

**MAIN CONCEPTUAL PROVISIONS OF THE CREATION OF AN
ELECTRONIC STATE REGISTER OF IMMOVABLE CULTURAL
HERITAGE OF UKRAINE. PART 1**

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Annotation. *To organize the creation of a new Electronic State Register of Immovable Cultural Heritage (CH) of Ukraine, it is proposed to use a methodology based on the so-called Solutions Framework (SoFr) of "something" = X, where X denotes both the specified system and set of such systems. The usage of SoFr to X "entirely" is called the Main Conceptual provision 0. The epigraph "The hardest thing is to see what is right in front of you.- Goethe» [1; Preface] is true for the X SoFr construction.*

X in the X SoFr record takes the meaning of a hierarchically structured Atlas Geoinformation System (AGIS), consisting of four strata (bottom-up $\hat{\uparrow}$): Operational (ω), Application (α), Conceptual (β) and General (γ). X SoFr in the article takes three meanings: AGIS1 SoFr (defines the activity of creating the first AGIS queue - AGIS1 = X system), AGIS1 α SoFr (defines the activity "between" Application and Operational strata AGIS1 subsystems top-down \downarrow), AGIS1 β SoFr (defines the activity "between" the Conceptual and Application AGIS1 subsystems strata top-down \downarrow).

X SoFr is defined by the packages and the relations between them, of the so-called Publication-Products-Processes-Basics-Services "petrad". Packages Products-Processes-Basics and the relations between them are called the main triad of SoFr. This triad is the basis of the Main Conceptual provisions 1-3. They are formulated as follows: SoFr.Products - provision 1, SoFr.Processes - provision 2, SoFr.Basics - provision 3.

Part 1 describes the introduction to the problem and provisions 0 and 1. Provisions 2 and 3 are described in Part 2. The methodology, based on the Solutions Frameworks, implements a specific systematic approach to creating a new Electronic State Register of Immovable Cultural Heritage of Ukraine.

Key words: *Solutions Framework (SoFr), Atlas GeoInformation System (AGIS), Electronic State Register of Immovable Cultural Heritage, Conceptual provisions*

Introduction

The article considers the fundamentally important issues of the initial stages of creating a new "Electronic State Register of Immovable Cultural Heritage (CH) of Ukraine", which are called the Main Conceptual provisions. The structure and content of this and similar articles should be different from the same components of "ordinary" scientific articles. In writing the latter, the so-called scientific approach is used, which from a systemic point of view is called "improvement". According to him, the author must first formulate the problem of improving the solution of a previously solved problem. Then you need to review the literature, which would prove to the reader that the formulated problem of improvement and its solutions are relevant. Then you need to describe a method to solve the problem of improvement. Finally, you need to present the main results of the article and provide conclusions based on the previously described material of the article. However, it is still not a question of solving the original problem, but of improving the existing solution.

The scientific approach does not allow us to focus on the most important issues at the beginning of the creation of new information systems, because then there is still nothing to "improve". Only after determining the architecture of the future system does it make sense to "improve" certain parts of the architecture. The systems approach is also called the "design" method of systems. The difference between scientific and systems approaches can be found in more detail in [2].

Research subject of the article is dualistic. On the one hand, it is the activity of creating the new "Electronic State Register of Immovable CH of Ukraine" as an automated system (AS). Earlier, when considering such constructions (eg, the National Spatial Data Infrastructure - NSDI), we indicated [3] that we are interested only in systematic activities or systems of activities. On the other hand, the application domain coincides with the final AS domain. The dualism of two systems - process (activity system) and product (final AS) - is absolutely necessary. This statement stems from the definition of dualism, which we simply formulate as follows: 1) without a process it is impossible to create a product, 2) without a product the process does not make sense. The dualism of these systems corresponds to the applied specific system design method, which is called "pattern-based".

The work done in 2021 by the Ministry of Culture and Information Policy (MCIP, formerly the Ministry of Culture) of Ukraine allows us to consider improving the created electronic "Declarative" register of immovable CH of Ukraine to the Electronic State Register of Immovable CH. However, it should be noted at once that the purpose of creating an electronic Declarative register of immovable CH was primarily to digitize the available information on immovable CH, so it should not be understood as consistent with the purpose of creating a register. The Electronic Declarative register of immovable CH may be an approximation of the Electronic State Register of Immovable CH, but the latter does not necessarily have to be a development of the created electronic Declarative register of immovable CH.

The term "Conceptual provisions of the Electronic State Register of Immovable CH" is not understood as strictly as the term "conception of the Electronic State Register of Immovable CH". The latter is understood in accordance with GOST 34.601, RD 50-34.698-90 of the "Complex of standards and guidelines for automated systems (AS)" (designation - GOST 34.*) as the Conception of the specified AS. In computer science, there is an opinion about the predominance of the so-called "document- conception" before the AS Conception and even before the AS Terms of Reference, if we keep in mind the documents of the initial stages of AS development. Thus, the authors [4] in Chapter 17 "Document-Conception" (The Vision Document) mention the following phrase of Philippe Kruchten, one of the parents of the Rational Unified Process: "If I were permitted to develop only one document, model, or other artifact in support of a software project, a short, well-crafted Vision document would be my choice."

The term "document-conception" is used in translation [4], but in the original the term "vision" is used. Conceptual provisions formulated in the article are closer in meaning to the document-conception than to the AS Concept. We can say that we consciously formulate them in such a way as to satisfy two epigraphs: 1) If we start with the wrong one, there is little hope for the right ending. - Kung Fu Meditation [1; *To Chapter 1 "Introduction"*], 2) Only with a full understanding of the problems it is possible to find appropriate ways to solve them. For results, it is more important to

ask the right questions than to answer the wrong ones correctly.- Christian Norberg-Schultz [1; *To section 2 "Solving system problems" of Chapter 1*].

The article does not consider all Conceptual provisions, but only those that seem to the authors the most important at the time of writing. They are: the so-called Solutions Framework (SoFr) of activities for the creation of the Electronic State Register of Immovable CH (X SoFr) and the main triad of Products-Processes-Basics packages of this X SoFr. That is why the described provisions are called Main.

X SoFr and the general description of its main triad are called (Main) Conceptual provision 0. It is a pattern, which means that it is both a thing (product) and a rule (process), because the pattern is characterized by dualism "product-process": "A pattern is, in short, both a thing that happens in the world and a rule that indicates how to create this thing and when to create it. This is both a process and a thing; it is both a description of the real thing and a description of the process that will give rise to this thing" [5]. Thus, X SoFr describes both the X (product) thing to be created and the process of using X SoFr to create it.

Conceptual provisions 1 and 2 refer to X Products and Processes of the X SoFr triad. X Product must be a Class of Atlas Geoinformation Systems (AGIS) class [6]. Such a system at any given time must consist (integrate) with the subsystems of the three "practical" strata: Operational, Application, Conceptual. From the viewpoint of Relational cartography [7] at any fixed moment on the Operational Stratum of this system there should be an Electronic Atlas (EA), on the Application Stratum - Atlas Information System (AtIS), on the Conceptual Stratum - GeoInformation System in the narrow sense (GISn). Moreover, the subsystems of each stratum must correspond to each other and this "correspondence" is formalized enough to reduce the ambiguity of this relation.

For the domain of the immovable CH, we now need to consider the components of two more strata, which we call Operational External and Conceptual External Strata, and they correspond to the Web Formation 1.0x1.0. We can also call them the Web Formation Operational Stratum 1.0x1.0 or the Web Formation Conceptual Stratum 1.0x1.0. From the viewpoint of Relational Cartography, these strata are additions to the Web 1.0 Formation described in the previous paragraph.

The AGIS-CH1 process is one of three possible methodologies for creating such systems. Each of them is based on patterns and is normative. They are called: 1) bottom-up (Atlas Extension - AtEx), 2) top-down (Geo-Information Extension - GIE) 3) combined.

The SoFr tool is a specialized portal, which at the beginning of the project is a pattern with the initial values of the patterns, together representing the initial value of AGIS-CH1. Development most often is made by step-by-step, where at each current stage a subsequent version of the system is developed.

A brief overview of the problem

Actuality

In 2021, due to the efforts of MCIP of Ukraine, the Module for Declaration (MD) of immovable Cultural Heritage (CH) of Ukraine (hereinafter MD-CH) was introduced into industrial operation. Its main purpose was the digitization of information about the immovable entities of the Ukrainian CH, existing physically or are included in one of the State registers, which are maintained currently by MCIP units. The process of this digitization had two main characteristics: 1) the result of usage the process to each entity was its digital model, called the declaration object of CH, 2) the declation was made for the attributes of the declaration object specified with the help of MD-CH, but by the specialist (employee associated with the MCIP) from the oblast of Ukraine, who introduced them and who was responsible for the value of the attributes.

MD-CH was developed and used in 2019 in a pilot project of the Ministry of Culture of Ukraine [8] on the example of Vinnytsia oblast. In 2020, in the most flexible way, without license restrictions, with open source codes, MD-CH was delivered to the MCIP. In 2021, from October to December, the attributes of information objects, which are the best at the moment declarative models of most entities of the immovable CH of Ukraine, were declared with use MD-CH. This is evidenced by the map "Monitoring the state of filling the electronic register of immovable cultural heritage" created specifically to track the progress of the declaration. From the map, which was dynamically updated during the declaration

process in accordance with the current state of the database, we see that as of 2021-dec-19 at 15:00 declared attributes of 108605 objects (Ошибка! Источник ссылки не найден.**a**), and as of 2021-dec-24 at 15:00 – 114677 of the planned 118207 objects (Ошибка! Источник ссылки не найден.**b**).

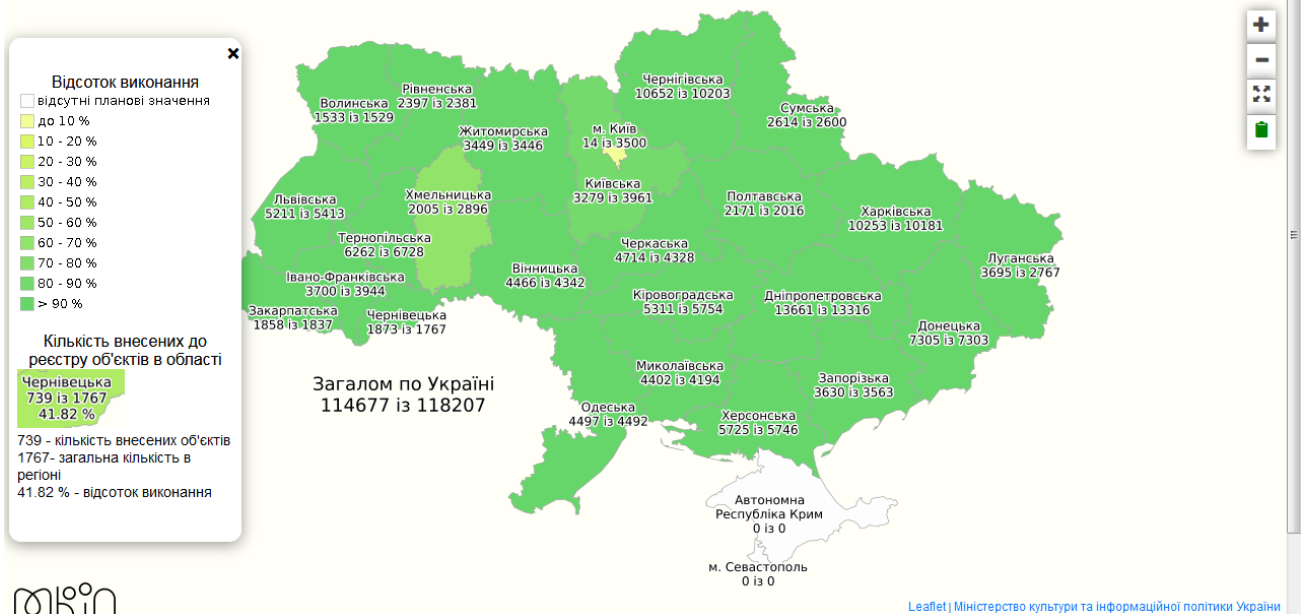
In the above-mentioned pilot project for the territory of Vinnytsia oblast, in addition to 1) MD-CH, two more important results were obtained: 2) Mock-up of process (sub)system of registration of immovable monuments of CH, 3) Conceptual provisions of “Electronic system of accounting, protection and evolution of immovable monuments of CH of Ukraine” (hereinafter "Conceptual provisions 2019"), although the plan was to develop not only Conceptual provisions, but also a Terms of Reference for the future system.



a) 2021-dec-19, 15:00

МОНІТОРИНГ СТАНУ НАПОВНЕННЯ ЕЛЕКТРОННОГО РЕЄСТРУ НЕРУХОМИХ ОБ'ЄКТІВ КУЛЬТУРНОЇ СПАДЩИНИ

Для актуалізації даних - оновіть поточну сторінку



b) 2021-dec-24, 15:00

Fig. 1 - Filling status monitoring map... for December 19 and 24, 2021

The electronic declaring of information on almost all known immovable monuments of CH of the whole country, determined in advance by the developers of MD-CH, is, without a doubt, an outstanding result in the history of independent Ukraine. However, the achieved result raised the main question: what's next? It seems MCIP must select one of two alternatives: 1) to evolve MD-CH to the Electronic State Register of Immovable CH without changing its "classic" purpose, 2) to create a fundamentally new system - Electronic State Register of Immovable CH with extension of its: 2.1) research subject, 2.2) "classic" purpose, 2.3) set of users. There may be other alternatives or options. However, they are not significant enough to be taken seriously. Some of them may be the result of the rejection of some of the Conceptual provisions identified here. For example, choosing between open source or proprietary software to implement the registry if the latter is chosen may lead to a third alternative. This third alternative is possible, although we consider it incorrect in terms of implementing the second alternative described in this work.

Evolution of the concept of the State Register of Immovable CH

We draw the reader's attention to the fact that the term "register" has many meanings. So on the page [9] the following values are given: **register** (from new lat. *regestrum*, lat. *regestum*, through Polish *rejestr* - list, enumeration):

- form of systematization, accounting; list, enumeration, inventory, system.
- a book for registering deeds, documents, property, etc. In accounting, a register of cards for analytical accounting is compiled.
- Windows registry - a hierarchical database of parameters and settings in most operating systems of the Microsoft Windows family.
- an information resource that includes documents on paper and electronic media, deeds and a system of entries in the prescribed form in the books of records produced by the registrar.

If we apply the concept of register to "land plots", their "state" register is called "land cadastre", which is defined in the LAW OF UKRAINE On State Land Cadastre as: "State Land Cadastre – unique state geographic information system of land located within the state border of Ukraine, their purpose, restrictions on their use, as well as data on quantitative and qualitative characteristics of land, their evaluation, the distribution of land between owners and users» [10].

It is easy to see that the land plots on which the entities of the immovable CH are located fall under the scope of this Law. This is true through the use of the Classification of land use types, which are defined in the document: STATE COMMITTEE OF UKRAINE ON LAND RESOURCES. ORDER 23.07.2010 № 548 {with changes 2012-2017} [11]. In the cited Order there is a "Section G. Lands of historical and cultural purpose", which corresponds to section "08 Lands of historical and cultural purpose (lands on which are located: cultural heritage monuments, their complexes (ensembles), historical and cultural reserves, historical-cultural protected territories, protected archaeological territories, open-air museums, memorial museums-estates):

08.01 To ensure the protection of cultural heritage objects

08.02 For accommodation and maintenance of museum institutions

08.03 For other historical and cultural purposes

08.04 For the purposes of subsections 08.01-08.03 and for preservation and use of lands of the nature reserve fund".

Overview of the sources of the Main Conceptual provisions

This section provides sources that have significantly influenced the Main Conceptual provisions. At the same time, we tried to mention sources that have not been published in the public scientific literature. Only as a last resort are published sources. This section was written in 2019, that's why we call them Conceptual provisions 2019. In 2022, only minor edits were made.

The system being created may be called Electronic System of accounting (registration), protection and evolution of immovable monuments of CH of Ukraine. It belongs to the class of AGIS systems and should be created by turn. AGIS-CH1 (Atlas Geographic Information System of CH, Queue 1) or (new) Electronic State register of Immovable CH is used to indicate the 1st queue. An explanation of why the designation AGIS-CH1 was used as an alternative to the notion Electronic State Register of Immovable CH is given above. Practice has shown that the CH register can be one of the possible accounting options (see, for example, **Fig. 1**, where the map name is invented by MCIP) and in this case be called an arbitrary CH register or arbitrary (permanent, preliminary, declarative, etc.) CH account. If the CH register complies with the Law of Ukraine, it will be called the CH State register. This State Register of Immovable CH may be a subsystem of AGIS-CH1 or coincide with it. AGIS-CH1, in turn, should become a subsystem of a more general system - AGIS of Cultural Heritage (AGIS-CH), the purpose of which will be the management of sustainable development of Ukraine.

Conceptual provisions of this and other articles of this group are based on the results:

1. RK 0117U006630. Scientific research work. Ministry of Culture of Ukraine. Ukrainian Center for Cultural Studies (UCCS). "Standardization of metadata and data exchange in the context of creating an electronic information resource of cultural heritage sites and cultural values".
2. RK 0118U100548. Scientific research work. Ministry of Culture of Ukraine. Ukrainian Center for Cultural Studies (UCCS). "Methods of topographic

determination of the territory of the monument depending on its type with reference to geospatial data”.

3. Ukrainian Cultural Foundation (UCF). Competition of individual projects in 2018 "Cultural heritage in the atlas geoinformation model of sustainable development. Concept and electronic model layout ". Monographs [6], [7] and the layout of the “Map Workshop” [12].
4. Ministry of Culture of Ukraine. Institute of Geography National Academy of Sciences (NAS) of Ukraine. Project "Public part of the State register of immovable Monuments of Ukraine".
5. Ministry of Culture of Ukraine. Pilot project for the introduction of electronic accounting of cultural heritage sites [8].
6. NAS of Ukraine. Institute of Geography. Scientific theme: "Development of the atlas 'Population of Ukraine and its natural and cultural heritage'", 2016-2020.
7. NAS of Ukraine. Institute of Geography. Scientific theme: "Geoinformation system of threats and challenges to the balanced development of the regions of Ukraine", 2020-2021.

The concept of AGIM-CH/AGIS-CH in 2018 was financially supported by the Ukrainian Cultural Foundation (UCF). However, in 2019, the UCF did not support the development of the unit for the transformation of AGIS-CH1 into a complete management system for sustainable development of AGIS-CH. Therefore, the register of CH (AGIS-CH1) is (can become) only the first stage of ACIS-CH - AGIS-CH1, and is not complete AGIS-CH.

The most important prerequisites for the State register of CH or AGIS-CH1 are the following:

1. It is a national level system whose constructions must correspond to similar constructions of the European Union (EU).
2. It is a spatial system of the AGIS-CH class [6].
3. Its context (domain) is determined by the immovable cultural heritage of Ukraine.
4. There is a conflict between the methodologies for designing and implementing the CH register. This conflict is understood as follows. The design should use a systems approach, according to which the AGIM-CH metasystem is first determined and

only then the AGIS-CH system. However, the upper, metasystem echelon of AGIS-CS is currently uncertain. At the same time, there is an urgent need to create an electronic record of cultural entities, which in paper form number about 130 thousand. Until September, 2021, consciously was digitized about 10 thousand. Therefore, the initial implementation plan of AGIS-CH is as follows:

- Phase 1 of Queue 1 ("digitization" of the existing accounting of the entities of the immovable CH). Done at the end of 2021,
- Phase 2 of Queue 1 (implementation of feedback - module "Provision of administrative services"),
- Queue 2 (transformation of the CH register into AGIS-CH).

Prerequisites 1 and 2 allow applying to the target system the theory and practice of Relational Cartography (RelCa), which is described in the monograph [7]. Prerequisite 3 is considered in detail from the viewpoint of RelCa in the monograph [6]. There, the theory and practice of RelCa were used to create the concept of the Atlas Geoinformation Model and System (AGIM and AGIS) and their application to CH. Therefore, the abbreviations AGIM-CH and AGIS-CH are used further without further explanation.

The main conceptual provisions were partially presented during the VIII All-Ukrainian scientific and practical conference (with international participation) "Regional problems of Ukraine: Geographical analysis and search for solutions" [23].

Later, the following conceptual provisions for the creation of AGIS-CH and AGIM-CH were improved and look as follows:

1. "AGIS-CH consists of two management systems:
 - 1.1. Protection of the essence of the immovable CH of Ukraine. This protection is carried out through the implementation of two complex activities: 1) electronic accounting (registration) of entities of the CH, as well as restrictions on their use, 2) provision of administrative services and actions for correct and incorrect use of registered entities in the electronic accounting system. This system is "embedded" in the next system.
 - 1.2. Management of sustainable development of Ukraine with the use of cultural indicators, which are a priority over other indicators of sustainable

development. This system includes a system of protection of the entities of the immovable CH of Ukraine and has an additional system of planning and control of sustainable development, which for each period of time (year, 3 years, 5 years, 10 years (until 2030 - according to Agenda2030) provides: 1) planning the necessary indicators of culture, 2) implementation of planned actions, 3) control of the achieved results, 4) adjustment and planning for the next period.

Without this block, AGIS-CH is transformed into AGIS-CH1”.

2. “AGIS-CH is a model of relational space, which is formed by combining the entities of an immovable CH into a spatial system. As a model of the relational space, AGIS-CH satisfies the three main types of bilateral RelCa relations:

2.1. Epistemological/reductive relations. These relationships exist in AGIS-CH between hierarchical layers: Operational, Application, Conceptual and General. Each of the strata can consist of sub-strata.

2.2. Transformational/verification relations. These relations exist in AGIS-CH between levels (or contexts): Datalogical (Technological), Infological (Language), Organizational (Usage). These levels (contexts) form a (geo)information system at each strata. As a rule, these (geo)information systems are in transformation/verification relations with the corresponding spatial systems of reality or, otherwise, with the corresponding relational spaces. At each strata, there are also relations of (geo)information systems with the corresponding general systems. In this case, the relations are called abstraction/concrete relations.

2.3. Evolutionary/de-evolutionary relations. These relationships exist in AGIS-CH between the formations: Web 1.0 (Static), Web 1.0x1.0 (Dynamic), Web 2.0 (Read-Write), Web 3.0 (Semantic)”.

3. “AGIS-CH automates the activities of four user groups, organized in hierarchical echelons and united by virtual organization. From the viewpoint of this virtual organization, AGIS-CH is a tiered system. Echelons are in accordance with the epistemological strata and are called: Operational, Application, Infrastructure, General. Each group can consist of subgroups. Examples of (sub)groups from each echelon (depending on the formation):

- 3.1. The Operational Echelon user group is often called end users. These can be both individuals and government officials. Moreover, both domestic and (in the long run) foreign.
- 3.2. The best-known example of an Application Echelon user (sub)group is the product development team used by end users. It can be an organization. For example, the Institute of Geography of the National Academy of Sciences of Ukraine, which developed the atlas "Population of Ukraine and its cultural and natural heritage".
- 3.3. An example of a (sub)group of Infrastructure Echelon users is a group that operates an electronic accounting system for CH entities. An example of an organization is the MCIP of Ukraine and its divisions”.
4. “An example of a (sub)group of the General Echelon is a group that operates a system of planning and control of sustainable development. Liaises with the Cabinet of Ministers of Ukraine, which may delegate system functions to the State Statistics Service. **This echelon in AGS-CH1 is absent.** Only models of this echelon are used”.
5. “AGIS-CH uses and is based on AGIM-CH. At any given time or period of time there is one and only one AGIS-CH. Unlike AGIS-CH, there are several AGIM-CH. The main criterion for choosing the best (most effective) AGIM-CH is typicality. If typicality is difficult to achieve for some reason, the use of atypical elements of AGIM-CH is allowed. One of the typical implementations of AGIM-CH is the system of the class of spatial data infrastructures (SDI). Such AGIM-CH should be integrated with the NSDI of Ukraine. As the NSDI of Ukraine does not currently meet the needs of AGIS-CH, 5 static and 4 dynamic principles of "cultural" SDI (CSDI) need to be applied to develop a standard AGIM-CH:
 - C1. Design, not improve.
 - C2. Classification (federal system), not generalization (unitary system).
 - C3. ‘Three-context’ harmonization.
 - C4. Open solutions.
 - C5. At least one custom application.

D1. Conceptual frameworks as constructors of elements of the Infrastructure echelon/Conceptual stratum.

D2. Application frameworks as constructors of user applications.

D3. The right start - Orientation on the border of CoFr BM. BM here is limited to the context of the CH.

D4. CoFr CSDI as a constructor of Spatially Enabled Society (SES) in Ukraine”.

Conceptual provision 0. X SoFr method: Mandatory usage of SoFr method to system X, being created

The most important Conceptual provision is formulated as follows: **"The usage of the appropriate (conformed) SoFr is mandatory for the success of the creation of a new Electronic State Register of Immovable CH"**. All other Conceptual provisions are derived from it, so in this section we consider in detail the "appropriate" SoFr. Since it is too early to determine "why" this SoFr is "appropriate", we use the notation X SoFr, where X="something to create". One of the values of X may be the new Electronic State Register of Immovable CH, although X may have other values, such as certain parts of the system.

To define the term SoFr formally we are reminding the few definitions from computer science. A *pattern* is a common solution to a common problem in a given context. A *mechanism* is a design pattern that applies to a society of classes. A *framework* is an architectural pattern that provides an extensible template for applications within a domain [13].

Unfortunately, we did not find a notation to represent SoFr that would be commonly understood, so we used the Universal Modeling Language (UML) notation. This notation may be incomprehensible to readers without special knowledge of computer science, so we will try to provide a such description of these figures, which should be clear to all readers.

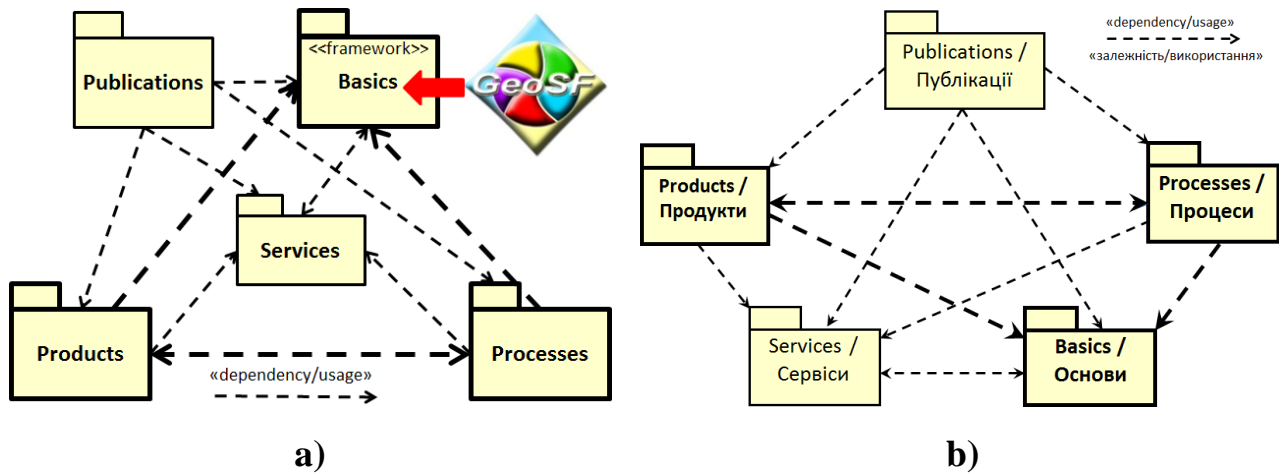


Fig. 2 - "Petrad" of any SoFr

A *package* is a general-purpose mechanism for organizing the model itself into a hierarchy; it has no meaning to the execution. Graphically, a package is rendered as a tabbed folder. The name of the package goes in the folder (if its contents are not shown) or in the tab (if the contents of the folder are shown) [13].

Perhaps the best presentation of SoFr can be obtained from the pentagram depiction of the "petrad" (**Fig. 2b**), which implies that any SoFr consists of five packages: Publications-Products-Processes-Basics-Services, and the relations between them. The above "pentagram" of the SoFr "petrad" was obtained by abduction from the practice of coordination of FGI projects and subprojects and the practice of development of some FGI subprojects. At the turn of the millennium, the implementation of SoFr shown in **Fig. 2b** was called the ProSF (Projects Solutions Framework), where projects meant FGI projects and subprojects.

Products and related Processes are the most important components of any project. Services and Basics are supporting packages, although supporting was significantly different for each of the two packages. Publications package arose from the need to present the project outside it, to the so-called "external environment" or "stakeholders". It turned out that there are no elements of this package in "Soviet design" practice. According to this practice, the main result of the IS creation project should be the content of the Products package. However, any project has an "external environment"/"stakeholders" that significantly influences the project and at the same time cannot deeply understand the contents of Products and/or Processes packages, as

it is external to the project. In "Western" practice, it is customary to advertise the results of the project, even if they are not significant.

Simultaneously with the coordination of FGI projects and sub-projects, we realized that the X SoFr model is applicable to a wider research subject - for example, to the subject domain of Ukrainian geo-enterprises activities that want/can/must use the National Spatial Data Infrastructure (NSDI). At the turn of the millennium, the "main triad" of "petrad" was identified in the SoFr model, which is shown as on **Fig. 2a**. We placed Services package inside the figure to make it more obvious that Service elements are auxiliary and they support the elements of all other packages (dotted arrows in their direction). We have placed Publications and Basics at the top on the same tier to show they have a significantly different meaning comparing to Products and Processes.

Publications are models of Products and Processes obtained using the relations of representation μ [14], which is their "different" meaning mentioned in the previous paragraph. In **Fig. 2** they are shown by the dotted arrows of the dependency/usage relation, which we use in all cases of insufficient certainty of the relation. To better understand the contents of these three packages and the relations between them, you first need to understand the differences in the activities of their users. Publications package is used by marketers, and Products and Processes packages are used by project developers and managers. Marketers use a variety of ways to create models of Products and, sometimes, Processes, for further use in marketing. However, the models they create do not always correspond to the contents of the Products and Processes packages. However, we will not delve into this issue now. Let's just say Publications package is needed, although it is not the main, but the auxiliary.

Basics package is the most important in ensuring the "frameworkness" of SoFr. It contains patterns of elements of all packages and so-called "global information resources" (for example, dictionaries for the whole project). We must say that it belongs to the tier, which in this case is the meta-stratum of the "epistemological" stratum, where Products and Processes are placed. In the FGI, the meta-products were elements that could be taken and used to obtain lower stratum products. For example, it was possible to take a unified example database (DB) and use it to create a database

of a specific sub-project. Please note that the direction of the dependency/usage relation Products and Processes, on the one hand, and the Basics, on the other hand, has changed. In fact, the dependency/usage relation between the elements of these packages can be clarified by two specific enough relations [14]: χ , ε . χ denotes the relation: ConformsTo (conformal (corresponding) model χ metamodel), ε denotes the relation: ElementOf (element ε set). The need to use μ relation: RepresentationOf (model μ sus) in both χ , ε relations is quite obvious. Unlike the auxiliary supporting Services package, Basic package is the main supporting due to its essence, which is also expressed in the existence of χ , ε , and μ relations, which detail the dependence/usage relation.

Fig. 2a shows that at the turn of the millennium it was proposed to use the GeoSF SoFr (GeoSolutions Framework; or rather, sGeoSF - the standard version of GeoSF), which was to be a major component of Basics package. If we use the well-known phases of the creation of computer system X, we obtain **Fig. 3**. It shows that when creating a system X as an element of the operational package ω Products, you need to have two main triads of SoFr: Conceptual (β) and Application (α). The main triad β SoFr consists of α Products- α Processes- α Basics(β Products, β Processes). It is shown in more detail in **Fig. 4**. The main triad α SoFr consists of ω Products- ω Processes- ω Basics(α Products, α Processes). For her also valid **Fig. 4** with replacement of letters β by α , and α - by ω and with replacement of values of elements of packages.

Between the Products and Processes, on the one hand, and the Basics, on the other hand, the relations \llangle instance \rrangle / \llangle instantiate \rrangle are shown, which are clarifications of the relations \llangle dependency \rrangle / \llangle usage \rrangle and are translated into Ukrainian as "екземпляр" and "екземпляризація". \llangle instance \rrangle is sometimes written as \llangle instanceOf \rrangle . Therefore, it seems that at least the "instance" (\llangle instanceOf \rrangle) is the above-mentioned relation ε : ElementOf (element ε set). In general, this is true, but it does not follow that this can not be a relation χ : ConformsTo (conformal (corresponding) model χ metamodel). We also do not see why at some stage of the transformation between the elements of the two strata do not use the relation μ : RepresentationOf (model μ sus).

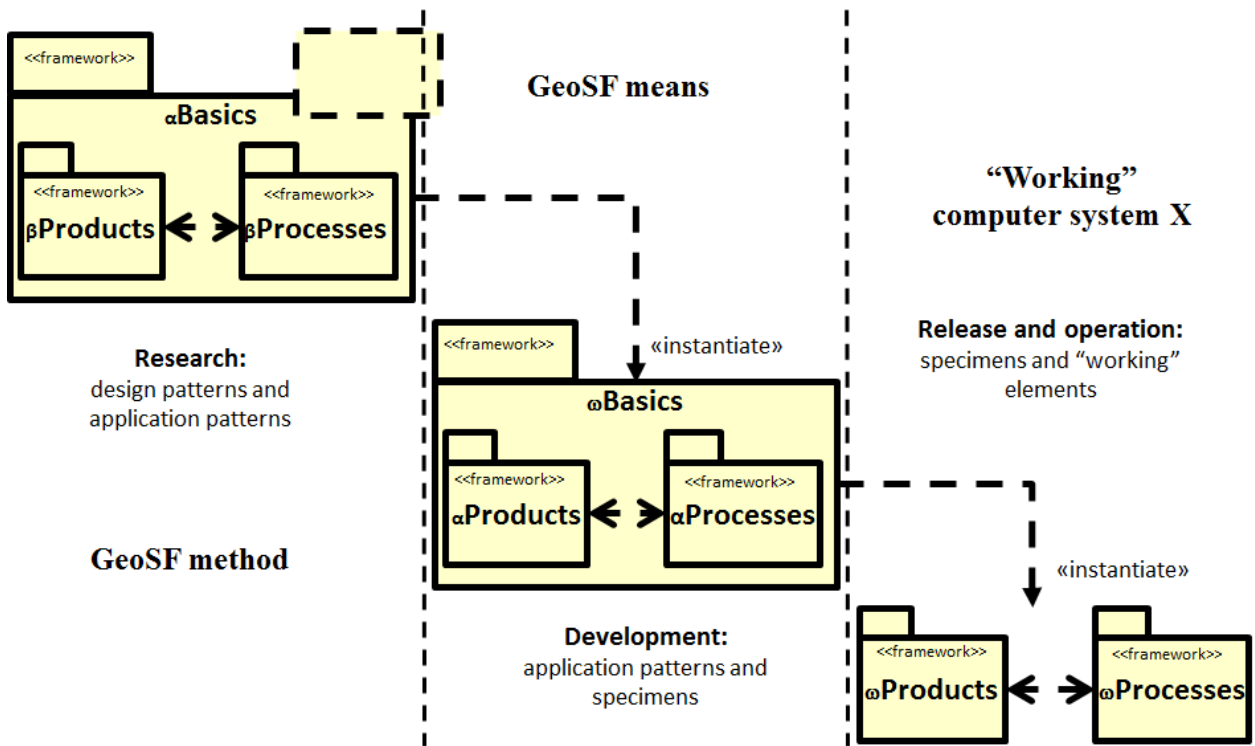


Fig. 3 - Usage of the GeoSF SoFr method to create a computer system X

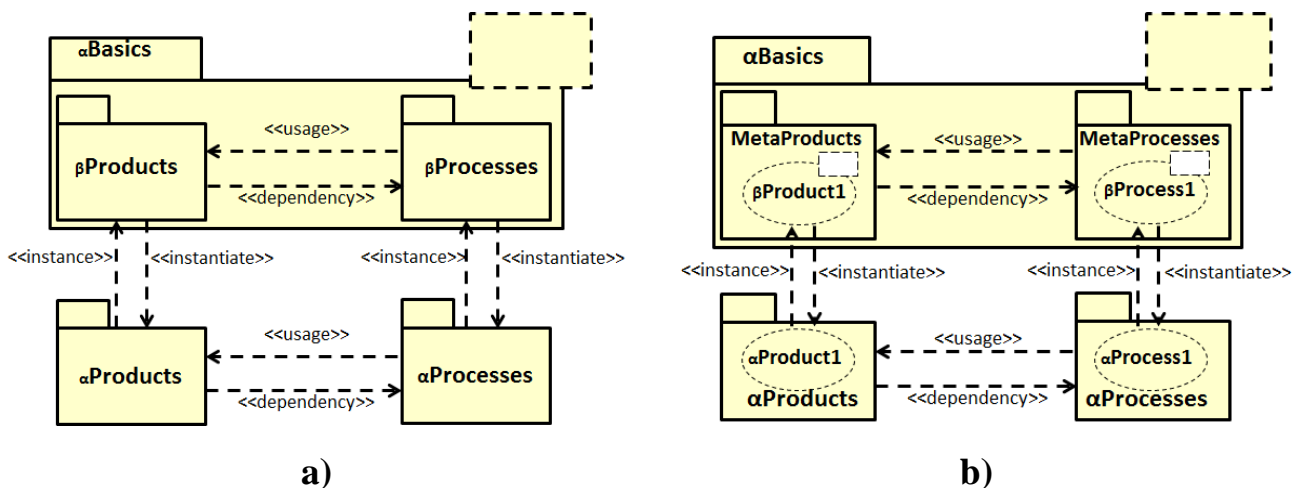


Fig. 4 - Main "triad" Products-Processes-Basics of β SoFr

In Fig. 4b elements of Products and Processes packages are shown as cooperations (collaborations, mechanisms) of classes, and elements of Basics package are shown as parameterized cooperation (mechanism). Collaboration is the combination of roles and other elements that work together to ensure a common behavior that is more than the sum of all the same components. Cooperation defines how an element such as a use case or operation is implemented using a set of classifiers and associations that play certain roles and are used in a certain way [15]. A *collaboration* (cooperation) is a society of classes, interfaces, and other elements that work together to provide some

cooperative behavior that's bigger than the sum of all its parts. A collaboration is also the specification of how an element, such as a classifier (including a class, interface, component, node, or use case) or an operation, is realized by a set of classifiers and associations playing specific roles used in a specific way. Graphically, a collaboration is rendered as an ellipse with dashed lines [13]. *Ошибка! Источник ссылки не найден.* *Ошибка! Источник ссылки не найден.* can be shown as in *Ошибка! Источник ссылки не найден.*

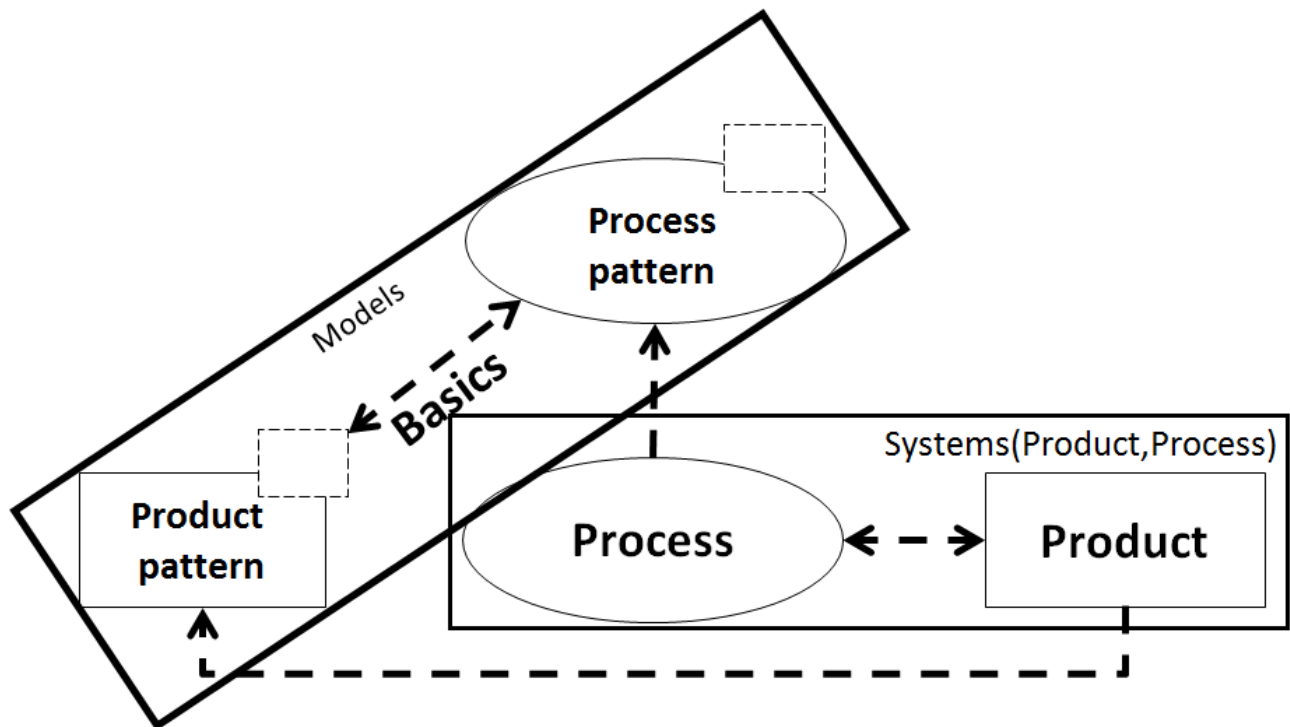


Fig. 5 - Scheme of any SoFr usage

Fig. 6 shows the principles of the relevant SoFr usage in the projects of creation: a) Atlas X, b) AGIS.

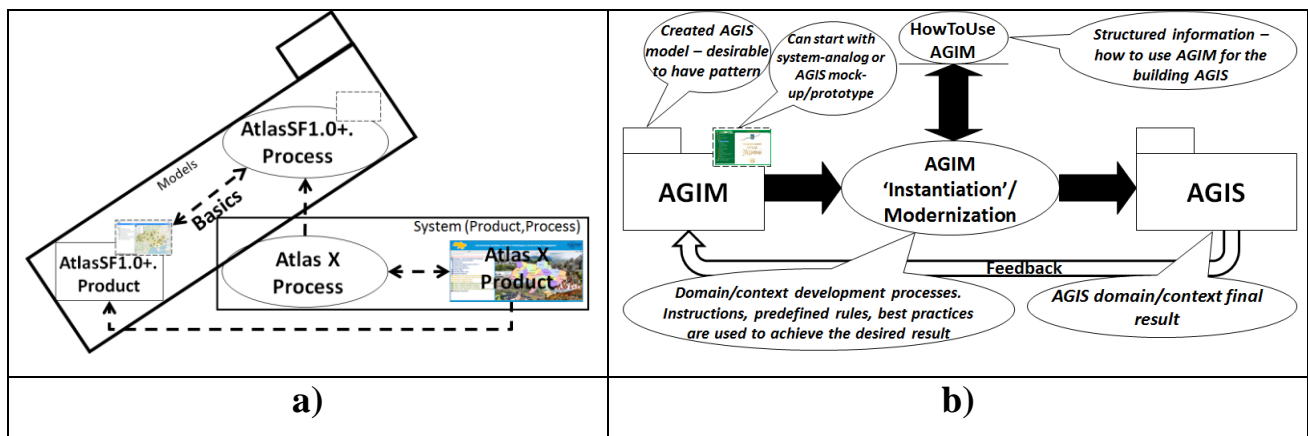


Fig. 6 - Usage of SoFr in projects of creation: a) Atlas X, b) AGIS

The following section and Part 2 of the article describe options for solutions for each of the three components of the main triad of X SoFr: Products-Processes-Basics

(Products, Processes). Given the final result of the SoFr usage - AGIS-CH, there are two queues of its creation: AGIS-CH1, as a result of the 1st queue, and full AGIS-CH, as a result of the 2nd and (if necessary) subsequent queues.

Conceptual provision 1. Products of X SoFr: First queue of final system X must be AGIS-CH1 as element of permissible AGIS set

In this section we explain why the new electronic State Register of Immovable CH (referred by the letter X), should be element of the set of permissible Atlas geoinformation systems (AGIS). The concept of AGIS was introduced in the monograph [6]. There it is used to the research subject of real models and systems of sustainable development (SD). Real “ideal” SD model was determined by the goals, directions and indicators of SD in Agenda2030. Thanks to many justifications, including ours [16], real “true” SD model of Ukraine has been modified by adding the 18th goal, targets and indicators of culture. It was proposed to model the real true SD model (and subsequent appropriate system) of Ukraine with the help of the so-called Atlas GeoInformation System (AGIS). AGIS is a hierarchical system of several systems strata subsystems, aligned with the organizational echelons of users. The main component of the lowest, Operational External stratum was the electronic version of the National atlas of Ukraine (EINAU). The main component of the next, Operational stratum, was the static Atlas information system (AtIS). The main component of the next, Application Stratum, was to be dynamic AtIS (AtIS²). The main component of the highest, Conceptual stratum, was to be the Geoinformation system in the narrow sense (GISn) or even the Geoinformation platform (GIP). AGIS was transformed into a purposeful system with the help of quantitative models of SD indicators of culture, which were proposed as variables of goal selection (criteria for achieving SD). Quantitative models of other Agenda2030 SD indicators were to become variables in the provision of SD targets (according to [1]).

In general, SoFr works great if you limit yourself to one project that creates one product. If you need to deal with several projects or products, SoFr should be performed for a (virtual) company that deals with these several projects/products. It is thanks to the activities of such a (virtual) enterprise that it is possible to create an Electronic State Register of Immovable CH. Regardless of any idea of the final

system, the most likely way to create it is the activities of several companies to create individual components of the system, provided that someone ensures the coordination of individual activities and the integration of their results.

Such activities have already arisen in our practice. The most recent and still relevant activities are the creation of EA and AtIS in the first two decades of the 21st century by a virtual enterprise consisting of "Intelligence Systems Geo" company and Institute of Geography. In 2014, on the example of the Electronic version of the National atlas of Ukraine (EINAU), we proved [17] that some editions of SoFr, specialized for our atlas creation activities - processes of the AtlasSF atlas solutions framework (example of the above α SoFr) - may change with local (non-global) changes in information technology, but there is a fixed and more general framework, which is the same for all EA in a particular context. This framework equally describes the generated EA, if we understand them not in the narrow (n), but in the broader (b) sense [18]. Not only for EA, but also for any fixed class of spatial information systems, this framework is called Conceptual and in case of its usage to a specific class of spatial System Under Study (SUS; SUS is an electronic atlas), the designation SUSb CoFr just used (sometimes SUS CoFr).

Such a generalized EINAUb SoFr for the context of NAU (National atlas of Ukraine) is called the EINAUb Conceptual Framework (CoFr). It is true for many SpIS classes, which is strictly proven for EA and Atlas information Systems (AtIS) classes. EINAUb CoFr consists of several interrelated SoFr for "different-strata" products in the context of NAU. It turned out that the implementation of atlas requires conceptual SoFr, which is at least sGeoSF (GeoSolutions Framework [19], standard edition) as well as application AtlasSF1.0 SoFr, which must comply with sGeoSF. It will be recalled that in the first decade of the 21st century, sGeoSF was proposed to be used to implement the NSDI (National Spatial Data Infrastructure) product model for geo-enterprises. However, this EINAU CoFr is only valid for the EINAU generation, which was created using information technology (IT), changed only locally and not globally. Global changes in IT have forced us to introduce the concept of spatial SoFr and CoFr Formations. Formations in some way conform to such generations of Internet evolution as Web 1.0, Web 2.0, Web 3.0, etc.

Fig. 7 is the first explanation of the AGIS-CH structure, which is given below (Fig. 8). It is here that we want to draw attention to the presence of two systems of the Operational stratum, the "extensions" of which can be AGIS-CH: the National Atlas or the National Cadastre. We also refer to the use of the term and concept of the Information System in the broader sense (ISb). It turned out that SoFr can be applied to EINAUb or to arbitrary CISb.

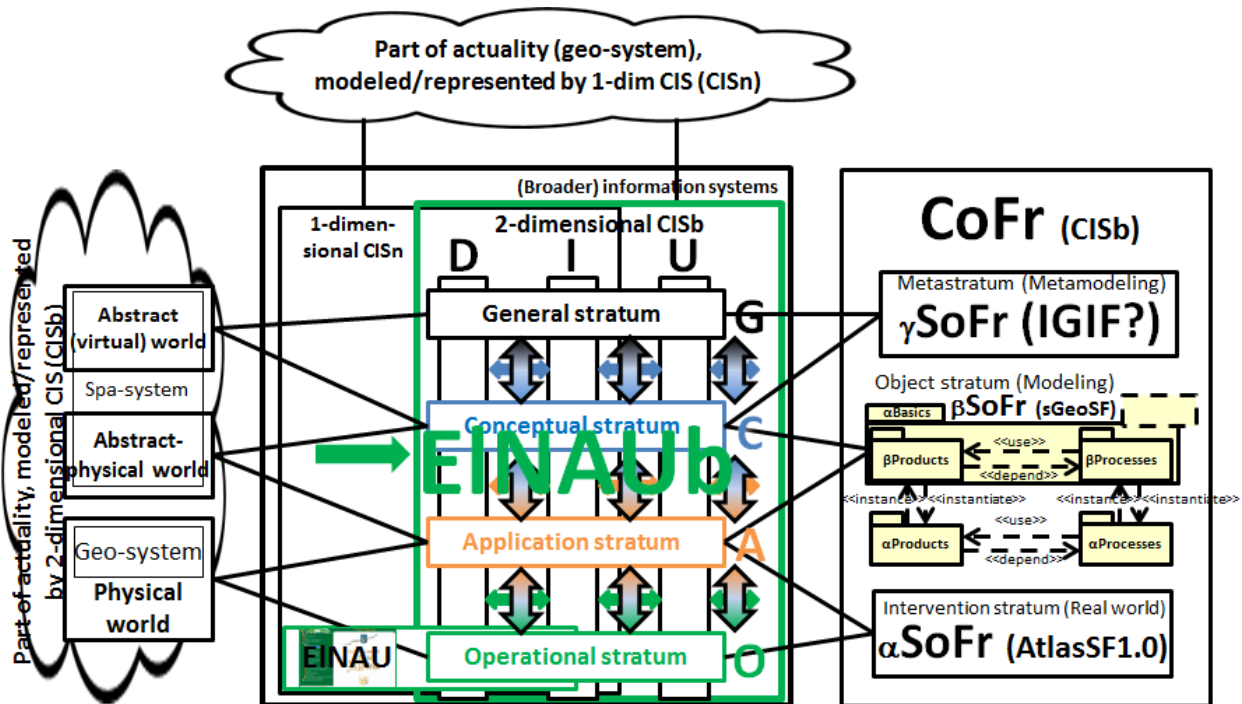


Fig. 7 - SUS (EINAU, EINAUb) CoFr method as a result of the usage of "per-stratum" SoFr

If you get acquainted with the activities of the MCIP on the entities of CH, it becomes clear and obvious the statement that the new Electronic State Register of Immovable CH should be more than a register (cadastre) of land plots of "historical and cultural purposes". In computer science, an object is defined by three characteristics: identifier, attributes, and methods. If you do not touch on the issue of identification of CH objects, the latter are often determined by attributes. Attributes are divided into spatial and semantic. We argue that the values of the semantic attributes of CH objects are determinative in the context of CH, but the spatial attributes are auxiliary. This division allows us to state that the State Land Cadastre allows determining only the spatial attributes of the CH objects and they are not decisive in the CH context.

It is not necessary to look for evidence of this statement in the above definition of the State Land Cadastre. It does not contain anything at all about the spatial characteristics of the entities or objects of the CH. Therefore, we do not understand the phrase “unique state geoinformation system of information about lands located within the state border of Ukraine”. What is this about? What is a geoinformation system? Why is there no further mention in the definition of the spatial characteristics (information) of objects?

From the viewpoint of spatial attributes, the new Electronic State Register of Immovable CH should become a component of the NSDI (NGDI), provided that the model of the latter corresponds to the INSPIRE model. Despite the fact that the INSPIRE model is evolving from product to process, neither its implementation of NSDI, let alone NGDI, created under the 2020 Law of Ukraine on NGDI, will not meet the needs of a more general system in terms of semantic attributes. NSDI should be a subsystem of AGIS, and in the development of any NSDI according to [6] should apply 5 static and 4 dynamic principles, which are valid for the "cultural" SDI (CSDI). Next we will help a slightly updated **Fig. 8**, which was created in 2019 [20].

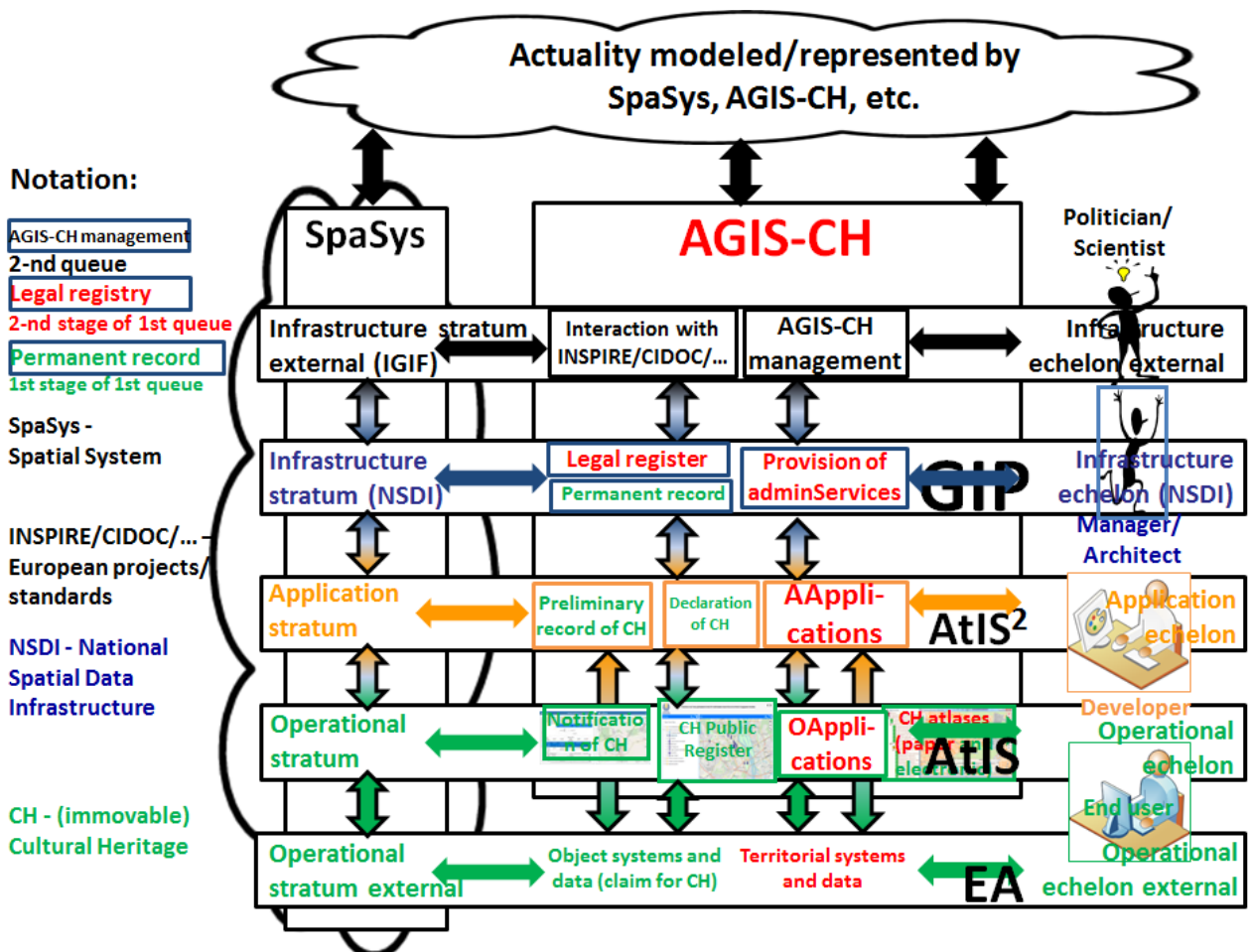


Fig. 8 - Conceptual structure of the new Electronic State Register of Immovable CH (AGIS-CH)

In **Fig. 8** there are several updates comparing with [20]. It is:

1. New "Declaration of CH" block is shown. Declaration was made in 2021 (see the results of the declaration in **Fig. 1**). This electronic result roughly corresponds to the paper "Preliminary record of CH", although the data from "Permanent record" and others were probably used in the actual process. Here, the records, declaration, notification and claim of the CH belong to the arbitrary register of the CH. By the way, AtIS² means "dynamic" Atlas information system, the beginning of which can be considered "Monitoring the state of filling the electronic register ..." **Fig. 1**. AtIS² is shown on the Application stratum/echelon, and "static" AtIS is shown on the Operational stratum/echelon.

2. Atlas information systems are an important addition. **Fig. 8** shows only the static AtIS, which currently takes the value of Atlases of the CH (paper (queue 1) and electronic (queue 2)). They are the starting block of the third column, after the OApplication block. "CH atlases (paper)" here mean atlases or parts thereof created outside the AGIS-CH. An example of such an atlas is "The population of Ukraine and its cultural and natural heritage", which was completed at the Institute of Geography of NASU in 2020 [21]. AGIS-CH is integrated with AGIS-LT (Large Territories, [16]) through the AtIS column.

3. Separation of strata and echelons. Strata show "tiers" of the computer system, and echelons - "tiers" of the (virtual) organizational system. The latter applies to users of the system and does not belong to the computer system. Therefore, the echelons are shown outside the AGIS-CH. In previous works, strata or echelons were most often used separately.

4. "AGIS-CH management" block has been specified. This is done through the separation of strata and echelons and the display on the "Conceptual external stratum" clarification (IGIF). IGIF [22] stands for Integrated Geospatial Information Framework. In the last few years, the UN has been promoting the IGIF concept as a replacement for the NSDI concept and trying to focus it on sustainable development in line with Agenda 2030. In some sense, instead of "Interaction with INSPIRE/CIDOC /..." it is possible to consider IGIF.

Additional information on the Electronic State Register of Immovable CH/AGIS-CH is:

1. The registration process corresponds to the left part of **Fig. 8**, bottom-up: claim → notification → preliminary record (declaration) → permanent record → legal register. This process consists of synchronized processes of refining the spatial and semantic characteristics of the immovable CH objects.

2. CH monuments protection of corresponds to the right part of **Fig. 8**, top-down: provision of administrative services (adminServices) → application applications (AApplications) → operational applications (OApplications).

3. Management of all types of activities related to the CH in order to ensure sustainable development of Ukraine. This type of activity is shown in "AGIS-CH management" block in **Fig. 8**. The display of strata and the appearance of IGIF clarification for the "Conceptual External stratum" are also a novelty.

If we return to X SoFr, we now have an X clarification using AGIS-CH1. In **Fig. 8** are four strata: from the "Conceptual stratum (NSDI)" to the "External operational stratum". In this case, the elements of all lower strata are determined if X SoFr: β and α are determined. Given the content of X=AGIS-CH1, we do not think it is a big problem to determine SoFr β and α . In some sense, AGIS-CH1 CoFr = AGIS-CH1 SoFr.

Conclusions to the Part 1 of Main Conceptual provisions

To organize the activities of creation the new Electronic State Register of Immovable Cultural Heritage (CH), it is proposed to use the Solutions Framework (SoFr) of this system, which belongs to the class of Atlas GeoInformation Systems (AGIS). The usφne of AGIS SoFr and components of its main triad is the optimal variant of systems approach to this activity. To implement this systems approach, it is necessary to fulfill the Main Conceptual provisions that correspond to the AGIS SoFr in whole (provision 0) and the three components of the AGIS SoFr main triad (provisions 1-3).

Part 1 of the article deals with the first queue of AGIS - AGIS1. Two of four Main Conceptual provisions considered: 1) provision 0 - AGIS1 SoFr in whole, and 2) provision 1 - AGIS1 SoFr.Products.

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ГОЛОВНІ КОНЦЕПТУАЛЬНІ ПОЛОЖЕННЯ СТВОРЕННЯ ЕЛЕКТРОННОГО ДЕРЖАВНОГО РЕЄСТРУ НЕРУХОМОЇ КУЛЬТУРНОЇ СПАДЩИНИ УКРАЇНИ. ЧАСТИНА 1

Анотація. Для організації діяльності по створенню нового сучасного електронного Державного реєстра нерухомої культурної спадщини (КС) України запропоновано застосувати методологію, що базується на так званих Каркасах Рішень (KaPi) «чогось»= X , де X позначає як вказану систему (підсистему), так і клас таких систем (підсистем). Застосування KaPi до X цілком у статті названо Головним концептуальним положенням 0, однак незважаючи на його очевидність, для конструкції KaPi X застосовний епіграф: «Найважче побачити те, що прямо перед тобою. – Гете» [1; Передмова].

X у записі *КаРі X* приймає значення ієрархічно структурованої Атласної ГеоІнформаційної Системи (АГІС), що складається з чотирьох страт (знизу-вгору \uparrow): Операційної (ω), Аплікаційної (α), Концептуальної (β) і Загальної (γ). *КаРі X* у статті приймає три значення: *КаРі АГІС1* (визначає діяльність по створенню першої черги АГІС – системи $АГІС1=X$), α *КаРі АГІС1* (визначає діяльність «між» підсистемами АГІС1 Аплікаційної і Операційної страт згори-вниз \downarrow), β *КаРі АГІС1* (визначає діяльність «між» підсистемами АГІС1 Концептуальної і Аплікаційної страт згори-вниз \downarrow).

КаРі X визначається пакетами і відношеннями між ними так званої «петради» Публікації-Продукти-Процеси-Основи-Севіси. Пакети Продукти-Процеси-Основи і відношення між ними називаються головною тріадою *КаРі*. Ця тріада є основою головних концептуальних положень 1-3. Вони формулюються наступним чином: *КаРі.Продукти* – положення 1, *КаРі.Процеси* – положення 2, *КаРі.Основи* – положення 3.

У Частині 1 описується вступ у проблему і положення 0 та 1. Положення 2 та 3 описуються у Частині 2. Методологія, що базується на Каркасах Рішень, реалізує конкретний системний підхід до створення нового електронного Державного реєстра нерухомої КС України.

Ключові слова: Каркас Рішень (*КаРі*), Атласна ГеоІнформаційна Система (АГІС), Державний реєстр нерухомої культурної спадщини