

The Modelling of Rights, Restrictions and Responsibilities (RRR) in the Land Administration Domain Model (LADM)

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SUMMARY

In this paper, the modelling of alternatives for Rights, Restrictions and Responsibilities (RRRs) are discussed, within the context of the Land Administration Domain Model (LADM, ISO 19152, under development). This includes the modelling of holding shares in a RRR.

LADM currently provides for the aggregation of objects into explicit ‘group objects’ with regard to (a) people and organisations (class `LA_Party`), and (b) parcels (class `LA_SpatialUnit`). This aggregation facility is not available for the RRRs. In case of RRRs it was recognized that these objects (as smallest units) should together form a ‘whole’; e.g. two different persons, both having a ½ ownership right on the same parcel. This is enforced in the current LADM by a constraint, performing this check.

In this paper two model alternatives are explored: (1) in one alternative the model was extended by an explicit class `LA_RRR_Group`, (2) in another alternative no new classes were introduced in the model, but the relevant constraint was refined. Especially, representing the case of multiple easements on a single parcel, without their own easement geometry (the ‘negative’ side), with each easement benefiting multiple parties (the ‘positive’ side), is challenging with respect to the possibility to group the various easement-‘shares’ (‘parts’) into a ‘whole’. This paper shows that even this case can be represented well in the current LADM (including the refined constraint). However, it is easier to model this situation in the extended LADM with the new class `LA_RRR_Group`, but at the cost of complicating the model and the registration of all RRRs (while most of them not do need this extension at all).

The conclusion (at least for the time being) is, that this complication of extending the LADM with an additional class `LA_RRR_Group`, is not worth the benefit and that therefore class `LA_RRR_Group` will not be included in the next version of the LADM.

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1. INTRODUCTION

The Land Administration Domain Model (LADM) is under development within the Technical Committee 211 (TC211) of the International Organization for Standardization (ISO, [ISO/TC211, 2010](#)) and identified as ISO 19152. The model provides an abstract, conceptual schema with five basic packages related to (1) parties (people and organisations) (2) spatial units (parcels, buildings and networks) (3) rights, responsibilities, and restrictions (property rights) (4) spatial sources (surveying), and (5) spatial representations (geometry and topology). In this paper the modelling of Rights, Restrictions and Responsibilities (RRR) will be discussed in detail; with a focus on the modelling of holding shares in a RRR and on the modelling of restrictions and responsibilities from the ‘positive’ or ‘negative’ side (from the perspective of respectively the ‘dominant parcel’ or ‘serving parcel’).

The LADM provides for the aggregation of objects into explicit ‘group objects’, for example in case of parties: a party belongs to class LA_Party and an aggregation of parties – a group – belongs to class LA_GroupParty.

For spatial units, aggregations can be done in three different manners:

1. A spatial unit belongs to class LA_SpatialUnit and an aggregation of spatial units refers to an ‘basic administrative unit’ of class LA_BAUnit; e.g. the rights, attached to (a) the house parcel (from class LA_SpatialUnit) and (b) the car-parking parcel at other side of the street (also from class LA_SpatialUnit), are equal and therefore grouped into one ‘basic administrative unit’ (from class LA_BAUnit).
2. A spatial unit belongs to class LA_SpatialUnit and an aggregation of spatial units belongs to class LA_SpatialUnitGroup; e.g. a number of parcels together (from class LA_SpatialUnit) form a cadastral section (from class LA_SpatialUnitGroup). Note however, that no rights are attached to the cadastral section, because it is not a spatial unit.
3. Both a spatial unit and an aggregation of spatial units belong to class LA_SpatialUnit; this is an option for recursive grouping and can be applied to model *subparcels* (to any depth) within a parcel. The subparcels can also have rights attached (both parcel and subparcel are instances of class LA_SpatialUnit).

In case of rights (restrictions and responsibilities) it was also recognized that these ‘smallest units’ (instances of classes LA_Right, LA_Responsibility, and LA_Restriction) should be aggregated to a ‘whole’; e.g. two different persons both having a ½ ownership right on the same parcel. However, in the working draft (WD) version of LADM ([ISO/TC211, 2008b](#)) and the committee draft (CD) version of LADM ([ISO/TC211, 2009a](#)) this was modelled by a constraint, not by having an explicit aggregation class. This constraint was attached to class LA_BAUnit and stated – in pseudo Object Constraint Language (OCL) – that *‘sum{RRR.share}=1 per type’*. Or in natural language: the sum of the shares of all associated

instances of classes LA_Right, LA_Responsibility, and LA_Restriction, grouped per RRR type must be equal to one.

One of the received comments on the WD and CD versions of LADM was that this share is not always meaningful; e.g. imagine two adjacent parcels having a right-of-way on a third parcel. Also related to this issue is the fact that a dependant RRR can be ‘owned’ by an instance of class LA_BAUnit and not by an instance of class LA_Party. For the Draft International Standard (DIS) version of LADM ([ISO/TC211, 2009b](#)) a number of model alternatives were explored: in one option the model was extended by an explicit class, in another model no new classes were introduced, but the constraint was refined. Design or selection criteria for the new version of the model include: being able to correctly and consistently describe the actual situation, model orthogonality (that is, apply similar model patterns to similar situations), model simplicity (rather having less than more model elements) and model understandability (intuitive meaning).

This paper is structured as follows. [Section 2](#) gives a short introduction to the LADM based on the current version in ISO DIS 19152 ([ISO/TC211, 2009b](#)). Different model patterns for representing ‘part-whole’ situations (similar to: member-group situations, or unit-collection situations) are described in [Section 3](#). Some real world RRR cases (examples), where share is, or is not meaningful, are introduced in [Section 4](#). In [Section 5](#) the UML model alternatives, the current LADM and an extended model (with a new class LA_RRR_Group), are presented at *class diagram* level, while [Section 6](#) will give the *instance diagram* level illustrations of the cases (examples) in the different model alternatives. [Section 7](#) discusses the advantages and disadvantages of the different solutions and in addition presents the conclusions and future work.

2. OVERVIEW OF CURRENT VERSION OF LADM

This section provides some background via a short introduction of the LADM, based on the current version in ISO DIS 19152 ([ISO/TC211, 2009b](#)) with some additional attention to ‘part-whole’ model situations. In the next three subsections, the three main packages of the LADM will be presented: the Party package ([Section 2.1](#)), the Administrative package ([Section 2.2](#)), and the Spatial Unit package ([Section 2.3](#)).

2.1 Party package

The main class of this package is class LA_Party (with ‘party’ as an instance), and with its specialization LA_GroupParty (with ‘group party’ as an instance). There is an optional association class LA_PartyMember. See [Figure 1](#).

Parties are persons, or groups of persons, or juridical persons, that compose an identifiable single (legal) entity. A juridical person may be a company, a municipality, the state, a farmer cooperation, or a church community. The definition of ‘party’ implies that a party may be a natural person, or a group of natural persons, or a non-natural person.

A ‘group party’ is any number of parties, forming together a distinct entity. A ‘party member’ is a constituent of a party or group party.

A 'baunit' (an abbreviation for 'basic administrative unit') is an administrative entity consisting of zero or more spatial units (parcels) against which (one or more) rights (e.g. an ownership right or a land use right), responsibilities or restrictions are associated, as included in a land administration system (LA system). An example of a 'baunit' is a basic property unit with two spatial units (e.g. an apartment and a garage). It should be observed in relation to this that rights, restrictions, and responsibilities may affect only a part of the spatial unit, with the geometric representation of that part missing. A 'basic administrative unit' may be a 'party' because it may hold a right of easement.

With regard to the topic of this paper it is necessary to mention two attributes of class LA_RRR:

1. share: a share in a right; there is a constraint that the sum of all shares should be equal to 1.
2. shareCheck: a Boolean indicating whether the constraint in 1. is meaningful.

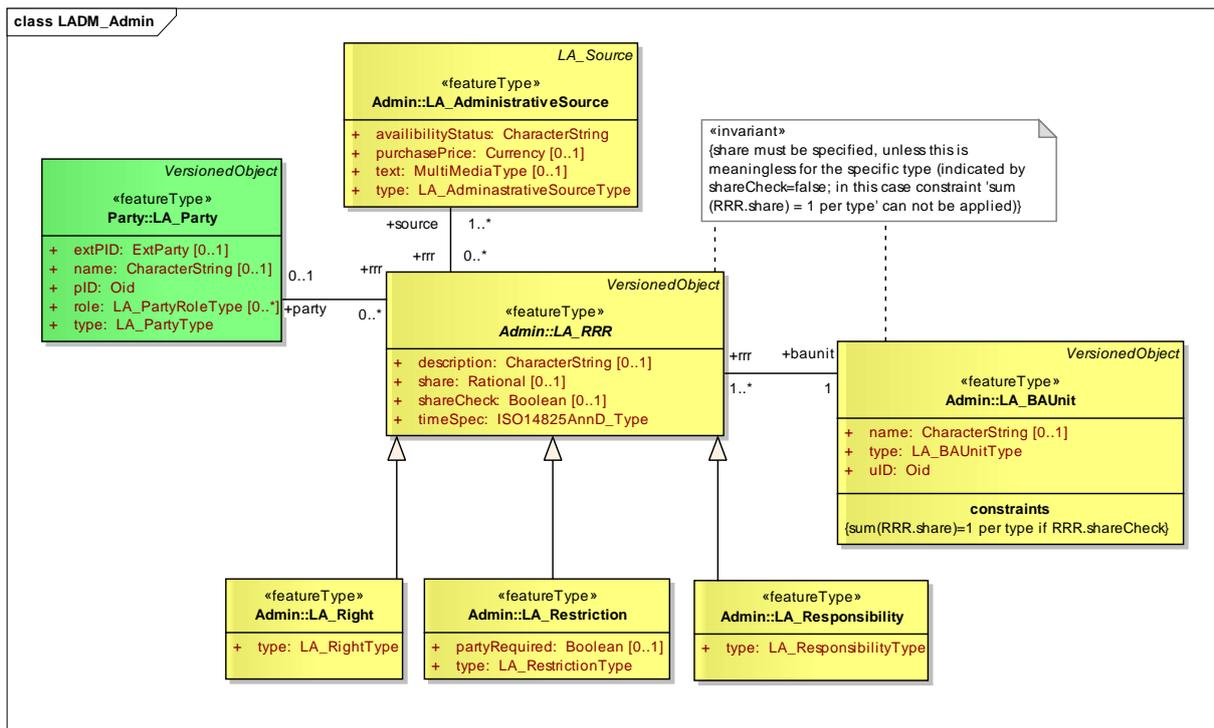


Figure 2 LADM Administrative package classes

2.3 Spatial Unit package

This package concerns the classes LA_SpatialUnit, LA_SpatialUnitGroup, LA_Level, LA_LegalSpaceNetwork, LA_LegalSpaceBuildingUnit and LA_RequiredRelationship-SpatialUnit; see [Figure 3](#).

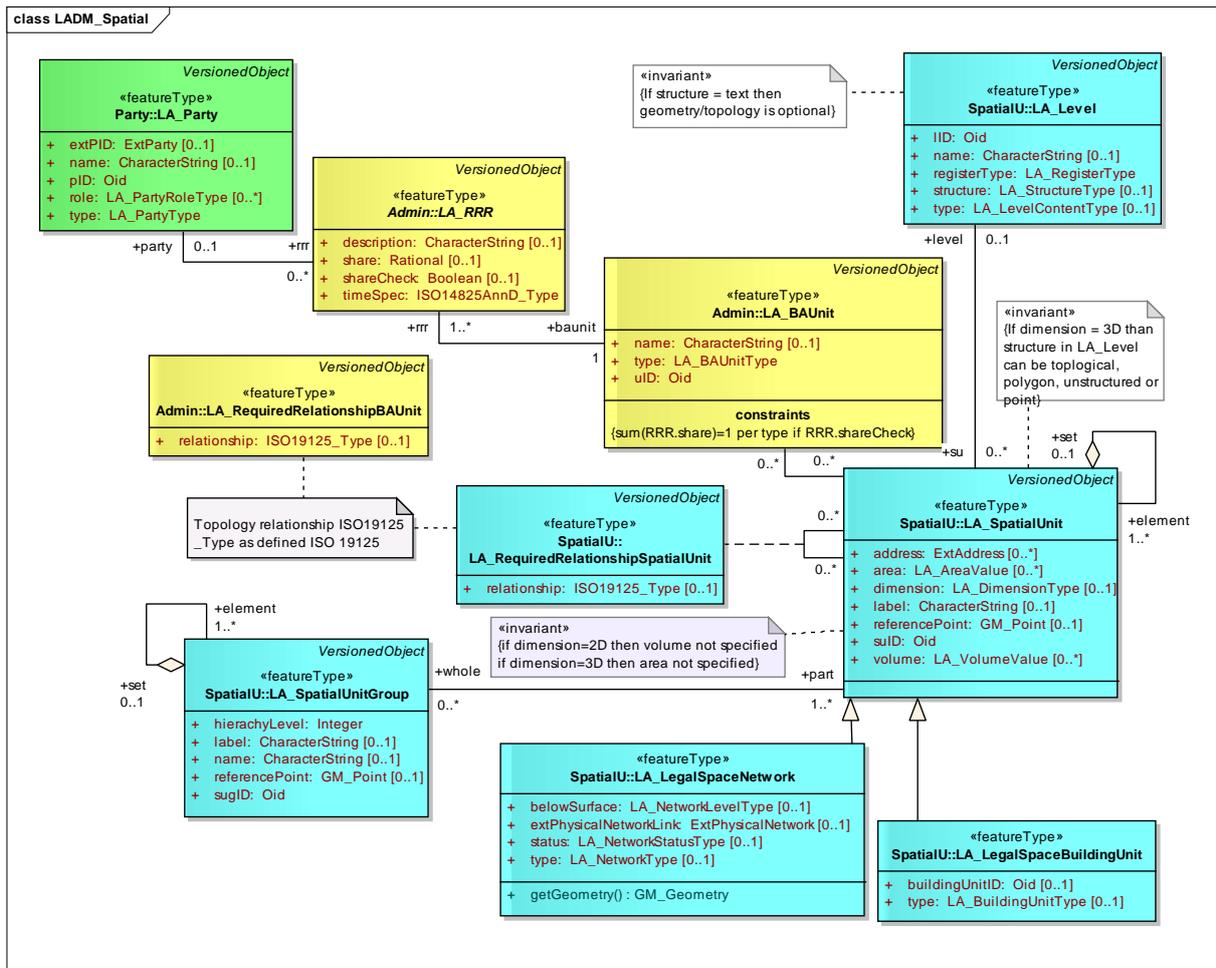


Figure 3 LADM spatial unit package classes

A ‘spatial unit’ is a point (or, multi-point), a line (or, multi-line), representing a single area (or, multiple areas) of land (or water) or, more specifically, a single volume of space (or, multiple volumes of space). Single areas are the general case and multiple areas the exception. Spatial units are structured in a way to support the creation and management of basic administrative units.

Spatial units are a flexible concept of representing reality; e.g. spatial units may be described: in text (“from this tree to that river”), or based on a single interior point, or as a collection of lines, or as a polygon, or as a 3D volume. A ‘spatial unit group’ is a group of spatial units; e.g.: spatial units within an administrative zone (e.g. a section, a canton, a municipality, a department, a province, or a country), or within a planning area (Lemmen et al, 2010).

A ‘level’ is a collection of spatial units with a geometric or thematic coherence. To implement the ‘principle of legal independence’, as introduced in ‘Cadastre 2014’ (Kaufmann and Steudler, 1998), it is necessary to investigate the laws in a jurisdiction and to identify those laws with an effect on land. The different spatial units may be arranged to ‘information levels’ according to the laws by which they are defined. This ‘information level structure’

allows the immediate adaptation of the land administration to the development of the legislation. It is not necessary to rearrange the information. New legal topics can simply be added by including a further information level. If a law is cancelled, the respective information level can be removed without reorganizing the other levels. In this way it is possible to deal with facts which are not formally written down in a law. A ‘legal space network’ is the description of the legal, recorded or informal space of a utility network. An instance of class `LegalSpaceBuildingUnit` is a ‘building unit’; this is a component of a building or a construction work (the legal, recorded or informal space of the physical entity).

A ‘required relationship spatial unit’ is an explicit association between spatial units – due to inaccuracies, because a polygon overlay operation may generate invalid relationships. It is a spatial type, re-used from ISO 19125-2 (e.g. overlaps, contains, etc.).

3. MODEL PATTERNS FOR ‘PART-WHOLE’ SITUATIONS

In this section three different model patterns will be described for a specific category of ‘*part-whole*’ situations (similar to *element-set*, *unit-collection*, *atom-group*, or *instance-aggregation* situations). The fact that the ‘whole’ in LADM is a subclass of the ‘thing’ makes the patterns a bit different from the normal aggregation in UML class diagrams (the open or closed ‘diamond head’ associations). The presented patterns in the subsections ([Section 3.2](#), [Section 3.3](#) and [Section 3.4](#)) can be used (1) to represent ‘part-whole’ hierarchies (instead of just one level ‘part-whole’), or can be used (2) if the ‘part’ and the ‘whole’ are to be used uniformly (‘whole’ will play the same role as ‘part’). In a sense the presented model patterns vary from being very generic and flexible, offering a lot of expressive power, but relatively complex, to model patterns with less expressive power but more simple and compact. However, to provide the right context, the next subsection ([Section 3.1](#)) first introduces the standard UML solution for ‘part-whole’ modelling.

3.1 Standard ‘part-whole’ in UML

UML offers two standard language elements to express the ‘part-whole’ relationship: the open or closed ‘diamond head’ for respectively (1) an aggregation association, or (2) a composition association. In case of a composition (closed diamond head) the ‘part’ can not exist without the ‘whole’, which might be considered as a stronger ‘part-whole’ relationship than in the aggregation; see [Figure 4](#).

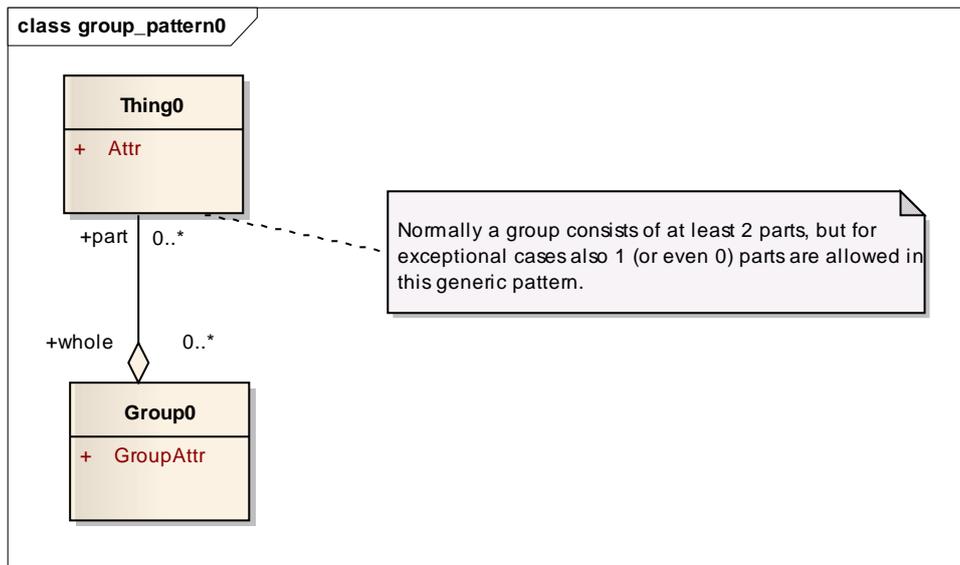


Figure 4. ‘part-whole’ relationship via the standard aggregation association in UML

Sometimes this language element is not used, and the ‘part-whole’ relationship is only deducible by the names of the related classes, the multiplicities of the associations and the text describing the model. In the current version of the LADM this is the case with class `LA_SpatialUnitGroup` (‘whole’) and class `LA_SpatialUnit` (‘part’); see [Figure 5](#). The reason for this LADM decision was to express the fact that a ‘whole’ of class `LA_SpatialUnitGroup` is more than the aggregation of spatial units, because it can have its own spatial description, which may be different from the union of the aggregated spatial units. For example, in some countries certain parcels (e.g. government parcels) are not included in the registration, but the municipality should still cover the complete region.

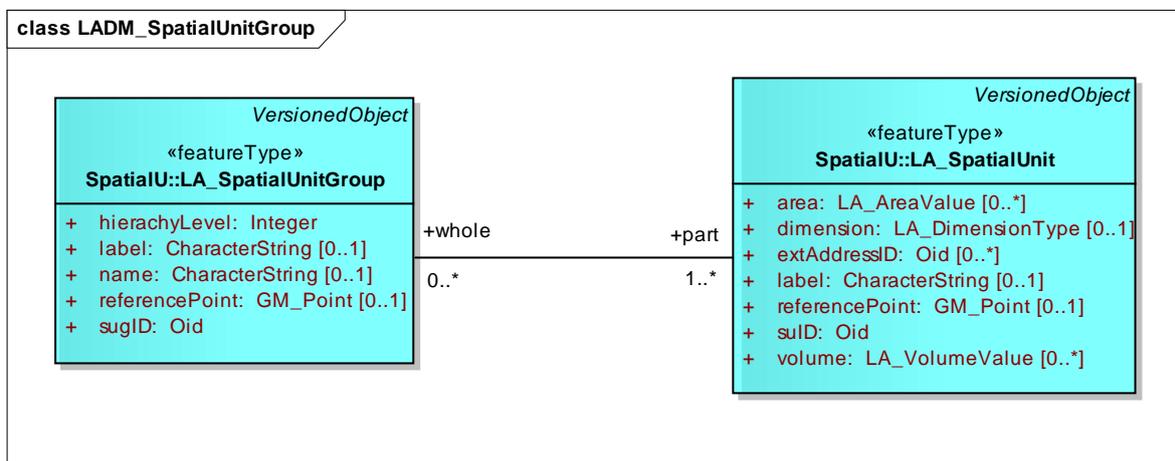


Figure 5. ‘part-whole’ relationship deducible by the names of classes, multiplicities and text

The standard UML solutions for modelling ‘part-whole’ doesn’t allow us to model hierarchies and doesn’t also allow us to use an instance of the ‘whole’ (e.g. from class

LA_SpatialUnitGroup) in the exact same way as an instance of the ‘part’ (e.g. from class LA_SpatialUnit); i.e. there is no association between class LA_RRR and class LA_SpatialUnitGroup, as there is an association between class LA_RRR and class LA_SpatialUnit (via class LA_BAUnit); see [Figure 3](#). In this situation, this is indeed the intension of the model as there should be no instances of subclasses of LA_RRRs attached (via LA_BAUnit) to instances of LA_SpatialUnitGroup. However, in other situations the ‘whole’ should also be used in the same manner as the ‘part’ (and then there should often be a way to express the hierarchy of groups); e.g. similar to class LA_PartyGroup and class LA_Party. Model patterns for these situations will be presented in the next subsections.

3.2 Group modelling pattern 1 (general case)

The first group modelling pattern has separate classes for representing respectively ‘atomic objects’ (class AtomicThing1) and ‘group objects’ (class GroupThing1), both are specializations of the same generic class (GenericThing1); see [Figure 6](#).

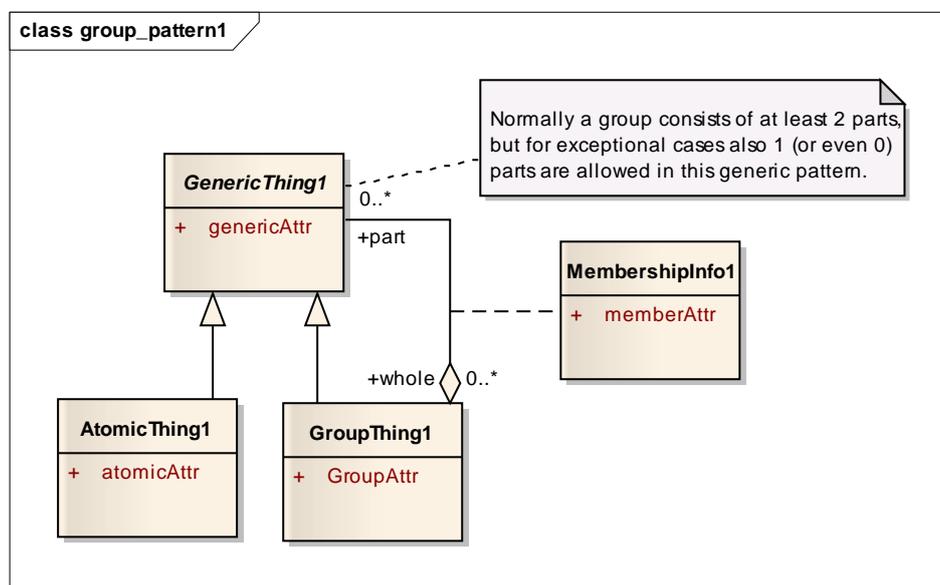


Figure 6. Group modelling pattern 1

The class GenericThing1 is abstract (thus cannot have instances) and carries the generic attributes, that is, attributes needed and inherited by both ‘atomic objects’ and ‘group objects’. Note that there is an indirect recursion in the pattern: a group is a generic thing and can therefore be a member of another group. For documenting the membership there is an association class MembershipInfo1 introduced in the aggregation of ‘atomic things’ or ‘group things’ into an instance of class GroupThing1. Typical attributes for the MembershipInfo1 class are: date (since when is a certain ‘part’ member of the ‘group’?), and share (what share does the ‘part’ have in the entire ‘group’?).

With regard to the multiplicity in the aggregation: every ‘group thing’ has normally at least two ‘atomic things’ as ‘parts’ (but most likely more), and every ‘atomic thing’ belongs to 0 or more ‘group things’ (that is can be member of zero, one or even several ‘groups’).

A more restricted ‘part-whole’ modelling pattern is a hierarchy: all instances of GenericThing1 have exactly one ‘parent’ (and are not more than once a member of a group) except for the top GenericThing1 that has zero ‘parents’. Further, an instance of GroupThing1 can only have members at one level lower. This pattern can be expressed in the model via different multiplicities (more strictly) and additional constraints that members are indeed one level lower (and for this it is convenient to include a level attribute in class GenericThing1).

In the current version of the LADM this very generic and expressive model pattern for ‘part-whole’ situations is not applied. More ‘simplified’ model patterns are used instead, as will be presented in the next two subsections.

3.3 Group modelling pattern 2 (simplified)

If the class AtomicThing1 has no specific (own) attributes it could be merged with the class GenericThing1 and this class is called Thing2 (a non-abstract class) in the second ‘part-whole’ model pattern; see [Figure 7](#).

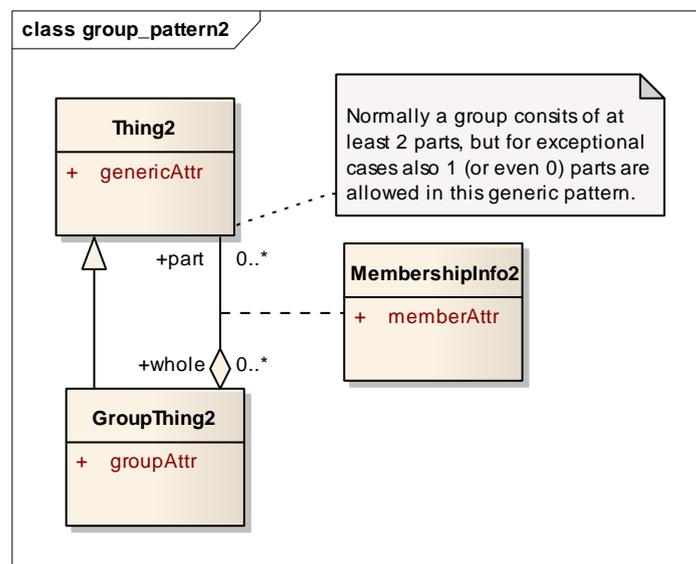


Figure 7. Group modelling pattern 2

In the current version of the LADM this model pattern is used respectively for the classes LA_Party, LA_GroupParty, and LA_PartyMember to treat them uniformly in relation to LA_RRR, and to be able to express a hierarchy of persons (e.g. heirs).

3.4 Group modelling pattern 3 (simplified)

Next, in case that the class GroupThing2 does not have any specific attributes then this class is also merged in the Thing 2 class and this is called Thing3 (and this represents both atomic and group things) in ‘part-whole’ model pattern 3; see [Figure 8](#). However, while this pattern is able to express a hierarchy of things, it doesn’t express that the ‘whole’ and the ‘part’ are two different things.

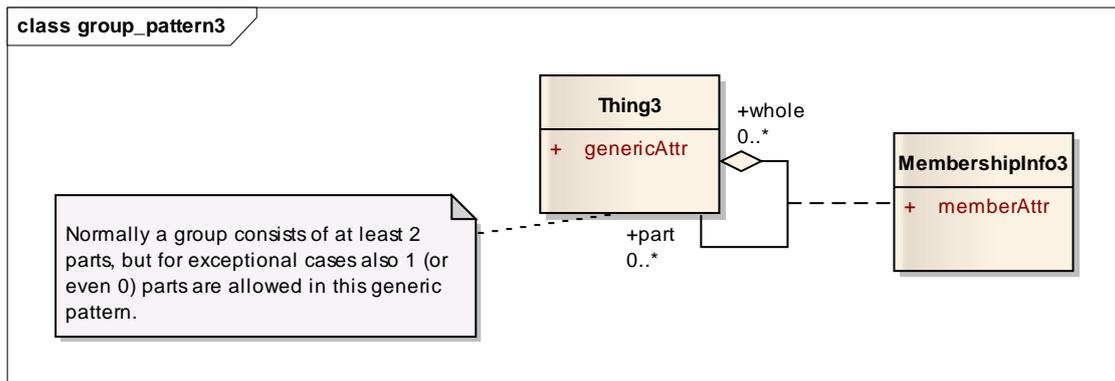


Figure 8. Group modelling pattern 3

In the current version of the LADM this type of model pattern 3 (without the MembershipInfo3) is used in the hierarchical representations of LA_SpatialUnit (e.g. to represent parcels and subparcels and perhaps even sub-subparcels) and of LA_SpatialUnitGroup (e.g. to represent an administrative hierarchical subdivision: e.g. section – municipality – province).

For ‘part-whole’ (group) model patterns 2 and 3 it is also possible to restrict the grouping to a hierarchy. Similar to model pattern 1 this can be realized by making the multiplicities more strict and adding a level constraint.

For all model patterns: in case there is no need to represent specific membership attributes, then the association class MembershipInfo may be omitted.

4. REAL-WORLD CASES

In this section two cases are presented, both using the easement as an illustration of how the grouping of LA_RRR in the LADM is supported. In [Section 4.1](#) there is just a single easement on a parcel (for the benefit of use by two other parcels). In [Section 4.2](#) there are multiple easements on a parcel. This second example is presented because it challenges the current version of LADM with regard to the expressive power of grouping LA_RRRs.

4.1 A single easement

Imagine the following real world case: three parcels, side by side, A (SU_PA), B (SU_PB) and C (SU_PC); see [Figure 9](#).

There is an easement: "Enabled to pass on foot and it burdens parcel A in favour of B and C, and it burdens parcels A and B in favour of C". It could be stated that the easement of A is shared by parcels B and C. The two restrictions on A could be grouped because they are of the same type (‘easement’) and connected to the same ‘baunit’. However, it does not seem useful to store explicit shares in class LA_RRR for this purpose (though it is possible in the LADM). Therefore the attribute ‘shareCheck’ in class LA_RRR should be set to ‘false’ and the attribute value of ‘share’ is not present.

Besides the mentioned grouping issue, there are different approaches possible to register and model the easements based on decisions such as: does an easement split the involved

parcels? What aspects of the easement are represented? And how are they represented? The solutions are mainly based on different national legislations, or different technical reasons, but the LADM, being a generic international standard, must be able to express all of them.

In the following, three main categories are presented (with each of them having more variations): (1) the easement geometry causing subdivision of crossed parcel ([Section 4.1.1](#)), (2) the easement geometry on a different ‘level’ ([Section 4.1.2](#)), and (3) an easement without geometry ([Section 4.1.3](#)).

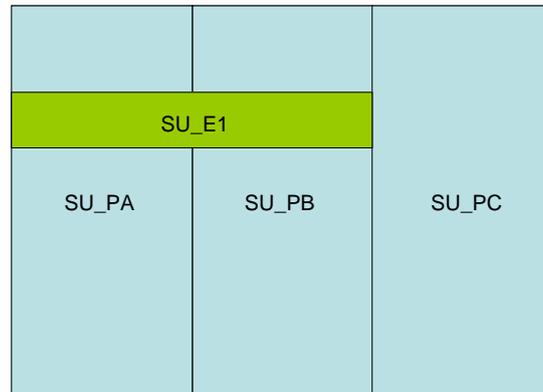


Figure 9. Three parcels with a single easement (restriction): a ‘path’ to access the other parcels (from the public road)

4.1.1 An easement based on subdivision

The spatial units SU_PA1, SU_PA2, SU_PB1, SU_PB2 and SU_PC (see [Figure 10](#)) are units with ownership right associated to a party via class LA_BAUnit. Spatial units SU_PA3 and SU_PB3 have an ownership right with an associated party and an ‘easement without party’ (a restriction, this can be considered as an “object restriction”; it means that it is not explicitly known to which party the restriction is valid, that is the person walking on the access road; if this is known then there can be a party associated to it).

Class LA_BAUnit can be used for grouping the spatial units SU_PA1 and SU_PA2 (both having the same rights) and for grouping the spatial units SU_PB1 and SU_PB2 (again with the same rights).

Note that the ‘principle of legal independence’ is not applied here as the geometry of the easement is intersected with the geometry of the parcels.

It is fair to state that in this approach the focus is on the recording of the ‘negative’ side of the easement. However, if it has to be recorded who is benefiting from the easement (a bit of the ‘positive’ side), then also that party could be attached to the restriction; e.g. most likely the owner/user of parcel SU_PC will be attached to the restrictions on parcels SU_PA3 and SU_PB3 (and similarly the owner/user of parcel SU_PB3 will be attached to the restriction on parcel SU_PA3). If the attached party would not be the ‘normal’ owner/user, but with a ‘baunit’ playing the role of party, then it is possible to model the ‘positive’ and the ‘negative’ side of the easement directly on the parcels; see the next subsection.

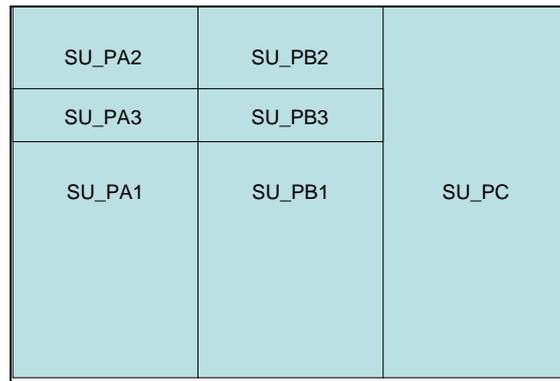


Figure 10. An easement based on subdivision'

4.1.2 An easement with two levels

The spatial units representing ownership are in one 'level' and the spatial units representing the easements are in another 'level', according to the 'principle of legal independence' of 'Cadastre 2014'. This is already more or less suggested in [Figure 9](#). The spatial units SU_PA, SU_PB and SU_PC (see [Figure 10](#)) are units with ownership right associated to a party via class LA_BAUnit. Spatial unit SU_E1 has no ownership right, but it has a restriction (via class LA_BAUnit) with an associated party. The restriction is representing the 'negative' side and with the use of spatial overlay it can be decided which parcels have this 'negative' side. It may be the case that a single easement, e.g. spatial unit SU4 in [Figure 11](#), has multiple overlays with parcel SU1. It may also be the case that the accuracy of the geometric representations of the spatial units is not sufficient to capture the fact that a certain easement is affecting a specific parcel; e.g. given the geometric accuracy it is unclear in [Figure 11](#) whether parcel SU4 is affecting parcel SU2. If important, then this has to be explicitly stated with a link in class LA_RequiredRelationshipSpatialUnit (with a value like overlap or disjoint).

The spatial unit who has the 'positive' side may be explicitly represented by attaching the party which benefits of this restriction (and normally is a person, or a 'baunit as party'). If the 'positive' side is not stored explicitly, then the spatial configuration and some rules may give some insight. However, for this it is important to know "Where is the public road?" and "Is it at one 'end' of the easement or at two?". Another interesting issue is "Can there be a network of easements?"

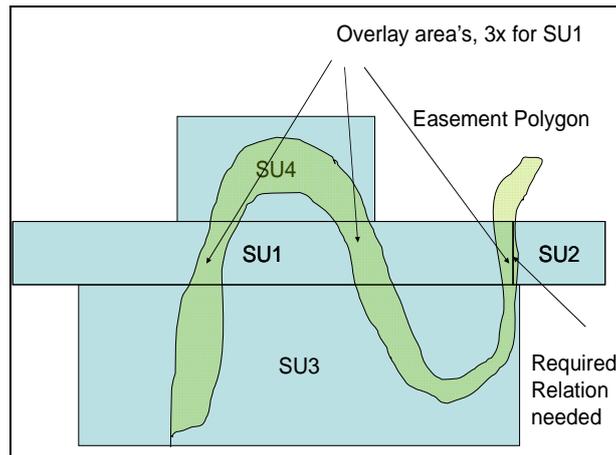


Figure 11. Easement SU4 is affecting parcel SU1 in multiple locations. An explicit ‘required relationship’ between SU4 and SU2 is needed to decide whether easement SU4 is affecting parcel SU2

4.1.3 Same as Section 4.1.1 without geometry

This means that the location of the easement is unknown. Two main options are possible for representing the ‘negative’ side within the LADM:

1. The ‘two level’ approach: The easement can be represented in a separate level as a ‘text spatial unit’ (with a restriction) and via a link in class LA_RequiredRelationship-SpatialUnit they are attached to the involved parcel.
2. The ‘one level’ approach: The easements are directly attached to the relevant parcels (with a restriction in addition to the rights attached to these parcels).

The difference between these two solutions are more theoretical than practical. For the ‘positive’ side the known alternatives are available again: no party (object restriction), a party (normal person), or the party role played by ‘baunit’. LADM offers various alternatives and what exactly is represented may depend on indications (of the ‘positive’ side and ‘negative’ side) in source documents and national legislations.

4.2 Two easements

This case is the same as in [Section 4.1](#), but there are two easements, with known geometry. Again there is a range of solutions:

1. The geometry of the two easements subdivides the crossed parcel (see [Figure 12](#)).
2. Two easements with their own geometry on different levels (see [Figure 13](#)).
3. The two easements have no geometry.

They are all very similar to their counterparts in [Section 4.1](#). The tricky part is now the grouping of the easements in case there is no geometry (option 3). Spatial unit SU_PA has four easements-parts (restrictions): two for the top part (in favour of parcel SU_PB and parcel SU_PC) and two for the bottom part (again in favour of parcel SU_PB and parcel SU_PC). It is not possible to group these easements-parts in the two groups. Note that the other two

solutions do not have this problem. Option 2 seems the most robust because option 1 might get a problem when the easements overlap and on one fragmented parcel multiple easements are valid (one could wonder: “how realistic is this?” and if so, “how important is the grouping?”).

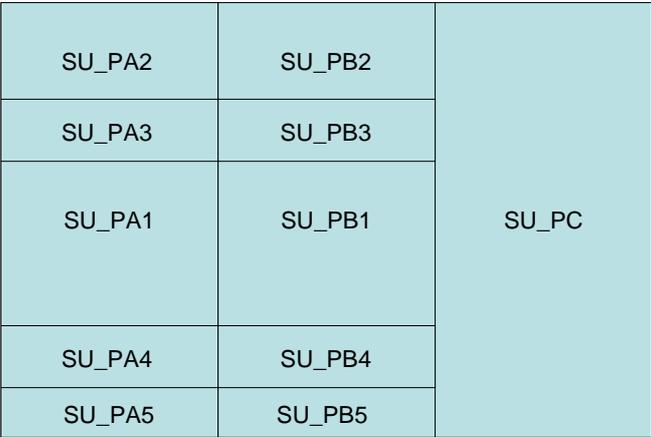


Figure 12. The geometry of the two easements subdividing the crossed parcels

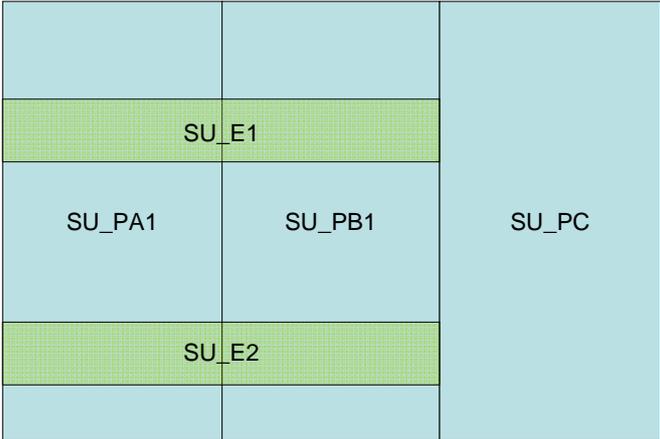


Figure 13. Two easements with their own geometry at a different level

5. MODEL ALTERNATIVES

In this section, first the current version of the LADM is analysed in [Section 5.1](#) with respect to being able to represent the grouping of LA_RRR’s (without extending the LADM). [Section 5.2](#) explores the possibility to extend the LADM with a explicit new class for the grouping of LA_RRR, this class is called LA_RRR_Group.

5.1 LADM

The current version of the LADM ([ISO/TC211, 2009b](#)) offers a kind of grouping (of shares) of rights via class LA_BAUnit. This works very well for right types such as ownership, because for one ‘baunit’ the total of all shares should be equal to one (if explicit shares are applicable). The same is true for other types of rights as long as they are grouped by type. The attributes ‘share’ and ‘shareCheck’ in LA_RRR and the constraint ‘ $sum(RRR.share) = 1$ per type if $RRR.shareCheck$ ’ provide sufficient quality control options.

However, if there are two different LA_RRR instances of the same type; e.g. easements as in [Section 4.2](#), then it is not possible to separate them in different groups (as their types are the same) and to check whether the total of shares equals 1. Note that this can only happen for certain specific types; e.g. for ‘ownership’ type this can not happen. Further, in case of easements it is unlikely that one would like to express different shares; e.g. for parcels B and C on Parcel A. So: this is a rather exceptional case.

5.2 LADM extended with class LA_RRR_Group

Extending the LADM with a class LA_RRR_Group, will make more explicit in the model the real world concept of, for example, a title; see [Figure 14](#). An instance of LA_RRR_Group is unique. It is different from any other instance of LA_RRR_Group in its combination of type and its connection with persons and parcels. Whether an instance of LA_RRR_Group is subdividable (in its type, or in its connections) is just a question of jurisdiction.

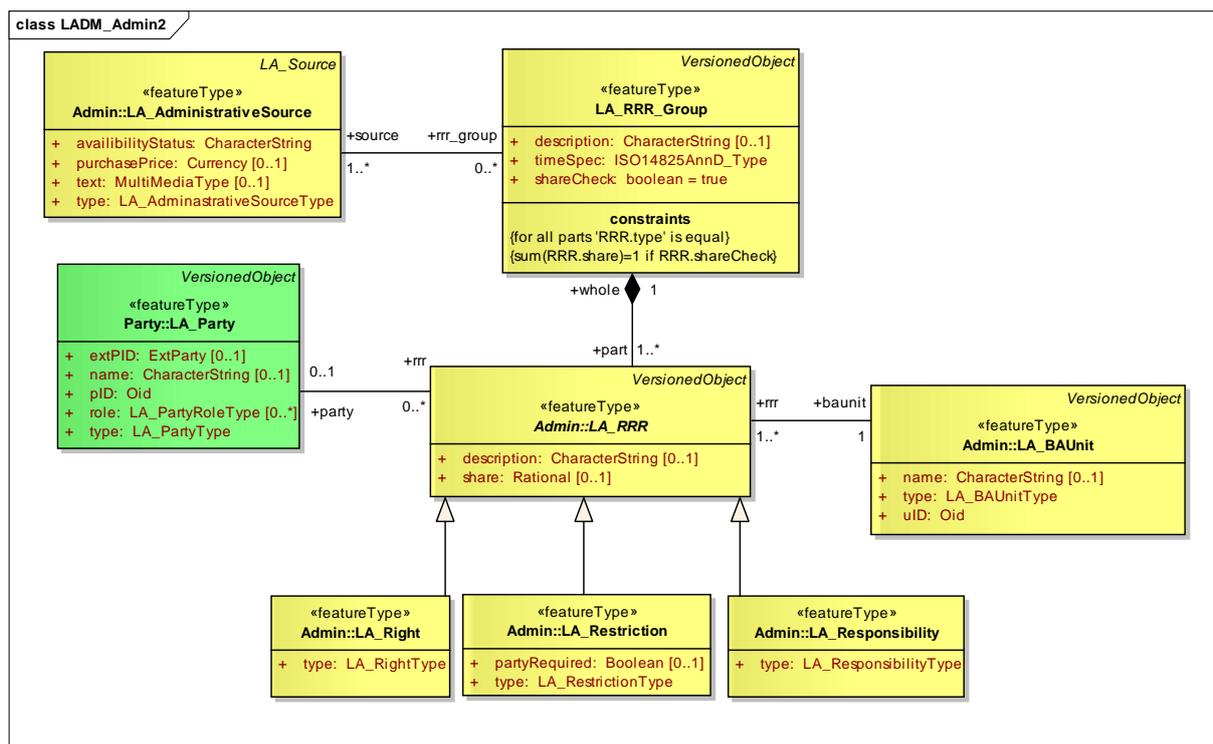


Figure 14. LADM extended with class LA_RRR_Group

Adding class LA_RRR_Group makes it possible to express the fact that a title might be subdivided with regard to parties (persons) and connecting parcels (same type of multiple

'RRR instances' of multiple 'RRR group instances' relevant for a single parcel). In case such an explicit class LA_RRR_Group is added to the model, on top of class LA_RRR, it is also preferable to associate this class with class LA_AdministrativeSource. Further, some of the attributes of class LA_RRR are moved to class LA_RRR_Group; e.g. timeSpec (assuming that this is equal for all parts of this single title) and shareCheck (because this was per definition something that was intended for the group level as it can not be such that for an instance of class LA_RRR_Group a few parts have a specified share and others have a non-specified share). An instance of a LA_RRR_Group can only have parts of the same RRR type, so this has to be expressed in a constraint. Further class LA_RRR_Group has now also the (slightly adjusted) constraint ' $sum(RRR.share) = 1$ ', which used to be in class LA_BAUnit before (see [Section 2.2](#)).

Note that LA_RRR_Group – LA_RRR is (again) following the 'part-whole' model pattern of standard UML (see [Section 3.1](#)) and not one of the inheritance based 'part-whole' patterns of [Section 3.2](#), [Section 3.3](#), and [Section 3.4](#), as the 'whole' is not a subclass of the 'part' (in our case this means that the parties and the 'basic administrative units' are not directly attached to the class LA_RRR_Group). So, this situation is more similar to the modelling of classes LA_SpatialUnitGroup and LA_SpatialUnit.

The presented extension of the LADM with an explicit LA_RRR_Group is just a first exploration. There are quite a number of remaining discussion point or design decisions:

1. Should there be a membership association class? It does seem that in this case the class LA_RRR does already play a little bit the role of a membership class as it carries the share attribute.
2. Should there be an ordering of LA_RRR_Group based on importance? In case of overlap (or conflict) of LA_RRR's on the same LA_BAUnit, then this provides a solution.
3. Should class LA_RRR and class LA_RRR_Group be treated uniformly? For example, to be able to connect an instance of class LA_RRR_Group directly (without class LA_RRR) to class LA_Party and class LA_BAUnit, expresses that there is no subdivision.
4. Should the three specialisations, LA_Right, LA_Restriction, and LA_Responsibility not be attached to class LA_RRR_Group? If so, then class LA_RRR should not be an abstract class, but a concrete class and class LA_RRR_Group should then become an abstract class.

6. INSTANCE LEVEL DIAGRAMS

This section presents the instance level diagrams for the various approaches to the easement registration as discussed in [Section 4](#). This will happen for the standard LADM for both the single easement example (from [Section 4.1](#)) and double easement example (from [Section 4.2](#)) in respectively [Section 6.1](#) and [Section 6.2](#). For the extended LADM (with class LA_RRR_Group) this will happen in [Section 6.3](#) and [Section 6.4](#) for respectively the single and double easement example.

In all four subsections there are in principle (at least) nine different approaches for registration. There are three different solutions for easement geometry (see [Section 4.2](#)):

1. Subdivision.
2. Two levels.
3. Easement without geometry.

There are also three different options to represent the ‘positive’ side of the easement (which party or parcel is benefiting):

- a. No party.
- b. Normal party.
- c. 'Baunit as party'.

When multiplying the numbers and letters we get $3 * 3 = 9$ combinations of instance level diagrams for the single easement registration, each will be labelled with a number-letter combination; e.g. 2a is indicating two levels (one for parcels and one for easements) and no explicit recording of the benefiting party. As these nine combinations are valid for all four subsections below, this would give a grand total of 36 different instance level diagrams. To provide sufficient proof of the LADM (with and without the LA_RRR_Group) representation capabilities a large number of instance level diagrams are needed. However, only the most relevant are given in this section. Further, some more diagrams are given in the annex.

6.1 Single easement in standard LADM

For representing a single easement (as introduced in [Section 4.1](#)) in the standard LADM, first the approach where there is no geometry for the easement will be presented in [Section 6.1.1](#), as this is the most simple approach with regard to the model. Next in [Section 6.1.2](#) the approach with two levels is treated, which is giving more (precise) information and the model is relatively simple to use. The third set is based on the subdivision of parcels using geometry of the easement and is presented in [Section 6.1.3](#). The result is a fragmentation of parcels and gives quite a large number of records at the instance level. Conceptually the ‘subdivision’ approach is not very difficult, but it is more the fragmentation, which could be considered as the largest drawback. All instance diagrams in this subsection are for recording the case of the single easement in the standard LADM. In all cases presented in this section 6.1, the problem of grouping the easement-parts does not apply as there is just a single easement to register and there can be no confusion to which easements the parts belong. Therefore, the standard LADM is simpler than the LA_RRR_Group extended version of the LADM for this situation; see Section 6.3.

6.1.1 An easement without geometry

The next three figures show how a single easement without geometry is represented.

1. [Figure 15](#) represents the easement, but without indication who (party or parcel/ baunit) is benefiting.
2. [Figure 16](#) shows a similar approach, but now a person is explicitly associated with the easement.
3. Alternatively the parcel (‘baunit’) could play the role of a party: ‘baunit as party’; see [Figure 17](#).

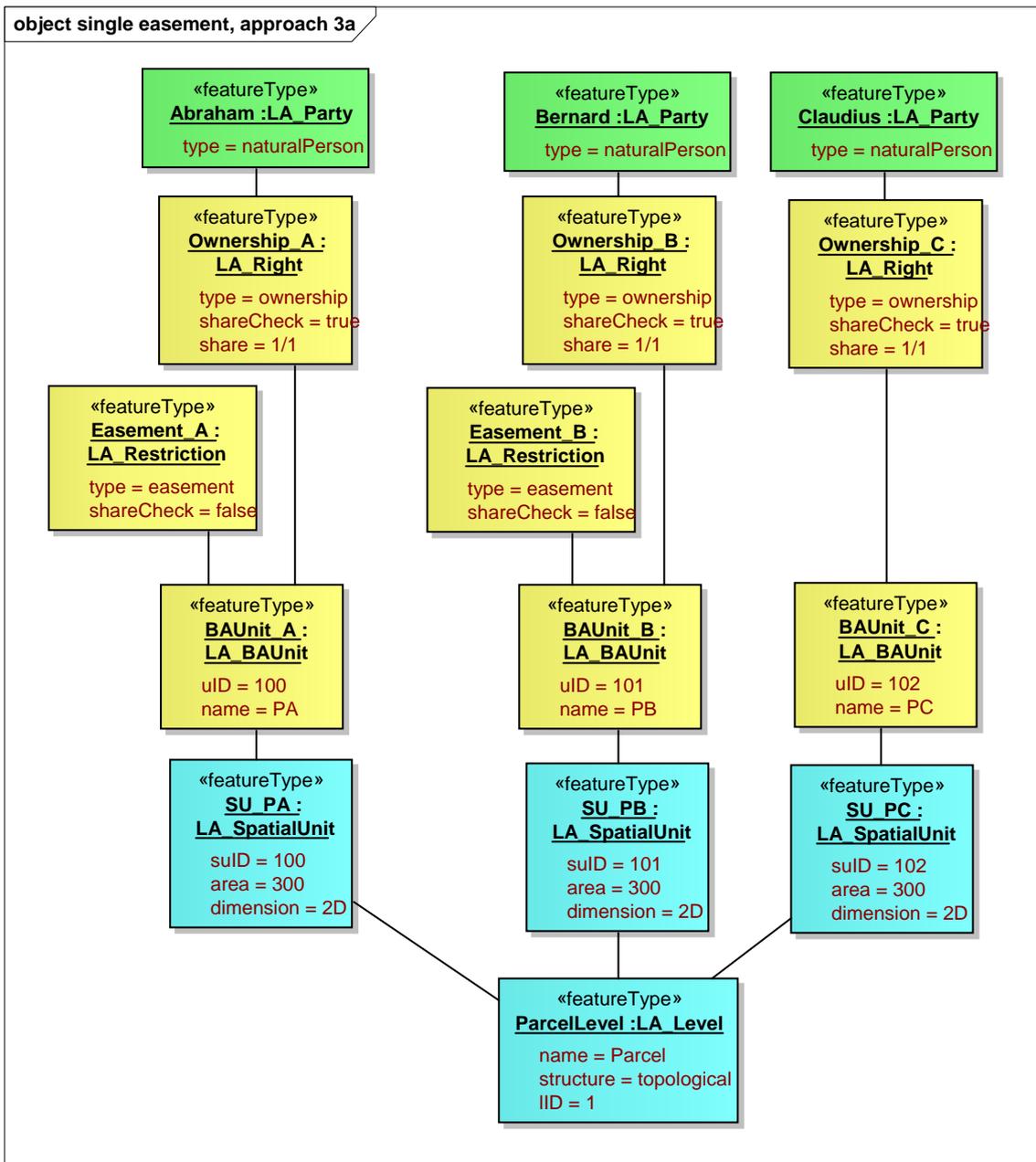


Figure 15. LADM instance diagram: single easement with no geometry, no party (option 3a).

[Figure 15](#) shows the simplest use of the model, but with the drawback that the (exact) easement location is unclear and that it is also unclear who is benefiting. In order to make clear who is benefiting, the LA_Party (as naturalPerson) can be attached to the LA_Restriction; see [Figure 16](#). In case multiple parties are benefiting then this is represented by multiple LA_Restriction ‘shares’ (parts); e.g. Easement_A_forB and Easement_AforC.

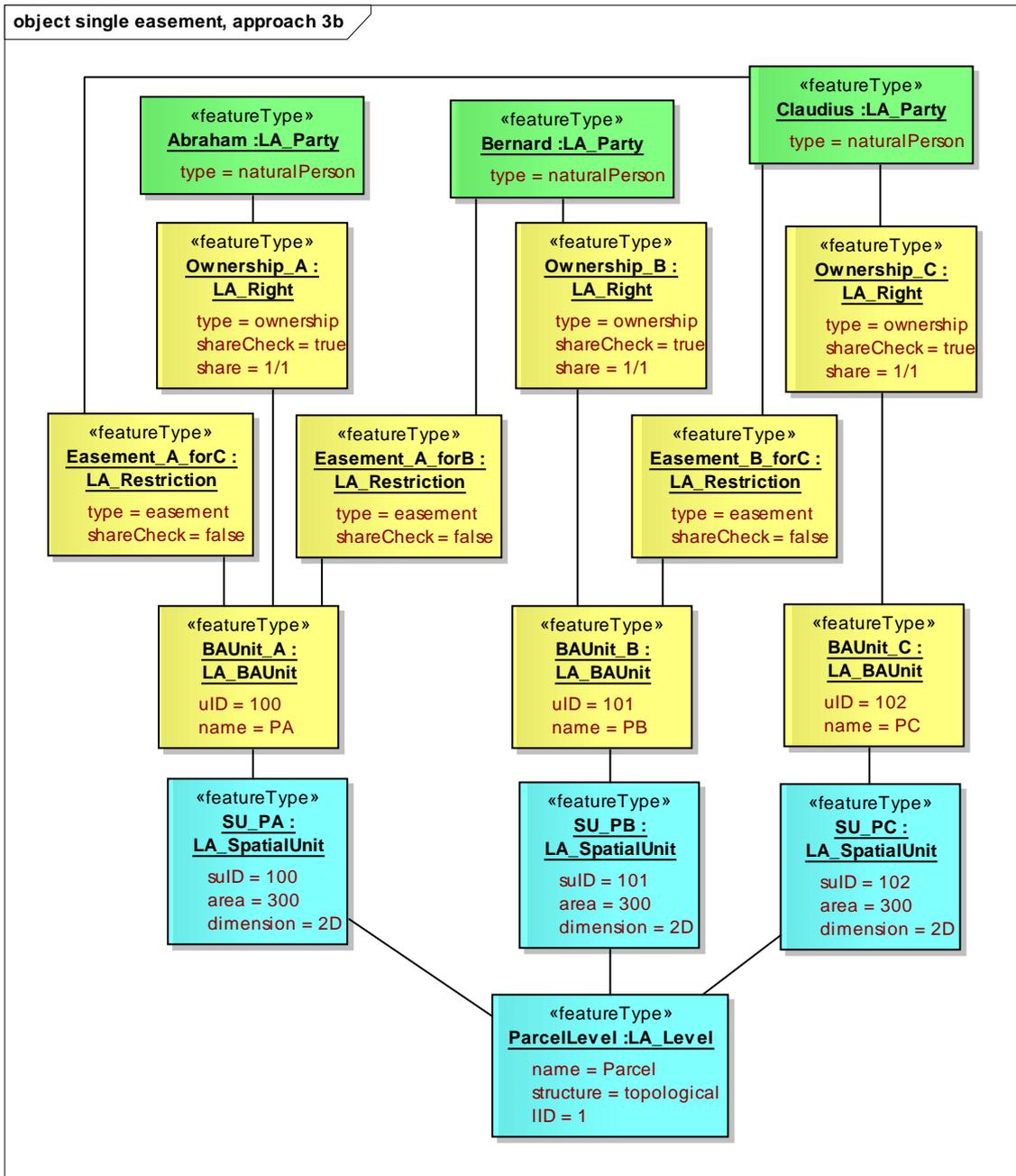


Figure 16. LADM instance diagram: single easement with no geometry, normal party (option 3b).

Perhaps a more elegant approach is to associate the easement not to a person but to the parcel ('baunit') that is benefiting (but as always, depending on national legislation and rules); see [Figure 17](#).

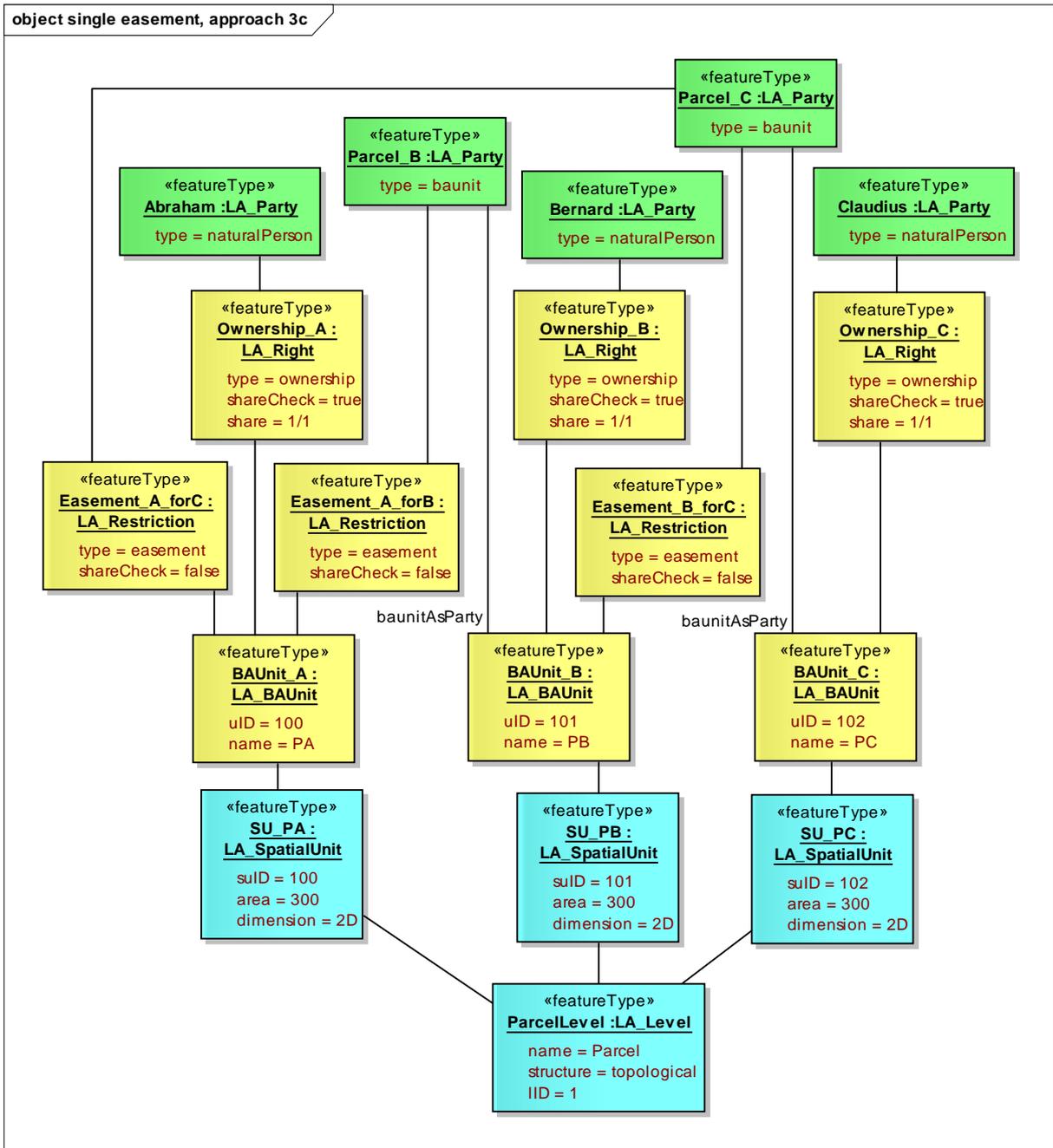


Figure 17. LADM instance diagram: single easement with no geometry; ‘baunit as party’ (option 3c).

6.1.2 An easement with two levels

Figure 18 shows how a single easement with its own geometry is represented (and with a normal party attached to LA_Restriction). Representations without a party, attached to the easement, or ‘baunit as party’, are quite similar to their counterparts in the previous section. They are included in the Annex: Figure 26a and Figure 26b.

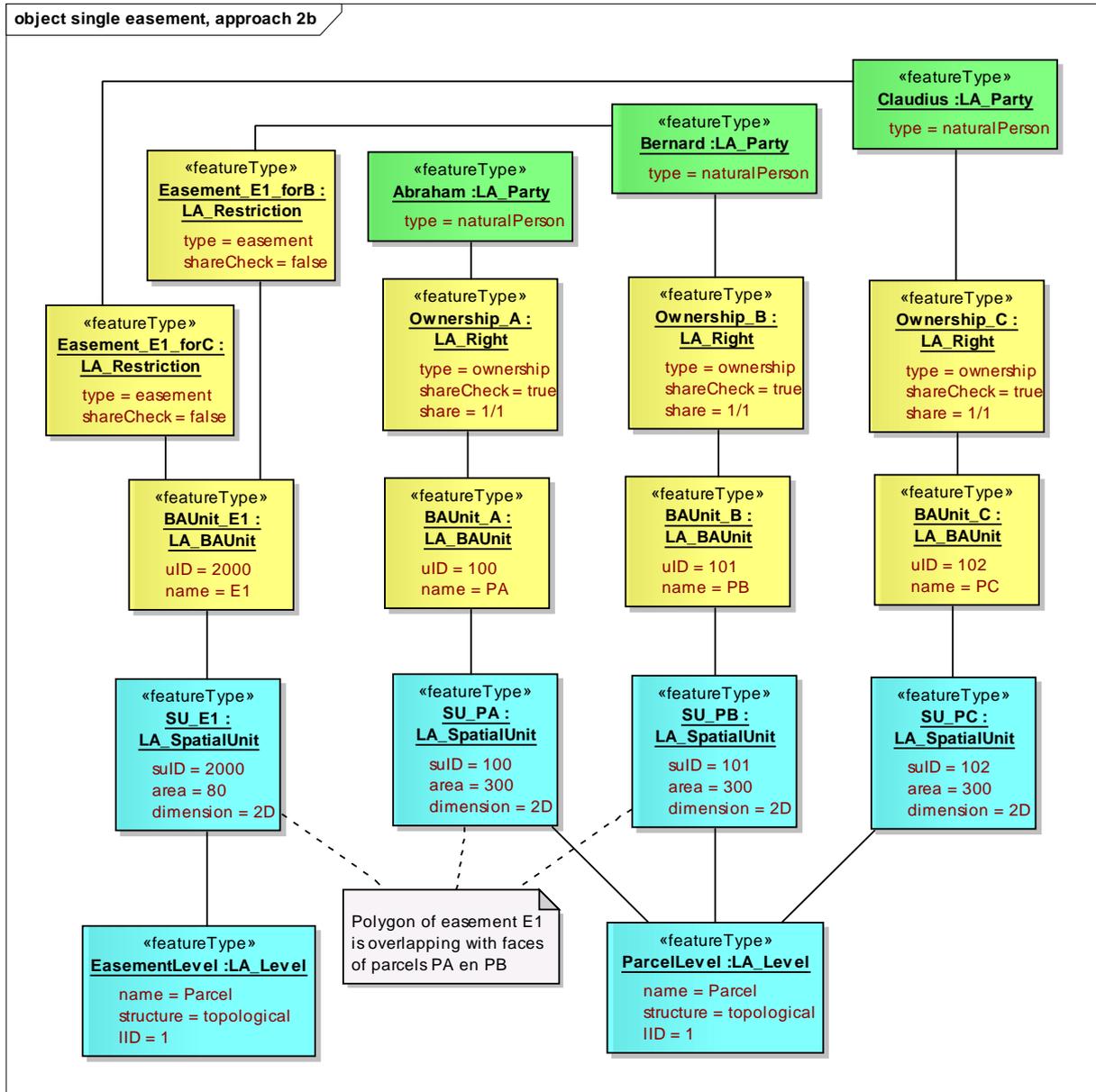


Figure 18. LADM instance diagram: two levels (parcels and easements), normal party (option 2b).

6.1.3 An easement based on subdivision

Figure 19 shows how a single easement with its own geometry is used to subdivide the involved parcels in a single parcel layer (and a normal party attached to LA_Restriction). Representations without a party, attached to the easement, or with 'baunit as party' are included in the Annex: Figure 27 and Figure 28. Note that this results in quite a fragmentation of the parcels (spatial units), which is only partly compensated by their grouping in LA_BAUnit; e.g. SU_PA1 and SU_PA2 in BAUnit_A1_2.

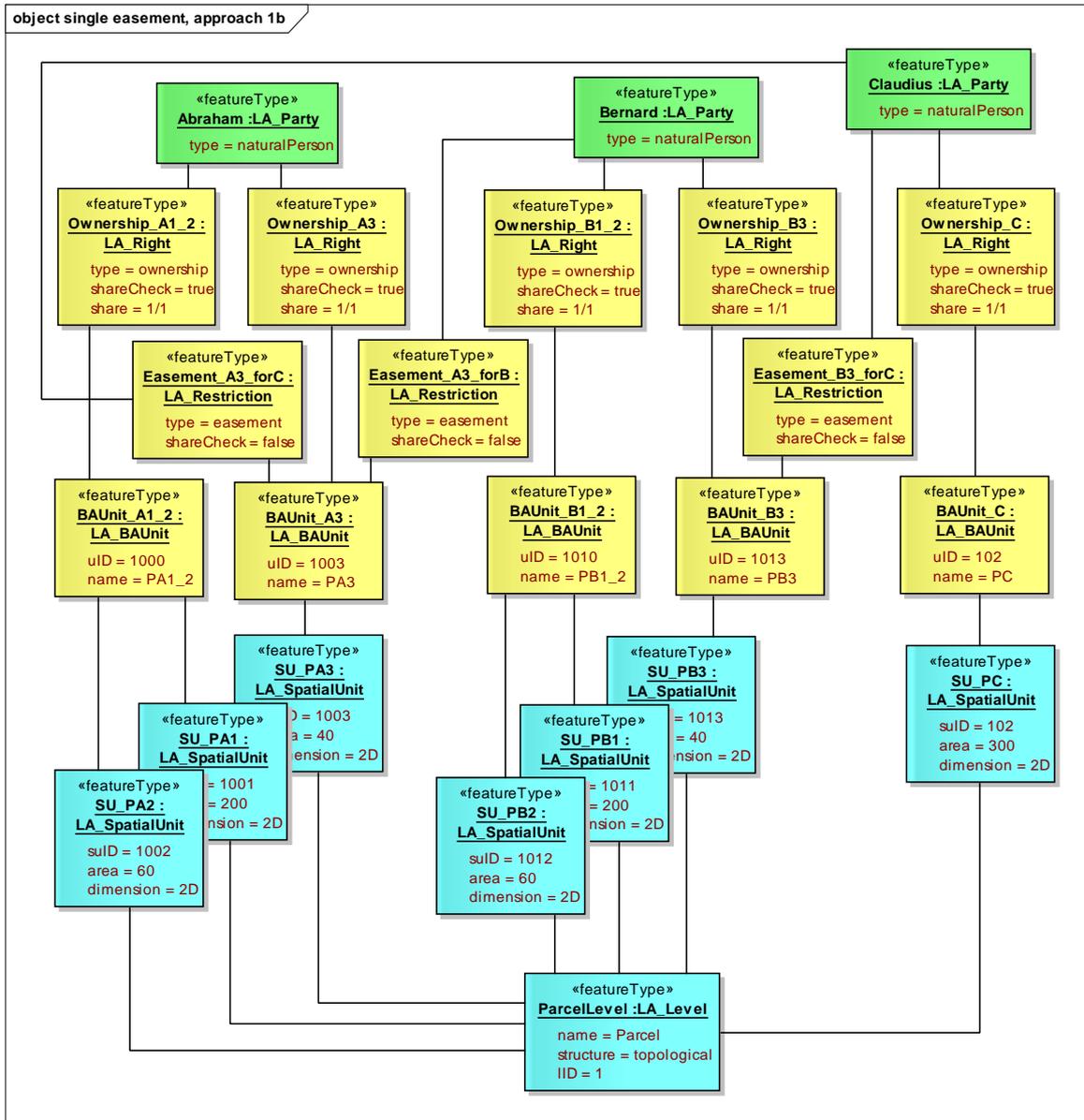


Figure 19. LADM instance diagram: a single level (subdivision of parcels by easement geometry), normal party (option 1b).

6.2 Two easements in standard LADM

The difference with the previous [Section 6.1](#) is that now two different easements need to be represented (having different locations), which maybe difficult to group, especially in the case where there is no geometry for the easement (within the standard LADM); see [Section 6.2.1](#).

However, this section will also give two alternative options to register easements without geometry, with the possibility to do a grouping (still within the standard LADM).

Next, in [Section 6.2.2](#) the approach with two levels is treated, where easement geometry is maintained in a separate level, which gives more (precise) information, and with a model that is relatively simple to use. Furthermore, because the easement has its own geometry (and identity), the grouping is not a problem within the standard LADM.

The third set is based on the subdivision of parcels using the geometry of the easement. It is not presented because, due to fragmentation, the number of parcels becomes too large to depict.

6.2.1 Two easements without geometry

[Figure 20](#) shows the initial attempt to register two easements on the same parcel, both easements without geometry (and a normal party is attached to the easements, option 3b). In the [Annex \(Figure 29\)](#) a similar instance diagram for two easements with no geometry is presented, but with no party attached (option 3a).

Note that in [Figure 20](#) the four easements ‘parts’ (A1_forB, A1_forC, A2_forB and A2_forC) attached to parcel SU_PA cannot be grouped via the model into the two different ‘whole’-easements (A1 and A2). Also if there would be shares, then this situation would give problems, because the sum of all shares would be equal to 2.

An alternative solution within the standard LADM is to introduce for each spatial unit with two (or more) easements an additional *text spatial unit* – introduced in [Section 2.3](#), one for every easement; e.g. SU_PA_E1 and SU_PA_E2; see [Figure 21](#). This could be considered the fourth option for representing the easement geometry: 1. subdivision within parcel level, 2. easement geometry in own level, 3. no geometry, but easement attached to complete parcel and now also 4. no geometry, but easement attached to text spatial unit. The text in this spatial unit will state that the geometry is based on the spatial unit, representing the base parcel. These additional text spatial units are organised in an easement layer with the structure attribute value set to ‘text’. The ownership right is attached to the normal spatial unit (parcel; e.g. SU_PA/ BA_Unit_A), but the easement facts are now attached to the additional text spatial units (e.g. SU_PA_E1/ BA_Unit_A_E1 for B and C and SU_PA_E2/ BA_Unit_A_E2 and again for B and C). The ‘positive’ side of the easement (which party or parcel is benefiting) is a normal party, coded before as option ‘b’. Therefore, the registration as illustrated in [Figure 21](#), is called ‘option 4b-double’ (for two easements in standard LADM).

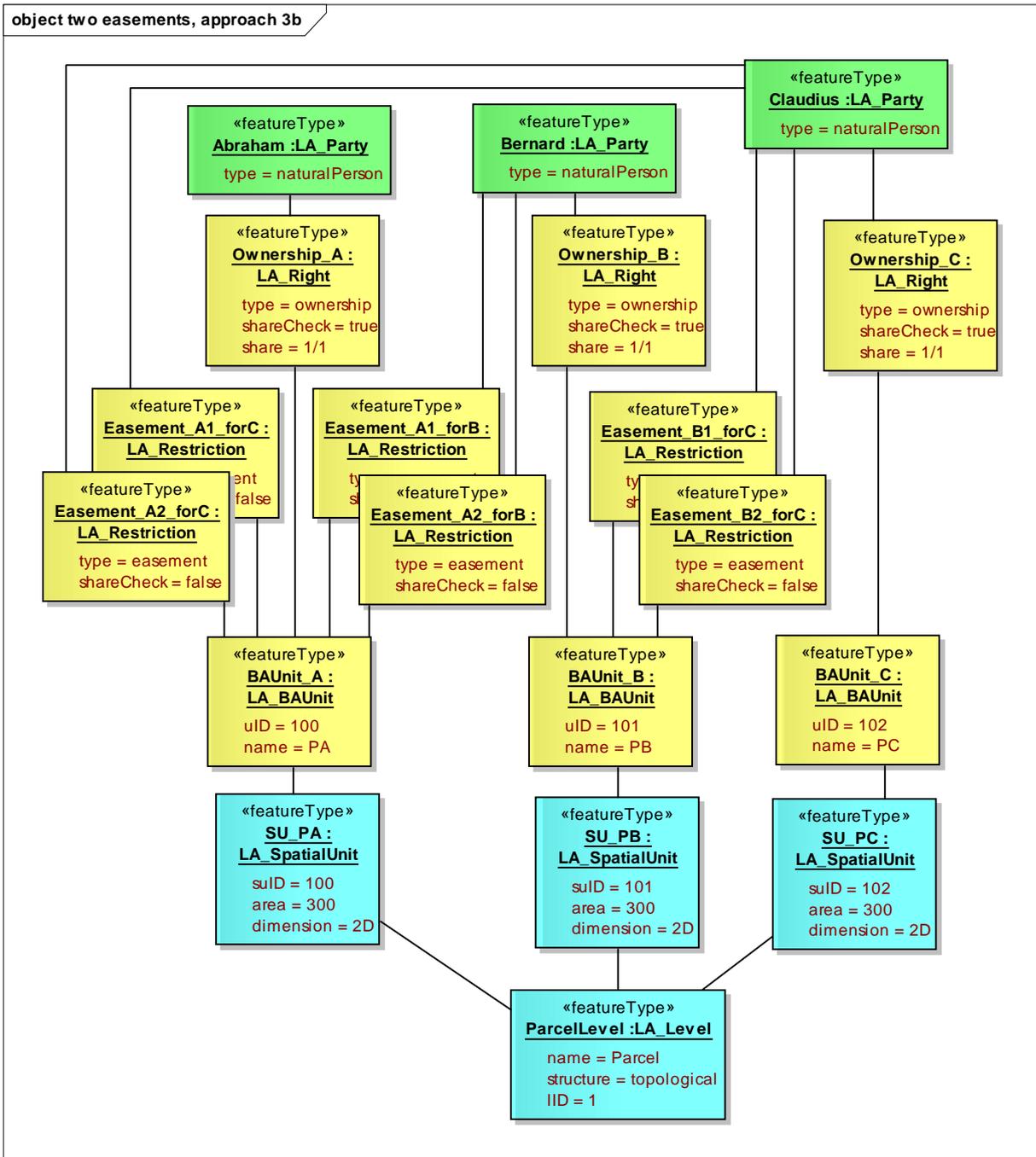


Figure 20. LADM instance diagram: two easements with no geometry, normal party (option 3b).

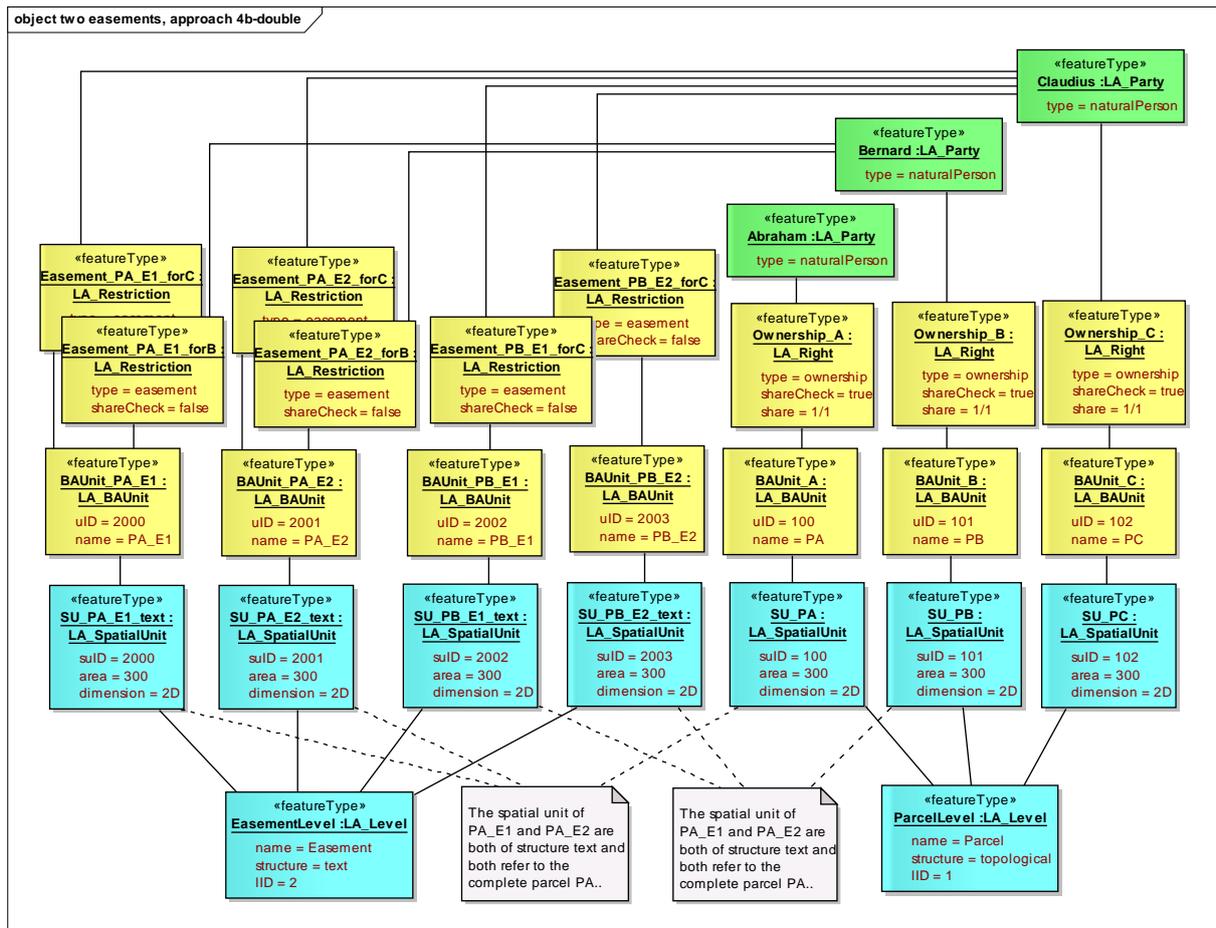


Figure 21. LADM instance diagram: two easements with text spatial unit, no own geometry, normal party (option 4b with easement text spatial units equal to normal parcels).

Perhaps an even simpler (and better) solution than represented in [Figure 21](#) is to combine the text spatial units in case they are introduced due to the same easement; see [Figure 22](#) (this option is called option 4b). The difference with [Figure 21](#) is that the easement text spatial units are now covering two complete parcels instead of covering just a single parcel per text spatial unit (which is resulting in a higher number of spatial units). The structure of this solution is quite similar to option 2b (two levels, normal party) for two easements with their own geometry; see [Figure 23](#) in the next section ([Section 6.2.2](#)). The difference is that the level containing the easements in [Figure 23](#) uses the polygon spatial unit with own geometry for the easement, while in [Figure 22](#) the text spatial unit is used (with textual references to the relevant parcels, which contain the actual geometry).

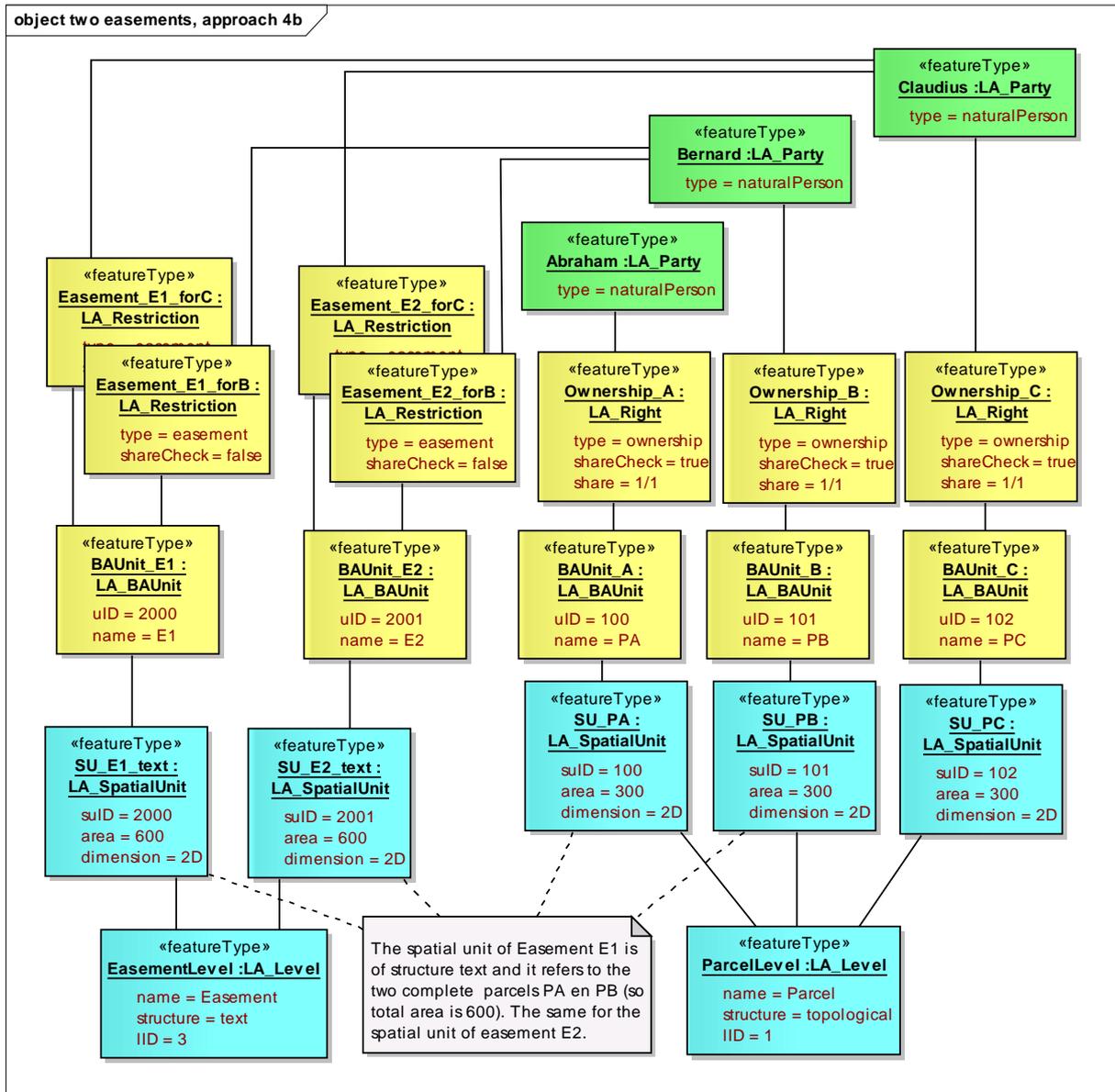


Figure 22. LADM instance diagram: two easements with text spatial unit, no own geometry, normal party (option 4b with easement text spatial units covering two complete parcels).

6.2.2 Two easements in their own level separate form parcels

Note: no problems with grouping easements E1 and E2 (Figure 23). In the Annex, Figure 30. LADM instance diagram: two easements using two levels (parcels and easements), no party (option 2a): no grouping problem.

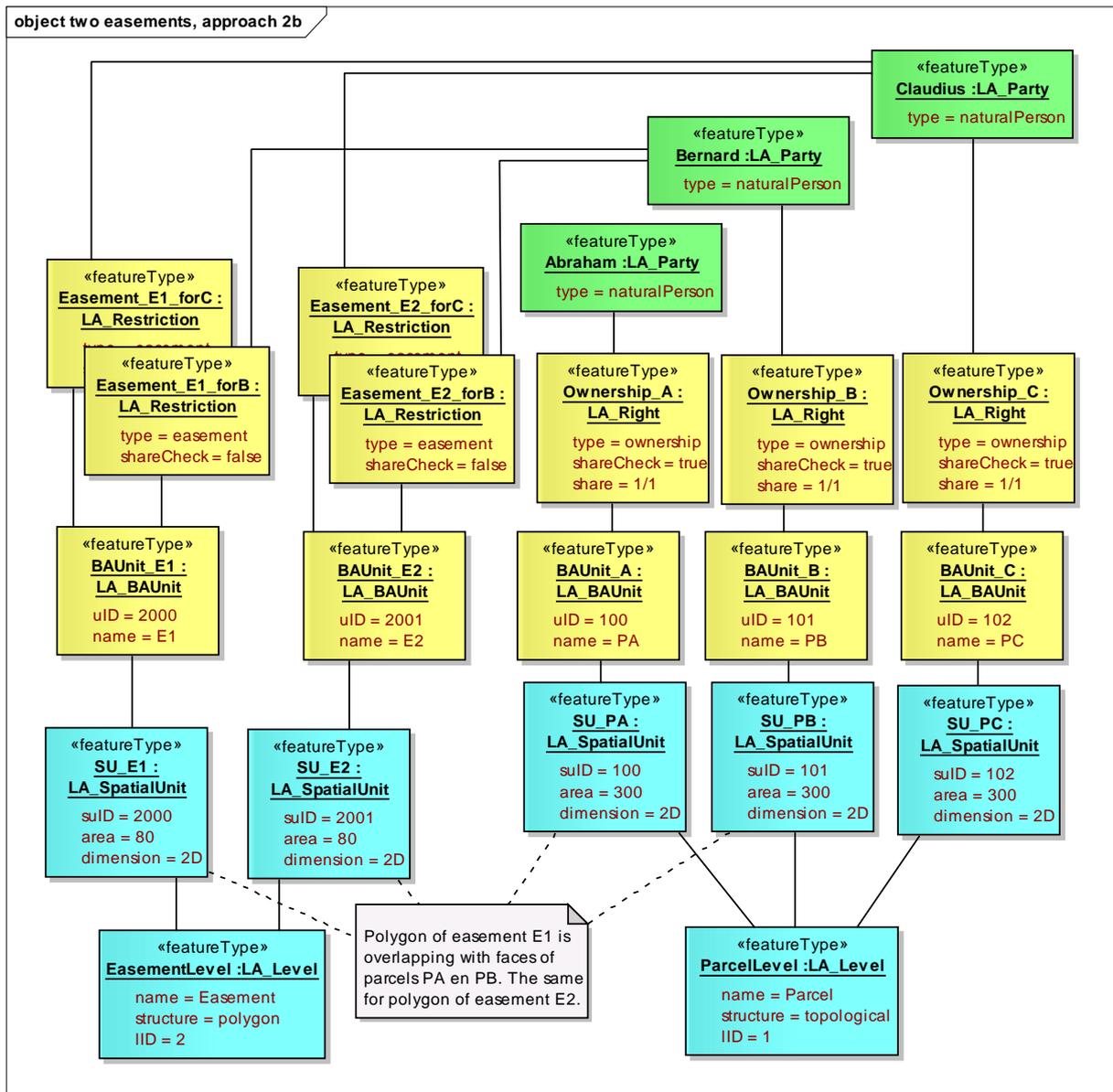


Figure 23. LADM instance diagram: two easements using two levels (parcels and easements), normal party (option 2b).

6.3 Single easement in extended LADM with class LA_RRR_Group

Out of the nine possible options for the easement registration, only option 3b is illustrated: an easement without its own geometry (that is based on complete parcels) and associated with normal parties; see [Figure 24](#). This option was selected for presentation here because the ‘without its own geometry’ option (3) was having the most difficulties with the grouping of the easement ‘parts’ in the standard LADM (however, for two easement, and not for just one easement). Note that due to the introduction of class LA_RRR_Group, there is nearly a duplication of the number of LA_Right and LA_Restriction records in this representation, without any benefit.

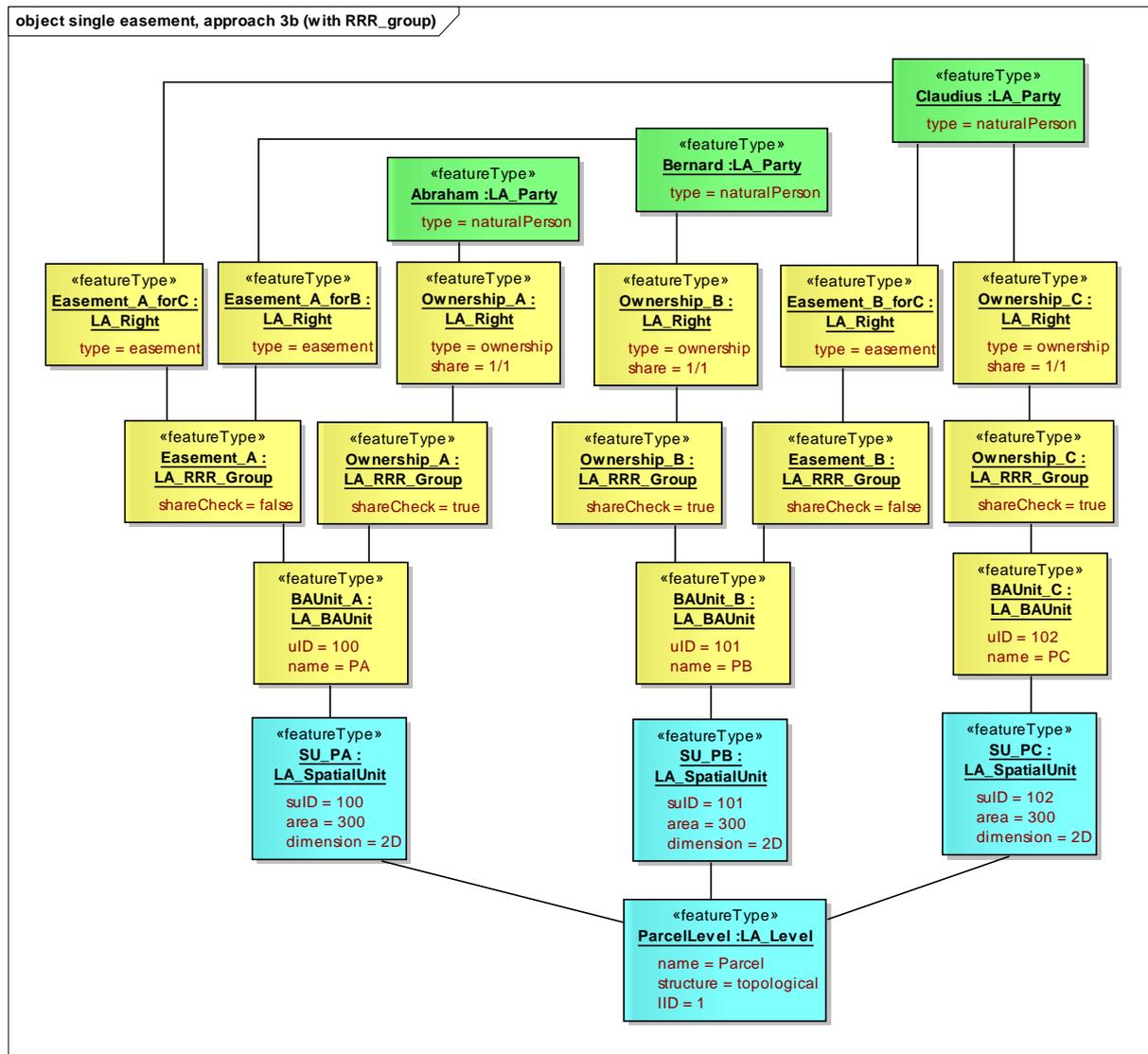


Figure 24. LADM with LA_RRR_Group instance diagram: single easement with no geometry, normal party (option 3b).

6.4 Two easements in extended LADM with class LA_RRR_Group

Again, out of the nine possible options for the easement registration, only option 3b is illustrated: easement without its own geometry (that is based on complete parcels) and associated with normal party; see [Figure 25](#). For two easements this option (without its own geometry) was posing the most difficulties with the grouping of the easement ‘parts’ in the standard LADM; see [Figure 20](#). This is now solved by using class LA_RRR_Group of the extended LADM. Note that due to the introduction of LA_RRR_Group, there is nearly a duplication of the number of LA_Right and LA_Restriction records. In some parts of this case this is useful, but not in all parts (e.g. in the Ownership representations, which are also doubled without need, due to separate LA_Right and LA_RRR_Group). Therefore one might even prefer the standard LADM approach as depicted in [Figure 21](#) and [Figure 22](#) (based on introducing and exploiting text spatial unit for grouping).

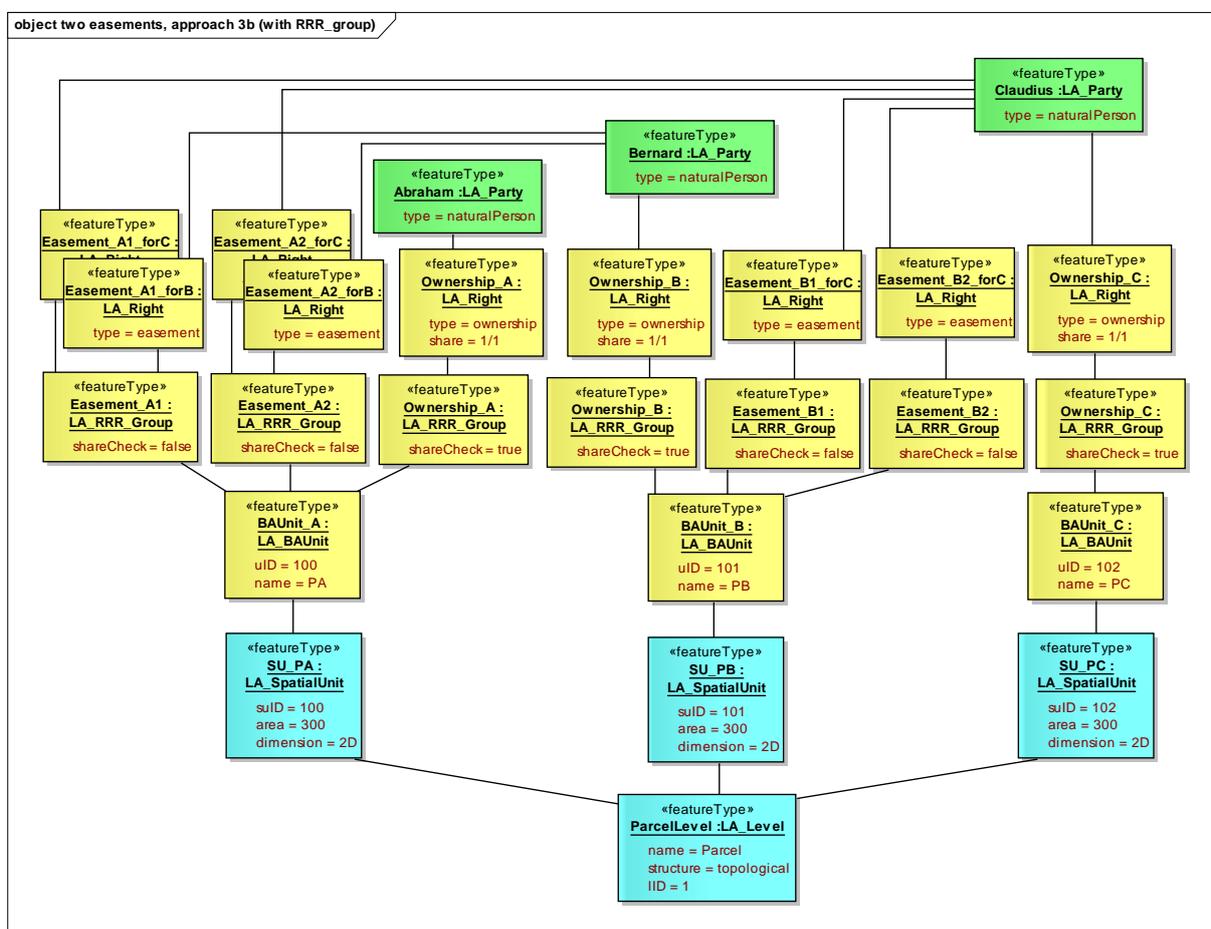


Figure 25. LADM with LA_RRR_Group instance diagram: two easements with no geometry, normal party (option 3b).

7. CONCLUSIONS, FURTHER DISCUSSIONS AND FUTURE WORK

In this paper we analysed the need for the grouping of rights (RRRs) and checking the correctness and completeness of the groupings; e.g. the sum of all shares should be equal to 1. To provide the proper theoretic background we first introduced four generic ‘part-whole’ model patterns. In the Party package and the Spatial Unit package of the standard LADM, the explicit representation of the group concept is already present. This group concept is analysed, compared and validated with the standard UML ‘part-whole’ model patterns: different generic ‘part-whole’ model patterns have been applied to different parts of the LADM. All are arguably correct, this is based on motivations why specific model patterns are used in specific cases (and why not always the same ‘part-whole’ model pattern could be applied).

As mentioned before, the standard LADM has explicit ‘part-whole’ solutions for class LA_Party and class LA_SpatialUnit, but not for class LA_RRR. It was investigated whether this was this a design omission. Therefore several cases were explored that might need an explicit grouping of rights (RRRs). It should be noted that for the same real-world case, there are many ways to model the registration (while the actual choice depends on the national legislation and practice). In this paper it turned out that, in case of the registration of multiple easements, without their own geometric representation (LA_Restriction) on the same parcel (LA_SpatialUnit / LA_BAUnit), the current LADM was challenged at the most. However, it was proven that all easement cases could be represented very well in standard LADM. Even for the mentioned before representation of easements, the ‘trick’ of using additional text spatial units provided a satisfactory and relatively simple solution.

In our further investigations (for potential improvements of the LADM) we also explored an LADM model extension with an explicit class LA_RRR_Group. For this extended model the same real-world cases were studied. Similar to standard LADM, the translation of the real-world cases (and the preferred type of representation) were illustrated with UML instance diagrams. The before mentioned, most challenging easement representation case, could be modelled more intuitively than with the standard LADM. However, this was at considerable cost: all RRRs records are more or less doubled (with pairs of LA_RRR_Group and LA_RRR records, that is, LA_Right and LA_Restriction in our cases).

One last remark on easements. An easement has one side that is allowed to do something, this is called the ‘positive’ side (e.g. pass another property via a path) and another side that has to tolerate something, this is called the ‘negative’ side (‘the two faces of the same coin’). In the standard LADM, using a single level, both aspects can be represented very well: the ‘negative’ side is the parcel (classes LA_SpatialUnit / LA_BAUnit) to which class LA_Restriction is associated, and the ‘positive’ side can explicitly be recorded through the associated class LA_Party with the attribute value ‘baunit’, and then further via the link ‘basic administrative unit (= baunit) as party’. In case the easement has its own geometry (two levels), the ‘positive’ side is represented in the same manner, and via a spatial overlay operation the ‘negative’ side can be determined.

The conclusion (at least for the time being) is, that this additional complication of extending the standard LADM with an additional class LA_RRR_Group, is not worth the benefit and that therefore class LA_RRR_Group will not be included in the next version of the LADM.

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ANNEX Additional instance diagrams

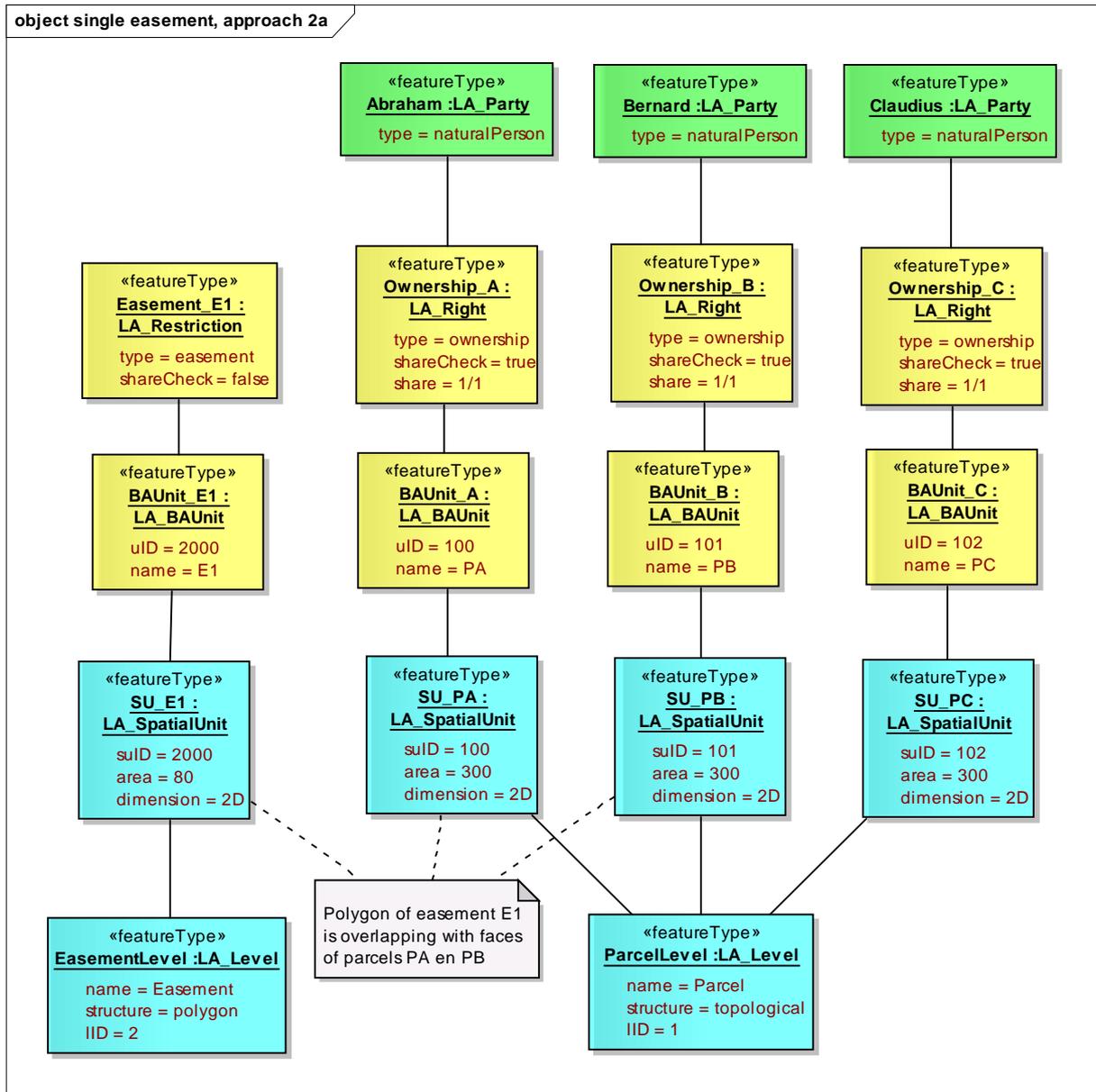


Figure 26a. LADM instance diagram: two levels (parcels and easements), no party (option 2a).

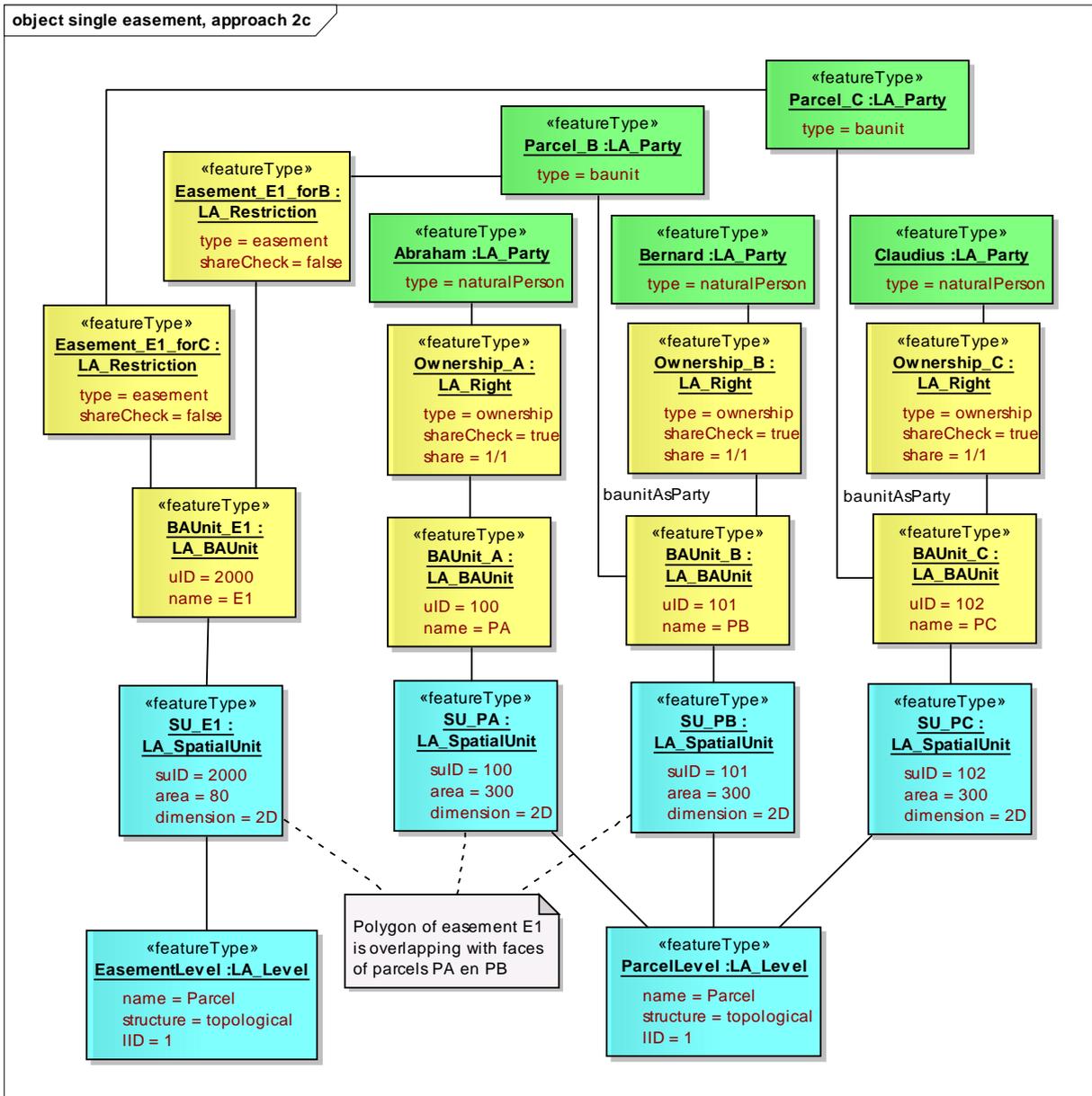


Figure 26b. LADM instance diagram: two levels (parcels and easements), ‘baunit as party’ (option 2c).

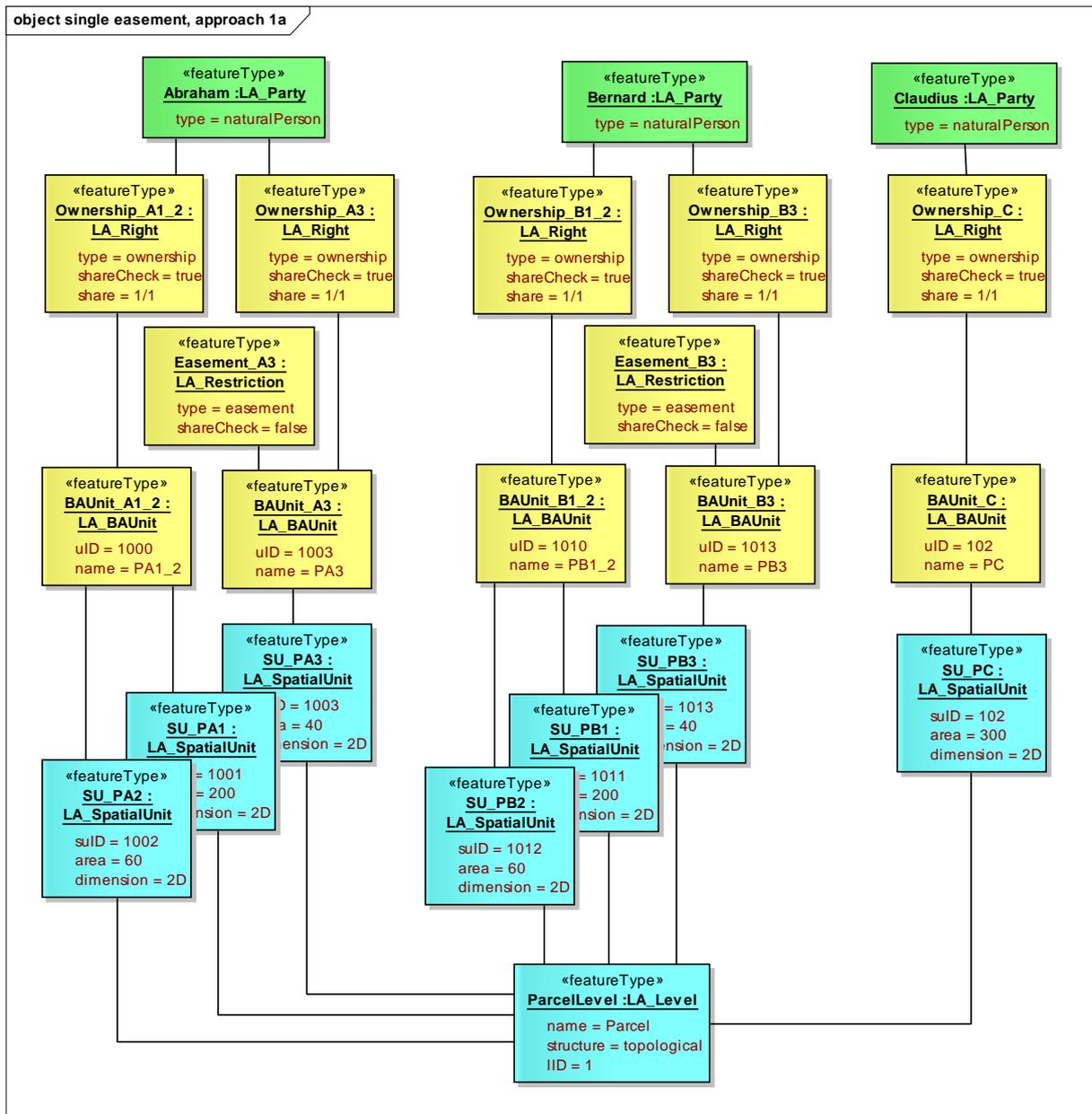


Figure 27. LADM instance diagram: a single level (subdivision of parcels by easement geometry), no party (option 1a).

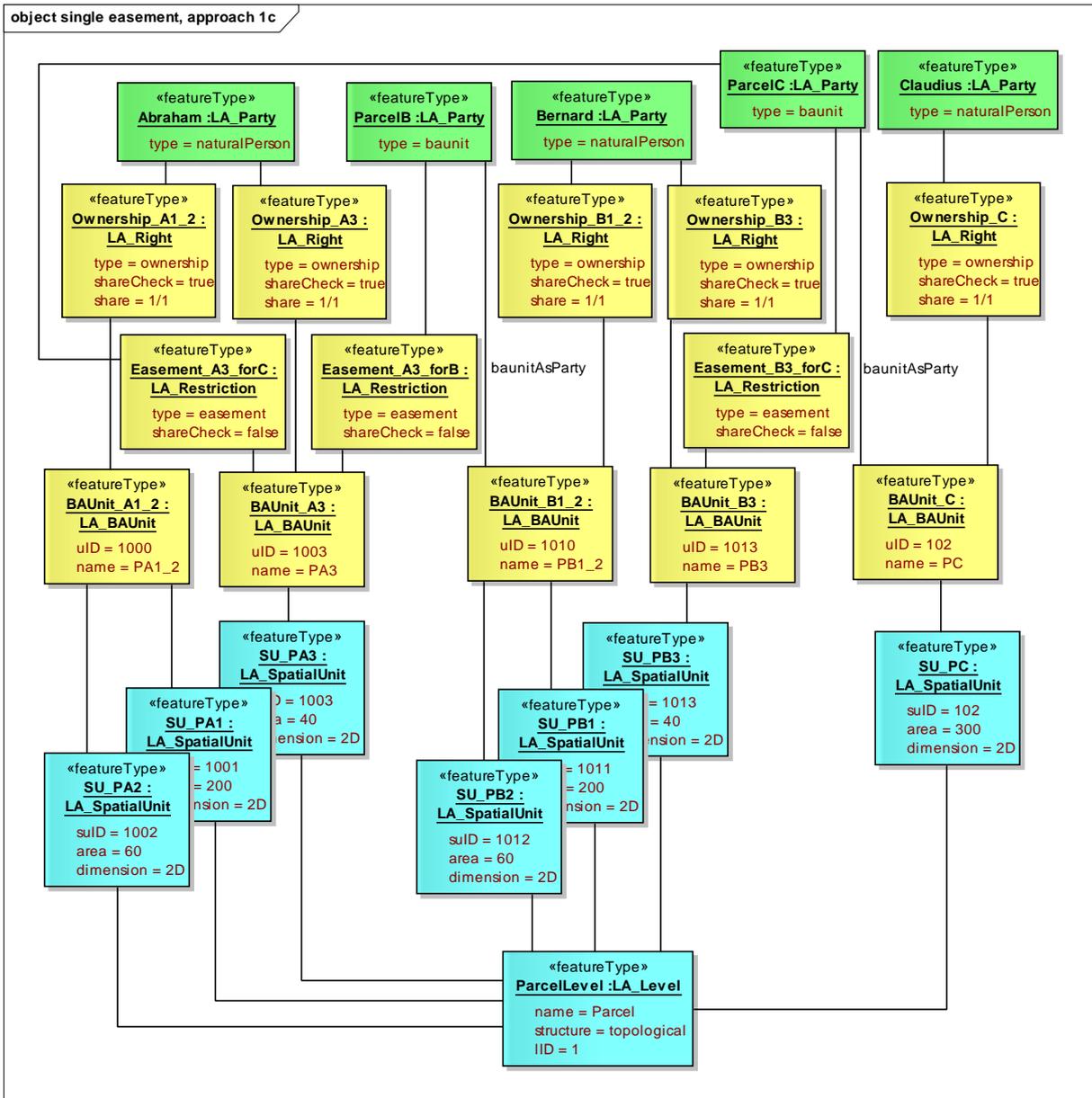


Figure 28. LADM instance diagram: a single level (subdivision of parcels by easement geometry), ‘baunit as party’ (option 1c).

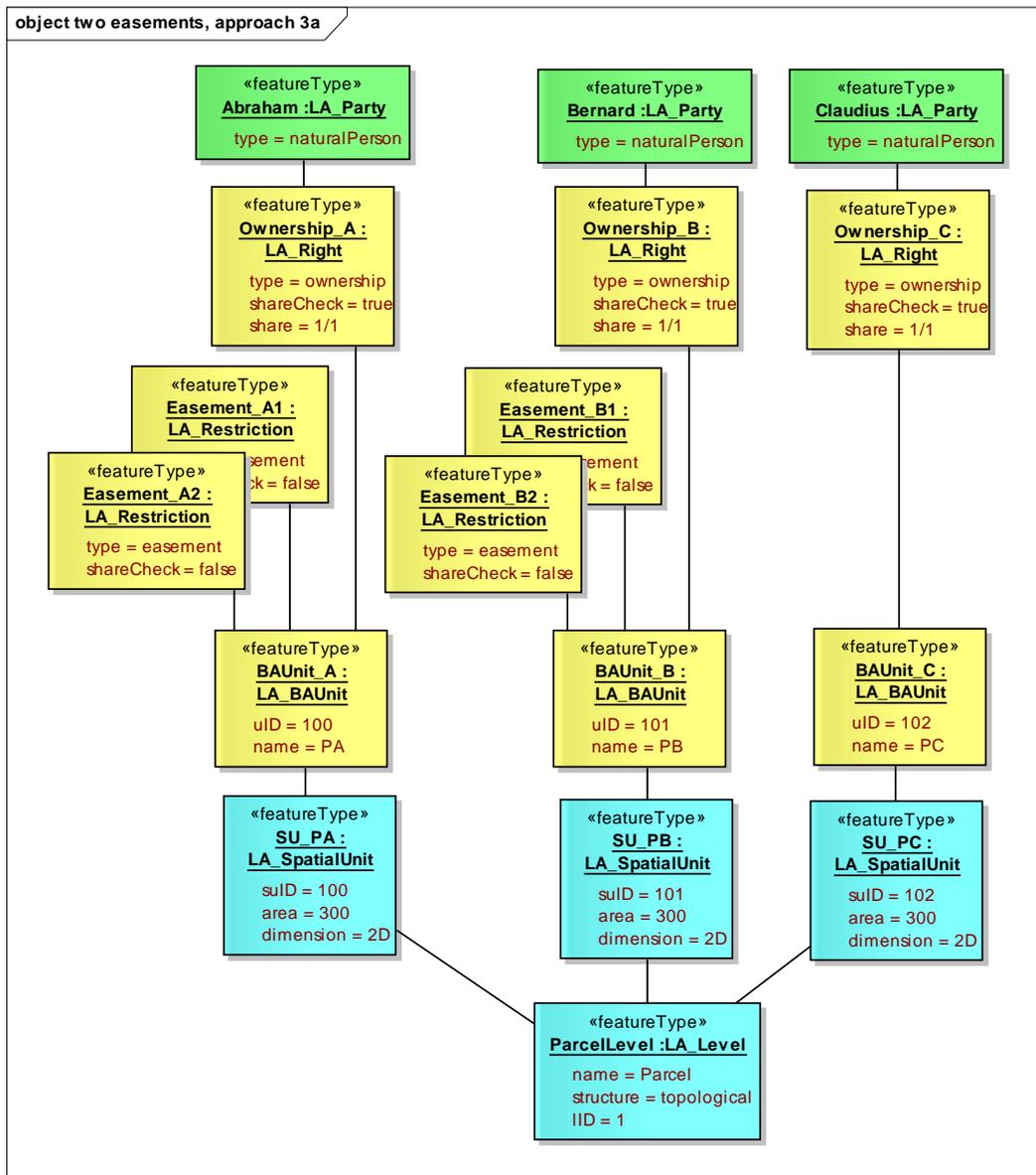


Figure 29. LADM instance diagram: two easements with no geometry, no party (option 3a).

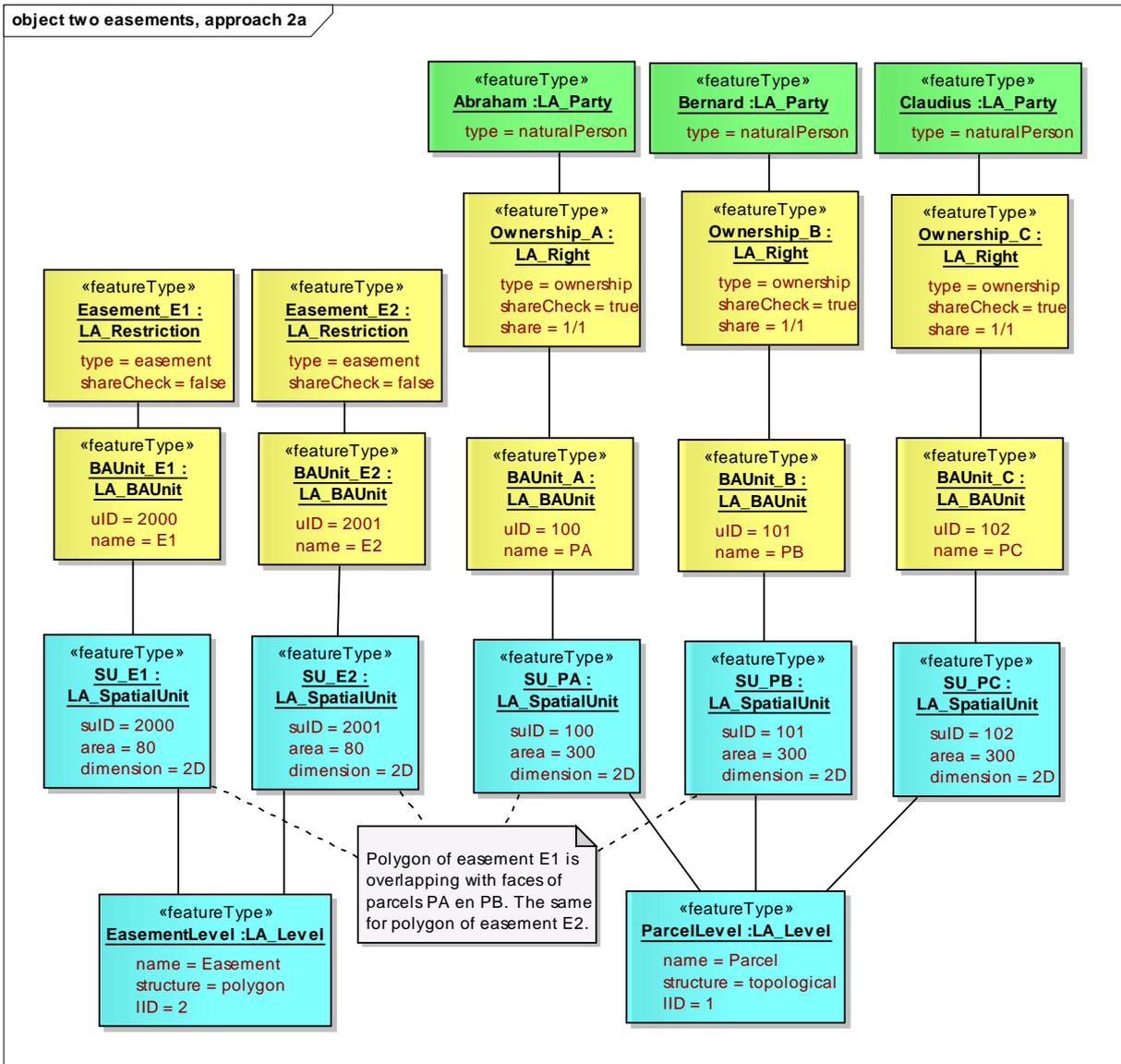


Figure 30. LADM instance diagram: two easements using two levels (parcels and easements), no party (option 2a).

BIOGRAPHICAL NOTES

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Bestandsnaam: Rights, Restrictions and Responsibilities in the Land Administration
DomainModel (LADM) (4221).doc
Map: E:\My Documents USB\ladm\ladm diversen\eisenhut paper\paper
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Auteur: LEMMEN et al
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Aantal tekens: 47.983 (ong.)