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CIDOC CRM as the basis of the Electronic State Register of immovable cultural heritage of Ukraine

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Abstract. The article is the final in the series of articles on Conceptual Provisions for the Creation of a New Electronic State Register of Immovable Cultural Heritage (CH) of Ukraine. These provisions correspond to the components of the Solutions Framework (SoFr) of special Spatial Information Systems (SpIS). The special SpIS of the new registry of the CH of Ukraine should belong to the class of Atlas Geoinformation Systems (AGIS). The first queue of AGIS – AGIS-CH1 – is proposed as the first queue of the new electronic State Register of Immovable CH of Ukraine. It should include, at least, three components that are simultaneously SoFr packages: Products-Processes-Basics. The conceptual provisions of AGIS-CH1 describe these most important components of the SoFr architectural pattern of AGIS-CH1: AGIS-CH1.Products, Part 1; AGIS-CH1.Processes, Part 2; and AGIS-CH1.Basics, Part 3; consisting of two subparts, 3.1 and 3.2.

Subpart 3.1 is dedicated to the "Basics.INSPIRE" theme. This article describes subpart 3.2, which is called "Basics. CIDOC CRM". It consists of two main sections. The first examines the prerequisites that lead to the use of CIDOC CRM. Such prerequisites are two evolutions: system and subject. System evolution claims that the

time has come to consider the registry of the CH of Ukraine as a SpIS of the Web 3.0 Formation, also known as the Semantic Web, especially if we have in mind the creation of a new registry.

Subject evolution refers to the evolution of understanding of the domain of cultural heritage. From the modern understanding of this issue, it is obvious that modern CH registers should be "process" rather than "product".

In order to proceed to the consideration of CIDOC CRM with a better understanding of the essence of the issue, the CHARM (Cultural Heritage Abstract Reference Model) model was considered. CIDOC CRM can also be considered as such, but CHARM is described in the monographic literature that is practically applicable, unlike the scattered articles on CIDOC CRM.

The second of the two main sections of the article deals with CIDOC CRM and its use. We do not describe CIDOC CRM completely. Attention is paid only to its "spatial" and "process" parts. In addition, attention is paid to the use of CIDOC CRM. For this, the information from the website (https://www.cidoc-crm.org/how-i-can-use-cidoc-crm, 2023-jun-26) is used first. Then there is some initial information about the Arches software platform. We offer the Arches platform for the implementation of AGIS-CH1.

Key words: *Solutions Framework (SoFr), Atlas geoinformation system (AGIS), Basics of AGIS SoFr, register of CH as the first queue of AGIS.*

Introduction. Formulation of the problem

The conceptual provisions for the creation of a new electronic State Register of Immovable Cultural Heritage (CH) of Ukraine correspond to the components of the Solutions Framework (SoFr) of special Spatial Information Systems (SpIS) defined in the monograph [1]. The special SpIS of the new registry of the CH of Ukraine should belong to the class of Atlas Geoinformation Systems (AGIS), which is described in [2]. The first queue of AGIS-CH is denoted by AGIS-CH1. The conceptual provisions of AGIS-CH1 describe these three most important components of the SoFr AGIS-CH1 architectural pattern: AGIS-CH1.Products, Part 1 [3]; AGIS-CH1.Processes, Part 2 [4]; AGIS-CH1.Basics, Part 3, consisting of two subparts, 3.1

and 3.2. Subpart 3.1 is described in the article [5]. This article describes subpart 3.2, which is called "Basics. CIDOC CRM". Subject evolution refers to the evolution of understanding of the domain of cultural heritage. From the review of this issue in the monograph [6], it is obvious that modern CH registers should be "process" rather than "product".

The CIDOC CRM standard [7], [8] is declared in work [3] to be an important component of the second of the two conscious Basics of the new modern electronic State Register of immovable cultural heritage (CH) of Ukraine. In addition to the standard itself, we are interested in its implementation in Ukraine. Therefore, on **Fig. 1** second Basics, including the CIDOC CRM standard, is shown as "Interaction with CIDOC/" in the block "Interaction with INSPIRE/CIDOC/...". The first Basics is "Interaction with INSPIRE/", which is also shown in **Fig. 1** in the block "Interaction with INSPIRE/CIDOC/...". The term "conscious" means the possibility of future inclusion of other basics after "consciousness". The possibility is indicated by the entry "...", which means that in addition to INSPIRE and CIDOC CRM, there may be other components of the Basics.

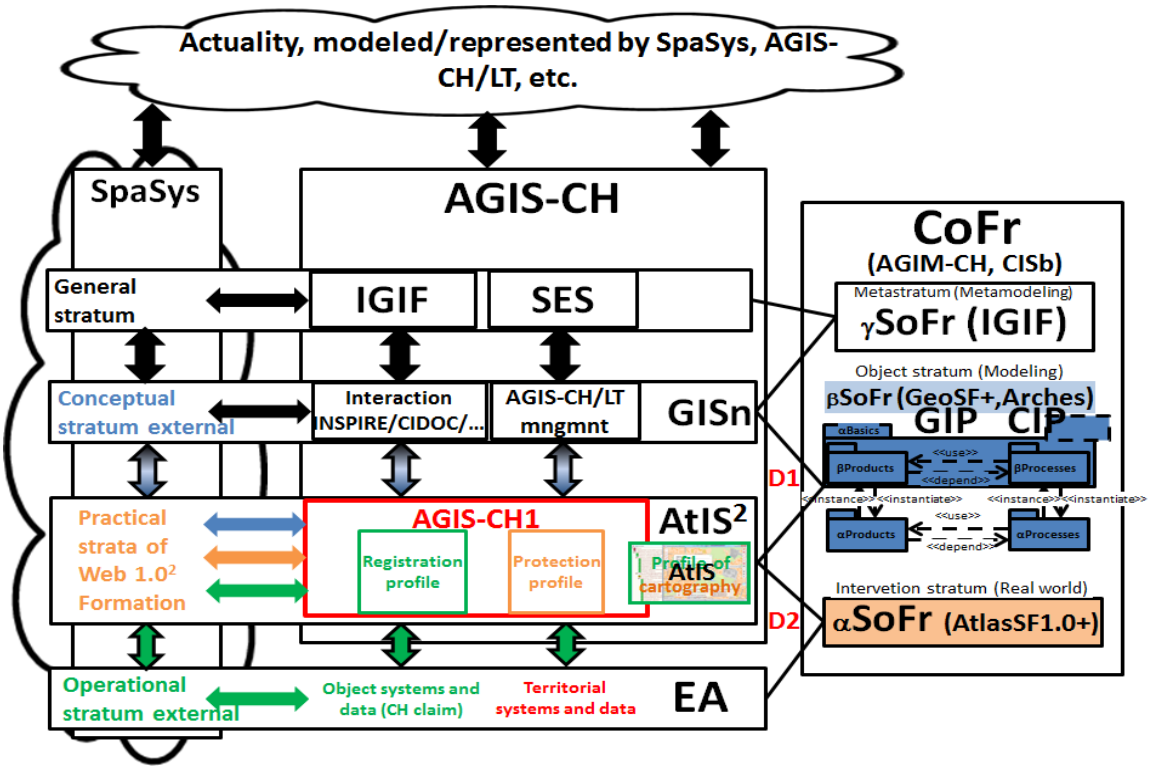


Fig. 1 - Structure of AGIS-CH

It is possible to create the first queue of the new register of immovable CH of Ukraine in 1-2 years under the mandatory condition of using the Relational Cartography pattern-based methodology [1]. It describes the architectural pattern Solutions Framework (SoFr), which, when fixing a certain class of spatial information systems (SpIS) X, is called the SoFr X method. If X belongs to the class of SpIS similar to the mentioned registry, then it must be an Atlas GeoInformation System (AGIS), which described in [2]. The first queue of the register is marked AGIS-CH1, therefore the entry SoFr AGIS-CH1 is used. In addition to the use of SoFr for AGIS-CH1, this article does not consider other conditions of creation, although among them, obviously, there should be financial and other important conditions.

The full AGIS-CH1 SoFr is represented by a "petrada" of AGIS-CH1 Products-Processes-Basics-Publications-Services packages of elements. For practical purposes, it is sufficient to control the creation of the so-called main triad of AGIS-CH1 SoFr: Products-Processes-Basics. These three packages of elements and the SoFr itself in general became the basis for the formulation of the main conceptual provisions for the creation of AGIS-CH1. Namely, the article [3] describes the Main Conceptual Provisions: 0: "The use of appropriate SoFr is mandatory for the success of the activity of creating a new electronic State Register of immovable CH" and 1: "SoFr products X: The first queue of the final system X should be AGIS -CH1 as an element of the set of allowable AGIS". Article [4] describes Main Conceptual Provision 2: "AGIS-CH1 SoFr processes: The process of AGIS-CH1 creation should be a portal normative extension." That is, at the moment we suppose the AGIS-CH1 product and the process of its creation are described. They are highlighted in red in **Fig. 2**.

Analysis of recent research and publications

The article [5] describes the elements of the first of the two basics - "Interaction with INSPIRE". This article describes the elements of the second of the two basics - "Interaction with CIDOC/". The main Conceptual Provision 3 is formulated as

follows: "Basics of SoFr AGIS-CH1: The Basics of AGIS-CH1 of Ukraine should be INSPIRE and CIDOC CRM".

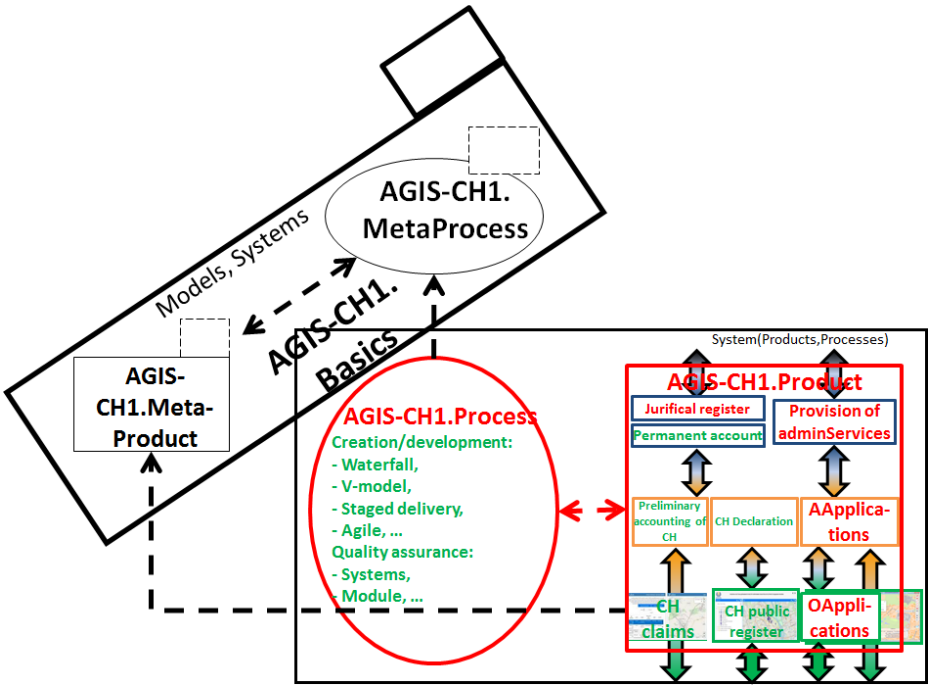


Fig. 2 – The main triad of AGIS-CH1 SoFr. The elements of the Products and Processes packages for AGIS-CH1 described in [3], [4] are shown in red

"To explain the prerequisites for the formulation of this provision, we will use the main theoretical construction of the monograph [9], which is built in the context of the design (modeling) of systems using the three investigated systems, their corresponding levels, and the relation between the elements of these systems/levels. The levels are called: 1 – intervention, 2 – object, 3 – goal. Van Gigh's concept of levels essentially coincides with the concept of strata from [10] and from [1], therefore instead of the term "level" the term "strata" is used below. There are stable relations between levels/strata that are decisive for many spheres of human activity (**Fig. 3**)".

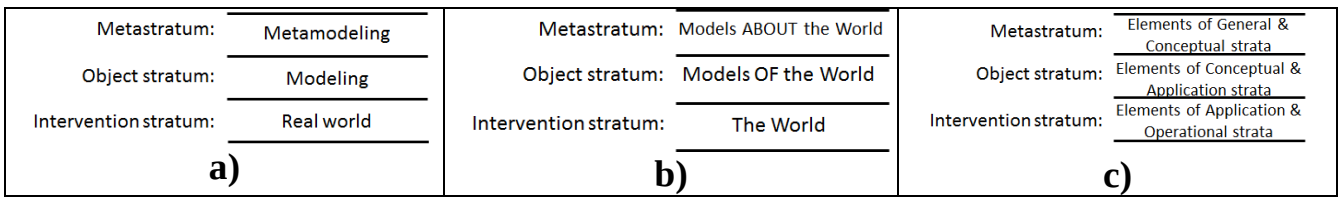


Fig. 3 – Relation between strata [9]: a) modeling and metamodeling, b) cognition and metacognition; and c) strata [9] and relational cartography [1]

"Van Gigh [9] claims that there is a dialectical relation between two elements of each dyad (object statum ↕ meta-stratum, model ↕ meta-model, world ↕ meta-world, etc.), because each element originates in the studied systems of different strata of abstraction or logic. When the metastratum is neglected, the Metamodeling (otherwise, the design process) from the metastratum, on which the lower-stratum systems under study are formulated, is neglected. This neglect can lead to dysfunctions and system failures".

The Basics package refers to the Metamodeling Metastratum in van Gig terminology or in the terminology of Relational Cartography - to the General stratum in relation to AGIS-CH1 and/or to the Conceptual stratum external in relation to AGIS-CH (see **Fig. 1**). The importance and necessity of this package follows from what has been said, taking into account the fact that this article is specifically about the dyads that exist between the Products-Basics and Processes-Basics packages. That is, in the practice of AGIS-CH1 creation, we will be more interested in the relations (dyads) between the elements of classes such as AGIS-CH1.Product - AGIS-CH1.MetaProduct and AGIS-CH1.Process - AGIS-CH1.MetaProcess. Or, otherwise, we will be interested in MetaProduct, from which it is easiest to create AGIS-CH1, and MetaProcess, from which the specific process of AGIS-CH1 creation will be determined. Preferably, these are instantiation/classification relations for models/systems, although it seems ideal.

Article [5] shows that even the seemingly simple "Interaction with INSPIRE" is not very obvious for Ukraine. The problem is that the Spatial Information Infrastructure (SII) of Ukraine does not comply with INSPIRE, although there is no alternative to Ukraine joining the European Union. And on the part of Ukraine, very little is being done for this direction, which we called harmonization. Harmonization with INSPIRE should begin with the harmonization of the Law of Ukraine "On the National Infrastructure of Geospatial Data" (NGDI). This Law was adopted in 2020 with a very outdated model of NGDI development. The evolution of NSDI development models is considered in [11]. In the Law of Ukraine "On NGDI" INSPIRE is mentioned only once, and not significantly. In this case, we should not

talk about INSPIRE as a product (including some fixed fundamental data), but we should talk about the process of harmonizing Ukraine's SII with INSPIRE, including the harmonization of Ukrainian: legislation, processes and, finally, data. It is currently unclear whether this is possible, and if so, how long it will take.

In fact, the AGIS-CH1.Basics package from **Fig. 1** consists of two blocks: "Interaction with INSPIRE/CIDOC/..." and "βSoFr (GeoSF+, Arches)". We have already said something about the components of the first block. The second block "βSoFr (GeoSF+, Arches)" is shown outside of AGIS-CH, although its relation with AGIS-CH is the most important here. "βSoFr (GeoSF+, Arches)" refers to: 1) Conceptual stratum of the outer (AGIS-CH), 2) Practical strata of Formation Web 1.02 (AGIS-CH1). In the situation at the time of writing the article, relations are more important than the products being created. Currently, it is more important to start the "correct" processes of creating the SpIS - AGIS-CH1 class (in fact, the AGIS-CH class) than to create a specific version of AGIS-CH1.

To achieve the goal of the article, it is not enough to consider the CIDOC CRM standard. In the end, everyone can get acquainted with it through the links provided, including in this article. In the situation that we have in Ukraine by the middle of 2023, it is more important to consider the dynamics of the development of the standard, including: 1) the prerequisites for its appearance in Ukraine, 2) its relations with the coordinating immovable CH (connection with the first Basics - INSPIRE), 3) the CIDOC CRM issue implementation. Therefore, in the main text of the article, we considered:

- system evolution of the SpIS, to which the registers of the immovable CH belong (should belong). For this, the evolution of such SpIS as Cartographic Information Systems (CIS) and Relational Cartography were used. The evolutionary periods here are the so-called Formations, among which we are interested in such Formations as Web 1.0, Web 1.02, Web 2.0 and Web 3.0. All of them are related to the registers of immovable CH, which are represented by versions and subsystems of the so-called Atlas Geo-Information System (AGIS).

- subject evolution of registers of immovable CH. For argumentation, we had to use a review of works on changing representations of CH as material things to a process representation. The process representation refers to the perception of CH by dynamically changing representations that depend on the representations of society at a given moment in time. The authors have a personal opinion on this issue, so we went to its extensive citation so that the reader can form his own relatively independent opinion. Note that the issue is very principal at the moment in Ukraine.
- CHARM model, which stands for the Cultural Heritage Abstract Reference Model. We will not campaign in its favor here, because the alternative CIDOC CRM standard has already been formally adopted in Ukraine. This is a standard (DSTU ISO 21127, 2018), where ISO 21127 is an international standard. An important advantage of CHARM is the availability of the monograph [6], where considerable attention is paid to this model. An obvious shortcoming of CIDOC CRM is the lack of its systematic description in the form of a monograph. Also, despite the large number of publications on CIDOC CRM, it is not easy to apply this standard.
- overview of the CIDOC CRM model and its spatial properties. Conceptual provisions from the article [12] are used.
- finally, the Arches software platform is considered, which we recommend to use in Ukraine for the implementation of CIDOC CRM in the realization of the AGIS-CH1 first queue.

The goal of the study. New Electronic State register of immovable cultural heritage. Evolution or revolution

In Ukraine today, there is still no Electronic State Register of immovable CH. In the article [13], a small review of the evolution of the issue of fixing the records of CH objects is made, starting with paper records that still work in Ukraine. There it is proposed to choose one of two possible approaches to the creation of a new Electronic State Register of immovable CH of Ukraine: evolutionary (scientific) or revolutionary (systemic). In our opinion, a revolutionary (system) approach is better suited to Ukraine today. At the same time, it is advisable to represent the register

itself as a system of the AGIS-CH class. When choosing a system approach, the cartographic point of view on the future register is taken into account, or, otherwise, the presence of a "profile of cartography" in the AGIS-CH system, which is shown in **Fig. 1**. Although it is still too early to talk about a "profile of cartography" in AGIS-CH1, AGIS-CH1 should be a subsystem of AGIS-CH, so the approaches to the creation of an AGIS-CH system can be transferred to the creation of an AGIS-CH1 subsystem.

This section is important for understanding the term "non-classical" new (newly created) Electronic State Register of Immovable CH. It is the system marked by this name that is the subject of this article.

System evolution of the class of CH systems

To explain the reason for using the term "non-classical", we will first use Relational Cartography [1]. There, for arbitrary Cartographic Information Systems (CIS), we considered the so-called evolutional relations on the Web 1.0 - Web 1.0x1.0 - Web 2.0 - Web 3.0 scale, where individual segments of the evolutional scale were called Formations. Web 1.0 and Web 1.0x1.0 (or 1.02) Formations were called classic static and, accordingly, classic dynamic. Formations Web 2.0, Web 3.0, and further, were called non-classical. It is this evolutional classification of systems that we propose to apply first to the domain of CH systems. We can say that (see **Fig. 1**):

- The registration profile of the State Register of immovable CH as a result of the development of the electronic Declarative State Register of CH is expediently to call the Classic Register. We consider this alternative to be a dead end from the viewpoint of creation a really necessary modern electronic State Register of immovable CH. It is needed to create a new system.
- When considering the profile of cartography of the new electronic State Register of immovable CH, it should be recognized that the dynamic properties of such CH still require research, but the systems being created remain classic.

- Registration profile of the new electronic State Register of Immovable CH as a component of the modern NSDI of Ukraine refers to the Web 2.0 Formation. This is exactly what we can say about the Protection profile.
- Registration profile of the new electronic State Register of immovable CH as a component of the Semantic Web can be realized and attributed to the Web 3.0 Formation.

This article is mainly about the interaction of the elements of dyads (dualisms) 1) the AGIS-CH1 product and 2) the process of its creation with 3.2) the CIDOC CRM standard, which is the semantic basis of dyads. The spatial basis of the specified dyads is 3.1) INSPIRE standards (directives). However, as in the case of INSPIRE, the problem is broader than actually interoperability with the CIDOC CRM standard. For a better understanding of the term "non-classic", we need to apply, in addition to the evolutional classification of systems, also the subject classification of the domain of CH systems.

Subject evolution of the class of CH systems

After applying the evolutional system classification, we will apply the subject classification of the CH systems domain. According to it, modern electronic registers of the CH should include information not only about the so-called "things", but also about the "processes" of operating with them. This modern vision of CH corresponds to the classes of CH that belong to Web 2.0 and 3.0 Formations. Next, two subsections from the monograph [2] are cited: "Cultural Heritage as a Process" (pp. 200-201) and "Cultural Heritage as Things" (pp. 201-202).

Materials and research methods

Cultural Heritage as a Process

Starting with the most recent and promising approaches, caused by the emergence of the now contested concept of "intangible heritage", voices began to be heard challenging the old and firm idea that CH is a matter of antiquity, authenticity and materiality [14]. Over the last few decades, an extensive literature has emerged that adheres to a different definition of CH.

Gonzalez-Perez [6; page 201] provides an overview of works following this line and notes that CH has been defined in a variety of ways that always highlight the social processes that give meaning to things. For example, CH was defined as "a mode of cultural production in the present that addresses the past", "a mode of cultural production that gives a second life to what is endangered or obsolete, as an exhibition of itself", "a form of communicative practice", "sphere of social/cultural action" or "a social and cultural process that mediates the meaning of cultural, social and political changes."

Behind these definitions is the idea that CH consists not of passive and given things of the past, but of active social processes in the present. This reaction against the thing-based view of the CH was expressed as provocatively as "there is no such thing as heritage". CH would be the processes by which people interact with their surroundings. CH would be a process of valorization, giving different values and meanings to things, understanding "things" here in the broadest sense, as any individual manifestation that occurs in the world. And by "things" we include other things, such as events.

Thus, according to this view, agents' active processes involving subjective perception and action are considered the main components of CH. The term "valorization" is used to refer to all such processes. Even in their most extreme and radical forms, these definitions do not imply that valorization is the only component involved in the creation of CH; by definition, something must exist in order to interact with it. "Heritage becomes not so much a thing or a place defined by AHD (Authorised Heritage Discourse - that is, a traditional practice) as 'heritage', but the values and meanings that are constructed in and around them".

So, and even if viewed simply as pure raw materials, things (again, in the broadest sense of the word) also play a role in the creation of CH according to this view. Even though things are passive and conditional, they are also part of the picture because for an evaluation to occur, something must exist as the recipient or object of that evaluation. Therefore, considering heritage as a process means bringing processes to the fore and relegating things to the background. This is in direct

contrast to the traditional view of CH, which considered it to be composed only of things.

Cultural Heritage as Things

Long before the development of the trends mentioned above, CH was considered as consisting of things that have special and usually inherent values. In fact, it is still what is agreed upon as a "common sense definition" or "a natural way of thinking about it", as criticized by Waterton, Smith [15]. CH, from this widely held view, is a set of things (including here a wide range of sensory elements, from objects to traditions) with inherent objective value. Processes of valorization, perception, or reception do not play an obvious role in this view of CH. "This process [of changes in the CH concept] is based on the replacement of the objective logic characterizing the historical monument with the subjective logic of heritage".

Of course, there have been significant changes in the definition of CH. However, it is not as obvious that this change can be described in terms of the incorporation of a previously non-existent subjectivity. It is debatable whether there ever was an objective logic to the concept of the monument. Whether in the field of CH norms and policies, or in academic practice, which simultaneously developed the concept of CH itself, the process of evaluation or valorization has always existed by considering some objects as part of CH. As a good example, not too distant in time, the Venice Charter states that "The concept of historical monument (…) applies not only to great works of art, but also to more modest works of the past *that have acquired cultural significance over time*" (our italics).

Even in the concept of "monument" inself there has always been an essential component of judgment. Why are some things culturally significant and others not? What exactly does "cultural significance" mean? Who appoints it and how? In any case, it should be quite obvious that, analytically speaking, the state or potentiality of anything that is part of a CH is not intrinsic to things, since meaningfulness is not an inherent property of things. Although the loss of the centrality of the concept of "monument" helped eradicate this idea, the concept of monument itself is no

different: monumentality is not a property of things, but a value conferred by some common agreement.

Although controversial, the concept of the CH behind formulations such as the Venice Charter is primarily restrictive, but not at all specific: there are no objective references to determine which objects are culturally significant and which are not. Traditional approaches of this kind relied on the knowledge of experts who, based on their disciplinary training in academic fields such as art history, history or archaeology, were implicitly considered to be the only people capable of "identifying innate value and meaning (…) often defined in historical, scientific, educational or more general 'cultural' terms". This is what Smith calls the "authorized discourse of heritage" [16], which is very clearly stated in such an influential document as the UNESCO World Heritage Convention of 1972: "For the purposes of this Convention, the following are considered to be 'cultural heritage': monuments: works of architecture, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of elements which of outstanding universal value from the point of view of history, art, or science".

A subjective, evaluative process is always present here. No matter how much this judgment may be based on criteria shared and agreed upon by all potential experts, so that the final diagnosis is always the same, it still remains a conditional attribution of something abstract (value) to something concrete (object) that does not inherently hold the former. This is precisely expressed as follows: “The recognition of the fundamental contingency of heritage values does not exclude the possibility of the existence of some values that are universal (or nearly so). These socially constructed values - think of the Great Pyramids, for example - are considered universal because they are so widespread, not because they are objective truths”.

If the existence of such an objective truth were true, that meaning could be perceived by anyone, anywhere, at any time, just as anyone can perceive specific colors or shapes. This is not the case, even when a limited group of experts refers to a limited subset of the CH: expert approaches to something as specific as 'heritage sites'

are largely characterized by a '… ad hoc approach (…) [which implies that] the result is a series of small studies, none of which can be easily compared with one another. (…) As a result, much of the discourse surrounding heritage sites continues to be based on an innate understanding of these places".

So, the main difference between the two approaches described above is not a change in the objective or subjective state of the CH. The assumption that things have intrinsic value was (is) a false belief. The concept of value itself implies a subjective and external judgment. The main difference is the context that is the source of the valorizations that turn things into CH: who has the legitimacy to turn things into CH, from which viewpoint and with what relation to these things. The focus has shifted from the domain of experts to the wider domain, often referred to rather vaguely as 'community', 'social groups' or simply 'society'. This does not mean that experts and their judgments do not play any role in the current practice of the CH. This means that expert judgments are no longer considered to be the ones who decide what things should be considered as part of the CH.

CHARM as a prerequisite for CIDOC CRM understanding

CIDOC CRM is not the only model that can be used to describe the domain of CH systems. For a general understanding of CIDOC CRM, let's first focus on CHARM, which stands for Cultural Heritage Abstract Reference Model. First, CHARM is a model, that is, a purposeful display of something relevant. Each model necessarily entails a simplification that removes some detail from the presented objects and allows information to be manipulated that would otherwise be too complex to process. Second, CHARM is a CH model. By "CH" here is meant anything that can be a recipient of a certain type of value attributed by a person or group; the associated values attributed to those things, and the ideas about those things that might exist. Thus, CHARM represents not only the specific entities that can receive the CH value, but also other entities necessary to describe and understand the former.

Third, CHARM is a reference model. This means that CHARM is designed to be used by a wide and diverse range of organizations and individuals to achieve a

common understanding. And finally, CHARM is an abstract model. This means that in order for CHARM to be used by a wide and diverse range of users, the model cannot be too specific about what it represents, as each organisation, project and situation has different and unique needs and even different and unique preferences and positions on what cultural heritage is. CHARM provides an abstract representation that hopefully can be shared with everyone, but each of us must define our own specifics through extension mechanisms. This means that CHARM is not usable right out of the box; rather, it needs to be expanded to a specific model that meets specific needs.

The monograph [6] offers a comprehensive review of the complete CHARM, using the main concepts: primary and derived entities, material entities, agents, manifestations, performative entities, events, abstract entities, valorizations, and virtual entities. It also describes how these basic concepts are organized in the model and how they are related to each other.

CHARM is organized around three main ideas: meaningful (valued) entities, valorization and representation. The complete CHARM Reference is available online at http://www.charminfo.org/Reference, accessed 2023-Jun-25, which includes full descriptions of every class, attribute, semi-association, and enumerated type, as well as comprehensive diagrams and a full-text search function.

Motivation and benefits of CHARM

There is constant tension in any modeling activity. On the one hand, we want to express things as clear and understandable as possible so that as many people as possible can benefit from it. It encourages us to adopt conventions, standards, shared views of reality and agreed approaches. But, on the other hand, we know that each project or task (for example, an archaeological excavation or an ethnographic research) has its own characteristics and specific needs, and therefore requires a special, unique way of expressing things. This prompts us to use special, unique ways of presenting things to best suit our purpose. Adopting traditions and applying unique solutions are actually two conflicting strategies, each of which has its pros and cons.

The general adoption of standards or generally accepted conventions for CH conceptualizing has the obvious advantage of greatly facilitating interoperability and comprehensibility. However, it has a serious drawback: everyone must adapt their way of working to what the standard dictates. This is usually not possible or desirable, especially in a research setting. A good example is ISO 21127, also known as the CIDOC Conceptual Reference Model (CRM), a museum-oriented standard which, although well known in the CH community, is far from universal in its acceptance; although CIDOC CRM is extensible and customizable, this has not led to widespread adoption. The opposite strategy, that is, avoiding standards entirely and using one's own conceptualization of each project or task, has the advantage of providing optimal fit for purpose; however, mutual understanding and interaction are very difficult in such conditions.

CHARM adopts a new hybrid approach based on model extension that has been used by ISO for some ontology-related work. According to this approach, a generic standard should involve as few concepts as possible and always at a very high level of abstraction, so that it is likely to be acceptable to a wide range of specialists. Furthermore, anyone who wishes to use the standard must extend it; that is, add specific classes, attributes, associations, and other model elements to provide the necessary detail to adapt the standard to the specific needs of a given project or task. The result of the extension is called a concrete model.

The extension approach used by CHARM combines the advantages of the previous two strategies. On the one hand, it to take into account the specifics of projects, creating a specific model that is optimal for each of them. On the other hand, CHARM is still used as a shared infrastructure, so interaction and interoperability with other models created by other people who also use CHARM is very easy. CHARM contains more than 160 classes and covers many areas of CH, including:

- Material entities such as places, buildings or books.
- Performative elements such as social activities, songs or crafts.
- Occurrences such as processes, situations and changes.

- Abstract entities such as beliefs and category systems.
- Norms such as rights, duties or conventions.
- Agents such as people or communities.
- Representations such as maps or photographs.
- Valorizations such as research or community position.
- Derived entities such as sites, landscapes, or styles.
- Measures of length, area, mass and other quantities.
- Locations, including absolute and relative.

General vision of CHARM

The general vision of CHARM is shown in **Fig. 4**. It shows CHARM's "top" classes, i.e. its most abstract (A) classes. Most of the other 160+ classes in the model are their descendants. At the top is the ValuableEntity class, which represents an entity that has received, is currently receiving, or may receive a cultural heritage value. Almost anything can be a valuable entity, which is consistent with the concept of a valuable CH. Each value entity can have multiple names; this allows us to refer to them as needed.

Things that can receive a CH value are called **valuable entities** in CHARM. There are two types of valuable entities: **primary entities**, which can be immediately discretized and classified in the absence of additional information, and **derived entities**, which cannot. Derived entities are always based on some basic of value entities.

There are several types of primary entities depending on their nature.

Material entities consist of matter and are perceived primarily through their materiality.

Manifestations are performances in which specific people participate in a specific time and place.

Performative entities are abstractions designed to represent such manifestations.

Occurrences are events or situations that occur with other valuable objects.

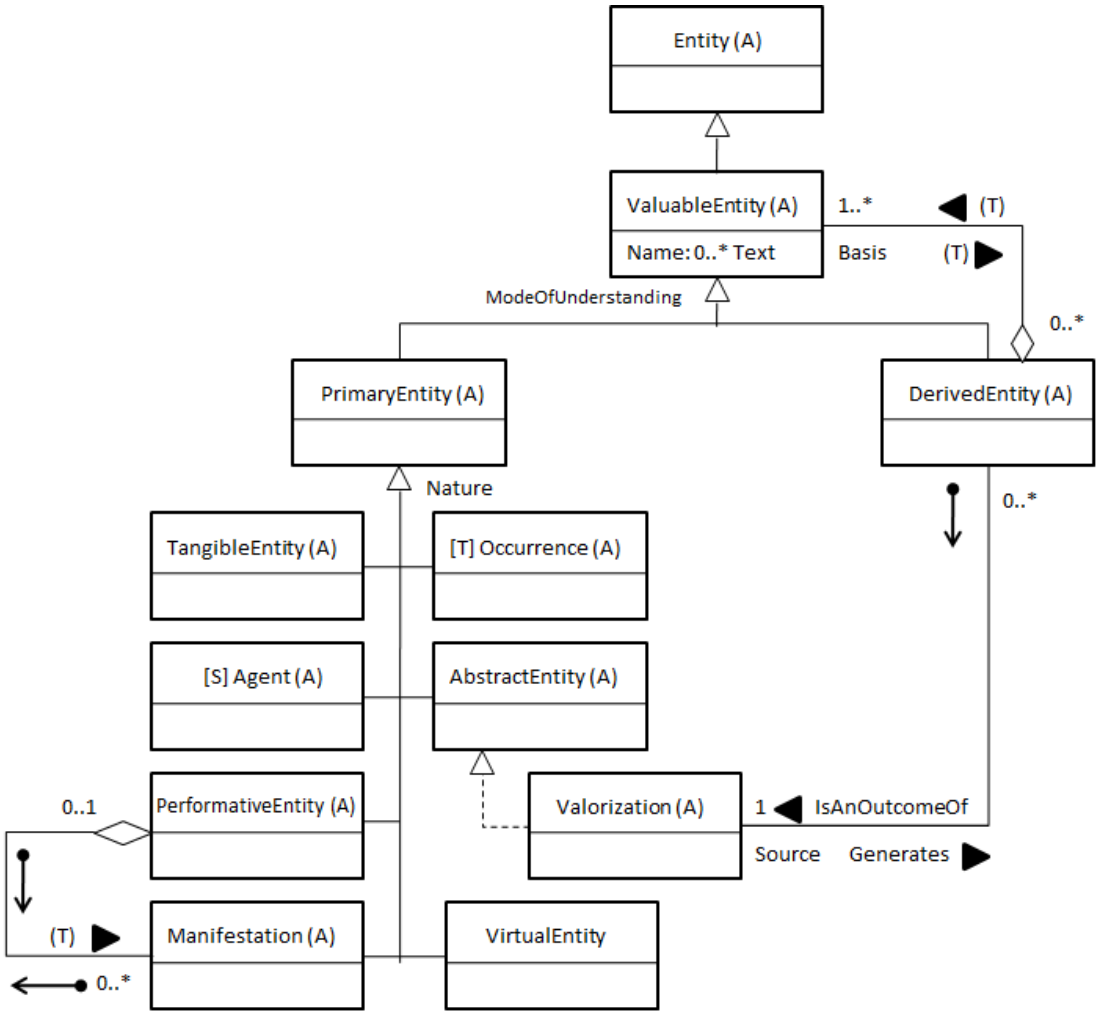


Fig. 4 – General vision of CHARM

Abstract entities are socially constructed abstractions without concrete implementation.

Valorizations are a subtype of abstract entities and correspond to agreed interpretive discourses that attach cultural heritage value to other valuable entities.

As a result of valorization, derived entities can be generated.

Agents are people and groups of people.

Virtual entities are things that can only be perceived through intermediate devices.

Interaction with CIDOC CRM

Description of CIDOC CRM 7.2 or 5.0.4

CRM (**5.0.4** and **7.2**) is an ontology in the computer science sense of the term. It is formulated as an object-oriented semantic model in the hope that this formulation will be understandable to both documentation experts and information scientists, and

which at the same time is ready for conversion to formats such as RDF Schema, KIF, DAML+OIL, OWL, STEP, etc. This model can be implemented in any Relational or Object-Oriented database schema. CRM instances can also be encoded in RDF, XML, DAML+OIL, OWL, and other formats.

The definition of CRM proposed here is comprehensive. It is a deliberately compact and concise presentation of 86 classes (81 - 7.2) and 137 (160 - 7.2) unique properties of CRM. It does not attempt to describe properties inherited by subclasses in the class hierarchy (this would require declaring not 137 (160 - 7.2), but several thousand properties). However, this definition still contains all the necessary information for inference and automatic generation of a complete description of all properties, including inherited ones.

"We use the term "ontology" in a philosophical and computer sense. In philosophy (https://uk.wikipedia.org/wiki/Онтологія, accessed 2022-Feb-19) **Ontology** (Latin *ontologia* from Ancient Greek ών, gen. Greek όντος — being, that which exists and Greek λόγος — teaching, science) is the doctrine of **being**, a section of **philosophy** in which the fundamental problems of existence, the development of the essential, the most important are clarified. The concept of "ontology" does not have an unambiguous interpretation in philosophy.

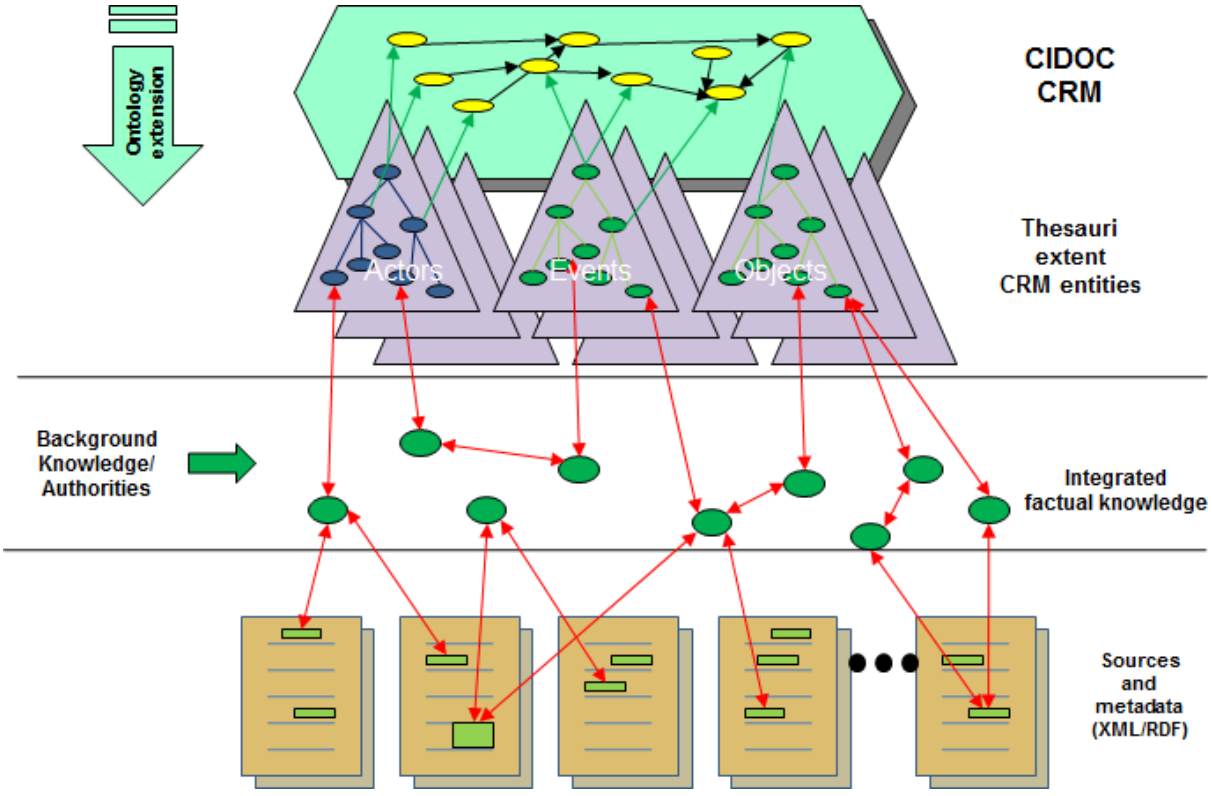
In computer science (https://uk.wikipedia.org/wiki/Онтологія_(інформатика), access 2022-February-19) Ontology is a formalized representation of knowledge about a certain **subject area** (**environment, world**), suitable for automated processing. Ontology is necessarily accompanied by some **concept** of this area of interest. Most often, this concept is expressed by defining basic **objects** (**individuals, attributes, processes**) and **relation** between them. Defining these objects and the relation between them is usually called **conceptualization**.

The following definition of ontology is a generalization: **Ontology** is a generally accepted and publicly available conceptualization of a certain domain of knowledge (world, environment), which contains a basis for modeling this domain of knowledge and defines protocols for interaction between agents that use knowledge from this

domain, and, finally, includes agreements on the representation of the theoretical foundations of this domain of knowledge"[1].

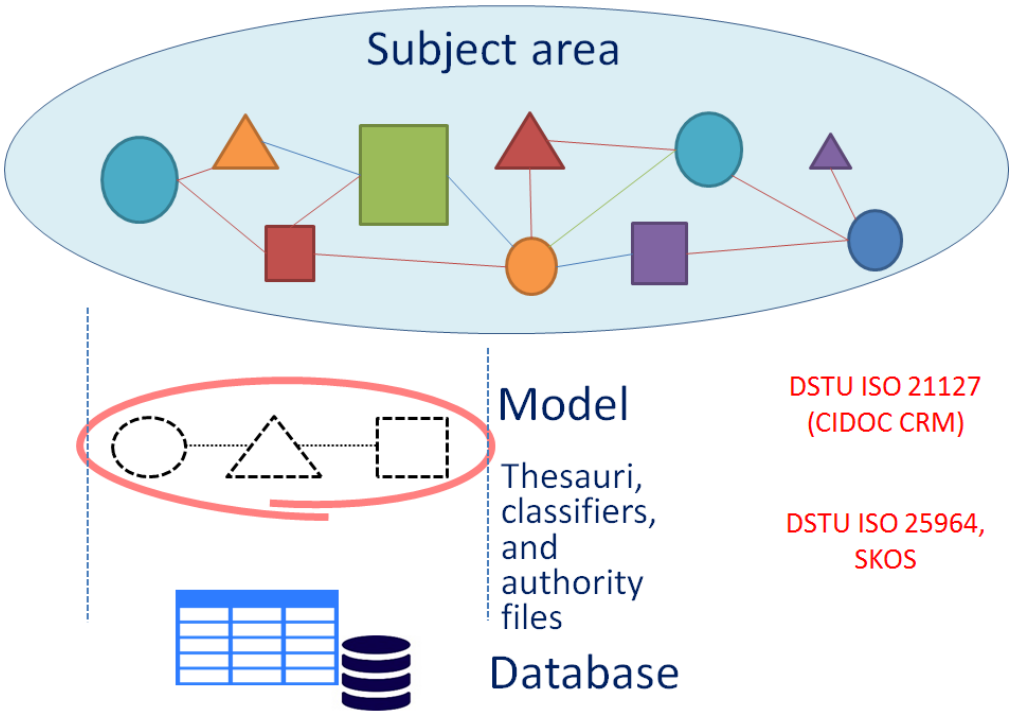
General vision of CIDOC CRM

The scheme "General vision of CIDOC CRM", similar to the scheme **Fig. 4**, we found in the article [13]. By a conceptual model or ontology is meant a description of categorical knowledge about "possible states of affairs" rather than about a single state of affairs, and both are treated as a special kind of knowledge base. The term "conceptual model" is preferred when referring to actual instantiation and constructions dictated more by representational formalism than by intended meaning. Categorical knowledge can come from analyzing data structures, hidden constants, or terminology used in the data. We have a vision of a global semantic network model, a fusion of relevant knowledge from all museum sources abstracted from the context of their creation and documentation units within a common conceptual model. The web, however, should not replace the quality of a good scientific text. Rather, it should support links to relevant primary textual sources to enable them to be discovered using relevant criteria.



a)

[1] http://www-ksl.stanford.edu/kst/what-is-an-ontology.html



b)

Fig. 5 - Information integration architecture: a) [12; Fig. 2], b) MCIP2021 Project (see below)

Fig. 5 shows a possible architecture combining an upper property-oriented ontology (here CIDOC CRM) that provides semantics for the properties of the underlying terminological systems and an integrated factual knowledge layer built from raw data, metadata and background knowledge.

CIDOC CRM plays the role of an "enterprise model", which is called a "generic model". It is assumed that there is a conceptual model ("source model") for all sources and that the outputs can be expressed without loss of meaning in terms of the source model, which is based on the same formalism as the enterprise model. The output model may be constrained by semantics that are within the scope of the overall model. The Telos data model [17] without its assertion language was chosen as the representation formalism. Telos, like many other knowledge representation languages, decomposes knowledge into elementary propositions – declarations of individuals, classes, and binary relations.

Properties of Telos are similar to properties of RDF, RDFS [18]. Since RDF (and OWL) have now become standards for Semantic Web applications, the

terminology used is RDFS (RDF Schema - a set of classes with certain properties that use the RDF extensible knowledge representation data model that provides the building blocks for describing ontologies. It uses various forms of RDF vocabularies designed to structure RDF resources) because it is more familiar than the Telos terminology for describing classes and properties. Since our main interest is ontological, we intend to edit CRM in various representations, but the primary source for CRM is the complete implementation in Telos in the SIS (Semantic Index System or Thesaurus Management System) knowledge management system (https://projects.ics.forth.gr/isl/manuals/manuals.html, accessed 2023-jun-29). Logical statements are omitted because they can be added at a later stage when the ontological commitment of isA primitive classes, properties and relations is satisfactorily established.

CIDOC CRM contains the classes and logic of property groups. These groups relate to the concepts of participation, participation and structure, location, evaluation and identification, purpose, motivation, use, etc. These properties put temporal entities and with them events in the central place, as symbolically shown in **Fig. 6**.

All property paths to dates go through temporary entities. Property paths to locations that bypass temporary entities are understood as temporary entity short paths. Similarly, Actors are considered to be related to tangible and intangible things (Physical Material, Conceptual Objects) only through temporal entities. Any instance of a class can be identified by appellations, names, labels, names, or anything else used in a historical context. We model relation to names and their ambiguity as part of the process of acquiring historical knowledge. This should not be confused with database identifiers in Model implementations that are not part of the ontology. All instances of a class can be further classified by Types for additional terminological distinction. Often Types serve as a range of properties that generally refer to things of a certain kind, such as "a dress made for a wedding" as opposed to "a dress made for my wedding".

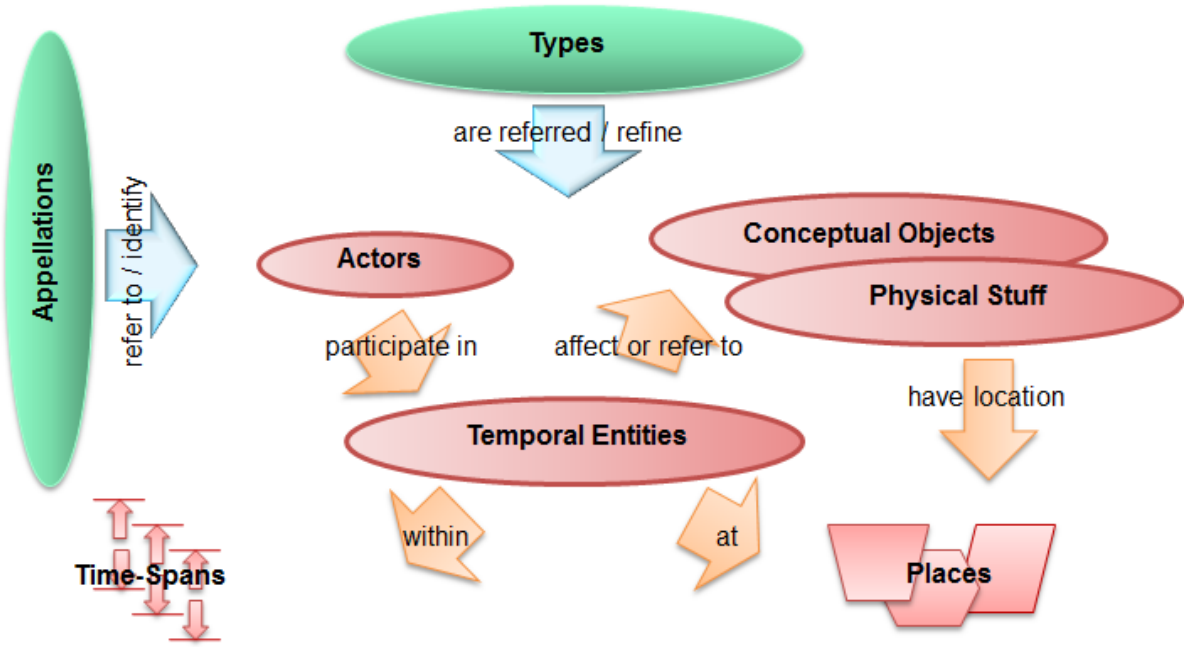


Fig. 6 - Qualitative metaschema of CIDOC CRM [12; Fig. 3]

Important details of CIDOC CRM 7.2 or 5.0.4

As of the date of writing this article, it is needed to work with two versions of the CIDOC CRM standard: 5.0.4 (pre-official), December 2011; 7.2 (currently published), October 2021. The fact is that DSTU ISO 21127:2018 Information and documentation. The Basic Ontology for the Exchange of Cultural Heritage Information via the ISO 21127:2014 standard conforms to CIDOC CRM version 5.0.4. We know that the translation of DSTU ISO 21127:2018 into Ukrainian was made from ISO 21127:2014/CIDOC CRM 5.0.4 and it is still being edited. In this work, we use the latest published version 7.2 in English (https://cidoc-crm.org/versions-of-the-cidoc-crm, accessed 2022-Jun-01), if the content we need does not fundamentally differ from the version 5.0.4.

Perhaps the best idea about CIDOC CRM can be obtained from **Fig. 8 - Fig. 10**. **Fig. 8** presents schemes of properties and classes of the highest level, and **Fig. 9**, **Fig. 10** - schemes of properties and classes for the description (reasoning) of spatial information of CH objects. Before considering the spatial part of CIDOC CRM, we present without comments the complete hierarchy of classes and the part related to processes (**Fig. 7**).

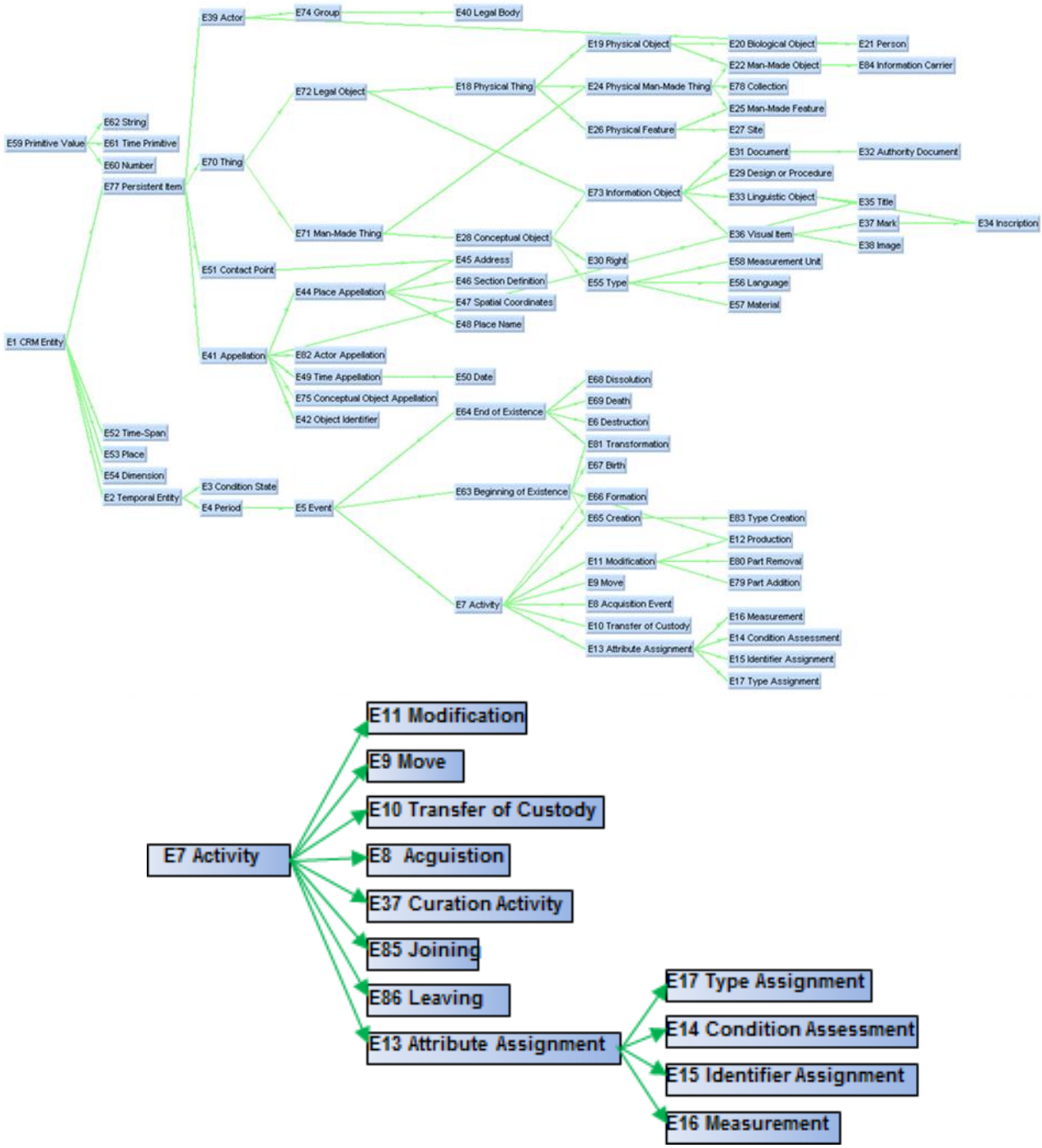


Fig. 7 – Hierarchy of CIDOC CRM classes and entity E7 Activity, with which the process part of the standard is modeled

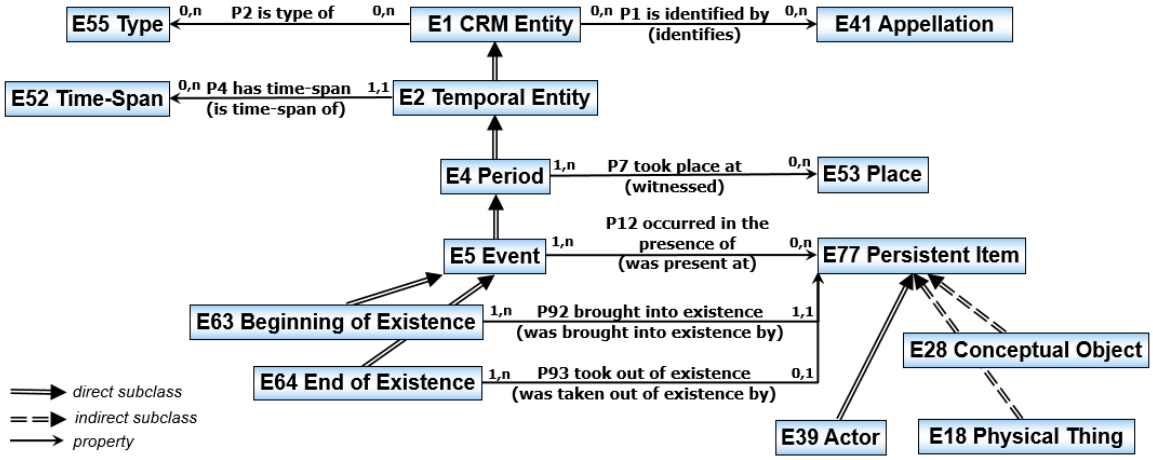


Fig. 8 - Properties and top-level classes of CIDOC CRM (7.2; Figure 1)

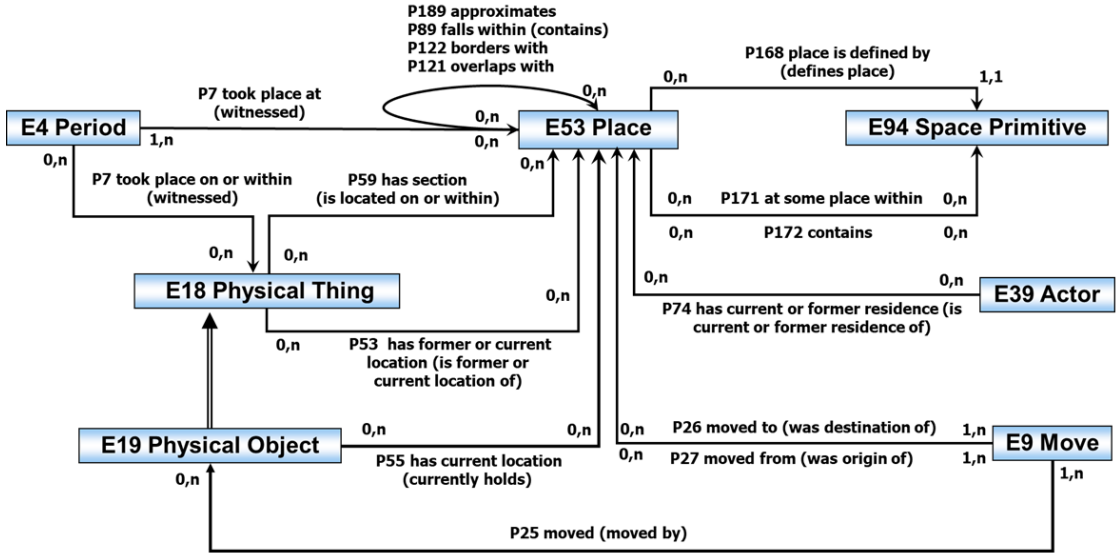


Fig. 9 – Basic properties and classes of CIDOC CRM for reasoning about spatial information (7.2; Figure 4)

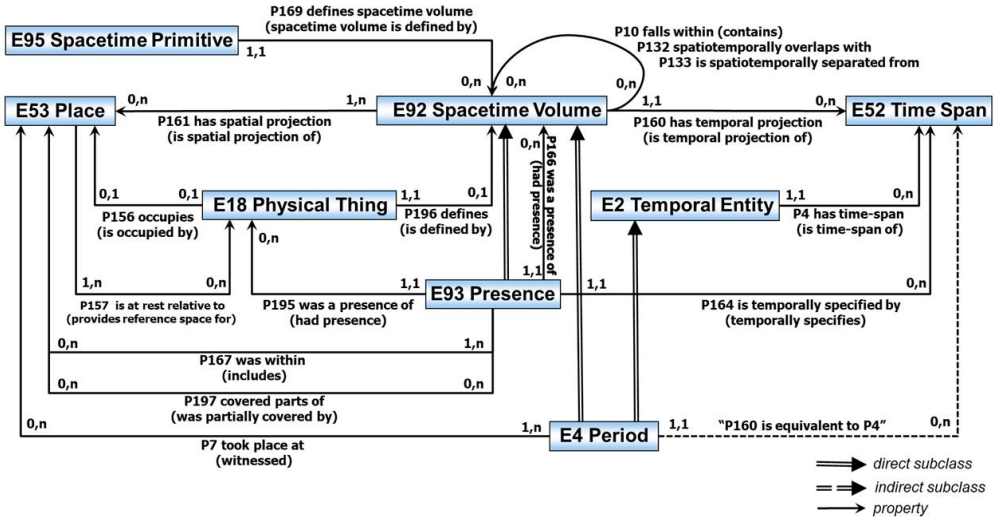


Fig. 10 - Basic properties and classes of CIDOC CRM for reasoning with spatio-temporal volumes (volumes) (7.2; Figure 6)

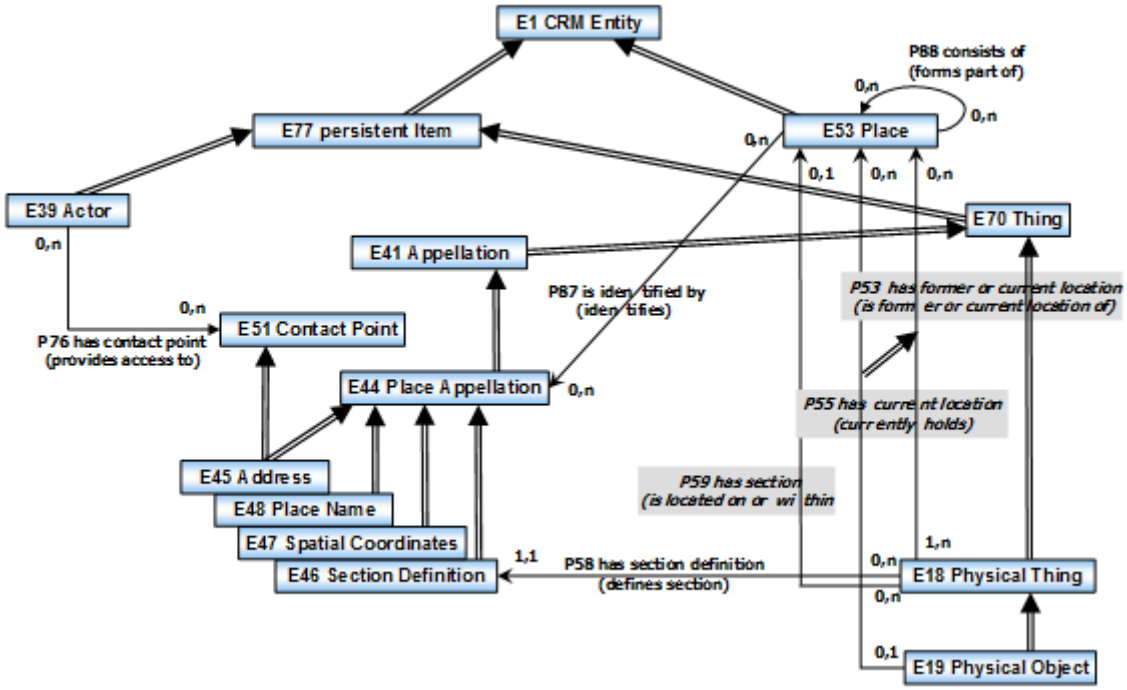


Fig. 11 - Reasoning about spatial information (5.0.4; Fig. 2)

We cannot review the CIDOC CRM standard in detail. We will give only a description of the scheme **Fig. 11**. The given scheme partially presents the logic of spatial information. Included in this scheme are five main branches of the hierarchy: E39 Actor, E51 Contact Point, E41 Appelation, E53 Place, and E70 Thing. All classes are marked with white and blue rectangles. Properties are marked with single arrows. In some cases, the order of precedence for property names has been reversed to make the chart easier to read from left to right. Double arrows indicate an "E" relation between classes and their subclasses or between properties and their sub-properties. Abbreviations are highlighted in light gray rectangles and their names are in italics: P59 has a section (located at or in) between E53 Place and E18 Physical Thing, which is an abbreviation of the path that goes through E46 Section Definition.

As you can see, an instance of E53 Place is *identified* by an instance of E44 Place Designation, which can be an instance of E45 Address, E47 Spatial Coordinates, E48 Place Name, or E46 Section Definition, such as *basement*, *bow of a ship*, or *lower left corner*. An instance of the E53 Place class can *consist* of or *form part of any* other E53 Place instance, thus enabling the construction of a hierarchy of geometric "containers".

The instance of E45 Address can be considered both as E44 Designation of Place - a reference to E53 Place - and as E51 Point of Contact for E39 Person. E39 An actor can have multiple instances of the E51 Contact Point class. E18 A physical phenomenon is in a location as a result of what was created here or brought here. Accordingly, the properties P53 *has a past or present location (is the past or present location of what)* and *P55 has a present location (present contains)* are considered contractions of fully articulated trajectories through the respective events. P55 *has the current location (now contains)* is a sub-property of P53 has the past or present location (is the past or present location of what). The latter is a container for location information in the absence of knowledge about the validity time and the time of related events.

An interesting aspect of the model is that property *P58 has a section definition (defines a section)* between E46 Section Definition and E18 Physical Thing (and the corresponding abbreviation from E53 Place to E19 Physical Object). It allows the E53 Place instance to be defined as a section of the E19 Physical Object instance. For example, we may know that Nelson fell on a certain part of the deck of His Majesty's ship "Victory" without knowing the exact position of the vessel in geospatial terms at the time of the fatal shot. Similarly, a signature or inscription may be located "in the lower right corner" of a painting, regardless of where the painting hangs."

CIDOC CRM Usage

Tim Berners-Lee proposed to separate syntax and semantics to define the language of the Semantic Web. Syntax is a set of rules for building phrases of a language, which allows you to determine correct sentences in this language. The main tool of syntax is the presence of validation rules that allow us to judge whether the syntax of a text is satisfactory or not. Semantics is a system of rules for the interpretation of individual language constructions. Semantics determines the meaning of language sentences.

An example of a language with syntax but no semantics is XML, and an example of semantics without syntax is human language, which is why it is so difficult for programs to understand where what is. For the practical implementation

of the Semantic Web, Tim Berners-Lee proposed a plan according to which it is necessary to consistently develop:

1. Syntax for knowledge representation using reference to ontologies (RDF).

2. Ontology Description Language (OWL).

3. Web services description language (WSDL, OWL-S).

Currently, there are already many automated web services without any semantics, but other programs, such as agents, have no way to search the network for a similar program that performs this or that function. This process, called the discovery of services, will become possible only after the emergence of a single language that allows describing services so that agents can understand what this service allows to do and how to use it. Services and agents may advertise the functions they perform, for example

4. Tools for reading and developing Semantic Web documents (Jena, Haystack, Protege).

The main disadvantage of the Semantic Web concept is the difficulty of application. The RDF format was developed by people with an academic background and was not originally intended for use by ordinary Internet users. Even many webmasters and programmers find it difficult to master RDF and OWL. But despite this, Tim Berners-Lee claims that in the future no special knowledge will be needed to create pages.

5. The language of queries to knowledge recorded in RDF (SPARQL).

SPARQL is a query language for rapid access to RDF data. Using the common protocol and the SPARQL language, applications can analyze RDF descriptions of resources and obtain the necessary information from the network.

6. Logical derivation of knowledge.

7. Semantic search engine (SHOE).

8. Agents of the Semantic Web.

If you choose software tools to implement the OWL Application Scheme, you need to make sure that they satisfy the points/options 1-5 and preferably 7 above.

More information about the mentioned terms and concepts can be found in [18], [19]. We used some of the mentioned standards in the MKIP2021 project. The general landscape of Semantic Web standards is shown in **Fig. 12**.

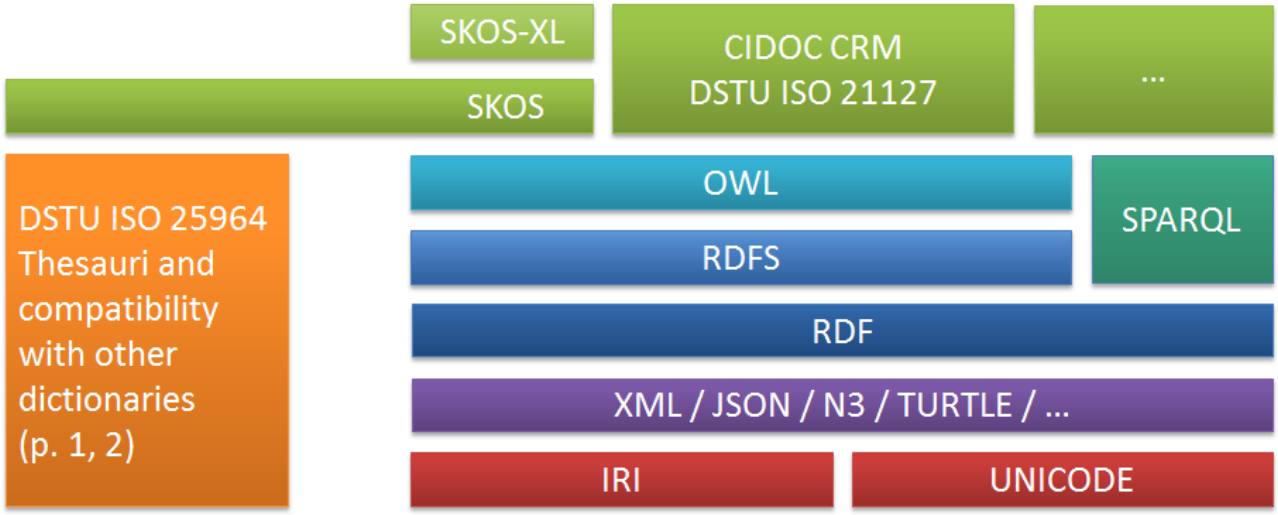


Fig. 12 - The Semantic Web Standards Landscape (Geomatic Solutions, 2021)

Interaction with CIDOC CRM

According https://www.cidoc-crm.org/how-i-can-use-cidoc-crm, 2023-jun-26, CIDOC CRM is, first of all, an intelligent system for the organization and integration of CH data. The system is officially expressed in specification documents. Documents are available in the resources section of this website. They are the official reference documents for CIDOC CRM, actively maintained by the CIDOC CRM SIG and updated according to user needs and the organic growth of the standard.

Using CIDOC CRM in practical data integration scenarios can be achieved in several ways. In a typical scenario, this can be implemented in knowledge bases based on RDF or OWL; alternatively, it can be used to implement cross-database query interpreters. It can also be used as an intelligent guide to making traditional relational databases more efficient.

To begin implementing CIDOC CRM in various usage scenarios, potential users are encouraged to consult the tutorials and information available in the training section of this website. There is also a series of frequently asked questions documents designed to help answer common questions asked by CRM users. Prospective users/members of the CRM community can also contact the CIDOC CRM SIG for

advice and information. If you are using CIDOC CRM and have questions or problems that are not addressed in the documentation and tutorials, it is always possible to join the CIDOC CRM SIG mailing list and post questions about specific topics there. The results of past questions and problems are compiled on the website and form a useful archive that can be consulted for answers to previously asked questions.

CIDOC CRM includes both the basic standard, CRMbase, and a family of modular extensions. Each of these extensions has its own dedicated website to support its use in the same way as described above.

To achieve the goal stated in the title of the subsection, let's make two remarks. First, we recommend that you carefully familiarize yourself with everything related to the figure [11; Fig. 6], which was called "The INSPIRE Model-Driven Approach". The authorship of this figure in the cited article was attributed to the company weTransform, GmbH, although it is a more general problem of interaction between OWL (Ontology Web Language) and UML (Unified Modeling Language). In the article [5], we proposed what is shown in **Fig. 14** adjustments.

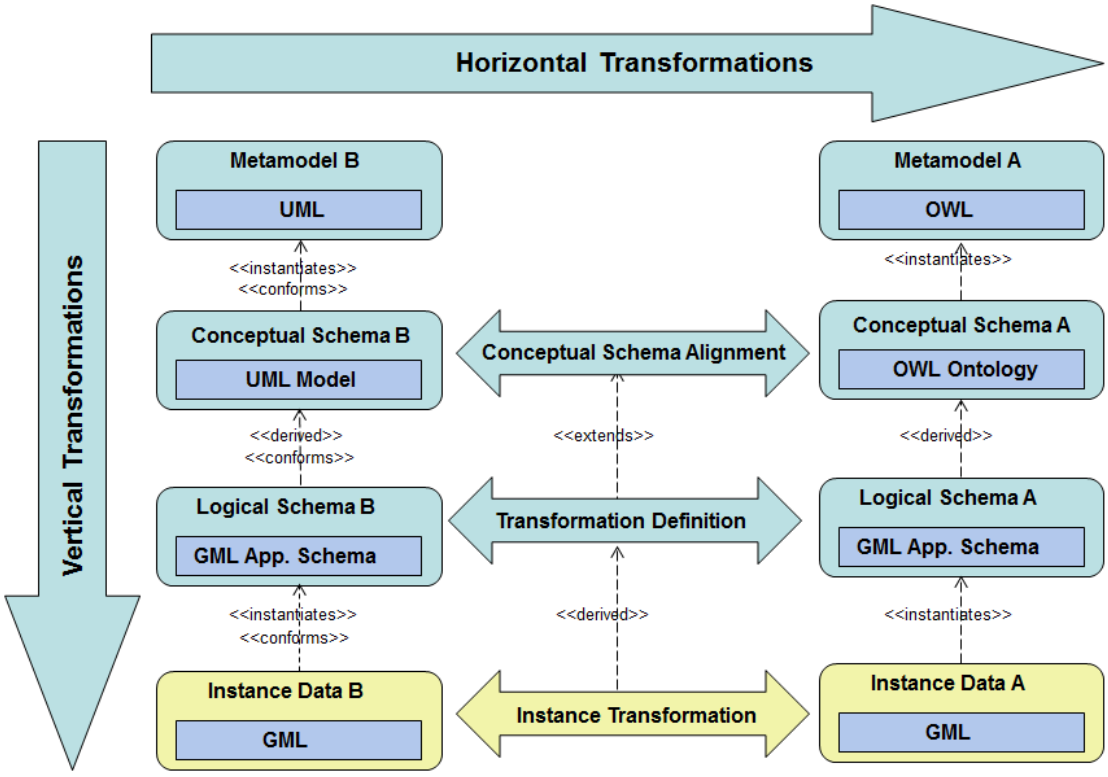


Fig. 13 – Adjusted interaction of OWL and UML

CIDOC CRM standard is an OWL ontology that represents the Conceptual diagram of a immovable CH (in **Fig. 13**, it is Conceptual diagram A). The standard itself "align" this conceptual scheme and describes Conceptual scheme B, which is a UML model. That is why we consider it necessary to separately discuss the translation in the standard of such terms as "E39 Actor" (translated as "Actor", although in UML terminology we are used to the translation "Actor" or, at least, "Acting person"), "E70 Thing" (translated "Phenomenon", although we translate it as "Thing"). We also don't like the translation of "E41 Appellation" (translated as "Designation", although Google translates "Appellation" primarily as "Name").

However, the main thing here is to obtain Logical Schemes A and B, which can be their corresponding GML Application Schemes. In fact, Logical Schemes may correspond to Logical Schemes that can be implemented with the help of certain technologies, called "realizable". Two software technologies are the most likely to be implemented: WissKI and Arches.

In 2021, we completed the project "Organization and conducting online educational seminars on the completion of the pilot project of collecting primary data of monuments of immovable cultural heritage of Ukraine" for regional units of the MCIP of Ukraine (hereinafter the MCIP2021 Project). The first stage of the project was the commissioning of the Declaration module (DM), which was discussed in the article [3]. For this, it was necessary to deploy the infrastructure in the (together with) MCIP, which de facto became, together with the DM, the Declaration system. The purpose of the "Declaration" system was and remains to ensure the formation of an electronic database of objects of cultural heritage that are already registered.

In the educational part of the MCIP2021 project, it was necessary to hold online seminars devoted to the automation of accounting and document management processes (**Fig. 14**) in view of the plans to use the Arches software platform (https://www.archesproject.org/, 2023-jun -30) in the MCIP. We were able to do this because around the same time we completed an internal pilot project on Automation of accounting and document management processes using the WissKI software platform (https://wiss-ki.eu/, 2023-jun-30). Here it is worth understanding that the

domains of systems created on the WissKI and/or Arches platforms overlap, especially if the CIDOC CRM standard needs to be used in both cases.

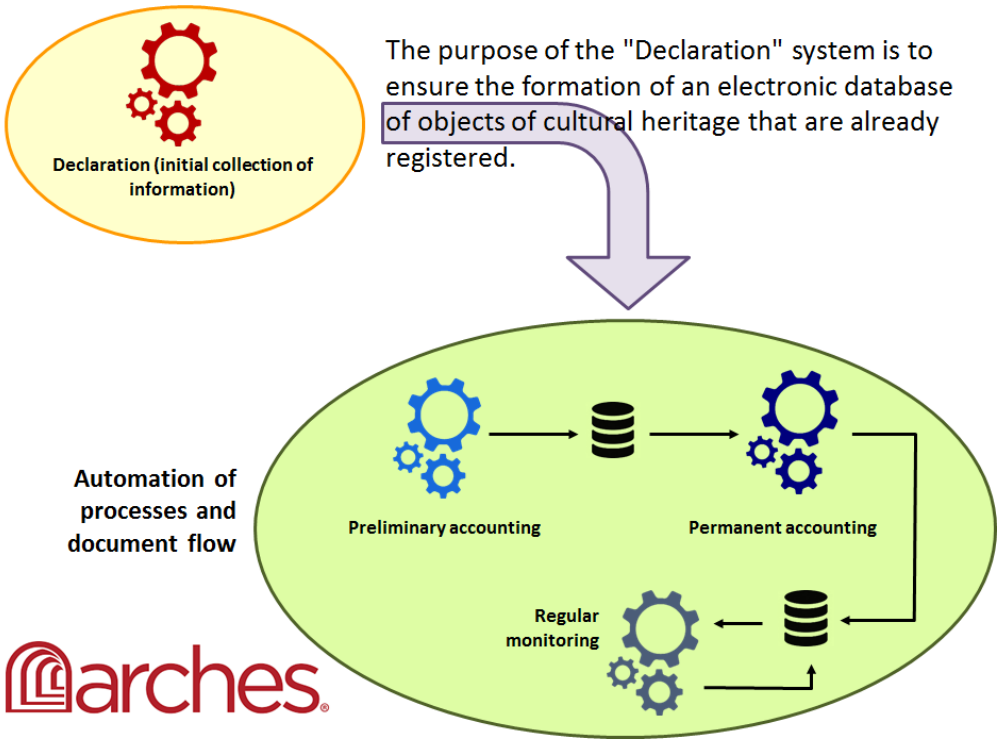


Fig. 14 - Basic structure of the MCIP2021 project. The scope of WissKI and Arches platforms is shown in the green oval

WissKI (Wissenschaftliche Kommunikations Infrastruktur – Science Communication Infrastructure) is a virtual research environment and associated open data management software. In addition to the basic capabilities of creating, reading, editing, and deleting content, WissKI offers solutions for all research data lifecycle tasks and helps users create and publish FAIR data. In addition, users can create revisions and translations, open access to data through a wide range of interfaces and integration options, and restrict it through detailed rights management. The associated open data is stored in an external triple repository accessible through its own endpoints and is therefore independent of the Drupal or WissKI architecture. Data modeling follows an ontological approach, mainly but not exclusively according to CIDOC CRM. As part of the open Drupal content management system, WissKI provides all the benefits of a web application that is constantly maintained and developed. Last but not least, WissKI's core functionality can be extended with a

variety of Drupal modules. This makes WissKI a full-featured research data management software suitable for a wide range of applications.

"βSoFr (GeoSF+, Arches)" block. We cannot pay enough attention to this block, so we will focus only on its component - the Arches platform, which we recommend for use in Ukraine. We considered the concept of "platform" in [1], where it is said that a platform (we will not claim that it is any) is an infrastructural pattern.

"The Arches platform was developed by the Getty Conservation Institute (GCI) together with the World Monuments Fund (WMF) for independent implementation by any cultural heritage institution, Arches combines state-of-the-art software with the knowledge and experience of specialists from cultural heritage from around the world. Institutions implementing Arches can conduct a digital inventory of objects that allows them to describe the types, places, locations, volumes, cultural periods, materials and condition of immovable heritage objects and to establish and capture the multiple and complex relation between these objects".

"Arches is a powerful enterprise-level platform designed for use at the corporation (organization) or project level, rather than a personal software solution. As a result, organizations and institutions wishing to implement the platform will need to purchase and install a server to host the Arches platform, and should also provide for the involvement of IT specialists of the organization (project), or specialized IT specialists, to configure and maintain the platform".

"Arches is designed with the following main principles in mind:

• Specialization: Arches is specifically designed and engineered for the international heritage industry and can be used to inventory and manage all types of immovable heritage sites.

• Affordability: As open source software, Arches is free and there are no license fees. Costs associated with Arches may include IT support for installation, configuration and maintenance. Arches allows users to share resources to improve and maintain the platform.

• Customizability: Arches' software code is open, and an experienced IT professional can easily extend and customize the platform according to their own requirements and needs.

• Adherence to standards: Arches already incorporates internationally accepted standards for heritage inventory, semantic data modeling and software, enabling best practices in the creation and management of heritage data and facilitating data sharing and their long-term storage and use despite technological advances. In particular, Arches implements the CIDOC CRM standard, which is one of the main arguments in favor of its use in Ukraine".

"Arches is designed to achieve a range of objectives to protect, understand, value and manage cultural heritage resources. They include:

• identification and inventory

• research and analysis

• monitoring and risk mapping

• research planning, conservation and management

• raising awareness of cultural heritage sites among the public, state authorities and decision-makers".

"Thanks to the benefits of open source, the Arches community can share new functionality to meet additional legacy needs, and community members provide support for the implementation and use of Arches through the Arches Community Forum".

"Peculiarity of Arches...

... a modern software platform with an easy-to-use web interface.

Once Arches is installed and configured in an organization, authorized users with or without basic technical training can enter, edit, and search data.

... reliable geospatial mapping and processing".

"Arches has the ability to draw, import and edit object geometries directly in the platform and perform complex spatial queries. The Arches component is a server for managing geospatial images such as basemaps, satellite images, aerial photographs

and historical maps. In addition, Arches can add maps from external mapping services such as Google, OpenStreetMap and Microsoft."

Arches accesses and processes geospatial data based on Open Geospatial Consortium (OGC) standards and specifications. Compliance with OGC standards ensures platform compatibility with GIS systems and applications (such as Quantum GIS [QGIS], ESRI's ArcGIS, or Google Earth), modern web browsers, and online mapping services.

... configuring access parameters and ensuring security control according to the requirements of the organization or individual project requirements".

"Arches enables organizations to restrict access to data based on individual or group permissions. For example, in Arches, you can specify which specific users can edit certain data fields or which visitors (if public access is allowed) can see them, to which type of data access is allowed.

... standards-based data architecture and semantics to facilitate data sharing and ensure data longevity".

"Arches uses CIDOC (CRM) to structure the relationships between data fields. The use of CRM promotes data independence from Arches software, which will facilitate the migration of data to other systems in the future and help preserve and use data for a long time. It also facilitates powerful and efficient searching both within and between datasets".

"The Arches community has developed libraries of ready-to-use and logically structured resource models (i.e. data or graph models) suitable for the cultural heritage domain that can be customized to meet any organization's specific data field requirements."

"Arches Designer facilitates the creation of new resource models and/or the addition of new data fields to existing resource models while automatically updating the data entry interface through a simplified automated process.

... an open, flexible, customizable platform."

"Institutions implementing Arches can customize the software based on their specific geographic, cultural, and administrative contexts. More in-depth and fine-

tuning is also possible, but requires an expert with open source experience. You can find such experts in organizations that have already implemented Arches, or in experienced IT service provider companies."

Conclusions

"For the organization of activities on the creation of a new electronic State Register of Immovable Cultural Heritage (CH) of Ukraine, it is proposed to use the Solutions Framework (SoFr) of the specified system, which belongs to the class of Atlas Geo-Information Systems (AGIS)". The usage of the SoFr architectural pattern in general and the components of its main triad for AGIS-CH of the first queue (AGIS-CH1) is the best option for applying a system approach to this activity. As part of this system approach, it is necessary to fulfill the main conceptual provisions described in a series of articles [3], [4] [5] and in this article.

The components of AGIS-CH1 SoFr correspond to the main triad of the created system and the activity system for its creation. Namely, the articles for 2022 describe two components of dualism: AGIS-CH1 product ↔ the process of AGIS-CH1creation, which should be a constantly updated portal of the project implementation environment (PIE - Projects Implementation Environment) and, at the same time, a normative extension. The main Conceptual Provision 3 is formulated as follows: "Basics of SoFr AGIS-CH1: AGIS-CH1 basics of Ukraine should be INSPIRE and CIDOC CRM".

The article [5] describes the first of two parts of the dualisms product↔meta-product and process↔meta-process. It was called "AGIS-CH1 Basics: interaction with INSPIRE". The second of two parts of dualisms product↔meta-product, process↔meta-process is called "AGIS-CH1 Basics: interaction with CIDOC CRM". It is described in this article.

Namely, in the first of the two main sections of the article, the system and subject evolution of AGIS-CH1 is first considered. According to the system evolution of the domain of cultural heritage, AGIS-CH1 should be created as a Web 3.0 Formation system [1]. This Formation is also called the Semantic Web. According to the subject evolution of the domain of cultural heritage, the AGIS-CH1 model should

be product-process. The product-process model of the National Spatial Data Infrastructure (NSDI) development was considered in the work [11]. Since the CH registers should be components of the Spatial Information Infrastructure (SII) of the country, we do not see anything strange in the analogies of the two models. The first section concludes with a consideration of the CHARM model, which stands for the Cultural Heritage Abstract Reference Model.

The second main section deals with the use of CIDOC CRM. First, the standard "DSTU ISO 21127:2018 Information and documentation. A basic ontology for cultural heritage information exchange" is described. Then the issues of using CIDOC CRM are considered. Briefly is described the Arches software platform that uses CIDOC CRM. This platform is recommended for use in Ukraine. In particular, in the Ministry of Culture and Information Policy (MCIP) of Ukraine. The use of CIDOC CRM requires answers to the following main questions in the context of this article: which processes should be automated first of all using CIDOC CRM? At the moment, these processes are: Declaration - Previous accounting - Permanent accounting – Regular monitoring.

References

1. Chabaniuk V.S. Reliatsiina kartohrafiia: Teoriia ta praktyka.- Kyiv: Instytut heohrafii NAN Ukrainy, 2018.- 525 s. [Chabaniuk V.S. Relational cartography: Theory and practice. - Kyiv: Institute of Geography of the National Academy of Sciences of Ukraine, 2018. - 525 p.] (Ukrainian)
2. Kulturna spadshchyna v Atlasnii heoinformatsiinii systemi staloho rozvytku Ukrainy: L.H. Rudenko, K.A. Polyvach, V.S. Chabaniuk ta in. / za red. L.H. Rudenka.- Kyiv: Instytut heohrafii NAN Ukrainy, 2018.- 172 s. [Cultural heritage in the Atlas geoinformation system of sustainable development of Ukraine: L.G. Rudenko, K.A. Polivach, V.S. Chabaniuk et al. / edited by L.G. Rudenko. - Kyiv: Institute of Geography of the National Academy of Sciences of Ukraine, 2018. - 172 p.] (Ukrainian)

3. Chabaniuk V., Dyshlyk O., Polyvach K., Pioro V., Kolimasov I., Nechyporenko Y. Holovni kontseptualni polozhennia stvorennia elektronnoho derzhavnoho reiestru nerukhomoi kulturnoi spadshchyny Ukrainy. Chastyna 1.- Zemleustrii, kadastr i monitorynh zemel, № 2, 133-154. [Chabaniuk V., Dyshlyk O., Polivach K., Pioro V., Kolimasov I, Nechyporenko J. The main conceptual provisions of the creation of the electronic state register of immovable cultural heritage of Ukraine. Part 1.- Land management, cadastre and land monitoring, No. 2, 133-154.]

4. Chabaniuk V., Dyshlyk O., Polyvach K., Pioro V., Kolimasov I., Nechyporenko Y. Holovni kontseptualni polozhennia stvorennia elektronnoho derzhavnoho reiestru kulturnoi spadshchyny Ukrainy. Chastyna 2: Protsesy.- Zemleustrii, kadastr i monitorynh zemel, № 3, 114-136. [Chabaniuk V., Dyshlyk O., Polivach K., Pioro V., Kolimasov I., Nechyporenko J. The main conceptual provisions of the creation of the electronic state register of the cultural heritage of Ukraine. Part 2: Processes.- Land management, cadastre and land monitoring, No. 3, 114-136.]

5. Chabaniuk V., Dyshlyk O. Harmonizatsiia Infrastruktury Prostorovoi Informatsii Ukrainy z INSPIRE (Infrastructure for Spatial Information in Europe) // Suchasni dosiahnennia heodezychnoi nauky ta vyrobnytstva. Zbirnyk naukovykh prats Zakhidnoho heodezychnoho tovarystva UTHK, Vypusk II (46).- Lviv: Vydavnytstvo Lvivskoi politekhniky, 2023. U drutsi (In Press). [Chabaniuk V., Dyshlyk O. Harmonization of Spatial Information Infrastructure of Ukraine with INSPIRE (Infrastructure for Spatial Information in Europe), pp. __ // Modern achievements of geodetic science and production. Collection of scientific works of the Western Geodetic Society of the UTGK, Issue II (46). - Lviv: Publishing House of Lviv Polytechnic, 2023. (In Press).]

6. Gonzalez-Perez C. Information Modelling for Archaeology and Anthropology. Software Engineering Principles for Cultural Heritage.- Springer.- 434 (449) p.

7. Definition of the CIDOC Conceptual Reference Model, Version 6.2.3, May 2018. Le Boeuf Patrick, Doerr Martin, Ore Christian Emil, Stead Stephen, Current Main Editors. ICOM/CIDOC CRM Special Interest Group.- 287 (331) p.
8. DSTU ISO 21127:2018 Informatsiia ta dokumentatsiia. Bazova ontolohiia dlia obminu informatsiieiu pro kulturnu spadshchynu. [ISO 21127:2018 Information and documentation. A basic ontology for cultural heritage information exchange.]
9. van Gigch J.P. System design modeling and metamodeling.- Springer.- 453p.
10. Mesarovich M.D., Macko D., Takahara Y. Theory of Hierarchical, Multilevel, Systems.- Academic Press, 1970.- 294 (306) p.
11. Chabaniuk V., Dyshlyk O. Natsionalna Infrastruktura Prostorovykh Danykh (NIPD) Ukrainy: Yakymy ye yii aktualna, zdiisnenna i odnochasno "pravylna" modeli?- Zemleustrii, kadastr i monitorynh zemel, № 3, 104-123. [Viktor Chabaniuk, Oleksandr Dyshlyk. National Spatial Data Infrastructure (NSDI) of Ukraine: What are its current, feasible and at the same time "correct" models? - Land management, cadastre and land monitoring, No. 3, 104-123].
12. Doerr M. The CIDOC CRM – an Ontological Approach to Semantic Interoperability of Metadata.- AI Magazine, 24 (3), pp. 75–92.
13. Polyvach K., Chabaniuk V., Dyshlyk O., Pioro V. Vykorystannia kartohrafichnykh produktiv pry stvorenni natsionalnykh reiestriv kulturnoi spadshchyny, S. 89-100 // Suchasni dosiahnennia heodezychnoi nauky ta vyrobnytstva: Zbirnyk naukovykh prats Zakhidnoho heodezychnoho tovarystva UTHK.– Lviv: Vydavnytstvo Lvivskoi politekhniky, 2022. – Vypusk 1 (43). [Polyvach K., Chabaniuk V., Dyshlyk O., Pioro V. The use of cartographic products in the creation of national registers of cultural heritage, pp. 89-100 // Modern achievements of geodetic science and production: Collection of scientific works of the Western Geodetic Society of UTGK.– Lviv: Lviv Polytechnic Publishing House, 2022. – Issue 1 (43).]
14. Munjeri D. Tangible and Intangible Heritage: from difference to convergence.- Museum International, 2004, volume 56, issue 1-2, pp. 12-20.

15. Waterton E., Smith L. There is No Such Thing as Heritage. In: Waterton E., Smith L. (eds) Taking Archaeology out of Heritage.- Cambridge Scholars Press, pp. 10–27.

16. Smith L. Uses of Heritage.-Routledge, 354 (369) p.

17. Mylopoulos J., Borgida A., Jarke M., Koubarakis M. Telos: Representing Knowledge About Information Systems.- ACM Transactions On Information Systems, Vol. 8, No. 4, October 1990, pp. 325-362.

18. Antoniou G., Groth P., van Harmelen F., Hoekstra R. A Semantic Web Primer.- The MIT Press, 2012.- 270 (287) p.

19. Allemang D., Gandon F., Hendler J. A. Semantic Web for the Working Ontologist: Effective Modeling for Linked Data, RDFS, and OWL.- Association for Computing Machinery, 3rd Ed.- 494 (512) p.

Чабанюк В., Дишлик О., Піоро В.

CIDOC CRM як основа Електронного Державного реєстру нерухомої культурної спадщини України

Анотація. *Стаття є заключною із серії статей про Концептуальні положення створення нового електронного Державного реєстру нерухомої культурної спадщини (КС) України. Ці положення відповідають компонентам Каркасу рішень (КаРі) спеціальних Просторових інформаційних систем (ПрІС). Спеціальна ПрІС нового реєстру КС України повинна належати до класу Атласних геоінфомаційних систем (АГІС). Перша черга АГІС – АГІС-КС1 – запропонована як перша черга нового електронного Державного реєстру нерухомої КС України. Перша черга повинна включати, як мінімум, три компоненти, які одночасно є пакетами КаРі: Продукти-Процеси-Основи. Концептуальні положення АГІС-КС1 описують ці три найважливіші компоненти архітектурного патерна АГІС-КС1: АГІС-КС1.Продукти, Частина 1; АГІС-КС1.Процеси, Частина 2; АГІС-КС1.Основи, Частина 3; що складається з двох підчастин, 3.1 і 3.2.*

Підчастина 3.1 присвячена темі «Основи. INSPIRE». У даній статті описана підчастина 3.2, яка називається «Основи. CIDOC CRM». Вона складається з двох основних розділів. У першому з них спочатку розглядаються передумови, які призводять до використання CIDOC CRM. Такими передумовами є дві еволюції: системна і предметна. Системна еволюція стверджує, що прийшов час розглядати реєстр КС України як ПрІС Формації Веб 3.0, відомої також як Семантичний веб, особливо якщо мати на увазі створення нового реєстру.

Предметна еволюція відноситься до еволюції розуміння домена культурної спадщини. З сучасного розуміння цього питання витікає, що сучасні реєстри КС повинні бути скоріше «процесними», ніж «продуктовими».

Для того, щоб перейти до розгляду CIDOC CRM з кращим розумінням суті питання, розглянуто модель CHARM (Cultural Heritage Abstract Reference Model) - абстрактну еталонну модель культурної спадщини. CIDOC CRM можливо також вважати такою, однак CHARM описано у монографічній літературі, яка є практично застосовною, на відміну від розрізнених статей про CIDOC CRM.

У другому з двох основних розділів статті розглянуто CIDOC CRM і питання його використання. Ми не описуємо CIDOC CRM повністю. Увага приділяється тільки його «просторовій» і «процесній» частинам. Крім того, увага приділяється використанню CIDOC CRM. Для цього спочатку використовується інформація з сайту (https://www.cidoc-crm.org/how-i-can-use-cidoc-crm, 2023-jun-26). Потім наводиться початкова інформація про програмну платформу Arches. Платформу Arches ми пропонуємо для реалізації АГІС-КС1.

Ключові слова: *Каркас рішень (КаРі), Атласна геоінформаційна система (АГІС), Основи КаРі АГІС, реєстр КС як перша черга АГІС.*