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Intelligent transport systems — Parking —

Part 1: Core data model

Systèmes intelligents de transport - Stationnement —

Partie 1: Modèle de données de base

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Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

A list of all parts in the ISO 5206 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Around the globe, new services and technologies are intersecting to create value-added convenience to customers and business owners while better utilizing available parking, mobility and transport infrastructure. Whether supporting car sharing, ride sharing, micro mobility services, prepaid parking, dynamic pricing in parking structures, remote management of operations, and/or improved reporting, the sharing of data is key to accelerating the adoption of these services.

To enable the sharing of data, the global community has collaborated to create consensus-built, international parking and mobility data specifications to establish a common language for data concepts and definitions in the parking, transport and mobility sectors. These “data specifications” define a common language composed of a set of data concepts and definitions that public and private property owners, operators and service providers can follow to facilitate communication between themselves and with the other industries. These specifications facilitate seamless integration, compatibility and communication between parking entities, mobility operators, the automotive industry, IT developers, ITS operators, services, and map and app providers, as well as other stakeholders.

These specifications, as defined in this document, seek to reduce the effort required to connect technology solutions to one another and to allow companies to refocus their resources on innovating new services and operations.

This document defines the structure, definition and relationships of data constructs relevant to parking and mobility data. This document provides a description of the data constructs in the context of the data model in Clause 6.

Annex A provides a data dictionary of definitions for attributes, classes and relationships.

Annex B provides a description of the data modelling approach defined in this document and how this relates to the CEN 16157 series "DATEX II" modelling approach, defined in EN 16157-1.

NOTE By choice, the Alliance for Parking Data Standards has substantively adopted the DATEX II modelling approach, as this can potentially facilitate simpler integration, at a later date, to data concepts and standards defining road traffic management and information concepts.

Annex C provides use cases and examples for the use of the data defined.

Intelligent transport systems — Parking —

Part 1:
Core data model

1 Scope

This document defines terms, characterization and the relationship of concepts, defined using model-driven architecture methods, for parking and parking-related activities (both on-street and off-street) covering common data supporting business to business exchanges and end user services.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 639-1, *Codes for the representation of names of languages — Part 1: Alpha-2 code*

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country code*

ISO 4217, *Codes for the representation of currencies*

ISO 8601-1, *Date and time — Representations for information interchange — Part 1: Basic rules*

ISO/IEC 10646, *Information technology — Universal coded character set (UCS)*

ISO/IEC 19505-1, *Information technology — Object Management Group Unified Modeling Language (OMG UML) — Part 1: Infrastructure*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
data receiving party
entity that is requesting or receiving data using the specification from a reliable data source

3.1.2
data distributing party
entity holding data with permission to distribute, that is issuing data using the specification to other entities

3.2 Abbreviated terms

ANPR automatic number plate recognition

RFID radio frequency identification

UML unified modeling language

4 Conformance

A specification, system or exchange of data (hereafter called "specification") claiming conformance to this document shall include a comparison of the specification of data against the data model defined in this document. This comparison shall be defined at two conformance levels:

— level 1 (data domain) which identifies which data domains within the specification correspond to the data domains specified in this document, and which are not;

— level 2 (detailed level) which compares the data model within the specification against the packages, classes, attributes and relationships specified in this document.

The level 1 conformance statement should be presented as a table based on the data domains defined in the normative part of this document. This includes place, occupancy, session, right, rates, quote, observation, energy infrastructure and parking common (PkCommon); or

The level 2 conformance statement should be presented as a table in which the data concepts used in the specification are described as follows.

— “Unmodified”: concepts in the specification which have the same definition, properties and relationships as in the corresponding data domain specified in this document.

— “Modified”: concepts in the specification which are similar to the data concept defined in this document, but which differ in the details of certain attributes and/or relationships (e.g. attributes added).

— “Alternative”: concepts or groups of concepts in the specification intended to model the same concepts as defined in this document but in a significantly different way.

— “Additional”: concepts in the specification which are additional to the concepts defined in this document and therefore are not covered by and drawn from the data concepts specified in this document.

— “Omitted”: data concepts specified in this document which are not used in the specification.

Data concepts shall include packages, classes, attributes, relationships, definitions and properties, and comparison shall present conformance with the following requirements as expressed in this document:

— conformance to all stipulated minimum and maximum multiplicity requirements for UML elements and relationships;

— conformance to all definitions, types and ordering;

— employment of optional elements as specified;

— conformance to all expressed constraints.

5 UML notation

The UML notation used in this document shall be as described in ISO/IEC 19505-1.

NOTE The use of UML notation follows the DATEX II methodology which is specified in EN 16157-1.

6 Data model

6.1 Data model overview

This specification facilitates the sharing of basic information between entities and systems. This includes map services, online marketing and aggregator services, event ticketing platforms, transit and transportation agencies, and other firms, organizations or individuals that have a need to know the location of parking and other mobility-related services and general information about the operation.

Figure 1 shows the data domains in this document. Each data domain defines a specific set of data concepts that logically can be grouped.

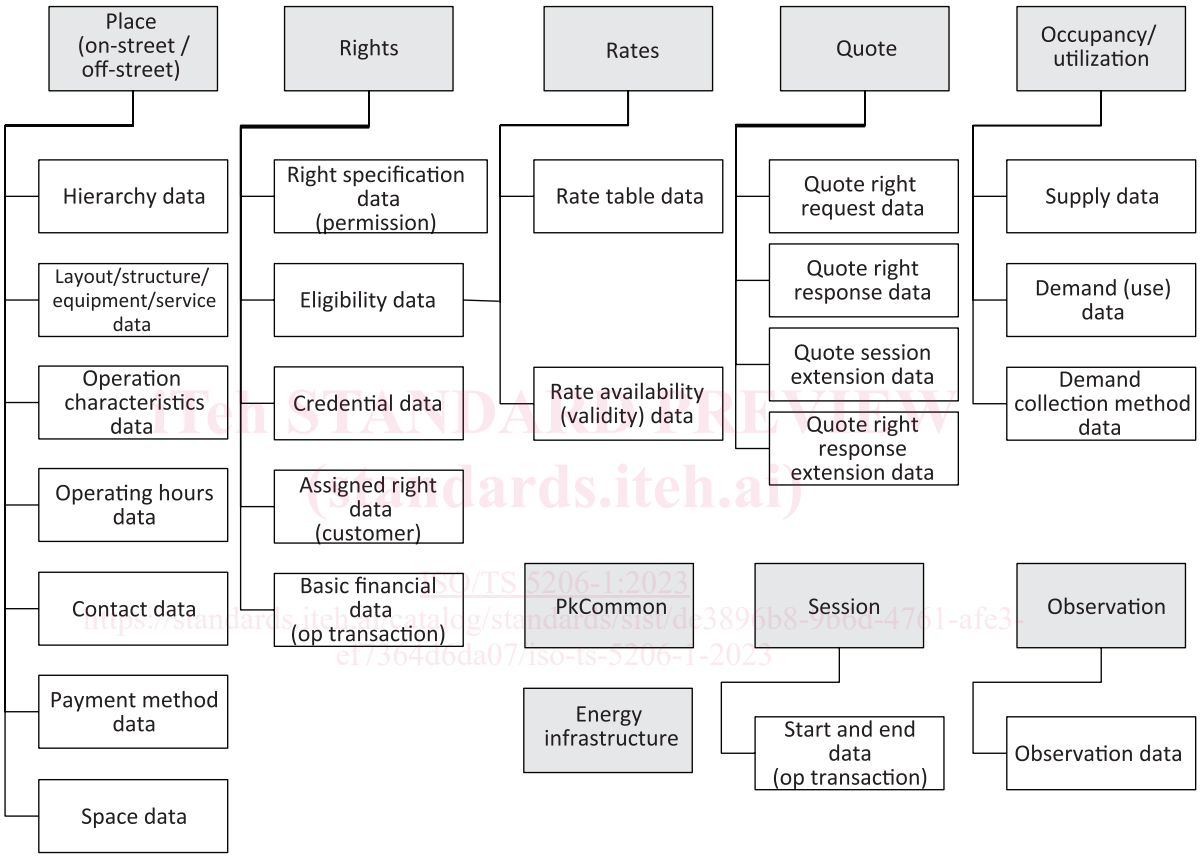

Figure 1 — Data domains

To assist navigation and understanding of the specification in this document, the overall model is separated into data domains, which can be seen in UML packages in Figure 2. The domains focus on functional groups of data concepts and relationships. Each of the domains is specified in its own namespace. In addition, the structure of the data model supports the definition of common concepts that are referenced and reused across several domains. These common concepts are specified in the "PkCommon" domain.

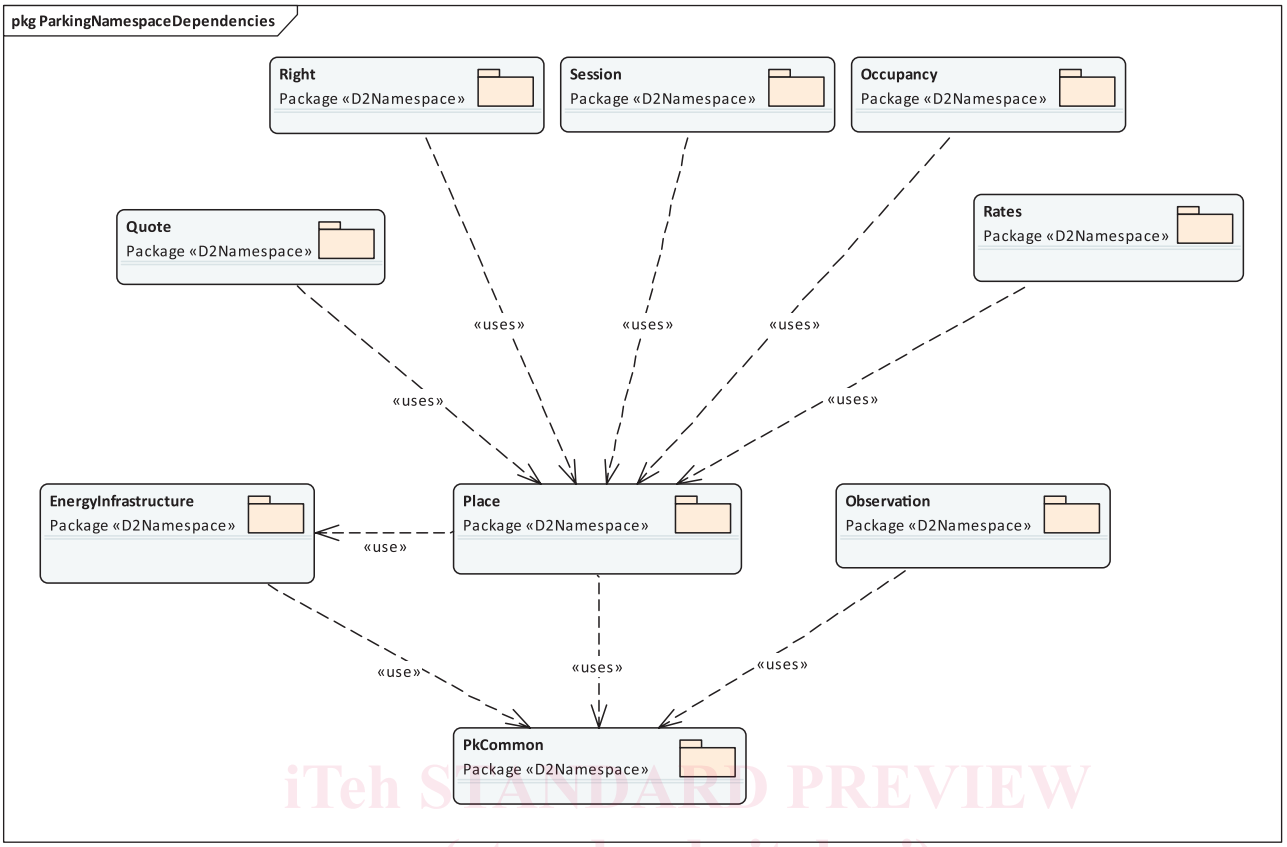

Figure 2 — Namespace dependencies

Figure 2 illustrates the dependency between namespaces.

These data domains, as characterized by the namespaces, are combined in various manners to support specific use cases that exist in parking and mobility operations. For example:

— the operations and systems to support automated valet parking rely on this document's data domains of place, rate, quote, session, right and occupancy;

— the operation and systems to support curbside management rely on all data domains in this document to support data sharing.

6.2 Place data concepts

6.2.1 Place hierarchy

6.2.1.1 Overview

This subclause describes concepts used in the place hierarchy, which are defined in the <Place> namespace of the data model.

NOTE Location, time and contact/organization concepts are defined in the <PkCommon> namespace of this data model.

6.2.1.2 Place hierarchy

The specification defines a method for building a hierarchy of place records in on-street, off-street and zone environments. Each instance of a place record corresponds to an instance of a class within the place hierarchy. This enables a parking or other type of operation to identify a location or zone in a

simple manner with a single hierarchy element or to break down a place into a multi-layered hierarchy that identifies discrete parking enclosures or defined areas to communicate operating hours, space counts, operating restrictions, location, rights and associated pricing and occupancy.

The hierarchy supports the ability of lower-level place hierarchy class instances (child records) to inherit specific instance data from a higher-level place hierarchy class instance (a parent record) in order to simplify the amount of data shared. The place hierarchy also enables lower-level place hierarchy class instances to document variations in specific attributes from their parent, higher-level place hierarchy class instance.

Additionally, the specification enables other operation types, not directly related to parking, to define a place in discrete operating enclosures. This may include a defined on-street area for managing delivery services or a sidewalk area enabled for bike or e-scooter placement.

The hierarchy allows a data distributing party to decide the appropriate level of detail to send to a data receiving party via messaging protocols. In addition, it is not necessary to build multi-layer hierarchies of Place data. Simple data needs can be represented without using the multiple layers available in the data specification.

Each of the component Place data concepts is mentioned in this subclause, but further details and descriptions follow in subsequent subclauses. These component data concepts are:

- `Place` (6.2.1.4),
- `SubplaceElement` (6.2.1.5),
- `IdentifiedArea` (6.2.1.6),
- `Space` (6.2.1.7),
- `Campus`,
- `PedestrianAccess` (6.2.2.1),
- `VehicularAccess` (6.2.2.2),
- `SpecificArea` (6.2.2.3), and
- `SupplementalFacility` (6.2.2.4).

Place is a term introduced in the specification to define 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.). Place is instantiated via the `Place` class. Place can also be used to define entry and exit roadways, driveways, and acceleration/deceleration zones for vehicles as well as pedestrian access points. Place supports both on-street and off-street operating environments. Place also defines specific areas to be defined for mobility or other related uses such as bike storage, e-scooter enclosures, etc. where it is useful to share operating parameters or assign RightSpecifications, Rates or other data domains.

A `Place` is an aggregation of instances of `SubplaceElement`, `IdentifiedArea` and `Space`. In this specification, the lowest mandatory class instance to define a Place is the `IdentifiedArea`.

NOTE `Space` is a lower data concept instance that can exist below `IdentifiedArea` data concept instance, but it is not required.

An aggregation of `IdentifiedAreas` can create an instance of a `SubplaceElement` or a `Place`. Specific attributes are associated to each of the four specialization types of `IdentifiedAreas`.

An aggregation of instances of `SubplaceElements` can be linked to an instance of a higher level `SubplaceElement` or a `Place`. This allows a data provider to share as much or as little detail as necessary to support their operation.

At the highest level of the place hierarchy, an aggregation of instances of `Place` can be linked to an instance of a `Campus`. An instance of `Campus` is not a required within an implemented place hierarchy.

Figure 3 illustrates how the instances of the various place hierarchy data concepts are combined to construct instances of nested parking hierarchy data concepts within one campus as a use case example.

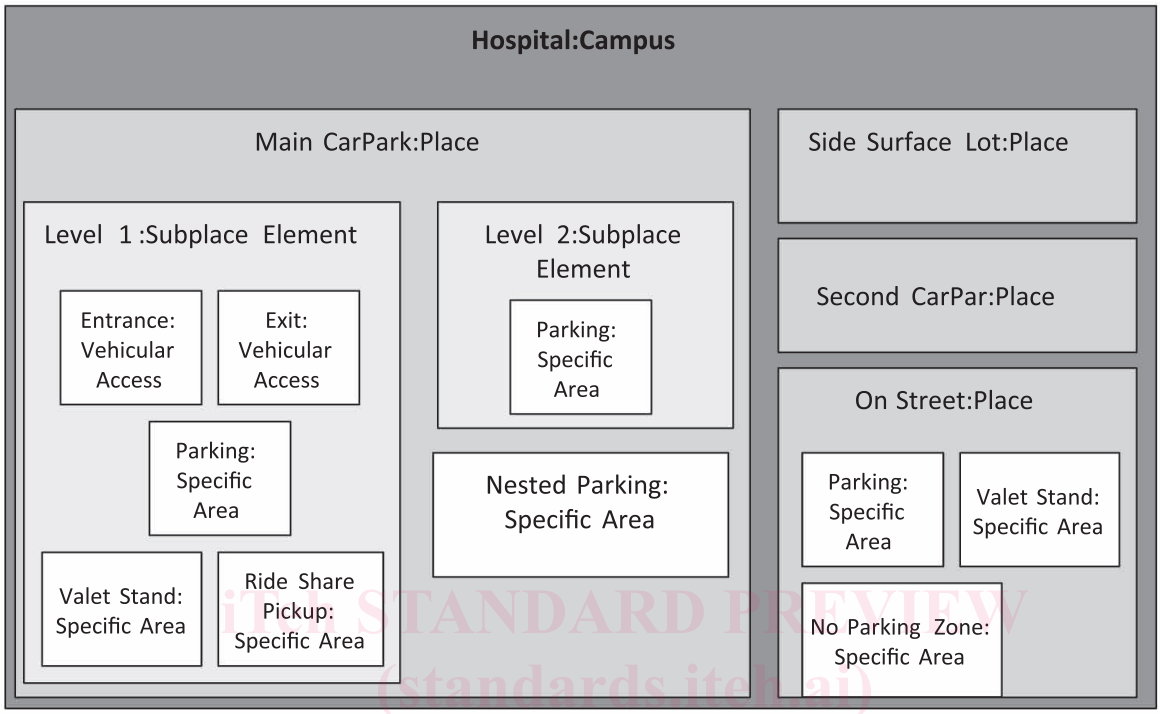

Figure 3 — Place hierarchy example – user-oriented

To support parking, mobility or curbside management operations, the `IdentifiedArea` class can be refined, through specialization, as one of four specialization types: `PedestrianAccess`, `VehicularAccess`, `SpecificArea`, and `SupplementalFacility`.

`PedestrianAccess` class is a specialization of `IdentifiedArea` class that enables a place to share coherent, relevant information about pedestrian entry and exit access points to a `Place`. This allows an entity to identify operating hours for the pedestrian access points and access requirements such as credentials or restrictions for each access point.

`VehicularAccess` class is a specialization of `IdentifiedArea` class that enables a `Place` to share coherent, relevant information about entry lane, exit lane and similar types of vehicular access points to a `Place`. The `VehicularAccess` class is used to define entry and exit to a specific facility or is used to provide a more macro description of an entry to a facility by reference to `Road` and `RoadNodes`.

`Road`: allows an organizational entity to identify the primary road on which a place exists and to describe routes to that `Place`.

`RoadNode`: allows an organizational entity to identify nearby major intersections of roads.

`SpecificArea` class is a specialization of the `IdentifiedArea` class that denotes a specific (generally geographically-bounded) area in a place that has a common operating purpose and common characteristics. Examples of common operating purpose include reserved parking area, electric vehicle parking, bike parking, delivery zone, loading zone, etc. The `SpecificArea` class describes the physical components of a `Place`.

For clarity, when defining the use of a `SpecificArea`, authorized activities to perform in an `IdentifiedArea` are defined by the assignment of a `RightSpecification` and include activities such as valet parking, disabled parking, delivery zone, etc. The assignment and authorization to perform a use

in a SpecificArea occurs via the assignment of a RightSpecification. As an example, valet parking is associated to an IdentifiedArea with a SpecificArea class via the RightSpecification which assigns valet parking to a specific person and place.

SupplementalFacility is a specialization of IdentifiedArea class that enables a Place to identify the type and location of equipment and services available within the Place. The SupplementalFacility class is used to define restroom/toilet, shower, food concession services, etc. It is also used to identify specific equipment available in a Place, such as bike storage, electric chargers, payment stations, etc. This IdentifiedArea specialization defines physical structures and equipment in the place as well as services available.

The IdentifiedArea data concept collects general operating information such as operating hours, operating restrictions, space information and payment information. If the data is absent at the specific instance of an IdentifiedArea, it is assumed the data for this information exists at a higher level in the hierarchy, encapsulated in either instances of Place or any level instance of SubplaceElement above the instance of IdentifiedArea. This allows for customization of operations at lower levels while relying on default data from higher levels in the Place hierarchy.

A Place is synonymous with the structure or area with which a consumer associates a vehicle being parked or a mobility service being delivered. It can be an entire parking structure or an aggregation of streets supporting on-street parking (also sometimes called a zone). General operating information such as operating hours, operating restrictions, space information, payment information, etc. is associated to a Place and any parts of the hierarchy underneath it as appropriate.

Place is a core component of this model as it defines a hierarchy that supports the identification of portions of locations that may be related to parking and other types of operations. Use of this hierarchy enables data suppliers to provide a structured mechanism to refer to related zonal and place concepts with an ordered hierarchy.

Figure 4 shows concepts within the place hierarchy.

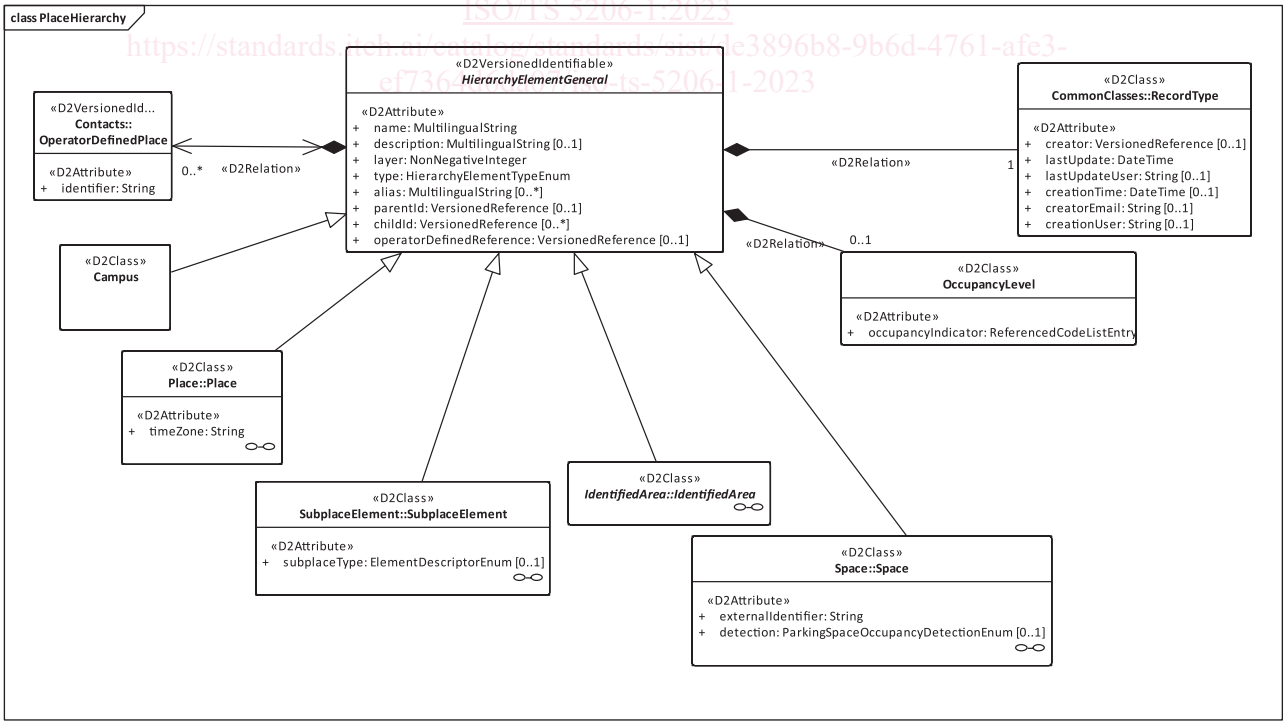

Figure 4 — Place hierarchy

The concepts shown in Figure 4 are:

— `HierarchyElementGeneral` – a generalized component of a `Place` hierarchy that forms one element in the tree-like hierarchy. This forms a reusable block of the hierarchy, with relations to its parent element (if one exists) and any child elements. Each `Place` in the hierarchy shall have a name and may support a free-text description and an operator/property-owner-defined reference (e.g. location number/identifier).

— There are five specializations of the `Place` hierarchy (`HierarchyElementGeneral` class), which conceptually defines different scales of hierarchy elements. From largest to smallest, they are:

  — `Campus` – the highest level in the hierarchy, it typically defines a large facility (such as a university campus, or an airport), or a large geographic zone (such as a city or a town), which may contain numerous places that can be logically reported together. A campus combines and encompasses a number of `Places` that can be logically reported together. Different entities sharing data may create their own aggregation of `Places`. Thus, a `Place` may appear in different campuses if a receiving party receives data from different sending parties. For example, a parking operator may group five (5) places together in which it operates and call it a campus to reflect the five (5) operations in a city. Three of the same places may be associated with a property management firm that defined a separate campus with the three places.

  — `Place` – a place or location used for parking, loading, unloading, standing, or another mobility or transport related activity. Place typically identifies a parking structure, surface lot or on-street parking zone.

  — `SubplaceElement` – a sub-division of a `Place` for the convenience of the operator to segment the `Place` and identify varied uses for parking and mobility-related operations or other purposes.

  — `IdentifiedArea` – an identifiable discrete bounded geographic zone that shares common characteristics and is used for parking and mobility-related operations or other purposes. IdentifiedAreas are segmented into four specializations: `PedestrianAccess` class, `VehicularAccess` class, `SpecificArea` class and `SupplementalFacilityArea` class.

  — `Space` – a single space for parking or other mobility-related purposes, usually designed for one vehicle, which may, but not necessarily, be denoted by painted marker or another road surface marker.

These specializations of place hierarchy (`HierarchyElementGeneral`) class (i.e. `Campus`, `Place`, `SubplaceElement`, `IdentifiedArea` and `Space`) support both the notion of different scales within the hierarchy as well as different forms of attribution, which are described later in this document.

The `Place` hierarchy shall be defined “top-down” with the highest layer being numbered 0 (zero) and each subsequent layer being numbered by incremental increasing integers.

The `Place` hierarchy can best be considered as a tree-like structure which starts from one common root element which will either be an instance of `Place` or, if used, `Campus`. Navigating down through the layers of the hierarchy, irrespective of which branch is taken, each subsequent layer sub-divides the previous. Each branch of hierarchy "tree" shall terminate in either an instance of `IdentifiedArea` or `Space`. Each branch of the hierarchy shall contain one instance of `Place`, and no more than one instance of `IdentifiedArea`.

A single instance of `Place` may support multiple branches, thus an instance of `Place` can have multiple instances of `IdentifiedArea` associated to it. If an instance of `Campus` is present, it shall only occur once in each branch of the hierarchy. See Figure 5, which provides an illustrative example of elements of a place hierarchy combined.

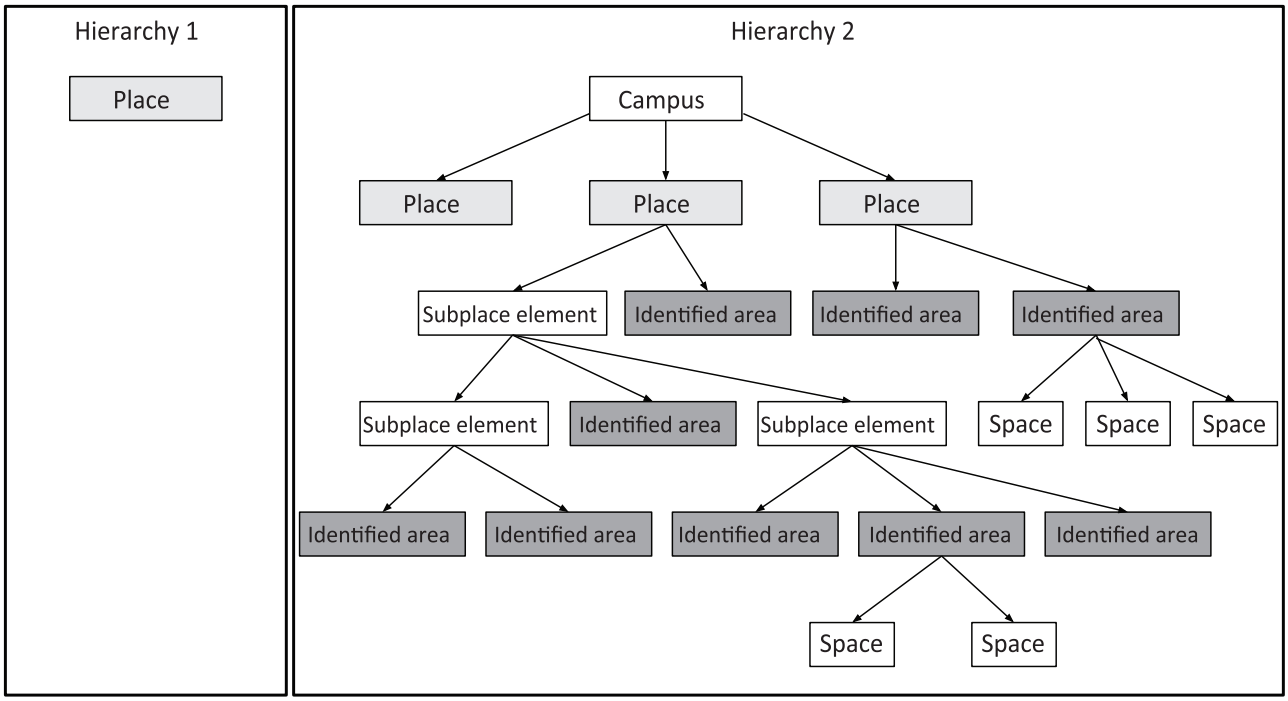

Figure 5 — Examples of place hierarchy

When describing the homogeneous characteristic for an entire place, the tree structure may terminate with the instance of `Place`, (see Hierarchy 1 in Figure 5) with no further child hierarchy elements (including `IdentifiedArea`).

If the place is sub-divided, each "branch" of the hierarchy tree shall terminate in one instance of `IdentifiedArea`, and the `IdentifiedArea` class shall appear only once in each branch of the hierarchy tree. Only instances of the `Space` class may exist at the levels of a hierarchy below the occurrence of `IdentifiedArea` in each branch of the hierarchy tree. Every branch of the hierarchy tree may use instances of the data concepts `Campus`, `Place`, `SubplaceElement`, `IdentifiedArea` and `Space` in the order stated. Instances of `SubplaceElement` may be repeated in any branch of the hierarchy, so long as this conforms to the order in the stated sequence.

6.2.1.3 Location hierarchy example

Top down:

Airport example

— Layer 0 – Campus (Airport)

— Layer 1 – Place (Short Stay Car Park) {others might be "long stay", "valet meet and greet", etc.}

— Layer 2 – SubplaceElement (Orange Level or Third Floor)

— Layer 3 – IdentifiedArea (Row J) - Type SpecificArea, with additional attributes

— Layer 4 – Space (74)

It is not necessary to build multi-layer hierarchies of `Place` data. Simple `Place` data needs can be represented without using the multiple layers available in the data specification.

6.2.1.4 Place

Figure 6 provides a UML class diagram for Place.