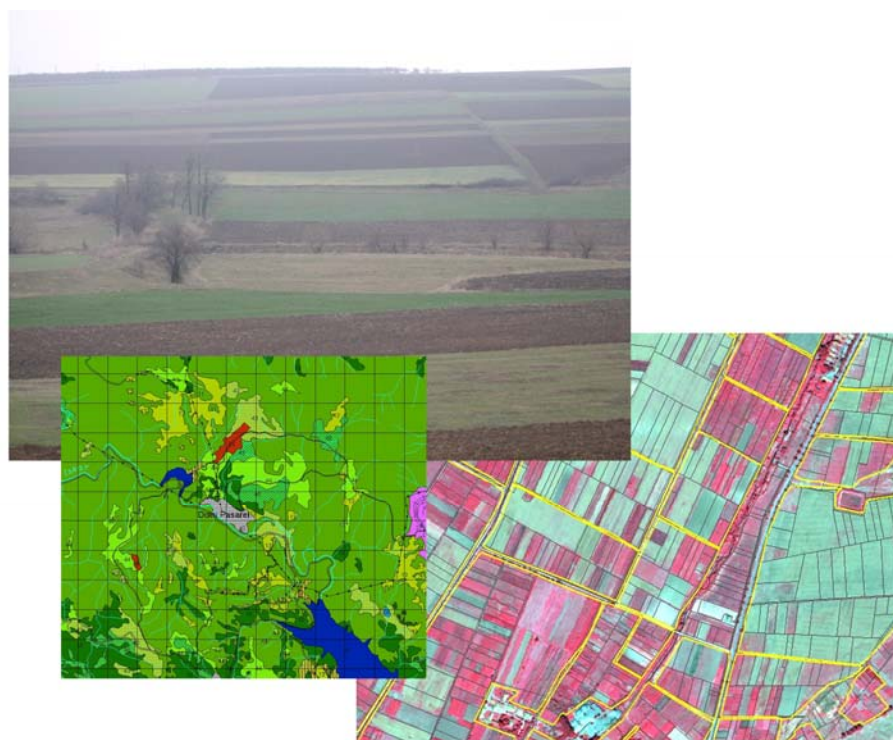# Core Conceptual Model for Land Parcel Identification System (LCM)

GeoCAP technical specification, version 1.1

Valentina Sagris and Wim Devos

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GeoCAP

Technical Specification

LPIS Core Conceptual Model (LCM)

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Approved:	Philippe Loudjani		
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Contents

1.   Introduction

1.1.   Objectives

1.1.1.   This specification is a part of the continued GeoCAP efforts to ensure the implementation of basic geographic information (GI) concepts into the LPIS domain and to follow-up the development of geomatics. It addresses the recent challenges on GI, such as the establishment of a Spatial Data Infrastructure (SDI), and compliance with the requirements for standardisation and interoperability of geographic data. The main outcome of this development is a standardized framework for the LPIS specifications that outlines compliance with the Regulation requirements.

1.1.2.   This document is a part of the Quality Assurance (QA) framework for LPIS, which is currently under development in the JRC. The LPIS Core Model (LCM) specification together with guidelines for the Abstract Tests Suite [9] constitutes the main documentation for testing of LPIS implementation conformance against the outlined requirements.

1.2.   LCM development steps

1.2.1.   This document contains version 1.1 of the LCM. The version 1.0 was developed from the first-cut version announced in 2007 [7] and further published via the wikiCAP portal for comments of the LPIS experts in January 2008. After collecting experts' feedback, the LCM was presented during the LPIS workshop in Sofia (BG), in September 2008. At the same time, Geo-CAP team was contacted by Working Group of the ISO standard 19152 'Land Administration Domain Model' with proposal to use the LCM for developing of an extension to LADM for agricultural application.

1.2.2.   The GeoCap team and the LPIS team of the Ministry of Agriculture, Forestry and Food of Slovenia and CosyLab (Slovenia) undertook an exercise on testing the LPIS Core Conceptual Model (LCM) in practice during the autumn of 2008 and the results were presented on the MARS 2008 Conference in Ljubljana (SI). During this practical exercise, the Slovenian LPIS implementation was mapped against the LCM. The anticipated outcome was twofold: first, to design an Abstract Tests Suit (ATS) for a mapping procedure and second, to fine-tune of the LCM model itself with the feedback of the practical exercises. For this ATS development, the methodology provided by ISO19105 – 'Conformance and testing' was adopted. The main idea behind an ATS is the prior testing of the logical consistency of a database structure: to verify that it correctly reflect the concepts laid down in the EU Regulations. From this ATS test report the next step towards Executable Tests Suit (ETS) was undertaken, testing the data content itself and focusing on such data quality elements as completeness, thematic and temporal accuracy.

1.2.3.   During spring and autumn 2009, we continued to test the model and improve ATS. We have repeated testing exercise for three implementations with different types of reference parcel, in particular, physical block, agricultural and cadastral parcel. The results were presented during

LPIS workshop in Tallinn (EE). The version 1.1 of the LCM is amended according to the findings of that exercise.

1.2.4. The current version of the LCM is designed to be fit in the LPIS testbed project that establishes Web based infrastructure allowing testing of MS databases' currency and quality in the Quality Assurance Framework [11]. It is envisaged to establish several WMS, WFS and WTS; therefore, the LCM should support on-line mapping and transformation of the national application schemas. For this purpose, we made LCM fully compatible with GML, and included an example of GML application schema in annex B.

1.2.5. What's new in the version 1.1 of the LCM?

- The Regulatory requirements references reflect the new Council Regulation 73/2009

- We introduce land cover concept via reference parcel's attribute; this concept is important for the testing of datasets quality during ETS implementation

- New type of reference parcel is introduced – topographic block;

- A CadSubParcel class for the cadastral parcel based LPIS is introduced;

- Classes for Cross Compliance and Rural Development are included,

- The usage of external classes for dataset, which are not managed under responsibilities of the LPIS custodian is proposed; whenever the standardized models for these classes will be available via INSPIRE process and European SDI model repository, they should be reused.

1.3.   Scope

1.3.1. As a conclusion of the abovementioned arguments, the scope of this document can be defined as follows:

- Provide a new technical specification of the LCM

- Represent the main concepts in the model (amends after new Council Regulation 73/2009)

- Redefine model packages and boundaries

- Define the core data classes

- Define classes for Cross Compliance and Rural Development

- Provide GML Application Schema example

1.4. Related documents

[1]	OL/I04/M2580/01	Land Parcel Identification System in the frame of Reg. 1593/2000
[2]	JRC IPSC/G03/P/SKA/ska D(2002)(1187)	Implementation of IACS-GIS, Reg. 1593/2000 and 2419/2001
[3]	JRC IPSC/G03/P/SKA/ska D(2004)(2575)	Implementation of IACS-GIS Reg. 1782/2003 and 796/2004
[4]	JRC IPSC/G03/P/SKA/ska D(2005)(4560)	Parcel Identification System Creation and Updating. Parcel Block interpretation and numbering
[5]	JRC IPSC/G03/P/SKA/pmi D(2007)(7111)	LPIS Update in the EU Member States (methods, technology, organisation)
[6]	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)
[7]	JRC IPSC/G03/P/SKA/vsa D(2007)(7665)	LPIS Core Conceptual Model: Methodology for Application Schema and Feature Catalogue
[8]	JRC IPSC/G03/P/RZI/rzi D(2008)(10107)	Summary results of the LPIS survey 2008
[9]	JRC IPSC/G03/P/VSA/vsa D(2008)(9916)	Conformance test for LPIS Core Model
[10]	JRC IPSC/G03/P/SKA/dka D(2008)(10133)	Guidelines for Best Practice and Quality Checking of Ortho Imagery
[11]	JRC IPSC/G03/P/WDE/wdeD(2009)(11164)	LPIS quality essesment: requirements and methodology

1.5. Terms and definitions

Abstract Tests Suite (ATS) – set of abstract tests specifying all the requirements to be satisfied for conformance [ISO19105]

Abstract test – generalized test for a particular requirement [ISO19105]

NOTE An abstract test case is a formal basis for deriving executable test cases. One or more test purposes are encapsulated in the abstract test case. An abstract test case is independent of both the implementation and the values. It should be complete in the sense that it is sufficient to enable a test verdict to be assigned unambiguously to each potentially observable test outcome (i.e. sequence of test events).

Application domain - A sphere of activity, concern, or function

Application schema – conceptual schema for data required for one or more applications [ISO19101]

Conceptual model – model that defines concepts of the universe of discourse [ISO19101]

Conceptual schema – formal description of a conceptual model [ISO19101]

Conformance - fulfilment of specified requirements [ISO 19105]

Executable test – specific test of an implementation to meet particular requirements. [ISO19105]

NOTE Instantiation of an abstract test case with values.

Executable Tests Suite (ETS) – set of executable tests [ISO19105].

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.

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 Modeling 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 (application domain) [ISO19101]

1.6. Acronyms and abbreviations

AEM	Agro-Environmental Measures
ATS	Abstract Tests Suite
CAP	Common Agricultural Policy
ETS	Executable Tests Suite
GAEC	Good Agricultural and Environmental Condition
GML	Geographic Mark-up Language
IACS	Integrated Administration and Control System
INSPIRE	Infrastructure for Spatial Information in Europe
ISO	International Organisation for Standardisation
LADM	Land Administration Domain Model
LCM	LPIS Core Model
LPIS	Land Parcel Information System
SDI	Spatial Data Infrastructure
SMR	Statutory Management Requirements
UML	Unified Modelling Language
JRC	Joint Research Centre

2. LCM basics and LCM packages

2.1. Spatial and non-spatial concepts in the CAP regulations

2.1.1. In order to be implemented in IT systems of the IACS and LPIS, the concepts established by the CAP Regulations should be presented as features and classes. Features (spatial and non-spatial) are abstractions of real world phenomena about which data are collected, maintained, and disseminated (ISO 19110). Similar features can be combined in to the classes called 'feature types'. The collection of all feature types participating in the system constitutes its Feature Catalogue, which is a central part of the database specification. In the context of a database model, features representing real-world concepts are described as classes. An UML class diagram shows a collection of declarative (static) model elements, such as classes, their attributes, and the relationships between the classes. Classes and relationships between them describe the static structure of a system. When implemented in a database, one class could be represented as a single geographic or alphanumerical data set in database, or, if several classes (features) belong to the same phenomenon (all types of rivers – hydrological network), they can be stored in one data set (for more discussion see also [7]).

2.1.2. Hereby we list the concepts, which are relevant to content of the LCM:

Farmer Art. 2 CR 73/2009	-means a natural or legal person, or a group of natural or legal persons, whatever legal status is granted to the group and its members by national law, whose holding is situated within Community territory, as defined in Article 299 of the Treaty, and who exercises an agricultural activity; 'agricultural activity' means the production, rearing or growing of agricultural products including harvesting, milking, breeding animals and keeping animals for farming purposes, or maintaining the land in good agricultural and environmental condition as established in Article 6;
Single farmer's application Art 19 CR 73/2009	Each year, a farmer shall submit an application for direct payments indicating, where applicable: (a) all the agricultural parcels on the holding, and where the Member State is applying Article 15(3), the number of olive trees and their positioning in the parcel; (b) the payment entitlements declared for activation; (c) any other information provided for by this Regulation or by the Member State concerned.
Payment schemes Art 1 CR 73/2009 Annex I	(b) 'single payment scheme' - an income support scheme for farmers (c) 'single area payment scheme' -a transitional simplified income support scheme for farmers in the new Member States as defined in Article 2(g) (d) support schemes for farmers producing rice, starch potatoes, protein crops, nuts, seeds, cotton, sugar, fruit and vegetables, sheep meat and goat meat and beef and veal;
Entitlements Art 33 CR 73/2009	Support under the single payment scheme, which shall be available to farmers if they: (a) hold payment entitlements which they have obtained in accordance with Regulation (EC) No 1782/2003; (b) obtain payment entitlements under (this) Regulation (EC) No 73/2009: (i) by transfer; (ii) from the national reserve; (iii) pursuant to Annex IX; (iv) pursuant to Art 47(2), Art 59, Art 64(2), Art 65 and Art 68(4)(c).

Eligible hectare Art 34 CR 73/2009 Art 55 (3)	Support under the single payment scheme shall be granted to farmers upon activation of a payment entitlement per eligible hectare. Activated payment entitlements shall give a right to the payment of the amounts fixed therein. shall mean: (a) any *agricultural area* of the holding, and any area planted with short rotation coppice that is used for an *agricultural activity* or, where the area is used as well for non-agricultural activities, predominantly used for *agricultural activities*; and (b) any area which gave a right to payments under the single payment scheme or the *single area payment scheme* in 2008 and which: (i) no longer complies with the definition of 'eligible' as a result of the implementation of Directive 79/409/EEC on the conservation of wild birds (1), Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (2) and Directive 2000/60/EC establishing a framework for Community action in the field of water policy (3); or (ii) for the duration of the relevant commitment of the individual farmer, is afforested pursuant Council Regulation (EC) No 1257/1999 on support for rural development; or (iii) for the duration of the relevant commitment of the individual farmer, is set aside pursuant Regulation (EC) No 1257/1999 or to Regulation (EC) No 1698/2005. Except for Bulgaria and Romania, any new Member State having applied the single area payment scheme may provide that, in addition to the eligibility conditions established in Article 34(2), 'eligible hectare' shall mean any agricultural area of the holding which has been maintained in good agricultural condition on 30 June 2003, whether or not in production at that date.
Agricultural parcel[1] Art 2 CR.796/2004	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 (also known as production unit)
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 Art. 18 CR. 73/2009. (also known as production block)
Cross-compliance Art 4, 5 and 6 CR 73/2009	A farmer receiving direct payments shall respect the statutory management requirements (SMR) listed in Annex II and the good agricultural and environmental condition (GAEC) referred to in Article 6. The obligations referred to in the first subparagraph shall apply only in so far as the agricultural activity of the farmer or the agricultural area of the holding is concerned. The statutory management requirements listed in Annex II shall be established by Community legislation in the following areas: (a) public, animal and plant health; (b) environment; (c) animal welfare Member States shall ensure that all agricultural land, especially land which is no longer used for production purposes, is maintained in good agricultural and environmental condition. Member States shall define, at national or regional level, minimum requirements for good agricultural and environmental condition
Agricultural area Art. 2 CR 73/2009	-means any area taken up by arable land, permanent pasture or permanent crops
Holding Art. 2 CR 73/2009	- means all the production units managed by a farmer situated within the territory of the same Member State;

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[1] Please note the definition of agricultural parcel is currently under review (05-2009)

2.1.3. Figure 1 presents the logical business model of the main concepts of IACS, described in chap. 2.1.2. All basic concepts are represented as UML classes (for UML notations see Annex A). The key concept 'Single Farmer's Application' is represented as class AidApplication and related to classes Farmer and Agricultural parcel. Each Agricultural parcel shall be located inside of one or more reference parcels (RP) of the LPIS (1:1), and a RP can contain none, one or several actively declared Agricultural parcel(s). Furthermore, each RP can have none, one or several farming limitations from cross-compliance measures. Reference parcel can be situated in administrative unit, which by rural development plan recognized as area less favoured for agriculture (LFA).
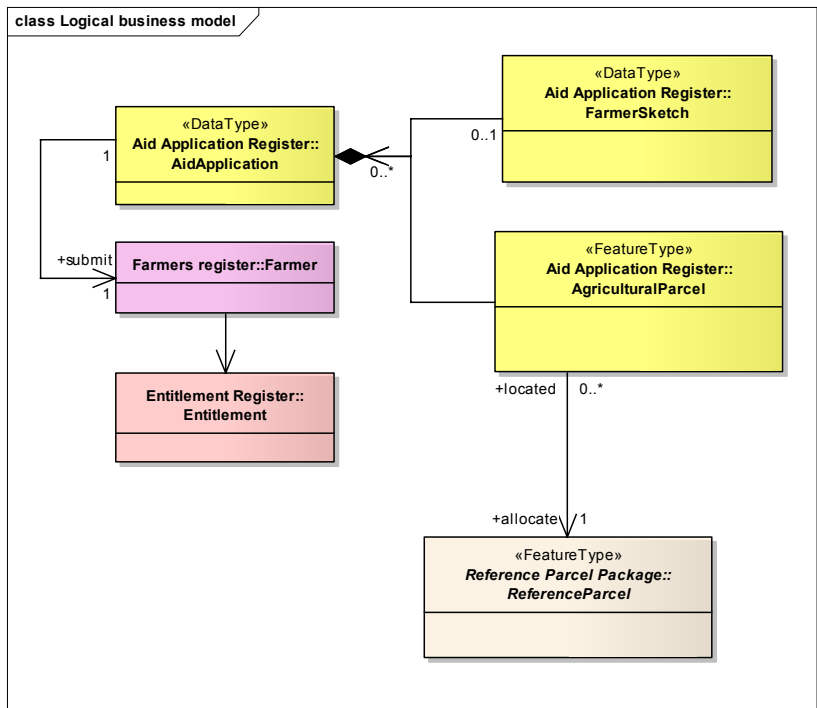
Figure 1. Logical business model

2.1.4. The colour code of the feature classes (figure 2) corresponds to the colours of the packages in the UML diagrams:

yellow: Aid Application register,
violet: Farmers' register/Entitlement register,
white: Cross- compliance and rural development,
beige: LPIS as described in this document, olive for cartographic reference.
green: geospatial objects of ISO 19100 for representing the geometry of LCM classes
pink: register for SPS entitlements
olive: ancillary cartographic data

2.1.5. The class *ReferenceParcel* in the diagram of Figure 1 is an abstract class: it has no object instances. It has instead a number of specialisations or subtypes that hold the actual features instances (in UML notation, abstract classes are indicated by *italic script).* The specialisations for

the class *ReferenceParcel* accommodate for each type of Reference parcel in use. These are described in chap 3.
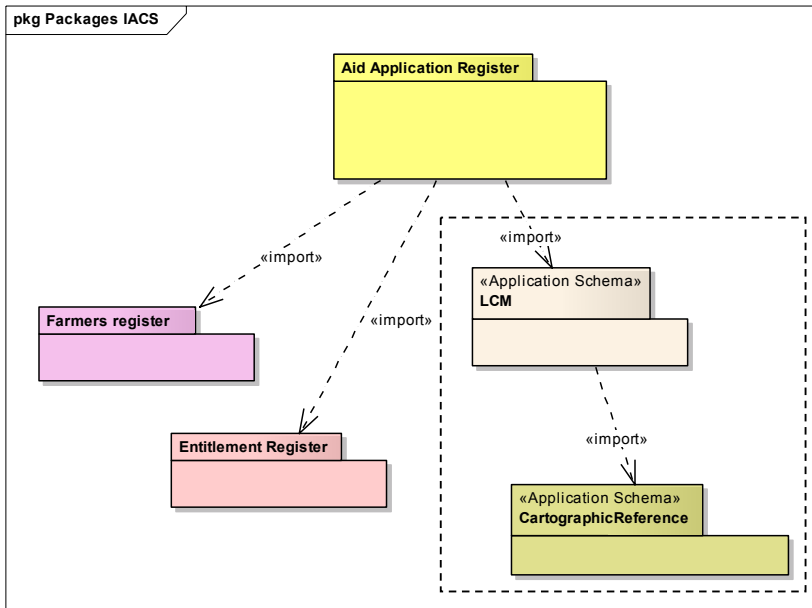
Figure 2. Packages diagram

2.1.6. By using the packages approach, we can define boundaries of the LCM, so that It includes the static structure with

- all data needed for functioning of LPIS as a part of IACS: layers of reference parcels (chap 3),
- data for cross-compliance and rural development (chap 4 and 5)
- a package of cartographic reference (chap 6).
- the relations towards relevant classes of the other IACS modules and registers LPIS

2.1.7. The logical LPIS (spatial) data model, which corresponds to the logical business model, is depicted in Figure 3. The class *ReferenceParcel* has a dependency relation with *FarmingLimitation and LFA*. Every reference parcel can have none, one or several types of areas of cross-compliance, and the latter can be entirely located or overlapped with the RP in question. On the other hand, a reference parcel may or may not be situated in one of the LFA zones. All classes are spatial features and therefore specialisations (sub-types) of the coordinate geometry type POLYGON as defined by the ISO 19107 standard 'Spatial Schema'. Please note that at implementation level, other types of geometry stereotypes can be selected according to the specific technical conditions (e.g. the software's ability to support topological relations).
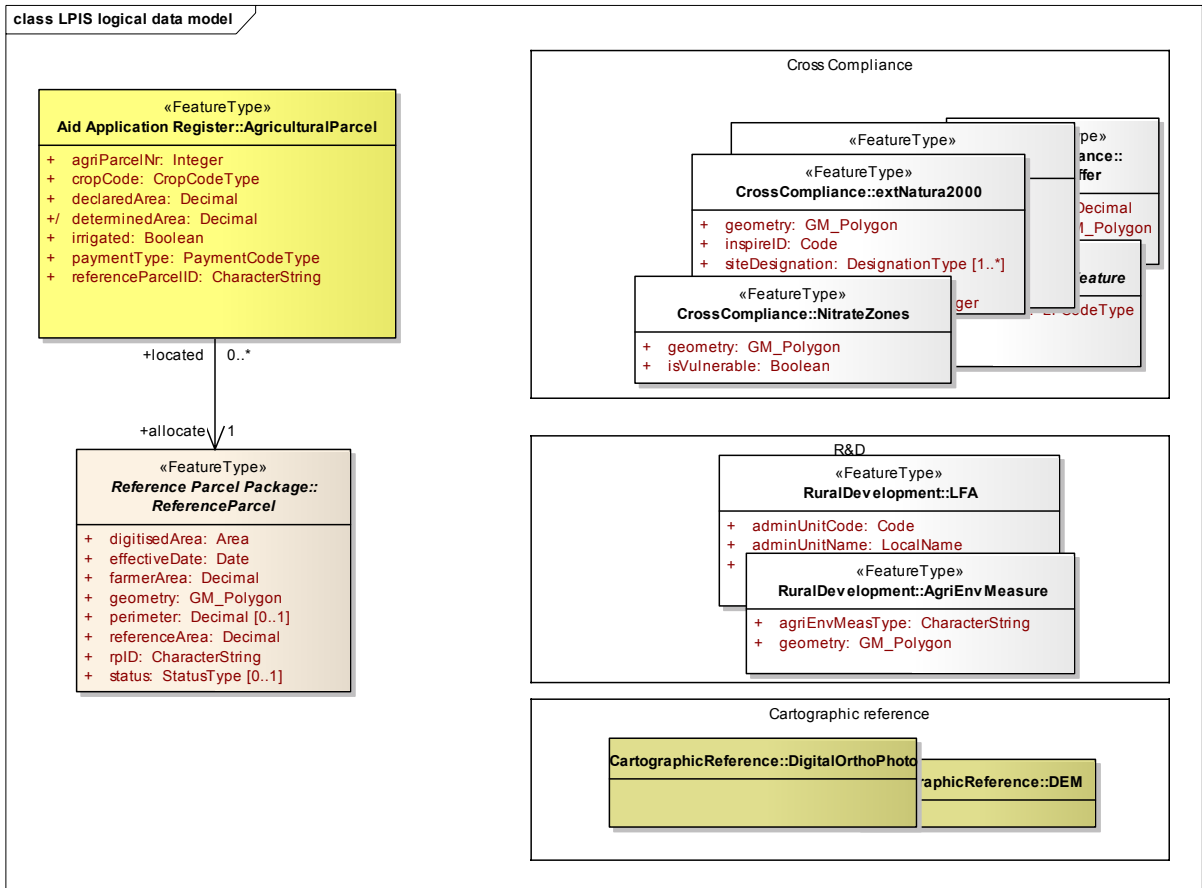
Figure 3. Logical data model

2.1.8. The data sets of package Cartographic Reference do not correspond to any of the basic concepts of administration of subsidies identified above, but they are explicitly mentioned by Art. 17 of the Council Reg (EC) No 73/2009 aiming for improvement of (i) communication level with the farmer and (ii) appropriate currency of LPIS information. The cartographic reference could be represented by digital orthophoto imagery or by a cartographic map product at scale 1:10000 or more detailed. Since a majority of the MS have chosen for orthophoto imagery, a class DigitalOrthoPhoto is included into diagram 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: class topoMap will be an aggregation of geographic features conventionally included into topographic map. It is worth mentioning, that the features represented in topographic maps often belong to INSPIRE annex I and II themes. Therefore they are already modelled in the INSPIRE Implementation Rules Specifications, and should be reused via INSPIRE model repository. The Cartographic Reference package can also include alternative data sets, not explicitly mentioned by Regulations, but used for various purposes of administrative and/or topographic reference, supporting information on cross compliance and rural development (administrative division, cadastral district, altitude, slope, etc.)..

2.1.9. Several data sets of Cross Compliance, Rural Development and Cartographic reference packages are produced and maintained outside of the LPIS by others authorities. Whenever standard models/application schemas for these data sets exist (e.g. for NATURA 2000 in the frame of INSPIRE Protected sites), these data sets should be considered as external classes and there models/application schemas should be re-used.

3.   LCM core classes

3.1.   Reference Parcel Package

Type: *Package «Leaf»*
Status: Version 1.1.
Package: LCM
Last modified on: *04/12/2009*
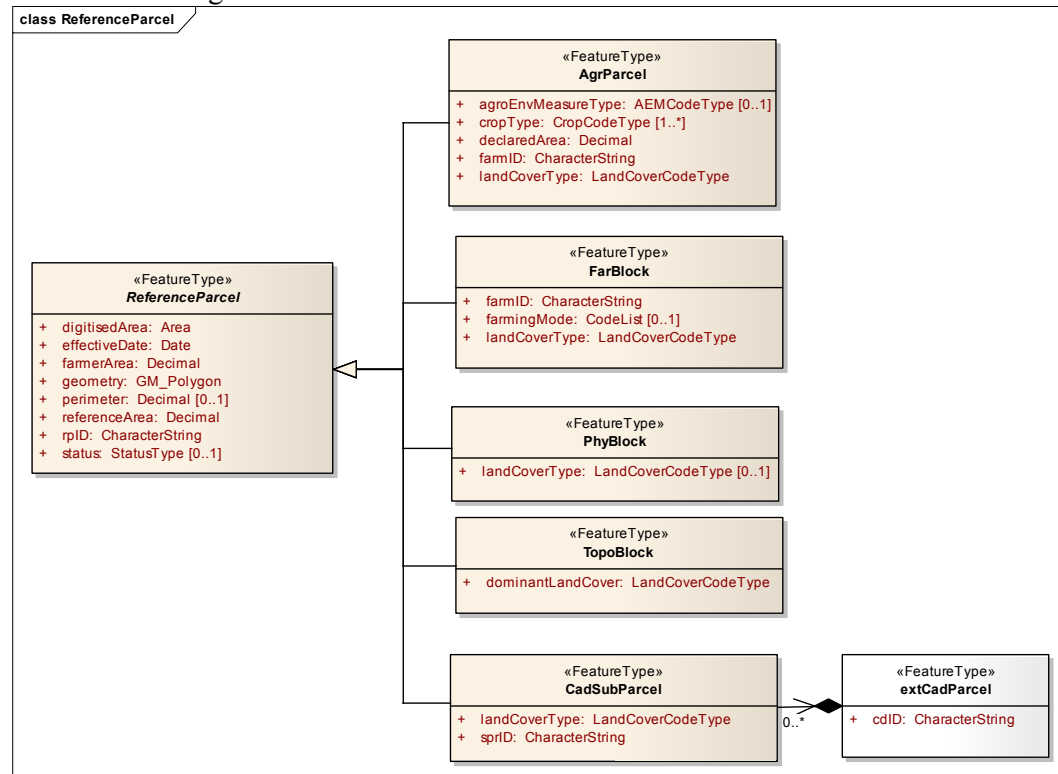*Created:* mars/vsagris

Figure4. ReferenceParcel
Last Modified: 07/12/2009 *Version:* 1.1.
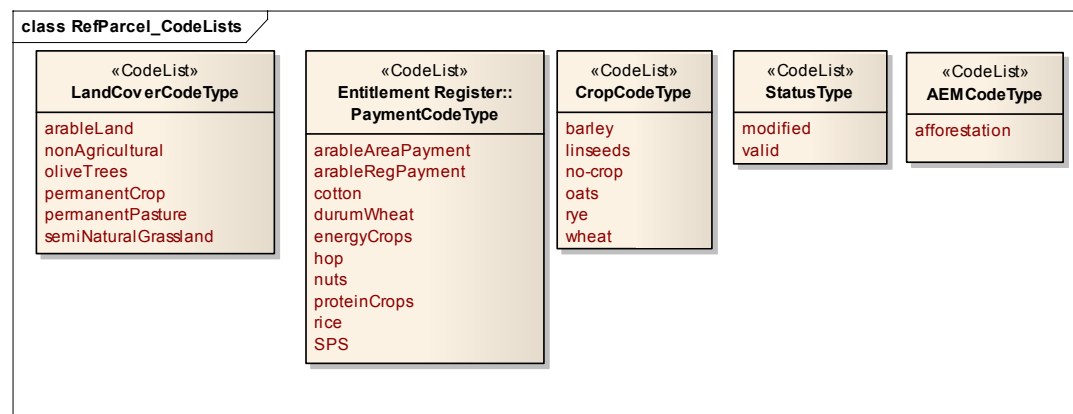
Figure5. Reference Parcel Code Lists
Last Modified: 07/12/2009 *Version:* 1.1.

3.1.1. ReferenceParcel

Type: «FeatureType»   Abstract
Package: Reference Parcel Package
Detail: *Last modified on 07/12/2009.*
Definition: Basic spatial unit for the administration and geographical localization of agricultural parcels. May contain one or more declared agricultural parcels in IACS and may be cultivated by one or more farmers (or producers association). Does not necessarily cover a territory nationwide, but overlaps are not allowed. Parent class of: CadSuBParcel, AgrParcel, FarBlock, PhyBlock and TopoBlock.

```
class ReferenceParcel

        «FeatureType»
        ReferenceParcel

  +   digitisedArea:  Area
  +   effectiveDate:  Date
  +   farmerArea:  Decimal
  +   geometry:  GM_Polygon
  +   perimeter:  Decimal [0..1]
  +   referenceArea:  Decimal
  +   rpID:  CharacterString
  +   status:  StatusType [0..1]
```
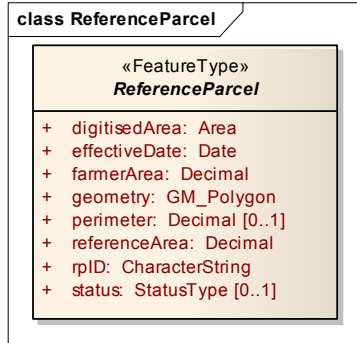
Last Modified: 04/12/2009 *Version:* 1.0.

Associations

Connector	Source	Target	Constraint
Association	AgriculturalParcel; role:located	ReferenceParcel; role:allocate	
Generalization	FarBlock; role:	ReferenceParcel; role:	
Generalization	CadSubParcel; role:	ReferenceParcel; role:	
Generalization	AgrParcel; role:	ReferenceParcel; role:	
Generalization	PhyBlock; role:	ReferenceParcel; role:	
Generalization	TopoBlock; role:	ReferenceParcel; role:	
Association	ReferenceParcel; role:	Intersect; role:hasIntersection	

Attributes

Attribute	Notes
geometry : GM_Polygon	polygon geometry
rpID : CharacterString	Nation-wide unique alphanumerical identification code
referenceArea : Decimal	Officially known area of reference parcel in hectare, which caps the maximum area that can be claimed for this reference parcel

Attribute	Notes
effectiveDate : Date	Date when new version or new data about RP come into force with respect to third parties (e.g. Paying Agency) and registers.
digitisedArea : Area	Digitized or GIS area. Area calculated area based on the coordinates of the boundary points. The relationship between **referenceArea** and **digitisedArea** depends on ReferenceParcel specialization
farmerArea : Decimal	sum of areas claimed by farmers and determined (approved) by PA for payment inside of RP. Less or equal to the referenceArea
perimeter : Decimal [0..1]	GIS polygon perimeter (may be used for tolerance calculation)
status : StatusType [0..1]	Validity/update status of reference parcel, values depend on implementation choice

3.1.2. AgrParcel

Type: «FeatureType» ReferenceParcel
Package: Reference Parcel Package
Detail: *Last modified on 07/12/2009.*
Definition: Reference parcel containing only one production unit/agricultural parcel - continuous area of agricultural land on which a single crop group is cultivated by a single farmer (not to confuse with Agricultural Parcel of farmer's application, which does not have spatial context).

Associations

Connector	Source	Target	Constraint
Generalization	AgrParcel; role:	ReferenceParcel; role:	

Attributes

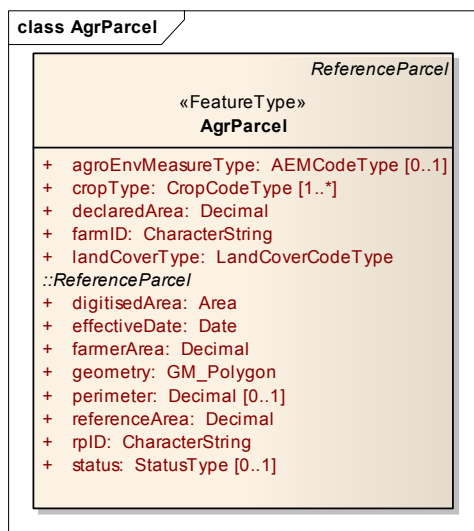| Attribute	Notes
farmID : CharacterString	ID of the farmer or farm (holding) the from farmers' register
landCoverType : LandCoverCodeType	land cover of the parcel; Land cover classes derived from article 34 Council Reg. 73/2009, list can be extended to accommodate non-agricultural land types
declaredArea : Decimal	area declared by farmer
cropType : CropCodeType [1..*]	land use: crop cultivated; since AgrParcel is defined by crop group, it is possible to have more than one crop
agroEnvMeasureType : AEMCodeType [0..1]	agro-environmental commitments on parcel

3.1.3. FarBlock

Type: «FeatureType» ReferenceParcel
Package: Reference Parcel Package
Detail: *Last modified on 07/12/2009.*
Definition: Reference parcel known as 'farmer's block' - a continuous area of agricultural land grouping together a number of neighbouring agricultural parcels cultivated by the same farmer. In other words, production block, which contains several adjacent production units of the farmer.

Associations

Connector	Source	Target	Constraint
Generalization	FarBlock; role:	ReferenceParcel; role:	

Attributes

Attribute	Notes

Attribute	Notes
farmID : CharacterString	ID of the farmer or farm (holding) the from farmers' register
landCoverType : LandCoverCodeType	land cover of the parcel; Land cover classes derived from article 34 Council Reg. 73/2009, list can be extended to accommodate non-agricultural land types. Possible values are in the landCoverCodeType code list.
farmingMode : CodeList [0..1]	attribute os applicable in national certification is required for organic farming (optional)

3.1.4. PhyBlock

Type:	«FeatureType» ReferenceParcel
Package:	Reference Parcel Package
Detail:	*Last modified on 07/12/2009.*
Definition:	Reference parcel known as 'Physical block' - a continuous area of agricultural land (production block) grouping together a number of neighboring agricultural parcels (production units) cultivated by one or more farmer(s) and delineated by most stable boundaries.

class PhyBlock

ReferenceParcel

«FeatureType»
PhyBlock

+ landCoverType: LandCoverCodeType [0..1]
::ReferenceParcel
+ digitisedArea: Area
+ effectiveDate: Date
+ farmerArea: Decimal
+ geometry: GM_Polygon
+ perimeter: Decimal [0..1]
+ referenceArea: Decimal
+ rpID: CharacterString
+ status: StatusType [0..1]

Associations

Connector	Source	Target	Constraint
Generalization	PhyBlock; role:	ReferenceParcel; role:	

Attributes

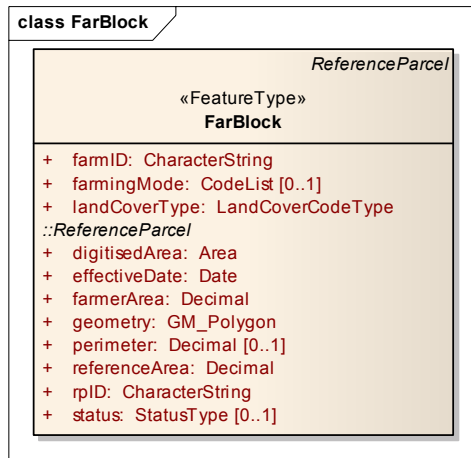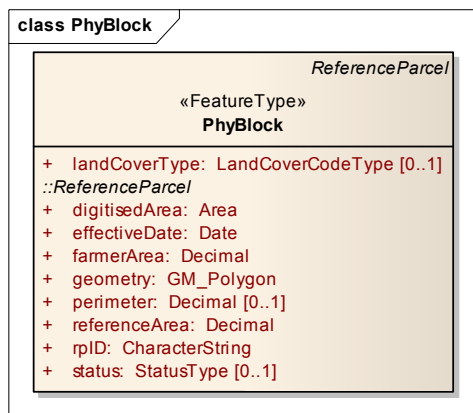| Attribute	Notes
landCoverType : LandCoverCodeType [0..1]	land cover of the parcel; Land cover classes derived from article 34 Council Reg. 73/2009, list can be extended to accommodate non-agricultural land types

3.1.5. TopoBlock

Type: «FeatureType» ReferenceParcel
Package: Reference Parcel Package
Detail: *Last modified on 07/12/2009.*
Definition: Reference parcel known as 'Physical block', but NOT satisfying criteria of
               production block with following characteristic:
               -100% subdivision of national territory to the blocks, which allows 'water', 'road',
               'residence area' etc blocks;
               -delineated by most stable boundaries,
               -can compose of mixture of land cover classes;
               -agricultural land cultivated by one or more farmer(s)

```
class TopoBlock

                                    ReferenceParcel
                      «FeatureType»
                        TopoBlock

  +   dominantLandCover: LandCoverCodeType
  ::ReferenceParcel
  +   digitisedArea:  Area
  +   effectiveDate:  Date
  +   farmerArea:  Decimal
  +   geometry:  GM_Polygon
  +   perimeter:  Decimal [0..1]
  +   referenceArea:  Decimal
  +   rpID:  CharacterString
  +   status:  StatusType [0..1]
```

Associations

Connector	Source	Target	Constraint
Generalization	TopoBlock; role:	ReferenceParcel; role:	

Attributes

Attribute	Notes
dominantLandCover : LandCoverCodeType	land cover of the parcel; Land cover classes derived from article 34 Council Reg. 73/2009, list can be extended to accommodate non-agricultural land types

3.1.6. CadSubParcel

Type: «FeatureType» ReferenceParcel
Package: Reference Parcel Package
Detail: *Last modified on 04/12/2009.*
Definition: Unit of agricultural or non-agricultural land cover inside of cadastral parcel. Class
               has topological relation with **extCadParcel**, which compose from one or many
               CadSubParcels

class CadSubParcel

ReferenceParcel

«FeatureType»
CadSubParcel

+ landCoverType: LandCoverCodeType
+ sprID: CharacterString
::ReferenceParcel
+ digitisedArea: Area
+ effectiveDate: Date
+ farmerArea: Decimal
+ geometry: GM_Polygon
+ perimeter: Decimal [0..1]
+ referenceArea: Decimal
+ rpID: CharacterString
+ status: StatusType [0..1]

0..*

«FeatureType»
extCadParcel

+ cdID: CharacterString

Associations

Connector	Source	Target	Constraint
Association	CadSubParcel; role:	extCadParcel; role:	
Generalization	CadSubParcel; role:	ReferenceParcel; role:	

Attributes

Attribute	Notes
landCoverType : LandCoverCodeType	land cover of the parcel; Land cover classes derived from article 34 Council Reg. 73/2009, list can be extended to accommodate non-agricultural land types
sprID : CharacterString	Due to the fact that inside of one cadastral parcel several plots of agricultural land can be found, sprID is identification of sub-parcel inside of cadastral parcel; rpID (the attribute inherited from ReferenceParcel class) can include combination of cadastral identifier of CadParcel and sprID.

3.1.7. extCadParcel

Type: «FeatureType»
Package: Reference Parcel Package
Detail: *Last modified on 07/12/2009.*
Definition: An external class, maintained outside AICS/LPIS.
                 A single area of land or more particularly a volume of space, under homogeneous real property rights and unique ownership. Basic unit of the cadastre - the register under responsibility of MS with purpose to provide their citizen stability and security in real property ownership. Homogeneous nationwide coverage, overlaps, in general, are not allowed. Contains agricultural and non-agricultural land.

Associations

Connector	Source	Target	Constraint
Association	CadSubParcel; role:	extCadParcel; role:	

Attributes

Attribute	Notes

Attribute	Notes
cdID : CharacterString	Identifier of Cadastral parcel

3.2. Code lists

3.2.1. CropCodeType

Type: «CodeList»
Package: Reference Parcel Package
Detail: *Last modified on 01/12/2009.*
Definition: indicative, up to 250 different crops can be added
Values:

Values	Notes
no-crop	
wheat	
rye	
barley	
oats	
linseeds	

3.2.2. StatusType

Type: «CodeList»
Package: Reference Parcel Package
Detail: *Last modified on 24/11/2009.*
Definition: indicative, depends on implementation
Values

Attribute	Notes
valid : CharacterString	
modified : Date	

3.2.3. LandCoverCodeType

Type: «CodeList»
Package: Reference Parcel Package
Detail: *Last modified on 03/12/2009.*
Definition: art. 34 of the 73/2009
Values

Attribute	Notes
arableLand	
permanentPasture	
oliveTrees	
permanentCrop	permanent crops which are not vineyards and olives
semiNaturalGrassland	

Attribute	Notes
nonAgricultural	

3.2.4. AEMCodeType

Type:　　　　　«CodeList»
Package:　　　Reference Parcel Package
Detail:　　　　*Last modified on 20/11/2009.*
Definition:　　indicative

Values

Values	Notes
afforestation : CharacterString	

3.3. Reference Parcel: discussion

3.3.1. In the frame of the 2008 LPIS questionnaire [7] several questions were asked about the representation of the basic data structure and the number of layers participating in the delineation of eligible land. In total, we received 25 responses on our questionnaire. In this chapter we discuss two topics, which are interesting from the LCM point of view, there are:

- double layer solutions; and
- handling of the small (less than 0,1 ha) ineligible exclusions. [anomaly class or sub-parcel]

3.3.1. In addition to the main reference layer, some MS administrations make use of a geographic layer of declared agricultural parcels digitized during of the ongoing campaign. The purpose is to facilitate control procedures. On the question- *'Is there a spatial layer for yearly declared Agricultural Parcels digitized (vector)?'*- 6 countries answered, that they practise digitalization of 100% of parcels. Those MS (BE-W, BG, CY, HU, MT, SI) use the reference parcel (different from agricultural parcel type) as a container to allocate another geographical object inside. Another six member states (EE, DK, NL, PT, SE, SK) responded that only agricultural parcels subject to control (usually 5% of claims) are digitized (table 1). Thus in production block systems (FB and PB together) 13 from 18 member states use double-layer approach. On contrary, only 1 of the 4 questioned cadastre based systems is using declared parcels' layer. As one observes that the practice of digitising AP is widespread, a layer of spatially represented agricultural parcels can be considered as a **candidate for optional class** in the LCM.

Table 1: Is there a spatial layer for yearly declared Agricultural Parcels digitized (vector)?

Answers	Physical block	Farmer's block	Agric. parcel	Cad. parcel
no	4	3		4
AP subject to control	4	2		
All AP claimed	3	2	2	1
(total answered)	11	7	2	5

3.3.2. Working Documents and Recommendations specify that for a LPIS layer of reference parcels internal patches of ineligible land of more than 0.1 ha should be spatially excluded. There is no obligation to exclude smaller parts from geospatial layer, however eligible area of the AP should be established with a precision 0,01 ha (art. 30) – in other words during field inspections, smaller parts of ineligible land should be measured and excluded from area calculation. Table 2 present answers for question – '*What spatial solutions do you have to handle exclusions (too small to be mapped)?*'. Thus 3:25 member states indicated that they store information on exclusions in reference parcel attributes, others make use of point (2:25) or shape (4:25) layer. In total 9:25 states indicated that the handle exclusions on data level. Therefore, at less extend than previous, double-layer solution, layer of attribute of ineligible exclusions can be considered as a candidate class to be included in the LCM.

Table 2: What spatial solutions do you have to handle exclusions (too small to be mapped)?

Answers	Physical block	Farmer's block	Agric. parcel	Cad. parcel
Flag or attribute in RP	2	1		
Points in separate layer		1	1	
Shapes in separate layer	1	1	1	1
(total answered)	11	7	2	5

4. Package Cross Compliance

4.1. Scope

4.1.1. Cross-compliance (CC) requirements link the eligibility of payments to the farmer's fulfillment of Statutory Mandatory Requirements (SMR) and Good Agricultural and Environmental Condition (GAEC) measures. The particularities of the CC requirements are laid down by every individual Member State and therefore reside outside of the LCM scope. What is however common is the CC framework and the requirement for inspecting its compliance.

4.1.2. Still, the LPIS does contain, in addition to core information described in previous chapter, geographic data regarding cross compliance, rural development, different type of cartographic reference on topography, hydrology, land cover etc. There are two approaches how this CC relevant data can be integrated in the system:

1. All these data are assigned to reference parcel via attributes. In this approach, at the time of the reference parcel creation/update, specific database operations are activated in order to re-calculate and record all required attributes.

2. The data are not recorded in attributes of reference parcel or separate related table, and calculations are produced 'on-the-fly', when they are needed for administrative checks.

4.1.3. The choice of approach depends on several considerations such as the need for speeding up of administrative checks or facilitating of work of operators and controllers. The first one has two advantages: 1) there is no need to carry out the computationally expensive geometry operations to find the values and 2) different operations can come up with slightly different results when applying spatial operators due to rounding errors or variations of interpretation in CRS precision. If the values are business sensitive (which is usually the case with land parcel area measurement) storing the values explicitly avoids (some of the) arguments arising from these differences.

4.1.4. However, the existence of separate geographic layers, corresponding to data relevant to cross complains and rural development issues is necessary for both approaches. For database conformance testing [9] it will be required that custodian of LPIS defines explicitly which approach is used.

4.1.5. Further on, we introduced in the LCM a special class for intersection between (1st approach) reference parcel and layer of cross-compliance or rural development. It contains attributes, which allows storing different kind of intersections: Boolean, area and percentage. The Farming Limitation class is designed to represent spatial layers of different kind of cross-complains limitation to farming activities. By introducing this name we like to avoid confusion with 'areas of cross-compliance', which are mentioned in the Regulations text and do not have spatial context.

4.2.   Cross Compliance requirements: SMR

4.2.1.   A full list of SMR that should be taken into consideration in respect to direct payments and references to the regulatory acts establishing them can be found in Annex II of Council Reg. 73/2009. In table 3 we list them together with geographic components which can support them in LPIS.

Table 3: List of SMR with geographic component

SMR	Description	GI component
	Environment	
SMR1	conservation of wild birds	-Special Protection Areas (SPAs) of NATURA 2000 -identified habitats (nests and buffers)
SMR2	protection of groundwater against pollution	-groundwater depth -depth of aquifer -soil types (infiltration, porosity) (classified by vulnerability)
SMR 3	protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture	-soil types (infiltration, porosity) classified by vulnerability
SMR 4	protection of waters against pollution caused by nitrates from agricultural	-nitrate vulnerable zones (with account on slops and erosion and soil types)
SMR 5	conservation of natural habitats and of wild flora and fauna (Habitat Directive)	-Special Areas of Conservation (SACs) NATURA 2000
	Public and animal health – identification and registration of animals	
	Animals identification	
SMR 6	Identification and registration of animals (pigs only)	-sty, farm location
SMR 7	ear tags, passports and holdings registers - (cattle)	-cattle farm, barn location
SMR 8	identification and registration of bovine animals and regarding the labelling of beef and beef products	-farm, barn location
SMR 8a	identification and registration of ovine and caprine animals and	-shed location
	Public plant and animal health	
SMR 9	placing of plant protection products on the market	NA
SMR 10	on the use in stock farming of certain substances having a hormonal or thyrostatic action and of betaagonists	NA

SMR 11	matters of food safety	NA
SMR 12	rules for the prevention, control and eradication of certain transmissible spongiform encephalopathies.	
	Notification of diseases	
SMR 13	Foot and Mouth Disease.	-farms' location
SMR 14	animal diseases and specific measures relating to swine vesicular disease.	-farms' location
SMR 15	Bluetongue disease	-farms' location
	Animal welfare	
SMR 16	calves	NA
SMR 17	pigs	NA
SMR 18	Protection of animals kept for farming purpose	NA

4.2.2. Therefore, in this package we can distinguish three spatial themes for SMRs to be modelled as three data classes/layers – NATURA2000, NitrateZones and AnimalFarms. These three can be further supported by layers for soil parameters (soil types, organic matter content, infiltration, porosity) and topographic/hydrological surfaces' parameters such as slope, ground water depth and depth of aquifer. This data originates from different external sources and is integrated into LPIS databases (ext classes in the model)

4.3.   Cross Compliance requirements: GAEC

4.3.1. The full list of GAEC that should be taken in to consideration in respect to direct payments and references to the regulatory acts establishing them can be found in Annex III of Council Reg. 73/2009. In table 4 we list them together with GI component they can contain.

Table 4: List of GAEC standards with geographic component (optional standards are in *Italic*)

Issue	Standards *(optional standards are in Italic)*	GI component
1.Soil erosion:	— Minimum soil cover — Minimum land management reflecting site-specific conditions — *Retain terraces*	Soil layer, slops, Landscape feature: terraces
2. Soil	— Arable stubble management	

organic matter:	— *Standards for crop rotations*	
3. Soil structure:	— *Appropriate machinery use*	
4. Minimum level of maintenance:	— Retention of landscape features, including, where appropriate, hedges, ponds, ditches, trees in line, in group or isolated and field margins (appl. 2010) — *Minimum livestock stocking rates or/and appropriate regimes* — *Establishment and/or retention of habitats(appl. 2010)* — Avoiding the encroachment of unwanted vegetation on agricultural land — *Prohibition of the grubbing up of olive trees* — Protection of permanent pasture — *Maintenance of olive groves and vines in good vegetative condition*	Landscape features' layer Orthophoto Permanent pasture registry
5. Protection and management of water:	— Establishment of buffer strips along water courses (app. 2012) — Where use of water for irrigation is subject to authorisation, compliance with authorization procedures (appl. 2010)	Network of water courses where measures applied, buffer strips

4.3.2. Therefore, in this package for SMR for GAEC we can identify following data classes/layers which belong to the general cartographic reference: orthophoto, soil type, slop, water courses (see also package CartographicReference). Layer(s) for retention of landscape features for standard 4 can be only managed by the IACS/LPIS custodian since these spatial feature are eligible for payment. Payments involve recording and location to enable inspection of the preservation. It is up to IACS/MoA authority to define scope and definition of landscape elements which are relevant.

4.3.3. GAEC standard 5 -Protection and management of water- is newly introduced after CAP Heath Check in 2009. Detailed implementation rules are not set up by now. The scope of water courses, where buffer strips should be applied is to be defined by MS in co-operation with authority responsible for Water Framework Directive implementation.

4.4. Cross compliance classes

CrossCompliance

Type: <u>*Package «Leaf»*</u>
Status: Version 1.1.
Package: LPIS
Last modified on: 04/12/2009
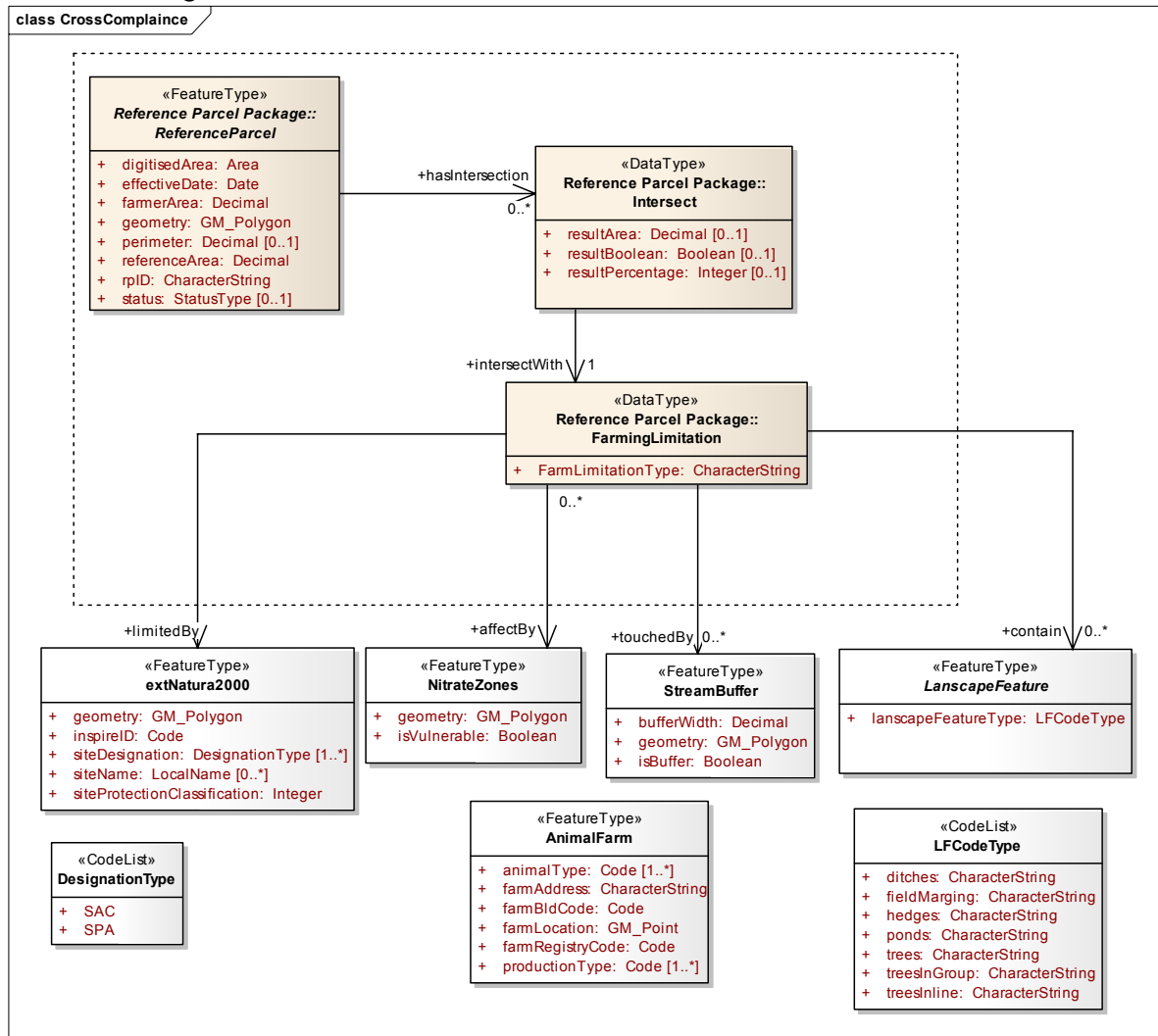*Created:* mars/sagris

Figure6. CrossComplaince
Last Modified: 07/12/2009 *Version:1.1* .

4.4.1. extNatura2000

Type: «FeatureType»
Package: CrossCompliance
Detail: *Last modified on 07/12/2009.*

Definition: A European Union-wide network of nature protection areas established under the 1992 Habitats Directive and the 1979 Birds Directive. An external class modeled in the INSPIRE theme Protected sites.

Associations

Connector	Source	Target	Constraint
Association	extNatura2000; role:limitedBy	FarmingLimitation; role:	

Attributes

Attribute	Notes
geometry : GM_Polygon	The geometry defining the boundary of the Protected Site
inspireID : Code	
siteDesignation : DesignationType [1..*]	The designation (type) of Protected Site. At least one designation is required, but designations may be available using a number of different designation schemes.
siteName : LocalName [0..*]	Geographical name of the protected site
siteProtectionClassification : Integer	The classification of the protected site based on the purpose for protection. The site may have more than one classification

NitrateZones

Type:	«FeatureType»
Package:	CrossCompliance
Detail:	*Last modified on 07/12/2009.*
Definition:	Nitrate Vulnerable Zones - combined index defining is area vulnerable for nitrate pollution; calculated from topographic and hydrological/ mechanical properties of land surface and soil, re-classified in two Boolean values: vulnerable/non-vulnerable. Usage: SMR4

class Nitrate Zones

«FeatureType»
NitrateZones

+   geometry: GM_Polygon
+   isVulnerable: Boolean
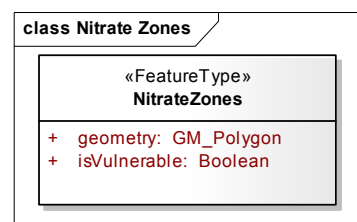
Associations

Connector	Source	Target	Constraint
Association	FarmingLimitation; role:	NitrateZones; role:affectBy	

Attributes

Attribute	Notes
geometry : GM_Polygon	
isVulnerable : Boolean	indicates is area vulnerable for nitrate pollution

4.4.2. AnimalFarm
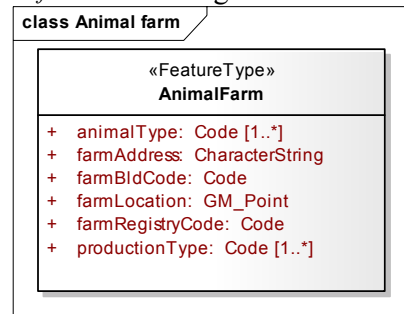
Type: «FeatureType»
Package: CrossCompliance
Detail: *Last modified on 07/12/2009.*
Definition: Agricultural facility for keeping animals

```
class Animal farm

    «FeatureType»
    AnimalFarm

+  animalType: Code [1..*]
+  farmAddress: CharacterString
+  farmBldCode: Code
+  farmLocation: GM_Point
+  farmRegistryCode: Code
+  productionType: Code [1..*]
```

Attributes

Attribute	Notes
farmLocation : GM_Point	Farm's location
farmRegistryCode : Code	registration code of the farm
farmBldCode : Code	registration code of the farm building
farmAddress : CharacterString	an address of the farm
animalType : Code [1..*]	type(s) of the animals on the farm
productionType : Code [1..*]	production type, e.g meat, milk, wool etc.

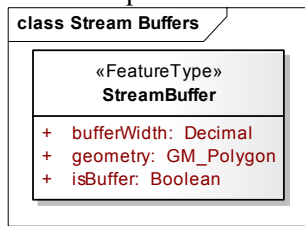### 4.4.3. StreamBuffer

Type: «FeatureType»
Package: CrossCompliance

Detail: *Last modified on 07/12/2009.*
Definition: GAEC 5 - establishment of buffer strips along water courses; polygon area including buffer strips' area around water courses

class Stream Buffers

«FeatureType»
StreamBuffer

+ bufferWidth: Decimal
+ geometry: GM_Polygon
+ isBuffer: Boolean

Associations

Connector	Source	Target	Constraint
Dependency	StreamBuffer; role:	WaterCourses; role:	
Association	StreamBuffer; role:touchedBy	FarmingLimitation; role:	

Attributes

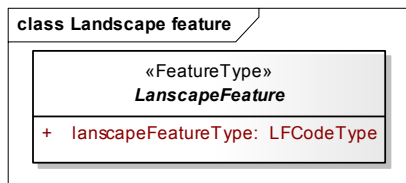| Attribute	Notes
geometry : GM_Polygon	
isBuffer : Boolean	polygon area including buffer strips' area around water courses
bufferWidth : Decimal	

4.4.4. LanscapeFeature

Type: «FeatureType»   Abstract
Package: CrossCompliance
Detail: *Last modified on 07/12/2009.*
Definition: An abstract class representing several possible layers of landscape elements recognised as features relevant to prevention of soil erosion (standard 1, optional) and/or to retention of landscape features important for agricultural practice and prevention of pollution, biodiversity (standard 4, appl from 2010) as well as landscape aesthetic or historical value (rural development).

class Landscape feature

«FeatureType»
LanscapeFeature

+ lanscapeFeatureType: LFCodeType

Associations

Connector	Source	Target	Constraint
Association	FarmingLimitation; role:	LanscapeFeature; role:contain	

Attribute	Notes
lanscapeFeatureType : LFCodeType	

4.5. Code lists

4.5.1. DesignationType

Type: «CodeList»
Package: CrossCompliance
Detail: *Last modified on 07/12/2009.*
Definition: indicative, external codelist (INSPIRE protected sites)

Attributes

Attribute	Notes
SPA :	Special Protection Areas for birds
SAC :	Special Areas of Conservation for habitats

4.5.2. LFCodeType

Type: «CodeList»
Package: CrossCompliance
Detail: *Last modified on 27/11/2009.*
Definition: indicative, can be extended by MS

Attributes

Attribute	Notes
hedges	
ponds	
ditches	
treesInline	
treesInGroup	
trees	
fieldMarging	

5.   Package Rural Development

5.1.   Requirements

5.1.1.   Regulatory framework for Rural Development support scheme consist of**:**

- Council Regulation 1698/2005 setting up provisions fro 2007-2013
- Commission Regulation 1974/2006 and 1975/2006

5.1.2.   From all the measures set up by those documents only measures of axes 2 of rural development scheme 'improving the environment and the countryside' have geographic component. Those measures are (1) handicap and mountain areas commonly known as less favoured areas and (2) areas of agri-enviromental measures, where farmers take environmental obligations not defined by of cross compliance and (3) afforestation measures.

Type: *Package «Leaf»*
Status: Version 1.1.
Package: LPIS
Last modified on: 04/12/2009
Created: mars/vsagris

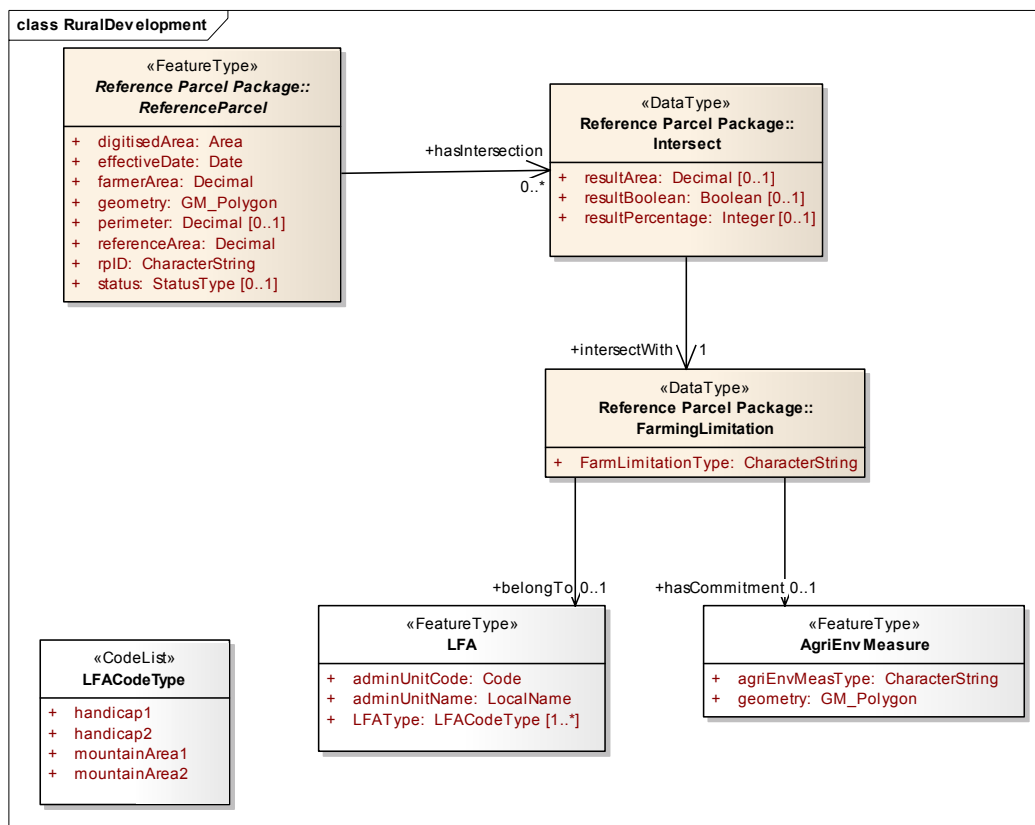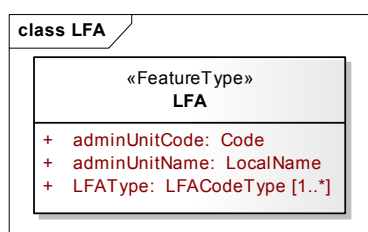Figure7. RuralDevelopment
Last Modified: 07/12/2009 *Version:1.1*

Package classes

5.1.3. LFA

Type: «FeatureType»
Package: RuralDevelopment
Detail: *Last modified on 07/12/2009.*
Definition: Less-favored Area. Areas where applied measures of axes 2 of rural development scheme: improving the environment and the countryside (Article 36Reg 1698/2005):
(i) natural handicap payments to farmers in mountain areas;
(ii) payments to farmers in areas with handicaps, other than mountain areas;
Each MS is in charge of its Rural Development plan, where LFA are defined at the level of settlements or municipalities. Administrative units assigned to belong by this document to LFA are explicitly listed in the annex to Rural Development plan.

```
class LFA

       «FeatureType»
           LFA

  +  adminUnitCode:  Code
  +  adminUnitName:  LocalName
  +  LFAType:  LFACodeType [1..*]
```

Associations

Connector	Source	Target	Constraint
Association	LFA; role:belongTo	FarmingLimitation; role:	

Attributes

Attribute	Notes
LFAType : LFACodeType [1..*]	type of LFA area (i) natural handicap in mountain areas or (ii) handicaps, other than mountain areas;
adminUnitName : LocalName	Geographical name of municipality
adminUnitCode : Code	NUTS code of municipality

5.1.4. AgriEnvMeasure

Type: «FeatureType»
Package: RuralDevelopment
Detail: *Last modified on 07/12/2009.*
Definition: Areas where applied measures of axes 2 of rural development scheme:
-measures targeting the sustainable use of forestry land through: (i) first afforestation of agricultural land; (ii) first establishment of agroforestry systems on agricultural land; (iii) first afforestation of non-agricultural land;
-improving the environment and the countryside: (iv) agri-environment payments (e.g. bio-farming)

```
class AEM

   «FeatureType»
   AgriEnvMeasure

+  agriEnvMeasType: CharacterString
+  geometry: GM_Polygon
```
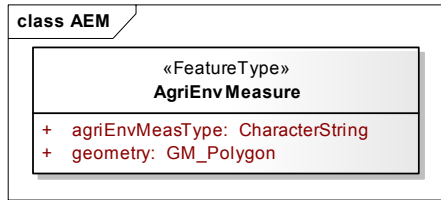
Associations

Connector	Source	Target	Constraint
Association	AgriEnvMeasure; role:hasCommitment	FarmingLimitation; role:	

Attributes

Attribute	Notes
geometry : GM_Polygon	
agriEnvMeasType : CharacterString	

5.2. Code Lists

5.2.1. LFACodeType

Type: «CodeList»
Package: RuralDevelopment
Detail: *Last modified on 07/12/2009.*
Definition: Art 50 Reg 1698/2005
                 In order to be eligible for payments provided for in Art 36 mountain areas shall be
                 characterised by a considerable limitation of the possibilities for using the land and
                 an appreciable increase in the cost of working

Attributes

Attribute	Notes
mountainArea1 :	**mountainArea1:** the existence, because of altitude, of very difficult climatic conditions, the effect of which is substantially to shorten the growing season;
mountainArea2 :	**mountainArea2:** at a lower altitude, the presence over the greater part of the area in question of slopes too steep for the use of machinery or requiring the use of very expensive special equipment, or a combination of these two factors, where the handicap resulting from each taken separately is less acute but the combination of the two gives rise to an equivalent handicap. Areas north of the 62nd parallel and certain adjacent areas shall be regarded as mountain areas

| Attribute	Notes
handicap1 :	**Handicap1**: affected by significant natural handicaps, notably a low soil productivity or poor climate conditions and where maintaining extensive farming activity is important for the management of the land;
handicap2 :	**Handicap2**: affected by specific handicaps, and where land management should be continued in order to conserve or improve the environment, maintain the countryside and preserve the tourist potential of the area or in order to protect the coastline

6. Package Cartographic Reference

6.1.1. The data sets of package Cartographic Reference do not correspond to any of the basic concepts specifically established the administration of subsidies, but they are explicitly referred to by the Art. 17 of the Council Reg (EC) No 73/2009:

> 'The identification system for agricultural parcels 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 techniques, including preferably aerial or spatial orthoimagery, with a homogenous standard guaranteeing accuracy at least equivalent to cartography at a scale of 1:10 000'

6.1.2. The main tasks of cartographic reference in IACS/LPIS are in support of (i) ensuring an appropriate currency of the LPIS information and (ii) improvement of the communication with the farmer via per-printed maps. The cartographic references can be roughly be divided into digital orthophoto imagery and cartographic map products at scale 1:10000 or more detailed. Since a majority of the MS chose for orthophoto imagery, a class DigitalOrthoPhoto is included into LCM.

6.1.3. Class DigitalOrthoPhoto
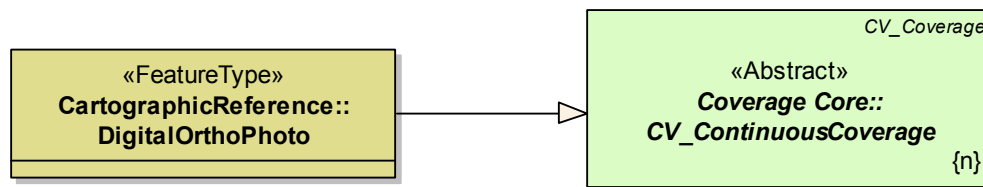
The most recent orthophoto imagery is the most widely used type of cartographic reference, and it is crucial for the determination of eligible land and prevailing conditions, as well as of for inspecting certain types of cross-compliance. The orthophoto imagery is a raster type of information and it is an implementation of the ISO standard 19123 Coverages. Instead it is supported by metadata specifying its quality such as spatial and radiometric resolution, acquisition date etc.. On orthoimagery specification for LPIS purposes see [10].

6.1.4. Class TopoMap.

Topographic maps have a much longer revision cycle than orthophotos imagery. In the case of a topographic map, the original application schema of that cartographic product should be integrated into the LPIS schema: the class topoMap is an aggregation of geographic features conventionally included into topographic map. In Figure 6 the two features are demonstrated: water courses and administrative units, both can be used for checking cross compliance and rural development payments. Topographic map features can be also used for extraction of information e.g. on land cover in order to facilitated definition of eligible land for reference parcel

layer. In this case, clear mapping of semantic between land cover/land use classification of topographic map and eligible land types should be undertaking. Alternatively, scanned topographic maps can be represented as raster coverages, very similar to the class DigitalOrthoPhoto.

6.1.5. The Cartographic Reference package can also include other data sets, not explicitly referred to by the Regulations, but used for various purposes of administrative and/or topographic reference, and supporting information on cross compliance and rural development (cadastral district, altitude, slope, etc.). Some of examples can be found in figure 6, but number of classes can considerably vary from one MS to an other.
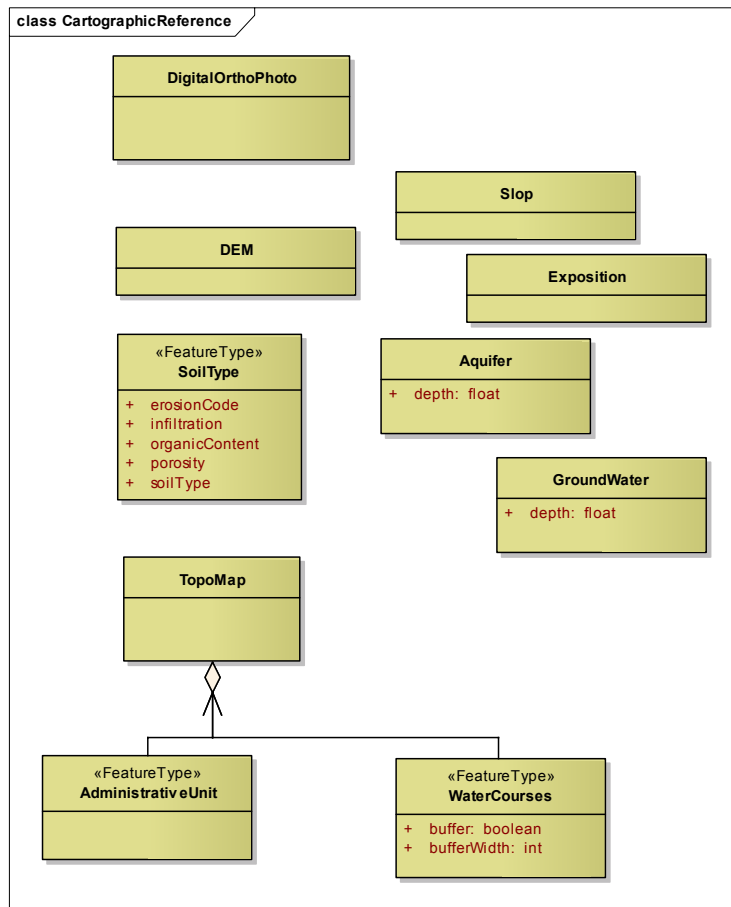
Figure 8. Package Cartographic reference

Annex A. UML notations

A.1   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:
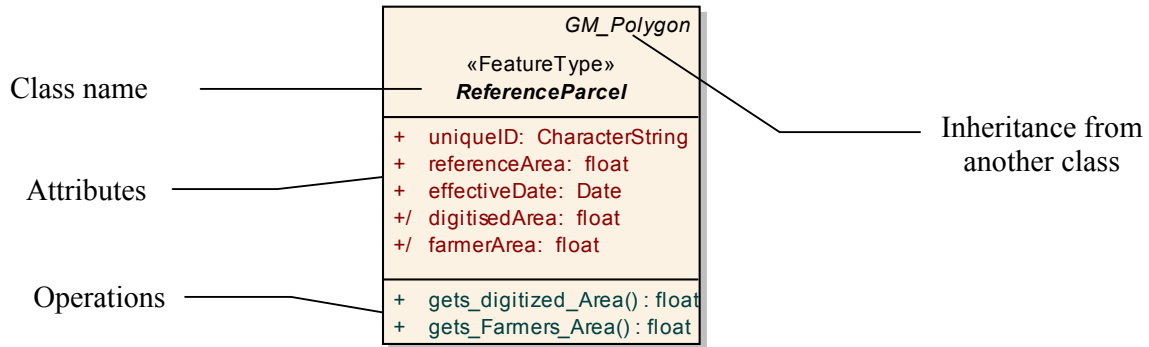
class

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

relationship

semantic connection among model elements. – 5 types of relationship make up the majority of these connections

association

        semantic relationship between two or more classes that specifies links among their instances

aggregation

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

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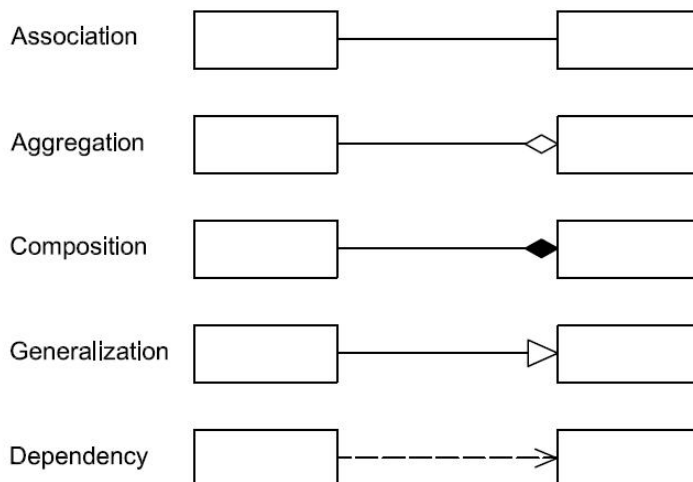
        form of aggregation which requires that a part instance be included in at most one composite at a time, and that the composite object is responsible for the creation and destruction of the parts. Composition may be recursive.

generalization

        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.
        The inverse of generalization is called " specialisation". A specialist element must "inherit" at least one attribute or operation from the general element

dependency

        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).
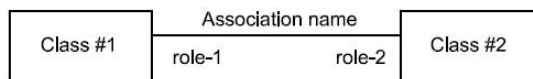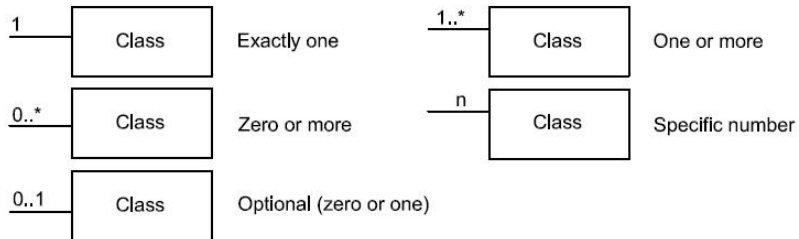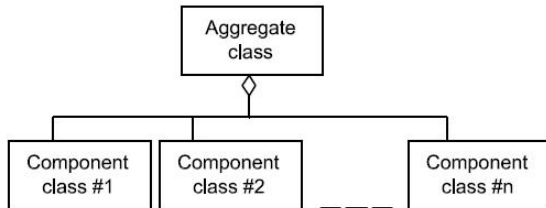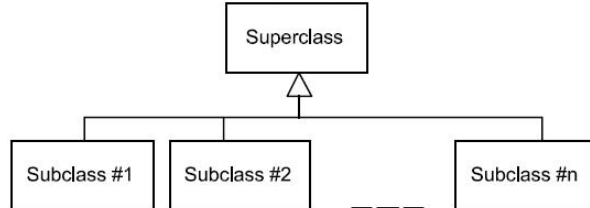
Annex B. Application Schema

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!-- edited with XMLSpy v2009 (http://www.altova.com) by Valentina Sagris (European
Commission DIGIT/A/2) -->
<schema xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:gml="http://www.opengis.net/gml" xmlns:lcm="http://mars.jrc.ec.europa.eu/geoCAP/lcm"
targetNamespace="http://mars.jrc.ec.europa.eu/geoCAP/lcm" elementFormDefault="qualified"
version="1.1">
        <annotation>
                <documentation>application schema for LPIS</documentation>
        </annotation>
        <import namespace="http://www.opengis.net/gml"
schemaLocation="./schema/gml/3.1.1/base/gml.xsd"/>
        <include schemaLocation="lcm.xsd"/>
        <include schemaLocation="lcm.xsd"/>
        <!--XML Schema document created by ShapeChange-->
        <!--Reference parcel package-->
        <element name="ReferenceParcel" type="lcm:ReferenceParcelType" abstract="true"
substitutionGroup="gml:_Feature"/>
        <complexType name="ReferenceParcelType" abstract="true">
                <annotation>
                        <documentation>Basic spatial unit for the administration and geographical
localisation of agricultural parcels.  May contain one or more agricultural paracels and may be
cultivated by one or more farmers (or producers association). Does not necessiraly cover a territory
nationwide, but overlaps are not allowed.  Parent class of: CadSuBParcel, AgrParcel, FarBlock and
PhyBlock
</documentation>
                </annotation>
                <complexContent>
                        <extension base="gml:AbstractFeatureType">
                                <sequence>
                                        <element name="geometry"/>
                                        <element name="rpID" type="string"/>
                                        <element name="referenceArea" type="double"/>
                                        <element name="effectiveDate" type="date"/>
                                        <element name="digitisedArea" type="gml:AreaType"/>
                                        <element name="farmerArea" type="double"/>
                                        <element name="perimeter" type="double" minOccurs="0"/>
                                        <element name="status" type="gml:CodeType"
minOccurs="0"/>
                                        <element name="hasIntersection" minOccurs="0"
maxOccurs="unbounded">
                                                <complexType>
                                                        <sequence>
                                                                <element ref="lcm:Intersect"/>
                                                        </sequence>
                                                </complexType>
```

```xml
            </element>
          </sequence>
        </extension>
      </complexContent>
    </complexType>
    <element name="AgrParcel" type="lcm:AgrParcelType" substitutionGroup="lcm:ReferenceParcel"/>
    <complexType name="AgrParcelType">
      <annotation>
        <documentation>Reference parcel containing only one production unit/agricultural parcel - continuous area of agricultural land on which a single crop group is cultivated by a single farmer.
</documentation>
      </annotation>
      <complexContent>
        <extension base="lcm:ReferenceParcelType">
          <sequence>
            <element name="farmID" type="string"/>
            <element name="landCoverType" type="gml:CodeType"/>
            <element name="declaredArea" type="double"/>
            <element name="cropType" type="gml:CodeType" maxOccurs="unbounded"/>
            <element name="paymentType" type="gml:CodeType" minOccurs="0"/>
            <element name="agroEnvMeasureType" type="gml:CodeType" minOccurs="0"/>
          </sequence>
        </extension>
      </complexContent>
    </complexType>
    <element name="FarBlock" type="lcm:FarBlockType" substitutionGroup="lcm:ReferenceParcel"/>
    <complexType name="FarBlockType">
      <annotation>
        <documentation>A continuous area of agricultural land grouping together a number of neighbouring agricultural parcels cultivated by the same farmer. In other words, production block, which contains several adjusent production units of the farmer.
</documentation>
      </annotation>
      <complexContent>
        <extension base="lcm:ReferenceParcelType">
          <sequence>
            <element name="farmID" type="string"/>
            <element name="landCoverType" type="gml:CodeType"/>
            <element name="farmingMode" minOccurs="0"/>
          </sequence>
        </extension>
      </complexContent>
    </complexType>
```

```xml
<element name="PhyBlock" type="lcm:PhyBlockType"
substitutionGroup="lcm:ReferenceParcel"/>
    <complexType name="PhyBlockType">
        <annotation>
            <documentation>A continuous area of agricultural land (production block)
grouping together a number of neighbouring agricultural parcels (production units) cultivated by
one or more farmer(s) and delineated by most stable boundaries.
</documentation>
        </annotation>
        <complexContent>
            <extension base="lcm:ReferenceParcelType">
                <sequence>
                    <element name="landCoverType" type="gml:CodeType"
minOccurs="0"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <element name="TopoBlock" type="lcm:TopoBlockType"
substitutionGroup="lcm:ReferenceParcel"/>
    <complexType name="TopoBlockType">
        <complexContent>
            <extension base="lcm:ReferenceParcelType">
                <sequence>
                    <element name="dominantLandCover"
type="gml:CodeType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <element name="CadSubParcel" type="lcm:CadSubParcelType"
substitutionGroup="lcm:ReferenceParcel"/>
    <complexType name="CadSubParcelType">
        <annotation>
            <documentation>Unit of agricultural or non-agricultural land cover inside of
cadastral parcel. Class has topological relation with &lt;b&gt;CadastralParcel&lt;/b&gt;, which
compose from one or many SubParcels
</documentation>
        </annotation>
        <complexContent>
            <extension base="lcm:ReferenceParcelType">
                <sequence>
                    <element name="landCoverType" type="gml:CodeType"/>
                    <element name="sprID" type="string"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
```

```xml
<element name="extCadParcel" type="lcm:extCadParcelType"
substitutionGroup="gml:_Feature"/>
<complexType name="extCadParcelType">
    <annotation>
        <documentation>An external class, mantained outside AICS/LPIS.
A single area of land or more particularly a volume of space, under homogeneous real property
rights and unique ownership. Basic unit of teh Cadastre System - the register under responsibility of
MS with purpose to provide their citizen stability and security in real property ownership.
Homogeneous nationwide coverage, overlaps are not allowed. Contains agricultural and non-
agricultural land.
</documentation>
    </annotation>
    <complexContent>
        <extension base="gml:AbstractFeatureType">
            <sequence>
                <element name="cdID" type="string"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
<element name="Intersect" type="lcm:IntersectType"/>
<complexType name="IntersectType">
    <sequence>
        <element name="resultBoolean" type="boolean" minOccurs="0"/>
        <element name="resultArea" type="double" minOccurs="0"/>
        <element name="resultPercentage" type="integer" minOccurs="0"/>
        <element name="intersectWith">
            <complexType>
                <sequence>
                    <element ref="lcm:FarmingLimitation"/>
                </sequence>
            </complexType>
        </element>
    </sequence>
</complexType>
<element name="FarmingLimitation" type="lcm:FarmingLimitationType"/>
<complexType name="FarmingLimitationType">
    <sequence>
        <element name="FarmLimitationType" type="string"/>
        <element name="belongTo" minOccurs="0">
            <complexType>
                <sequence minOccurs="0">
                    <element ref="lcm:LFA"/>
                </sequence>
                <attributeGroup ref="gml:AssociationAttributeGroup"/>
            </complexType>
        </element>
        <element name="hasCommitment" minOccurs="0">
            <complexType>
```

```xml
                                <sequence minOccurs="0">
                                        <element ref="lcm:AgriEnvMeasure"/>
                                </sequence>
                                <attributeGroup ref="gml:AssociationAttributeGroup"/>
                        </complexType>
                </element>
                <element name="affectBy" minOccurs="0" maxOccurs="unbounded">
                        <complexType>
                                <sequence minOccurs="0">
                                        <element ref="lcm:NitrateZones"/>
                                </sequence>
                                <attributeGroup ref="gml:AssociationAttributeGroup"/>
                        </complexType>
                </element>
                <element name="contain" minOccurs="0" maxOccurs="unbounded">
                        <complexType>
                                <sequence minOccurs="0">
                                        <element ref="lcm:LanscapeFeature"/>
                                </sequence>
                                <attributeGroup ref="gml:AssociationAttributeGroup"/>
                        </complexType>
                </element>
                <element name="limitedBy" minOccurs="0" maxOccurs="unbounded">
                        <complexType>
                                <sequence minOccurs="0">
                                        <element ref="lcm:extNatura2000"/>
                                </sequence>
                                <attributeGroup ref="gml:AssociationAttributeGroup"/>
                        </complexType>
                </element>
                <element name="touchedBy" minOccurs="0" maxOccurs="unbounded">
                        <complexType>
                                <sequence minOccurs="0">
                                        <element ref="lcm:StreamBuffer"/>
                                </sequence>
                                <attributeGroup ref="gml:AssociationAttributeGroup"/>
                        </complexType>
                </element>
                </sequence>
        </complexType>
        <!--CC and RD packages-->
        <element name="AnimalFarm" type="lcm:AnimalFarmType"
substitutionGroup="gml:_Feature"/>
        <complexType name="AnimalFarmType">
                <annotation>
                        <documentation>Agricultural facility for keeping animals
</documentation>
                </annotation>
                <complexContent>
```

```xml
                    <extension base="gml:AbstractFeatureType">
                            <sequence>
                                    <element name="farmRegistryCode"/>
                                    <element name="farmBldCode"/>
                                    <element name="farmAddress" type="string"/>
                                    <element name="animalType" maxOccurs="unbounded"/>
                                    <element name="productionType"/>
                                    <element name="farmLocation"
type="gml:PointPropertyType"/>
                            </sequence>
                    </extension>
            </complexContent>
    </complexType>
    <element name="NitrateZones" type="lcm:NitrateZonesType"
substitutionGroup="gml:_Feature"/>
    <complexType name="NitrateZonesType">
            <annotation>
                    <documentation>Nitrate Vulnerable Zones - combined index defining is area
vulnerable for nitrate pollution; calculated from topographic and hydrological/ mechanical
properties of land surface and soil, re-classified in two Boolean values: vulnerable/non-vulnerable.
Usage: SMR4
</documentation>
            </annotation>
            <complexContent>
                    <extension base="gml:AbstractFeatureType">
                            <sequence>
                                    <element name="geometry"/>
                                    <element name="isVulnerable" type="boolean"/>
                            </sequence>
                    </extension>
            </complexContent>
    </complexType>
    <element name="extNatura2000" type="lcm:extNatura2000Type"
substitutionGroup="gml:_Feature"/>
    <complexType name="extNatura2000Type">
            <annotation>
                    <documentation>A European Union-wide network of nature protection areas
established under the 1992 Habitats Directive and the 1979 Birds Directive.
</documentation>
            </annotation>
            <complexContent>
                    <extension base="gml:AbstractFeatureType">
                            <sequence>
                                    <element name="geometry"/>
                                    <element name="inspireID"/>
                                    <element name="siteDesignation" type="gml:CodeType"
maxOccurs="unbounded"/>
                                    <element name="siteName" type="gml:CodeType"
minOccurs="0" maxOccurs="unbounded"/>
```

```xml
                              <element name="siteProtectionClassification"
type="integer"/>
                        </sequence>
                    </extension>
                </complexContent>
        </complexType>
        <element name="StreamBuffer" type="lcm:StreamBufferType"
substitutionGroup="gml:_Feature"/>
        <complexType name="StreamBufferType">
            <annotation>
                <documentation>GAEC 5 - establishment of buffer strips along water
courses; polygon area including buffer strips' area around water courses
</documentation>
            </annotation>
            <complexContent>
                <extension base="gml:AbstractFeatureType">
                    <sequence>
                        <element name="geometry"/>
                        <element name="isBuffer" type="boolean"/>
                        <element name="bufferWidth" type="double"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <element name="LanscapeFeature" type="lcm:LanscapeFeatureType" abstract="true"
substitutionGroup="gml:_Feature"/>
        <complexType name="LanscapeFeatureType" abstract="true">
            <annotation>
                <documentation>Abstract class representing several possible layers of
landscape elements recognised as features relevant to prevention of soil erosion (standard 1,
optional) and/or to retention of landscape features important for agricultural practice and prevention
of pollution, biodiversity (standard 4, appl from 2010) as well as landscape aesthetic or historical
value (rural development).
</documentation>
            </annotation>
            <complexContent>
                <extension base="gml:AbstractFeatureType">
                    <sequence>
                        <element name="lanscapeFeatureType"
type="gml:CodeType"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
        <element name="LFA" type="lcm:LFAType" substitutionGroup="gml:_Feature"/>
        <complexType name="LFAType">
            <annotation>
```

```xml
                        <documentation>Less-Favoured Area in context of agriculture. Areas where
applied measures of axes 2 of rural development scheme: improving the environment and the
countryside (Article 36Reg 1698/2005):
(i) natural handicap payments to farmers in mountain areas;
(ii) payments to farmers in areas with handicaps, other than mountain areas;
Each MS is in charge of its Rural Development plan, where LFA are defined at the level of
settlements or municipalities. Administrative units assigned to belong by this document to LFA are
explicitly listed in the annex to Rural Development plan.
</documentation>
                </annotation>
                <complexContent>
                        <extension base="gml:AbstractFeatureType">
                                <sequence>
                                        <element name="LFAType" type="gml:CodeType"
maxOccurs="unbounded"/>
                                        <element name="adminUnitName" type="gml:CodeType"/>
                                        <element name="adminUnitCode"/>
                                </sequence>
                        </extension>
                </complexContent>
        </complexType>
        <element name="AgriEnvMeasure" type="lcm:AgriEnvMeasureType"
substitutionGroup="gml:_Feature"/>
        <complexType name="AgriEnvMeasureType">
                <annotation>
                        <documentation>Areas where applied measures of axes 2 of rural
development scheme:
&lt;ol&gt;
        &lt;li&gt;measures targeting the sustainable use of forestry land through: (i) first
afforestation of agricultural land; (ii) first establishment of agroforestry systems on agricultural
land; (iii) first afforestation of non-agricultural land;&lt;/li&gt;
        &lt;li&gt;improving the environment and the countryside: (iv) agri-environment payments
(e.g. bio-farming)&lt;/li&gt;
&lt;/ol&gt;</documentation>
                </annotation>
                <complexContent>
                        <extension base="gml:AbstractFeatureType">
                                <sequence>
                                        <element name="geometry"/>
                                        <element name="agriEnvMeasType" type="string"/>
                                </sequence>
                        </extension>
                </complexContent>
        </complexType>
</schema>
```

 (end document)

Abstract

This specification is a part of the Quality Assurance (QA) framework for LPIS, which is currently under development in the JRC. The LPIS Core Model (LCM) specification together with guidelines for the Abstract Tests Suite constitutes the main documentation for testing of LPIS implementation conformance against the outlined requirements.

The LCM version 1.0 was developed from the first-cut version announced in 2007 and further published via the wikiCAP portal for comments of the LPIS experts in January 2008. Further, during 2009, several consultations and testing in member states were undertook for different types of land reference parcels.
The current version (1.1) of the LCM is designed to be fit in the LPIS testbed project that establishes Web based infrastructure allowing testing of MS databases' currency and quality in the Quality Assurance Framework. It is envisaged to establish several WMS, WFS and WTS; therefore, the LCM should support on-line mapping and transformation of the national application schemas. For this purpose, LCM is fully compatible with GML, and current specification includes an example of GML application schema.

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