

# LADM as a Basis for the Hellenic Archaeological Cadastre

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**Key words:** Hellenic Archaeological Cadastre (HAC), Hellenic Cadastre (HC), Cultural Heritage, Land Administration Domain Model (LADM)

## SUMMARY

Greece consists of a complex-structured environment, with horizontal, vertical and mixed properties in which is exercised a variety of property rights. The Hellenic Cadastre (HC) applies to a two-dimensional registration system, with the property being the core of the system and quest of the legal information (Tsiliakou and Dimopoulou, 2011). Special property objects such as cultural monuments and areas of cultural and archaeological interest are numerous all over the country but not registered in detail. In order to cover the necessity for registration and protection of the antiquities, an Archaeological Cadastre Project is being implemented. The Hellenic Archaeological Cadastre (HAC) is an ongoing project for the digital registration of the cultural heritage of Greece, together with the recordation of property rights exercised in such areas and the clarification of the ownership status. The main goal of the project is the creation of a management tool for the protection of the cultural heritage, with explicit and quantitative features for the cultural reserve of the country.

This paper aims to explore the possibilities of applying international standards and especially the Land Administration Domain Model (LADM), in the Hellenic Archaeological Cadastre. Modeling the archaeological space and its constraints with LADM, could lead to the integration of a cadastral system that reflects the property ownership status for public and private properties with archaeological interest, based on the international experience. A second goal is the improvement of the Archaeological Cadastre core model. The adjustment of international standards in modeling could be the link between the meeting of international requirements of land administration and the right protection of the archaeological space. In international trends, there are many standards used for the documentation of the cultural heritage, mostly aiming to record cultural objects. As mentioned, the LADM is used in order to explore the property dimension of the cultural environment. Using the terminology proposed through the LADM model is a challenge that this paper aims to accept.

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## 1. INTRODUCTION

The Greek civilization is important and affected the evolution of European cultures, contributing to modern western civilizations. Political ideas, such as democracy, philosophy, sciences, architecture and cultural heritage, are all representatives of the rich Greek civilization. In modern times the remaining Greek cultural heritage is considered to be world heritage, due to the importance and the oldness of the antiquities, gathering the global interest of people, who travel in Greece to visit them.

The protection of cultural heritage is being fortified by the Greek Constitution since the establishment of the Greek State in 1831. Until nowadays, many types of legislation have been issued in order to contribute to the conservation of the cultural features in the Greek social and economic life of Greece, all tucked under the title ‘Archaeological Legislature’. The Greek State has encompassed all the international conventions, declarations, agreements and European directives concerning the protection of all aspects of cultural heritage in the legislation, e.g. Convention for the Protection of World Natural and Cultural Heritage (UNESCO, 1972), European Conventions for the Protection of the Archaeological Heritage (European Union, 1969, 2001) etc. However, the adoption of laws confronts many problems, such as the inadequacy of protecting the public space, which leads to infringement by the individuals, the bad conservation of the antiquities and most important, the lack of efficient management structures to the protection services.

As the archaeological space in Greece is vital for the conservation of the antiquities, the implementation of a special cadastre, such as the Archaeological Cadastre, reflects the necessity for a system for efficient land administration.

The implementation of a cadastral system that includes immovable antiquities with terms of LADM should reflect land administration and management needs and clarification of property ownership status. The information produced should be accessible to both government and citizens. Providing accessible information to people for ‘land relationships’ is crucial for sustainable economic and infrastructural development and interrelated spatial planning (Lemmen, 2012). The core model of LADM also gives the opportunity to the Greek cadastral systems to adjust to international experience and good practices. The effort for harmonization is worth-making.

## **2. THE HELLENIC ARCHAEOLOGICAL CADASTRE**

### **2.1 The Problem of immovable antiquities**

The protection of the antiquities is considered to be right and responsibility for the State at the same time. Most of the monuments are under the protection of the Ministry of Education, Religions, Culture and Sports and mainly under the responsibility of the Section of Culture (Former Ministry of Culture and Tourism). The Section is divided in management directions that are occupied with the conservation of classical, Byzantine and After-Byzantine antiquities, ancient and modern cultural objects and their documentation and museums. Furthermore, other public services are responsible for cultural monuments, such as monuments of war (Ministry of National Defense), architectural buildings and traditional houses (Ministry of Environment, Energy and Climate Change). There is a variety of ancient objects in the Greek territory, divided in three categories:

- immovable property, such as archaeological sites, ancient and modern monuments, historic places, traditional villages, fortresses etc
- movable objects, such as tools, pots, coins and ancient findings that can be transferred
- non material antiquities, such as language idioms, traditional songs, customs and everything that is considered people's intellectual property

Discussing about immovable antiquities, many problems arise due to their existence in the place. These problems are mainly related to the bad management of the protection services and the restrictions created in the use of land. As mentioned, there is not one protection service for the whole of the cultural heritage. Therefore, there is not a unified organizational structure, under which legislation could be applied for the best management of cultural objects. As a result, the collaboration is difficult and the extent of the public and private property with cultural interest is unknown. Concerning the use of land, it is common that owners of parcels with antiquities discovered are obliged to pay for the excavation, which could take long time to be completed. In some cases, ancient findings in private properties are important examples of the Greek civilization, leading to expropriation, a process that means that the owner loses every right in his property. Even if the findings are not so important and the owner keeps the right to use his property, many restrictions appear in this use, for example the construction of a building should not affect the ancient monument, the commonplace is limited etc. Other problems that appear are related to the construction of linear works like motorways, railways and metro lines, where ancient findings come to the light, causing delay to the completion of the works. Distortion of the architectural features of traditional villages and neglect of historical buildings or antiquities in basements are also problems to be faced.

### **2.2 The Lack of National Cadastre**

The Hellenic Cadastre Project is being implemented over the last few years. The registration concerns all the rights exercised by the owners to their properties, including those with archaeological interest, public or private. As the National Cadastre is not yet completed, there is not ownership status information about these properties which are mainly public. The fact that the public property is not yet recorded in its whole in a national scale means that there is no knowledge for its extent, leading to infringement from individuals. When infringement happens in areas with archaeological findings, the land uses are far different from the uses the law accepts. Arbitrary buildings (see Figure 1) do not assist the promotion of archaeological

monuments and their inclusion to world heritage lists. Furthermore, the protection services have no access to property information such as the range of rights, restrictions and responsibilities exercised, the boundaries of the public and private parcels, the illegal uses of land and the protection framework the antiquities should follow.



**Figure 1 Arbitrary buildings next to the archaeological site of Knossos**  
(source: <http://odysseus.culture.gr>)

### **2.3 The Project of Archaeological Cadastre**

The Archaeological Cadastre Project includes the first attempt of the Greek State to record and document the public and private real estate property, which involves archaeological and architectural interest. According to the Hellenic Ministry of Education, Religions, Culture and Sports, the Archaeological Cadastre is a complete and systematic survey, codification and recordation of data for properties that belong to the Ministry, mainly for archaeological purposes and which are part of the public or private property of the Public Sector. It includes archaeological sites, historic places and all protected locations of the cultural environment and all monuments of the country, dating back to the ancient times until nowadays, with the outer goal of recording the quantity of the natural, legal and socioeconomic situation of the above cultural reserve (source [www.archaeocadastre.gr](http://www.archaeocadastre.gr)).

The main goal of the project is the creation of a management tool for the protection of the cultural heritage, with explicit and quantitative features for the cultural reserve of the country. This tool will be able to offer citizens valuable information about the cultural heritage, leading to faster transactions with the state services. Direct information about property with antiquities will also lead to resolving matters concerning the public and private real estate, which is of high importance for the smooth flow of the state transactions. At this time, both state and owners will have knowledge of the limits of the archaeological space and of the rights and restrictions they have.

#### **2.3.1 Database structure and operation**

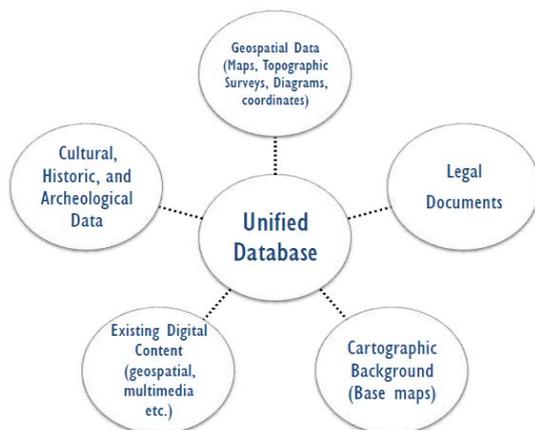
The HAC is being implemented by the Ministry of Education, Religions, Culture and Sports and specifically by the Management Direction of Expropriation and Immovable Property of the former Ministry of Culture and Tourism. It consists of a wide database system, in which properties with cultural features will be incorporated. Furthermore, information for the clarification of the protection status of the above properties and the protection zones around

them will be included. The system is based on a geographic information management model, which includes special information about the properties with archaeological interest. The properties recorded are divided in the following basic categories:

- Immovable Monuments, of the Prehistoric, Classical, Byzantine, After-byzantine or Modern period
- Immovable Property of the Public Sector, such as parcels with historic buildings
- Areas of Cultural Environment that need protection, such as the archaeological sites with the protection zones around them, the protection zones around monuments and the historic places

The department collaborates with other services such as the Hellenic Cadastre, who provides the cartographic background, mainly with orthophotomaps, for the creation of the archaeological map of the country with maps and aerophotographs, the Hydrographic Military Service, providing information about the protection zones of submarine archaeological sites and other services such as the National Monuments Archive and the Archaeological Resources Fund.

All registrations for the properties are organized in two levels, the descriptive and the geospatial level. Initially the property is being categorized in the first level which embeds archaeological, historical, legal and administrative information together with descriptive documentation for the parcels. Problems such as clarification of the expropriation of the parcel for the public benefit or the type of buildings existing in the parcel are being resolved in this stage. Furthermore, details for the antiquities inside the parcels, the legal frame of their protection and their administrative status are being recorded. The geospatial level includes procedures of identification and delimitation of the parcel boundaries and is based on maps and orthophotographs of 2007-2009, as well as on Google maps; see Figure 2. At the same time, the quality, availability and credibility of the data is being checked concerning intellectual property rights.



**Figure 2. Database information types and structure (source: Hellenic Ministry of Culture)**

The HAC is being implemented in three stages. The first stage involves an archaeological labor working team, responsible for procedures of preparation of the collected data, together with quality control of the system and its content. The second stage is called intermediate

management system. Collection of archive material, cataloguing monuments, sites and real property and quantification of data are the core of this stage. The last stage is the implementation of an Integrated Information System by an external contractor. At this point there will be a digitalization of the archives collected such as maps or survey plans on a GIS system with functionality. This means that raster data will be vectorized and georeferenced, with topologies built as well. For the best coordination of data, spatial positioning and field surveying is being implemented. The complete Integrated Information System will provide spatial data infrastructure for archaeological, architectural and historic information, with the overall of a geoportal, for the better dissemination of the information. After its integration, the Archaeological Cadastre will serve as a multipurpose development tool as follows:

- By managing the cultural heritage with modern technological means, which protect the archaeological space and the invaluable antiquities
- By assuring the public real property and making difficult the possible infringement of public space
- By creating the online archaeological map of the country, one of the most important touristic tool for citizens and tourists that want to visit Greece

### **3. THE INTERNATIONAL STATE OF THE ART**

#### **3.1 International trends in modeling cadastral systems**

Every country has developed its own cadastral system in order to detect and record the ownership rights and restrictions that arise from land property. Each system created is depended on the needs of national cadastre and should be flexible enough to answer in any time and with a precise way questions such as who is responsible for the management of the system, which is the range of rights appeared in land property and how reliable all this information is (Zentelis, 2011).

Today the international trends endorse the standardization of cadastral systems with the use of internationally recognized standards. Standards are widely used to form conceptual models for cadastral or other land management systems due to their efficiency and the possibilities they offer for communication between information systems based on a common language. Their structure focuses on the identification of objects, transactions and relationships between them, such as the rights, restrictions and responsibilities existing, the land value and the map representation. They support non-person-centralized systems and describe spatially the geometry of land parcels, leading to the creation of common Spatial Data Infrastructure (SDI). Harmonization of spatial data is also a policy of the European Union in support to the implementation of environmental policies (INSPIRE Directive). Therefore, the spatial referencing is of high importance, as it involves a spatial description of the relationships between people and land, which can lead to sustainable governance, such as infrastructural development, interrelated spatial planning, resource and environmental management and disaster management (Lemmen, 2012).

The standardization leads to the formation of the core model. This process consists of four stages, with the model used to specify the different levels of maturity. These levels are Standards, Connectivity, Integration and Network (van Osterom et al, 2009). The first stage

implies the setting of the standards that will be used to form the core model. Connectivity is the second stage in which different organizations or countries can be connected with each other. Their communication is based on exchanging information about Land Administration, both legal and spatial. The integration of the above information leads to the formation of Land Administration Information Infrastructure which starts to act as a whole. At the final level of networking there is the infrastructure for decision-making for social themes, such as urban planning, water management and public safety.

### **3.2 The use of standards in the documentation of the cultural heritage**

The protection of cultural heritage is a large field of discussion today. International organizations such as UNESCO play an important role to the promotion of conventions and directions concerning the preservation of the archaeological heritage, the architectural monuments, the historic places etc. The last few years, experts in the field have recognized the importance of Information Technologies (IT) in cataloguing, archiving and conserving antiquities, monuments and generally cultural assets.

Due to the lack of organized and standardized methods of recording cultural heritage, modern trends show the way to the development of globally accepted standards. Applying these standards means that specialists such as archaeologists, maintainers or engineers are enabled to record the cultural heritage with an integrated formula. A standard in modeling the cultural heritage can be defined as a set of regulations for the correct development and protection of digital data produced by the recordation and documentation of cultural objects. These standards can help all experts involved in the restoration, archiving and monitoring of the history of mankind and secure this for the future (Ioannides et al, 2005).

The use of common prototypes in documentation of the cultural information is of high importance, as they help the past be connected with the present. This fact boosts the value of cultural heritage in time, as the cultural exchange is achieved. International regulations have been determined since the second half of the last century, e.g. NEPA 1969, OPN 11.03 1980, for the monitoring and assessing of the side effects of development activities to the cultural environment. Nevertheless, ISOs are being used over the last few years. International standards in cultural heritage aim to provide a commonly shared vocabulary for its scientific documentation. Labors such as gathering of information, detailed documentation and proper management are being performed through procedures based on technology, e.g. databases and GIS, creating digital archives.

### **3.3 The Land Administration Domain Model (LADM)**

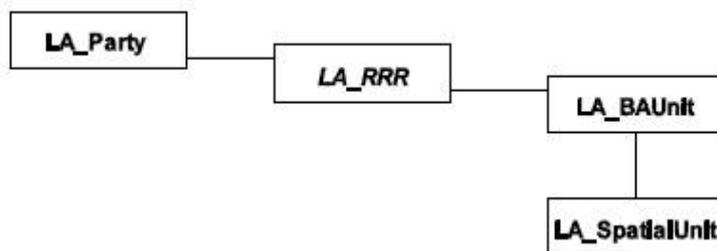
The LADM is a conceptual model formed to provide a formal language for the description of existing cadastral systems, so that their similarities and differences can be better understood (Text for ISO/FDIS 19152). The LADM is officially recognized from the International Standards Organization (ISO 19152, 1<sup>st</sup> November 2012). Most countries have implemented their own land administration system by integrating cadastral systems. The different implementations do not make meaningful communication across borders easy. As mentioned, the LADM does not wish to replace those cadastral systems, but to provide a prototype for their common representation, which can lead to the communication between

organizations and services. At the same time, the communication between systems should be achieved by using an internationally shared vocabulary.

The main scope of LADM is to define a reference model that will cover basic information-related components of Land Administration, including those over water and land and elements above and below the surface of the earth (Text for ISO/FDIS 19152). The conceptual model consists of four groups of components:

- parties, that means people and organizations that perform transactions basic administrative units, that include ownership rights such as rights, restrictions and responsibilities
- spatial units, mostly parcels and the legal space of buildings and utility networks
- spatial sources, such as surveying procedures and their spatial representations (geometry and topology)

The standard offers all the terminology needed for sharing description of different formal or informal procedures in various jurisdictions. Furthermore, it provides a conceptual basis for the formation of national or regional profiles and promotes the combining of land administration information from different sources with cohesion. The conceptual schema of the core model is based on a Model Driven Architecture (MDA) structure, in which all groups of information are related with each other, forming a land administration and management system. In the system, rights, restrictions and responsibilities are appeared for each spatial unit that belongs to a party. The ownership status of the spatial unit is demonstrated with administrative information, represented by the administrative unit; see Figure 3.



**Figure 3. The core model of LADM (source: Text for ISO/FDIS 19152)**

The LADM is organized based on the features of the classes into three packages and one subpackage. A subpackage is a group of classes with a certain degree of cohesion. The classes have the prefix ‘LA\_’; see Figure 4. The core model can also represent a cadastral database a single moment in the past, by using the special class Versioned Object for every class of the system. The use of the Versioned Object class leads to management and maintaining of historical data of the database, with a certain time-stamp; see figure 5. Furthermore, external information can be added as well with the external and the interface classes. Code lists are a flexible tool for the description of the classes’ features. They are used to express a long list of potential values and they aim to allow the use of local, regional or national terminology; see Figure 6.

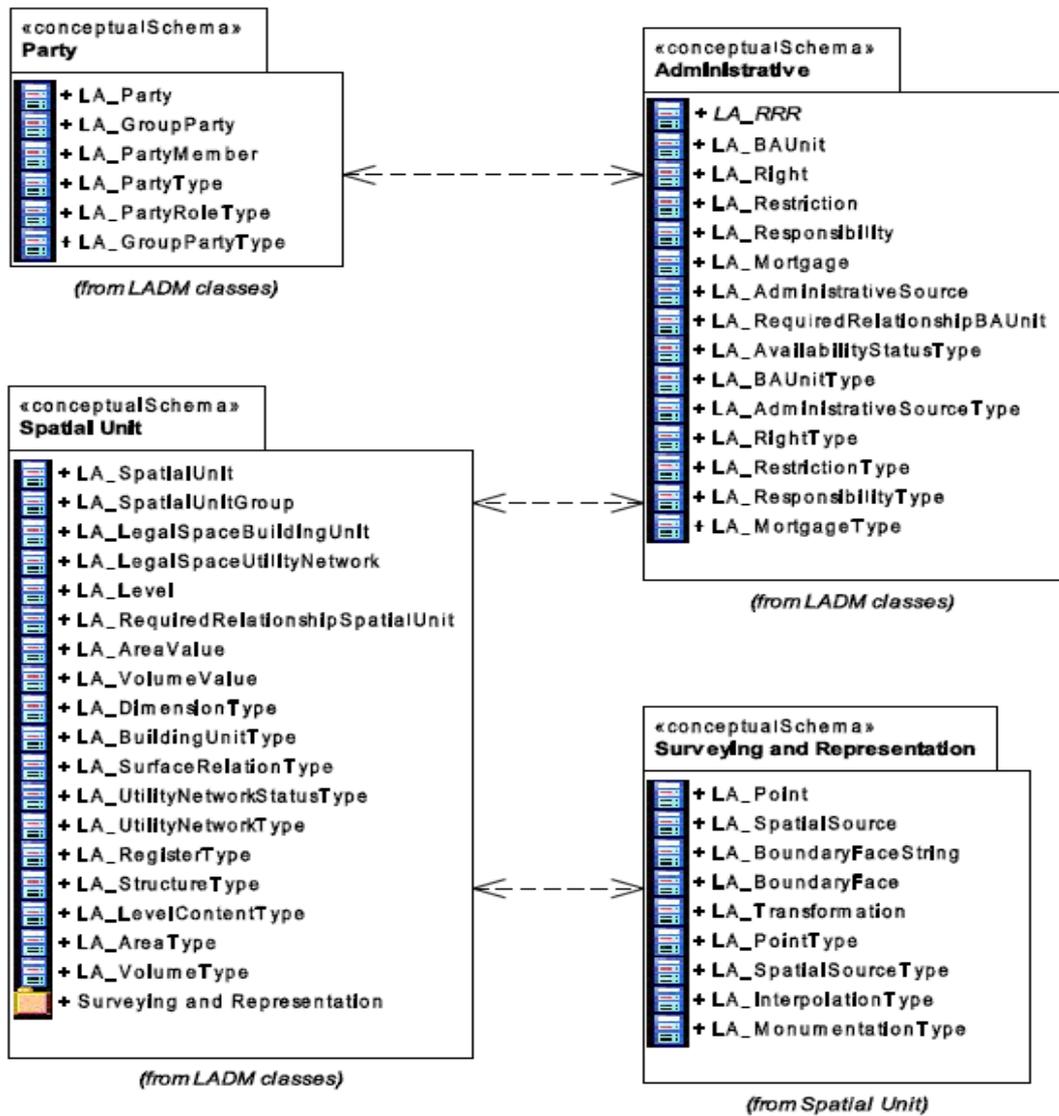


Figure 4. Classes of the LADM (source: Text for ISO/FDIS 19152 GI-LADM)

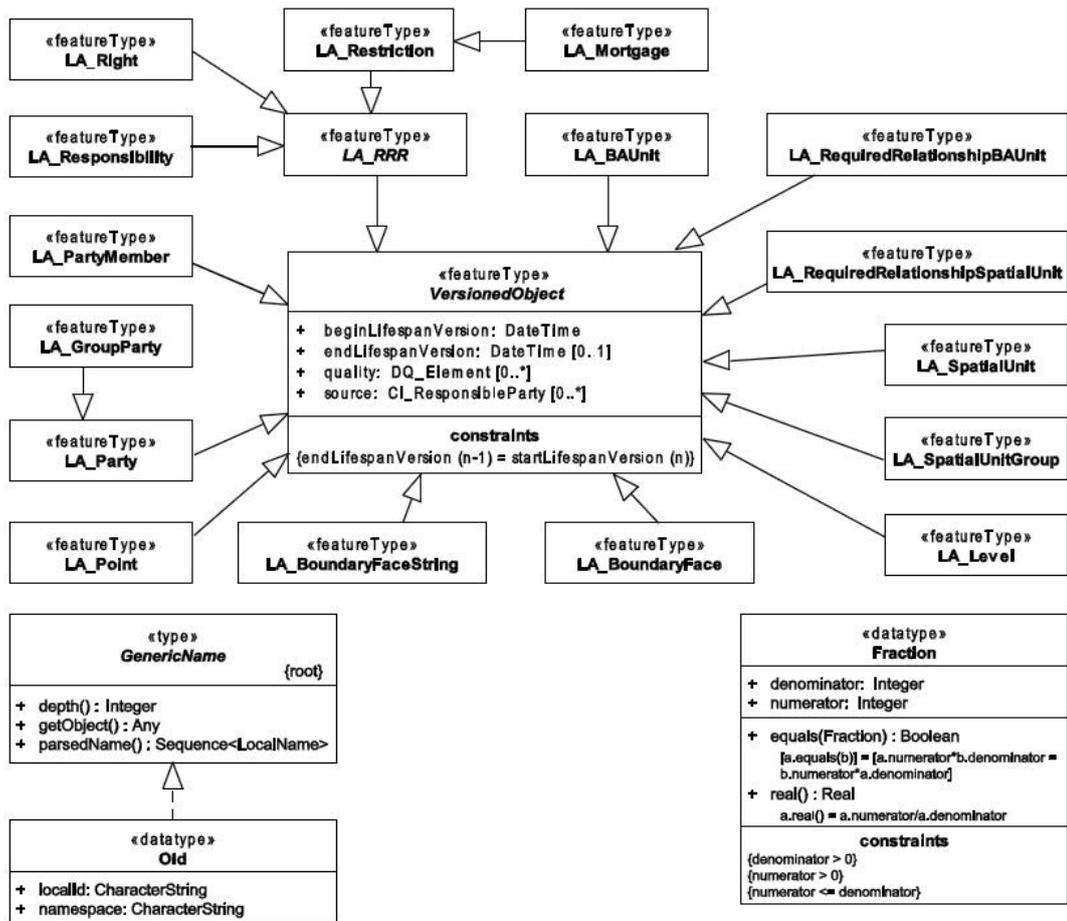


Figure 5. Versioned Object Class (source: Text for ISO/FDIS 19152 GI-LADM)

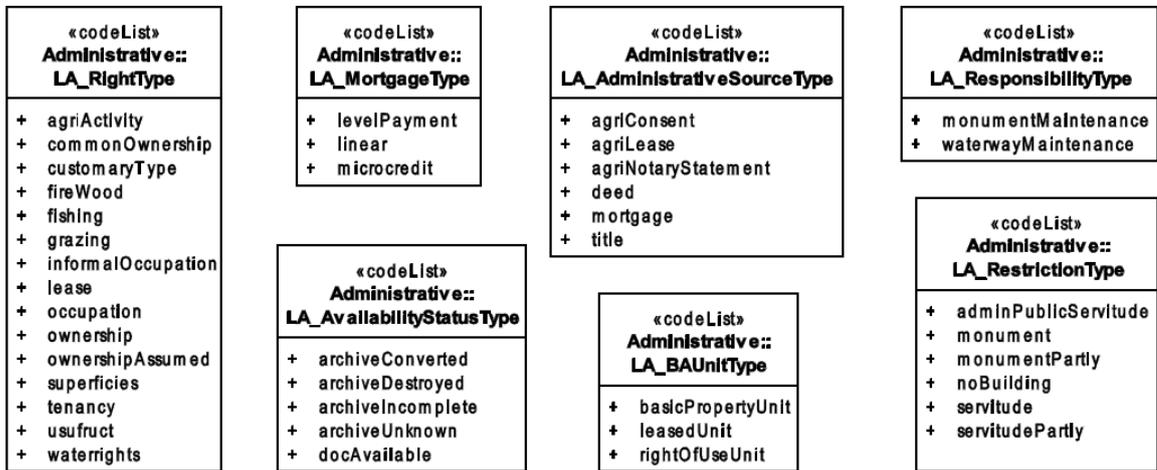


Figure 6. Code Lists for Administrative Package Classes (source: Text for ISO/FDIS 19152 GI-LADM)

## 4. THE ARCHAEOLOGICAL CADASTRE BASED ON LADM

### 4.1 Why LADM

The dynamic features of spatial information, together with the continuous need for its representation through geographic information technologies are the two basic reasons for the adoption of internationally recognized standards in the core structure of modern cadastral systems. As the Hellenic Archaeological Cadastre is being implemented, the use of standards for land administration and management could serve its harmonization with the international practices. The core model provided by the Land Administration Domain Model (LADM) is an excellent basis for this purpose. The LADM, as an ISO since 2012 seems suitable for the detailed administrative and spatial representation exported by the properties that include immovable antiquities, as the core model provided includes a wide range of classes and possibilities of including external information concerning the ownership status of the above properties. In this way a modern geospatial infrastructure could be created for the best management of the archaeological space of Greece, combining not just classic GIS platforms, but descriptive administrative information for the ownership status of immovable antiquities in a standardized structure as well.

The international state of the art shows that innovative models have been created in order to achieve effectiveness and interoperability between different systems. Sufficiency of administrative and spatial representation of land properties could also be achieved if common standards are used. The LADM serves a second goal in this paper. As the ongoing Hellenic Cadastre (HC) and the Hellenic Archaeological Cadastre (HAC) are registries that both provide information concerning properties with archaeological interest, the LADM could be used for their common representation. For the quest of the convergence of the above cadastral systems we use the basic conceptual schema of the LADM. The matching of their entities is the premise for their expression with a shared vocabulary. As the codification of all types of rights existing was required, the classes of LADM were used.

As the figure shows below; see Figure 7, the entities of the HAC and the HC have a general view in order to match with the basic classes of the LADM. In HAC the ownership of a property with archaeological interest could be spatially represented with the entity of Archaeological Parcel (LA\_SpatialUnit) that belongs to public or private owners (LA\_Party). The rights, restrictions and responsibilities existing (LA\_RRR) are related to the use of land together with the protection of the antiquities in the properties and the detailed administrative information for them is included (LA\_BAUnit). The structure of the HC is shown in a general view for the needs of the matching. The entities represent all the beneficiaries (LA\_Party) that own properties in the Greek territory together with their spatial representation (LA\_SpatialUnit) and the rights or weights exercised on them (LA\_RRR) with the registration of their administrative information (LA\_BAUnit).

The flexibility between the two cadastral systems could be achieved by expressing their core model with terms of LADM. The process of standardization could create connectivity and interoperable possibilities for the best management of both systems in Greece. Furthermore, the integration of a unique system that would include all registrations concerning properties

could be completed with the following of international practices and the adaptation of recognized standards.

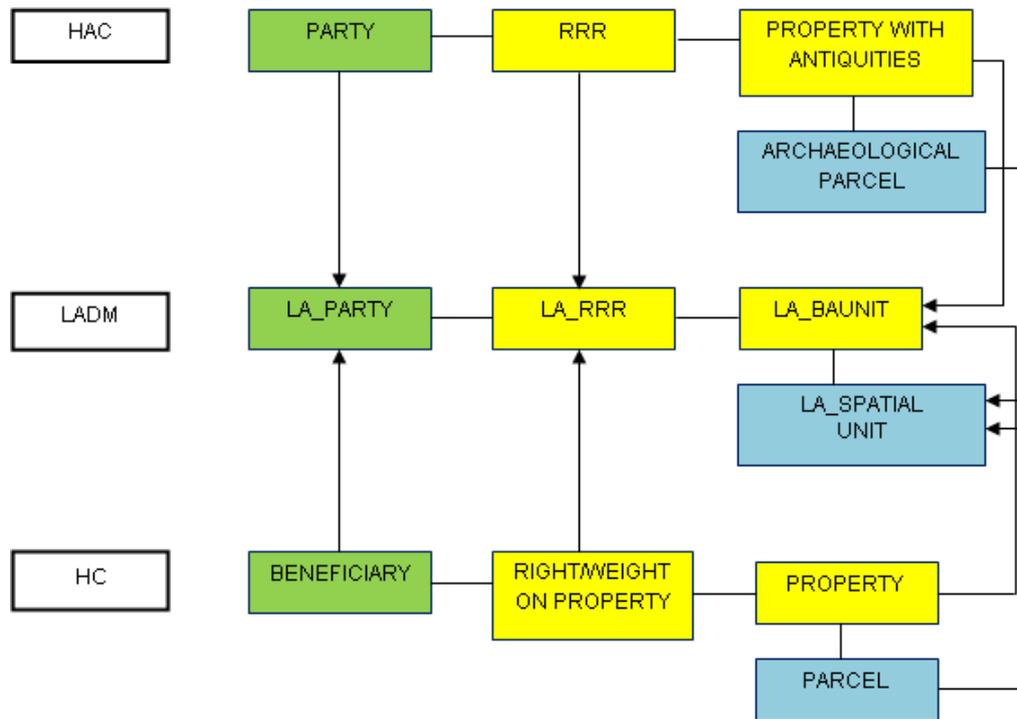


Figure 7. Entities of HAC and HC interacting with LADM Classes

#### 4.2 The adjustment in Greek data

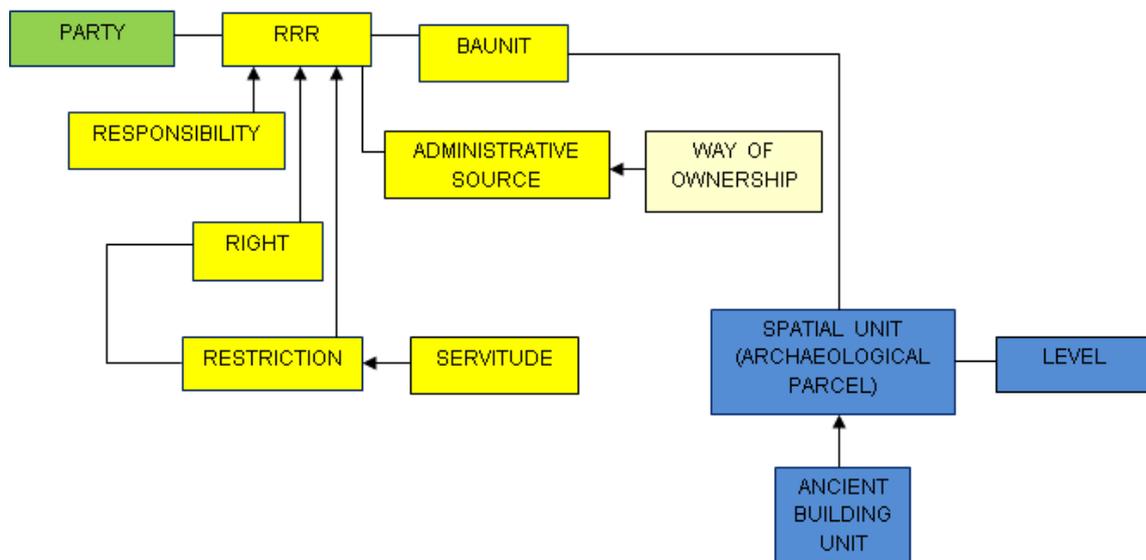
The archaeological space in Greece is of high importance. Properties with archaeological features such as archaeological sites, protection zones, traditional architectural ensembles and parcels with immovable antiquities are numerous all over the country. The aim is to use the administrative and geospatial data that come from the above properties for the construction of a model with descriptive information about the rights, restrictions and responsibilities that owners and the State have. The conceptual model is visualized in a database system. The entities formed are based on LADM classes and their characteristics are described as well in code lists. The recordation of the historical status, the legal framework and the archaeological and architectural details of the monuments is also included. In this way, a multi-purpose registry is created, based on international standardization formulas. The integration of such a core model should reckon a management tool with adaptability and possibilities of expansion so as to confront future challenges, such as connectivity with public services systems for taxation, clarification of the ownership status, contribution to the integration of the national cadastre and other registries etc.

As mentioned the conceptual model is created by adopting the classes of LADM. Their adjustment in the archaeological data introduces changes and external classes in the system in order to serve the construction of a registry for the cultural heritage. In some cases the classes keep the codification of LADM, nevertheless, the majority of classes have been changed so as to represent the entities of the Archaeological Cadastre. The features of the archaeological

space are represented in the code lists that refer to every class, together with the range of rights, restrictions and responsibilities that appear in the properties. The types of rights, restrictions and basic administrative units follow the Hellenic Cadastre Standards and the types of responsibilities follow the Archaeological Legislation. All the other types of classes adopt the features of the LADM classes.

### 4.3 The final conceptual model

The model consists of two profiles, the legal profile, which includes the classes that represent the parties and the property rights, restrictions and responsibilities in the system, together with the administrative sources for their description and the spatial profile, which includes the classes for the spatial representation; see Figure 8. For the description of the classes there are types and roles presented as features, which are explained in the code lists. In both profiles the design refers to two dimensions, although there is a prognosis for three dimensional representations of the spatial classes with the special class “3D Boundary Face”. ISOs used in the core model of the LADM such as ISO19125\_ST for the geometry of polygons and principles such as the 2D Polygon Based and the 2D Line Based principles are very useful for the credibility of the spatial information produced in the proposed model.



**Figure 8 The Core Model Proposed**

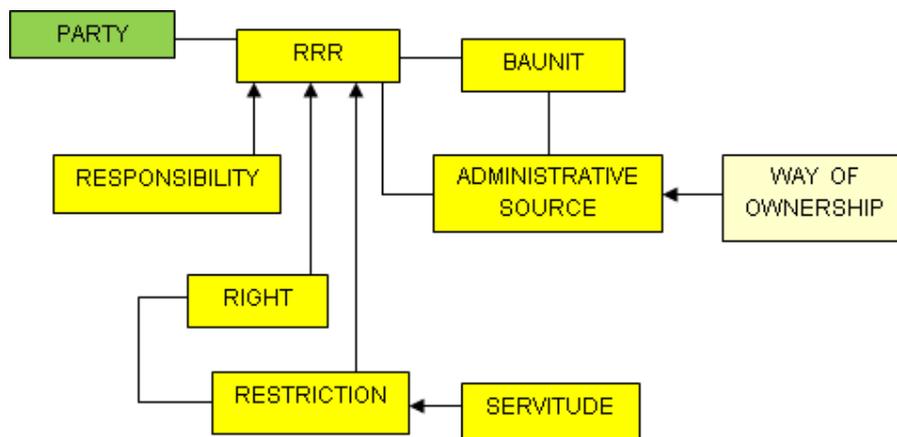
#### 4.3.1 The Legal Profile

The Legal Profile matches with the administrative level of the model and includes the packages below with their classes; see Figure 9:

- Package of Parties, referring to private owners and the State such as the Ministry of Education, Religions, Culture and Sports and the Touristic Real Estate Company. The class of Party also represents all the individuals and services involved in the registration in the HAC, such as lawyers, notaries, engineers, tax authorities and other state services that take part in the administrative process.
- Package of Basic Administrative Units, including three classes. The basic class, BAUnit, describes the ownership status of the properties. The BAUnit includes the

descriptive information for all types of properties according to HC Standards, such as horizontal, vertical and mixed properties. The Administrative Source includes the information that come from property deeds such as laws, administrative deeds and topographic charts. The Way of Ownership is an external class that refers to the types of the class Administrative Source. The implementation of the HAC aims to the delimitation of the archaeological space of Greece in order to clarify the protection zones of cultural heritage from infringement. The acquisition of ownership is of high importance and the class Way of Ownership describes all the reasons of ownership such as donation, inheritance, expropriation etc.

- Package of RRRs. RRR is an abstract class which is explained on Rights, Restrictions and Responsibilities owners have. The Rights represent all the registrable rights that can be declared in a property such as bare and full ownership, the right of use and utilization. The Restrictions refer to the constraints in the use of the property, for example properties with architectural buildings should have specific uses of land. There are also restrictions in the economic activities exercised on properties inside the protection zones of archaeological spaces. A type of Restrictions is the Servitudes. Servitude includes a special constraint for the owner, which appears as a right for another owner, e.g. a right of way introduces a restriction for one owner to the use of his property and at the same time a right for another. The Responsibilities are related to the obligations the owners have for the protection of the antiquities inside their property and are extracted from the Archaeological Legislation. The State is obliged to protect, promote and make the antiquities accessible, a fact that generates responsibilities for the owners of properties with archaeological interest.



**Figure 9. Legal Profile Classes**

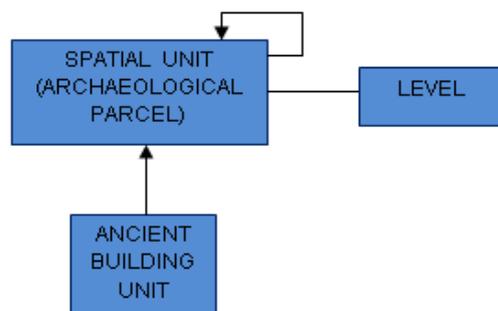
#### 4.3.2 The Spatial Profile

The spatial profile consists of one package of basic classes and one subpackage of classes for the spatial representation:

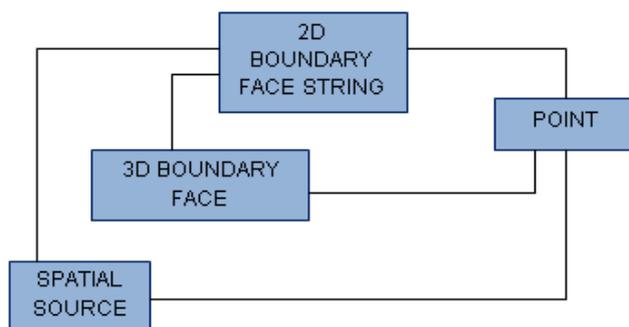
- Package of Spatial Units; see Figure 10. The Spatial Unit in the system refers to the spatial object in which there are archaeological immovable antiquities. It is represented with the class Archaeological Parcel, in which are mapped the three categories of the HAC; see section 2.3.2. The term Archaeological Parcel means a unique property expressed in spatial level, in which there is one or more immovable

antiquities. A large public parcel such as an archaeological site is considered one Archaeological Parcel. A homogeneous area of archaeological or cultural interest could consist of many Archaeological Parcels, due to different owners. The geospatial data are registered as polygons according to HC Standards. The class Level is useful for the representation of the Archaeological Parcel and includes points, lines, polygons and topological relationships. The class Ancient Building Unit is equivalent with the LADM class LegalSpaceBuildingUnit. The spatial representation of the HAC includes parcels and building units with special features, such as archaeological interest and protection frameworks. For this reason the model that is described should integrate a descriptive management tool for the cultural objects inside the parcels and the clarification of their ownership status. The descriptive information for the types and the number of the antiquities is the core of the HAC. The class Ancient Building Unit includes all this information by following the HC Standards, which means that every building unit has a serial number and is displayed as a point inside the Archaeological Parcel.

- Subpackage of Survey and Spatial Representation; see Figure 11. There are four additional classes for the representation of the basic classes of the spatial profile. The class Point refers to points used for the delineation of the Archaeological Parcel, such as check points or trigonometric points. The class Spatial Source refers to the topographical charts and the aerial photographs used as basemaps for the tracking of the parcels and the building units. The classes Boundary Face String and Boundary Face are used for the 2D and the 3D description of the boundaries of the parcels.



**Figure 10. Basic Spatial Profile Classes**



**Figure 11. Representation Spatial Profile Classes**

### 4.3 Structure of the database system

The conceptual design of the proposed model is being completed with the construction of a database system. The use of Information Technologies (IT) adds many benefits to the operability of cadastral systems, such as faster transactions, easy management of all types of registrations, possibilities of spatial analysis of cadastral data, interconnection of land registries and construction of 2D and 3D base maps. The database system described in this paper is integrated with the database software Microsoft Access under the name ArchLADM. The relational model is used in the structure of the database, which means that data are stored in tables according to their attributes. The entities' names begin with the prefix "Arch" (Archaeological), eg Arch\_Party and they are given an object identifier with the "ID" extension as an identifying feature. The object identifier is a serial number and is considered a primary key of the entity for its recognition from the system. The attributes are related to the cadastral data needed for a registration, such as types of owners, rights or spatial units. The attributes represent the types or roles of each entity and they appear in the code lists; see Annex and they are considered as foreign keys and descriptive features in the system. For the completion of a registration most of the fields are compulsorily filled; see Figure 12 and Annex.

ATTRIBUTE	DESCRIPTION	FIELD VALIDITY
Arch_BAUnitID	Unique BAUnit Identifier	Mandatory
Arch_NameProperty	Name of Property in Deed	Mandatory
Arch_BAUnitType	Type of Property	Mandatory
KAEK	Code Number of Hellenic Cadastre	Mandatory
expKAEK	Expanded Code Number of Hellenic Cadastre	Optional

Figure 12. Attributes of the class Arch\_BAUnit

The LADM imposes the formation of versioned objects in the model. For this reason there are additional attributes to the tables of the entities in order a registration to be visualized as a certain moment in the past. These features are very useful for the reconstruction of the database and the authentication of the data recorded; see Figure 13. ISOs for the complete representation of a specific registration in the past are used in features of quality and source as indicated in LADM.

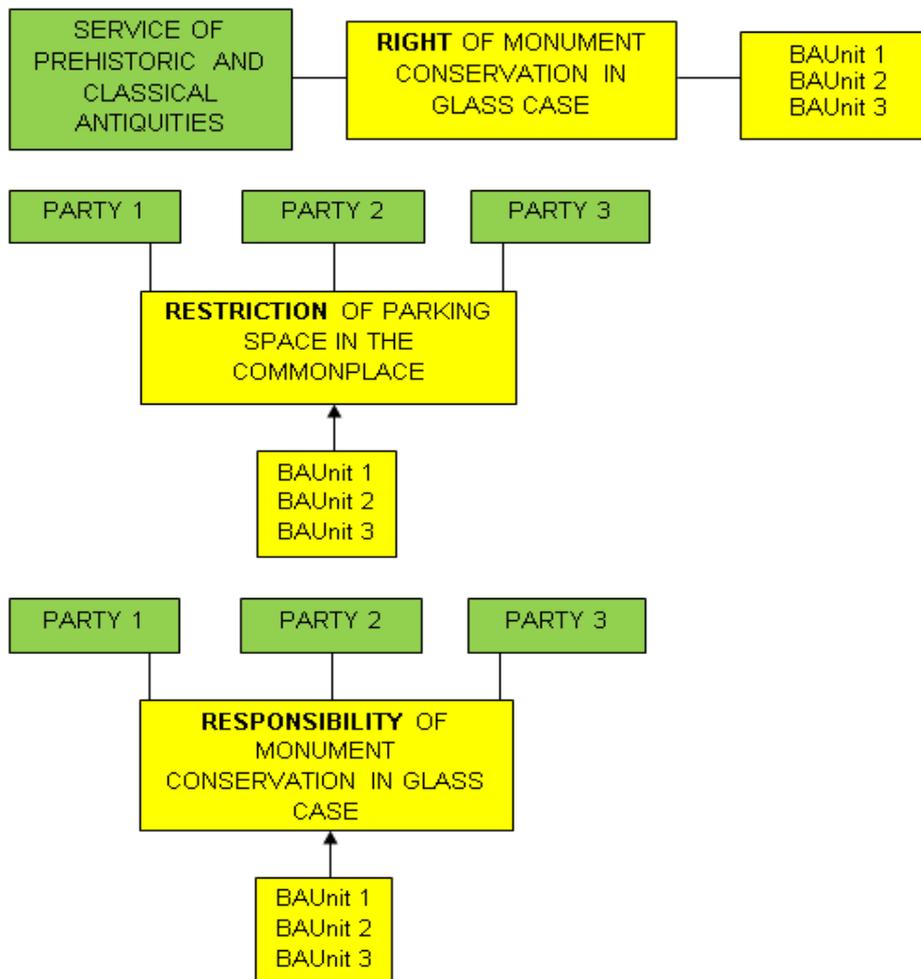
ATTRIBUTE	DESCRIPTION	FIELD VALIDITY
beginLifespanVersion	Start Time of Registration	Mandatory
endLifespanVersion	End Time of Registration	Mandatory
quality	Registration Quality	Mandatory
source	Responsible Organization of Registration	Mandatory

Figure 13. Attributes for the formation of Versioned Objects

## 5. RESULTS - DISCUSSION

Over the last few years the international discussion has shown that standardized structures should be incorporated in the architectural design of cadastral systems. The possibilities LADM offers for interoperability and extensibility of the systems provide solutions for the legal representation of the ownership, the reduction of bureaucracy and faster transactions between the state services and the citizens (Elia, 2012).

The management of the “archaeological” information is of high importance for the development in Greece. The implementation of the HAC with international standards, such as the one described in this paper reflects the cadastral dimension of the archaeological space. This means that the system proposed is formed with a standardized structure which focuses in the administrative information that comes from properties with archaeological features and their ownership status, including their detailed spatial representation. The use of LADM in the conceptual structure of the HAC offers advantages such as interoperability with national registries, e.g. Hellenic Cadastre or European Standards, e.g. INSPIRE Directive, use of information technologies, easy manageable and maintained databases.



**Figure 14. Right, Restriction and Responsibility exercised on a mixed property with Antiquities**

The management of the archaeological space is supported with an internationally tested model, a fact that could lead to better knowledge of the property rights exercised on this special territory. This information is provided by the administrative sources for each Basic Administrative Unit with details for the persons-owners, leading to the protection of public and private property and the cultural heritage. As mentioned, the representation of legal and administrative information is supported by the LADM. As the properties with archaeological features are under special ownership status, this possibility of LADM could lead to the clarification of the relationships between the owners and the antiquities. Rights, restrictions and responsibilities could be exercised at the same time from different parties; see Figure 14 above.

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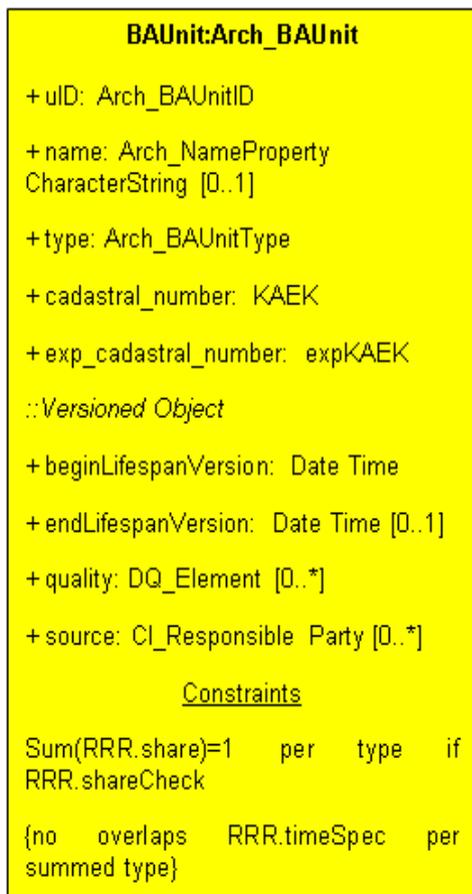
www.archaeocadastre.gr

## ANNEX ENTITIES AND THEIR CODE LISTS

1. Class Arch\_Party: the Types refer to the possible owners and roles to people and organizations that take part in the transactions.



2. Class Arch\_BAUnit: Basic Administrative Unit Types represent all the types of properties according to Hellenic Cadastre Standards.



3. Class Arch\_AdministrativeSource: the Types describe the legal titles of a property and the Availability Status attribute refers to the used on non-used deeds of the HAC Implementation Service.

**Administrative Source:  
Arch\_AdministrativeSource**

- + asID: Arch\_AdministrativeSourceID
- + availabilityStatus: Arch\_AvailabilityStatusType
- + text: Arch\_TextType MultimediaType [0..1]
- + type: Arch\_AdministrativeSourceType
- + recordation: Date Time [0..1]
- + submission: Date Time [0..1]
- + lifeSpanStamp: Date Time [0..1]
- ::Versioned Object
- + beginLifespanVersion: Date Time
- + endLifespanVersion: Date Time [0..1]
- + quality: DQ\_Element [0..\*]
- + source: CI\_Responsible Party [0..\*]

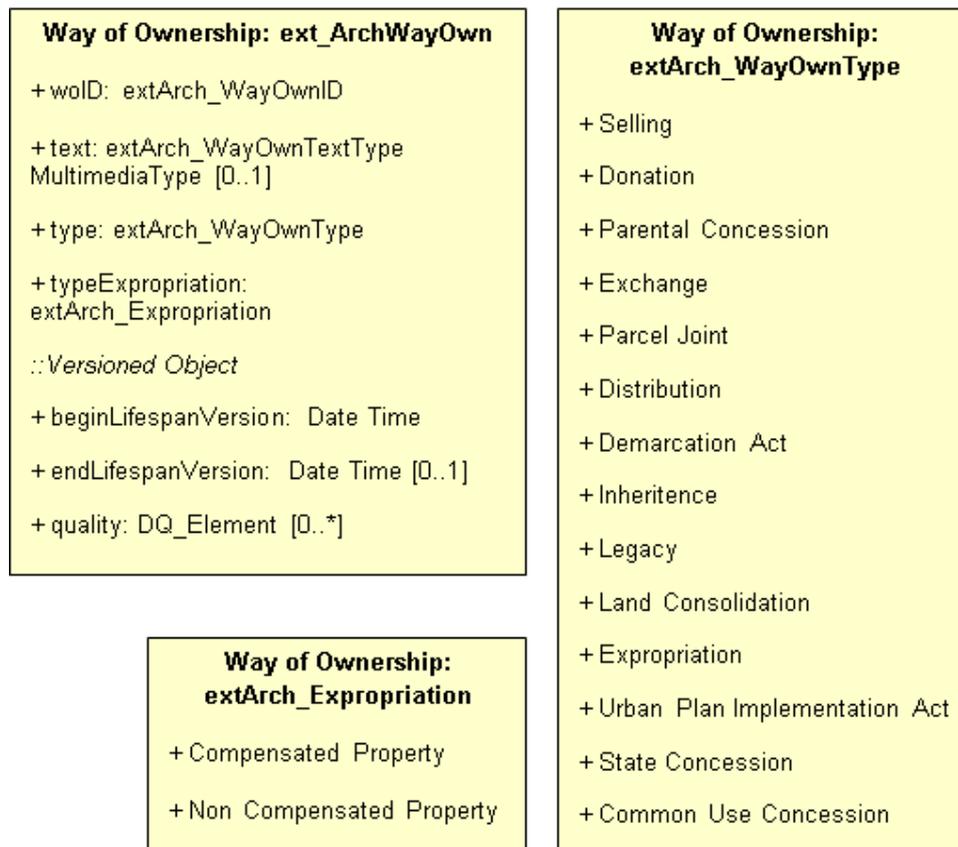
**Administrative Source:  
Arch\_AdministrativeSourceType**

- + Presidential Decree
- + Legislative Decree
- + Court Decision
- + Law
- + Emergency Law
- + Administrative Act
- + Official State Deed
- + Notary Deed
- + Documentation Deed
- + Topographic Chart
- + Historical Source

**Administrative Source:  
Arch\_AvailabilityStatus**

- + Registered Deed
- + Non Registered Deed

4. External Class `ext_ArchWayOwn`: the Types of Ownership refer to the reasons of acquisition of a property and the Expropriation code list informs the system if the property is expropriated and compensated or not.



5. Class Arch\_Right: the Types of Rights refer to the rights the owner is able to exercise in his property.

<b>Restriction:Arch_Right</b>
+ rightID: Arch_RestrictionID
+ type: Arch_RightType
+ share: Rational [0..1]
+ shareCheck: Boolean [0..1]
+ timeSpec: ISO8901_Type [0..1]
::Versioned Object
+ beginLifespanVersion: Date Time
+ endLifespanVersion: Date Time [0..1]
+ quality: DQ_Element [0..*]
+ source: CI_Responsible Party [0..*]

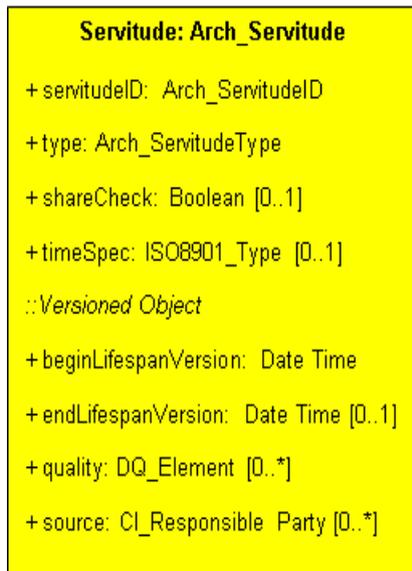
<b>Right:Arch_RightType</b>
+ Limited Ownership
+ Full Ownership
+ Registrable Lease
+ Building Density Factor Transfer
+ Surface Right
+ Implantation Right

6. Class Arch\_Restriction: the Types of Restrictions are the constraints owners have.

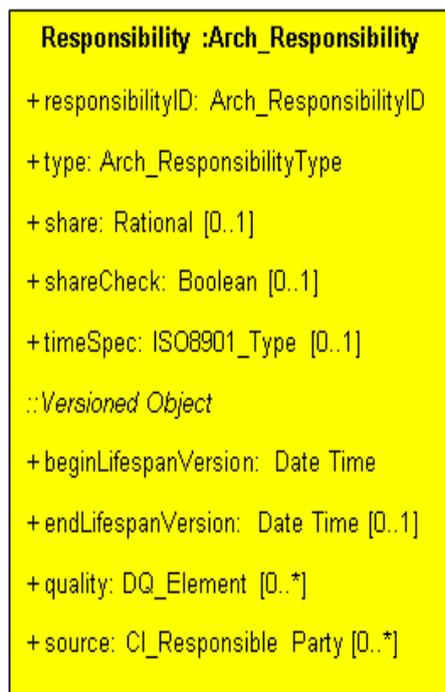
<b>Restriction:Arch_Restriction</b>
+ restrictionID: Arch_RestrictionID
+ type: Arch_RestrictionType
+ partyRequired: Boolean [0..1]
+ share: Rational [0..1]
+ shareCheck: Boolean [0..1]
+ timeSpec: ISO8901_Type [0..1]
::Versioned Object
+ beginLifespanVersion: Date Time
+ endLifespanVersion: Date Time [0..1]
+ quality: DQ_Element [0..*]
+ source: CI_Responsible Party [0..*]

<b>Restriction: Arch_RestrictionType</b>
+ Building Constraint
+ Urban Planning Constraint
+ Monument Irrelevant Use
+ Exercise of Agriculture
+ Exercise of Farming
+ Exercise of Hunting
+ Economic Activity in Protection Zone

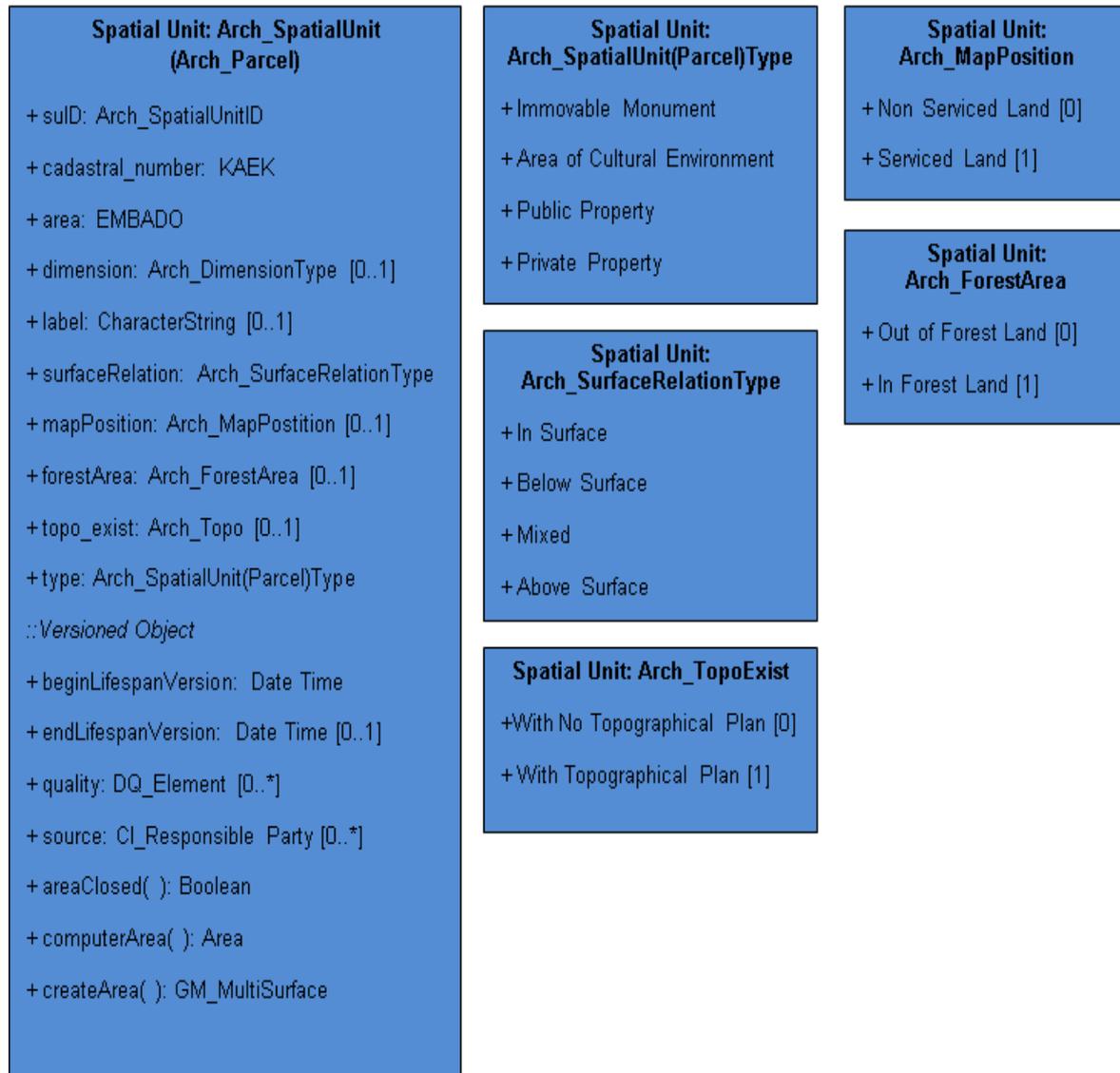
7. Class Arch\_Servitude: the Types of Servitudes refer to special constraints in the use of the property.



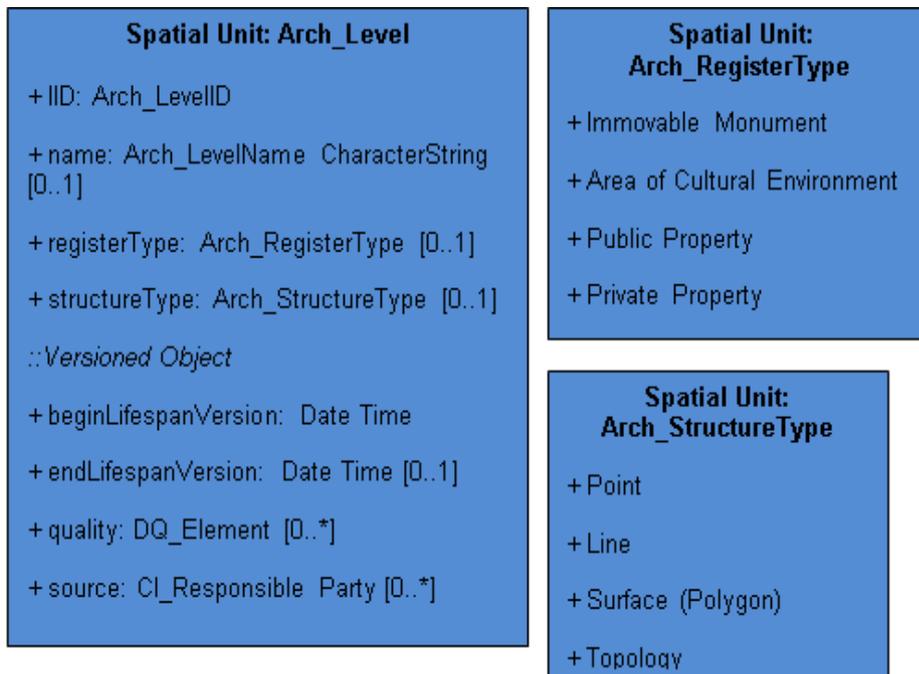
8. Class Arch\_Responsibility: the Types of Responsibilities refer to the responsibilities the owners and the State have for the protection of the immovable antiquities.



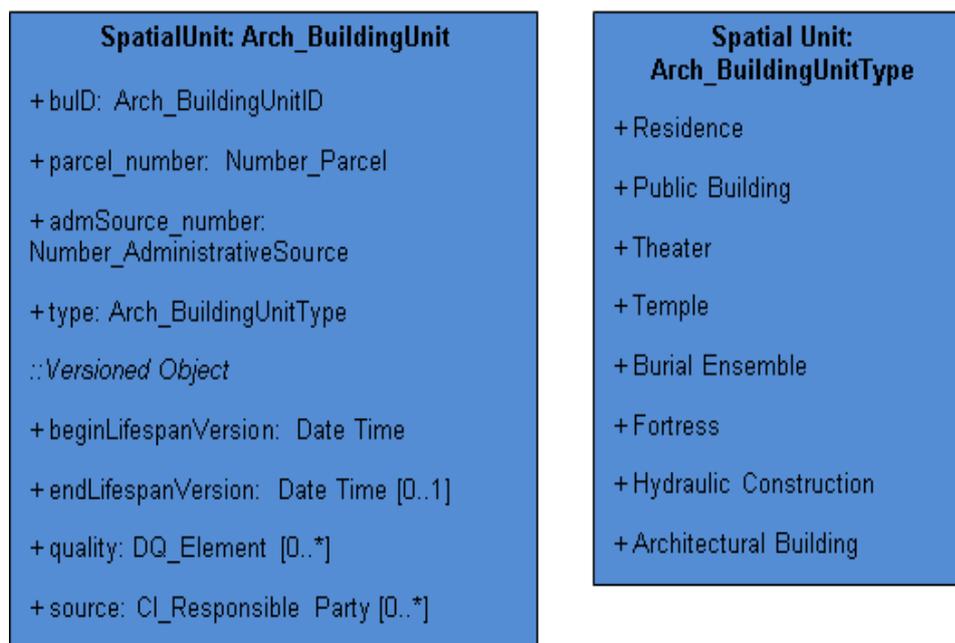
9. Class Arch\_SpatialUnit (Arch\_Parcel): the Arch\_Parcel is used for the representation of the Spatial Unit. The Types of Arch\_Parcel represent the categories of areas of cultural interest defined by the HAC. All the other types of features are related with the position of the parcel.



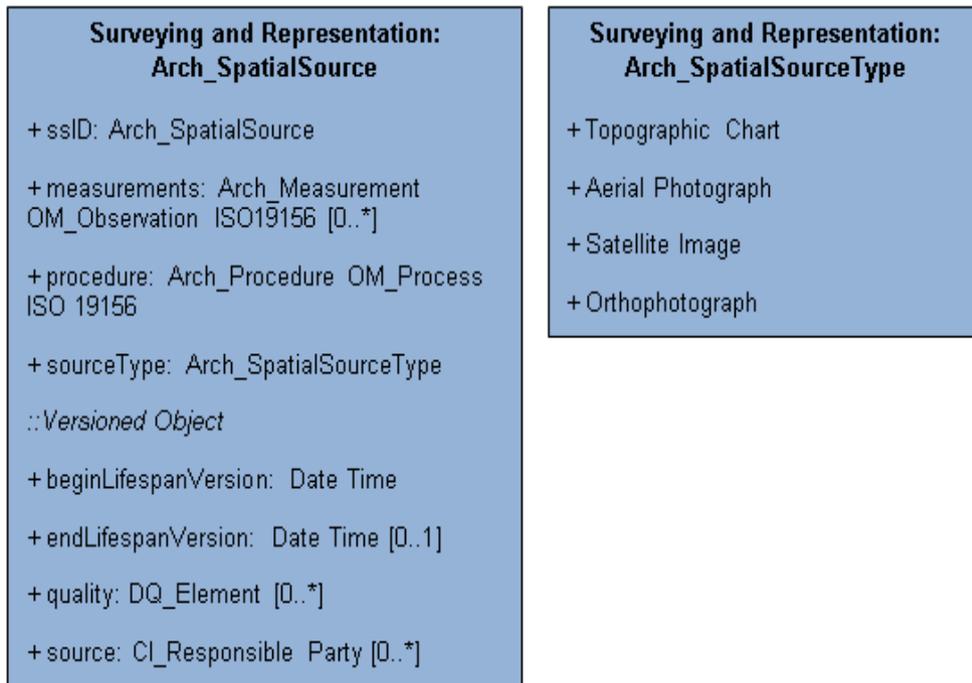
10. Class Arch\_Level: the class is useful for the complete representation of the parcel. The Types of Register match with the Types of Arch\_Parcel and the Types of Structure refer to the geometry used for the representation.



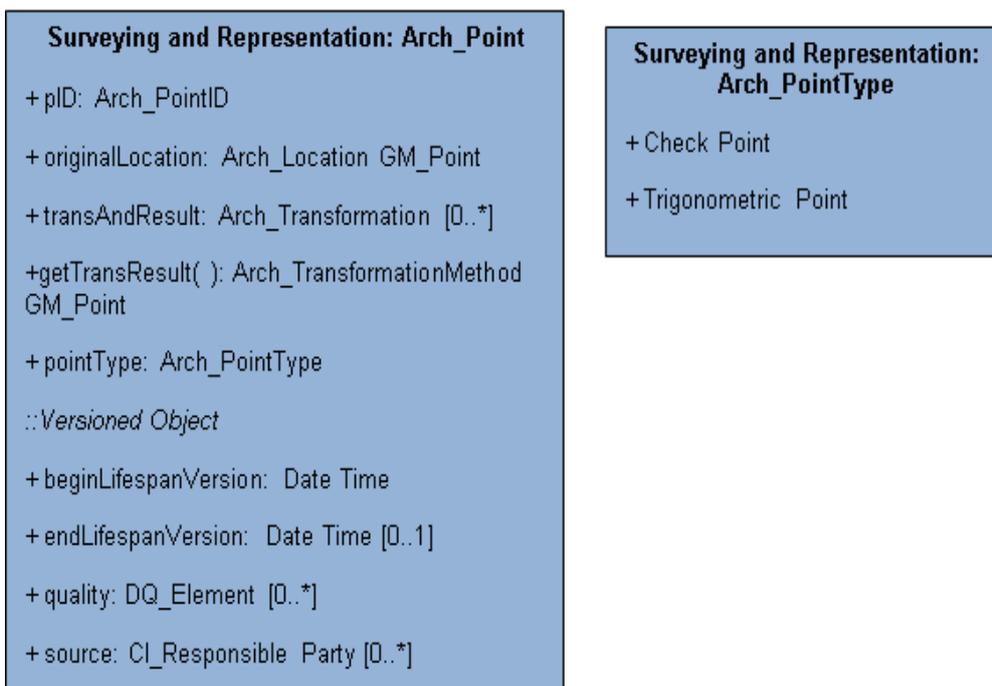
11. Class Arch\_BuildingUnit: the Types refer to the kinds of immovable antiquities.



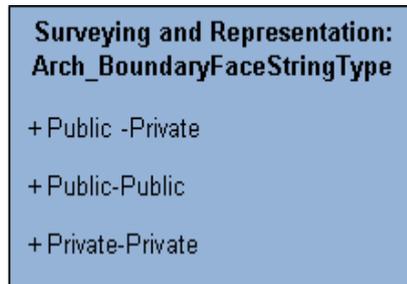
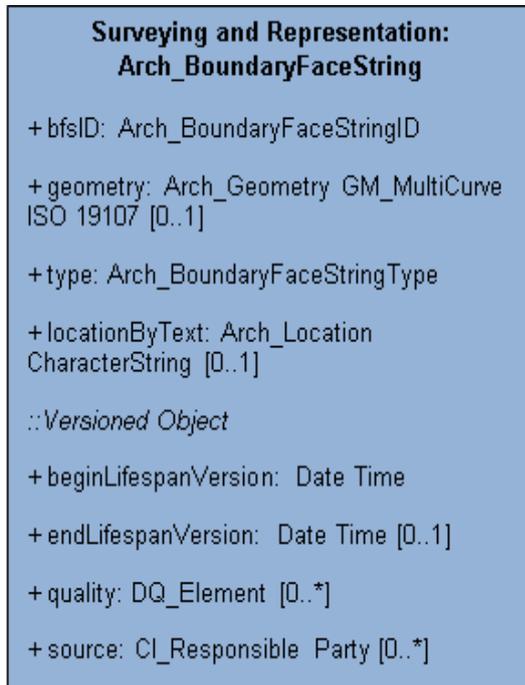
12. Subclass Arch\_SpatialSource: the Types of Spatial Sources represent the patterns used for the spatial representation of the parcels.



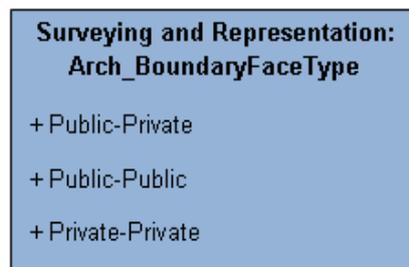
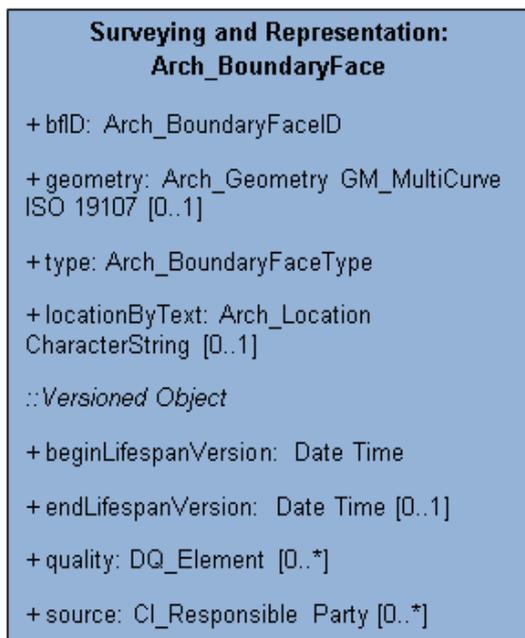
13. Subclass Arch\_Point: the Types of Points represent the points used for the positioning of the parcel.



14. Subclass Arch\_BoundaryFaceString: the Types are related to Boundary Faces in two-dimensional representation.



15. Subclass Arch\_BoundaryFace: the Types are related to Boundary Faces in three-dimensional representation.



## **BIOGRAPHICAL NOTES**

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