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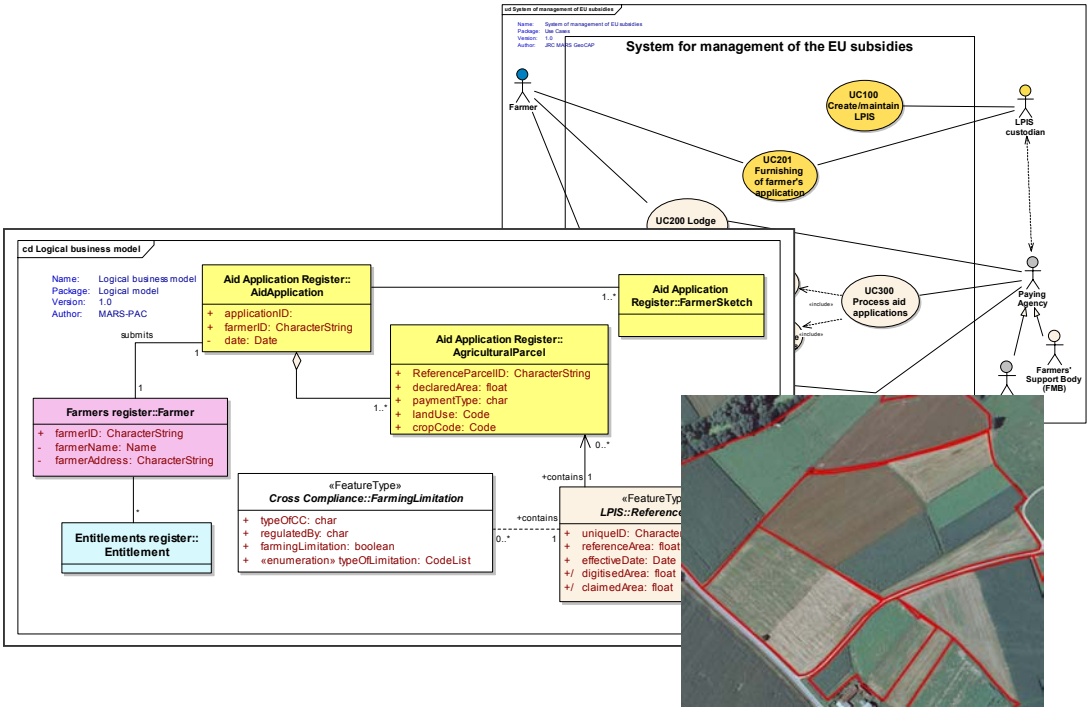
LPIS Core Conceptual Model

Methodology for Feature Catalogue and Application Schema

Valentina Sagris and Wim Devos



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Discussion paper

LPIS Core Conceptual Model: Methodology for Feature Catalogue and Application Schema

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1. Introduction

1.1. Objectives of this document

1.1.1. This discussion paper is a continuation of the MARS-PAC efforts to ensure the implementation of basic geographic information (GI) concepts into the LPIS and to follow-up the development of geomatics. It addresses the recent challenges on GI, such as establishing of a Spatial Data Infrastructure (SDI), and the requirements for standardisation and interoperability of geographic data. The main outcome of this development is a standardized framework for the LPIS specifications, that records compliance with the Regulation requirements.

1.1.2. In order to arrive at a pragmatic LPIS content and ontology, and a comparative model of the related functions and processes we have to share the same understanding of the reality. If we are about to create a sustainable structure, we should ensure that the models that we arrive at will easily adapt and extend to remain relevant in various future scenarios- policy reforms, technology evolution, increasing needs for date sharing. The identification of effects of the Direct Payments support schemes as well as assessment of the CAP impact on the environment and rural development will increasingly need a system with the ability to support numerous services and to communicate between the models of different domains of geographic data on European and national level through the Spatial Data Infrastructures (SDI).

1.1.3. This discussion document only expresses the technical point of view of its authors. The content of the document is not yet aligned with opinions of the EC and the MS or of users of LPIS in general. It can be seen as a starting point for the elaboration of data interoperability and SDI principles in the domain of the CAP. It is intended to stimulate participation of the main actors and stakeholders of the CAP (EC DG-AGRI, national administrations and Paying Agencies) in the process of ensuring compatibility with the European SDI (INSPIRE) by means of providing additional use case and long time experience in making use of geographic information data for CAP support.

1.2. A case for standardization

1.2.1. Conceptual core models that act as a reference or standard are already developed in several other application domains (e.g. cadastral, agricultural and business models). The purpose of such core models is not to provide a standard to which everybody is forced to adhere, but rather to represent common modelling components and practice that can be reused for specific domains and also permit the translation from one conceptual realm into another. In other words: all domain models can be considered as having the core model as a basis, and extending it according to their own specific requirements. National models will inevitably result in interoperable systems which still reflect the

particular demands of the different countries. Mapping will be needed between each national model and the core model in order to test conformity.

1.2.2. There are several good reasons for the LPIS and IACS-GIS community to develop a core model for the LPIS domain: all LPIS were designed around concepts laid down in common Regulations, all systems cater for well described procedures and all are audited by a single body. The LPIS over the different member states have therefore much more in common than most other spatial information systems such as cadastre or topographic map as these developed within a confined national context.

1.2.3. To investigate the outlines of such a core LPIS model one must consider the legislative requirements laid down by the Regulations and analyse of implementations and update of the Land Parcel Identification System of the IACS. The latter exercise identified a number of distinguishable cases in the LPIS domain and it's clear that LPIS conceptual core model will have to accommodate these.

1.3. Process of standardization in the LPIS domain

1.3.1. To move towards this remote goal of a harmonised domain, the sequential order of development steps or milestones should be set up at the very beginning. Putting forward the methodological approach not only answers the question "What is the next step?", but also helps us to identify appropriate means to achieve the objective. At the same time the participation of all stakeholders in every step is of paramount importance for success of the process. The idea is that for each step, identified in the process below, a discussion document shall be provided in order to initiate a dialogue between the key parties handling and using spatial information. On the basis of these discussions, consolidated document(s), in the form of technical specifications and/or recommendations, will be produced.

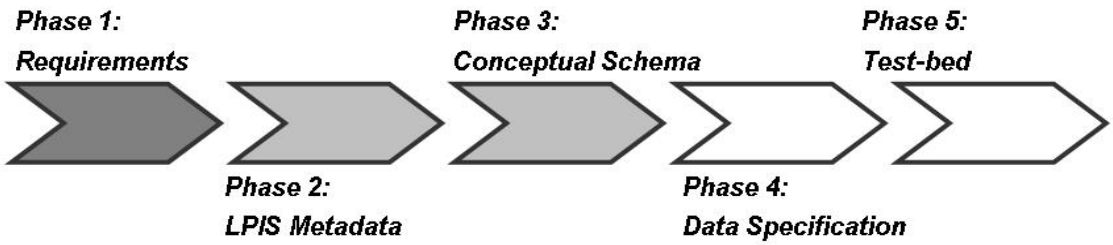

Figure 1: Process of standardisation and harmonisation

1.3.2. To answer the question "what is the next step?" a plan needs to be produced indicating dates and milestones, resources and outputs. This discussion text doesn't cover all methodological steps; rather it focuses on phase 1 and partly deals with phase 3 and 4.

- Phase 1 covers the analysis of the requirements laid down by the EU Regulations, dealing with identification of actors, basic concepts, spatial objects concerning and description use cases (chap. 3). Since this process will be built on observations of existing and operational MS LPIS systems, the monitoring of the current situation and status of LPIS will be continued as an additional input factor.
- Phase 2: the practice of ad-hoc LPIS questionnaires will be used as a template to design a permanent metadata repository, documenting LPIS implementations in the MS. It is assumed that a standardized metadata approach of International Standards will be adopted.
- Phase 3 will document requirements and concepts of step 1 into a core data specification by means of a feature catalogue (FC) which will provide explicit (semantic) definition of objects, guaranteeing a common understanding of the features. These will be expressed in the first-cut of FC for core LPIS data is proposed in chap 5. The definitions of the feature types in the FC and their properties will be derived from the Universe of Discourse (UoD) laid down in the Regulations and particular implementations of the LPIS.
- Phase 4 builds a LPIS Conceptual Model (LCM) including core Feature Catalog and Application Schema by means of the conceptual schema language (UML) in terms which are understood for computer systems and users and guaranteeing explicit (semantic) interoperability between applications, bearing in mind data content and structure for data exchange/interoperability, naming conventions.
- This will provide the basis for phase 5, which deals with a mapping of national implementations towards core Application Schema and creates XML/GML schemes for a standardized environment for testing conformity in respect to the core model.

1.3.3. This core model approach will dramatically change the way LPIS is presented to its users and stakeholders, but it still deals with exactly the same content. The process should not add or remove any features from a well designed operational LPIS. The model will however provide for a formal and uniform reading of that system and its relatives in other Member States.

1.3.4. The proposed workflow for modelling uses the geographic standards from ISO and OGC (Open GeoSpatial Consortium a.k.a. OpenGIS) as much as possible. The ISO series 19100 of International Standards provides the methodological framework of *conceptual modelling* including standard methodologies as well as IT industry standards for development tools. The ISO 19100 series employs conceptual modelling for two proposes: (i) to provide a rigorous description of geographic information (GI) and GI services; (ii) to standardise the definition of GI and GI services so that software systems interoperate in distributed computing environments. If one intends to create a LPIS implementation which is sustainable amidst continuous technological changes, one should opt for a so-called ‘open’ system. An ‘open’ system allows for the sharing of geographic data, its integration among different GIS technologies and integration with the other non-geographic applications. It

should expose **objects**[1] that allow for the customisation and extension of functional capabilities using industry standard development tools and it should be capable of operating on different platforms and at different scales. The OGC standards need to be supported by both GIS software and data models if one intends to introduce Web-based services using interoperable standards of XML/GML.

1.3.5. The INSPIRE directive is a pan-European initiative for creation of European SDI and standardization of GI data for the environment. The INSPIRE methodology applies the same methodological framework proposed by international standards. As several data themes included in the INSPIRE annexes have a multi-purpose use and are widely incorporated in IACS-GIS for the LPIS creation and update and for the controls of cross-compliance, applying at the very beginning the same principals which are laid down by the INSPIRE directive will be of great benefit to the standardization process in LPIS domain.

1.4. Scope

1.4.1. How far does this document intend to harmonise LPIS or extend the model? As a conclusion of the aforementioned arguments, the scope of this discussion text can be defined as follows:

- introduce the framework of conceptual modelling in LPIS;
- propose first-cut of the LPIS Core Model in short (LCM) as the minimum base data components required by the Regulation
    - introduce the concept of a Feature Catalogue (FC) including a draft FC
    - define a general application schema for the domain of the Common Agricultural Policy (CAP);
    - use a standardised conceptual schema language for the proposed application schema;
- apply the methodology as proposed by European efforts of standardisation for geographic information (e.g.INSPIRE)

1.4.2. The following topics are outside of the scope of this document:

- a complete LPIS model
- a model of geospatial features in IACS (outside of LPIS)
- the elaboration of a particular ('National') application schema
- the compilation of the pan-European feature catalogue covering all data components;

[1] An object is a particular instance of a data component. In the general context here, model can refer to a representation of spatial features as well as to an service provided by the software of the system.

- the detailed technical data specification such as collection/exclusion criteria and measurement tolerances for feature instances
- a detailed plan for future development of the LCM.

1.5. Preceding documents

OL/I04/M2580/01	Land Parcel Identification System in the frame of Reg. 1593/2000
JRC IPSC/G03/P/SKA/ska D(2002)(1187)	Implementation of IACS-GIS, Reg. 1593/2000 and 2419/2001
JRC IPSC/G03/P/SKA/ska D(2004)(2575)	Implementation of IACS-GIS Reg. 1782/2003 and 796/2004
JRC IPSC/G03/P/SKA/ska D(2005)(4560):	Parcel Identification System Creation and Updating. Parcel Block interpretation and numbering
JRC IPSC/G03/P/SKA/pmi D(2007)(7111)	LPIS Update in the EU Member States (methods, technology, organisation)
JRC IPSC/G03/P/PMI/pmi D(2007)(7152):	Results (raw data) from the LPIS questionnaire to the EU MS (Data updated up to Nov 2006; RO and BG not included)
JRC IPSC/G03/P/SKA/vsa D(2007)(8158)	

1.6. Terms and definitions

Anomaly - observed non-conformance

Application domain – in informational technology is the kinds of purposes for which users use a software system, in general language - a field of study
Application schema – conceptual schema for data required for one or more applications [ISO19101]
Conceptual formalism – set of the modelling concepts used to describe a conceptual model [ISO19101]
Conceptual model – model that defines concepts of the universe of discourse [ISO19101]
Conceptual schema – formal description of a conceptual model [ISO19101]
Conceptual schema language – formal language based on a conceptual formalism for the purpose of representing conceptual schema [ISO19101]. Examples: UML, EXPRESS.
Conformance - fulfillment of specified requirements [ISO 19105]
Domain - a territory over which rule or control is exercised. A sphere of activity, concern, or function
Event – action which occurs at an instant in time
Generalization – feature association describing inheritance relationship between feature types, where more general feature type (supertype) is result of **generalization** and one specialized feature type (subtype) is result of specification.
Feature – abstraction of real world phenomena [ISO 19101].

NOTE A (geographic) feature may occur as a type or an instance. Feature type or feature instance should be used when only one is meant.
Feature association – relationship between features [ISO 19109].
NOTE: A feature association may occur as a type or an instance. Feature association type or feature association instance is used when only one is meant
Feature type – a class that specifies set of spatial objects sharing common properties and operations applicable to the objects.
Feature attribute – characteristic of a feature [Adapted from ISO 19110]. NOTE A feature attribute has a name, a data type, and a value domain associated to it.
Feature operation – operation that every instance of a feature type may perform [ISO 19110]
EXAMPLE An operation upon a "dam" is to raise the dam. The results of this operation are to raise the height of the "dam" and the level of water in a "reservoir".
NOTE Feature operations provide a basis for feature type definition.
Lineage - data quality overview element, which describes the history of a feature from collection and acquisition through compilation and derivation to its current form.
Spatial object = feature
Specialization - association describing inheritance relationship between feature types, where more general feature type (supertype) is result of **generalization** and one specialized feature type (subtype) is result of specification.
Unified Modelling Language (UML) - an open modelling standard for conceptual schema language defined and maintained by the Object Management Group.
Universe of discourse – view of the real or hypothetical world that includes everything of interest [ISO19101]

1.7. Acronyms and abbreviations

AEM	Agro-Environmental Measures
CAP	Common Agricultural Policy
CRS	Coordinate Reference System
GAEC	Good agricultural and environmental condition
IACS	Integrated Administration and Control System
INSPIRE	Infrastructure for Spatial Information in the Europe
ISO	International Organisation for Standardisation
LCM	LPIS Core Model
LPIS	Land Parcel Information System
SDI	Spatial Data Infrastructure
SMR	Statutory management requirements
UoD	Universe of discourse
UML	Unified Modelling Language
WPLA	Working Party on Land Administration (operating under the auspices of the UN-ECE Committee on human Settlements)

2. Conceptual modelling framework

2.1. Conceptual modelling framework

2.1.1. Any description of reality is always an abstraction, always partial, and always just one of many possible 'views' depending on the application field. The portion of the real world containing all phenomena of interest, their properties and relations constitutes the '*universe of discourse'* (UoD). The CAP Regulations define one and only one portion of the real world concerning the Direct Payments for European farmers, so the resulting UoD is common for all stakeholders and is the one that we are going to model.

2.1.2. Conceptual data modelling, the main focus of this discussion document follows a pathway from the universe of discourse down to geographic and non-geographic data which reflect our phenomena of interest in a computerized database. The modelling process consists of the creation of an abstract description and a set of concepts about the world of interest by means of conceptual formalism. The core of conceptual formalism is the General Feature Model (GFM) which provides general concepts needed for an application field to classify the real world. It results in a *conceptual model* which can be described verbally or be documented by means of a *conceptual schema language.* The rigorous description of a conceptual model for some portion of the real world by means of conceptual modelling language is a *conceptual schema* (figure 2).

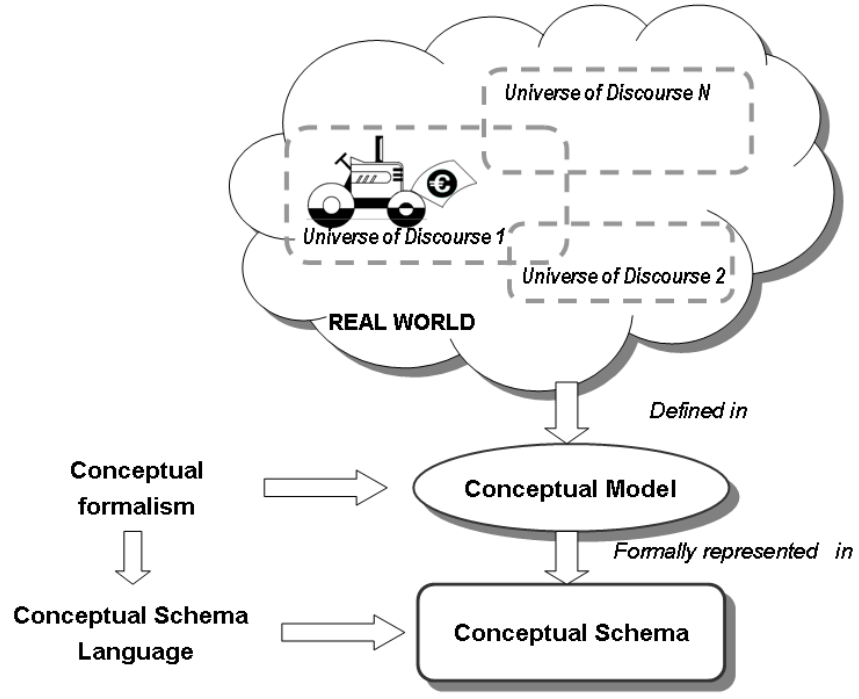

Figure 2: From reality to conceptual schema. (adopted after ISO 19101)

2.2. Feature Catalogue and Application Schema

2.2.1. The conceptual formalisation is a steps process on the pathway from UoD to the concrete data. These tiers follow the steps involved in information modelling (ISO 19109) and can be illustrated by figure 3:

Step 1. Surveying the *requirements* from the intended field of application (UoD).

Step 2. Making a conceptual model of the application with concepts defined in the General Feature Model. This task includes the identification of feature types, their properties and constraints via the Feature Catalogue.

Step 3. Describing the application schema in formal modelling language (e.g. UML) according to rules defined in International Standard.

Step 4. Integrating the formal application schema with other standardized schemas (spatial schema, quality schema, etc) into a complete application schema.

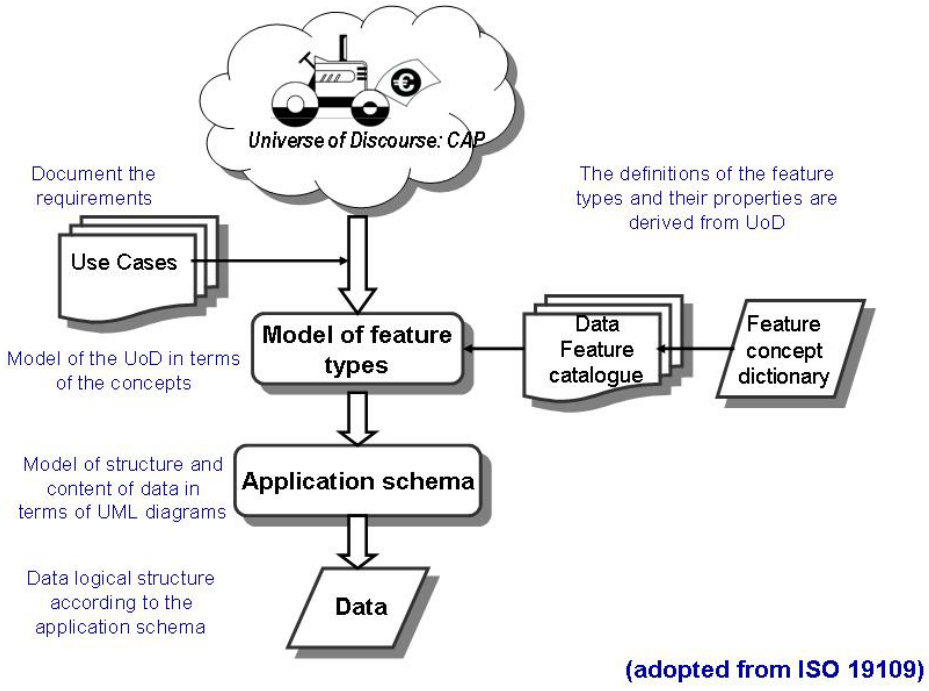

Figure 3. Levels of abstraction in conceptual formalisation – a pathway from real world to application data through the application scheme (adopted after ISO 19109).

2.2.2. The role of Use Cases as a methodological element to capture and identify user requirements should be specially underlined on the way from UoD to an application schema. User requirements are strongly related to the policy framework provided by the Regulations and deal with the activities which are performed by different involved parties. The analysis of Use Cases is intended to identify the information required, to describe the current situation with information available and to analyze the gaps between required and currently used data.

2.2.3. Geographic **features** (or spatial objects as they are named in the INSPIRE directive) are abstractions of real world phenomena associated with a location relative to the Earth's surface, about which data are collected, maintained, and disseminated (ISO 19110). A feature may occur as an *instance* or as a *type.* The feature instance deals with concrete phenomenon, such as 'Danube river', and can be associated with its geographic and temporal coordinates. Similar instances with common characteristics can be classified into feature type –e.g 'river'- which may be portrayed in a similar way. Feature types constitute a class of real world phenomena with common properties. Geographic feature types are an instrument for organizing and representing the classification of real world phenomena in a set of geographic data, they are the main elements of geographic data specification and standardisation.

2.2.4. **Feature catalogues** are collections of feature types of geographic data, including: feature type names, definitions, attributes, operations and interclass associations. The format of a Feature Catalogue is the most convenient way of representing database content for domain experts and the creation of the FC is an action where participation of expert users is of crucial importance.

- A feature type name is usually a meaningful word or phrase referring to the real world concept it represents (e.g. river, road or parcel).
- A definition establishes the semantics which is an indispensable description. It portrays the concept and acts as a filter defining the group of objects. Practical definitions include all the information required to describe the concept unambiguously but nothing else. To meet this requirement this modelling exercises may introduce for geographical features a definition that extends beyond the strict definition phrase of the Regulations.
- An attribute holds a characteristic of feature types expressed as a numerical or text value.
- Finally, an association is called in to express the relation between different feature types.

2.2.5. An **application schema** is a conceptual schema for data required for one or more applications (implementation). It provides the formal description of the data structure and content required by the application in a particular domain. An application schema is called to specify the domain-relevant spatial objects –features types- describing specific view of the real world based on information requirements. It elaborates conceptual schema language (e.g. UML) to represent, by means of diagrams, features described in previous modelling. The spatial feature types describe the core concepts by means of meaningful names along with definition, properties, possible constraints, etc. An application schema contains the description of both geographic data and other related data and it is documented in Conceptual Schema Language. The purpose of an application schema is two-fold:

- Semantics & data structure: to achieve a common and correct understanding of the data content, by documenting the data for a particular application field, thereby making it possible to gain an unambiguous and computer-readable representation and to retrieve information from the data.

- Specifications of operation for manipulation and processing of data by the application to provide a computer-readable data description defining data structure, which makes it possible to apply automated mechanisms for data management and interoperability.

2.2.6. The Regulations themselves form a clear Universe of Discourse that forms a good entry point for the modelling approach described above. The various components of core model should make reference to the relevant articles of the Regulations that lay at the basis of that particular element.

2.2.7. However, each Member State and sometimes Region has developed its specific application schema. Based on how the national LPIS represents basic agricultural activity units, it is possible to group the application schemas on the basis of the concept chosen for the reference parcel (see discussion later in chap. 3). The analysis of the implementation of application schema in the various MS will allow the extraction and better modelling of the core content of the proposed conceptual model, as well as the main specializations of a generic model. To facilitate semantic harmonisation across the CAP domain, national definitions for core feature types as well as feature attributes in use should be analyzed and harmonized. The establishment and documentation of common vocabulary by means of a conceptual schema is a major cornerstone in the harmonisation process.

3. The requirements and basic concepts

3.1. 'Universe of Discourse': defining domain for the CAP direct support schemes for farmers

3.1.1. The CAP, since the 2003 reform, aims to provide for a stable farmer's income, decoupled from production, within a framework of sustainable development of the rural areas while respecting environmental and other societal needs (figure 4). There are three main categories of player in the process of direct payments under the Common Agricultural Policy: the EU Institutions, Member State Administrations (including some MS Regions) and farmers. The EU Institutions, and in particular the European Commission, identify general policy principles which are laid down in legislative acts specifying common rules and requirements needed to carry out the policy and the verify that systems are implemented to comply with requirements laid down by the common rules. The Regulations spell out what farmers should explicitly state in their claims for aid under direct support schemes, through the mechanism of Single Application. To distribute Community aid, the MS have to establish a Paying Agency to collect, control and reimburse all farmers' applications through the Integrated Administration and Control System (IACS) with its geographical module LPIS. Within MS administrations, the tasks are subdivided between IACS registers administrators and LPIS custodians (not necessarily the same body is responsible for both) and field inspectors.

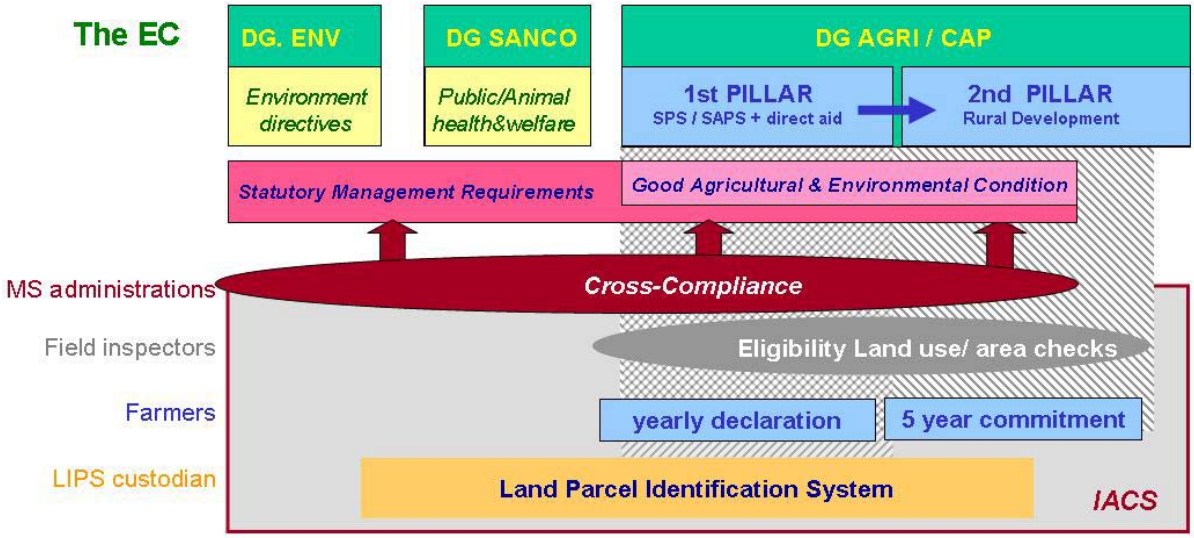

Figure 4. Universe of discourse: the CAP Direct payments, modules and key stakeholders

3.1.2. The Regulation (Council Reg (EC) No 1782/2003, Art 17) state that each MS shall set up an Integrated Administration and Control System (IACS) as a tool to manage direct payment support at national level. IACS should be established as (Art.18(1)) 'computerised data base' (read = information system) and containing following components:

(b) an identification system for agricultural parcels;

(c) a system for identification of entitlements;

(d) register for aid applications;

(e) an integrated control system;

(f) identification system for farmers.

For this conceptual modelling exercise, each component will henceforth be addressed as a module.

3.2. The EU regulatory requirements for LPIS

3.2.1. The system for identification of agricultural parcels indicated in point (b) of Art.18(1) the Council Reg (EC) No 1782/2003, also known as LPIS, is the main subject of the modelling efforts. It is part of IACS and it is closely related to other modules. It is often implemented as an independent state register. It has GI content and according to the Art. 20(1) Council Reg (EC) No 1782/2003

> shall be established on the basis of maps or land registry documents or other cartographic references. Use shall be made of computerized geographical information system (GIS) techniques including preferably aerial or spatial orthoimagery, with a homogenous standard guaranteeing accuracy at least equivalent to cartography at a scale of 1:10000
>
> Art 6 (1) of the Comm Reg (EC) No 796/2004
> The GIS shall operate on the basis of a national geodetic system.

3.2.2. The Regulations specify the main purposes of LPIS, which are (i) identification and location of agricultural parcel (ii) determination of area eligible for payment and (iii) furnishing of the farmer's aid application with map information as referred in two following citations[2]:

> Art 12(3) of the Comm Reg (EC) No 796/2004 establishes that:
> For the purpose of the identification of all agricultural parcels on the pre-printed forms distributed to the farmer in accordance with Art 22(2) of the Council Reg (EC) No 1782/2003 shall mention the maximum eligible area per reference parcel for the purposes of the single payment scheme. Moreover, the graphical material supplied to the farmer in accordance with that provision shall indicate the boundaries of the reference parcels and their unique identification and the farmer shall indicate the location of each agricultural parcel.
>
> Art 6 of the Comm Reg (EC) No 796/2004
> Member States shall, moreover, ensure that agricultural parcels are reliably identified and shall in particular require the single application to be furnished with particulars or accompanied by documents specified by the competent authority that enable each agricultural parcel to be located and measured.

3.2.3. The design of LPIS should ensure the interoperability with other components of IACS and allow cross-checks between different registers:

- Calculation of entitlements

> Art 21(1) of the Council Reg (EC) No 1782/2003
> The system for the identification and registration of payment entitlements shall be set up allowing verification of entitlements and crosschecks with the aid applications and the identification system for agricultural parcels.

[2] For eligibility see also Art. 30 Comm Reg (EC) No 796/2004

- Administrative cross-checks

  Art 24(1) of the Comm Reg (EC) No 796/2004

- Furnishing on-the-spot check

  Art 28(1) of the Comm Reg (EC) No 796/2004
  Every on-the-spot check under this Section shall be the subject of a control report which makes it possible to review the details of the checks carried out. The report shall indicate in particular:
  (a) the aid schemes and applications checked;
  …
  (c) the agricultural parcels checked, the agricultural parcels measured including, where applicable, the number of olive trees and their positioning in the parcel, the result of the measurements per measured agricultural parcel and the measuring methods used;

3.2.4. With regard to cross-compliance the administrative check of at least of 1% of applications (Art.43 of the Comm Reg (EC) No 796/2004) shall be carried out to determine the 'extent' of a non-compliance with SMR's and GAEC's. This means that correspondence between agricultural parcels in question and 'areas of cross-compliance' –areas where farming restrictions from SMRs and GAECs are applied (Art 2 (31) of the Comm Reg (EC) No 796/2004)- should be determined.

3.2.5. Table 1 summaries of Regulatory requirements for LPIS

Use cases	Council Regulation 1782/2003	Commission Regulation 796/2004	proportion of applications affected
Main use cases			
A. Identification and location of agricultural parcel	Art 20	Art 12(3), Art 6	100%
B. Determination of area eligible for payment	Art. 23	Art 12, 6, & 30	5%
C. Furnishing of the farmer's aid application with map information/interaction with farmer		Art 12, Art 6	100%
Interoperability with other components of IACS			
D. Calculation of entitlements	Art 21(1)		100%
E. Administrative cross-checks		Art 24(1)	100%
F. Furnishing on-the-spot check		Art 28(1)	5%
G. Cross-compliance		Art.43	1%

3.2.6. For each use case of the table above, a set of functional system requirements relating to LPIS implementation, quality and reliability can be drawn up. At the time the LPIS creation was in focus,

the discussion document "*Implementation of IACS-GIS, Reg. 1782/2003 and 796/2004"* [3] presented recommendations and expected functional performance. The document contains tables of critical issues for system compliance assessment on three sections: (i) LPIS creation and use in the aid application process; (ii) administration and cross checks; (iii) on-the-spot checks, including remote sensing controls. The majority of these functional requirements remain relevant to this date, but as some of these can be relevant to one or many present use cases, careful cross-mapping of the tables of the 2004 document against the above table 1 of this document is required to complete the full model of requirements.

3.3. Spatial concepts in Direct Payments

3.3.1. Therefore we can identify the central concept connecting all actors in the domain covered by the farmer's Single Application. The Single Application, according to Art. 12 (1) of the Comm Reg (EC) No 796/2004, shall contain:

(a) the identity of the farmer;

(b) the aid scheme(s) concerned;

(c) the identification of payment entitlements;

(d) particulars permitting identification of agricultural parcels in holding and their area,

(e) where appropriate, the olive area in ha and

(f) statement by the farmer of awareness of the payment conditions.

Each sub-paragraph from (a) to (e) can serve as separate concept in modelling functionality of IACS

3.3.2. An **agricultural parcel (AP)** is a key concept applied in relation to area-based payments which determines the subject of the aid application, geographic location and extent (area) of agricultural activity. In addition to being the subject of the payment calculation, AP is also a subject of administrative cross-checks and control procedures (measurements) established in IACS. It is also worth mentioning that, due to the dynamic nature of agricultural activities, AP can be unstable over time (crop rotation, out of use, different extent of use, conditions for eligibility, etc.). Therefore, the Regulation set up that for purpose of identification of the APs the **reference parcel** (RP) should be used:

> Art 6(1) of the Comm Reg (EC) No 796/2004
> the identification system for agricultural parcels …. shall operate at reference parcel level such as cadastral parcel, or production block which shall ensure unique identification each of reference parcel.

3.3.3. The Commission Regulation (EC) No 796/2004 Art *2* defines agricultural parcel and reference parcel (RP) as follows:

[3] **MARS-Pac ref:** JRC IPSC/G03/P/SKA/ska D(2004)(2575)

(1a) 'Agricultural parcel': shall mean a continuous area of land on which a single crop group is cultivated by a single farmer. However, where a separate declaration of the use of an area is required in the context of this Regulation that specific use shall further limit the agricultural parcel;
(26) 'Reference parcel': shall mean a geographically delimited area retaining a unique identification as registered in the GIS in the Member State's identification system referred to in Article 18 of the Council Reg (EC) No 1782/2003;

3.3.4. The definition of Agricultural Parcel above, includes the concepts "area of land cultivated" and "use of an area" which fully comply with the INSPIRE Directive theme of **land use**

Annex III.4 of 2007/2/EC
Territory characterised according to current and future planned functional dimension or socio-economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational).

3.3.5. Whilst this definition of the agricultural parcel is not much changed from the original Council Reg 3508/92 version (only the insertion of the word "group"), the definition of the reference parcel was introduced to clarify the concept already present in the Commission regulation applicable at the time[4]. Additionally to Arc 6(1) mentioned above, the relation between the two definitions is described in Art. 12 which says that the single application shall contain

(d) particulars permitting identification of all agricultural parcels on the holding, their area expressed in hectare to two decimal places, their location and where applicable their use and whether the agricultural parcel irrigated.

And finally, according to Art. 24 no payment can be made for areas in excess of the reference parcel:

(c) [detection of irregularities] between the agricultural parcels as declared in the single application and the reference parcel as contained in identification system for agricultural parcels to verify the eligibility for aid of the areas as such.

3.3.6. **Eligible hectare** is a reference parcel attribute that quantifies the level of the general applicability of the direct support scheme. For the SPS this relates solely to the terrain conditions on at the time of the aid applications whereas for the SAPS there is the additional constraint based on the historic terrain conditions on a reference date.

Art 44.2 of Council CR No 1782/2003
'Eligible hectare' shall mean any agricultural area of the holding taken up by arable land and permanent pasture except areas under permanent crops, forests or used for non agricultural activities. 'Eligible hectare" shall also mean areas planted with hops or being under a temporary resting obligation, or planted with olive trees (Annex VII. H) or areas under olive trees within approved planted schemas
or
Art 71a.3 of Council CR No 1782/2003
Any new Member State having applied the single area payment scheme may provide that, in addition to the eligibility conditions established in Article 44(2), 'eligible hectare' shall mean any agricultural area of the holding which has been maintained in good agricultural condition at 30 June 2003, whether in production or not at that date

[4] Namely, as last illustrated by Art 4 of Reg 2419/01: "The identification system referred to in Article 4 of Regulation (EEC) No 3508/92 shall operate at agricultural parcel level. The Member States may provide that another unit, such as the cadastral parcel or production block, be used instead of the agricultural parcel." The phrase "another unit" was considered later too generic a term and was replaced by "reference parcel" in current legislation, Comm Reg (EC) No 796/2004

3.3.7. The spatial concept quantified in this eligible hectare attribute value, being the "area of the holding taken up by arable land and permanent pasture except areas under permanent crops, forests or used for non agricultural activities" matches the definition of the **land cover** theme of the INSPIRE Directive

> Annex II.2 of 2007/2/EC
> Physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies.

3.3.8. **Hectare eligible for set aside entitlement** is a spatial concept that further restricts the eligibility for the specific set-aside entitlements based on the field conditions (land cover) on a particular reference date:

> Art 54.2 of Council CR No 1782/2003
> shall mean any agricultural area of the holding taken up by arable land, except areas which at the date provided for the area aid applications for 2003 were under permanent crops, forests or used for non agricultural activities or under permanent pasture. For the new Member States, the reference to the date provided for the area aid applications for 2003 shall be construed as a reference to 30 June 2003. However, for Bulgaria and Romania, the date provided for the area aid applications shall be 30 June 2005

3.3.9. Cross-compliance is a concept for ensuring that agricultural activity of farmers is undertaken with respect to rural sustainability, environmental and sanitary requirements. According to Art. 2(31) of the Comm. Reg (EC) No 796/2004 'areas of cross-compliance':

> shall mean the different areas of statutory management requirements within the meaning of Art 4(1) of the Council CR No 1782/2003 and the good agricultural and environmental condition in accordance with Art 5 of that Regulation;

The term "area" here has a different meaning than the strictly spatial used in the previous paragraphs. "Areas" mean the "policies" established by Environment Directives and Directives on public and animal health and listed in Annex III of the Council Reg (EC) No 1782/2003. The MS should also ensure that all agricultural land is maintained in good agricultural and environmental condition and should establish national or regional measures on the basis of the framework provided in Annex IV of the Council Reg (EC) No 1782/2003. Although Art 2 doesn't define a spatial concept per se, a considerable part of its requirements involve geospatial components (e.g. location inside of protected zone or topographic elements such as slopes prone to erosion) of the land. These requirements call for the special practices on the land (often called as 'farming limitations' or 'farming restrictions') and many MS include spatial layers in the LPIS to define their geographic extent. The spatial concepts defining geographic extent of cross-compliance elements will hereby be referred to as '**areas of farming limitations'** (to avoid confusion with "areas of cross-compliance")..

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3.3.10. In view of the aforementioned definitions, we can conclude that two of five main spatial concepts are internal to IACS: (1) agricultural parcel which is a part of aid application, (2) reference parcel which is the spatial object in LPIS and corresponds to its core data layer especially maintained for purpose of aid application administration. The reference parcel's eligible hectares for assessing general

applicability of direct aid and set aside entitlement represent concepts of land cover. By contrast, the agricultural parcel definition includes concepts of land use. Both land cover and land use are INSPIRE annex themes. The areas of farming limitations are usually external geographic data incorporated into LPIS, originating from different sources and is often produced by other relevant administrative bodies according to their specific requirements. This document will further concentrate on modelling and standardization of the LPIS core concepts, rather than on standardization and harmonization of data representing areas of farming limitations. The latter is a task which is related to intentions and thematic content of the INSPIRE Directive and should be undertaken in cooperation with the INSPIRE community[5].

3.3.11. As already mentioned, the Reference parcel is the key spatial object of any LPIS database, whereas an Agricultural parcel is more a concept used for the aid application IACS, in other words, the AP is not a core part of the LPIS. The distinctive properties of these two different concepts are illustrated in figure 6.

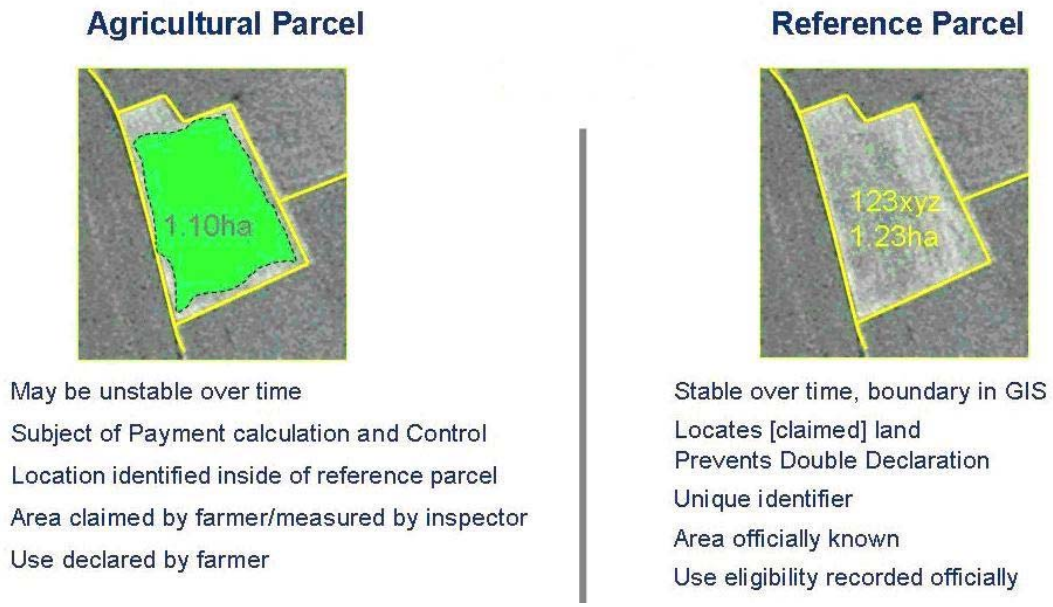


Figure 6: Identified properties of Agricultural and Reference parcels

3.3.12. The properties of database objects are reflected in their attributes and will be discussed in chap. 4. Concerning the figure above, attention should be paid to the following properties of the Reference Parcel (RP):

- 'Use eligibility recorded officially' which is actually an attribute stating what types of aid may be claimed in that reference parcel;

[5] Directive 2007/2/EC : ANNEX I - 9. Protected sites and ANNEX III – 11. Area management/restriction/regulation zones and reporting units

- 'Area officially known' which **caps** the area of land that can be claimed for that RP. How big a proportion of the topographic parcel area that is, strongly depends on the type of reference parcel in use and the nature (size) of ineligible areas within it. It is a fixed, conventional quantification of the largest possible eligible area within the RP.

3.3.13. A last spatial concept to be addressed is that of boundary as mentioned in Art 12.3 and 12.4 of the Comm Reg (EC) No 796/2004. Boundaries delineate the RP and AP and constitute a closed perimeter that is used for applying the tolerances (Art 30 of the same Regulations). These parcel boundaries in the LPIS can be derived from topographical linear elements, land cover borders and/or land use practices. Each boundary type is well elaborated in other domains of geographic information, but their conceptual roles in the LPIS are not extensively documented. Some parts of the parcel perimeter may not correspond to terrain phenomena, so virtual boundaries could be considered to enable closure of that perimeter.

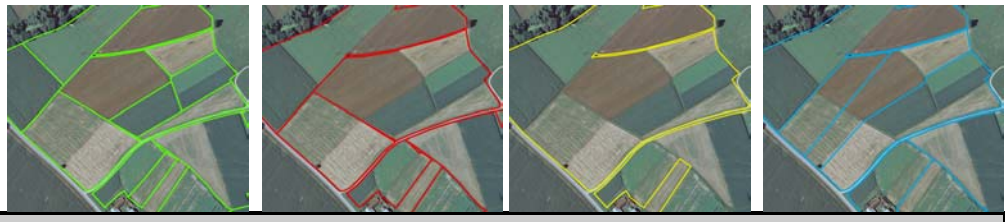
	Topographical boundary	**Land cover border**	**Land use delineation**
Original domain	Topography	Environment	Economy (agricultural activity)
Example	Fence / wall	Forest/pasture transition	crop transition
Applied for	Delineation of some types of production blocks	Eligibility of land	Control of claim

4. Reference parcel –'as is' analysis

The aim of this chapter is to overview the diverse practices of representations of Reference Parcel in the GIS databases within various MS. Information for the analysis was obtained from questionnaires, reports on bilateral meetings with MS LPIS teams, presentations given by national administrations during workshops and conferences. These provisional materials should be considerably complemented during LPIS Metadata phase of harmonisation.

4.1. Different types for Reference parcel

4.1.1. The statement of Art 6.1 of the Comm Reg No 796/2004 created the opening for a diverse practice among MS of 'reference parcel' representations as: **Cadastral parcel** (CP), **Agricultural parcel** (AP), **Farmers' block/ilot** (FB) and **Physical block** (PB). The cadastral parcel is based on ownership, whilst the other LPIS reference parcels are based on land cover delineated by topographical boundaries and/or agricultural land use. The latter representations (see table below) correspond either *directly* to a single Agricultural parcel or *indirectly* to an association of one or more agricultural parcels into 'blocks' according to production pattern or physical (topographic) boundaries of agricultural land use.



	= Agricultural parcel	< Farmer's block/ilot	< Physical block	Cadastral parcel
land use for aid scheme	one single crop group	one or several crop groups	one or several crop groups	do not match agricultural pattern
applicants	single farmer	single farmer	one or several farmers	one or several farmers
temporal aspect	annual	multi-annual	semi-permanent	land tenure cycle
main data source	farmer's application	farmer's survey	administration survey	land register/cadastre

Table 2. Different types of RP

4.1.2. Unfortunately, there is a confusion in use of terms which exists when one refers to the term "agricultural parcel". In IACS database, AP corresponds to unit of agricultural activity relevant for aid application (see 3.3.2), definition of AP in IACS can change when different types of payments, crops (eligible for payment) and crop groups are concerned. In LPIS context AP has a different meaning: a reference parcel which by definition contains only one declared object "agricultural parcel". To avoid confusion "declared AP" or "Reference parcel: AP" should be used when only one is meant.

4.1.3. The overview[6] of approaches adopted by the EU MS based on survey form 2006 – covering 23 Member States and 2 CC – noted that the most commonly used reference parcel is 'physical block' (10 countries), followed by 'agricultural parcels' and 'Farmer's blocks' in equal proportion (5 & 5), and finally cadastral parcels (4 countries). Federal States of Germany vary greatly in approach from CP to PB/FB/AP. The choice of the reference parcel is an example of subsidiarity in the adoption of the EU Regulations in order to find the most appropriate solutions for the agricultural pattern of each country/region (figure 7). It depends mainly on the historical development of the land management in the country and the usual farmer practices. On the other hand, this choice is crucial for the development of the IACS and the organization of the control. It is also linked to the way the LPIS was initially created.

4.1.4. In the systems, where Reference parcel is identical to AP we can expect that compliance with LPIS performance indicator -75%/90% rule- set by Art. 6.2 of the Comm. Reg No 796/2004 will return figures 100%/100%. Also all information which is contained in aid application such as name of the farmer, use of the land, crop etc., can be directly linked to the spatial object of RP. These systems automatically avoid overlaps and double declarations, reducing number of administrative checks in IACS. On the other hand, these systems require rigorous update approach whereas the boundaries must match the farmed area (all ineligible elements must be identified). It involves a thorough annual update and an intensive information exchange with the farmer.

4.1.5. In block-based systems, there is no need for farmers to identify Reference parcel boundaries each year, even when the farmer may only partly declare. A reference parcel may contain one or more declared objects, but should the sum of these be carefully checked against cap area of land that can be claimed for that RP. Results of survey already mentioned in 3.4.2 shown that a considerable amount of RP (20%-40%) which are not claimed exists for any PB-based LPIS. For FB-based systems this proportion on unused blocks remains very low. The proportion of RP fully claimed varies from 10-30% for PB to 90% for FB systems. In respect to the 75%/90% rule, if the proportion of unclaimed land remains substantial (e.g. an agricultural land is partially abandoned within an otherwise active reference parcel), it should trigger a revision or subdivision of the RP in question.

4.1.6. The LPIS based on the cadastre, have specific problems due to the different philosophy of the cadastral parcel (based on ownership) comparing to the other LPIS reference parcels (based on land use). Difficulties related to identification of AP become more pronounced when system created for purpose of fiscal legal register no longer matches the agricultural pattern. The cadastre system must assure currency and accuracy of eligibility criteria which is needed of IACS. A parcel reference system that correlates well with the currently cropped fields would obviously approach a better ratio in respect to 75%/90% rule

[6] Mars ref: JRC IPSC/G03/P/SKA/pmi D(2007)(7111): LPIS Update in the EU Member States (methods, technology, organization)

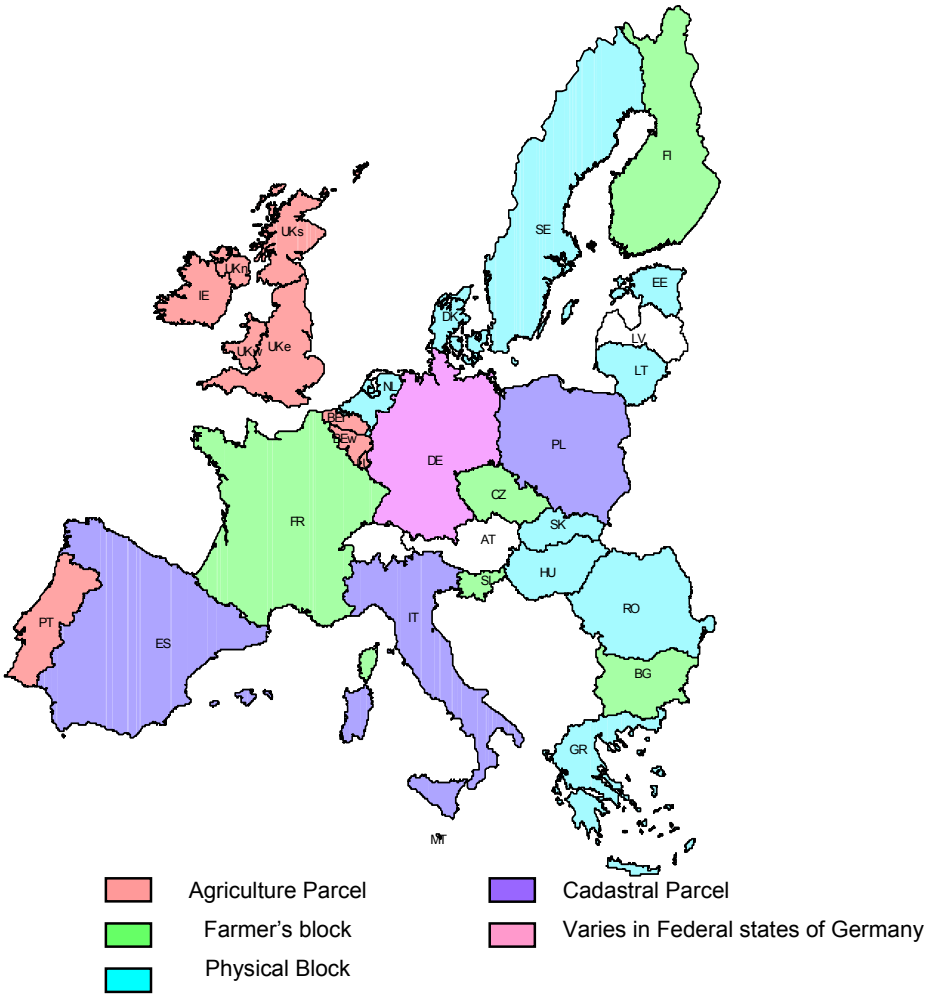


Figure 7: Types of Reference parcel in use in MS as declared by the MS

4.2. Attributes of Reference parcel as observed in the MS implementations

4.2.1. Attributes typically stored for each reference parcel object in database can be subdivided into (i) mandatory or core attributes serving purpose of identification and area determination and (ii) additional attributes helping localisation, retrieval of information on cross-compliance and management of the spatial object in the database. Hereby we will cover core attributes and some of additional attribute groups.

Mandatory attributes:

- Unique identifier
- Area
- Effective date of the parcel
- Geometry

Additional attributes:

- Localisation (e.g. administrative unit, municipality, state)
- Farmers ID (for AP and FB)
- ID of other relevant register (permanent pasture register, vineyards etc.)
- Payment scheme/Crop group
- Land use (for AP and FB)/Crop (for AP)
- Farming mode (in case of national certification or AEM)
- Farming restrictions and limitations
- Areas of cross compliance
- LFA
- Topography (mean slope, altitude, exposure)
- History of the parcel (effective date, expiration date, previous parcel versions etc.)
- Database management (update/validity status; comments on date of control, date of interview with farmer, discrepancy found, reference to decision made etc.)

4.2.2. **Unique identifier** (ID) is a mandatory attribute of the RP, aimed at unambiguous geographical identification of agricultural parcels for aid application. The RP parcel identifier should be unique under the national system and it is a key attribute for connection with other IACS and MS national registers. The structure of the unique identifier and principles for it generation are very different among the MS. In some MS a sequential number approach is in use (e.g. Slovenia), whilst others make use of coordinates of a RP central point expressed in the national geodetic system. There are also some MS with approaches to integrate codes from administrative units, blocks or grids into the identifier (e.g. Czech Republic). Some of approaches support spatial object 'history', referring on the ID of the previous object version in the database e.g. in case where an RP was divided into two new objects.

4.2.3. In view of the above observations, one should investigate the effects of harmonisation on EU level carefully before any recommendation can be produced. The observations also indicate that in practice, many unique identifiers do not fully adhere to the database "best practices" that suggest that a primary key should be unique (not null), immutable and preferable an integer value without any semantic meaning.

4.2.4. Attribute(s) of **area** is another core property of the RP, ultimately aiming at calculation of the aid amount. Given that there are many kinds of area currently in use, the terminological distinction should be made very clear. This harmonisation on terminological level is vitally important to avoid mis-understandings between stakeholders at all levels of communication. Areas, and other geometric parameters, are always considered as the orthogonally projected in the national CRS (Art

6.1 oft the Comm Reg (EC) No 796/2004). To meet regulatory requirements MS should on a systematic basis establish and record in the LPIS[7]:

- **Maximum eligible area**, also known as 'reference area' or 'area officially known', caps the area of land that can be claimed for the RP concerned. It acts as the benchmark to test the sum of all claimed areas of the RP in execution of Art. 24 (3) crosschecks. This reference area is an attribute and determined once.
- **Digitized area** - GIS calculated area of a topographic polygon of the reference parcel determined in the LPIS. Mostly, this area is a result of measurement/interpretation on aerial photo, but it could conceivably be also the vector measure in loco by GPS or other survey technique (for example, the cadastre). Stored as geometry and as attribute. Alternatively terms like 'system area', 'LPIS area' or 'Gross area' are in use in some MS. In case the RP contains piece(s) of non-eligible area that are too small to be individually mapped as polygons in the LPIS, an attribute area, calculated as the digitized area minus estimated exclusions, determines the maximum area potentially eligible for claim[8], also known as a 'Net area'.
- **Claimed area –** area claimed by all farmers inside a given reference parcel; may have geometry (map) and attribute information.

For Farmer's Block RP, either the Digitized area or the Farmer's area must be selected as the reference area following a strict decision schema. For Physical Block RP, the reference area is calculated as the digitized area minus the identifiable and scattered ineligible land.

Attention should be paid to the fact that the IACS database contains area attributes for Agricultural parcels, following execution of Art. 24 of the Comm Reg (EC) No 796/2004 crosschecks and (possibly) on-the-spot checks:

- **Declared area** – "claimed area"- area claimed by a farmer for the current year (Art 2 (22) the Comm Reg (EC) No 796/2004)
- **Measured area** – outcome of field (GPS, CwRS, etc.) measurement; stored as geometry and/or as attribute
- **Retained area** – resulting from a comparison between declared and measured areas, after application of tolerances and/or consultation of reference material (maps, orthophotos, digitised boundaries, and so forth).

[7] Mars ref: JRC IPSC/G03/P/SKA/vsa D(2007)(8158)

[8] Actually, it is what we expect the farmer to claim, since they are normally aware of such exclusions. It is also a primary reason for providing maps with an up to date orthophotos background.

- **Determined area** (defined in Art. 2 (22) the Comm Reg (EC) No 796/2004)) – retained area accepted for aid calculation when all conditions for granting the aid have been met (e.g. accompanied by a corresponding number of payment entitlements, etc.).

4.2.5. The **effective date** of the reference parcel is crucial for all bodies working with LPIS register. On the effective date new version and new attribute values of the RP come in to force with respect to third parties (e.g. Paying Agency) and registers. Possible dates are (i) those of the proposal for RP modification is made by farmer, LPIS operator or inspector; or (ii) those specified within the time period when it is certain that a change will occur in the future(e.g. changes in use rights, lease contract, activating/transferring of entitlement). This attribute is also connected to a group of attributes concerning the RP history and database administration/management.

4.2.6. Many of MS indicate[9] that they store **land use** as an attribute of the RP (see table 3). The approach to define the LPIS type of land use ranges from a classical land use or land cover classification (PL, SI) to a more agricultural activity specific methodology related to eligibility (HU, LT) or crop group (DE-Bavaria, IE). Also the level of details is different, e.g. Ireland indicates that 250 different crop types (!) are recorded inside the more generic land use types.

Table 3: Types of land use defined in LPIS, some examples from MS

Country	Type of land use recorded	Type of RP	Payment scheme
DK, UK-NI	None	PB	SPS
HU	SAPS eligible/SAPS non eligible	PB	SAPS
SE	Agricultural land only	PB	SPS
LT	- Agricultural blocks (bl1) - Build-up blocks (bl2) with small areas of cultivated land - Miscellaneous blocks (bl3) contain all the other land cover (forests, non-eligible land, etc.) - Grassland blocks (bl4) - Orchard blocks (bl5) - Non-subsidized area blocks (bl2003) are abandoned and treated as ineligible area (reference year 30/06/2003) and claimed for subsidies after 30/06/2003.	PB	SAPS
PL	1-forest; 2-tree or bushes; 3-water; 4-roads; 5-industrial area; 6-habitats; 7-other; 8-permanent grasslands; 9-orchards; 10-arable land; 11- gardens	CadP	SAPS
DE-Bavaria	farmland, permanent grassland, permanent orchard, vineyard	FB	SPS
FI	Field, forest (forestation and environmental schema) and pasture.	FB	SPS

[9] Mars ref: JRC IPSC/G03/P/PMI/pmi D(2007)(7152): Results (raw data) from the LPIS questionnaire to the EU MS (Data updated up to Nov 2006; RO and BG not included)

BEf	All types	AP	SPS
IE	Forage; Arable; Set-aside; Forestry; Other plus 250 crop types...	AP	SPS

4.2.7. Production block (PB & FB) systems use **land cover / land use** for the delineation of the RP at the initial phase of the LPIS data set creation[10]. By convention, blocks should have stable limits (i.e., do not usually vary from year to year), which are easily recognisable on the cartographic support documents that are used for the application process (orthophotos), and on the ground. For the delineation purpose limits between two homogeneous land cover patterns (e.g. forest / arable land) became only appropriate when more stable borders (e.g. infrastructure, farm facilities) could not be found. In this case, blocks are classified according to predominating land cover.

4.2.8. In 3.3.7, it was suggested that the eligible hectare attribute of the reference parcel represents a quantification of the **land cover**. By contrast, the crop group concept defined by the Comm Reg (EC) No 796/2004 Art. 49, regulates the activation of entitlements providing the basis for calculation of aid, reductions and exclusions. This clearly relates more closely to the concept of **land use** (see 3.3.4). Article 49 states that the following crop groups shall be distinguished as appropriate:

> (a) areas for the purposes of the single payment scheme,
> (b) areas for which a different rate of aid is applicable;
> (c) set-aside areas … and, where applicable, set-aside areas for which a different rate of aid is applicable;
> (d) forage areas declared for the purposes of Article 131 of Regulation (EC) No 1782/2003 (Stocking density);
> (e) forage areas other than pasture land and other than areas used for the production of arable crops, within the meaning of Article 132(3) (b) and of Article 132(3) (c) of Regulation (EC) No 1782/2003
> (f) pasture land within the meaning of Article 132(3) Regulation (EC) No 1782/2003 declared for the purposes of that Article;
> (g) areas for the purposes of the Single Area Payment scheme in accordance with Article 143b of Regulation (EC) No 1782/2003 (Single Area Payment scheme);
> (h) areas declared by producer groups in accordance with Article 15a Comm Reg (EC) No 796/2004; (hops payments)

4.2.9. The importance of land use and land cover as RP attributes is shown by fact that some national definitions of RP also contain reference to land use/land cover, for example, definition of Slovenian GERK (FB): 'GERK is graphical land use unit of farm, which is: (i) continuous piece of agricultural land; (ii) with the same land use; (iii) in use of one single farmer; (iv) on which grows usually one crop.

> Comm Reg (EC) No 796/2004 Art. 2 (15)'Use': shall mean the use of area in terms of the type of crop or ground cover or the absence of a crop;

[10] **Mars ref:** JRC IPSC/G03/P/SKA/ska D(2005)(4560): Parcel Identification System Creation and Updating. Parcel Block interpretation and numbering.

4.2.10. Another, often mentioned group of attributes relates to the life cycle of a RP in the database: it holds the object's **history**. These history attributes do not participate in calculation of payments and administrative cross-checks, but are essential for database *management and update*! As a minimum set rule there are effective date, status and cancellation / expiry date As mentioned, the attribute 'effective date' of the parcel, which from should be recognized as a core attribute, is important for relations to other registers. Some LPIS systems maintain RP attributes for previous parcel versions affected (which have area conflict with current version); status (in data management process) and free text comments (e.g. date of control, data of interview with farmer, discrepancy found, reference to decision made etc).

4.2.11. As policy reforms tend to merge other direct support schemes into the SPS, the importance of the historical dimension of the LPIS will become ever more important. Whereas there is currently only a single timestamp condition ('hectare eligible for set-aside' 3.3.8), there will be a growing need to keep track of the land that came under SPS from other schemes as, quite often, special condition apply on such land.

5. Towards the Feature Catalogue

5.1.1. The objective of this chapter is to provide draft Feature Catalogue according to the minimum requirements of the Regulations, technical recommendations and existing practices in the MS. As a template for Feature Catalogue we used one proposed by ISO19110 standard, it can be found in Annex I.

5.1.2. The components of the proposed feature catalogue maintain the full basic structure of the ISO standard. For the sake of clarity and discussion, non-essential ancillary information is included the feature types and feature attributes by means of fields that are specific to the LPIS Core Model (LCM). These specific entries are

- LCM_discussion: clarification of the definition, that strictly adheres to ISO19104 Annex 1.
- LCM_example: exemplary values from a MS implementation (not necessarily a "best practice" example)
- LCM_reference: reference to the UoD/Regulation
- LCM_comment: various comments

5.2. Feature catalogue metadata

Feature Catalogue	
Name:	Draft Feature Catalogue for LPIS
Scope:	Identification of agricultural parcels
Field of Application:	Common Agricultural Policy: Direct payments to farmers
Version Number:	1.0
Version Date:	1/12/2007
Definition Source	none
Definition Type	N/A
Producer	GeoCAP action, MARS unit (former MARS PAC action, Agriculture unit) DG JRC, European Commission
Functional Language	N/A

5.3. Feature types

5.3.1. Feature type - Reference parcel

FEATURE TYPE	
Name:	ReferenceParcel
Definition:	unit for identification and geographical localisation of agricultural parcels.
Code:	RP1000
Feature Operation Names:	'caps area of AP(s)' – RP area is equal or more than sum of areas of declared AP(s) inside of RP'spatial overlap' – AP is inside of RP+ gets digitized area' – gets area from geometry'gets farmer's area' – gets sum area claimed by framer(s) from aid application database
Feature Attribute Names11:	M- uniqueID; referenceArea; effectiveDate; + C – digitizedArea; farmedArea
Feature Association:	RefrenceAP + UpdateDocument+ ParcelHistory;
Subtype of:	[Abstract Feature type]
LCM_discussion	May contain one or more agricultural parcels and may be cultivated by one or more farmers (or producers association). Does not necessarily cover a territory nationwide, but overlaps are not allowed.
LCM_reference	2004R0796 Art 2. (26)
LCM_example	
LCM_comment	Generalisation of reference parcels: Cadastral parcel, Agricultural parcel, Farmer's block, Physical block

Feature attribute	
Name:	uniqueID
Definition:	National-wide unique alphanumerical code -identifier
Code:	A1000
Value Data Type:	CharacterString
Value Measurement Unit:	n/a
Value Domain Type:	0= 'not enumerated'
Value Domain:	
LCM_discussion	In practice this codes are sometimes attributes regionally
LCM_reference	2004R0796 Art 2. (26)
LCM_example	SE: Kalmar / Farmer H04038 / 41A
LCM_comment	

Feature attribute	
Name:	referenceArea
Definition:	'maximum eligible area' or 'area officially known' which caps the area

[11] M – mandatory; O – optional; C - conditional

	of land that can be claimed as established when the RP object is created.
Code:	A2000
Value Data Type:	Float
Value Measurement Unit:	ha, 2 decimal points
Value Domain Type:	0= 'not enumerated'
Value Domain:	
LCM_discussion	The regulation consistently uses one tenth of a ha as resolution, indicating a practical resolution
LCM_reference	2004R0796 Art 24.1.c
LCM_example	42.5 ha
LCM_comment	

Feature attribute	
Name:	effectiveDate
Definition:	date when new version or new data about RP come in to force with respect to third parties (e.g. Paying Agency) and registers.
Code:	D1000
Value Data Type:	Date
Value Measurement Unit:	
Value Domain Type:	0= 'not enumerated'
Value Domain:	
LCM_discussion	
LCM_reference	
LCM_example	2005/01/01
LCM_comment	

Feature attribute	
Name:	digitizedArea
Definition:	calculated area based on the co-ordinates of the boundary points.
Code:	A2100
Value Data Type:	measure
Value Measurement Unit:	ha, two decimal points
Value Domain Type:	0= 'not enumerated'
Value Domain:	
LCM_discussion	This area derived from geometry of GIS feature or measured in the field. This area is not always exactly equal to the referenceArea
LCM_reference	
LCM_example	42.67 ha
LCM_comment	

Feature attribute	
Name:	farmerArea
Definition:	Sum of areas claimed inside of RP.
Code:	A2200
Value Data Type:	Float
Value Measurement Unit:	ha
Value Domain Type:	0= 'not enumerated'
Value Domain:	
LCM_discussion	Less or equal to referenceArea

LCM_reference	
LCM_example	
LCM_comment	
Feature Association	
Name:	ReferenceAP
Inverse Relationship:	n/a
Definition:	references AP inside of RP through unique identifier of RP
Code:	AS1000
Feature Types Included:	Reference parcel; Agricultural parcel
Order Indicator:	1= ‘ordered’
Cardinality:	1 : *
Constraints:	
Role Name:	
LCM_discussion	
LCM_reference	Comm Reg (EC) No 796/2004 Art 23.1.c and Art 24.2
LCM_example	
LCM_comment	
Feature Association	-to be elaborated
Name:	ParcelHistory
Inverse Relationship:	
Definition:	
Code:	
Feature Types Included:	
Order Indicator:	
Cardinality:	
Constraints:	
Role Name:	
LCM_discussion	
LCM_reference	
LCM_example	
LCM_comment	
Feature Association	-to be elaborated
Name:	UpdateDocument
Inverse Relationship:	
Definition:	
Code:	
Feature Types Included:	
Order Indicator:	
Cardinality:	
Constraints:	
Role Name:	
LCM_discussion	
LCM_reference	
LCM_example	
LCM_comment	

5.3.2. Subtype (specialisation) of Reference Parcel: Cadastral Parcel

FEATURE TYPE	
Name:	RP::CadParcel
Definition:	single area of land or more particularly a volume of space, under homogeneous real property rights and unique ownership (WPLA, WG-CPI, 2006).
Code:	RP1001
Feature Operation(s):	
Feature Attribute(s):	M – uniqueID; referenceArea; effectiveDate; + O - parcelAddress; parcelName; landUse; parcelOwner; farmerID
Feature Association(s):	
Subtype of:	ReferenceParcel
LCM_discussion	Basic unit of the Cadastre system – the register under responsibility of MS governments with purpose to provide their citizens stability and security in real property ownership. + Homogeneous nationwide coverage, overlaps are not allowed. Contains agricultural and non-agricultural land. + Contains agricultural and non-agricultural land. May contain one, many or only part of agricultural parcel
LCM_reference	Comm Reg (EC) No 796/2004 Art 6.1
LCM_example	
LCM_comment	Should it have attributes to identify areas of cross compliance, farming limitations LFA?? Or topography (average slope, altitude, exposure)??

5.3.3. Subtype (specialisation) of Reference Parcel: Agricultural Parcel

FEATURE TYPE	
Name:	RP:AgrParcel
Definition:	Reference parcel containing only one agricultural parcel - continuous area of agricultural land on which a single crop group is cultivated by a single farmer.
Code:	RP1002
Feature Operation(s):	
Feature Attribute(s):	M – uniqueID; referenceArea; effectiveDate + O – farmerID; perpastreID; vinID; paymentType; landUse; cropType; farmingMode; farmingLimitation; isLFA - averSlope, averAltitude, averExpositon
Feature Association(s):	FarmedBy;
Subtype of:	ReferenceParcel
LCM_discussion	
LCM_reference	
LCM_example	
LCM_comment	
Feature Association	-to be elaborated
Name:	FarmedBy
Inverse Relationship:	
Definition:	
Code:	
Feature Types Included:	AP or RP and Farmer

Order Indicator:	
Cardinality:	
Constraints:	
Role Name:	

5.3.4. Subtype (specialisation) of Reference Parcel: Farmer's block

FEATURE TYPE	
Name:	RP:FarBlock
Definition:	Reference parcel which is grouping together a number of neighbouring agricultural parcels cultivated by the same farmer.
Code:	RP1003
Feature Operation(s):	
Feature Attribute(s):	M – uniqueID; referenceArea; effectiveDate; + O – farmerID; farmingMode; areaOfFI; isLFA + - perpastureID; vinID; landUse;
Feature Association(s):	FarmedBy;
Subtype of:	ReferenceParcel
LCM_discussion	
LCM_reference	
LCM_example	
LCM_comment	
Feature Association	-to be elaborated
Name:	Farmed By
Inverse Relationship:	
Definition:	
Code:	
Feature Types Included:	
Order Indicator:	
Cardinality:	
Constraints:	
Role Name:	

5.3.5. Subtype (specialisation) of Reference Parcel: Physical block

FEATURE TYPE	
Name:	RP::PhyBlock
Definition:	Reference parcel which is a continuous area of agricultural land and grouping together a number of neighbouring agricultural parcels cultivated by one or more farmer(s) and delineated by most stable boundaries.
Code:	RP1004
Feature Operation(s):	
Feature Attribute(s):	M – uniqueID; referenceArea; effectiveDate; O - landUse; isLFA

Feature Association(s):	
Subtype of:	ReferenceParcel
LCM_discussion LCM_reference LCM_example LCM_comment	

5.3.6. Attributes of specialisations – attributes of particular subtypes of reference parcel can be applicable for one or many subtypes. So, in order to avoid repetitions we decided to list all of them in alphabetical order.

Feature attribute	
Name:	averAltitude
Definition:	Average altitude of the parcel
Code:	A3810
Value Data Type:	Integer
Value Measurement Unit:	meters
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

Feature attribute	
Name:	averExposition
Definition:	Average exposition of the parcel
Code:	A3820
Value Data Type:	Integer
Value Measurement Unit:	degree
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

Feature attribute	
Name:	averSlope
Definition:	Average slop of the parcel
Code:	A3830
Value Data Type:	Integer
Value Measurement Unit:	Percentage
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

Feature attribute	
Name:	cropType
Definition:	Type of the crop which occupies AP
Code:	A3200
Value Data Type:	CharacterString
Value Measurement Unit:	
Value Domain Type:	1="enumerated"

Value Domain:	Label	Code	Definition
	Drum wheat	1001-1	
	Other wheat	1001	
	Ray	1002	
	Barley	1003	
	Oats	1004	
	….	….	

Feature attribute	
Name:	farmerID
Definition:	Identification number of farmer from register of farmers in IACS
Code:	A3400
Value Data Type:	CharacterString
Value Measurement Unit:	N/A
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

Feature attribute*	
Name:	farmingLimitation
Definition:	Area of the parcel when SMR and GAEC should be respected
Code:	A3100
Value Data Type:	Float, 2 decimal points
Value Measurement Unit:	hectares
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A
*Note:	Can be defined differently for different types of cross-compliance

Feature attribute			
Name:	farmingMode		
Definition:	Attribute is applicable if national certification is required for organic farming or if agro-environmental measures are applied		
Code:	A3500		
Value Data Type:	CharacterString		
Value Measurement Unit:	N/A		
Value Domain Type:	1="enumerated"		
Value Domain:	Label	Code	Definition
	conventional	0	
	organic	1	
	….	….	

Feature attribute	
Name:	isLFA
Definition:	RP parcel is situated inside of Less Favoured Areas

Code:	A3600
Value Data Type:	Boolean
Value Measurement Unit:	
Value Domain Type:	
Value Domain:	Label Code Definition non-LFA 0 is-LFA 1

Feature attribute	
Name:	landUse
Definition:	Usage of land
Code:	A3700
Value Data Type:	CharacterString
Value Measurement Unit:	N/A
Value Domain Type:	1="enumerated"
Value Domain:	Label Code Definition Housing 1000 Industrial 2000 Forestry 3000 Swampy meadows 3100 …… …… Arable land 4100 Forage 4200 Permanent pasture 4210 Vineyard 4300 Olive groves 4310 Orchards 4320 Greenhouses 4400 …. …..

Feature attribute	
Name:	parcelAddress
Definition:	Postal address of cadastral parcel
Code:	A4100
Value Data Type:	CharacterString
Value Measurement Unit:	N/A
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

Feature attribute	
Name:	parcelName
Definition:	name of the (cadastal) parcel as locally known
Code:	A4200
Value Data Type:	CharacterString
Value Measurement Unit:	N/A
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

Feature attribute	
Name:	parcelOwner
Definition:	Natural or legal (institution or organisation) person who has exclusive right on cadastral parcel in question
Code:	A4300
Value Data Type:	Name
Value Measurement Unit:	N/A
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

Feature attribute	
Name:	paymentType
Definition:	Payment type applied for AP/RP in question
Code:	A5100
Value Data Type:	CharacterString
Value Measurement Unit:	N/A
Value Domain Type:	1="enumerated"
Value Domain:	Label Code Definition Arable land 1100 Permanent pasture 1200 Fruits and vegetables 2100 Cotton 2200 Tobacco 2300 Dried grapes 2400 Olive trees 2500 Vineyards 2600 Nuts 2700 AEM 3100 Forestry (aforestation mesures) 3200 …. …..

Feature attribute	
Name:	perpasuteID
Definition:	ID of permanent pasture register
Code:	A5100
Value Data Type:	CharacterString
Value Measurement Unit:	N/A
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

Feature attribute	
Name:	vinID
Definition:	ID of vineyards register
Code:	A5200
Value Data Type:	CharacterString
Value Measurement Unit:	N/A
Value Domain Type:	0= ‘not enumerated’
Value Domain:	N/A

6. A first cut Core LPIS Model and Application Schema

The following first cut LPIS Core Conceptual model is intended to be a technology-neutral model that can form the basis for an interchange format using evolving information technology (e.g. XML, GML). It is a generic model of requirements and concepts defined in the CAP regulations with specific emphasis on concepts related to the spatial objects included in the IACS. It consists of two parts: (i) a Use Case and Requirements Models and (ii) an Application Schema. Both models and the Application Schema are documented by means of UML diagrams, basic elements, notations and key glossary of which can be find in Annex II. For developing these diagrams and elements, Enterprise Architect software free evaluation version was used.

6.1. Requirements' and Use Case models

6.1.1. As it was discussed in Chap. 3 IACS-LPIS has set of requirements either by laid down the EU Regulations or imposed on it by recommendations (guideline) documents and technical constrains. Requirements establish an agreement between all stakeholders on to what the system should do, define system scope and boundaries, provide a basis for technical content and means. The way that modelled system meets the requirement is main assessment criteria for efficiency. Unfortunately, requirements are not stable – stakeholder goals evolve, triggering changes in the system function rules; technology evolves at en ever faster pace. As a result, requirements are needed to be recorded, traced and prioritized - in other words managed formally in order to master them. The way of documentation of system requirements in modelling process –called requirements model- is described below.

6.1.2. In our model, we classified requirements in two ways: (i) by the requirement area or where it laid down, so there are REG- regulatory requirements and REC-recommendations; and by requirement type, which are FUN–functional or TEC-technical. Thus, both REG and REC requirements can be either functional, that expect some functionality from the system or technical that specify appropriate means or constrains to system functionality. Requirements in our model (Figure 8) have identifier that composes from combination of requirement area, sequential number, and requirement type. They are combined into packages: Implementation, Quality, Functionality, Extensibility, Standards.

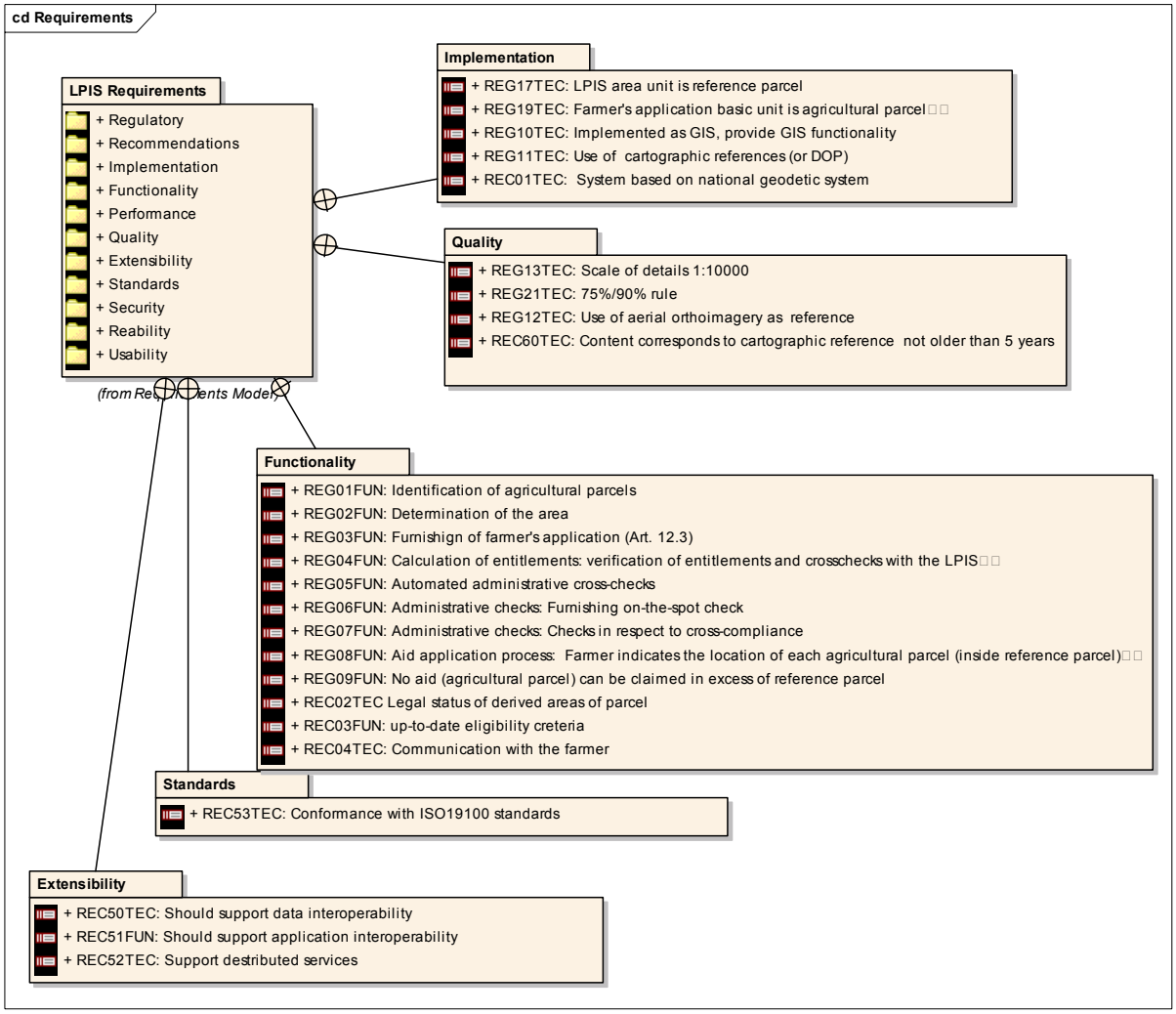


Figure 8 Model of requirements

6.1.3. In order to further model requirements on the IACS-LPIS a ‘Use Case’ method was applied. A “Use Case Model” represents a usage pattern on modelled system, and thus it describes the desired functionality of the system based on requirements. Each Use Case (see Annex II) represents a discrete unit of interaction between a user and the system, it is a single unit of meaningful work, for example logging of application, register within the system etc. A high level Use Cases are related to 'actors', human or machine entity that interacts with the system to perform meaningful work - a contract that will deliver some action or provide some value to the actor and system. Use Cases are not elementary operations, but end-to-end high-level processes covering several stages, transactions, operations etc.. Some Use Cases representing particular meaningful part of the high-level process may be 'included' into another Use Case's functionality or 'extend' another Use Case with its own behaviour. In case of repetitive action, which can be part of different high-level Use Cases these smaller procedures can be defined as ‘fragments’.

6.1.4. Figure 9 presents the generic level Use Case diagram for management of the EU subsidies. From the overview of the domain of the EU subsidies provided in chap. 2, we can assume that the LPIS is not 'just a system handling only geographic information' within IACS, but together with other registers the application field covers a legally meaningful relationship amongst farmer, institutions and land. The 'Farmer' is the primer actor benefiting from the use of the system; he triggers all the system via logging aid application. Whereas 'Paying agency' and 'LPIS custodian' are participating actors necessary for system counteract. The Use Cases are main functions with the Regulations impose on IACS as a system.

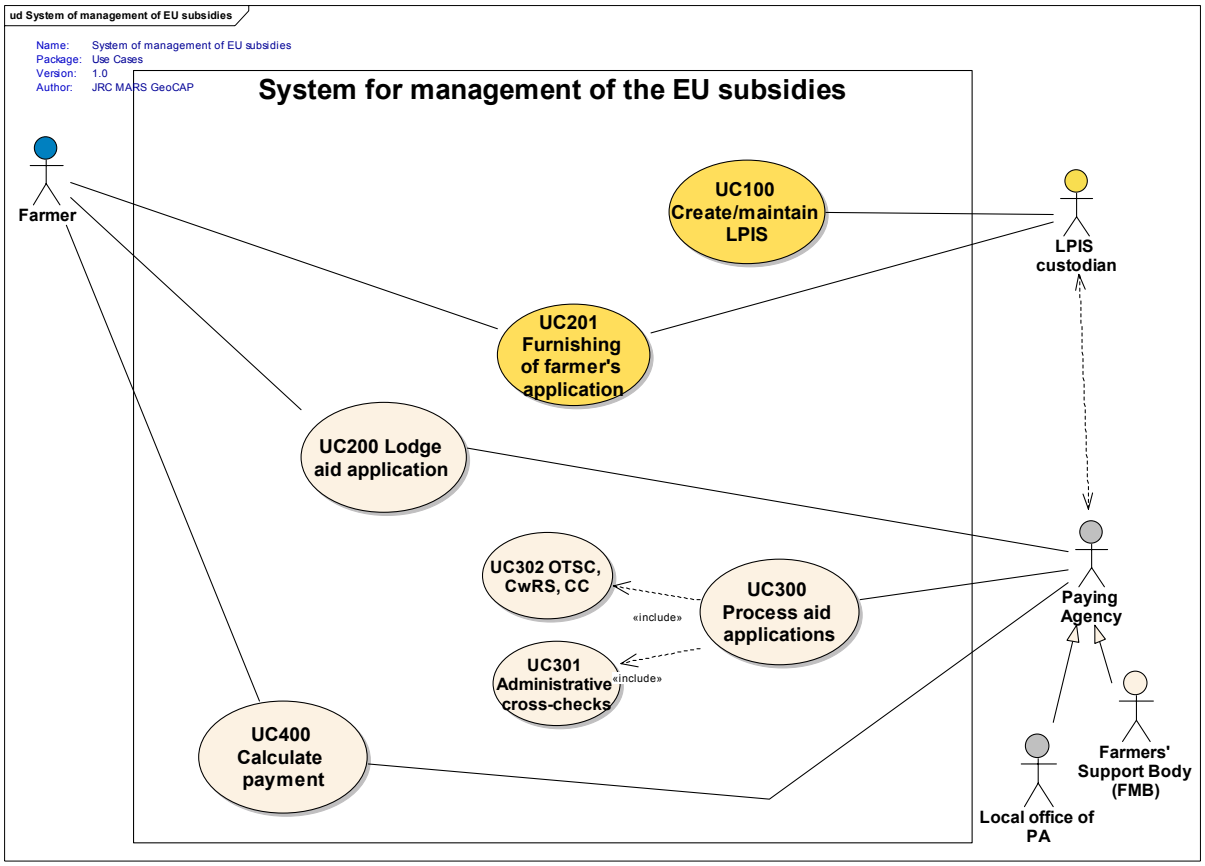


Figure 9. Use Case: System for management of the EU subsidies and actors

6.1.5. As it followed from analysis of chap. 3.2 that integrated in table 1, the LPIS is sub-system of IACS system and has functions either related to the main actor - 'Farmer' or to IACS system. Figure 10 illustrates the functional view of LPIS sub-system, where main actions of LPIS –location of agricultural parcel, determination of the area, and provision of spatial reference for some of CC-serve different IACS Use Case.

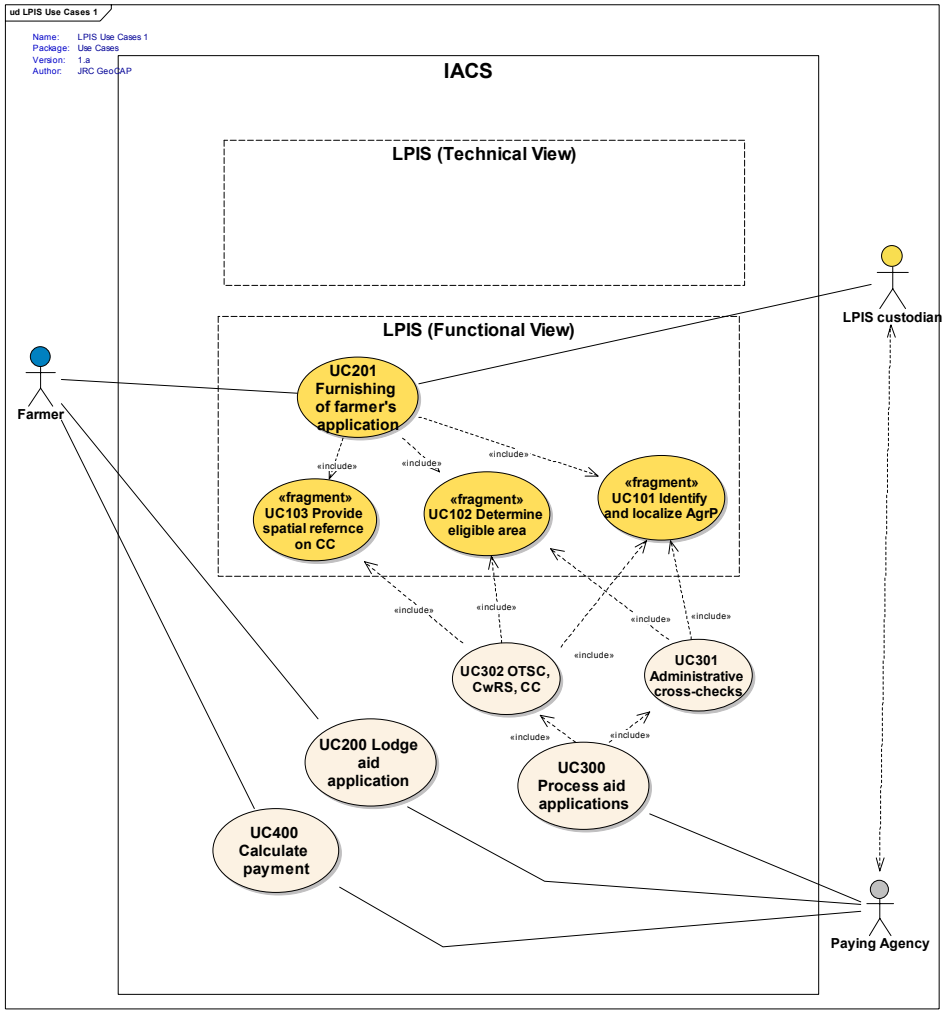


Figure 10. LPIS Use Cases: Functional view.

6.1.6. Apart of Use Cases which participate in the process of administration of aid applications, LPIS contains some technical operations and procedures related to system maintenance and presented in Figure 11. There is only one player here – 'LPIS custodian'- interacting with the system. The Use Cases in this compartment do not have direct influence on the structure of information, but on its quality and currency.

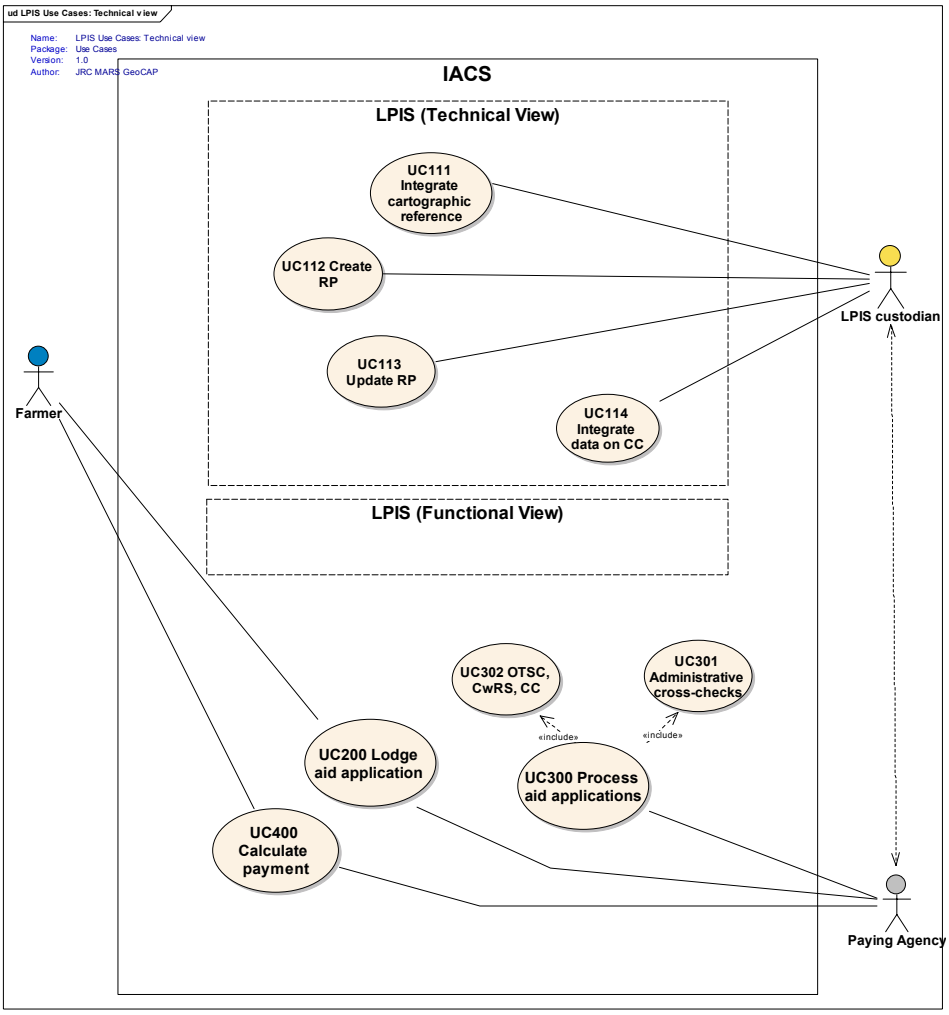


Figure 11. LPIS Use Cases: Technical view

6.1.7. Use cases provide the formal description (scenario) which defines: (i) at which circumstances is the Use case invoked; (ii) who and how (actors) participate in the use case. Two following pictures illustrate in more details Use Case 201 ‘Furnishing of farmer’s application”: figure 12a explains relalisation of requirements in the use case and figure 12b provides textual description.

a) b)

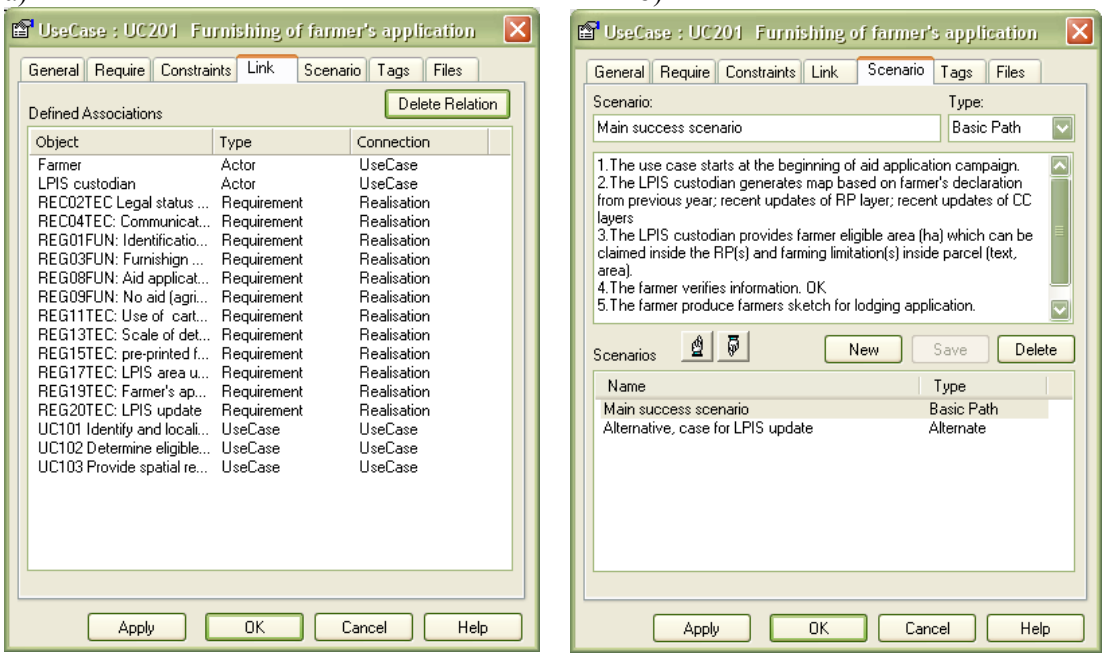


Figure 12. a) Realization of requirements by Use Case 201 and b) textual description

6.2. Application Schema

6.2.1. An Application Schema provides the formal description for the data structure and data content. In addition to the formalized spatial concepts described in chap.2, the Application Schema contains spatial and non-spatial features which purpose is to achieve appropriate level of functionality, accuracy and database management. An Application Schema should conform to the ISO 19101 Reference Model and be based on the Rules for Application schema defined in ISO 19109. A modular approach is adopted for the integration of an application schema with standard schemas of ISO 19100 series. The model is organized into several interrelated packages, which allow handling the model in smaller, more comprehensive parts. Another advantage of packages is that the process of development can be split into more or less independent parts. This document covers the schema for the core dataset of the LPIS– layer (the Reference Parcel) and leaves cross-compliance and control aspects for the feature untouched. It does however create the opening for discussion on update package. As LPIS is so closely interrelated with other registers of IACS, the boundaries of the model should also include the relations towards relevant classes of other IACS modules. The colour code of the packages (figure 13) corresponds to the colours of feature type classes in the Application Schema: yellow for the Aid Application register, pink for the Farmers' register, green for the geospatial objects of ISO 19100, beige for the LPIS as described in this document. White packages are LPIS packages which are not covered in this document.

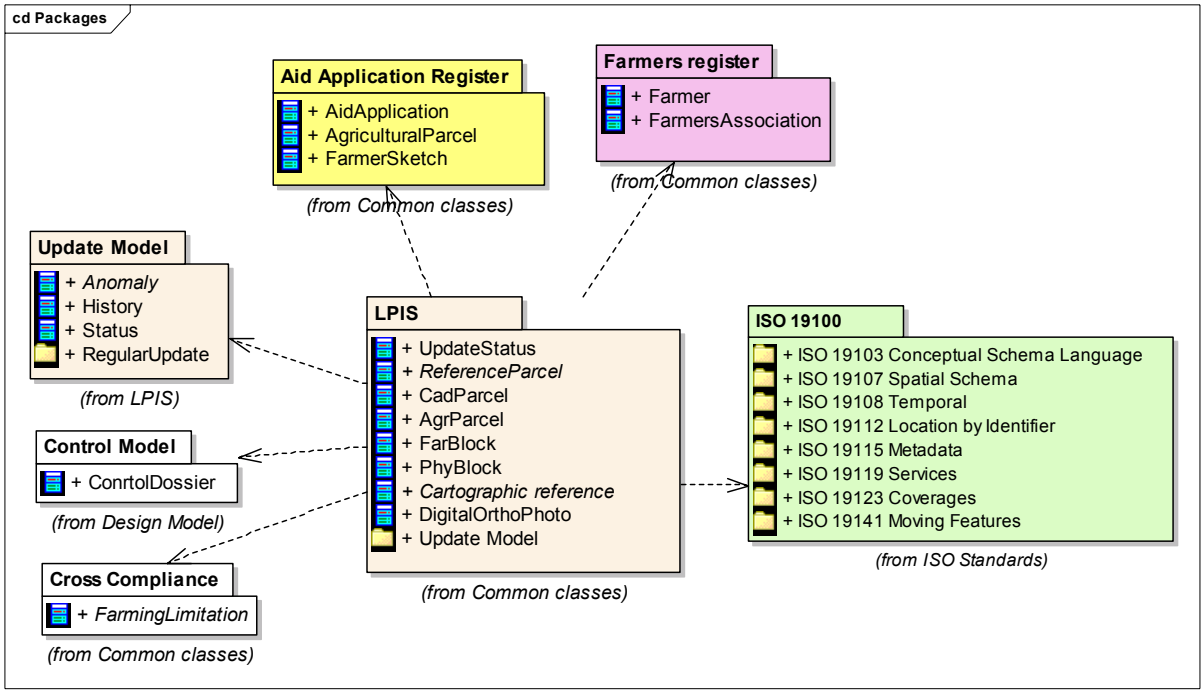


Figure 13. Packages diagram

6.2.2. It should be underlined that it was not the intention of the authors to propose an exhaustive model that covers every aspect of the system. The boundaries of the first-cut model could be extended by

domain experts via further analysis and development. So, candidate packages that are related to, but outside of the core LPIS model can include:

- spatial (coordinate) reference system;
- digital orthophotos,
- satellite imagery,
- DEM and topography

6.2.3. Figure 14 represents the logical business model of the main concepts, described chap. 2. All basic concepts are represented as classes. The key concept 'Single Application' is related to a farmer and an agricultural parcel he cultivates. Each Agricultural parcel shall be located inside of one of Reference parcel of the LPIS (1:1), but on the other hand each RP can contain none, one or several actively declared AP. Furthermore, each RP can have none, one or several farming limitations from cross-compliance measures. Two classes in the diagram below - *ReferenceParcel* and *FarmingLimitation* (area of farming limitations)- are abstract classes; there are no object instances of those classes. They have instead a number of specialisations or subtypes that hold the actual features. In UML notation, abstract classes are indicated in *italic script*. The specialisations for class *ReferenceParcel* accommodate for the type of Reference parcel in use. For the *FarmingLimitation* class there should have two additional abstract specialisations: one for SMR and one for GAECs and both these specialisations are further differentiated by type of Directive or by GAEC imposing particular farming restrictions. The *ReferenceParcel* class is refined in figure 15.

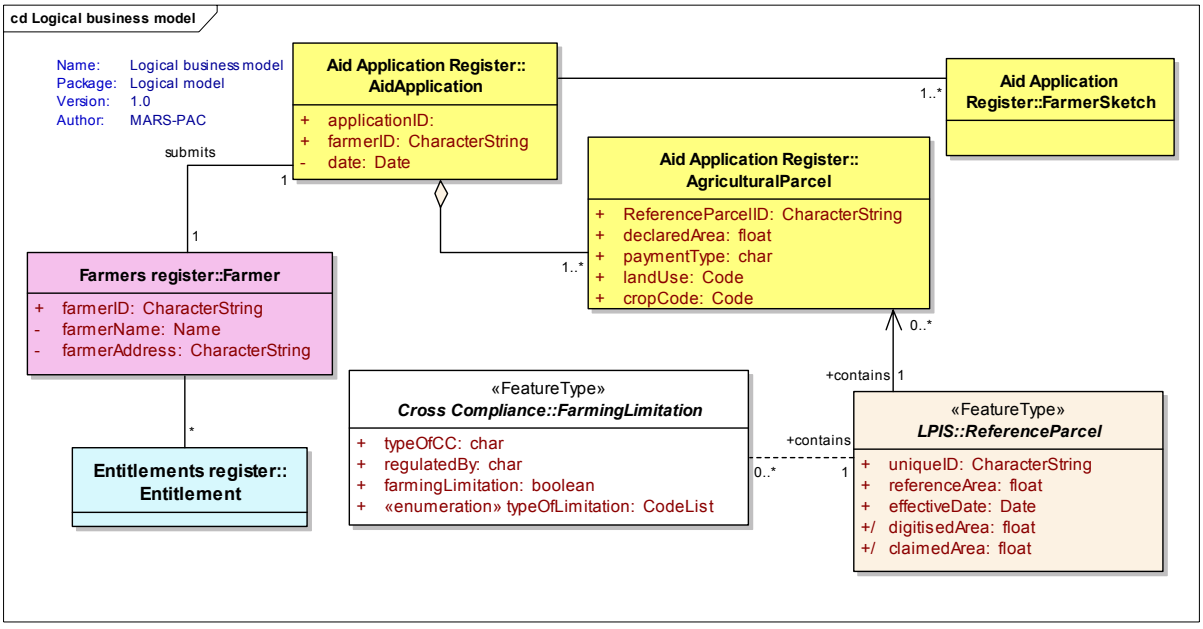


Figure 13. Logical business model

6.2.4. The logical data model which corresponds to logical business model is depicted in Figure 14. Classes *ReferenceParcel* and *FarmingLimitation* have dependency relation between each other:

every Reference parcel can have none, one or several types of areas of cross-compliance, and latter can be entirely located or overlapped with the RP in question. Both classes are spatial features and therefore specialisations (sub-types) of coordinate geometry type POLYGON as defined in ISO 19107 standard '*Spatial Schema'*. On implementation level, other types of geometry stereotypes can be chosen according to technical solutions (e.g. software ability to support topological relations). The feature class *CartographicReference* does not correspond to any of the concepts of administration of subsidies, but it is explicitly required by the Art. 20(1) of the Council Reg (EC) No 1782/2003 calling for (i) improvement of communication level with the farmer and (ii) appropriate currency of LPIS information. It can be represented by digital orthophoto imagery or cartographic map product at scale 1:10000 or more detailed. Since a majority of the MS chose for orthophoto imagery, class DigitalOrthoPhoto is included as sub-type of *CartographicReference* class and it is an implementation of the ISO standard 19123 *Coverages*. In the case of a topographic map, the original application schema of that cartographic product should be aggregated with the LPIS schema.

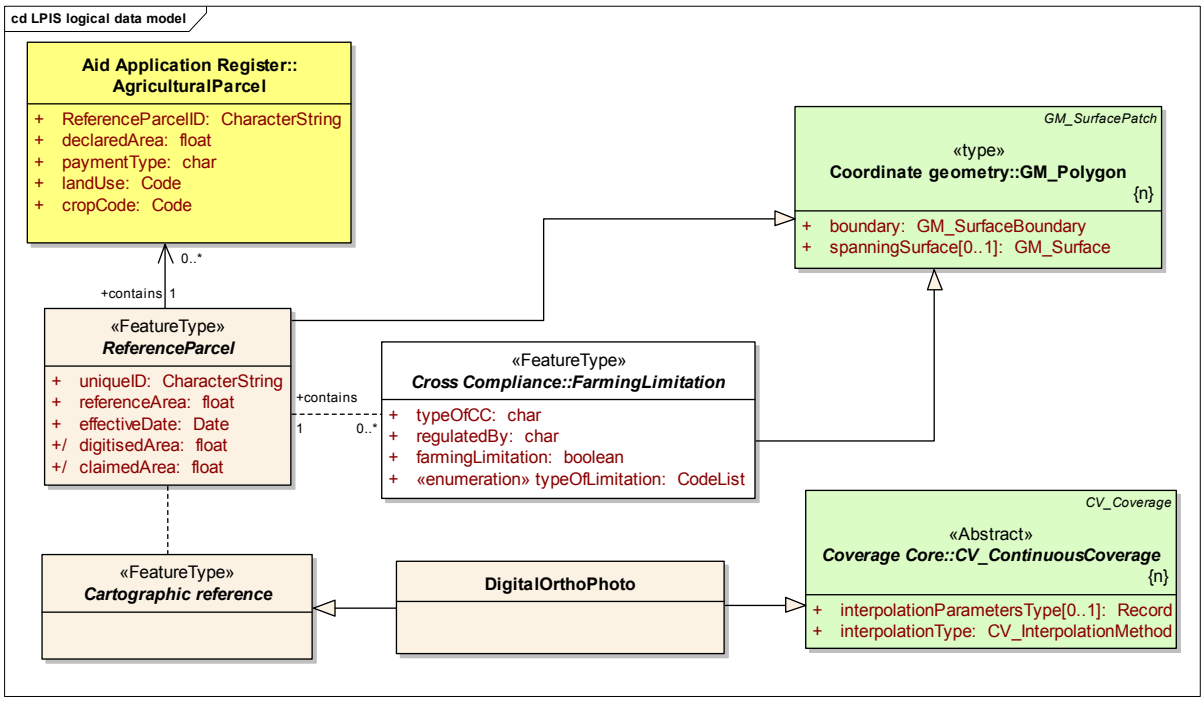


Figure 14. Logical data model

6.2.5. As was mentioned before, in our model *ReferenceParcel* is an abstract class which has four specialisation classes (figure 14) corresponding to different types of RP in use: CadParcel, AgrParcel, FarBlock and PhyBlock. Names of the features are conventional names currently in use, there is no semantic associations between two types of 'parcel' and 'block' from the model point of view They inherit all the properties from parent object *ReferenceParcel,* such as uniqueID, referenceArea, effectiveDate plus operations and derived attributes concerning digitizedArea and farmedArea. Constrain {xor} indicates that on one type of Reference parcel shall be used in LPIS.

In table 2, the definition of AgrParcel is widened to become the definition of FarBlock which in turn is further broadened to define the PhyBlock. In the LCM this behaviour is represented as PhyBlock being a generalization of FarBlock and FarBlock being a generalisation of AgrParcel. As a result, the specialisation classes FB and AP inherit properties from their respective generalisation classes PB and FP. However, please note that such conceptual generalisation does not mean that feature instances (the actual parcels) of any of the respective classes can be nested or can migrate between the different sub-types

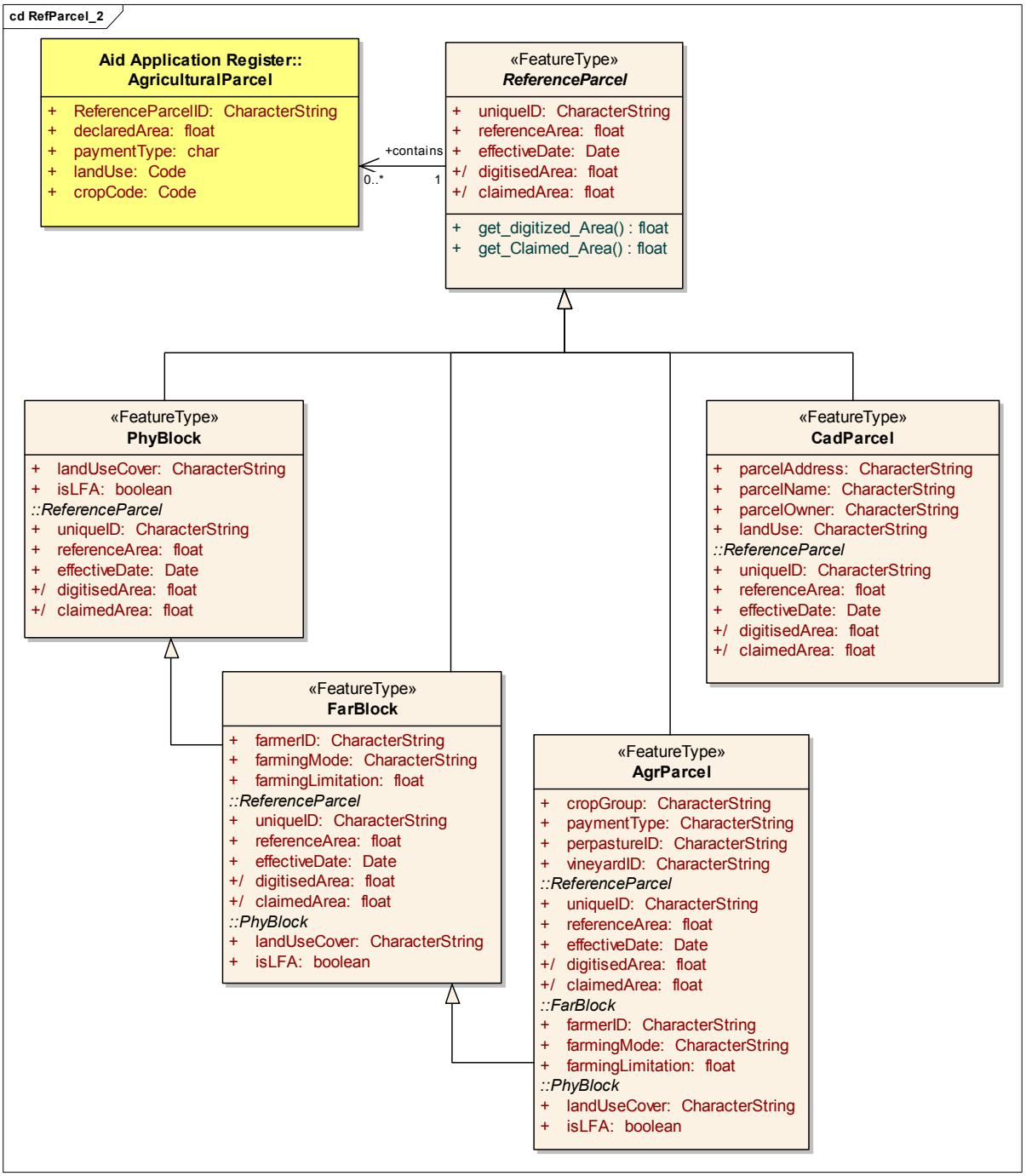


Figure 15. Specialisations of class *Reference parcel*

6.3. Life cycle of the Reference parcel

6.3.1. The previous section of this chapter focused on the class diagrams describing structural aspects of the LPIS. However, features in datasets are continually being created, updated and merged/subdivided as the pattern of land cultivation is being changed by agricultural activities. Therefore, besides the data structure and features' static properties the dynamic aspects of processes inside the LPIS should be accommodated by some specific classes. As the LPIS needs to meet functional and quality requirements at all times, this is triggering a continuous process of update and refinement of the datasets. Additionally to obligations laid down in the CAP regulations, geoinformation standards to be concern are (i) the ISO 19113 standard which describes *Quality principals* for geographic datasets and (ii) the ISO 19114 standard providing methodology for *Quality evaluation procedures.*

6.3.2. The ISO 19100 series standards mentioned above establish *data quality elements* and *sub-elements* (table 4) for evaluation and documentation of quality of datasets. Each element and sub-element can be measured in categorized or quantitative values; therefore the set of thresholds and pass-values for data quality evaluation should be defined as quality requirements for each specific dataset. Dataset *conformance* with specified requirements is established when all data quality elements for dataset in question passed the respective threshold values.

6.3.3. Any detected failure to meet quality requirements creates an evidence of non-conformity or anomaly. An anomaly is the observed deviation from quality requirements which exceeds a threshold value pre-defined in the data specification. An anomaly can be either an obvious error due to poor mapping or poor data processing or a change in 'real world' conditions. In the LPIS the evidence of an anomaly that will trigger the update of the dataset can originate from (i) the process of the check of the pre-printed map by farmer during lodging of aid application, from (ii) the LPIS regular update against new orthophoto imagery or from (iii) control observation during the spot checks.

6.3.4. Whereas anomalies hold evidence of non-conformity to the data specifications, the stability of these specifications can unfortunately not be guaranteed. As our concept about 'real world' changes, e.g. by a change in policy goals and consequently in the Regulations, this could potentially generate a mass of anomalies, not caused by mapping, data processing or terrain changes. To bring the LPIS back in conformity with its revised specifications is called the upgrade process. However, the concept of anomaly remains equally relevant.

Table 4.

Data Quality Element ISO 19113	Data Quality Sub-elements ISO 19113	Example of an anomaly (identified non-conformity)	Cause of such non-conformity
completeness	commission omission	excessive data (planning) missing data	poor mapping erratic processing
logical consistency	conceptual consistency codelist consistency format consistency topological consistency	data structure error	poor data processing
positional accuracy	absolute or external accuracy relative or internal accuracy gridded data position accuracy	accuracy error/	poor mapping
thematic accuracy	classification correctness non-quantitative attribute correctness quantitative attribute accuracy	classification error	change of concept/ poor mapping / processing
temporal accuracy	accuracy of a time measurement temporal consistency temporal validity	outdated value	terrain change

6.3.5. For all abovementioned reasons an anomaly should be modelled as separate class within the model. The solution we propose is illustrated by figure 15: the abstract class *Anomaly* has three sub-classes according to causes of the anomaly and resulting attributes, describing a type of non-conformance with its specific quality element/ sub-element. The temporal aspect can be covered by attributes of *submission date* (in case of farmer's proposal for change), *registration date*, *date of field check,* etc. Due to the fact that one anomaly can affect more than one parcels e.g. in case of change of the topographic situation (new road), it should have its own identifier and in cases where the indirect geo-referencing proves impossible, its proper geometry (e.g. new water reservoir).

6.3.6. *The Anomaly* class is connected to the *ReferenceParcel* class through an association UpdateStatus which contains information related to the live-cycle of the RP current version. An attribute currentStatus of the association is storing the stage of the management procedure it currently is. A code list of this attribute enumerates: proposal (for change), farmer contacted, approved, disapproved etc…. The UpdateStatus association may also contain as an attribute the name of the staff member responsible for handling the case and his/her comments relevant to procedural issues.

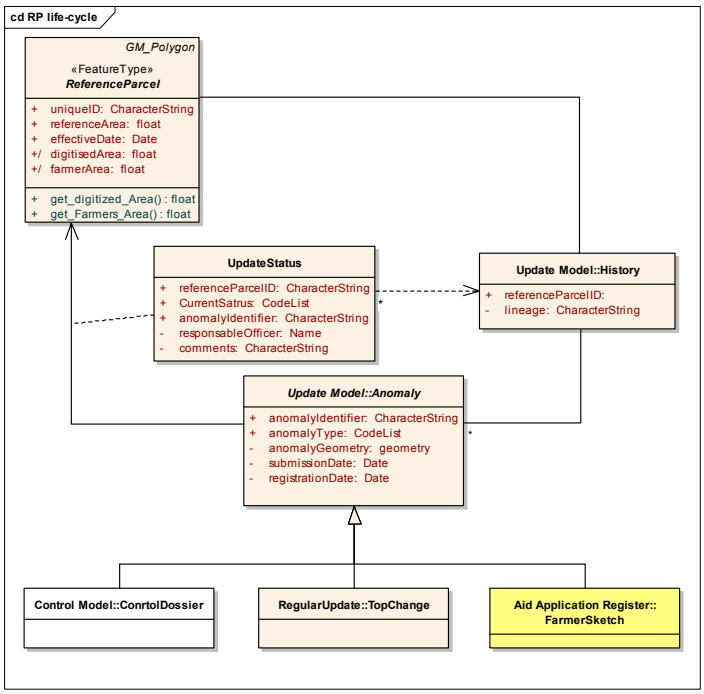


Figure 16. Classes corresponding to management of reference parcel update in LPIS.

6.3.7. The class History from the Update package represents the data quality overview element providing general, non-quantitative information on the RP. It holds the lineage of the spatial object RP, which recounts its history from the initial creation of the first version (creation of particular identifier) through all intermediate versions to its current form. It should contain records on all transformations of spatial object, accompanied by the date when transition occurred, identity the anomaly the action was triggered by as well as the name responsible for update and approval. Additionally it may contain information on the parentage between spatial objects and identify other objects which were affected by the change. This History class from the first-cut model needs to be elaborated in more detail.

6.4. Aggregated Application Schema

6.4.1. After having described main construction blocks of the Application Schema, all presented classes and relations can be aggregated in an overview in one modular schema. Figure 16 combines features presented in figures 13, 14 and 15 and forms the 'complete' first-cut modular schema of the core LPIS model..

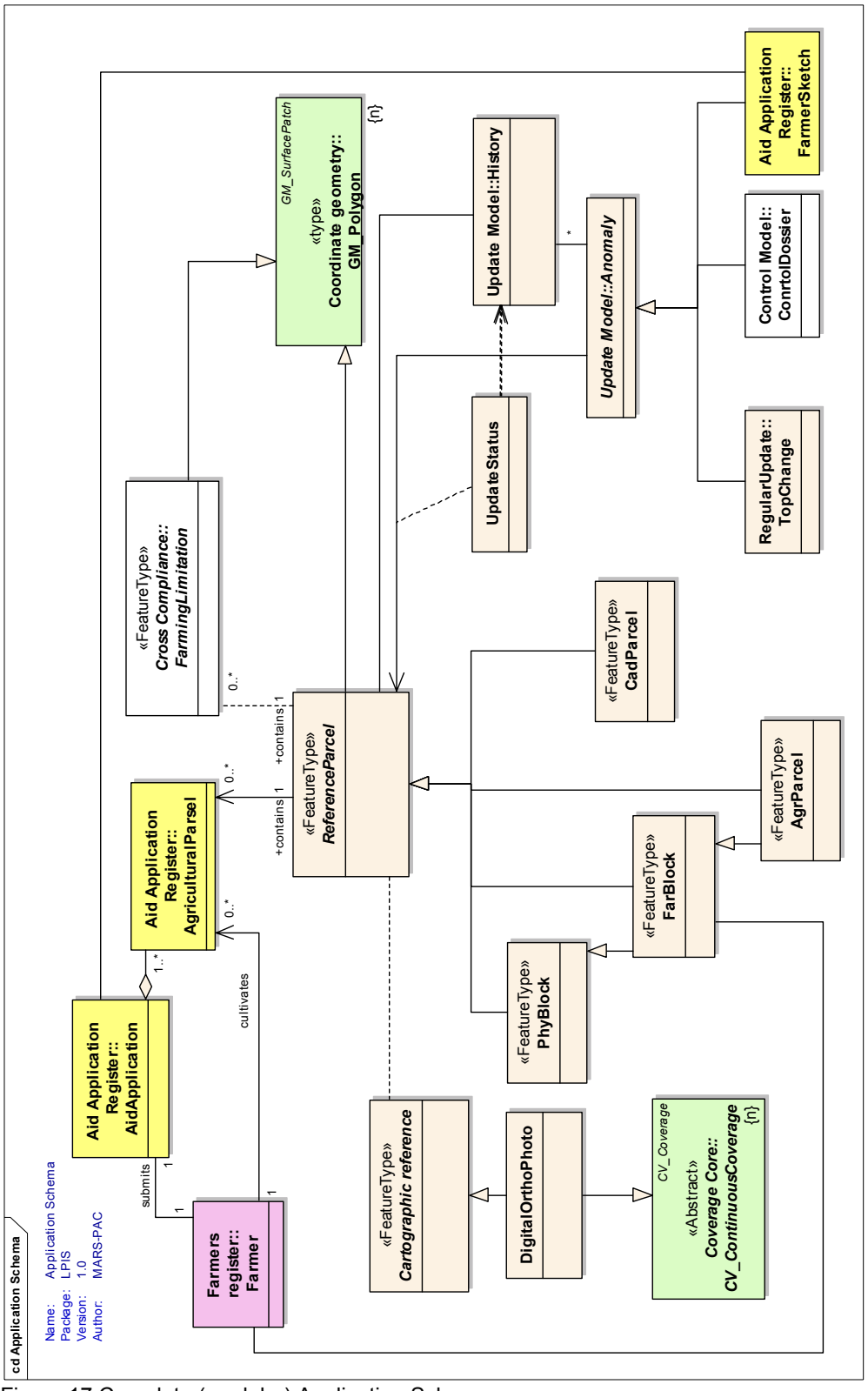


Figure 17 Complete (modular) Application Schema

Annex I. Template for Feature Catalogue

(adopted after ISO 19110, 2001)

M – The section or element is mandatory: it shall be included in the feature catalogue.
C – The section or element is conditional: the condition is stated as a question. If the answer to the question is yes, the section or element shall be included in the feature catalogue.
O – The section or element is optional: if a section is included in the feature catalogue, mandatory elements of the section shall also be included.

Catalogue element	Definition	Obligation/ condition	Occurrence	Data type	Domain
Feature Catalogue	**Identification and contact information for feature catalogue**	**M**	**1**		
Name	Name for feature catalogue	M	1	Text	Free text
Scope	Subject domain(s) of feature types defined in feature catalogue	M	N	Text	Free text
Field of Application	Description of kind(s) of use to which the feature catalogue may be put	O	N	Text	Free text
Version Number	Version number of feature catalogue	M	1	Text	Free text
Version Date	Effective date of feature catalogue	M	1	Text	Free text
Definition Source	Bibliographic reference, including author, title, edition, publisher, place of publication, and date of publication, to a published external source of definitions for information included in feature catalogue	O	N	Text	Free text
Definition Type	Indicates the category of catalogue information to which each given definition source applies: feature type names, feature operation names, feature attribute names, feature attribute value labels, feature attribute value data types, feature association names, feature type codes, feature attribute codes, feature attribute value codes, and (or) feature association codes.	O	N	Text	Free text
Producer	Name, address, country, and telecommunications address of person or organization having primary responsibility for the intellectual content of the feature	O	N	Text	free text (see ISO 3166- 1 for country codes)

	catalogue				
Functional Language	Notation system used for formal definition	C/ Feature operation formal definition occurs in feature catalogue?	1	Text	Free text
Feature Type	**Abstraction of real world phenomena with common properties**	**M**	**N**		
Name	Text string that uniquely identifies the feature type within the catalogue	M	1	text	free text
Definition	Definition of the feature type in a natural language	C/ Definition not provided by definition source?	1	text	free text, max 250 words
Code	Code that uniquely identifies the feature type within a catalogue	O	1	text	free text
Feature Operation Names	Operations that every instance of this feature type may perform	O	N	text	free text
Feature Attribute Names	Characteristic(s) of the feature type	O	N	text	free text
Feature Association Names	Association(s) between instances of this feature type and instances of the same or a different feature type	O	N	text	free text
Subtype of	Identifies one or more feature types from which the subject feature type inherits all properties, including feature operations, feature attributes, and feature associations	O	N	text	free text
Has subtypes	Identifies one or more feature types which inherit all properties from subject feature type, including feature operations, feature attributes, and feature associations	O	N	text	free text
Feature Operation	**Operation that every feature of a feature type may perform**	**C/ feature operation name occurs in 'feature operation names' list**	**N**		
Name	Text string that uniquely identifies the feature type within the catalogue	M	1	text	free text
Feature Attribute Names	Name(s) of feature attribute(s) participating in feature operation	M	N	text	free text
Feature Type Names	Name(s) of other feature type(s) affected by operation	C/ operation affects different feature			

		types?			
Definition	Definition of the feature type in a natural language	M	1	text	free text
Formal definition	Signature and/or equation for the feature operation	O	1	symbols	symbols
Feature attribute	**Characteristic of the feature type**	**C/ feature attribute name occurs in 'feature attribute names' list?**			
Name	Text string that uniquely identifies the feature attribute within the catalogue	M	1	text	free text
Definition	Definition of the feature attribute in a natural language	C/ Definition not provided by definition source?	1	text	free text
Code	Code that uniquely identifies the feature attribute within a catalogue	O	1	text	free text
Value Data Type	Data type of attribute values	C/ Definition not provided by definition source?	1	text	free text
Value Measurement Unit	Measurement unit for attribute values	O	1	text	free text
Value Domain Type	Indicates whether or not domain for feature attribute values is enumerated (if omitted, domain is not specified)	O	1	integer	0="not enumerated" 1="enumerated"
Value Domain	Permissible values of feature attribute	C/ Feature attribute value domain type = 0 (not enumerated)	1	text	free text
Feature Association	**Relationship that links instances of the feature type with instances of the same or a different feature type**	**C/ Feature association name occurs in 'feature association names' list**	**N**		
Name	Text string that uniquely identifies the feature association within the catalogue	M	1	text	free text
Inverse Relationship	Text string identifying opposite or inverse of feature association	O	1	text	free text
Definition	Definition of the feature association in a natural language	C/ Definition not provided by definition source?	1	text	free text
Code	Code that uniquely identifies the feature association within a catalogue	O	1	text	free text
Feature Types Included	Names of feature types participating in the association	M	N	text	free text

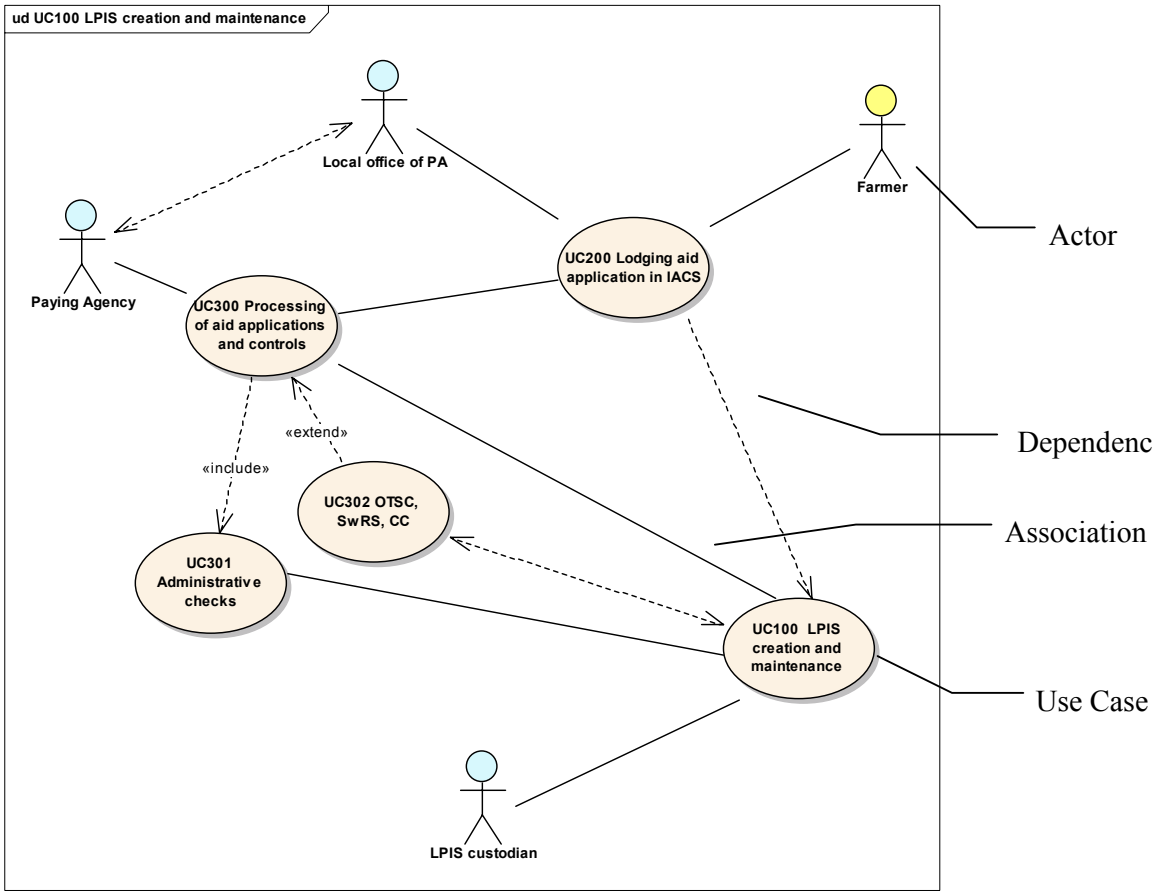
Order Indicator	Indicates whether the ordering of feature types is significant in the association	M	1	integer	0 ="not ordered;" 1 ="ordered"
Cardinality	Possible cardinality of the association	O	1	text	1 :1 ="exactly one"; 1 : ? ="one or more" ;0 :1 ="zero or one"; 0 : ? ="zero or more"
Constraints	Constraints on the feature association	O	N	text	free text
Role Name	Role played by the feature type included in the feature association	O	N	text	free text

Annex II. UML notations

Use Case diagrams

A *Use Case diagram* captures Use Cases and Actor interactions and it used for modeling of requirements of the system. It describes the functional requirements of the system, the manner that outside things (actors) interact at the system boundary, and the response of the system.

Example



use case [class]

A *Use Case* is a UML model element that describes how a user of the proposed system will interact with the system to perform a discrete unit of work. It describes and signifies a single interaction over time that has meaning for the end user (person, machine or other system), and is required to leave the system in a complete state: either the interaction completed or was rolled back to the initial state.

actor [class]

A coherent set of roles that users of use cases play when interacting with these use cases. An actor has one role for each use case with which it communicates.

use case model

A model that describes a system's functional requirements in terms of use cases.

association

Communications and interactions between Use Cases and Actors. The semantic relationship between two or more classifiers that specifies connections among their instances

dependency

A relationship between two modeling elements which is used to denote any kind of logical connection, in which a change to one modeling element (the independent element) will affect the other modeling element (the dependent element).

extend

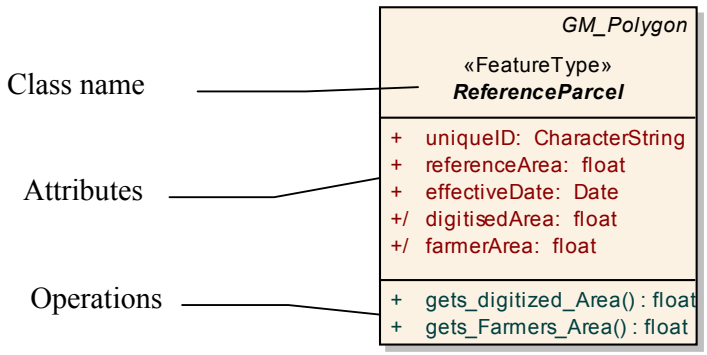
Describes conditional behavior. An Extend connection is used to indicate an element extends the behavior of another. Extensions are used in use case models to indicate one use case (optionally) extends the behavior of another

include

The inclusion base case describes a fragment of reusable behavior of base use case.which acts as pre-condition. The base use case depends on performing the behavior of the inclusion use case, but not on its structure (ie., attributes or operations

Class diagrams

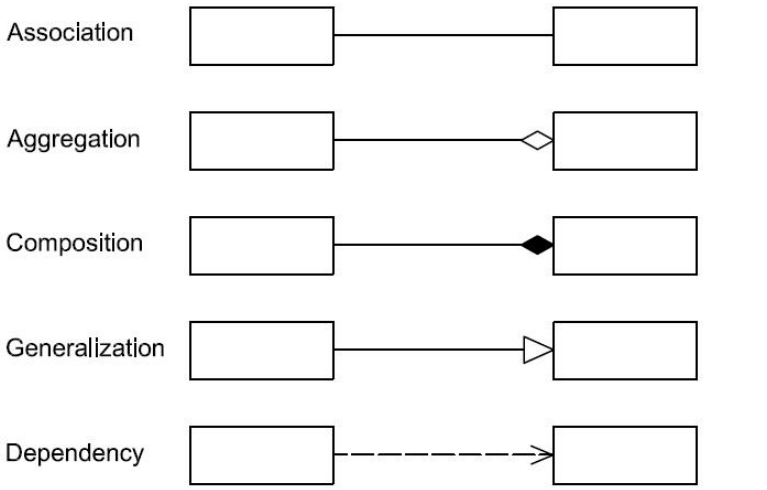
A diagram that shows a collection of declarative (static) model elements, such as classes, types, and their contents and relationships. Classes represent real-world concepts. Classes and relationships between them describe the static structure of a system.
Example of class:



class

A representation of real-world concepts. Used to describe of a set of objects that share the same attributes, operations, methods, relationships, and semantics.

Relationships between classes



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relationship

A semantic connection among model elements.

association

The semantic relationship between two or more classifiers that specifies connections and links among their instances

aggregation

A special form of association that specifies a whole-part relationship between the aggregate (whole) and a component part.

composition

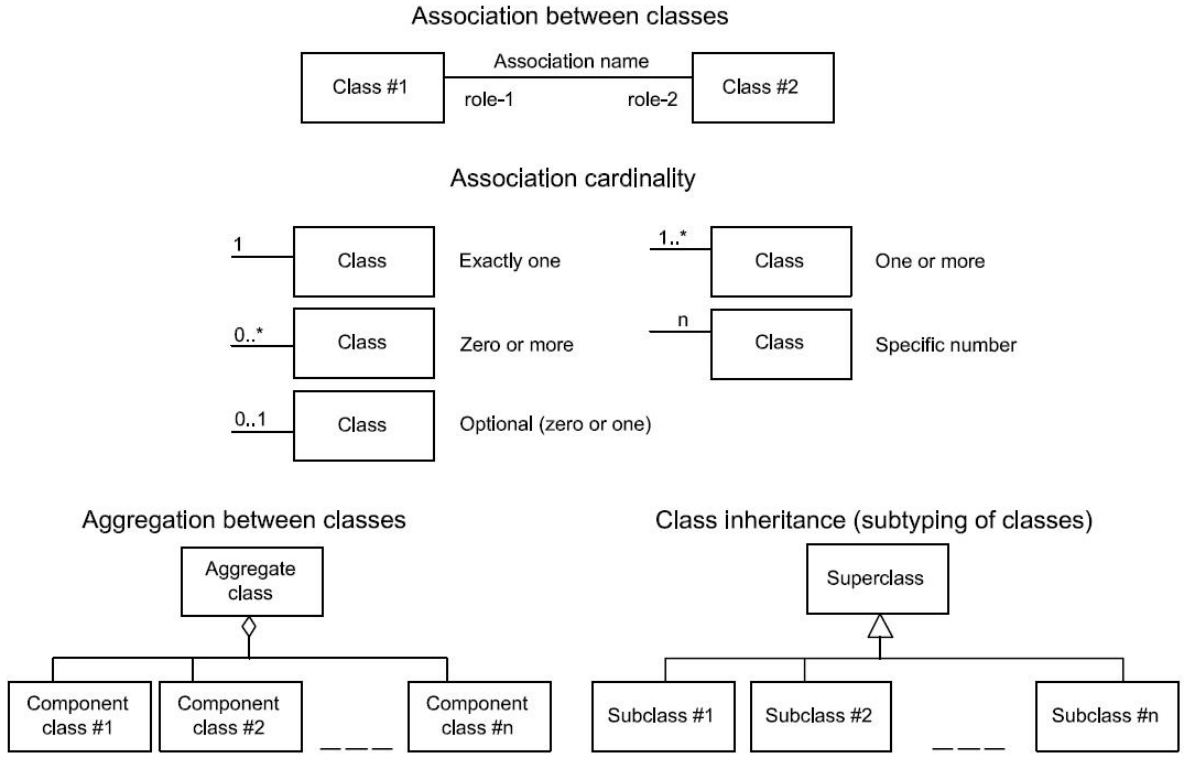
A form of aggregation which requires that a part instance be included in at most one composite at a time, and that the composite object is responsible for the creation and destruction of the parts. Composition may be recursive.

generalization

A taxonomic relationship between a more general element and a more specific element. The more specific element is fully consistent with the more general element and contains additional information. An instance of the more specific element may be used where the more general element is allowed.

dependency

A relationship between two modeling elements which is used to denote any other logical connection, in which a change to one modeling element (the independent element) will affect the other modeling element (the dependent element).



Annex III. Structure of Requirements' database

LPIS REQUIREMENTS
DATABASE STRUCTURE

Table 1. REG_requir
Table 2. REC_requir

NAME	DESCIPTION	CODE_LIST	TYPE
REQ_AREA	Requerement type	REG- regulatory requirement; REC- recommendation;	code_list
REQ_NR	sequential number for each type		integer
REQ_TYPE	requirement area	FUN- functional requirement; TEC -technical (non-functional) requirement;	code_list
REQ_UID	Complex string -REQ_AREA + REQ_NR + (if applic) REQ_TYPE		text
DECRIPTION	Requirement description		text
REQ_REF	Reference to regulatory/guidlines document		text
CIT_UID	Citation unique identifier (applic for regulatory requirements) in table Regulatory_CIT		text
USE_CASE	Model Use Case where requirement should be realised		code_list
GIS_FEATURE	Feature type(s) where GIS data is stored		code_list
GIS_QUAL	Quality requirements		text
NOTE			text

Table 3. Regulatory_CIT

NAME	DESCIPTION	CODE_LIST	TYPE
CIT_UID	Citation unique identifier, related to table 1		text
REGULATORY_REF	Legislative act		text
REGULATORY_CIT	citation of legislative text		text
REGULATORY_AREA	applicable area	e.g CC: SMR	code list

(end document)

European Commission

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Abstract

This discussion paper is a continuation of the MARS-PAC efforts to ensure the implementation of basic geographic information (GI) concepts into the LPIS and to follow-up the development of geomatics. It addresses the recent challenges on GI, such as establishing of a Spatial Data Infrastructure (SDI), and the requirements for standardisation and interoperability of geographic data. The main outcome of this development is a standardized framework for the LPIS specifications, that records compliance with the Regulation requirements.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

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