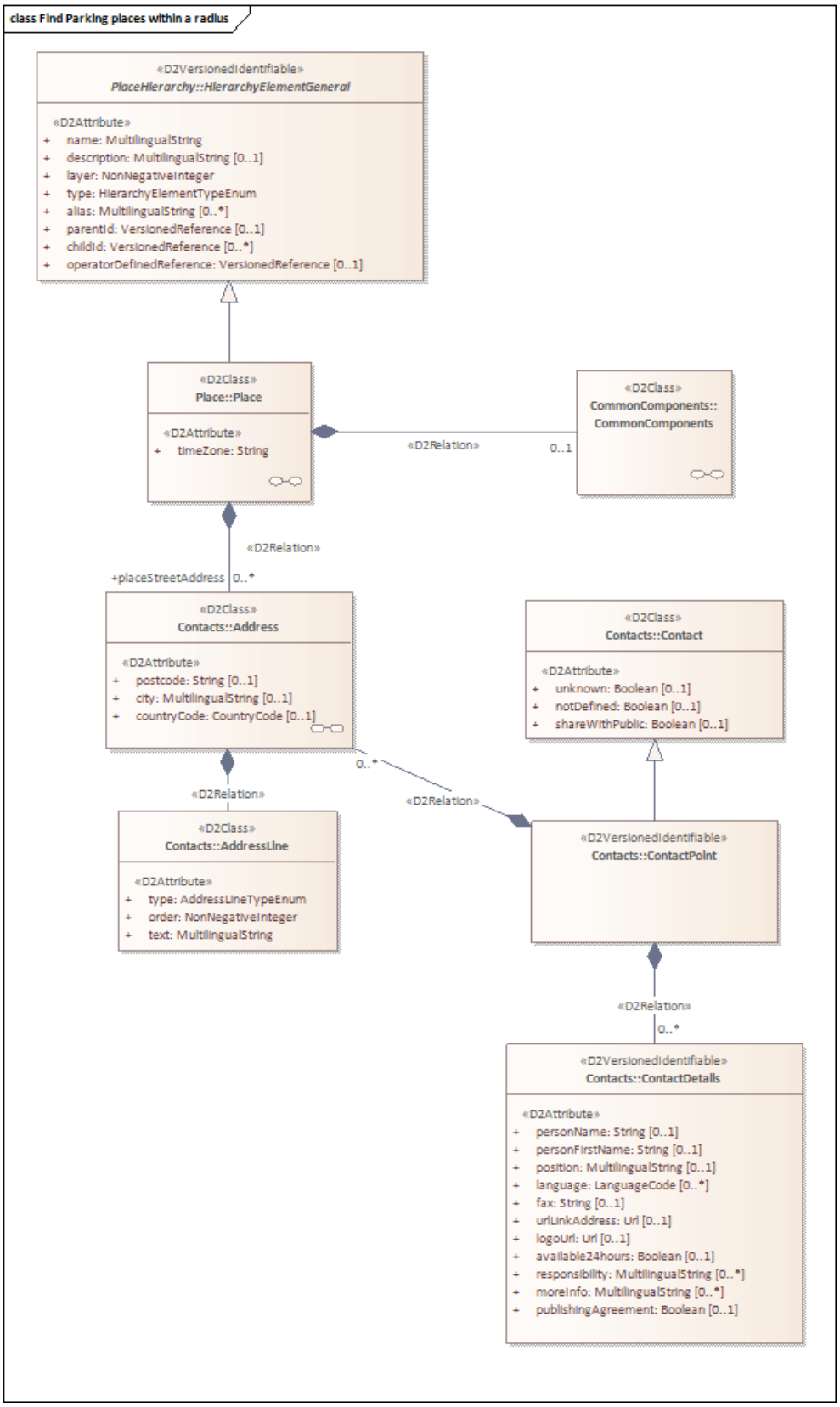

Figure C.2 - Find places within a radius – information data model (class) view

Figure C.2 shows the key UML classes used in this example.

C.1.1.3 Retrieving Information on an Identified Place

C.1.1.3.1 Requirement

Data exchanges require detailed data to be exchanged about a requested *Place* or *SubplaceElement* including operating restrictions, credentials, payment options, open/closing times – availability times, etc. Each has a slightly different specific data requirement. This use case provides general information about a Place. An entity could also use the Quote domain to retrieve specific information and eligibility for specific Right specification and Rates at the Place.

C.1.1.3.2 Data Request Example

The request must identify the *Place* but may include other elements as required:

- Place Identifier (e.g., name, specific position).
- SubplaceElement identifier (provided by the responder to enable further requests to be made).
- Date/Time of the desired session.
- Request originator (may be required if only contracted requestors will be replied to).
- Data requested.

C.1.1.3.3 Data Response Example

The response will be tailored to the information requested. For example, a typical response will include the following detail:

- Place name.
- Operating hours.
- Operator (or Brand Name).
- Spatial coordinates for the Place entrance (including coordinate referencing system) – e.g., latitude/longitude using WGS84/GPS.
- URI to Map.
- Type of facility, (garage, surface).
- Contact information.
- Phone number.
- Information source (may not be the same as the owner of the Place).
- Reservation available (yes/no).
- Payment service accepted (i.e. – would customer's payment service be able to pay on his behalf?).

C.1.1.4 Find a place where I can use a specific payment method

C.1.1.4.1 Requirement

Many Place requests refer to a method of payment:

- A connected car is acting as the payment provider on the customer's behalf.
- A data aggregator lists all payment methods accepted at each Place.
- A web/mobile platform provider lists acceptable payment methods and service providers acting as payment providers

C.1.1.4.2 Data Request Example

The request includes a method of payment and may include a named *Place* or *SubplaceElement or IdentifiedArea*:

- Method of payment required.
- Place, SubplaceElement, IdentifiedArea identifier.
- Date/Time of the required session (e.g., cashiers may only work during certain hours).
- Data requested.

C.1.1.4.3 Data Response Example

- Spatial coordinates (including coordinate referencing system) – this may typically be latitude/longitude using WGS84/GPS.
- Place, SubplaceElement, IdentifiedArea identifier (provided by the responder to enable further requests to be made).
- Physical Location/ Street Address (a human readable identifier).
- Name of the Place (a human readable identifier).
- Payment method result.

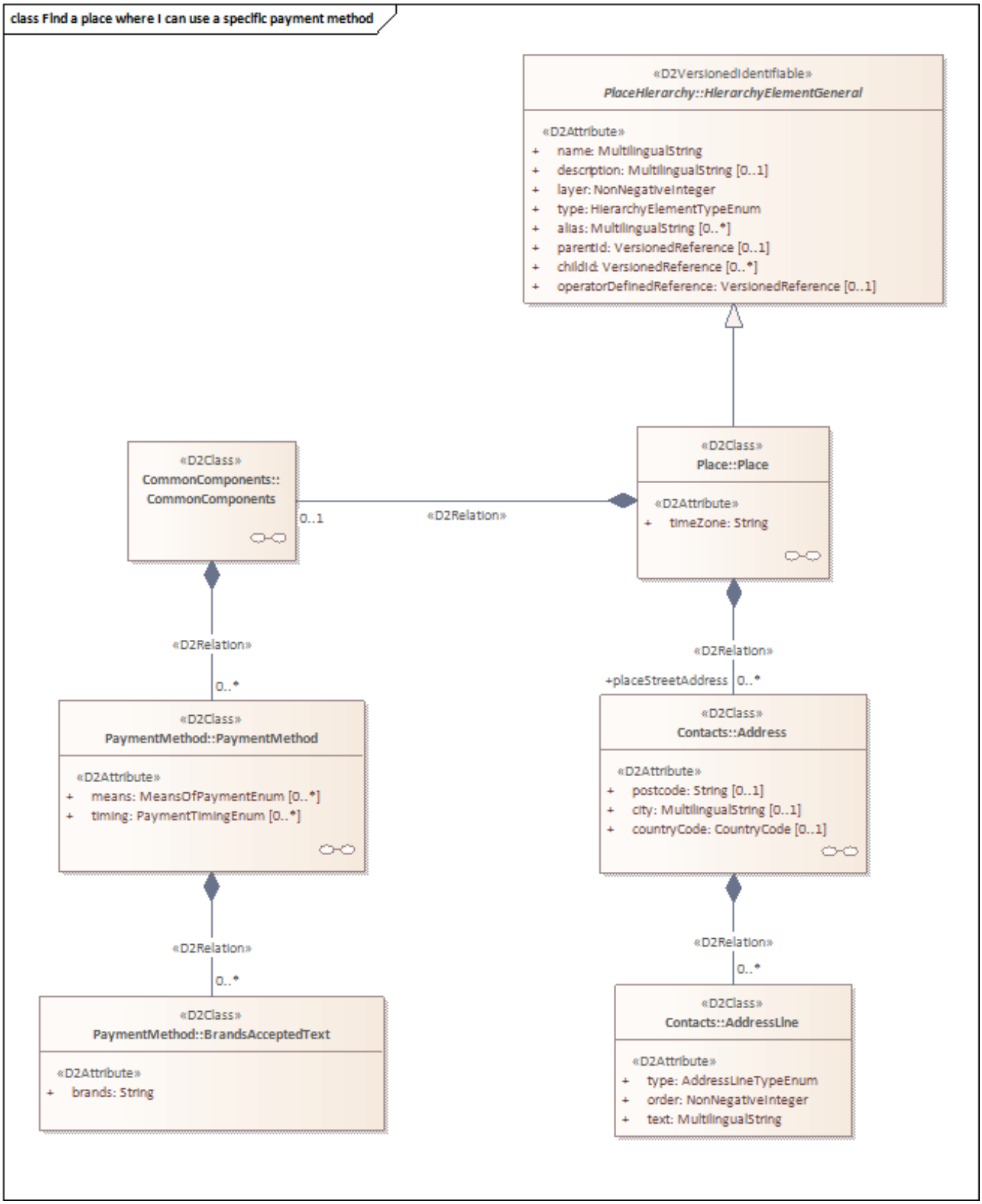

Figure C.3 - Find a place where I can use a specific payment method – data model (class) view

Figure C.3 shows the key UML classes used in this example.

C.1.1.5 What are the hours of operation for this car park?

C.1.1.5.1 Requirement

Place data requests require data on operating times. These can be very complex, varying by:

- Day of the week, month, or year.
- Opening at certain times to a limited group of eligible customers (e.g., out of hours access for residents only).
- Differing opening times for entry and exit.
- Differing access arrangements by time of day (e.g., certain entries closed, emergency release arrangements, etc.)

A typical connected car can make a relatively simple request – when is the Place open? Bearing in mind that a typical parking event may involve an overstay, the exchange should be more nuanced. The connected car might have to exclude a Place that closes 5 minutes before a customer leaves.

This use case provides general information about a Place. An entity could also use the Quote domain to retrieve specific information and eligibility for specific Right specifications and Rates at the Place.

C.1.1.5.2 Data Request Example

- *Place, SubplaceElement, IdentifiedArea* identifier
- Anticipated arrival date/time.
- Anticipated departure date/time.
- Place access/exit closure time.
- Out of hours emergency access arrangements.

C.1.1.5.3 Data Response Example

- Place status at anticipated arrival date/time.
- Place status at anticipated departure date/time.
- Place access/exit closure time.
- Out of hours emergency access arrangements.

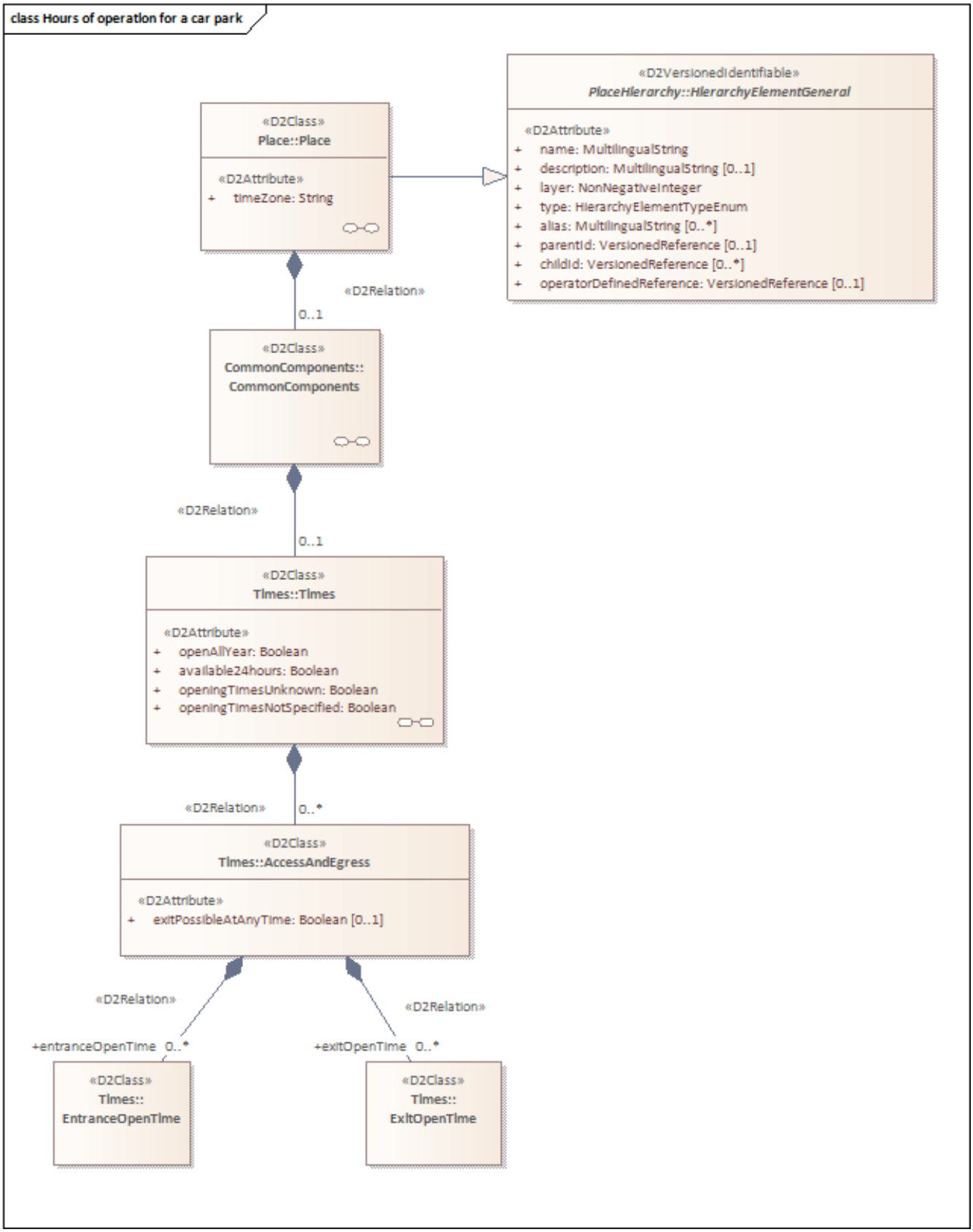

Figure C.4 - Hours of operation for a car park – data model (class) view

Figure C.4 shows the key UML classes used in this example.

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C.1.1.6 Update place information

C.1.1.6.1 Requirement

Updates can be performed two ways.

1. “Full” - Replace all data previously supplied, requiring the data requestor to archive or delete an entire record before replacing with newly supplied data
2. “Change” - Replace only that data that has been newly supplied. In this case:
    - New data overwrites existing data.
    - Where existing data is not overwritten it remains valid,
    - Where existing data should be removed but not replaced with new data, this will be identified.[2]

In both methods, the specification supports a model where the requestor can ask for the type of update they require; either “Full” or “Change”.

C.1.2 Occupancy

C.1.2.1 Overview

Place is largely concerned with ‘static’ elements of a location or facility. *Occupancy* provides a more dynamic view for these data concepts, providing data on the number of spaces that are available at a specific moment, as well as the number of those spaces that are in use.

C.1.2.2 Occupancy (Supply)

C.1.2.2.1 Requirement

Assume an entity publishes Supply data for on-street space availability for Main Street to various aggregators and service providers. Main Street has an 84 metre (275 feet) parking area on each side of the street but for a 2-week period, street works will reduce the total available area length on one side of the street to 20 metres (65 feet).

WebleyParking.com publish the entity’s parking data on their website. They calculate on-street parking spaces for non-demarcated bays on the basis of 6 metres (19 feet) average per space. On receipt of the update, they reduce the number of spaces their website lists for Main Street from 28 ((84 metres *2 sides)/ 6 metres) to 17 ((84 metres + 20 metres)/ 6 metres). When the work is finished, a further update indicates that the bay has been restored to its former length and WebleyParking.com restores the total number of spaces to 28.

C.1.2.2.2 Structured message content

- *Place, SubplaceElement, IdentifiedArea* identifier from the Place description of the parking bay – This may need to identify the specific bay that is to be restricted
- Supplyqty = number of spaces usable
- SupplyViewType=vehicleview (space count is derived based on estimate of space length)
- startValidUsagePeriod – the date/time that the new value is valid
- endValidUsagePeriod – the date/time that the new value expires

[2] For every field to be nulled, a null identifier can be provided. This will have to correspond to the data type of the supplied field, e.g., in the case of a string this could be "##Null##"; for an integer -99999; for a date/time 01/01/1000 00:00:00 and so on.

C.1.2.3 Occupancy (Demand)

C.1.2.3.1 Requirement

WebleyParking.com publish “live” occupancy figures for all Chicago car parks that will supply WebleyParking.com with data. Corporate Parking (a 600-space parking garage on Van Buren St) publish their supply and demand data to WebleyParking.com every 5 minutes. Each update includes the date and time (of update), the update frequency and the number of spaces in use. This information is then featured in WebleyParking.com’s website listing for the garage. Corporate Parking provides demand in aggregate view and not by individual space

C.1.2.3.2 Structured message content

- *Place, SubplaceElement, IdentifiedArea* identifier from the Place description.
- RecordDateTime: timestamp (Date/time)
- DemandType.Count: aggregate utilized space count
- Frequency of update
- occupancycalculation: how the utilization was determined (counted, derived, expected, verified)

C.1.3 Rate

C.1.3.1 Overview

Rate is related to the ability to define and communicate a table of fees related to parking and other mobility operations.

Rates are built from several elements that combine to identify the fee to be applied to a specific customer, at a specific *Place*, for a specific *RightSpecification.* The specification defines a method that uses a number of elements to build a *Rate*. This *Rate* can then be applied to an *AssignedRight* and associated to a *Session* to identify the amount to be charged. The *Rate* specification only defines how to communicate fee structures between parties. Use the *Quote* domain to communicate specific fees based on the desired use of a *Rate* at a specific time interval.

C.1.3.2 Rate Concepts

The data model contains several key concepts (each is explained further in the data model).

C.1.3.2.1 Rate Line

This is equivalent to a single line on a *Rate* table (e.g., $1 per 30 mins, £3 for 3 hours or €20 per day). *Rate Lines* may be ‘Flat’ (the line is to be applied without a test) or ‘Tiered’, where the line will be tested to determine its applicability.

C.1.3.2.2 Rate Line Collection

This is a group of related *Rate Lines* that together describe the fee structure for a specific situation (for example, Up to 1 hour $1.20, 1 - 2 hours $2.20, 2 - 3 hours $3.00, maximum 3 hours)

C.1.3.2.3 Rate Table

A group of logically coherent *Rate Line Collection*(s) (i.e., grouping of rate lines) that apply to an *IdentifiedArea* or *SubplaceElement*. A *Rate Table* is composed of one or more *Rate Collections*

The nearest analogue equivalent to a *Rate Table* is the traditional tariff board outside a car park. However, whilst a tariff board may describe the fees charged to a number of different customer

types (e.g., customers with a reservation, customers with a membership, public parking, weekend parking, daily parking, evening parking, etc.) the *Rate Table* is a single set of fees that can be applied to one or more customer types.

C.1.3.2.4 Rate Matrix

To facilitate transfer of a large amount of information on multiple *Places*, *Rate Tables* for unrelated *Place* hierarchies can be combined.

C.1.3.2.5 Rates and Taxes

Applying taxes to parking and mobility services can be complex. Whilst in Europe the application of Value Added Tax (VAT) is reasonably straightforward, in some jurisdictions there may be more than one tax to be applied, *Rates* may differ between parking and mobility services (for example valet) and the order in which taxes are applied is important. In addition, application of a tax may depend on where the sale is being made.

The specification allows for taxes to be applied at different points. For example, a customer has incurred the following charges (before tax) for parking and car cleaning:

Parking (2 days): $30
Car wash: $15

Local sales taxes include:

Table C.1— Example – Local sales taxes

Tax Name	Applied to	Rate
Parking Tax	Parking charges	4%
Services tax	Services (not including parking)	5%
Sales tax	All sales (including specific taxes)	10%

The specification allows taxes to be applied on lines and totals. In this example, taxes are applied as follows:

Table C.2— Example – Application of local sales taxes

Charge	Amount	Tax Rate	Tax Amount	Subtotal	Tax described
Parking (2 days)	$30	4%	$1.20	$31.20	Rate Line
Car wash	$15	5%	$0.75	$15.75	Rate Line
Subtotal	$46.95	10%	$4.70	$46.95 + $4.70	Rate Line Collection
Total (including taxes)				$51.65	

C.1.3.3 Creating Rate Tables

Rate Tables are applied to a number of different scenarios, each describing a range of times when a customer may be present in the *Place* and the fee for a length of stay[3]: The appropriate rate table is identified based on the *Eligibility* requirements of the *Rate* table

C.1.3.3.1 Scenarios

The following describe four different rates based on day and time of day as depicted in Table C.3

1. Rate 1 for vehicles accessing facility between 07:00 and 17:59 Monday to Saturday
2. Rate 2 for vehicles accessing facility between 18:00 and 23:59 Monday to Saturday Rate
3. Rate 3 for vehicles accessing facility between 07:00 and 23:59 on Sunday
4. Rate 4 for vehicles accessing facility between 00:00 and 06:59 (no entry during this time)

Table C.3— Example Rate Tables 1-4

Time Parked	Monday to Saturday 7am to 6pm	Monday to Saturday 6pm to midnight	Sunday 7am to Midnight	Overnight (7 days) Midnight to 7am
	Rate Table 1	**Rate Table 2**	**Rate Table 3**	**Rate Table 4**
Up to 1 hour	€ 3.20		€ 1.50	€ 0.50
Up to 2 hours	€ 4.20	€ 2.00		€ 1.00
Up to 3 hours	€ 5.00		€ 2.00	€ 1.50
Up to 4 hours	€ 5.50	€ 4.00		€ 2.00
Up to 5 hours	€ 6.50		€ 6.50	€ 2.50
Up to 6 hours	€ 7.50	€ 5.00		€ 3.00
Up to 7 hours	€ 8.50		€ 8.50	€ 3.50
Up to 8 hours	€ 11.00		€ 11.00	
Up to 9 hours	€ 13.00		€ 13.00	
Up to 17 hours	€ 17.00		€ 17.00	

In addition, the operator charges a fee and a different *Rate* for customers that have reserved a space before entering the car park. This results in four further scenarios:

1. Rate 5 for a reservation and vehicles accessing facility between 07:00 and 17:59 Mon to Sat
2. Rate 6 for a reservation and vehicles accessing between 18:00 and 23:59 Mon to Sat
3. Rate 7 for a reservation and vehicles accessing between 07:00 and 23:59 on Sunday
4. Rate 8 for a reservation and vehicles accessing between 00:00 and 06:59 (cars cannot enter during this time)

The resulting *Rate Matrix* has eight *Rate Tables*, corresponding to each of the above scenarios.

Use of a *Rate table* is based on the expected or actual use time as defined in *RateTable.overallPeriod* and *RateTable.period*.

[3] Taxes are not included in this example for clarity.

The date and time the customer entered (for Rate Tables 1 -3 & 5 – 7) or whether the vehicle was present at the qualifying time (07:00 for Rate Tables 1,3, 5 & 7)

Table C.4— Example – Rate tables 5 – 8

	Scenario (time entered)			
Time Parked	Monday to Saturday 7am to 6pm	Monday to Saturday 6pm to midnight	Sunday 7am to Midnight	Overnight (7 days) Midnight to 7am
	Rate Table 5	**Rate Table 6**	**Rate Table 7**	**Rate Table 8**
Reservation Fee	€ 2.00	€ 2.00	€ 2.00	€ 2.00
Up to 1 hour	€ 3.00	€ 0.50		
Up to 2 hours	€ 3.00	€ 1.00		
Up to 3 hours	€ 4.00	€ 1.50		
Up to 4 hours	€ 4.50	€ 2.00		
Up to 5 hours	€ 5.50	€ 2.50	€ 5.00	
Up to 6 hours	€ 6.50	€ 3.00		
Up to 7 hours	€ 7.50		€ 6.00	€ 2.00
Up to 8 hours	€ 10.00			
Up to 9 hours	€ 12.00			
Up to 17 hours	€ 16.00		€ 8.00	
Notes:Whether the vehicle was present at the qualifying time of 00:00 (for Rate Tables 4 & 8)[4] Whether the customer had a reservation on entry.				

Using the specification defined in the Rate domain, the *Rate Lines* contain information on the sequence, value, duration start and end. *Rate Tables* 5 - 8 also have *Rate Line Collections* with flat *Rate Lines*, the reservation fee, that are charged irrespective of the amount of time spent in the car park. The *Rate Lines* in *Rate Line Collections* for *Rate* Tables1 & 5 are shown in Table C.4 and Table C.5

Table C.4 -Rate Lines and Rate Collections in Rate Table 1

Rate Line Collection Sequence	Rate Line Type	Rate Line Sequence	Value	Duration Start (secs)	Duration End (Secs)
1	FlatRateTier	1	€3.20	0	3599
1	FlatRateTier	2	€4.20	3600	7199
1	FlatRateTier	3	€5.00	7200	10799
1	FlatRateTier	4	€5.50	10800	14399
1	FlatRateTier	5	€6.50	14400	17999
1	FlatRateTier	6	€7.50	18000	21599
1	FlatRateTier	7	€8.50	21600	25199
1	FlatRateTier	8	€11.00	25200	28799
1	FlatRateTier	9	€13.00	28800	32399
1	FlatRateTier	10	€17.00	32400	61199

[4] Note that a customer who qualifies for Rate Table 4 or 8 will also be liable for fees based on one or more of the other Rate Tables depending on when they enter and leave the car park.

Table C.5 - Rate Lines and Rate Collections in Rate Table 5

Rate Line Collection Sequence	Rate Line Type	Rate Line Sequence	Value	Duration Start (secs)	Duration End (secs)
1	flatRate	1	€2.00	N/A	N/A
2	FlatRateTier	1	€3.00	0	3599
2	FlatRateTier	2	€3.00	3600	7199
2	FlatRateTier	3	€4.00	7200	10799
2	FlatRateTier	4	€4.50	10800	14399
2	FlatRateTier	5	€5.50	14400	17999
2	FlatRateTier	6	€6.50	18000	21599
2	FlatRateTier	7	€7.50	21600	25199
2	FlatRateTier	8	€10.00	25200	28799
2	FlatRateTier	9	€12.00	28800	32399
2	FlatRateTier	10	€16.00	32400	61199

C.1.3.4 Using the RateTable to calculate a fee for an AssignedRight and Session[5]

The *RateTable* featured in Table C.5 can be used to calculate the fees. In an example, the customer reserved a space and paid in advance for four hours. The customer enters the car park at 13:41 and stayed for five hours and thirty-one minutes. The proposed fees can be derived by an entity collecting the specific rate table data and calculating the appropriate tariff based on the rate data or by using the Quote data domain to request tariff results based on relevant inputs in the quote request.

Based on the time the vehicle entered the Place (and with the reservation fee), the fee is calculated based on RateTable 5. Since the vehicle is not present in the car park at 00:00, it is not liable for fees based on RateTable 8.

The initial fee for four hours (paid at the time of reservation) is calculated as follows:

Table C.6 –Initial Fee Calculation

Advertised Rate	**Amount**	**Rate Collection Sequence**	**Rate Line Sequence**	**Rate Line Type**	**Duration Start (secs)**	**Duration End (secs)**
Reservation (Flat Fee)	€2	1	1	Flat	N/A	N/A
3 - 4 hours	€4.50	2	4	Tiered	10800	14399
Total Fee	*€6.50*					

The final fee is comprised of the flat fee plus the fee from *Rate Line* sequence 6 (5 – 6 hours):

[5] Note that fee calculations for individual transactions will be covered in a future revision of this document. This example is for illustration only.

Table C.7 – Final Fee Calculation

Advertised Rate	Amount	Rate Collection Sequence	Rate Line Sequence	Rate Line Type	Duration Start (secs)	Duration End (secs)
Reservation (Flat Fee)	€2	1	1	Flat	N/A	N/A
3 - 4 hours	€6.50	2	6	Tiered	18000	21599
Total Fee	*€8.50*					

C.1.3.4.1 Requirement

Two exchanges of data are required:

- The initial customer request for information, reservation, and fee payment
- The final reconciliation and payment as (or just after) the customer departs.

Each will be a series of messages and responses.

C.1.3.4.2 Data Request example

For the initial customer request and payment, the first data request may include:

- *Place, SubplaceElement, IdentifiedArea* identifier (see Example A).
- Desired Rightspecification
- Quote request time
- Known eligibility requirement
- Anticipated arrival date/time.
- Anticipated departure date/time.
- Reservation request.
- Payment Service Provider name.
- The above represents a QuoteRightRequest or a QuoteSessionExtension Request

C.1.3.4.3 Data Response example

The corresponding response may include:

- Fee quotation for requested Rightspecification
- Quote expiration time.
- Whether the quoted payment service provider is an acceptable method of payment.

Further message exchanges are required to confirm payment and reservation.

C.1.3.5 Publishing Rate Tables

Whilst in some cases the calculation of charges is performed by the operator, there are other scenarios in which fees are calculated by others. This alternative case requires that the aggregator receive full information on the *Rates* charged at a *Place* in order that they can advertise and calculate the charges on their site. This potentially involves creating a human readable fee table (as found on signs at the entrance to car parks), and/or calculating a fee based on anticipated use (similar to the way hotel aggregators advertise room fees).

The *Rate Matrix* can be used to create a bulk update on all *Rate* information for multiple *Places* (for example all car parks managed by an operator).

C.1.3.5.1 Requirement

The recipient in both cases needs to receive all relevant *Rate* information related to a *Place* in order that they are able to re-construct the *Rate* table and calculate a specific fee.

C.1.3.5.2 Data Request example

- *Place, SubplaceElement, IdentifiedArea* identifier (previously provided by the responder to enable further requests to be made).
- Ratetable.overallPeriod.start for which rate information is required.
- Ratetable.overallPeriod.end for which rate information is required.
- Customer Types for which the rate information is required.

C.1.3.5.3 Data Response example

The response will need to provide the full *Rate* structure in order to fully describe *Rates* and *Eligibility.*

C.1.3.6 Eligibility

Eligibility describes tests to determine the applicability of a *Rate Table* to a customer (e.g., *Eligibility* based on vehicle type, use of a previous *Rate Table*, customer membership (i.e., resident, office employee, work in a specific department of a company), etc.) via the *RightSpecification*. *Eligibility* is determined from individual tests (Criteria) grouped into *Qualifications*, which are then further grouped into *Qualification* sets.

C.1.3.7 Right

A *Right* is the authorisation for a vehicle, individual, or entity to use a specific *Place* via a *Credential* at a specific *RateTable* while performing specific activities (parking, loading, delivery, etc.*)*. *RightSpecifications* cover the full range of operating authorisations from single use (for example, a cash payment at a parking terminal allowing parking for a specific length of time) to multiple use by a range of vehicles (for example rights allocated by an employer to employees).

C.1.3.8 RightSpecification

Rights are defined through a *RightSpecification*. The RightSpecification is essentially the 'template' of a *Right* as defined by the *Place* owner and defines the operating parameters for parking or mobility activities (Delivery, pick-up/drop-off, electric vehicles only, etc.). It explicitly defines the abilities that the owner or manager of a *Place* grants to specific users (i.e., park, delivery, pickup, etc.) and charged based on a specific *RateTable*. A *RightSpecification* is the combination of operating privileges, *RateTable*(s), at *Place*(s), during a specific time period for a type of user or vehicle. *RightSpecifications* will have the following characteristics:

- A unique identification within a *Place.*
- A description of the permission (Rightspecification) being granted.
- A type: allowing permissions (Rightspecification) to be grouped (e.g., Parking, Delivery, Ride Share, etc.).
- An expiration: the date/time when the right is no longer valid for any user as defined by the *Place* owner.
- A Creator: the entity, typically the *Place* owner that defines and authorizes the *RightSpecficiation*.
- Authorized credential types to prove access to a specific *RightSpecification*.

C.1.3.8.1 Defining Simple RightSpecifications

A simple *RightSpecification* for a *Place* may include:

a. Eligibility: All Passenger cars are eligible
b. Rates:
   (1) Early Bird special (in by 07:00 out by 15:00) £18
   (2) Hourly Rate £2 for 1st hour; £3 per hour up to 24 hours
   (3) Evening Parking (in after 19:00, out by 06:00) £15

A single *Place* may have more than one *RightSpecification* with different *Eligibility*, for example:

i. RightSpecification A:
   a. Eligibility: Public users, passenger vehicles
   b. Rates:
      (1) Daily parking $2 per hour no limit
      (2) Early bird special (in by 7am out by 3pm) $20 (flat rate)
      (3) Weekend rate ($1.5/hour) Saturday and Sunday only

ii. RightSpecification B:
   a. Eligibility: Residents of the building
   b. Rates:
      (1) Reserved monthly rate $200/month
      (2) Unreserved monthly rate $150/month
      (3) Daily rate ($7/day)
      (4) Guest validation up to 4 hours of parking ($5)

C.1.3.9 Assigning and Holding Rights

A *RightSpecification* is used to grant an *AssignedRight* to a specific *RightHolder* by an *AssignedRight.issuer*. The *AssignedRight.issuer* can be the *Place* owner, a reservation service, or other entity authorized to sell or distribute the *RightSpecification* on behalf of the *Place* owner. When a *RightSpecification* is granted to a specific *RightHolder*, an *AssignedRight* is created.

The *AssignedRight* includes the information from the *RightSpecification* as well as specific information related to the *RightHolder* (expiration of the *AssignedRight*, number of uses, etc.). When a specific, future use of the *AssignedRight* is initiated a *PlannedUse* is generated.

C.1.3.9.1 Defining an AssignedRight

The data concepts within the *AssignedRight* are:

Place: “Parking Defense1”.

RightSpecification: Created by the owner/operator of “Parking Defense1”, the *RightSpecification* includes details of *Eligibility* and *Rate* for customers who reserve a space, times (operating hours and times of valid use of *RightSpecification* and Rates), approved credentials

AssignedRight.Issuer: This may also be the owner/operator, or the service provider used by the car (if a contract authorises the service provider to sell spaces on behalf of the owner/operator).

RightHolder: In this case the *RightHolder* is likely to be the vehicle as the *AssignedCredential* is the vehicle’s license plate.

Issue Dates and times: when the *AssignedRight* was issued.

PlannedUse: When the *AssignedRight* includes a reservation for future use, a *PlannedUse* is generated that will include dates and times of when the reservation is valid.

C.1.3.9.2 Defining AssignedRights and multiple uses

In some cases, an *AssignedRight* can include the ability to perform a specific action multiple times (ex, an individual prepays for five (5) parking events). These future uses are defined as *PlannedUses*.

The following are two examples of where *AssignedRights* are used to grant a holder multiple uses:

a) A customer buys a parking pass that enables them to reserve and park five times in a garage. An *AssignedRight* is created that includes a number of uses equal to five.

   Each of the five (5) reservations (*PlannedUse*) do not have a defined time to use, but they do have an expiration date (the end of the calendar year). When the *RightHolder* makes a reservation, one of the available uses in the *AssignedRight* are taken and a *PlannedUse* is created with the specific date and time for the proposed use.

b) A company buys monthly parking for 10 employees for the year. The *RightHolder* is the company and the *AssignedRight* includes 10 credentials. The *RightHolder*, the company, 10 separate *PlannedUse* ready to be issued to employees, one *PlannedUse* to associate a credential to each employee. The *AssignedCredential* can be assigned to a Customer or a Vehicle.

C.1.3.10 Defining a RightSpecification with multiple Rates and Eligibility

A parking facility has a RightSpecification that is available to access from Jan 1, 2022, to Dec 31, 2022. The RightSpecification enables the general public in a standard passenger vehicle to access the facility from 8am to 11pm on Monday through Friday. On Saturday and Sunday, the facility is accessible from 7am to 11:59pm. Customers pull a ticket from the pay device as their credential. There are two rates associated to the Right Specification. Rate 1 is the General Public rate and is available to the general public and includes a simple fee of $2 per hour. Rate 1 is the current rate from Jan 1, 2022, to June 30, 2022 (A new rate schedule is expected to be released on July 1, 2022) Rate 2 is special rate for tenants of an office across the street. Rate 2 is available on Sat and Sun and includes a fee of $1/hour.

The description of the above RightSpecification and Rates is given in tables C.8, C.9 and C.10.

Table C.8 – RightSpecification

Attribute	Value	Notes
RightSpecification (Data Class)		
ElementID	1456	This is a user defined ID
Type	Onetimeuseparking	
Description	general public in a standard passenger vehicle	
Financialreference		
Issuer	Firstclassparkingoperator	
Transferable	No	
Transferableconditions	NA	
Validity (Data Class)		
OverallPeriod:start	January 1, 2022	
OverallPeriod:end	December 31,2022	
Period.startofperiod	January 1, 2022	
Period.endofperiod	December 31,2022	
Periodname	weekday	
Dayweekmonth	Mon,Tue,Wed,Thu,Fri	
Timeperiodofday.starttimeofperiod	0800	
Timeperiodofday.sendtimeofperiod	2300	
Period.startofperiod	January 1, 2022	
Period.endofperiod	December 31,2022	
Periodname	weekend	
Dayweekmonth	Sat,Sun	
Timeperiodofday.starttimeofperiod	0700	
Timeperiodofday.sendtimeofperiod	2359	
Credential (Data Class)	Ticket from pay device	
Ratettable (Data Class)	Rate 1, Rate 2	
Eligibility (Data Class)		
Name	General Public	
Nofeetouse	False	
Combinable	Yes	Rate 1 and Rate 2 can be combined in a Session/Assigned Right
	General public, standard vehicle car ⇔ Rate 1, (this eligibility is identified as priority 1) General Public, standard vehicle, tenant of office building ⇔ Rate 2 (this eligibility is identified as priority 2	Tenant is a form of membership

Table C.9 – Ratetable 1

Attribute	Value	Notes
Righttable (Data Class)		
Name	Generalpublic, standard vehicle	
Availability	Public	
Responsibleparty	Firstclassparkingoperator	
Validation	No	
Ratetype	Daily	
Validity (Data Class)		
OverallPeriod:start	January 1, 2022	
OverallPeriod:end	June 30, 2022	
Period.startofperiod		Defaults to overallperiod
Period.endofperiod		Defaults to overallperiod
Periodname	weekday	
Dayweekmonth	Mon,Tue,Wed,Thu,Fri	
Timeperiodofday.starttimeofperiod	0800	
Timeperiodofday.sendtimeofperiod	2300	
Period.startofperiod		Defaults to overallperiod
Period.endofperiod		Defaults to overallperiod
Periodname	weekend	
Dayweekmonth	Sat,Sun	
Timeperiodofday.starttimeofperiod	0700	
Timeperiodofday.sendtimeofperiod	2359	
Ratelinecollection (Data Class)		
Applicablecurrency	US$	
Taxincluded	True	
Resettime	0000	12:00am / midnight
Rateline (Data Class)		
Ratelinetype	incrementingrate	
Durationstart	0	
Durationend	86400	Value in seconds.
Incrementperiod	3600	Value in seconds 1hr
Value	2.00	$2.00 per hour
Eligibility (Data Class)		Same as on RightSpecification

Table C.10 – Ratetable 2

Attribute	Value	Notes
Righttable (Data Class)		
Name	Tenant of Office, standard vehicle	
Availability	Private	
Responsibleparty	Firstclassparkingoperator	
Validation	Yes	Tenant needs to have ID
Ratetype	Daily	
Validity (Data Class)		
OverallPeriod:start	January 1, 2022	
OverallPeriod:end	December 31, 2022	
Period.startofperiod		Defaults to overallperiod
Period.endofperiod		Defaults to overallperiod
Periodname	weekend	
Dayweekmonth	Sat,Sun	
Timeperiodofday.starttimeofperiod	0700	
Timeperiodofday.sendtimeofperiod	2359	
Ratelinecollection (Data Class)		
Applicablecurrency	US$	
Taxincluded	True	
Resettime	0000	12:00am / midnight
Rateline (Data Class)		
Ratelinetype	incrementingrate	
Durationstart	0	
Durationend	86400	Value in seconds.
Incrementperiod	3600	Value in seconds 1hr
Value	1.00	$1.00 per hour
Eligibility (Data Class)		Same as on RightSpecification

C.1.4 Quote

There are circumstances where it may not be possible (or desirable) for an entity to use the published Rates and Rights to establish whether a Customer can park at a specific Place and time and calculate the cost. In these circumstances, a Quote may be used to establish a firm price and confirmation of availability of a specific RightSpecification, at a specific time, by a specific user. This often refers to a specific Place.

Quotes are established by making a request for quote prices on a RightSpecification where Eligibility requirements are met for a specific time range. In some cases, a specific Place may be defined. A response will provide the Option(s) available that meet Eligibility requirements.

Quotes may be used in the following ways:

1. At the point the Customer requests options from his service provider, a QuoteRightRequest is made, related to a RightSpecification for each candidate Place the service provider has identified. The QuoteRightResponse from each Place confirms the availability and cost of parking for each Place, enabling the service provider to present a list to the Customer.

2. At the point the Customer chooses the Place, the service provider can use data from the QuoteRightResponse to submit a request to purchase an AssignedRight (with a plannedUse) on the basis of the Quote.

3. If the Customer anticipates they will overstay an existing *AssignedRight*, the service provider can request a quote for the extended time by making a QuoteSessionExtensionRequest. This is based on the existing Session and the QuoteSessionExtensionResponse is used both to ensure that an extension is possible as well as determine the cost of the extension.

C.1.5 Session

C.1.5.1 Overview

The *Session* data domain includes data concepts that document the actual act of parking, or other use of an *AssignedRight* such as delivery, pickup, etc. A *Session* captures the ACTUAL use of an *AssignedRight* and includes start time, end time, credential, and other relevant data related to an operational activity. A *Session* is not used for future activities.

A *Session* is broken into one or multiple *Segments*. Each *Segment* can relate to a different *RightSpecification* (through an *AssignedRight*) or no *Right* at all in cases where the activity has not been authorised (e.g., on street parking outside of permitted hours). *Segments* enable a single *Session* to capture and report changes in *Rate* and *AssignedRight* during a *Session*.

A *Segment* can only have one *AssignedRight* and *Rate* associated to it.

Note the following characteristics of *Sessions* and *Segments*:

Session

- Has a unique identification within a *Place.*
- Has a start time and end time.
- Has at least one *Segment.*
- Is associated to a *Place.*

Segment

- Is associated to a *Session.*
- Is associated to an *AssignedRight.*
- Is associated to a specific *Rate* via the *AssignedRight.*
- Has a start and end time.
- Has a *Credential* via the *AssignedRight.*
- Is associated to financial data via the Assigned Right (financial transaction defined as fees, taxes, payment records).
- Has a version control on the *AssignedRight* (i.e., a segment starts with one *AssignedRight* and then is updated to a new *AssignedRight* at the end of the segment, replacing the original).
- Has a *Place* reference or *Space* ID.
- Can be associated to one or multiple *Observations.*

C.1.5.2 Session with Multiple Segments

A customer uses a reserved parking pass that authorizes parking from 10am to 2pm for €10. If the customer stays beyond 2pm a rate of €2 per hour is charged. The customer enters at 10:03am and exits at 3:45pm. The total fee for the *Session* is €14.

This *Session* has two segments:

- *AssignedRight:* Parking Reservation for €10 from 10am to 2pm (note: a *PlannedUse* will have been created and converted to an *AssignedRight* when used, defined as the entry at 10:03am)
    - *SegmentStart*: 10:03am
    - *SegmentEnd*: 2:00pm
    - *Fee*: €10

- *AssignedRight: Overstay fee of €2 per hour*
    - *SegmentStart: 2:01pm*
    - *SegmentEnd: 3:45pm*
    - *Fee: €4*

C.1.6 Observation

C.1.6.1 Overview

The *Observation* data domain includes the data concepts that document the *Observation* of an entity in a *Place* performing an action. *Observations* can be visual or electronic (i.e., ANPR read, RFID read, etc.).

Observations can be used for a number of purposes including gathering data for statistics or compliance monitoring.

Note the following characteristics of *Observations* and *ObservationElements*:

Observation

An *Observation* has:

- a date/time when the *Observation* is made.
- a location where the *Observation* is made.
- an association to an *ObservationElement.*

ObservationElement

An *ObservationElement* has:

- a reference identification of the Observation.
- a method of Observation (ANPR, visual, ticket, rf transponder, etc.).
- an observer identifier (e.g., the person who made the observation).
- a credential type observed (license plate, tag, hang tag, etc.).
- the credential identification observed.

Optionally, the *ObservationElement* may contain other information such as credentials (permits etc.), the position of the Observer, etc.

C.1.6.2 A Simple Vehicle Observation

In a sample use case, the observer creates two independent *Observations* with the details of the vehicle, place, etc. These can be summarised as shown in Table C.11:

Table C.11 – Observation Examples

Observation:	***Observation 1***	***Observation 2***
Location:	Herenstraat, Bay 1	Herenstraat, Bay 1
Creation DateTime:	2019-02-05 11:05	2019-02-05 12:02
Method:	ANPR	ANPR
Observer:	Attendant 205	Attendant 212
Type:	vehiclePlate	vehiclePlate
plateIdentifier:	KD-342-F	KD-342-F
Make	Volkswagen	Volkswagen
Colour	Green	Green

Each *Observation* may also include images of the vehicle and its location.

The *Observations* can be compared with information from the *Rights* and *Sessions* domains to establish whether enforcement action is appropriate. Information from the *Observation* can form the basis of the enforcement action.

C.1.7 Prepaid Parking

C.1.7.1Description

Arnau reserves and pre-pays for a parking space for a duration of 4 hours within a place (Parking Defense1), on April 20, 2019 (future date) starting at 13:30. The license plate is used as the credential. He arrives at 13:41 and stays until 19:12, leaving after the reservation expired, paying an additional fee.

C.1.7.2 Data Model

Right

RightSpecification: park in Parking Defense1, in any unreserved parking space at any time for a period less than 24 hours and purchase online as a reservation (Note: this is a different right specification vs a drive-up right specification)

Rate: *RightSpecification* is associated to multiple rates available to any person in the public based on a variety of periods of use:

- Rate 1: €1.50 for 1st hour; €1 per hour after 1st hour with a €2 reservation fee.
- Rate 2: €3.00 flat fee for parking between 11:00am &2:00pm daily with a €2 reservation fee.
- Rate 3: €1.25 per hour past reservation time.

Right Holder:

- Vehicle with license plate FE-011-BX
- Customer: N/A

AssignedRight: Vehicle with license plate FE-011-BX can park in Garage 1, in any unreserved parking space at any time for up to 24 hours

PlannedUse:

- CredentialAssigned: license plate FE-011-BX
- StartTime: April 20, 2019, 13:30
- EndTime: April 20, 2019 17:30pm

Session

Session is created when the vehicle arrives at facility on April 20, 2019

Segment:

- Segment 1 is from 13:41 to 17:30 on Rate 1
- Segment 2 is from 17:30 to 19:12 on Rate 3

C.1.8 Monthly Parker

C.1.8.1 Description

Jane pays $150 for the right to park one vehicle in the Store Street Parking Lot (a single garage) at any time during a month period (1st to 31st January 2019). Jane has 'in and out' privileges (i.e., no limit to the number of entries or exits in the month or day). She is given an AVI Tag ID=3245w.

C.1.8.2 Data Model

Right

RightSpecification: park in the Store Street Parking Lot, in any unreserved parking space at any time for a period ending at the end of the current calendar month

Rate: $150 per month. This *RightSpecification* is available to any member of the public

RightHolder: Jane Doe (an individual)

AssignedRight: Jane Doe can park any vehicle in the Store Street Parking Lot, in any unreserved parking space at any time. This has the following features:

- Credential (AVI Tag id=3245w)
- Date: N/A
- Vehicle: any
- Expiration: January 31, 2019

Session

Session: Each time Jane arrives at the garage and presents AVI Tag ID 3245w, a new session is generated that documents entry and exit time. The session is categorized as "operational"

Segment: Only one *Segment* is created, with the same start and end time as the *Session*

C.1.9 Daily/Transient Parker

C.1.9.1 Description

Julia parks on Plaza Cortes, an on-street parking place, at 08:01 on Jan 5, 2019. On arrival she enters her license plate (JAW 325) at a pay station terminal (meter). Returning at 14:50 on Jan 6, 2019, she pays on departure via a mobile app then leaves the Plaza.

C.1.9.2 Data Model

Right

RightSpecification: Drivers may park on Plaza Cortes in any unreserved parking space at any time for a period less than 24 hours at a variety of public rates.

This *RightSpecification* is available to any member of the public.

Rate:

- Rate i - Daily rate: €2/hour
- Rate ii - Weekend rate €1.50/hour (Saturday and Sunday only)
- Rate iii - Overstay penalty: €50 (greater than 24 hours of parking)

RightHolder: The vehicle:

- Vehicle: license plate JAW 325
- Customer: N/A

AssignedRight: vehicle with license plate JAW 325 can park on Plaza Cortes, in any unreserved parking space at any time for up to 24 hours

- Credential: license plate JAW 325
- Date:24 hours from entry (Jan 5, 2019 at 8:01am)
- Expiration: Jan 6, 2019 at 8:01am (24-hour max parking duration)

Session

Session is started when vehicle with license plate JAW 325 is registered at the pay station at 8:01am on Jan 5, 2019. (Note: if observation data was available, the session may have been registered when the vehicle was identified in space versus when the license plate was entered in the pay station)

Segments:

As the customer leaves at 14:50 on Jan 6, 2019 (i.e., stays beyond 24 hours):

- Segment 1 shows an end time of 8:00am on Jan 6, 2019. Rate i (€2/hour) is applied to the segment.
- Segment 2 shows a start time of 8:00am on Jan 6, 2019 and shows an exit time of 14:50 on Jan 6, 2019. Rate iii ($50 fee) is applied to segment 2.

C.1.10 Monthly Parking for a Company in a Building

C.1.10.1 Description

NewCo LLC purchases parking for its employees in a building. The company is allowed to let employees' park in Garage 1 Monday – Saturday from 7am to 7pm. The contract is renewable annually on 1st February each year.

C.1.10.2 Data Model

Right

RightSpecification: park in Garage 1, in any unreserved parking space Monday through Saturday from 7am to 7pm.

*R*ate: Eligibility is defined as a member of NewCo, LLC

- First 10 parkers: $150/month
- Next 10 parkers: $125/month
- Next 5 parkers: $75/month

RightHolder: NewCo, has the right to park up to 25 vehicles

Vehicle:

- Vehicle #1 license plate data …
- Vehicle #25 license plate data

Customer: N/A (note: could easily swap from vehicle registration to customer name registration and assign an access card to customer)

AssignedRight: NewCo can park up to 25 vehicles in Garage 1, Monday through Saturday from 7am to 7pm

- Credential: Vehicle ID #1 - #25
- Date: Any date (Mon – Sat) between 1st Feb 2019 and 31st January 2020
- Vehicle: any of the vehicles registered
- Expiration: 7pm January 31, 2020

Session

Session: Each time a registered vehicle under NEWCO arrives at the garage and presents a credential, a new *Session* is generated that documents entry and exit time. The *Right* permits up to 25 concurrent parker vehicles. *AssigndRight*(s) *RightSpecification.period.endofperiod* is at 7:00 pm each day and *Rightspecification.period.dayweekmonth.applicableday* is Mon, Tue, Wed, Thu, Fri, Sat

Segment: is associated to the *Right*. Only one *Segment* is created for each *Session*

C.1.11 On Street Permit

C.1.11.1 Description

Loviise purchases a resident's parking permit (on street) that allows her to park one vehicle within a zone (i.e., an on-street parking area in one or more streets) 7 days per week.

C.1.11.2 Data Model

Right

Right Specification:

- Eligibility: Any resident of a property within a designated boundary (the Zone)
- Place: any on street parking bay or space allocated as “residents’ parking” within the Zone
- Rate: Annual fee of €435
- Credentials: 1 license plate
- Max stay: Unlimited
- Max Sessions: Unlimited

Assigned Right:

- ID: #657
- Credential: Types: License plate 367RTB
- Date: One year from purchase date

Session

Session: Each time the vehicle is parked in a resident’s parking bay a new session is created. Each session has only one segment.

C.1.12 Pre-Payment Card

C.1.12.1 Description

Frank purchases a pre-paid card for 30€ that enables him to park 10 times between 9 am and 5 pm Monday – Friday, in one of 3 off street parking places, operated by one of 2 operators.

C.1.12.2 Data Model

Right

Right Specification:

- Eligibility: public (holder of prepayment card can park at discounted rate)
- Place: any one of 3 named parking places
- Rate: 3€ per parking day
- Valid credentials: 1 license plate
- Max stay: 8h / day
- Max Sessions: 10

Assigned Right:

- ID: #31
- Credential: Type: License plate / Country: DE / Value: B KL 8136
- Number of Sessions remaining: 10 (decrements upon each use)
- Date: Unlimited from purchase date

Session

Session: Each time Frank enters one of the 3 parking places a new session is created. Each *Session* has only one *Segment*.

C.1.13 Pay on Arrival

C.1.13.1 Description

Herman pays for 1 hour on arrival at a parking terminal (meter). He leaves after 2 hours 20 minutes without making any further payment.

C.1.13.2 Data Model

Right

Right Specification:

- Eligibility: public
- Place: Utrecht, Zone B
- Rate: 4€/h, Mon-Sat. Free on Sundays, and Holidays
- Valid credentials: 1 license plate
- Max stay: 4h / day

Assigned Right:

- ID: #42
- Credential: Type: License plate / Country: NL / Value: SZ-VB-69
- Date: Jan 31st, 2019 10:04 am to 11:04 am

Session

Session:

- Date: Jan 31st, 2019 10:04 am to 11:04 am
- Credential: Type: License plate / Country: NL / Value: SZ-VB-69

Segment:

- Assigned Right: #42
- Cost: 4€
- Date: Jan 31st, 2019 10:04 am to 11:04 am

C.1.14 Reserved Parking

C.1.14.1 Description

Walter buys a permit from an operator that:

- Provides a guaranteed (reserved) space Monday to Friday from 8am to 6pm.
- Enables parking at a reduced rate for Saturday and Sunday from 8am to 6pm.
- Charges a higher rate than the drive-in rate for parking at all other times.

C.1.14.2 Data Model

Right

Right Specification: drive-in

- Eligibility: public
- Place: any unreserved space
- Rate: Drive-in rate: Mon-Sun all-day: $2/h

Right Specification: reserved parking

- Eligibility: public
- Place: any reserved space
- Validity: 3 months (after assignment)
- Right Pool:
- (state before purchase):
- Spaces available: 55
- Unused spaces: 41
- (state after purchase):
- Spaces available: 55
- Unused spaces: 40
- Rate:
  - Reserved space permit fee: $20
  - Reduced weekend rate: Sat-Sun 8am-6pm: $1/h
  - Reserved parking rate: Mon-Fri all-day & Sat-Sun 6pm-8am: $3/h

Assigned Right:

- ID: #43
- Credential: Type: RFID card / ID: #63452
- Date: Feb 4th, 2018, 5:02pm
- Expiry: May 4th, 2018, 5:02pm

Session

- Session #1
- Assigned right: #43
- Date: Mon, Feb 5th, 8:05am - 4:34pm
- Cost: $0 –
- Credential: RFID card / ID: #63452
  - Segment #1
  - Date: Mon, Feb 5th, 8:05am - 4:34pm
  - Rate: $0/h
  - Cost: $0

- Session #2
- Assigned right: #43
- Date: Sat, Feb 10th, 7:30am - 9:03pm
- Cost: $25.5
- Segments:
  - Segment #1
  - Date: 7:30am-8am

- Rate: $3/h
- Cost: $1.5

- Segment #2
- Date: 8am-6pm
- Rate: $1/h
- Cost: $10

- Segment #3
- Date: 6pm-9:03pm
- Rate: $3/h
- Cost: $4

C.1.15 Annual Permit, One Right – multiple vehicles

C.1.15.1 Description

Peter and Zahra buy an annual permit from an operator that allows them to park one of their two cars at any car park in the city.

C.1.15.2 Data Model

Right

Right Specification:

- Eligibility: public - any member of the public can purchase a permit
- Place: any one of the operator's parking places in the City
- Rate: Annual fee of $4350
- Valid credentials: Unlimited license plates (each one to be registered)
- Max stay: Unlimited
- Max Sessions: Unlimited but only one session at a time

Assigned Right:

- ID: #431, #432
- Credential: Types: License plates BAP2650, AZM9235
- Date: One year from purchase date

Session

Each time one of the vehicles enters one of the operator's parking lots a new *Session* is created. Each *Session* has only one *Segment*.

C.1.16 Annual and Visitor Permits

C.1.16.1 Description

Anika has an annual resident's permit. This gives her the right to purchase 50 visitor's permits each year. Each visitor's permit allows one vehicle to be parked in the resident's zone for up to 8 hours. Visitor permits are purchased online up to 2 weeks before parking and are able to be exchanged between vehicles during their validity via an app.

C.1.16.2 Data Model

Right

Right Specification:

- Eligibility: The holder of an annual resident permit linked to a property within a designated boundary (the Zone)
- Place: any on street parking bay or space allocated as “residents’ parking” within the Zone
- Rate: £30 for 10 permits
- Max no: 50 (5 blocks of 10)
- Max session length: 8 hours
- Valid credentials: 1 license plate per permit (can be exchanged between license plates but each one must be registered and linked to the permit)
- Date: up to one year from purchase date (expires same date as annual permit)

Assigned Right:

- ID: (Each visitor’s permit has a unique ID)
- Credential: Types: License plate (linked to ID via an app)
- Date: any date up to annual resident permit expiry date

Session

A *Session* is created when a license plate is registered as using the permit. Each *Session* has only one *Segment*. A permit can have any number of *Sessions* with a total length of 8 hours.

C.1.17On-Street Interdependent Sessions

C.1.17.1 Description

An on-street parking zone in a city charges fees between 09:00 and 13:00 then 15:00 and 20:00 on weekdays. Payment is on arrival.

Each vehicle can park a maximum of two (2) hours in the morning period and again a maximum of two (2) hours in the afternoon.

Every vehicle has 30 minutes free, each day, during its first parking session. If a vehicle parks for less than 30 minutes during the first session of the day, the vehicle loses the right to the anytime remaining time of the initial 30 minutes of time. If payment exceeds the charge for the current payment period, it is counted towards the next period.

- Example: Martim parks at 12:00 and pays 4,20 euros. His session starts as 12:00 and he receives:
- 30 minutes free (until 12:30)
- 30 minutes until 13:00 (0,60€)
- 2 hours between 15:00 and 17:00 (2,40 – total 3,00€) – then he needs to leave.
- 30 minutes free the next morning (09:00 to 9:30)
- 1 hour until 10:30 (the remaining 1.20 €).

C.1.17.2 Data Model

Rate

See Table C.12.

Table C.12 –Rate Example

RATETABLE NAME	ELIGIBILITY	Rate value
First Parking Session 0900-1300 1500-2000	Passenger vehicle NO ASSIGNEDRIGHT FOR FIRSTPARKINGSESSION in previous 22 hours	1.2€/ hour 30 min free Max 2 hours
Second Parking Session 0900-1300 1500-2000	Passenger vehicle	1.2€/ hour Max 2 hours

Right

Right Specification: Ability to park on street by any vehicle between the hours of 0900 and 1300 for a fee and between the hours of 1500 and 2000 for a fee. All other times are no fee to park

Assigned Right #1

- Martim parks at 12:00 and pays 4,20€.
- issued by operator at 1200 for payment of 4,20€ against Right Specification.
- Assigned Right has balance of 4,20€

Session
- Start: 1200
- End

Segment 1
- Start: 1200: Rate Table: First Parking Session
- Eligibility: No use of First Parking Session Ratetable on AssignedRight in previous 22 hours
- End: 1300 (end of available fee-based parking)
- Fee: 0,60€

Segment 2
- Start: 1500
- RateTable: SecondParkingSession; not eligible for First Parking Session Rate
- End: 1700
- Fee: 2,40€

Segment 3a (hypothetical if vehicle stayed past 2 hours in afternoon)
- Start: 1700
- End: ?
- Ratetable: to be defined penalty
- This vehicle is in violation

Segment 3b (hypothetical if vehicle followed rules and parked next morning)
- Start: 0900
- Ratetable: First Parking Session

- Eligibility: No use of First Parking Session Ratetable on AssignedRight in previous 22 hours
- End: 1030
- Fee: 1,20€ (includes 30 free mins)

C.1.18 Event Parking Off-Street (Soccer Stadium)

C.1.18.1 Description

A soccer stadium car park has 3 charging structures, depending on whether there is no match (a "Normal" day), a "Regular" match or an "Important" match. The local cinema and supermarket also have agreements with the car park operator. Cinema and supermarket rates only operate on Normal days.

The rates work as follows:

Normal days:

- General Rate: First 15 minutes: 0,40€, Additional periods of 15 minutes: 0,30 €, Maximum Daily; 6.00€.
- Cinema visitors: People entering between 8pm and midnight and staying between 2 and 4 hours pay 1.00€, flat rate.
- Supermarket customers: First hour free, payment to be done inside the supermarket.

Soccer match days:

- **Regular matches**: People entering between 3 hours before starting the match and 30 minutes after start and leaving in the next hour after finishing the match, pay a flat rate of 5 euros.
- People entering more than 3 hours before match starts pay the normal price but during the 2 hours of the match the price is 2,50€ an hour. (Maximum daily, in this case, goes to 11:00€)
- **Important matches**: People entering between 3 hours before starting the match and 30 minutes after start and leaving in the next hour after finishing the match pay a flat rate of 10 euros.
- People entering more than 3 hours before match starts pay the normal price but during the 2 hours of the match price is 5,00€ an hour. (Maximum daily, in this case, goes to 16:00€)

C.1.18.2 Data Model

Rate

- Rate 1 (Normal day, general rate): First 15 minutes: 0,40€, Additional periods of 15 minutes: 0,30 €, Maximum Daily; 6.00€
- Rate 2 (Normal day, cinema visitors): 1.00€, flat rate
- Rate 3 (Normal day, supermarket customers): First 60m: free, Additional periods of 15 minutes: 0,30 €, Maximum Daily; 6.00€
- Rate 4 (Regular match, 3h before match): 5.00€ flat rate
- Rate 5 (Important match, 3h before match): : 10.00€ flat rate
- Rate 6 (Regular match, during match): 2.50€/h. Charged in 1h periods
- Rate 7 (Important match, during match): 5.00€/h. Charged in 1h periods

Right

Right Specification 1 (normal days):

Rates:

- Rate 1. Eligibility: public, all-day
- Rate 2. Eligibility: entry between 8pm and midnight, for stays over 2h and under 4h
- Rate 3. Eligibility: only if payment done at supermarket terminal

Right Specification 2 (regular match days):

Rates:

- Rate 4. Eligibility: entry between 3h before and 30m after start of match / exit until 1h after match ends
- Rate 6. Eligibility: stays during the 2h of the match
- Rate 1. Eligibility: public, all-day

Right Specification 3 (important match days):

Rates:

- Rate 5. Eligibility: entry between 3h before and 30m after start of match / exit until 1h after match ends
- Rate 7. Eligibility: stays during the 2h of the match
- Rate 1. Eligibility: public, all-day

Assigned Right 1 (upon entering car park on regular days)
Right Specification: #1
Credential: Ticket #1234

Assigned Right 2 (upon entering car park on regular match days)
Right Specification: #2
Credential: Ticket #5678

Assigned Right 3 (upon entering car park on important match days)
Right Specification: #3
Credential: Ticket #8906

Example Sessions – Normal Days

Session 1 (normal day, regular rate)

- Assigned Right: #1
- Dates: 4pm/5:30pm
- Cost: 1,90€
- Segments
- Rate: #1
- Cost: 1,90€

Session 2 (normal day, supermarket customer)

- Assigned Right: #1
- Dates: 4pm/5:30pm
- Cost: 1,50€
- Segments
- Dates: 4pm/5:30pm
- Rate: #3
- Cost: 1,50€

Session 3 (normal day, customer staying during cinema hours but exceeding max stay)

- Assigned Right: #1
- Dates: 8pm-1:30am (following day)
- Cost: 6.70€ (4.90€ first day + 1.80€ next day, so daily max can be exceeded)
- Segments
- Dates: 8pm-12:30am (following day)
- Rate: #1
- Cost: 6.70€ (4.90€ first day + 1,80€ next day)

Session 4 (normal day, cinema customer)

- Assigned Right: #1
- Dates: 8pm-10:30pm
- Cost: 1.00€
- Segments
- Dates: 8pm-10:30pm
- Rate: #2
- Cost: 1.00€

Example Sessions – Match Days
(Assuming matches are always 8pm-10pm)

Session 5 (regular match day, enters 5h before match, leaves during match)

- Assigned Right: #2
- Dates: 3pm-9pm
- Cost: 8,60€
- Segments:
  Segment 1
  - Dates: 3pm-8pm
  - Rate: #1
  - Cost: 6.10€

  Segment 2
  - Dates: 8pm-9pm
  - Rate: #6
  - Cost: 2.50€

Session 6 (important match day, enters and leaves during match)

- Assigned Right: #3
- Dates: 8:30pm-9:45pm
- Cost: 10.00€
- Segment:

- Dates: 8:30pm-9:45pm
- Rate: #7
- Cost: 10.00€

Session 7 (regular match day, enters 2h30 before match, leaves 30m after)

- Assigned Right: #2
- Dates: 5:30pm-10:30pm
- Cost: 5.00€
- Segment:
- Dates: 5:30pm-10:30pm
- Rate: #4
- Cost: 5.00€

Session 8 (important match day, enters 15m after match starts, leaves 30m after)

- Assigned Right: #3
- Dates: 8:15pm-10:30pm
- Cost: 10.00€
- Segment:
- Dates: 8:15pm-10:30pm
- Rate: #5
- Cost: 10.00€

Session 9 (important match day, enters 2h00 before match, leaves 1h30m after)

- Assigned Right: #3
- Dates: 6:00pm-11:30pm
- Cost: 14.30€
- Segments

  Segment 1
    - Dates: 6pm-8pm
    - Rate: #1
    - Cost: 2.50€

  Segment 2
    - Dates: 8pm-10pm
    - Rate: #7
    - Cost: 10.00€

  Segment 3
    - Dates: 10pm-11:30pm
    - Rate: #1
    - Cost: 1.80€

Session 10 (important match day, enters 6h before, leaves 5h before match)

- Assigned Right: #3
- Dates: 2:00pm-3:00pm
- Cost: 1.30€
- Segments
    - Dates: 2:00pm-3:00pm
    - Rate: #1
    - Cost: 1.30€

C.2 Additional Use Cases

The following Use cases each describe a complex requirement and, whilst the specifications would be required to communicate between different elements of the solution, the complexity of the solution masks the simplicity of the data exchange requirement. These use cases and the role of the specifications are described here.

C.2.1 Pay by Space parking with a required check in activity via app

Zhangsan from Zhejiang University has an appointment for new job interview at 15:00 at the Singapore-Hangzhou Science & Technology Park (SHSTP) in Qiantang New District of Hangzhou.

The parking lot has a surface level with a 90 min limit, and an underground level with 4 hr. limit for visitors and 10 hr. limit for permit holders.

The parking lot is controlled by license plate recognition, with free entry and a barrier at the exit. Each parking space has a unique space ID marked on the ground.

The parking terms and conditions require the user to check-in while in a parking space (indicating the space ID occupied) to start and check-out to end. At check-in, the driver must provide:

- Vehicle license number
- The ID of the space the vehicle is parked in
- An estimated parking end time (which must not exceed the maximum allowed time) or the duration of the desired parking,
- Any other eligibility/qualification criteria (e.g., VIP or season permit, payment credential)

Zhangsan will arrive with a passenger car with vehicle license number ZA-XP571, find a vacant parking space to park at his arrival without reservation and pay by mobile application or at pay kiosk at departure.

To park successfully, Zhangsan needs to know:

- What is the likely space availability for the time he will arrive?
- Does he have to reserve a space in advance?
- Are there any parking restrictions (maximum time, etc.)?
- Is it possible to extend the parking session?
- Where are the parking spaces convenient to the interview office?
- What are the rates for surface parking and underground parking?
- What are acceptable payments?
- Can he pay for the parking on site?

Zhangsan's service (app) provider uses the information gathered to show that both reservation and park-on-arrival are available. Limitations of 90 min for surface level and 4 hr. for underground level apply. He needs to check-in to start and check-out to end his parking. Payment is available both online for reservation and on-site for park-on-arrival before exit. Spaces are usually available, so Zhangsan chooses to park on arrival.

When Zhangsan arrives at 14:25, the time is logged against vehicle license number ZA-XP571 at the entrance.

Zhangsan finds a vacant parking space at surface level, parks his car, and uses his mobile APP to check in his vehicle license number with space ID for 90 min. Before check-in is confirmed, he receives a message "90 minutes is the maximum stay time and no extension is available, YES to check in, NO to move". Zhangsan considers he may need more time for interview and clicks NO.

Zhangsan relocates to the underground parking, finds a vacant space to park and checks-in again with his vehicle license number and space ID for 120 min. At the time of check-in, he receives a message "Sorry, check-in is not successful, the parking space has been reserved for another vehicle! Please double check your vehicle license number, otherwise book a space in advance for your convenience".

Zhangsan moves his vehicle to another vacant space to park and check in. Before check-in is confirmed, he receives a message "Parking for 120 min, Extension for additional 120 min available! YES to check in, NO to move". Zhangsan clicks YES and checks-in successfully. The time of check-in, vehicle license number and space ID are logged, and a countdown timer on his mobile APP is triggered at the same time.

At 16:10, 15 mins prior to the expiration, Zhangsan receives a reminder message "15 min to check-out, YES to confirm, NO to apply extension". He estimates he will require 30 min longer than he anticipated. He clicks NO to extend the parking until 16:55.

At 16:30, Zhangsan checks out of the parking space. An invoice is generated automatically showing vehicle license number, space ID, times for entry, check-in, check-out, and the parking fee. Zhangsan confirms the payment on his mobile APP. A message confirms that payment is successful, and he is reminded to exit within 10 mins.

Immediately after paying, Zhangsan answers an incoming call. He remains in the parking space and talks for 15 mins after check-out. His vehicle license number is logged at 16:49 as he approaches the exit. He receives a message that he must make an additional late exit payment regardless of the extension until 16:55. He uses his mobile APP to scan the QR at the exit, to make the payment and open the exit gate.

In this example, ISO/TS 5206-1 compliant messages are used to communicate required information between the PLACE and the service provider's app. The service provider's app uses this information to create relevant interactions with the customer. For example, the process by which Zhangsan finds a suitable parking space is relatively complex (see Figure C. 5). However, in theory only three ISO/TS 5206-1 compliant information exchanges are required to support this process:

- A request for Information on the Place, Rate, Right Specifications and expected Occupancy at the Singapore-Hangzhou Science & Technology Park (used to advise the customer in advance on where to park and whether a reservation is required). This information enables the app to alert the customer to the maximum stay time in the surface lot.

- When the vehicle enters the facility, an Observation is recorded that includes Place, Date/time, and the Credential, in this case the license plate.

- A submission of a QuoteRightRequest at the point the Customer parks in a Space. This may return the information, via QuoteRightResponse that the RightSpecification cannot be provided as the Space is not available (as - in the example - it is reserved for another vehicle). The QuoteRightResponse includes valid reasons for the rejection. If the QuoteRightResponse is returned with a rejection, the app directs the Customer to move to another space.

- Once a QuoteRightReponse is offered with an acceptable option, check-in is performed via the App. In other scenarios, check-in can occur based on the Observation of the vehicle

license plate at the entrance or via a payment kiosk (i.e., entering vehicle license plate or space number to activate an Assigned Right) or via an RFID or AVI tag (Observation)

- Check-in converts the RateQuoteResponse to an AssignedRight via a purchase. At the same time, a session and segment are created with the start time. NOTE: in some scenarios the session and segment will start with the observation of the vehicle license plate at the entrance with a generic AssignedRight issued. A second segment is initiated at the time of check-in, where a new AssignedRight is issued defining specific RightSpecification, Rates, etc. associated to the vehicle due to the check-in and associations to Rates via eligibility requirements.

- In the existing scenario, Zhangsan checks out via the app. This action associates an end date and time to the segment. A financial transaction record is attached to the AssignedRight for the segment. In some scenarios, an additional segment is defined to record the user's exit from the facility based on an Observation (of the vehicle license plate). This event closes the session.

All other aspects of the flow chart shown in Figure C.5 are part of a process flow managed by the service provider's app (in blue) or the parking management system (in green).

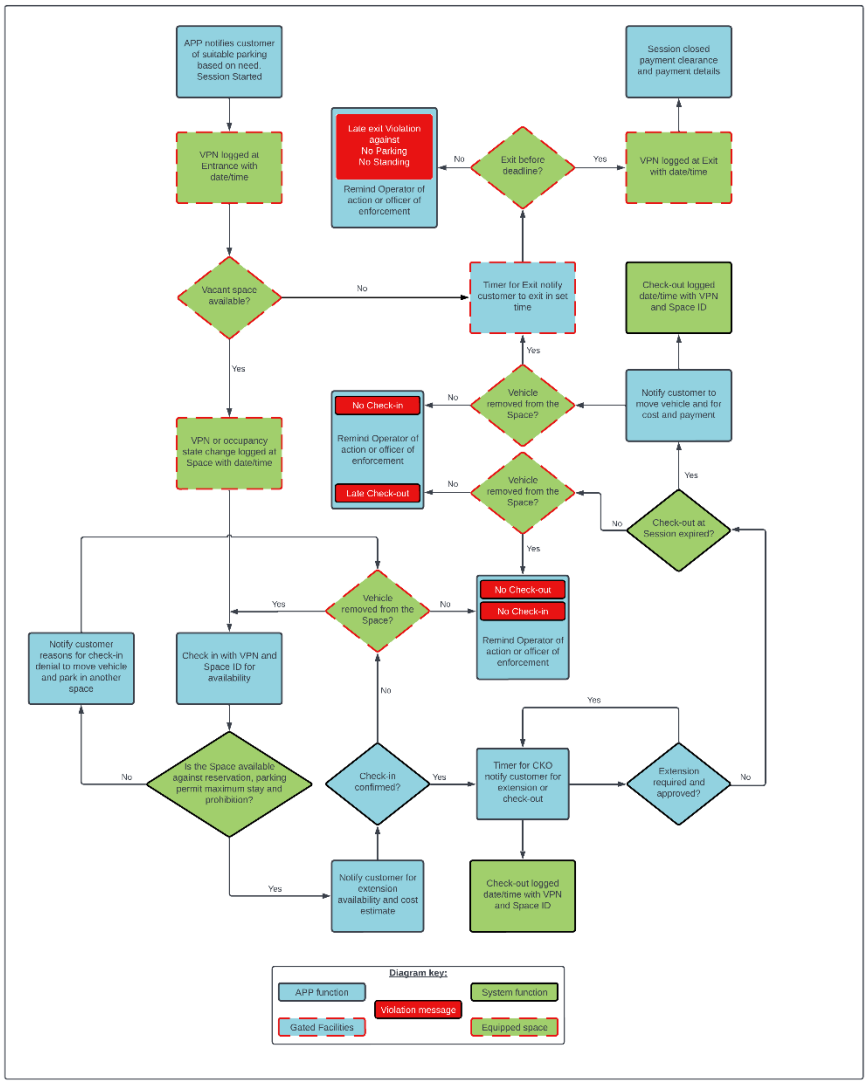

Figure C.5 - Check-in Flow

Using these specifications to model the complete process requires a modified approach. In the example, the payment period begins when the customer enters the facility, not when the vehicle parks. So, in this case the session begins at time of initial entry to the facility (Place).

To achieve this, a segment is defined with the appropriate AssignedRight when the vehicle is first observed entering the facility. When the customer uses “check-in” on the app, a second segment is defined, and the initial segment has an end time associated to it – the initial segment defines the time the vehicle is driving from the entry to a space. This is illustrated in Figure C.6.

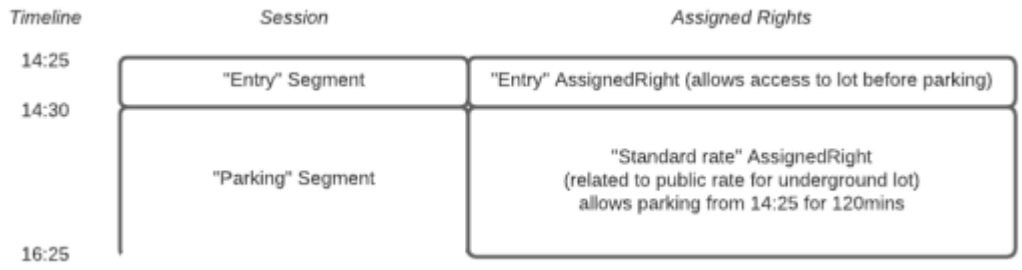

Figure C. 6 - Creation of Segments

Note that AssignedRights and Segments are only named here for illustration purposes.

When the customer extends the parking time, a new, third segment is defined with a new AssignedRight:

When the payment is made, a new segment is again defined, related to a new AssignedRight that allows the Customer 10 minutes to exit –a grace period. See Figure C.7.

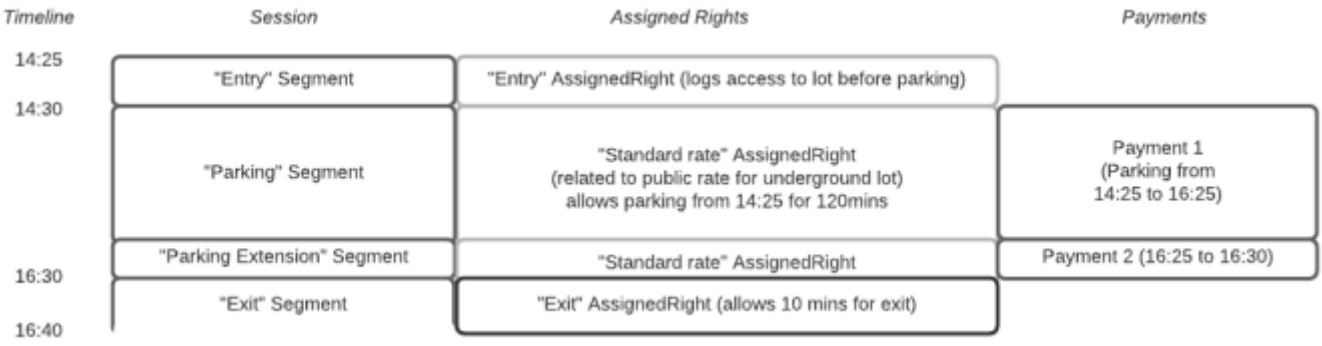

Figure C.7 - Grace period to exit

Note the new segment supersedes the previous AssignedRight that allowed for the 30 minutes extension. The “Exit” Segment is closed when the vehicle leaves the lot.

Modifying the previous example, assume the customer overstays their initial paid parking and grace period and must extend the parking time and complete a second payment. This extension of time generates a new AssignedRight that is related to the overstay as shown in Figure C.8.

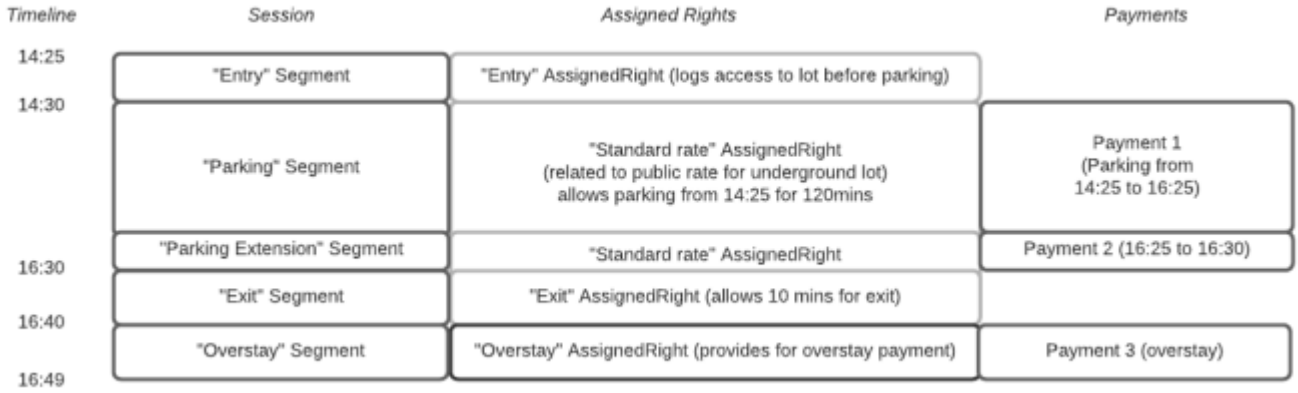

Figure C.8 - Extension of parking time

Note: This example does not address the application of rates. The AssignedRights are each linked to an appropriate Rate (even if that Rate is “no fee”). Depending on the capabilities of the service provider’s app and parking systems, rates may be calculated by the app or requested from the operator’s system using the Quote domain elements.

C.2.2 Parking enforcement and user check-in

Hangzhou Xiaoshan International Airport (HGH) has 7 parking places (P1 – P7). P6 is an underground parking garage directly under the terminal for Premium parkers, VIPs, and employees. Customers can reserve parking in advance or drive-up to facility and enter if space is available. Several spaces are equipped with Electric Vehicle charging points.

The entry and exit are equipped with license plate cameras. Time of entry and vehicle license plate are logged (observation). If the customer does not check-in within the 5 min grace period or exit within the 15 min grace period after check-out, a late check-in or late exit violation is registered. Drivers also have the option of automatic check-out as they exit. Vehicles equipped with vehicle license plate cameras may also be used to patrol the garage.

The time for entry, exit, as well as that for check-in and check-out is logged along with the license plate number and space ID. The check-in and check-out times are logged through the connected vehicle or mobile APP along with the vehicle license number and parking space ID.

Check-in is mandatory to ensure that the status of vehicles (including VIP status, parking reservation or EV charging) are correctly identified. Transaction exceptions, include:

- *No check-out or late check-out (from a reservation)*
- *No check-in or check-out after the grace period for check-in or exit*
- *Checked-in to a reserved space without a valid reservation*
- *Checked-in with a reservation to the wrong parking space (not the space reserved)*
- *Checked-in to the wrong space (not the space reported by the customer)*
- *Parking in an EV space with an ICE vehicle*

Parking enforcement officers patrol the car park. They carry a device that has a real-time view of the active reservations, check-in and known transaction exceptions. Through the enforcement device , the enforcement officer can identify the status of vehicles or parking spaces. The parking enforcement officers' role is to assist people where possible (e.g., helping people who do not understand where they should park) and identify any transaction exceptions that have not been previously identified by the systems. the transaction exceptions can be converted into violation notices that create fines/penalties for the owner of the vehicle. An enforcement officer cannot cancel violations generated by the system, but they can generate new violations based on observations of transaction exceptions.

These specification support this use case in a number of ways:

Eligibility
The example does not describe rates, but does include a number of potential Eligibility criteria (e.g., premium rate, VIP status, etc.). These criteria are defined in the RightSpecifications and published to the service provider's app and reservation systems used to access the car park, along with any specific Rates or other conditions that are linked to each criteria (e.g., VIP users may be charged a different rate from a premium rate user).

Reservations
When a customer books a space, an AssignedRight is created. This AssignedRight includes details of the Space that has been assigned to the reservation. An associated PlannedUse is also generated that defines the dates and times of when the reservation is intended to be used. This information is exchanged between booking systems and the parking management system.

Sessions
This example is very similar in nature to Figure C. 6, which contains an example of the method to use Session and Segments to describe a parking transaction by a specific vehicle. This includes using Session, Segments and Observations to identify transaction exceptions which can lead to violations.

Observations
A patrol vehicle using license plate recognition, or an enforcement officer, may encounter a vehicle that is not authorized due to lack of payment, incorrect location, or does not meet AssignedRight criteria. Observations enable the data to be collected and forwarded to systems that can compare Observation with information from the Rights and Sessions domains to determine if a transaction exception exists for the specific vehicle.

The Status of Spaces
The example above illustrates that spaces may have a number of factors that affect their availability at any one time. As an example, a space may be available or occupied but (in the given example) it may be:

- Vacant with a limitation (e.g., booked for a reservation that commences a short time in the future)
- Vacant with a prohibition (e.g., the space is reserved but not yet occupied)
- Vacant but checked in (i.e., a vehicle should be in the space but is actually elsewhere)
- Vacant without check out (similar to vacant without check in but in this example describes the status of a space when the vehicle has left the space but not yet exited the garage)
- Vacant and unavailable (e.g., the space is closed for a technical reason)
- Occupied without check in
- Occupied after check-out

These statuses are directly related to the operation of the car park, and it is not necessary for a standardised interface to communicate all the status detail for a particular space for customer information. In practice, it would only be necessary for a customer to understand:

a. Whether spaces are available
b. Which spaces are available
c. Which space they are to use for their reservation
d. Which space their vehicle is occupying

The specification enables specific Occupancy Levels to be defined for each Place. These user defined codes enable a user of the specification to define the code for a specific Occupancy Level and then provide a definition of the Occupancy Level code to ensure clear communication of meaning. As data is shared from the Place to other users of the data, the user defined codes and related definitions can be shared.

C.2.3 Using a smart parking approach to co-operate and improve customer experience

The benefits of smart parking as part of a smart city initiative can be financial, environmental, and social. However smart parking is not simply a question of access control, online fee collection and open data. Effective smart parking requires an overview as well as cooperation between stakeholders. The following example demonstrates just a few of the benefits that could result from a cooperative smart initiative and the role of this specification:

The Memorial Hospital, see Figure C.9, is in an old part of the City. It is surrounded by residential streets, a large school, shopping, and offices. It is also near the City's main rail station. There are a number of small car parks (managed by a number of different operators), but these do not meet all the parking needs of drivers entering the area.

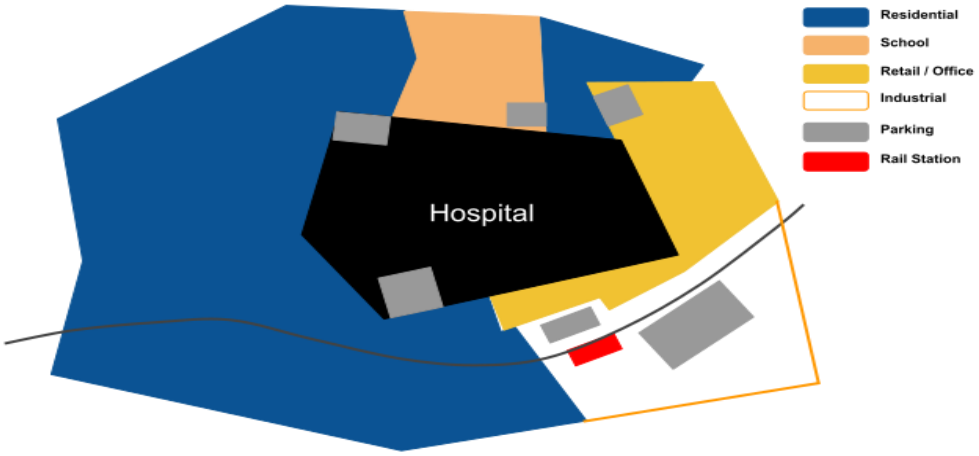

Figure C.9 - Illustration of zones relating to Memorial Hospital

The hospital faces a critical situation. Roads are congested with vehicles queuing for spaces which also block access for emergency vehicles, while patients and staff are unable to find a parking space and are missing appointments.

The City administration is also receiving complaints from residents about people from outside the area parking in the streets, parents waiting for their school children blocking access to roads, etc.

The City convenes a meeting of stakeholders in the area, including representatives from the hospital, school, residents, and local businesses as well as the rail station operator. It is agreed that the City will coordinate efforts to improve the parking experience and reduce the traffic congestion. The solution involves providing drivers with information on available parking, the creation of specific permits and on-street controls for both parking (for example a residential parking programme) and curbside activities (such as ride hailing, delivery service, passenger/ride share drop-off etc.).

The off-street parking operators agree to contribute information on parking availability as well as enable under-used parking to be offered to reduce pressure on over-used facilities. Each operator has their own parking management system that suits their particular needs, so the City is developing a "data platform" to enable information to be exchanged between systems.

As the situation at the hospital requires priority attention the initial objectives are to:

- *Re-direct drivers destined to park at the hospital to parking at the rail station (if there is capacity) when the hospital's existing car parks are full (or near full) – the rail station is usually only available to Customers with a rail ticket.*
- *Share information on parking activity across the area*

The City's data platform intends to enable systems to exchange data and will use this specification to define compliant messages. The City data platform will provide information to signs, apps, and websites on available parking.

The initial data exchanges have two objectives:

- **Location related information.** This includes the Place information, Rates and RightSpecifications for all relevant parking areas. The platform receives data from the individual operators and then aggregates and publishes the data to service providers (app providers, etc.).
- **Availability information**. This includes Occupancy (for apps, VMS signs, etc.) PlannedUse/ AssignedRights, and Occupancy Level (User defined Codelist) which are aggregated and published to data consumers. The availability information enables the rail station operator's system to monitor the hospital parking and, when it is near full, update the platform with a RightSpecification for use by apps whose users are attempting to drive to the hospital. The hospital's VMS and access control can also respond to the new RightSpecification and start to re-direct drivers to the station parking.

Over the following months the Occupancy data reveals that, whilst the shopping area car parks are least used on a Monday and Tuesday, they are the busiest days at the Hospital. The Hospital and the shopping area managers then agree that up to 100 hospital workers can park in the shopping area parking on Mondays and Tuesdays (for which the Hospital will pay $5 per user), freeing up space for hospital patients.

The shopping centre system sends a RightSpecification for 100 spaces to the platform with an Eligibility Qualification of being a member of the hospital staff at a Rate of $5 per day (valid on Mondays and Tuesdays). The staff parking pass is used as a credential to park in the shopping area car park.

When Staff begin using the shopping area parking, an AssignedRight for each staff member that enters is issued from a RightPool. The Occupancy of the staff spaces is sent to the platform. This enables the hospital to keep the staff updated as to whether they can park in the shopping area car park or the hospital car park. As staff members leave the parking the AssignedRight expires, freeing the space for the next hospital staff member.

C.2.4 A parking discount scheme

The Golden Shopping Mall has 752 parking spaces in an underground parking garage. Every day the Mall serves about 5000 customers arriving by car to shop, dine and for entertainment. In a recent survey however, 28% of customers complained about the availability of parking. The mall is concerned that this group of customers may be lost.

To find a solution, the mall administrator invited owners of the tenant stores and the parking operators of parking in the surrounding area, to suggest how the parking experience can be improved. This resulted in a discount (validation) scheme that tenant stores and the mall can use to reward customers and encourage them to park in one of a number of parking facilities in the area. The validation program is managed by the mall and is entirely digital. Store owners use an app to issue a digital validation to discount the customer's parking, based on a vehicle license plate number. The resulting fee is paid by the validation issuer (i.e., store, restaurant, etc.).

All parking management systems used by the parking operators include automatic license plate recognition to track observations. The parking management system compares the observations to Assigned Rights to identify transaction exceptions.

As there are a number of parking operators involved, it is agreed that the mall will act as a clearing house, issuing invoices to validation issuers and paying operators on a monthly basis for validations accepted. The mall also tracks and reports usage of validations by end customer based on vehicle license plate number.

The mall implements a system that manages the validation issuer accounts (including an interface for use by the individual stores, restaurants, etc.). This system interfaces with each parking system to enable a parking operator to query the status of every Assigned Right with a validation in the mall system.

The system records parking fees paid (including tax) for each session in order to monitor the use of validations by each parking operator. To achieve this:

1. The mall system updates all parking systems with the vehicle license plate and balance of each account as they are created or changed. The account balance can be communicated via an Assigned Right associated to an end customer.
2. When payment is collected for a validation, a parking system sends a message containing AssignedRight and Session information. This includes:
    - A Segment and an associated AssignedRight with a payment that relates to the part of the Session that has been paid from the balance of the Validation issuer account (this value cannot exceed the balance on the account).
    - Other Segments (and associated AssignedRights) that represent the other portions of the parking event.
3. The mall system records the details of all Sessions, Assigned Rights and amounts paid to enable the system to inform Customers and Validation Issuers

    The mall system uses the discount value AssignedRight to update the account balance and sends this to all parking systems
4. At the end of each month the mall system automatically generates:
    - An invoice to each store that is participating in the scheme.
    - A payment to each parking operator.
    - A report reconciling the invoice or payment to the Payments.

Example User-defined Code Lists

Figure D.1 provides examples of user-defined code list that could support specific use cases in the data model.

Figure D.1: Examples of User-defined Code Lists

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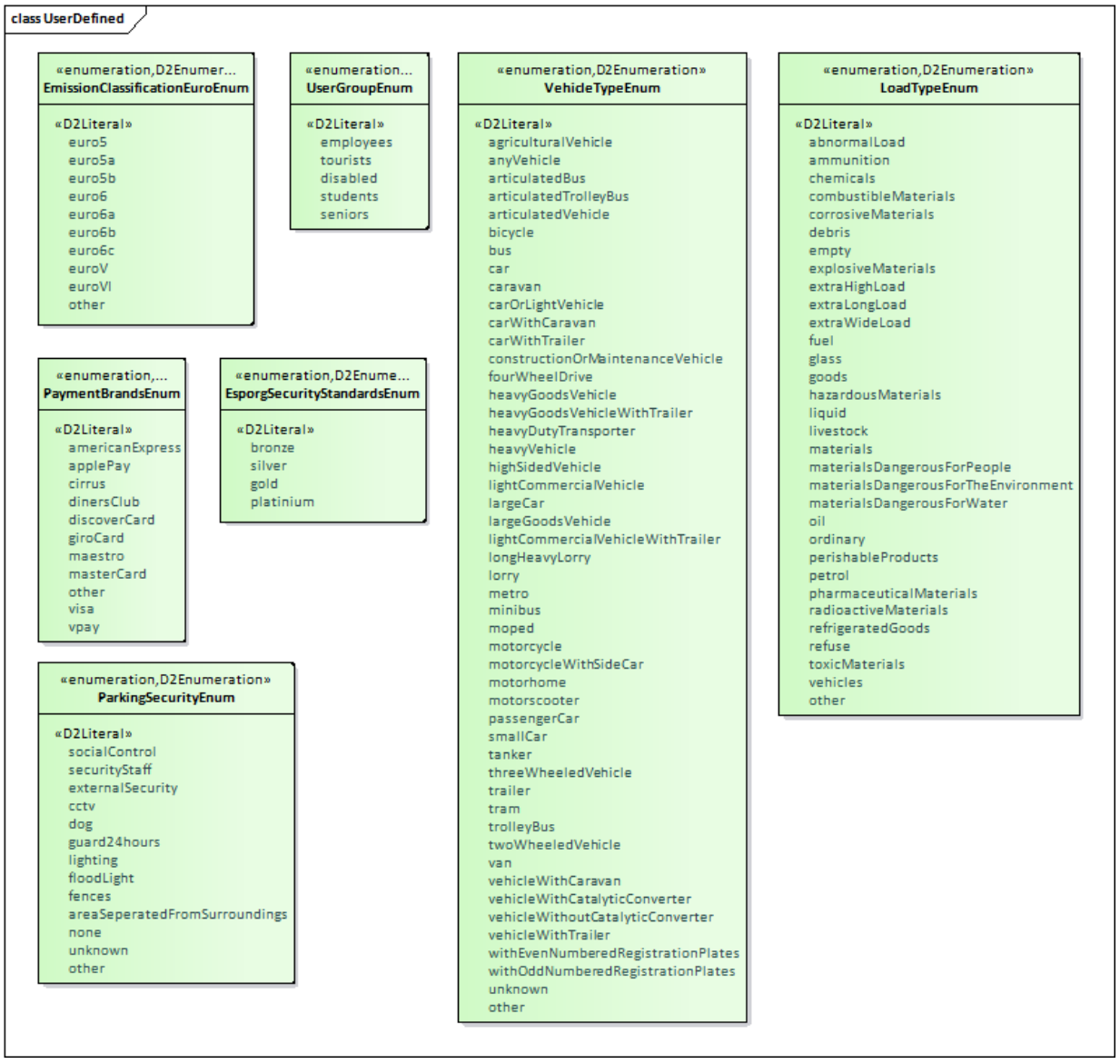

Figure D.1 – Examples of user-defined code lists

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